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ABSTRACTS VOLUME

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PREFACE

The volume you have in your hands is the Book of Abstracts of the XIX Congress of the Carpathian-Balkan Geological Association, known as CBGA 2010 (Thessaloniki, Greece, 23-26 September 2010). Being one of the largest in the long-lasting series of CBGA Congresses, CBGA 2010 offered the authors the choice of a dual submission mode: either full papers (published after peer reviewing) or abstracts. This allowed for greater flexibility from part of the authors as they more easily adjust their presentation and publication needs.

The contents of the Book of Abstracts include both the stand-alone abstracts and the abstracts of the submitted full papers. They are ordered alphabetically based on the first author's surname. The Editors have edited the text of certain abstracts, either for clarity, or to comply with the requirements set by the Organizing Committee. In any case though, the meaning has not been changed and the final outcome is the respective authors' responsibility.

In total, 540 abstracts are published in this volume, including 3 of invited speakers that gave a plenary talk to all delegates. Of those, 130 correspond to full papers and 410 to stand-alone abstracts. Authors come from tens of countries, including the 14 CBGA countries, Eastern and Western Europe, Turkey, but also from countries far away from the geographical core of CBGA, such as Japan, U.S.A., Canada, New Zealand, Australia, etc. The total number of contributing authors has exceeded 1,400 researchers.

The presentations in CBGA 2010 cover nearly the whole spectrum of Earth and Environmental Sciences including Geophysics and Meteorology/Climatology as well as some related disciplines.

We all know that Earth operates as a constantly changing complex, dynamic system which, however, has not yet been fully understood. The Earth system comprises a lot of interdependent components that interact in complex ways. Planet Earth is changing in all spatial and temporal scales. Our Planet has been investigated in many respects and a huge amount of knowledge, both basic and applied, has been accumulated. However, much more has to be done. The understanding of our Planet system and its reaction to natural and anthropogenic changes must be of predominance concern. Water shortage, environment protection, mineral resources, climate changes, natural hazards, and the Earth's origin and evolution are some of the priorities. The XIX CBGA Congress hopes to contribute with its works towards this direction.

The Organizing Committee CBGA 2010 is grateful to the editing team of *Geologica Balcanica* (Sofia, Bulgaria), one of the official journals of CBGA, as well as the Geological Institute of the Bulgarian Academy of Sciences for the publication of this volume and would like to thank all participants and sponsors that made the XIX Congress of the Carpathian-Balkan Geological Association such an exciting meeting.

The President of the Organizing Committee would like to express his gratitude and his sincere thanks to all members of the Organizing Committee and the team of post-graduate and graduate students of the School of Geology of the Aristotle University of Thessaloniki, for the excellent organization of the Congress which was the result of a hard, systematic and conscientious work.

On behalf of the Organizing Committee
Prof. Georgios Christofides
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Abstracts of invited talks

Exploration for Platinum-group elements (PGE) in the Carpathian-Balkan system

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The platinum-group elements (Os, Ir, Ru, Rh, Pd and Pt), which are the most valuable elements, are of strategic importance due to their growing use in advanced technologies and automobile catalyst converters. They have been described in a wide range of geotectonic settings, but the majority of the world supply of PGE is produced from magmatic ores derived from basaltic magmas. In most cases the PGE are associated with primary magmatic sulfides with interstitial textures to the silicate host. Major Pt and Pd economic mineralization is hosted in well-defined stratiform reefs of large layered intrusions, as is exemplified by the Bushveld Complex (South Africa), the Great Dyke (Zimbabwe) and the Stillwater Complex (USA). Zoned mafic-ultramafic igneous complexes of the Ural-Alaskan type are targets of Exploration and sources of significant economic platinum placer deposits as well.

The type of mafic-ultramafic complexes dominated in the Balkan-Carpathian system, is ophiolites associated with orogenic zones. Although chromite is major collector of the platinum-group elements (PGE), their content in large chromite deposits is generally low (few hundreds of ppb). However, PGE-enrichment: (a) in all PGE, (b) only in Os, Ir and Ru or (c) in Pt and/or Pd, are a common feature of disseminated chromite and/or relatively small chromite occurrences, of both high-Cr and high-Al type, in the uppermost parts of the mantle and/or in the lowest crust sequence. Examples of PGE-enrichment include the ophiolites of Pindos, Skyros Island and Veria (Greece), Bulqiza and Tropoja (Albania), Dobromirski (Bulgaria) (Economou-Eliopoulos, 1996; Ohnenstetter et al., 1999). The platinum group minerals (PGM) may be precipitated directly from silicate melt (S-poor), immiscible sulfide liquids, and the magmatic volatile phases. PGM can be classified into two subgroups: the more Os-, Ir- and Ru-rich or IPGE (Ir-group) and Pt, Pd-rich or PPGE (Pt-group) assemblages. The more Pt- and Pd-rich assemblages (Pd-Pt, Pd-Pt-alloys, Pt-arsenides, most likely sperrylite) occur interstitial to chromite grains. On the basis of field and experimental data small grains of PGM (average 25 μm) of the IPGE-group, commonly laurite, as inclusion in unaltered chromite have been interpreted as an early magmatic phase formed by direct crystallization of a basaltic magma. The presence of members of the irarsite-hollingworthite solid-solution series and other Os-, Ir, Ru- and Rh-bearing PGM in PGE-enriched altered chromitites from some ophiolite complexes may indicate either in situ alteration or/and re-mobilization and re-deposition of PGE. A salient feature of the latter case is the presence of extremely large (over 1.3 mm) PGM grains and extremely abundant PGM small grains/fragment (over 100) dispersed along a highly fragment chromitite zone, in a distance over 3 mm. They occur within small chromite occurrences located along a shear zone of strongly brecciated chromite ore of Veria having high PGE (up to 25 ppm) content (Tsoupas and Economou-Eliopoulos, 2008). Such fluid-driven multistage platinum-mineralization and subsolidus reactions are considered to be widespread, but the system is considered to be a closed one with respect to PGE. The relatively high IPGE-enrichment in chromitites seems to be related to post magmatic processes covering a long period of deformation episodes, starting from the asthenospheric mantle flow (plastic deformation). Thus, most targeting locations in the Balkan-Carpathian system are (a) for the chromitite-IPGM associations exclusively small chromite occurrences along shearing zones of ophiolite complexes, post-dating their initial/magmatic PGE deposition, and (b) for the PPGE the uppermost parts of the mantle and the lowest crust sequence.

Platinum and Pd contents in sea-floor massive sulfides are very limited. However, elevated contents, reaching values up to 1 wt % Pt in marcasite and chalcopyrite from massive sulfides on the East Pacific Rise, 1000 ppb Pd in sulfide deposits on the mid-Atlantic, and 1000 ppb Pt in disseminated pyrite and chalcopyrite from brecciated pipeform diabase, underlying the massive ore of the Pindos ophiolite complex (Greece) may indicate that Pt and Pd are quite soluble under a range of hydrothermal conditions (Economou-Eliopoulos, 2005

and references there in). Traditionally PGE are associated with mafic-ultramafic complexes. Although porphyry deposits are major sources of Cu, Au or Mo, recently, in addition to gold the research interest has been focused on the Pd and Pt distribution in porphyry deposits because certain porphyry Cu-Au deposits have shown elevated Pd and Pt contents, reaching values over 5 ppm in high-grade bornite-chalcopyrite and/or flotation concentrates from Au-rich (average ≥ 0.4 ppm Au) porphyry deposits in British Columbia and Colorado (Eliopoulos and Economou-Eliopoulos, 1991; Economou-Eliopoulos, 2005). Late Cretaceous to Miocene porphyry Cu deposits, extending from Romania, through Serbia and Bulgaria to Greece are the most important porphyry intrusions related to continental collision and post-collision magmatism.

The Pd-telluride, merenskyite, has been described as the main PGE mineral in porphyry Cu–Au–Pd–Pt deposits, such as Skouries, Elatsite, Medet and Bor/Madjanpek. Merenskyite occurs mostly as inclusions and at margins of chalcopyrite and bornite or forms intergrowths with Pd–Pt–Bi- and Ag-tellurides. The potential for PGE mineralization associated with such large Cu and Au-Cu porphyry deposits is still unknown. However, the average (Pd+Pt) values (over 5 ppm) are considered to be encouraging for Pd and Pt as by-products, with Au as a by- or co-product, and porphyry deposits a good target for Pd & Pt exploration. Porphyry Cu-Au-Pd±Pt deposits of the Carpathian-Balkan system show some similarity in terms of their associations with alkaline rocks, in particular those characterized by (a) $\text{SiO}_2 < 65$ wt%, (b) a major contribution by crust material, as is exemplified by the $^{87}\text{Sr}/^{86}\text{Sr}$ and $^{207}\text{Pb}/^{204}\text{Pb}$ values, (c) their association with alkaline or K-rich calc-alkaline systems, characterized by relatively high of REE, Th and halogen (F, Cl) contents (d) the close association of the Cu-minerals with the main Pd-bearing mineral, merenskyite, and Au–Ag tellurides, (e) the association of the elevated Pd, Pt, and Au contents with magnetite-bornite-chalcopyrite assemblages, and the pervasive potassic alteration type at the central parts of the deposits, and (f) the transportation of Cu and precious metals, as chloride complexes, by relatively hot (400-700°C) and saline to hypersaline (>70 wt% NaCl equiv) hydrothermal fluids. Thus, critical factors controlling base/precious metal potential of porphyry Cu+Au+Pd±Pt deposits are considered to be the composition of parent magmas (contribution of mantle, oceanic and continental crust) and the physico-chemical conditions during the formation of porphyry Cu deposits. The oxidized nature of parent magmas, as is exemplified by the abundance of magnetite, may be related to the ability of producing hydrothermal system with ideal chemistry for transporting precious metal and represent good exploration target for the precious metals, whilst “reduced” porphyry Cu-Au deposits, lacking primary hematite, magnetite, and sulphate minerals (anhydrite), contain abundant pyrrhotite, and are relatively Cu-poor, but Au-rich deposits.

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Miocene-Recent magmatism and geodynamic processes in the Carpathian-Pannonian region - relations with Balkan and Aegean areas

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This presentation will review and interpret recent data on magmatic processes in the Carpathian – Pannonian Region (CPR) during Early Miocene to Recent times, and will compare them with contemporaneous magmatism in the Balkan Peninsula and the Aegean, all of which belong to the Eastern Mediterranean realm. This geodynamic system was controlled by the collision of part of Africa (Adria or Apulia) with Europe that generated the Alps to the north, the Dinaride-Hellenide belt to the west, and caused the extrusion and inversion tectonics in the CPR. The present-day tectonic configuration is a result of the Cretaceous to Neogene Africa–Eurasia convergence and collision that formed a complex lithosphere supplied with numerous subduction components. The CPR contains Neogene to Quaternary magmatic rocks of highly diverse compositions that were generated in response to complex post-collisional tectonic processes. These processes formed back-arc extensional basins in response to an interplay of compression and extension (e.g. subduction with roll-back, collision, slab break-off, delamination, strike-slip tectonics, core complex type extension, and block rotations) of two microplates: Alcapa and Tisia (Tisza)-Dacia. Competition between the different tectonic processes (syn- and diachronous) on both local and regional scale caused variations in the associated magmatism that were mainly a result of extensional processes, the rheological properties, and the specific lithosphere composition of the two microplates. No volcanic activity directly related to pre-collisional subduction is recorded in the CPR area. Meanwhile in the Balkans a regional extensional tectonic setting developed in Oligocene-Miocene times and progressed to the present-day in the Aegean where it was dominantly associated with calc-alkaline, ultrapotassic and Na-alkaline magmatism and formation of small sedimentary basins.

Major oxide, trace element, and isotopic data of lavas and mantle xenoliths from the CPR suggest that subduction components were preserved in the lithospheric mantle after the Cretaceous-Miocene subduction and were reactivated by asthenosphere uprise via various processes (subduction roll-back, rotation-induced extension, slab detachment, slab-break-off or slab-tearing). Changes in the composition of the mantle through time support various geodynamic scenarios that are linked to the evolution of the main blocks and their boundary relations: Alcapa (1), Tisia-Dacia (2) and Balkans (3):

1a. In the Western Carpathians and Pannonian Basin, magmatism occurred in a back-arc setting producing felsic volcanic rocks at 21-18 Ma, followed at 18-8 Ma by felsic and intermediate calc-alkaline lavas and ended with Na-alkaline basaltic volcanism (10-0.1 Ma). Volcanism became younger towards the north. Geochemical data imply both a change in source from a crustal one, through a mixed crustal/mantle source, to a mantle source with a decrease of the subduction component in the mantle lithosphere through time. Garnet-bearing varieties occurred at 16.4-15 Ma. Extrusion tectonics, block rotation, subduction roll-back and continental collision triggered partial melting by delamination and/or asthenosphere upwelling. Generation of Na-alkaline magmatism at the western margin of Alcapa suggests a north-east-directed asthenosphere mantle flow acting as small finger plumes that caused high thermal anomalies at the base of the lithosphere and triggered magma generation along NW-SE strike-slip faults. The process was most likely controlled by mantle perturbations resulting from the counterclockwise rotation of the Adriatic microplate and tectonic inversion in the Pannonian Basin. The continuous volcanic activity in central Slovakia, firstly as calc-alkaline (16.5-11 Ma), then as transitional calc-alkaline (11-8 Ma) and finally as Na-alkaline basalts (8-0.13 Ma) supports a mantle plume scenario, with increasing asthenospheric input through time;

1b. The westernmost Pannonian sub-basins (Styrian basin and adjacent areas) contain felsic and intermediate calc-alkaline, K-alkaline and ultrapotassic volcanic rocks generated at 17.5-14 Ma. They are related to extension and extrusion tectonics and core-complex

generation at 21.9-13.4 Ma that produced strong mantle perturbations and triggered melt generation. Na-alkaline basalts occurred at 11-12 Ma and ended at 4-1.8 Ma. They show heterogeneous isotopic features that suggest an association with the Adria push and tectonic inversion, causing a north-east directed asthenospheric mantle flow;

1c. In the north-westernmost part of the Pannonian Basin, at 15-9 Ma, felsic and normal calc-alkaline volcanism erupted in the Transcarpathian basin at a triple junction between Alcapa, Tisia-Dacia and the European foreland. This is a result of extension via counter-clock rotation of Alcapa, causing core-complex exhumation. Geochemical studies indicate a heterogeneous lithospheric mantle source associated with fractionation-assimilation processes in crustal magma chambers. Melting was most likely triggered by back-arc rotational extension and asthenosphere uprise;

2a. Calc-alkaline magmatism generated at 12-8 Ma in the northern part of the Tisia-Dacia block follows the Dragoş Vodă-Bogdan Vodă transcurrent fault and is entirely intrusive, ranging from basalts to rhyolites. Each body evolved independently with specific fractionation, crustal assimilation and/or magma mixing processes, suggesting decompression melting of the local heterogeneous mantle lithosphere. Garnet-bearing varieties occurred at 9.5-10.5 Ma. Sinistral transtensional stress regimes at 12-10 Ma along the transcurrent fault system controlled the generation and emplacement of the intrusive bodies. This may be the result of oblique convergence of Tisia-Dacia with the NW-SE striking European margin, evidenced by eastward thrusting in the external Miocene thrust belt;

2b. Calc-alkaline and adakite-like magmas were erupted in the Apuseni Mountains at 15-9 Ma. Garnet-bearing rocks occurred at 13-12 Ma. Lithosphere breakup during extreme block rotations (~60 degree) at 14-12 Ma was responsible for extension with core-complex formation at the easternmost continuation of Bekes basin. This led to decompression melting of an enriched lithospheric source. Magmatic activity ended with small volume Na-alkaline basalts (2.5 Ma), shoshonitic (K-alkalic) at 1.6 Ma and ultrapotassic magmas at 1.3 Ma. This suggests a close relationship with Pliocene inversion tectonics along the South Transylvanian fault due to the Adria push, with small volume melt generation from diverse lithospheric and asthenospheric sources;

2c. Calc-alkaline magmatism occurred along the easternmost margin of Tisia-Dacia forming the Călimani-Gurghiu-North Harghita volcanic chain, with diminishing age and volume southwards at 10-3.9 Ma. This marked the end of subduction-related magmatism along the post-collision front of the European convergent plate margin. Magma generation was associated with progressive break-off of a subducted slab and asthenosphere uprise. Fractionation and crustal assimilation were typical;

2d. At ca. 3 Ma, magma compositions changed in South Harghita to adakite-like calc-alkaline and continued until recent times (< 0.03 Ma) interrupted at 1.6-1.2 Ma by simultaneous generation of Na and K alkaline varieties in nearby areas, suggestive of various sources and melting mechanism. This complex magmatism situated in front of the Moesian platform was associated with two main geodynamic events: (a) slab-pull and steepening, with opening of a tear-window in the vertical Vrancea lithospheric block hanging into the asthenospheric mantle (forming adakite-like calc-alkaline magmas) and (b) inversion tectonics along reactivated fault systems that allowed decompression melting of asthenospheric and lithospheric sources, thus generating the Na and K-alkaline magmas;

3a. Calc-alkaline volcanic rocks occur at the southern border of Tisia-Dacia with the Dinarides along the Drava-Sava depression in several successive periods between 22.8 and 7.4 Ma, with K-alkaline rocks at 17.5-15.4 and 9.8-7.4 Ma. The area acted as a strike-slip fault at the terrane boundary that was probably reactivated several times in transtensional mode, generating magmas via decompression melting of heterogeneous lithospheric mantle, also influenced by fractionation and assimilation;

3b. Miocene-Pliocene magmatism characterizes the Serbian and FYR Macedonian part of the Vardar zone. Ultrapotassic, shoshonitic and high K-calc-alkaline magmas were erupted at 23-21 Ma; at 12.9-10 shoshonitic rocks were generated and ended with K-potassic and ultrapotassic magmas at 9.1-1.5 Ma, becoming younger toward the south. Magmas were generated in a metasomatized depleted mantle related to different extensional events in the Pannonian Basin and Aegean region;

3c. In the Thrace Evros basin, Early Miocene (22-19.5 Ma) calc-alkaline and K-alkaline rocks occur, suggesting an origin from both lithospheric mantle and crust related to post-collisional extensional processes and core complex exhumation. In the Thrace basin, Na-alkaline basalts occurred at 8.9-4.5 Ma; decompression melting of an asthenospheric source may be related to a westward mantle flow generated by the block movement along the North Anatolian fault system;

3d. The South Moesian block has an N-S line of Na-alkaline basalts that started in the Oligocene and become younger toward the south at 21.4-19.4 Ma. They have an asthenospheric source that may be connected to local fractures related to Tisia-Dacia block rotation movements around stable Moesia.

Thus, the mantle dynamics and melt generation in CPR and surrounding areas are echoes of many subduction, collision, rotation and extension processes of several microplates that acted variably in the convergence between Africa (chiefly Apulia) and Europe since the Cretaceous period until Recent time.

From local geology to global plate tectonics

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There is no plate tectonics modelling without local geological investigations, and a few square meters of well-dated radiolarian cherts can completely change a tectonic model. If ample geological information can be obtained from a given outcrop, the next step consisting in interpreting these in terms of geodynamic environment will often generate contradicting points of view. That is where the larger plate tectonics modelling will bring some constraints.

Most disagreements are rooted in 2D cross sectional approaches of local information, usually considering all the presently juxtaposed geological units as potential actors of a single geodynamic history. Plate tectonics modelling certainly helps in solving the exotic nature of a given unit, and it can be shown that large scale displacement of terranes is rather the rule than the exception.

This can be tested in the Pacific region during the last 250Ma. Terranes have been crossing this large expanse of water, colliding with each other, and then being re-dispersed from tropical to polar regions. Still, these processes are constrained through properly done local investigations. Similarly the Variscan terranes have experienced long distance travelling, from their peri-Gondwana position to their amalgamation along the Eurasian margin. Their final juxtaposition resulted from further displacement during the formation of Pangea. In this instance, the final juxtaposition cannot be used readily to decipher the wander path of these terranes, and only a well constrained plate tectonics model will offer a possible solution.

It is clear from our plate model that the European Variscan terranes occupied the whole border of Gondwana, from South China to South America. The different geodynamic settings along that margin allow defining the former location of the different terranes. The intra-alpine Variscan and Mediterranean terranes were located close to South China, the Iberian terranes were close to the Libyan-Egyptian part of Gondwana, and the Armorican terranes s.l. were located further west. The so-called Rheic margin of Gondwana experienced quite different geodynamic evolutions before the detachment of the Variscan terranes. This can be used as a guideline to put in place this amazing puzzle.

The western Tethyan realm is dominated by the closing of the Paleotethys and the concomitant opening of the Neotethys in the Permo-Triassic times. This process followed the assembly of Pangea and amalgamation of Variscan terranes. However, if continent-to-continent collision took place from the Alleghanian N-American domain to the west Mediterranean area, further east (from Italy to the Middle East) the southern margin of Eurasia remained an active margin. This generated the opening of numerous back-arc basins along that margin from the Late Permian to Late Triassic. The continuing subduction of Paleotethys northward also generated slab pull forces that triggered detachment of the Cimmerian ribbon terrane from Gondwana in the Permian, as did the Variscan terranes in the Devonian.

In that respect the Variscan scenario is quite similar to the Cimmerian one, terranes detached from Gondwana collided with terranes derived from Eurasia, and finally the amalgamated terranes were squeezed between larger continental masses (Gondwana and Laurasia in the Carboniferous for the Variscan orogenic event, Africa-India and Eurasia in the Tertiary for the Cimmerian-Alpine event).

The eo-Cimmerian orogenic event, however, has quite distinct features. The collision was mainly Late Triassic in age corresponding to the final closure of the Paleotethys in Greece, Turkey, Iran, Afghanistan and further east. Jurassic Cimmerian events in the Balkan and Turkey were related to the closure of some Paleotethyan back-arc basins (Maliac, Küre) and to shortening in neighbouring areas such as the Caucasus. The final collision in these areas with larger landmasses occurred only in the middle Tertiary, so the delay between terrane accretion and final orogenic events was locally quite long (up to 200 Ma).

So, the Cimmerian collisional events must be regarded as separate from the Variscan and Alpine ones. The other main difference is that the Variscan terrane accretion was an arc-arc collisional event, resulting in important HT type metamorphism, accompanied by large magmatic pulses related to mantle delamination. For the Cimmerian event, the collision was between a ribbon type passive margin and island arc type terranes, it resulted in soft docking with little metamorphism and magmatism, and limited orogenic processes. In areas where the Cimmerian suture can be studied in details, such as central Iran, the fore-arc series (arc side, upper plate) are found resting directly on the flexural bulge of the passive margin (lower plate), both separated by a few hundred meters of highly sheared flysch-like deposits. The lower plate is hardly deformed, the upper plate presents some imbrication and shortening, and the intervening accretionary prism has nearly completely disappeared, it was totally underplated.

Both upper and lower plates had been previously thinned due to rifting (separation of the Cimmerian terrane from Gondwana on one hand, separation from the Eurasian active margin by back-arc spreading on the other hand). Thus the superposition of both thinned plates in the Triassic did not create much isostatic rebound, and in some areas where the Cimmerian terrane was not very large, sedimentation continued during most of the Triassic, both on the lower plate side, and on the newly created passive margin of the back-arc, to the north of the orogenic zone.

This makes the Cimmerian event difficult to recognize in some areas. The suture zone was not very large, and in Greece and Turkey it hardly outcrops. However, this Late Triassic period was accompanied by widespread clastic influxes in surrounding basins, the Cimmerian collage being surrounded by oceans on its southern (Neotethys) and northern (Eurasian back-arc) sides. Some of these clastic deposits contain olistostroms with blocks clearly pertaining to the disappeared Paleotethys (e.g. pelagic Carboniferous to Early Permian, totally absent outside of the Paleotethys). Some remnant flexural (molassic) basins are also known in Iran (Shemshak). In Turkey they were often interpreted as rift basins. However, a thorough study of the clasts in Late Triassic Turkish conglomerates has shown their exotic nature, and mainly their late Paleozoic pelagic characteristics, showing that they were derived from a suture zone and not rift related; they are commonly followed by a major stratigraphic gap.

In Greece, the remnants of the Cimmerian events are scarce, because of the lack of relevant outcrops. This situation is due to the fact that the final collision with a large landmass (i.e. Africa) has not yet taken place. The Cimmerian remnants are still underplated under the external Hellenides, and/or covered by large carbonate platforms. Our investigation during the last 20 years on this problem has brought to the light that most substratum of the external domain can be attributed to the Paleotethys Permian fore-arc domain, strongly affected by Triassic rifting (somehow quite similar to the present-day Aegean sea area) that led to the opening of the Maliac and Pindos back-arc basins. The latter ceased opening when the arc to the south of it collided with the Cimmerian Apulian terrane. However, the suture zone is not seen, or indirectly, because some Triassic conodonts found in the east Mediterranean basin (Neotethys) are not present in the Pindos north of it. A major barrier prevented these animals and few other species to pass from one basin to the next.

So, in conclusion, the larger geodynamic picture can be derived from the study of suture zones over a large area and from the evolution of margins on both sides of it, but in

some areas, only pebbles or microfossils will lead to the solution. It is up to the geologists to use both approaches with some wisdom.

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Abstracts

Socioeconomic influence of natural disasters in the Western Balkan countries

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The Western Balkan region is a region of south-eastern Europe that presents pronounced activities of various types of natural hazards and natural disasters. This paper analyses data sets from two international databases of the main types of natural disasters namely geophysical, hydrological, climatological and meteorological disaster events during the period 1900-2008. The following have been analysed: the number of natural disaster events, natural disaster occurrence by disaster type, the total number of fatalities, the total number of affected people and the corresponding economic damages expressed as a percentage of selected types of natural disasters. The data analysis in this paper aims to confirm the importance of data collection and analysis as a foundation for planning and preparing disaster reduction programs for the Western Balkan countries.

Statistical methods applied to aftershock sequences

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Temporal distribution of triggered seismicity following a strong earthquake has been the subject of many studies that focus on applying statistics to earthquake sequences. The earthquake occurrence can be described by stochastic processes and therefore probabilistic models are developed in order to assess the seismicity rate changes resulted after a strong event. The several statistical methods that serve this purpose are based on different assumptions. The seismicity rate changes during three earthquake sequences that took place in the territory of Greece are investigated. The first is the 1981 Corinth Gulf seismic sequence, with three strong ($M=6.7$, $M=6.5$ and $M=6.3$) events between February 24 and March 4, the second one the 2001 Skyros Island sequence, with the main shock occurring on July 26 with $M=6.3$, and the last one the 2003 Lefkada Island, with a main shock of $M=6.2$ occurring on August 14. An attempt is made for modeling the aftershocks, as they comprise a major portion of an earthquake catalog including important information about the rate changes. Firstly, a homogeneous Poisson model is tested to fit the data, with the waiting times of the point process being exponentially distributed and the rate λ of the Poisson process constant in time. The process has no memory and any particular event is regarded as unrelated to any other. Substituting a function $\lambda(t)$ for the rate λ leads to a non-homogeneous Poisson process with intensity function $\lambda(t)$. In this case the rate parameter is time dependant and the appropriate form of the function has to be chosen in order to describe the way seismicity rate evolves with time. In the present work two forms were tested, both allowing the rate decaying as time passes. The first one is an exponential function with two unknown parameters, whereas the second one is a non-homogeneous Poisson process with a Power Law intensity function $\lambda(t)$. Because of the rate's form the particular model is also known as a Weibull process. The third statistical method applied to the data is the Autoregressive model of second order (AR(2)), which is used in time series analysis to describe stationary time series, and is a linear regression of the current value of the series against two previous values of the series. In order to apply the AR model to the above earthquake sequences, a random variable $Z(t)$ was

considered to represent the number of earthquakes at any time t and the parameters of the model were estimated using the Yule–Walker equations.

Weathering of building stones of the Medieval Sasov Castle in Slovakia: Indication and impact of the mineral alteration

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The ruin of the medieval Sasov castle, a cultural heritage object in the Middle Slovakia, suffers from a strong deterioration. Besides the weathered binder, a reasonable part of the damages is caused by the intensive weathering of the building stone. The walls are built mainly of Neogene andesite, which is common in this area of the volcanic Stiavnické Vrchy Mts. The sound rock is of dark grey colour, but most of the building stones have yellowish-brown coatings of iron oxyhydroxides on the surface and in the fissures. Highly macro-porous stones are most affected by the alteration. Weathering of the andesite was studied within the project VEGA 1/0413/09 of the Ministry of Education of the Slovak Republic.

The X-ray diffractometry (XRD) of the powdered weathered building stone showed that the mineral assemblage is dominated by the plagioclase andesine (63 wt%) and the main alteration product smectite (up to 22 wt%), the rest are amorphous phases/volcanic glass (13 wt%), augite (1 wt%), magnetite (1 wt%) and traces of mica. The building stone material was compared with the rock material from an old local quarry, which was assumed to be the source of the building material for the castle walls. The study with polarized light microscopy (PM) of thin sections revealed the glomeroporphyritic character of this rock, i.e. phenocrysts of the same type (here plagioclase) are partly grouping into distinct clusters. There are three types of plagioclase: 1. sound plagioclase with regular shape and typical crystal twinning, 2. phenocrysts exhibiting growth zoning, and 3. plagioclase disintegrated due to magmatic corrosion. The corrosion creates alteration rims around the plagioclase grains or intrudes the whole mineral. A secondary mineralisation can be seen in some fine cracks cutting the phenocrysts, as well. The alteration of mafic minerals (augite, magnetite, mica) resulted in opaque phases. The rock matrix is built of volcanic glass, fine-grained plagioclase and some not identified brown phases. These are probably products of a post-magmatic alteration, i.e. weathering and/or post-volcanic hydrothermal alteration processes, very common in Neovolcanites.

The results from XRD, PM and tests on physical properties confirmed a very good match of the building stone material with the most altered parts of the rock mass in the local quarry. Therefore, a comparison with the sound rock from the deeper parts of the quarry was used for the illustration of the alteration impact on the rock properties. The sound rock consists of andesine (≈ 62 wt%), the rest are amorphous phases (27 wt%), augite (8 wt%) and magnetite (3 wt%), no smectite is present. It means that amorphous phases are the most unstable components of the rock. With the alteration, smectite appears and its content is increasing (up to 22 wt%), while amorphous phases, augite, and magnetite are decreasing. A considerable part of the macro-pores is the result of selective leaching of weathering products. Total porosity increased from 2.4 % to 21.2 %, the effective porosity from 2.2 % to 15.0 % when compared with the sound rock. The uniaxial strength (tested by the point load test) dropped from 270 MPa (sound rock) to 51 MPa in the weathered, but still coherent macro-porous stone. However, the most altered building stones are almost white and disintegrate into sand. Cyclic volume changes due to smectite swelling and water freezing in the effective pores probably weaken the structure and enhance the deterioration. Both processes are supported by the high water uptake due to the high smectite content, reflected also in the results of the Enslin-Neff tests. Therefore, ruins should be prevented from the infiltrating

water precipitations (rain, snow) by roofing of the wall crowns. Missing or deteriorated building stones could be replaced by material taken from the deeper parts of the local andesite quarry.

Geology of the Caucasus and adjacent areas: 1:2 500 000 scale geological map

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The geological map of the Caucasus and adjacent areas of 1:2 500 000 scale, being presented on the 19th Congress of the CBGA includes on-shore and off-shore parts of the Black Sea-Caspian Sea region (Fig. 1). Small-scale thematic (geologic, tectonic, metallogenic etc) maps of the World and its large parts, such as Europe, Middle East etc., have been periodically compiled and published under umbrella of the Commission for Geological Map of the World (CGMW), for example: *carte geologique de l'Europe*, 1:10 000 000, 1970; *carte tectonique de l'Europe et des regions avoisinantes*, 1:10 000 000, 1975; *carte tectonique internationale de l'Europe et des regions avoisinantes*, 1:2 500 000, 1980; geological map of the Middle East, 1:5 000 000, 1986; 1:5 000 000 International geological map of Europe and adjacent areas, 2005, BGR Hannover; the international geological map of the Middle East, 1:5 000 000, second edition, 2009-2010. The Caucasian region, situated at the junction of the European and Asiatic segments of the Alpine-Himalayan orogenic belt and serving as a connecting link between these two branches, as a rule, is illustrated by maps of the both segments. The presented map demonstrates up-to-date level of knowledge on geological structure and evolution of the region.

Mapping the spatial distribution of precipitation, biological soiling, and decay on monuments in Northern Ireland: towards understanding long-term stone response to moisture

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The Natural Stone Database for Northern Ireland was constructed to address the paucity of information available to stone conservation practitioners. Almost 2000 listed buildings, 260 monuments and 118 quarries were surveyed over three years to produce an interactive GIS database for the Northern Ireland Environment Agency. This contains information on stone sources, together with details of stone condition and decay processes and is complimented by a website available to the general public. This paper uses elements of this GIS to link annual rainfall data for Northern Ireland with information on the biological soiling, and decay of stone monuments across the province to examine the relationship between moisture and availability on these processes. Results suggest that biological soiling is indeed strongly influenced by moisture availability (i.e. precipitation), with higher levels of biological soiling evident in the wetter North-West of Northern Ireland where annual precipitation is higher in response to a strong Atlantic signal. This compares to lower levels of biological soiling evident in the more rain-sheltered South-East of the province. Stone deterioration appears to be less influenced by climate and more closely related to the geology characteristics with higher levels of decay often observed on sandstone monuments and lower levels of decay associated with areas in which low porosity stone types such as basalt predominate. The results have clear implications for future patterns of soiling in light of projections for regional climate change that indicate increased winter wetness, but they also demonstrate the

multifactorial nature of the controls on stone decay and highlight the need for careful and thorough analysis before any generalizations are proposed.

The Early Pleistocene fish fauna of Faliraki Bay section (Rhodes Island, Dodekanese)

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The first results regarding the Early Pleistocene Teleostean marine fish fauna of the Faliraki area (Rhodes Island, Dodekanese) are presented as revealed through the study of fish otoliths. In the Faliraki Bay section outcrops the Rhodes Formation, consisting of Kritika Member, Kolymbia Member, and Lindos Bay Clay Member, both now assigned to the Early Pleistocene. Fish otoliths have been found within the Kolymbia and Lindos Bay Clay Members.

Significant is the first record of the modern species *Notoscopelus bolini* Nafpaktitis 1975 in the Kolymbia Member of Faliraki Bay section. *N. bolini* resembles the *N. elongatus* which has been recorded in various localities of the Western and Central Mediterranean, but has a greater postero-ventral width. The Faliraki specimen also shares a lot of characters with *N. resplendens* of Nolf & Cappetta from the Neogene sediments of SE France may also be attributed to *Notoscopelus bolini*. This species has been recorded in the Mediterranean Sea since the Tortonian, and today it occupies the central – eastern Atlantic Ocean and the Mediterranean Sea. It is a temperate pelagic – oceanic species, which exhibits a maximum abundance between 45-50 meters modern sea depth. Important also is the presence of the *Lampadena* aff. *urophaos atlantica* Maul 1969 in the Early Pleistocene deposits of the Kolymbia Member, which has previously only been recorded in the Middle Pleistocene bathyal deposits of Vallone Catrica section. The modern distribution of this species is restricted to the North Atlantic. It is a bathypelagic species which occupies water depths between 60 m and 1000 m.

The sediments of the Lindos Bay Clay Member of Faliraki Bay section reveal a very rich otolith association. The great majority of specimens belong to the Myctophidae family, with representatives namely *Ceratoscopelus maderensis* Lowe 1939, *Diaphus holti* Taning 1918, *Diaphus rafinesquii* (Cocco 1838), *Diaphus taaningi* Norman 1930, *Hygophum benoiti* (Cocco 1829), *Hygophum hygomi* (Lutken 1892), *Lobianchia dofleini* (Zugmayer 1911), *Electrona risso* (Cocco 1829), *Notoscopelus* sp., *Myctophum punctatum* Rafinesque 1810, *Benthoosema glaciale* (Reinhardt 1837) (very scarce and small otoliths only), *Lampanyctus crocodilus* (Risso 1810), and *Scopelopsis pliocenicus*. Present are also members of the family Gadidae, such as *Gadiculus argenteus* Guichenaut 1850, as well as Gobiidae. The Teleost fish assemblage of the Lindos Bay Clay Member is composed of an abundant and diversified pelagic group and to a lesser degree by a benthopelagic and benthic group. This type of fauna generally characterizes the continental slope environment, with the depth usually exceeding 200 meters. This is in good agreement with the estimations of 300-600 meters in the lower part of the section to 200-300 meters near the top, as provided through the study of the bryozoans associations in the Lindos Bay section.

Fluid inclusion and S isotope systematics of some carbonate-related Pb-Zn-Cu mineralizations in NW Anatolia, Turkey

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The studied Pb-Zn-Cu deposits are located between Çanakkale and Balıkesir in NW Anatolia. Two ore deposits are investigated here, in Lapseki-Çataltepe to the northwest and in Yenice-Kalkım to the southeast of Çanakkale. The host rocks in both areas are represented, from the bottom to the top, by lense- and/or band-shaped recrystallized limestones, and/or marble-intercalations bearing Permo-Triassic metamorphic rocks. Eocene granitoids and subvolcanics are found in Lapseki area, whereas Oligo-Miocene aged granitoids and Middle Miocene subvolcanic rocks are found in Yenice area. The Pb-Zn-Cu mineralizations in these areas are observed at and around the carbonates and along fractures in the metamorphic rocks. The sulfide minerals comprise mainly galenite, sphalerite, chalcopyrite, pyrite and arsenopyrite, whereas the gangue minerals in the ore zones are represented by garnet, epidote, quartz and calcite. In addition to these minerals, manganiferous hedenbergitic pyroxene and hematite have been detected in the ore zones of Kalkım area.

Fluid inclusion studies of Kalkım area (Handeresi, Bağırkaç and Fırıncıkdere mineralizations) revealed that fluids in pyroxenes have salinities of 5.4 to 8 wt.% NaCl equiv., and the homogenization temperatures (Th) range between 290 and 430°C. The salinities of sphalerites are around 11 wt.% NaCl equiv., and the Th vary from 272 to 338°C. The fluids during quartz formation stand out with the salinities of 1.4 to 2.6 wt.% NaCl equiv., and Th of this stage is 157-267°C. On the other hand, the Th of the fluids during calcite formation ranges between 68 and 75°C. The salinities of this stage could not be measured. The fluid inclusion measurements of Lapseki area (Çataltepe mineralizations), showed that the fluids in garnets have salinities of 0.7 to 1.4 wt.% NaCl equiv., and their Th range between 310 and 353°C. Sphalerites have salinities of 0.5 to 1.2 wt.% NaCl equiv., and Th of 220 to 300°C. The salinities of fluids related to the quartz formation vary between 0.5 and 1.1 wt.% NaCl equiv., and their homogenization temperatures from 200 to 310°C. Because the system was open, based on the fact that both liquid and gaseous phases could be observed at the same fluid inclusions in both areas, sphalerite homogenization temperatures could be evaluated as formation temperatures varying between 220 and 340°C.

In Kalkım area, the sulfur isotope compositions of the sulphide minerals are: $\delta^{34}\text{S}_{\text{PbS}} = -1.1$ to 1.5 ‰ with a mean around -0.2 ‰, $\delta^{34}\text{S}_{\text{ZnS}} = -0.7$ to 2.1 ‰ with a mean around 0.7 ‰, and $\delta^{34}\text{S}_{\text{CuFeS}_2} = -0.6$ to 1.5 ‰ with an average around 0.4 ‰. The sulfur isotope composition of the sulphide minerals in Lapseki area are characterized by $\delta^{34}\text{S}_{\text{PbS}} = -0.5$ to 0.0 ‰ with an average around -0.25 ‰, $\delta^{34}\text{S}_{\text{ZnS}} = 0.8$ to 1.3 ‰ with a mean around 1.03 ‰, $\delta^{34}\text{S}_{\text{CuFeS}_2} = 0.9$ to 1.5 ‰ with an average around 1.2 ‰, and $\delta^{34}\text{S}_{\text{FeS}_2} = 0.0$ to 1.0 ‰ with a mean around 0.5 ‰. The $\delta^{34}\text{S}$ values of sulfide minerals in both areas show a narrow range near 0 ‰ which can be interpreted as indicating magmatic sources and the sulfur isotopes are very similar to $\delta^{34}\text{S}$ values of skarn deposits.

The timing of volcanism and associated precious metal mineralization in the Apuseni Mountains, Romania

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The Apuseni Mountains of Romania contain a large number of precious metal deposits, many of which are epithermal in character and closely associated with calc-alkaline, Miocene volcanism. These magmatic rocks which host the mineralization have recently been subjected to several detailed geochemical and isotopic studies and our understanding of their genesis and evolution is now fairly well-developed. However, in spite of the detailed mineralogical studies which have over the years been carried out on the mineral deposits, there are still many aspects about their formation which are poorly understood. The timing of the mineralization in particular is not well defined, and so a geochronological study using K-Ar and Ar-Ar methodology and focussing mainly on the mineralization at the classic Sacaramb deposit, was initiated.

In order to check the published K-Ar ages of fresh, host magmatic rocks, two Ar-Ar ages for amphibole were obtained (from Zuckerhut, Sacaramb, and Rovina Remetea, near Brad). The ages of these rocks (Ar-Ar 11.2 and 15.2, compared to published K-Ar ages of 10.9 and 15.2 Ma respectively) appear to conform the validity of the K-Ar technique for these magmatic rocks.

There is a general lack of minerals in the mineralized veins which are suitable for age dating. However, hydrothermal alteration selvages to the mineralized veins contain K-mica (sericite) and K-feldspar and these have been analysed and used as a proxy for the metallic mineralization.

K-Ar ages of sericite from veins in the Sacaramb area are in the range 9.9-10.8 Ma, whilst the ages of host rocks in the near vicinity are in the range 10.9 and 11.2 Ma. Hydrothermal K-feldspar from Hondol gives similar ages of 10.6 Ma (K-Ar) and 9.8 Ma (Ar-Ar), compared to the K-Ar age of the host rock of 10.8Ma. A K-Ar age of sericite from Magura of 11.1 Ma is slightly younger than a K-Ar age of the host rock of 11.5 Ma. Ar-Ar analyses of sericitic mica tend to give apparent ages which are 1-3 Ma older than the K-Ar ages but it is at present unclear whether these are real or a result of the analytical method (argon recoil in fine-grained mica samples). These results also suggest that earlier attempts at dating the alteration using Rb-Sr isochrons are probably inaccurate.

The mineralization in this region occurred at a roughly similar time to that proposed by previous studies in the Baia Mare region of northern Romania. The ages of the Apuseni mineralization appear to be slightly younger than the ages of the host volcanic rocks, although this difference is usually within the analytical uncertainty of the analyses (typically <1 Ma), and there is no confirmation of perceived gap in time between mineralization and volcanism seen at Baia Mare (0.5-1.5+ Ma). Although there is quite a large span in age for the volcanism of the Apuseni Mountains as a whole (7.4-14.9 Ma) these age data indicate that the associated hydrothermal activity (and thus most likely the mineralization also) was directly linked to the immediate, host magmatic rocks, was fairly short-lived, and took place within a limited time interval after the cessation of volcanism.

Trend analysis of surface longwave and shortwave radiation over Europe

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The results of a detailed trend analysis of surface longwave and shortwave radiation over Europe are presented on a basis of data from the ISCCP project (International Satellite Climatology Cloud Project). The ISCCP FD SRF dataset includes spatially and temporally homogenized up-welling and down-welling longwave (LW = 5.0-200.0 microns) and shortwave (SW = 0.2-5.0 microns) radiation estimates coming from the synergistic use of satellite data and models. The area of interest, Europe, consists of equal area grids with a spatial resolution of equatorial 2.5x2.5 degrees (280 km²). The temporal resolution of the data is 3 hours while the dataset spans from January 1984 to December 2007. In order to study the long-term variations of the longwave and shortwave radiation, monthly mean values of the above mentioned period were considered. A statistical analysis is applied to derive trends and seasonal variability for this time period over Europe. To fit the time series, a model with a linear trend and a seasonal component for the annual cycle of radiation has been used. The seasonal component is estimated by a harmonic analysis. The significance of the longwave and shortwave radiation trend is also determined. As it is shown here, the observed trends and their significance are rather variable for different areas in Europe.

Mantle source characteristics of Late Miocene-Pleistocene alkaline basalts, western Pannonian Basin, Austria

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Late Miocene-Pleistocene alkaline mafic magmas were erupted in the Carpathian-Pannonian Region following the Eocene to Miocene subduction-related calc-alkaline volcanism. The lavas range from hy-normative basalts through alkali olivine basalts and basanites to nephelinites.

The majority of basaltic lavas are fresh, olivine-phyric and holocrystalline, whereas olivine is coupled by clinopyroxene phenocrysts in some samples. The olivine phenocrysts contain occasionally spinel inclusions. The matrix consists of plagioclase, clinopyroxene and olivine along with titanomagnetite, ilmenite, and apatite. Phlogopite, interstitial alkali feldspar, nepheline and leucite also occur in some of the lavas. In contrast, nephelinites are rich in clinopyroxene and nepheline and contain titanomagnetite in the groundmass along with subordinate amounts of olivine, apatite and leucite.

Olivines mg-numbers vary between 88-66. They are generally zoned and began to crystallize with Fo around 87 and 79. In the course of crystallization Fo decreases to 84-66 at the rims of phenocrysts being similar to Fo in the groundmass. The NiO of the olivines decreases with decreasing MgO content, while CaO and MnO increase.

Clinopyroxene compositions range from augite to diopside. They exhibit both oscillatory and sector zoning as a result of disequilibrium crystallization. The compositional difference between cores and rims follow the normal pyroxene fractionation trend; the cores are richer in Mg, Si and Cr and poorer in Fe, Mn and Ti than the rims. The majority of the clinopyroxenes have Al^{VI}/Al^{IV} (0.0-0.65) typical for low pressure clinopyroxene and support shallow level crystallization.

Most alkali basalt corresponds to the criteria for primitive rocks having high mg-number (>0.62), high MgO (>9 wt. %) and high Ni (>192 ppm) and Cr (>286 ppm). These

magmas underwent only minor olivine±clinopyroxene±spinel fractionation and apparently approach a primary melt composition.

The silica saturation index (vary from -59 to +2) and trace element ratios ($La_N/Yb_N=11-31$) generally suggest that these lavas have experienced different degrees of partial melting. The hy-normative basalts of Oberpullendorf have the highest degree of melting while Stradnerkogel nephelinites have the lowest. Those rocks that formed via a low degree of melting possess high Zr/Hf ratios (60-66), and negative K and Ti anomalies similar to those of carbonatites. All studied rock varieties have high Nb/La ratios (>1) suggesting OIB-like asthenospheric mantle source. The absence of LILE enrichments (K, Rb and Ba) indicating no interaction with fluids possibly derived from subducted slab. The steep REE patterns and the high D_{Y_N/Yb_N} ratio (average 1.8) strongly suggest that garnet was a residual phase during the partial melting in the source region.

The $^{87}Sr/^{86}Sr$ isotopic compositions of the studied lavas are low (0.703505-0.704279), and the $^{143}Nd/^{144}Nd$ ratios are high (0.512736-0.512858). Thus, they are isotopic depleted relative to the bulk Earth and similar to HIMU-OIB. Moreover, they are similar to those of Romanian basalts and Neogene alkali basalts throughout Europe.

Petrographic characteristics of some Middle Triassic volcanic and volcanoclastic rocks in the External Dinarides (Croatia and Bosnia and Herzegovina)

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In the geotectonic unit of the External Dinarides, several volcanoclastic-sedimentary successions of Middle Triassic age have been investigated from outcrops in Croatia (in the vicinity of Sinj and Knin) and in Bosnia and Herzegovina (in the vicinity of Bosansko Grahovo). The appearance of volcanic and volcanoclastic rocks in the External Dinarides have usually been interpreted as the Middle Triassic syn-rift phase in which graben-like depressions had been formed along deep structural fractures. The Middle Triassic rift phase in the External Dinarides is marked by volcanic activity that had been defined as basaltic extrusions at the beginning and more acidic explosive activity that characterised deposition of thick pyroclastic and volcanoclastic successions in the later phases. Volcanic and volcanoclastic successions near Sinj have been described mineralogically and petrographically by the same authors and interpreted as vitric to crystal tuffs and ignimbrites deposited as pyroclastic flows in intrashelf environment, not far from a subaerially located caldera.

In our investigation we examined several lithotypes of volcanic and volcanoclastic rocks not previously described. Near Bosansko Grahovo there are occurrences of blocky pepperites. In the angular pepperite type jigsaw-fit texture can be observed suggesting quenching of Mg-depleted basaltic lava on the contacts with unconsolidated pelagic limestones. The Ladinian age of the succession was determined on the basis of conodonts found in limestones intercalations.

Near Sinj a thick volcanoclastic beds (called “pietra verde”) are interbedded with marine bioclastic, well bedded limestones, cherts and dolomites. Bioclastic limestone and dolomites are characterised by an abundance of calcareous algae, foraminifers, gastropods, bivalves, brachiopods, crinoids, serpulids as well as radiolarians, ammonoids and conodonts, the latter suggesting open marine (pelagic) associations. Limestone beds are strongly silicified and recrystallised. Dolomites exhibit macrocrystalline anhedral texture suggesting a secondary dolomitisation. Lower Ladinian age was inferred on the basis of conodonts and ammonoids.

Volcanoclastic beds (tuffs) near Sinj are massive or evenly laminated. Cross lamination occurs at the top of some beds. Several volcanoclastic lithotypes (tuffs) do not significantly differ in composition. They contain predominant former glassy fragments which are cusped,

platy, or undeformed bubble-wall shards. Pumice wisps occur in some lithotypes showing random orientation and relict tube vesicle texture. Other components are sparse feldspar and quartz crystal fragments. The formerly glassy shards are recrystallised to a fine quartz-rich mosaic. Shards are occasionally well preserved due to carbonate microcrystalline calcite that outlines them.

The dominance of juvenile pyroclasts, particularly the abundance of various shard types and quartz crystal fragments suggest that they were sourced from explosive, acidic eruptions. The interlayering with carbonates containing pelagic (open marine) fossil assemblages suggests that they have been deposited farther offshore. In this circumstances are these subaqueous deposits not likely to be strictly primary pyroclastic in origin. Bedforms indicate rapid, possibly mass-flow, deposition in offshore environment. Nevertheless the abundance of texturally poorly or unmodified pyroclasts suggests that pyroclastic material was delivered more or less directly to sedimentary transport and deposition systems. Although it has been suggested that the origin had been primary pyroclastic surge deposits from subaerial depositional settings, we thought that pyroclastic material generated from explosive eruptions at marine submerged vents. The dominance of juvenile pyroclasts suggests that fragmentation occurred when lavas emplaced into marine unlithified sediments allow explosive vaporisation of pore fluids or when superheated water flashed to steam that rapidly expands. Thus we interpret deposits near Sinj as pyroclast rich offshore mass-flow deposits.

Buzau Land Geopark. Steps in building a new Geopark in Romania

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Rapid development of geopark concept and positive results of existing geoparks have generated in Romania both the official recognition of geopark as distinctive protected area and the increase of interests of new territories to develop geoparks. Based on a local initiative and a grass root effort a new geopark project has been launched in Romania: The Buzău Land Geopark. Located in the south-eastern part of Romania, the territory covers about 1100 sq kilometers, comprises 18 mayoralities and a population of 45000 inhabitants. Unique geological sites like mud volcanoes, amber deposits, salt caves, and oil springs are present. Sedimentary rocks folded and overthrust outline a geological history covering more than 70 million years. The paper presents the main steps taken so far in building the new geopark. The approach is based on our previous experience in Hateg Geopark and in other geoparks members of the European Geoparks Network. The process comprises: interdisciplinary research studies, stakeholders identification, local heritage evaluation, and sustainable development strategy design, establishing the basic requirements for a brand development, correlation with local projects and initiatives and design of training courses for the geopark team. This approach allowed us to identify the optimal territory for the geopark, to create a framework for partnership, local needs identification and to set-up clear objectives for sustainable use of local resources. The commitment of local communities has generated national projects dealing with public awareness, cultural events, promotion, and informal education. All these are valuable elements to prove the rightness of the geopark concept and its capacity to join around groups and stakeholders from different areas of interest.

Devonian stratigraphy and Depositional environment of the Moesian Platform, NE Bulgaria

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The Devonian sequence of the Moesian Platform in Bulgaria and Romania represents a part of the pre-Variscan sedimentary cover which overlies the Proterozoic metamorphic basement. A total of sixteen boreholes have been run in different parts of the Devonian.

The Lower Devonian, together with the Silurian, consists of dark shales, siltstones, and minor limestones and sandstones (calcareous-terrigenous-clayey formation). The age assignment of this formation is based on chitinozoans, acritarchs, miospores, graptolites, and conodonts.

Predominantly carbonate rocks (limestones and dolostones) and rare evaporites (anhydrites) build the Middle and Upper Devonian successions. They were subdivided into the following formations from bottom to top: carbonate-sulphate formation, dolomite formation, formation of banded limestones, formation of intraclastic and peloidal limestones, and formation of organogenic limestones. The lower clayey-carbonate package of the carbonate-sulphate formation consists of clayey limestones and shales of Eifelian age and the upper parts of this unit consist of Givetian dolostones, limestones, anhydrites, and scarce shales. The dolomite formation includes mainly dolostones and limestones, also of Givetian age. The formation of banded limestones consists of banded micritic limestones related to Upper Givetian and Lower Frasnian. The uppermost part of the Devonian is represented by the formation of intraclastic peloidal limestones (Frasnian-Famennian) and the formation of organogenic limestones (Famennian). The Middle and Late Devonian ages of these formations were mostly proved by conodont faunas and less commonly by brachiopods and foraminifers. Sedimentary features and conodont evidence indicate the presence of numerous erosional surfaces and stratigraphic hiatuses within the Middle and Upper Devonian carbonate sequence.

The siliciclastic sediments of Silurian and Early Devonian age (calcareous-terrigenous-clayey formation) are regarded as formed in deep-water open-marine to shallow shelf settings. Middle Devonian successions are interpreted as inner- and mid-ramp deposits developed in a shallowing-upward sequence. Eifelian carbonate sedimentation (clayey-carbonate package of the carbonate-sulphate formation) occurred in an open-marine setting below normal wave base (mid-ramp zone) which is gradually replaced by a shallow open-marine environment above normal wave base (inner-ramp zone). The shallowing tendency continued during the Givetian when carbonate-evaporite sediments precipitated under arid climate conditions (carbonate and evaporite packages of the carbonate-sulphate formation). Deposition took place in a low-energy tidal-flat setting (back ramp) with restricted or semi-restricted water circulation and locally developed supratidal sabkha evaporites. Repeated alternation of subtidal, intertidal, and supratidal successions observed in the well sections suggests a cyclic character of the Givetian sedimentation. Tidal-flat deposition continued later during the Givetian and Frasnian (dolomite formation, formation of banded limestones and formation of intraclastic and peloidal limestones) but without distinct evaporite precipitation. However, carbonate pseudomorphs after gypsum crystals observed in some intertidal/supratidal sediments indicate that arid climate conditions still existed. Finally, the Famennian carbonate deposition (part of the formation of intraclastic and peloidal limestones and the formation of organogenic limestones) reflects a gradual transition to open-marine shallow and deeper-water settings.

With the final of the carbonate sedimentation in the Early Carboniferous, the whole Devonian underwent intense folding, vertical and horizontal displacement as a result of the Variscan orogenic events.

Planktonic foraminiferal biostratigraphy and palaeoenvironmental implications of a Middle Miocene transgressive sequence in the Ionian zone of Levkas Island, Ionian Sea, Greece

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Asprogerakata section, located in the northeast part of Levkas Island, Ionian Sea, consists of well-bedded grey-brown calcareous sandstones and silty to sandy marls and represents part of the Miocene transgressive cover of the Ionian zone. Biostratigraphic data and palaeoenvironmental conditions are inferred based upon the planktonic foraminifera. A rich, highly to moderately diverse and well preserved planktonic foraminiferal association enabled biostratigraphic zonation of the Lower-Middle Miocene deposits. On the basis of the composition of the foraminiferal assemblages, palaeoecological and palaeoclimatic interpretations have been made. Quantitative and qualitative analyses provide a detailed distribution of the identified taxa and defined a number of bioevents for the Middle Miocene. The recognition of the first Acme End (AaE) of *Paragloborotalia siakensis* proved that the Neogene deposits in Levkas Island have an age of 15.435 Ma and belong to the MMi4 planktonic foraminiferal zone. The MMi4c-MMi4d boundary has been defined by the presence of *Praeorbulina glomerata circularis* dated at 14.89 Ma. Planktonic foraminiferal assemblages identify a significant change in variability of climate system at around 15.2 Ma, probably corresponding to the global cooling events superimposed to the Middle Miocene Climatic Optimum. In particular, faunal composition suggests a warm phase in the lower part of the section followed by a cooling phase.

Structure of the Eastern Hellenides and emplacement of ophiolites. Field evidences

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Our recent research in most areas of Eastern Hellenides has given following results:

In Vourinos and Vermion, the ophiolites are in normal, not tectonic contact with their supporting layers (marbles of mostly upper Triassic age). This contact shows a typical thermal transformation with layers of hornstein, amphibolites and granatites. The directly underlying series shows progressive and clear evolution from a carbonate platform into a submarine environment with increasing volcanic influences, including pillow lava flows.

In northern Pindos, at the ophiolitic overthrust masses, outcrops of limestones are observed. Detailed analysis of these limestones showed that they are remainings of transgressions, their age determined by the microfauna as upper Campanian – early Maastrichtian. The limestone series ends upwards in a karstic surface supporting doleritic lava flows with essential thickness. In the locations of Tragopetra and Tzina we can observe that these lavas clearly intrude in the caves of the paleokarst. At the same section, over this lava formation can be found the basic conglomerate (Auversian) of the "mesohellenic trench" sediments. An important outcome of this is that there is no ocean floor before the overthrust but that land, with karstification of the limestones, was already emerged instead.

In central Pindos, near Artotina, we observe ophiolite outcrops in the Pindos flysch, with a transgression enclosing microfauna of the same age.

In Euboea, a "subpelagonian" ophiolitic unit, with his underlying limestones, is overthrust over a paleozoic and mesozoic continuous sedimentary succession (Eretria unit), but the contact is violently folded and characterized by a thick mylonite. This Eretria unit is

the equivalent in South Euboea of the Styra unit and is overthrust over a continental platform carbonate unit (Almyropotamos unit).

In Argolide, we observe the same situation: an ophiolite unit, overthrust over limestones and flysch with a mylonitic contact, with insertions of klippen of a continental slope unit (Pindos). Locally, the limestones are karstified before the overthrust.

As a conclusion of these observations we can state that we should respect the principle of actualism (James Hutton, Charles Lyell). Now, in present world, the geographic zones are large, extended: so was also in the past. The distinction of a (paleo) geographical zone must be based on the trend through geological times, not on local variations of sedimentation. Today, we observe a breaking up of geological units, due to more successive tectonic phases, not to a primary differentiation. Like this, already in Middle Cretaceous or even earlier, Tethys's floor (ophiolites with effusive emplacement) was deformed and at least folded, and emerged. This emersion possibly characterizes also certain parts of African shelf. Immediately afterwards, ophiolites overthrust on the African shelf in an enormous movement, which drifted, fragmented and disintegrated the continental slope (Pindos unit, Eretria unit). This movement is accompanied also by proportional movement of the European-Asian mass. It is deformed in the scale of planet. It is obvious that this major movement was immediately followed by a phase of strongly, isoclinal folding, trending from SSW to NNE. The most obvious today (because latest) deformation during Late Eocene and Oligocene is the one which caused the actually observed main structural lines of the Hellenides.

Gold-base metal deposits in Greece: Genetic types and economic perspectives

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Greece's geology favours a potent and dynamic use of mineral resources, which became a major incentive of the country's mining business, and economic and social growth. Among the Non-Energy Metallic Minerals commodities, base and precious metals, in particular zinc, lead, copper, gold, and silver are becoming an increasingly important and rapidly growing target of the mining industry. In NE Greece, where most of the potential resources and feasible deposits are hosted, gold-base metal mineralizations occur in a wide range of genetic types comprising magmatic, hypothermal/mesothermal, epithermal, and supergene mineralization types. The magmatic porphyry copper type deposits and mineralizations show economic gold grades (e.g. Skouries, Fisoka, and Pontokerasia), the hypothermal/mesothermal manto-type base metal sulphides form high-grade gold ores (e.g. Olympias, Mavres Petres, Piavitsa, Thermes, Pangeon, Farasino) and the epithermal gold systems lead to potential high-sulphidation mineralizations (e.g. Konos, Perama, Kirki, Pefka). Proven reserves amount to porphyry gold and copper of 3.9 Moz and 0.8 Mt, respectively, manto-type gold of 3.6 Moz, lead + zinc of 1.6 Mt and silver of 66 Moz, as well as more than 2.0 Moz epithermal gold. The genetic link between porphyry coppers and large base metal manto style sulphide deposits can be incorporated into regional exploration strategies in a complex metamorphic terrain of schists, gneisses and marbles, whereas the epithermal type deposits were emplaced within a broad volcanic belt, which developed first in Bulgaria and then moved south through northern Greece to the region of Thrace. The epithermal gold mineralization occurs in hydrothermal breccia zones, related to volcanic rocks of andesitic, dacitic or shoshonitic composition as well as hosted by sedimentary rocks. All previous types of sulphide minerals (particularly those hosted by Rhodope and Serbo-Macedonian marbles) were overimposed by post-Pliocene co-active supergene oxidation and karstification

processes (e.g. Angistro, Menikio). All the main types of gold mineralization are linked to plate tectonic movements during the Tertiary. From the global metallogenetic point of view the post-Alpine Tertiary geodynamic systems in SE Europe are potential in producing high-grade ore deposits of base and precious metal sulphide minerals.

Mineral chemistry and geothermobarometry of the Kulu-Karacadağ volcanic rocks, Central Anatolia, Turkey: evidence for magma mixing

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Early Miocene (ca. 21-18 Ma) volcanic activity in the Kulu (Konya)-Haymana (Ankara) area produced a series of lavas and pyroclastic deposits with calc-alkaline and mildly alkaline affinities. The volcanic products display a broad range of compositions from basic to acidic (48-72 SiO₂ wt%). The calc-alkaline volcanic rocks include plagioclase (An₂₇₋₆₀), clinopyroxene (Wo₄₀₋₄₄En₄₁₋₅₀Fs₈₋₁₇), orthopyroxene (Wo₁₋₄En₆₄₋₇₆Fs₂₀₋₃₅), amphibole (Mg[#] = 0.63-0.77), Fe-Ti oxide, quartz, apatite, and scarce biotite whereas the mildly alkaline rocks contain plagioclase (An₄₁₋₇₄), olivine (Fo₆₄₋₈₉), clinopyroxene (Wo₄₁₋₄₈En₃₉₋₅₀Fs₇₋₁₆), orthopyroxene (Wo₂₋₄En₆₅₋₇₄Fs₂₃₋₃₃), amphibole (Mg[#] = 0.59-0.69), Fe-Ti oxide, apatite, and scarce anorthoclase. The rocks generally show disequilibrium textures such as: (a) resorption, oscillatory zoning, honeycomb and sieve textures in plagioclase phenocrysts, (b) amphibole phenocrysts pseudomorphed by opaque aggregates and surrounded by clinopyroxene corona, (c) composite pyroxene phenocrysts with core of orthopyroxene (enstatite) and rim of clinopyroxene (augite), (d) quartz surrounded by acicular clinopyroxene, and (e) reverse zoning in all phenocrysts. Estimations of pre-eruptive temperature (T) are in the range of 810-1120 °C for the calc-alkaline and 1055-1300 °C for the mildly alkaline rocks. Estimations of crystallization pressure (P) range between 1.0-7.5 kbar for the calc-alkaline and 1.9-8.6 kbar for the mildly alkaline rocks, suggesting polybaric fractionation history. Textural and compositional relationships of mineral phases and P-T conditions of the rocks suggest that magma mixing played an important role in the evolution of the investigated volcanic rocks.

Radiolarian dating of the sedimentary cover of Sevan ophiolite (Armenia)

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Dating radiolarites overlying ancient oceanic crust preserved in the Lesser Caucasus is of key importance to understand the geodynamic evolution of the greater area between Eurasia and the South-Armenian Block, a micro-continent detached from Gondwana during Late Palaeozoic–Early Mesozoic time. Micropalaeontological data are few and/or obtained before the development of a modern taxonomic framework for Mesozoic Radiolaria.

Two main ophiolitic zones are recognized in the Lesser Caucasus and they are linked to the evolution of Tethys: 1) the Sevan-Akera zone, situated in the East and SE of Lake Sevan, constitutes the main suture zone of Neo-Tethys ocean in the Lesser Caucasus, and 2) the Vedi

ophiolitic unit, in the SE of the capital city Yerevan, is considered as a folded klippe sequence thrust on the South-Armenian Block. We focus here on biostratigraphic results obtained recently on the sedimentary cover of the Sevan ophiolite, considered to have been formed in a low spreading back-arc oceanic basin. Amongst the various localities studied, three yielded identifiable radiolaria. Radiolarian assemblages obtained from the Sarinar section allow to investigate the sedimentary and volcanic history recorded in an ca. 30 m-thick radiolarite sequence associated with spilitic lavas of the Sevan ophiolitic suture zone. Three distinct Radiolarian assemblages were recognized and they establish that the studied sequence is tectonically reversed. The younger assemblage can be assigned to the Unitary Association Zones (U.A.Z.) 19-22 of Baumgartner et al. (1995) and correlated with the Early Hauterivian/late Barremian to early Aptian interval, based on the co-occurrence of species “*Sethocapsa*” (?) *orca*, *Tethysetta boesii* and *Hiscocapsa uterculus*. The latter two species last occur in the lower Aptian Verbeeki subzone of O’Dogherty (1994). The intermediate assemblage is Late Jurassic in age (middle Oxfordian to early Tithonian; U.A.Z. 9-11), based essentially on the presence of *Zhamoidellum ovum*. Finally, the oldest assemblage may be correlated with the late Bajocian-early Bathonian, based on the presence of “*Tricolocapsa*” sp. *M sensu* Baumgartner et al. 1995. Several tuff levels are intercalated within the Upper Jurassic part of the radiolarite sequence. They are the evidence for a subaerial volcanic activity that took place in the oceanic realm of Tethys preserved in the ophiolites of Sevan-Akera zone.

In the Dali section, radiolarites overly spilitic lavas and are intercalated with tuffites. The co-occurrence of *Cinguloturris cylindra* and *Emiluvia pessagnoii multipora* allows the assemblage to be correlated with the Late Tithonian-Berriasian (U.A.Z. 12-14). This age proves that oceanic crust was being formed at the Jurassic/Cretaceous transition being accompanied by subaerial volcanic activity.

At the locality Tsegnaged, situated north of the town Sevan, two chert samples associated with lavas yielded Early Cretaceous radiolarian assemblages: the first can be assigned to U.A.Z 13-17 (latest Tithonian to late Valanginian) based on the co-occurrence of *Archaeospongoprunum patricki* and *Obesacapsula cetia*, while the other to U.A.Z. 18-22 (latest Valanginian/Hauterivian to early Aptian) based on the presence of *Aurisaturnalis carinatus perforatus*.

The Nea Santa submarine rhyolite dome of the Triassic silicic volcano-sedimentary succession, Circum-Rhodope Belt, northern Greece

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A Triassic Silicic Volcano-Sedimentary (SVS) succession is part of the Circum-Rhodopes Belt in Northern Greece. It records the voluminous rhyolitic activity that occurred on a Paleozoic composite basement (united Vertiscos plus Pelagonia terranes) at the early stages of extension that ended in continental break-up, separation of the above two terranes and creation of the Almopias Ocean. The SVS succession stratigraphically overlies the alluvial fan deposits of the Permo-Triassic Examili Formation, sourced from the eroded Vertiscos terrane, and is overlain by a Neritic Carbonate Formation of Triassic age. It comprises pyroclastic rocks, lava flows and quartz-feldspar-phyric intrusions, as well as epiclastic volcanic, non-volcanic and mixed volcanic – non-volcanic sediments, all now metamorphosed in low greenschist facies.

The Nea Santa rhyolite dome is part of the SVS succession and is exposed in the Xiropotamos Creek between Nea Santa and Krithia villages. The dome is ~1000 m across and includes four facies recognizable despite their metamorphism and deformation. These are: (a) the “coherent rhyolite facies”, representing the core of the dome and consisting of massive, non-vesicular quartz-feldspar porphyry, locally flow-banded; (b) the “lithophysal rhyolite

facies”, occurring in parts of the periphery of the dome. It is perlitic rhyolite porphyry containing spherulites weathered out from the host rock. Each spherulite contains a quartz-filled, star-shaped internal cavity (lithophysa); (c) the gradational “carbonate sediment matrix – sericite-altered rhyolite breccia facies”, defining the original contacts of the dome with carbonate sediments of the Neritic Carbonate Formation. It is composed of fluidal, ragged clasts and stringers of sericite-altered pumiceous rhyolite enclosed in bio-calcirudite host sediment (reef-debris). It is interpreted as intrusive hyaloclastite or fluidal peperite, based on criteria like: hydrothermal metamorphism of the host sediment adjacent to rhyolite clasts (bleaching, silicification and calcite recrystallization) and fluidization of the host sediment (calcite-filled vesicles in rhyolite clasts); (d) the “carbonate sediment matrix – quartz-feldspar porphyry breccia facies”, occurring as dyke-like breccia zones that range from 5 mm to 50 cm in width and penetrating the western part of the dome. It comprises blocky, angular, in places jigsaw-fitted porphyry clasts enclosed in carbonate host sediment. It is interpreted as blocky peperite intruded into dome’s open fractures formed at its last, brittle stage solidification. Some clasts were also spalled from the sides of the fractures. A relatively younger facies, named “mixed rhyolite – carbonate epiclastic sedimentary facies” was formed adjacent to the dome. It consists of rounded quartz-feldspar porphyry and carbonate clasts (granular siltstone, pebbly granular siltstone and pebble conglomerate). It is interpreted as mixed provenance mass- and debris-flow deposits.

The Nea Santa dome displays typical characteristics of domes formed in submarine successions. During emplacement, its margins were quench-fragmented and mingled with wet unconsolidated carbonate sediment forming intrusive hyaloclastite (fluidal peperite). The pumiceous nature of the fluidal hyaloclasts and the lithophysal nature of the periphery of the dome imply volatile exsolution not inhibited by the confining pressure, implying further that the sediment cover above the dome was thin and the water depth probably less than 200 m. The host carbonate sediment composed of reef-debris indicates that the dome intruded in a shallow submarine environment, below wave-base. The dome finally reached above storm wave-base level and was at least partly extrusive. Its fragmented margins were subjected to reworking and were syn-deposited with carbonate clasts on its flanks below wave-base as mixed provenance gravity-driven debris- and mass-flows. The identification of peperitic or intrusive hyaloclastite margins of the Nea Santa dome within the SVS succession is decisive for the relative chronology, facies architecture and palaeoenvironmental reconstruction because its presence demonstrates approximate contemporaneity of rift magmatism and sedimentation.

Petrology and geochronology of the Vitoshka volcano-plutonic edifice, Western Srednogorie, Bulgaria

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The Vitoshka volcano-plutonic edifice crops out in the western part of the Srednogorie structural zone. The plutonic body is composed of abyssal gabbros and anorthosites, hypoabyssal monzonites, syenites and late veins of granosyenitic composition, intruded in Late Cretaceous volcano-sedimentary sequence. Volcanic rocks are represented by basaltic andesites and andesites.

The major rock-forming mineral phases are plagioclase, K-feldspar, amphibole and clinopyroxene. Common accessory minerals include apatite, titanite, magnetite, ilmenite and zircon. Secondary minerals are epidote, tourmaline, chlorite, actinolite, adularia and clay minerals.

Plagioclases span much of the crystallization history throughout the magmatic series, generally decreasing in anorthite component from basic to acid plutonic varieties. In volcanic rock the plagioclase is in the bytownite–labradorite range.

Potassium feldspar of orthoclase composition is typical for the monzonite and syenite. It forms large crystals, disposed between plagioclase. The orthoclase is the major carrier for Sr, Ba, Pb, Rb.

Amphibole is the main mafic mineral in all rock types, with Mg# 58-97. In the classification diagram of Leake et al. (1997), the amphibole from the plutonic rock falls in the field of the magnesio hornblende and ferrohornblende, whereas the amphibole from the volcanic rocks is tschermakite.

Clinopyroxene is a characteristic mineral for all rock types with Mg# 58-84. It forms deep resorption nuclei or single grains with euhedral contours. Compositionally it is augite and diopside.

U-Pb single zircon method was used for the precise geochronological dating of the Vitosha volcano-plutonic edifice. Sr and Nd whole rock and Hf–zircon tracing have been used to clarify the origin of the studied rocks.

Following U-Pb single zircon age data have been obtained for the plutonic rocks: gabbro 81.58 ± 0.23 , monzonite 82.45 ± 0.4 and syenite 79.67 ± 0.76 . U-Pb data of single zircon grains from an andesite plot on a discordia with a Paleozoic age.

Strontium isotope data are quite variable, ranging between 0.7044 and 0.7042 in the less evolved gabbro and andesite, through 0.7052 in the monzonite, to 0.7091 in the syenite. Nd (80 Ma) values also show a large variation, from 0.37 to 2.74.

The new age data reported here provide that the rocks of the Vitosha pluton range between 82.4 and 79.7 Ma. Chemistry of the parental magma suggests similarity with the other plutonic suites from the axial part of the western Srednogorie. Compositional variations of the rock-forming minerals indicate calc-alkaline I-type signature for the Vitosha pluton. Sr and Nd isotope data indicate the presence of depleted mantle source for the parental magma, whereas generation of most evolved magmas requires different degree of crystal contamination. The upper discordia intercept U-Pb zircon of Paleozoic age suggest that the contaminant must have been lithologies from the Variscan basement.

New Hippopotamid finds in Eurotas Valley (Laconia, Greece)

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A new locality tracked down in the Eurotas Valley (Laconia, Greece) yielded mammalian dental remains of a young individual referred to as *Hippopotamus antiquus*. The findings are of very large size compared to already known specimens from Greece and W. Europe. The new locality is biochronologically dated at the Early–Middle Pleistocene.

On Pliocene mammal remains in the area of Epanomi (Macedonia, Greece)

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Neogene/Quaternary deposits along the east shoreline of Thermaikos Gulf (Thessaloniki, Greece) occasionally yielded several isolated fossil vertebrate remains. A proboscidean tusk and an equid astragalus have been recently unearthed from a new

palaeontological spot near Epanomí. The finds are referred to *Mammuthus* cf. *meridionalis* and *Equus* sp. On the basis of biochronological data the deposits are dated as latest Pliocene.

Large Scale Geoelectrical survey of the Sarantaporon Basin (Thessaly, Greece)

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A large-scale Vertical Electrical Sounding (VES) survey was conducted at the basin of Sarantaporon, Ellassona in order to study the tectonic and hydrogeological setting of the area. More than 150 soundings (AB/2 > 500m) were measured on a near-regular grid and were processed with 1-D inversion algorithm. Selected Interpretation models took into account the existing detailed drilling information of the area. Since some of the dense measured soundings were co-linear was possible to combine 1-D sounding data and produce 2D data sets which were interpreted using a fully 2D inversion algorithm. Finally the 2D and 1D results were combined to produce pseudo-3D geoelectrical images of the subsurface.

Interpretations are in very good agreement with the existing drilling and geological information and reveal a relatively detailed picture of the basin's lithological and hydrogeological environment. Further, the results allowed us to obtain new, and verify existing, structural information regarding the studied area. Overall it is concluded that advanced interpretation to 1-D VES measurements can produce improved subsurface geophysical images and presents a very useful tool for larger scale geological investigations.

Middle Jurassic matrix radiolarians from the Meliata ophiolite melange at the type Meliatic sites Meliata and Jaklovce (Western Carpathians): palaeogeographic evidence.

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The Meliata Unit is crucial for understanding the West Carpathian geology. Its remnants mark an important suture zone which remained after the Meliata part of Neotethys Ocean which was open in the Middle Triassic and partly closed in Late Jurassic time. The key areas, in which occurrences of this unit are concentrated, are near Meliata village and in the wider surrounds of Margecany and Jaklovce villages. The first site lies southwest of the Gemeric Superunit, whereas the second occurs at its NE margin. Position of the Meliata Unit on the both sides of this crustal block (comparable with Greywacke Zone of the Eastern Alps) led some authors to opinions about two branches of the Meliata Ocean surrounding the Gemeric Superunit, whereas others inferred that the northern occurrences do not represent a true suture but they were transported to its recent position tectonically by thrusting (obduction). If the first opinion was true there would be some time difference between the closures of the two branches. Therefore, the two principal sites, Meliata and Margecany were revisited and new micropaleontological data were obtained, the first report of which is given herein.

Margecany (the type outcrops of radiolarite-basalt succession along the railway at the local cement factory were sampled)

In a red cherty limestone intercalated in the basalts, Triassic radiolarians (together with some poorly preserved conodonts (similar conodont fauna was previously found here by Kozur & Mock) with a mixture of some Jurassic ones, were extracted by dissolution. Microfacies of most of the reddish cherty limestone to radiolarites, is evidently Triassic. From a reddish cherty limestone to radiolarite overlying the basalts, following radiolarian fauna was extracted: *Actinomma* cf. *siciliensis*, *Crucella squama*, *Crucella* spp., *Hagiastrum* sp., *Paronaella pygmaea*, *Praeconocaryomma* spp., *Spongotripus* sp., *Elodium cameroni* and *Hsuum parasolense*. The assemblage indicates Middle Jurassic age (Aalenian to Bajocian with two species; Callovian to Oxfordian indicated by one species). Estimation of the exact stratigraphic position is problematic due to the actual knowledge of the age range of the species.

Meliata (the type locality of the meliata Unit)

Late Middle Jurassic matrix between the olistostromes and slide blocks of the upper part of the succession has already been investigated. The Lower part of the section was interpreted as a continuous Anisian to Carnian sequence. A sample from the basal part of the section below the Ladinian cherty limestones and radiolarites and above the Anisian limestones yielded *Higumastra winteri*, *Dictyomitrella* cf. *kamoensis*, *Stichocapsa cicciana*, and *Zhamoidellum* cf. *ovum*. The assemblage indicates the Callovian to Early Oxfordian age. A sample taken higher, but still in the basal part contained *Sethocapsa* cf. *kodrai* indicating late Middle Jurassic. Microfacies of the samples represent radiolarian bearing filament limestone (resembling silicified Bositra limestone with radiolarians). In the upper part of the Meliata type section occur several grey limestones and dolomites in a late Middle Jurassic mélange. Besides Carnian limestones also Norian grey limestones occur representing typical components which were derived from the grey Hallstatt facies (Pötschen sequence in the Eastern Alps).

The studied samples all contain Jurassic or mixed Triassic-Jurassic fauna which is in accordance to the mélange character of the Meliata Unit with Triassic/Jurassic blocks and Middle to early Late Jurassic matrix. However, no new constraints concerning the time difference between the southern and northern occurrences of the Meliata Unit are possible.

The floods and regime of Hármas-Körös since river regulation in Hungary

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The studied area is located in Hungary, one of the deepest parts of the Carpathian Basin. Körös Rivers (it means Fekete-, Fehér-, Kettős-, Sebes-, Hármas-Körös) is belonging to Tisza river drainage basin that is the second main watercourse in the country. The Körös catchment area is 27,537 km², but 53% is in Romania, and 47% is in Hungary. Vast areas of the Hungarian Plain were flooded by the Paleo-Tisza and its affluents; and the river itself had not fix bed. The settlements were threatened by the enormous flood hazards returning year by year. The flood control has a long history in Hungary, because barrages were already built in 1613 along Tisza and other rivers. The real work started (with mapping) when a big flood was happened in the Körös–Berettyó region, in 1816. The Körös river regulation plan was made by M. Huszár, who distributed the work, and gave the depth and width of the bed, barrages distance and dimension. He determined the width of the active floodplain: by Hármas-Körös 379 m, by Kettős-Körös 246 m, by Sebes-Körös 246 m, by Fekete-Körös 190 m, by Fehér-Körös 114 m. The river regulation of the Danube and Tisza, and their affluents, was the most important reform in the remaking of nature in the 19th century Europe. These impacts were filled the requirements of the era's economic and social assumption. Low and a high water level database were made for the time interval between 1907 and 2006 with two water gauges in case of analysing the regime of Hármas-Körös River. The low water level had occurred in

winter time (57%) in Gyoma (first water gauge), the lowest was -116 cm on 3rd August in 1930. The highest water level had happened in the first five month of the year. The highest water level was 918 cm on 9th July in 1970. The biggest difference was 943 cm in 1919. In Kunszentmárton (second water gauge) the lowest water level had happened in winter time (69%) as well, and the lowest water level was -240 cm on 24th August, 1946. The highest water levels occurred in January, March, April, and May. The highest water level was 1041 cm on 21st April, 2006. The biggest difference was 1134 cm in 2006. We are dealing with measurements of alluvial deposits of floodplain, as well. The sampling was made at the Hármas-Körös River in Takács-zug. The aim of the study to find out the amount of flood deposits on the floodplain after the river regulations. Geomorphological mapping was made near Kunszentmárton and Öcsöd in scale 1:10 000. The new map demonstrates some paleo-drainage system of the study area. The thickness of alluvial deposit is increased with 150–180 cm after the river regulations on the study area. The greater part of mapped area is high floodplain; a low floodplain is deepening into this, which was perhaps a fossil riverbed. This low floodplain was occupied by Körös River. The deposits of the last few year of the 20th century could be easily recognized; it is 5–13 cm by floods.

Romanian mud volcanoes – main features and methane flux to the atmosphere

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Studies performed in the last decade have shown the importance of geological sources in releasing methane, an important greenhouse gas, following only to carbon dioxide in the ranking of global warming producing gases. The IPCC Fourth Assessment Report, released in 2007, for the first time considers the geologic source of methane beside the other natural sources taken into account in the previous reports.

Mud volcanoes are important methane releasing geological features, occurring onshore and offshore in many parts of the world. Most of them are located in compressional settings, although in some cases they may be found in other tectonic environments. Most commonly, the onshore mud volcanoes are cone-shaped, with variable dimensions, from a few meters in diameter and less than one meter in height, to several kilometres in diameter and hundreds of meters in height. The shape of the mud volcanoes depends on the nature of the expelled fluids. Convex shapes are formed when the mud is viscous, but very frequently, circular pools with muddy water occur when the mineral fraction/water ratio is very low. In Europe, mud volcanoes are distributed in some specific areas. Such features were identified in Italy, Romania, and their occurrence continues eastward on the northern shore of the Black Sea (Ukraine, Russia), and in the Caucasian – Caspian area, where the world's most impressive mud volcanoes were described.

The most important Romanian mud volcanoes are located in Berca area (Carpathian Foredeep), close to the bending zone of the Carpathian chain. These mud volcanoes are distributed in four distinct areas: Paclele Mari, Paclele Mici, Fierbatori, and Beciu, and seem to be the biggest in Europe, excepting the giant structures in Azerbaijan. In Transylvania, quite numerous methane releasing structures were identified. The mud volcanoes here are generally small, not exceeding a few meters in height and tens of meters in diameter. In some spots, dry gas emissions occur.

In the past years, the methane flux was measured by using the classical closed chamber method. After the chamber deployment, gas samples were collected by syringes and analysed in the laboratory by gas chromatography. Recently, an innovative measuring method was introduced by using a portable methane and carbon dioxide fluxmeter. Specific sensors for the two gases are connected to the accumulation chamber, and after deploying the device in the field, the gas concentrations are measured and fluxes derived. This new method has been used until now in Transylvania and a total flux of about 680 t CH₄^{y⁻¹} was estimated for the

investigated areas in the Miocene basin of Transylvania. The total methane flux in Berca area is exceeding 1000 t CH₄ y⁻¹.

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Stones and quarries of Castle of Chambord, France

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The project "SACRE" is based on the achievement of a health record from Chambord castle and aims to provide a basis for scientific monitoring and planning of restoration work using health and aesthetic specific criteria. The collected data (nature of degradations, weather measurements, architectural and historical archives) are used to reference all the information necessary to establish a detailed diagnosis of the state of alteration of the monument.

This program of research both fundamental and applied is divided into 5 parts:

1. The CAD modelling aims at constructing a graphic base used to gather all data acquired during the project.
2. The realization of the health record of the book will reference all the information necessary to establish a detailed diagnosis of the state of alteration of the monument: mapping of degradations, weather conditions, architectural and historical archives.
3. The simulation and prediction of degradations, which is the most fundamental step of this research program, is to simulate both in sequences of experimental laboratory and in numerical modelling the process of degradations in order to understand their evolution and to estimate their kinetics.
4. The creation of a tool for decision support is the application of simulation to work, and aims to estimate the rate of degradation. Added to that a costing of restoration, this software tool will provide a rational schedule of restoration work.
5. The valuation of the project to the public will be achieved by giving an access to a simplified version of the software, presented at an exhibition at Chambord.

The castle has undergone many restorations and architectural changes that have resulted in replacement of stones. Dating and identification of rocks were determined by searching in the historical and architectural archives that are sometimes incomplete. In developing the health record of the castle, we aim to identify and localize all the stones used over the time since the sixteenth century for the construction and for the restoration.

The 'tuffeau', porous chalk-lime and with very low mechanical strength, is the stone most commonly used in construction of buildings in the Loire Valley. It was also used for construction and restoration of the castle of Chambord. Stones used in the sixteenth century from quarries that are no longer used today. Over the successive restorations, new quarries have been opened.

The objective of this study is to identify geographically the various careers that have served the construction and restoration of the castle of Chambord, and locate the different stone facades employed. Indeed, these stones juxtaposed on the building are not always compatible. Correlating these data with the changes observed on the walls can give indications about the evolution of alterations observed on the chateau.

Calculations of the elastic parameters (velocity of P-waves and S-waves) and bulk density for selected wells from the Western Carpathians

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The paper presents results of calculation of the following elastic parameters: compressional wave velocity (VPEQ), shear wave velocity (VSEQ), velocity ratio VPEQ/VSEQ, acoustic impedances for either wave (AIPEQ, AISEQ), and bulk density (RHEQ). Elastic parameters were calculated for different lithostratigraphic series from fourteen selected boreholes from the Western Carpathians for which results of the quantitative interpretation of well logs were available. The analyzed area is located in the Polish Carpathians between Bielsko-Biała and Nowy Targ.

Those series contain Precambrian, Cambrian, Devonian (Lower, Upper and Middle), Carboniferous (Lower and Upper), Triassic, Jurassic, Cretaceous, Miocene and Paleogene rocks. The calculations were made for very different lithology, which was characteristic for those stratigraphic series, with the use of the *Estymacja* computer program written by Maria Bala and Adam Cichy within the research project No 8 T12B 046 20.

The idea of the method of estimation of P-waves and S-waves elastic parameters was based on known theoretical models (e.g. given by Biot-Gassmann or Kuster-Toksöz) relations which describe multiphase media corresponding to rocks with granular structure (grains: solid phase) filled with pore saturating medium (liquid phase, gas phase, solid phase). Elastic parameters of rocks are a resultant of all phase components: rock matrix and medium, and depend on relationships between components of the rock medium and isotropy or anisotropy of the rock skeleton. The computer program *ESTYMACJA*, allows elastic parameters of the rocks to be determined from results of integrated analysis of well logging data i.e. lithology, porosity and water, gas and oil saturation in the flushed zone or virgin zone. In our calculation the theoretical Biot-Gassmann's model was used.

Those calculations were made for rocks in the A – 3 well, Ch -1 well, D – 6 well, J – 2k well, L-3a well, L - 7 well, R - 3 well, Ś – 1 well, W – 6 well, W – 1 well, W - 3 well W-4 well, Z – 1 well.

Averaged values of estimated velocities VPEQ and VSEQ, VPEQ/VSEQ ratio, acoustic impedances (AIPEQ, AISEQ), and bulk densities RHEQ for each stratigraphic units together with lithology description were used to create a generalized set of parameters for groups of nearest wells or boreholes situated at the same profile. However, due to great variability of rocks belonging to different lithostratigraphic units, only the results from the nearest wells were compared.

The characteristics of VPEQ and RHEQ variability was performed for selected wells and stratigraphic series. One can observe a great variability of studied parameters, even for the same series and the same lithology. Results of estimated elastic parameters and bulk densities, presented in this paper, characterize a rock model with much varied lithostratigraphy.

Natural reservoir systems in the Tertiary section of the East Rhodope depression and perspectives for storage of natural gas and carbon dioxide

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The East Rhodope Depression situated in South Bulgaria is a Paleogene superimposed structure. It is mostly filled with Tertiary sedimentary, sedimentary-volcanogenic, and

volcanic rocks. The tectonic low-order elements distinguished in it are specific volcano-tectonic, block, and block-fold structures. The subjects of our study are the aquifer layers (reservoir systems) situated in these structures investigated from the point of view of the possibilities, if other favorable conditions for storage of natural gas and carbon dioxide (CO₂) exist. Special studies carried out by the authors in the limits of the perspective structures are concentrated mostly on the: lithological-physical segmentation of the Tertiary section; defining of permeable and hard-permeable formations and their studying (structure, lithology, reservoir and sealing parameters, spatial behavior); defining of natural reservoirs and studying their spatial relationships; prognosis of possible types of local structures and natural traps. Because of the restricted volume and the absence of specialized information for a number of important geological preconditions and parameters, prognostic assessments are made with the use of indirect data, based on the contemporary ideas about the geological evolution of the examined region. Such are the structural-tectonic, the seismotectonic and the hydrogeological (hydrochemical, hydrodynamic) and the thermo-baric conditions. The prognoses concerning the perspectives for storage of natural gas and CO₂ are related to the sunken areas within the Dzhebel and Krumovgrad depressions.

Loss of ⁴⁰Ar(rad) from leucite-bearing basanite at low temperature: implications on K/Ar dating

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The Bakony-Balaton Highland Volcanic Field (BBHVF) is located in the central part of Transdanubia, Pannonian Basin, with over 50 alkali basaltic volcanoes. The volcanism was related to the post-extensional tectonic processes in the middle part of the Pannonian Basin. The basanite plug of Hegyestű erupted in the first phase of volcanic activity. It overlies Triassic limestone and dolomite forming a double hill. Since there is no clear evidence of explosive eruption history, Hegyestű is likely either a remnant of a dominantly lava emitting volcanic vent, or remnant of a lava derived from some sources nearby.

Ar/Ar [1] and K/Ar [2] ages were published on the alkali basalt rocks of the BBHVF. Conflicting K/Ar (5.97 ± 0.41 Ma, isochron) and Ar/Ar (7.78 ± 0.07 Ma, isochron, 7.94 ± 0.03 Ma, plateau) ages were measured on the leucite-bearing basanite of Hegyestű. As it has been shown, this effect is caused by the special Ar retention feature of leucite in this basanite.

In a new study 18 K/Ar ages were measured on subsamples of HT-4 and on its fractions produced by magnetic and heavy liquid separation. 18 K/Ar ages measured in the usual way were 25 – 45 % younger, but after HF or HCl treatment of the rock, or after reducing the baking temperature of the argon extraction line from 250 °C to 150 °C, they became similar to the Ar/Ar ages.

HCl treatment dissolved olivine, nepheline, leucite, magnetite and from 1-1 sample analcime or calcite. K dissolution studies on 6 samples from different locations of Hegyestű have shown that K content is mostly ~2 %, but it may decrease to ~0.3 %. HCl treatment dissolved 19 – 32 % of the rocks, 28.0-63.5 % of the K content, reduced the K concentration of the residue to 1.1 – 0.3 %, and for the dissolved part of samples with ~2 % K, the calculated K concentration was 4.02 – 6.42 %. These data and EMP analysis suggest leucite is the responsible mineral for the low temperature loss of ⁴⁰Ar(rad) during baking the extraction line, though a minor role of nepheline can not be excluded.

Ar may release at low temperature from very fine-grained mineral, or when the Ar release mechanism changes. A ⁴⁰Ar(rad) degassing spectrum has been recorded in the 55 –

295 °C range by stepwise raising the baking temperature and the data were plotted in the Arrhenius diagram. The arrangement of points proves very great change of Ar release properties in the 145 – 295 °C temperature range. This infers that Ar release is caused by a low temperature process, the change of the mineral structure of chemistry. Using the method presented here 7.56 ± 0.17 Ma, regarded as minimum age and similar to the Ar/Ar isochron age (7.78 ± 0.07 Ma) is determined for Hegyestű.

The result presented here point to the importance of checking the suitability of leucite-bearing rocks for K/Ar dating, and simple methods are given for this control.

Parameters of phase transitions in the mantle and its influence on mantle convection

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Reconstruction of the mantle flows within the mantle is essential for understanding of the Earth evolution. A temperature and pressure increase in the mantle causes phase transitions and related density changes in its material. The transition boundary in the pressure–temperature phase diagram is determined by the curve of phase equilibrium. If the slope is nonzero, a phase transition in hot ascending and cold descending mantle flows occurs at different depths and, therefore, either enhances ($\gamma > 0$) or slows down convection ($\gamma < 0$). Endothermic phase transition at a depth of 660 km in the olivine partially slows down mantle flows. The mantle material has a multicomponent composition. Therefore, phase transitions in the mantle are distributed over an interval of pressures and depths. In this interval, the concentration of one phase smoothly decreases and the concentration of the other increases. The widths of phase transition zones in the Earth's mantle vary from 3 km for the endothermic transition in olivine at a depth of 660 km to 500 km for the exothermic transition in perovskite, and the high-to-low spin change in the atomic state of iron takes place at a depth of about 1500 km. We present results of calculations for 2D and spherical models, demonstrating the convection effect of phase transitions as a function of the transition zone width. Transitions of both types with different slopes of the phase curve and different intensities of mantle convection are examined. The mixing of material under conditions of partially layered convection is examined with the help of markers. We analyze 2D and 3S mantle flow models with strong viscosity variations and phase transition to investigate this joint effect. For 2-D models we employ the generalized Moresi method. The 3S models are calculated with the CITCOM code.

Ore microscopy, EPMA, and X-Ray Diffraction studies on Hamehkasy-1 and Korkora-1 iron deposits western Iran

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Hamehkasy-1 and Korkora-1 are two iron deposits in Western Iran. Hamehkasy iron deposit is situated in the Sanandaj-Syrjan zone. It consists of two major economic indices and several sub-economic minor indices. Hamehkasy-1 is the largest index and is located to the north of Hamehkasy-2 at distance of 400 m. This ore body is being exploited at present. Korkora-1 iron deposit is located in the Oromieh-Dokhtar volcanic belt. It is one of ten indices in the Shahrak mining district. This ore body is the largest deposit in the area. Magnetite is the main ore in these deposits, but hematite, pyrite and goethite are present, too. For study magnetite in these ore bodies we used ore microscopy, EPMA and XRD methods. X-ray powder-diffraction data were obtained using: magnetite ($\text{Mg}_{0.04}\text{Fe}_{2.96}\text{O}_4$), hematite (Fe_2O_3), quartz (SiO_2) are common minerals, on records from Hamehkasy-1 samples we report magnesian arfvedsonite ($(\text{Na,K})_3(\text{Fe,Mg,Al})_5\text{Si}_8\text{O}_{22}(\text{F,OH})$) for the first time in this

deposit. In Korkora-1 samples the common minerals are: magnetite ($\text{Fe}_{2.92}\text{O}_4$), hematite (Fe_2O_3), goethite ($\text{Fe}^{+3}\text{O}(\text{OH})$), clinochlore ($(\text{Mg,Fe,Al})_6(\text{Fe,Cr})_4\text{O}_{10}(\text{OH})_8$), and hydrohematite ($\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$). Ore microscopy studies: in these studies we found magnetite in Hamehkasy-1 deposit which consists of high exsolution but in Korkora-1 exsolution in magnetite is rare. Magnetites in samples of each deposit were characterized by (EPMA) studies.

Camptonites from the Ditrău Alkaline Massif, Romania: Geochemistry and petrogenesis

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Camptonite dykes, 20 cm to 2 m wide, occur at the northern part of the Ditrău Alkaline Massif [DAM] (Eastern Carpathians, Romania), intersecting granitoids, syenitoids and hornblendites. Based on their low SiO_2 and high alkali, TiO_2 , LILE and LREE content, high Yb/Nb, Ti/V, (La/Yb)N ratios, Zr/ TiO_2 vs. Nb/Y distribution, nepheline and olivine normative composition they are defined as silica- and alumina-undersaturated, alkaline basic rocks and basanitic in composition. The Mg#, Cr, Ni, Co and Sc concentration, and low S.I. and high D.I. values of the DAM camptonites indicate that they could be fractionates of primary melts. Based on strongly incompatible trace element composition the DAM camptonites derive from an OIB mantle source containing HIMU and EM I mantle components. The high LREE and low HREE content of the DAM camptonites (La/Yb=15-24) may indicate both a metasomatised mantle source for the magma generation and a garnet lherzolite source by very low degrees (~1-2 %) of partial melting. The latter mean that the camptonite magma must have originated at a great depth, around 60-80 km.

Ophiolites in the Dinarides and Hellenides: the contribution of radiolarian biochronology to the understanding of their formation and emplacement

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Mesozoic radiolarian biochronology has been essential in the understanding of the timing of formation and emplacement of remnants of ancient ocean basins in the Alpine-Mediterranean orogens. The first descriptions and biochronologic assessments of radiolarian faunas of the late 1970ies in the Hellenides and Dinarides depended on biostratigraphic calibrations from Deep Sea Drilling Sites and on the first zonations established in Western North America, that were not adequate for the area. In the early 1980's, as the first European Jurassic-Cretaceous radiolarian zonations were established, the dating of radiolarian-bearing sediments associated with basalts and ophiolitic mélanges became possible. The age assignments have been continuously refined since. The discovery of Triassic radiolarites associated with MORB-like basalts in the late 1980's considerably changed the interpretations. Now, a wealth of biochronologic work has been published in the last 3 decades. For this report we have revised data from NW-Croatia, Serbia, Albania, Northern Greece, Othris, Evvia, Argolis, in an attempt to produce a coherent picture of all this data.

Radiolarian biochronology established in oceanic sediments associated with ophiolite belts in the Dinarides and Hellenides reveal 3 age clusters: Middle to Late Triassic, Middle Jurassic and Late Middle to Late Jurassic. Early Jurassic ages are extremely rare. Triassic ages have been found in oceanic sediments, chiefly radiolarites, associated with MORB-like

and within-plate basalts, while the majority of Middle Jurassic ages have been found in sediments associated with basalts that geochemically are related to an intraoceanic convergent margin setting. Middle Jurassic radiolarites and radiolarian mudstones are also associated with ophiolite mélanges that are allochthonous with respect to the continental margins. Late Middle to Late Jurassic ages are found in synorogenic deepwater pelagic and ophiolite-bearing detrital sediments that stratigraphically overly marginal series. These deposits formed during the obduction of the ophiolites onto the adjacent continental margin. Exposure/erosion and emplacement of the ophiolites is largely diachronous along the Pelagonian-Korab-Durmitor margin and in part synchronous with an ongoing formation of Vardar (suprasubduction) oceanic crust. Westward younging of ophiolite detritus on the Pelagonian margin implies an eastern (Vardar) origin of the ophiolites in Eastern Greece.

In our simplest geodynamic scenario the Triassic ophiolite components are interpreted as remnants of the Maliac-Meliata Ocean that formed NE of the Pelagonian microcontinent, during the detachment of the latter from Eurasia. During the Middle Jurassic an intra-oceanic subduction zone developed in the Maliac-Meliata Ocean outboard of the Pelagonian-Korab-Durmitor-Drina-Ivanjica margin. Pieces of Triassic Maliac-Meliata ocean floor and seamounts became ripped off the lower plate and accreted in this subduction zone together with very young (0-10 my, supra-subduction) oceanic basalts of the upper plate attributed to the Vardar (backarc) Ocean. When the subduction zone reached the Pelagonian- Korab-Durmitor-Kuci margin, the latter became the lowermost unit of the accretionary wedge. The intraoceanic arc collided with the trench and was overthrust by the young back-arc Vardar crust just before subduction ceased. Further westward thrusting (mostly during Late Cretaceous-Early Tertiary) emplaced this composite ophiolite unit onto the more external Pindos-Cukali zones.

OneGeology-Europe – a general overview, data specification, and an example of a contribution from Slovenia

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OneGeology-Europe is a project which originated in the global initiative OneGeology. It started in September 2008 and will conclude in October 2010. It is a truly multilateral and multinational project with 29 partners from 20 European countries. The aim of this EC-funded project is to make geological spatial data held by surveys and national geological institutes discoverable and accessible. It will do this through a uniform data model, and create dynamic digital geological map data of Europe. The results of the project will allow researchers, consultants, environmentalists, construction and water industries, planners and local, regional and central governments, to make more informed decisions about the resources and hazards in Europe. It will also provide a means of seeing just what lies beneath your feet!

Major objectives and achievements for OneGeology-Europe include:

- A web-accessible, interoperable, geological spatial dataset for the whole of Europe at 1:1 million scale.
- Accelerating the development and deployment of the emerging international interchange standard language for geological information (GeoSciML).
- Removing barriers and making it easier for a wide range of both public and private sector organizations to use geological data through codes of practice on licensing.
- Creating a common language that helps to acquire geological knowledge and move it closer to end-users for a greater public impact.
- Making substantial progress in the implementation of the INSPIRE European Directive in the geoscience domain.

In addition to the work in the field of informatics, a challenging and important task was the development and agreement of a common geological data specification. The project is delivering a specification for geological spatial data and an interoperable 1:1 million scale dataset for the whole of Europe - an essential platform for the whole project. This foundation includes at its core a vocabulary to describe lithology, age and genesis of the rocks and the tectonic structures and term definitions and their relations. Generic and specific geometric and semantic harmonisation issues were identified. Existing national datasets were then “reworked” to make significant progress towards a harmonised dataset – a crucial step towards INSPIRE goals. The standards, architecture and framework developed by the project can then be “upscaled” to more detailed levels and progressively deployed for higher resolution geological data. The Geological Survey of Slovenia is one of more than 24 data providers in the project. To deliver the Slovenian contribution an existing geological map at a scale of 250000 was edited and simplified to fit the requirements of 1:1 million scale target map. The spatial data were mapped into the common data model and were also partly harmonized with neighbouring countries. An additional benefit of Slovenia’s participation in the project will be a new printed geological map of the country in scale 1:1.

Hydrogeological investigation of the Beysehi Lake and surrounding area

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The Beysehir Lake, which is one of the largest freshwater lake reservoirs in Turkey, is the most important drinking and irrigation water source for Central Anatolia. The lake has an area of approximately 656 km² with an average depth of 5 meters. The most important creeks discharging to the Beysehir Lake (Sarisu, Ustunler, Ebulvefa, and Eflatun) and their drainage area form the southeast basin of the lake. The rocks in these basins and their hydrochemical relation with surface and subsurface water will be given briefly in this study.

The Lower-Middle Cambrian Caltepe Formation comprising dolomite, crystallized limestone, and nodular limestone, occurs at the basement and has reservoir rock characteristics. The Upper Cambrian-Lower Ordovician Seydisehir Formation overlies conformably the Caltepe Formation and comprises schist, phillite and shale-bearing limestone and quartzite lenses in places. The Anamasdag Formation, which is the most important reservoir rock in the study area, has widespread outcrops around the lake and rest unconformable on the Seydisehir Formation. It is composed of conglomerate, marl, sandstone, ferric bauxite, dolomite, limestone and is Upper Jurassic-Upper Cretaceous in age. The Hoyran complex comprising serpentinite, pyroxenite, harzburgite, dunite, diabase and chromites emplaced tectonically over the abovementioned units. This unit has outcrops starting from northern part of the Beysehir Lake extending approximately in the NNW- SSE direction up to the Yesildag town located at the south of the lake. Besides, the Eocene Buyukkopru Formation comes unconformable on these units and, begins at the bottom, with the red marl and continues with mudstone – claystone – turbiditic sandstone. The Topraklı Formation is made up of partially consolidated pebble, sand and clay and, covers all the above mentioned units.

The Landsat 5 TM satellite image was used in the interpretation for providing the important hydrological data and individual pollution source in the Beysehir Lake, with its drainage area, which is one of the important water resources in the area. The lineaments and drainage characteristics of the study area have been determined by developing a Digital Terrain Model using filtering methods such as single banded Fast Fourier Transformation and Convolution methods of image enhancement methods. Besides, composites obtained through hue enhancement and combination in differing ratio of data, in the three visible and three reflected infrared wave lengths occurring of the Thematic Mapper image, give very promising results in differentiating the hydrogeological units and determining pollution spreading in the surface waters. The interpretive linearity and geological maps prepared by supervised and

unsupervised classification methods of the digital image data are seen to be overlap with the geological map of the area after surface controlling.

Karstification and their size in the limestone which are widespread in the basin and which are mostly forming the reservoir rock were interpreted by means of their chemical analysis results. The permeability of alluvial sediments was determined by means of sieve analysis. The variations in the water level of the lake were interpreted statistically. The chemical analysis results of surface and spring water were evaluated in different diagrams and the possibly of these water as being drinkable and usable were searched.

Deformation history of the Outer West Carpathian Flysch Units and Pieniny Klippen Belt (NW Slovakia, SE Czech Republic)

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The project Karpatian Tectonics Slovakia addresses the development of a coherent tectonic model for the Early Miocene in the Vienna Basin and adjacent areas. Studies include 2D/3D seismic interpretation in the Vienna Basin and structural fieldwork in the Outer West Carpathians. Structural data comprises 105 outcrops from the NW-rim of the Pieniny Klippen Belt (PKB) and Outer West Carpathian Flysch units in Northwest Slovakia and Eastern Czech Republic.

Structural data from the Outer West Carpathian Flysch Units (Biele Karpaty-, Magura-, Silesian Unit) depict (N)NW-directed shortening (D_{F1}), which is related to the large scale architecture of the ENE-striking fold-and-thrust-belt. Thrust ages, obtained from the ages of youngest overthrust sediments indicate Eocene to Early Miocene in-sequence thrusting towards the European foreland. Foreland propagating thrusting is also regarded to be responsible for the progressive steepening of thrust units towards the internal parts of the fold-and-thrust-belt, which causes overturning of the innermost flysch units and the PKB.

Crosscutting relationships observed in outcrops give evidence that (N)NW-directed shortening is followed by ENE-striking strike-slip faulting (D_{F2}), reactivating former thrusts of D_{F1} . Strike-slip faults occur at the front of and within the Bystrica and Biele Karpaty Unit close to the PKB. Structures of D_{F1} and D_{F2} are further cut or overprinted by (N)NE-striking sinistral strike-slip faults and fold-thrust structures related to (N)NE-directed shortening (D_{F3}). Structural data and geological maps indicate that (N)NE-striking strike-slip faults and NNE-directed out-of-sequence thrusts coincide with bends at the front of the Magura and Bystrica Unit.

Structures from the NW margin of the adjacent PKB prove a complex polyphase deformation history. Multiple folding events, tilted and refolded ramp-flat structures and overturning of strata complicate deciphering individual deformation events and their relative chronology. However, NNW-directed shortening, which postdates large scale overturning of strata, was identified in the region around the Middle Váh Valley. There, the NNW-directed shortening is followed by NNE directed shortening. Deformation styles are comparable with D_{F1} and D_{F3} in the flysch units. NNW-directed shortening is interpreted as out of sequence thrusting during deformation D_{F1} . In addition, ENE-striking sinistral strike-slip faults are recorded within the PKB, close to the border to the Biele Karpaty and Bystrica Unit.

The outcrop-derived deformation history is compared to tectonics in the Vienna Basin area, where seismic data provide excellent constraints for deformation ages. In the Vienna Basin, out-of-sequence thrusting coeval with NE-striking sinistral strike-slip faulting occurs in the flysch units and Northern Calcareous Alps during the Early Miocene contemporaneously with in-sequence thrusting in the external Waschberg Unit. Early Miocene NE-striking sinistral strike-slip faults are cut by (N)NE-striking Middle to Late Miocene sinistral strike-slip faults. NE- and (N)NE-striking strike-slip faults mapped in the Vienna Basin are related to the eastward lateral extrusion of the Eastern Alps towards the Pannonian region, whereas (N)NE-striking faults are linked to the pull-apart stage of the

Vienna Basin during Middle to Late Miocene times. D_{F2} and D_{F3} , identified in the Outer West Carpathians are therefore interpreted as to be linked to Miocene extrusion kinematics. ENE-striking strike-slip faulting (D_{F2}) may represent Early Miocene kinematics. NNE-directed out-of-sequence thrusting and (N)NE striking strike-slip faults (D_{F3}) are interpreted to be linked to the pull-apart stage of the Vienna Basin. Considering several blocks moving towards (N)NE at different velocities during Miocene lateral extrusion, structures of D_{F3} may depict a transfer of such (N)NE-directed movements to thrusts into the Outer West Carpathians.

Groundwater vulnerability assessment to contamination (Erzeni Basin, Albania)

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Groundwater quality has been recently deteriorating in different alluvial aquifers of Albania due to industrialization expansion, waste disposal, and agriculture activity. A preliminary assessment of vulnerability to groundwater contamination in Erzeni watershed area was undertaken because of enormous mining activities of river bed alluviums, the presence of the largest urban solid waste disposal site of Tirana and intensive agricultural and industrial activities at the plane part of the river course. The major geological and hydrogeological factors that affect and control groundwater contamination were incorporated into the DRASTIC model. Moreover, a Geographical Information System (Arc Gis 9.2 INFO) was used to create a groundwater vulnerability map of Erzeni river basin. Aquifer vulnerability assessment aims at predicting areas, which are more likely than others to become contaminated as a result of human activities at the land surface. As a result of the vulnerability assessment, 20% of the Erzeni basin was classified as being very highly vulnerable, 5% highly vulnerable, 15% vulnerable at moderate to low levels and, finally, around 60% of the basin has very low vulnerability.

Crust to upper mantle geophysical imprints of the West Black Sea opening

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Some inherited geophysical evidence in the lithosphere of the SE Carpathians, created by the geodynamic processes related to the W Black Sea opening are subject of the paper.

During the time, various models have been proposed for the Black Sea genesis. They are dominated by the idea of the basin opening within the back-arc extensional environment created behind Pontides by the northward subduction of the Neo-Tethys ocean floor.

Overall, the presence of the oceanic crust in the central part of W and E Black Sea basins is well revealed in the pattern of the geomagnetic anomaly.

But, the hypothesis of the Black Sea opening during a unique geodynamic event is less supported by the residual geomagnetic and gravity anomalies pattern, showing completely different strikes for western and eastern Black Sea. Besides, gravity high, typical for the presence of the oceanic crust correlates with a geomagnetic high (normal magnetization) within W Black Sea, while E Black Sea, the gravity high correlates with a geomagnetic low, advocating for a reverse magnetization of the crust. These aspects advocate for a distinct opening of the W and E Black Sea basins during two time-spans with normal and, respectively, reverse geomagnetic field.

In depth extension of the W Black Sea rifting processes is well revealed by the seismic tomography. Two major issues are well outlined by the geophysical information provided at various levels: the indent representing the lithosphere expelled towards the Carpathians (which is consistent with the two types of the Moesian Platform basement), and the splitting of the Moesian Plate (MoP) into several slivers by reactivation or creation of some deep crustal/lithospheric faults striking north-westward.

Some of the well known regional faults on the Romanian territory (e.g. Sfântu Gheorghe Fault (SGF), Peceneaga-Camena Fault (PCF), Intra-Moesian Fault (IMF)) may be seen as lithospheric boundaries deep to more than 100 km.

After the Black Sea opening ended, it seems that the geodynamic engine in the area became the active rifting within SW Arabian Plate, pushing the plate northward by about 48 mm/year. After accommodating about 15 mm/yr along the North Anatolian Fault, part of the motion is relocated to the Black Sea microplate, pushing the East Carpathians foreland encompassed between PCF and IMF towards NW. Evidence of this push are provided by the Quaternary (Walachian) folds in the bending zone of East Carpathians, and, more recently, by the stress revealed by borehole breakouts studies, or direct geodetic monitoring of the crust deformation along the PCF flanks.

It seems that under this stress, the above-mentioned MoP compartments advance towards the Carpathians kept together by friction. However, from time to time, when tectonic forces overcome the frictional forces the above-mentioned lithospheric slivers may relatively slip each other thus generating earthquakes within their brittle, upper part. This may explain the unusual intracratonic crustal seismicity of the eastern Moesian Platform.

Within the bending zone of East Carpathians, speed excess provided to MoP by the W Black Sea opening created circumstances for the occurrence of an unstable FFT (transform-transform-compression) unstable triple-junction between the three tectonic plates joining the area: MoP, East European Plate (EEP) and the Intra-alpine Microplate (IaP).

Results of a combined inversion of seismic and gravity data are fully consistent with the assumption, by revealing a prismatic triangularly shaped high velocity compartment collapsed into the upper mantle, having vertices parallel to the plate boundaries. Therefore, Vrancea unstable triple-junction (VTJ) might be responsible for the unusual intermediate-depth seismicity within full intra-continental environment. The sinking into the hotter upper mantle of a colder lithospheric compartment generates P-T disequilibrium to which thermo-baric accommodation phenomena (e.g. thermal stress, phase transform processes) may occur as seismic sources.

In depth distribution of the Vrancea intermediate-depth seismicity, with maxima located at the depths where the colder high velocity (seismic) body met the hotter asthenosphere of the surrounding tectonic plates is fully consistent with the assumption.

Top of geological maps creation in the last forty years in the Slovak Republic: a new general geological map 1 : 200 000

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Geological mapping in the territory of the Slovak Republic has a long tradition. The climax of production of geological maps in the last century was a complete edition of synoptical maps 1:200 000 at the beginning of 60-ies. The centre of gravity in the following period was shifted to systematic geological mapping in the scale 1:25 000. Mapping was organized in particular geomorphologic units – regions. These maps had utilized for compilation of regional maps 1:50 000 which were issued together with book explanations for public using. Hither-to the nearly whole Slovakian territory is covered by regional geological maps in scale 1:50 000. The first regional map 1:50 000 was issued in the 1972 and to the present day number of 47 regional maps from the total of 51 were issued. When compared with other countries it is relatively high per cent covering of the territory. On the basis of the

maps 1:50 000 a new “General geological map of the Slovak Republic 1:200 000” has been compiled, which should solve many interregional problems that emerged during the long period of mapping. The map is available in the aggregate form and in the individual sheets as well. The each sheet contents of geological sections, sketches of the tectonic units and the scheme of authors` contributions. The common legend to the General Map has been compiled. The legend to tectonic sketches was compiled in accordance with the principles of the Tectonic map of the Slovak Republic 1: 500 000. The General Map is prepared also in an electronic form, which enables interconnection among single sheets. Common explanatory text to the map was issued in the 2009.

The Slovak Republic is located in the Western Carpathians mountain range. On the new general map actual conception of the geological structure and division of the Western Carpathians is presented. This conception appears from tectonic evolution and succession of the tectonic unit's origin. Western Carpathians are divided into Outer and Inner as a result from the youngest Neoalpine tectonic processes between the European platform and the Inner Carpathian block. The outer Carpathians are represented by the Flysch belt. A splitting element from the Inner block is the Neoalpine structure of the Klippen belt which contents units from both zones. The inner block is composed of Paleo - alpine tectonic units on which Tertiary sediments and volcanics are deposited.

Aspects and significations of plagioclase disequilibria in the rocks of the Ditrau Alkaline Intrusive Complex (Romania)

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The Ditrau Alkaline Intrusive Complex (DAIC) is exposed in the southern part of the Crystalline-Mesozoic Zone of the East Carpathians. It is a complex Mesozoic intrusive body, which was incorporated in the Alpine Bucovinian Nappe during the Mid-Cretaceous shortening (the Bucovinian shear plan cut the DAIC at a depth of about 1800 m).

In terms of petrography, DAIC is characterized by diverse rock types, lacking compositional constancy and gradual transitions from one petrographic type to another.

By universal stage (US) plagioclase feldspars from hornblendite, diorite and monzonite cropping out in the left side of the Jolotca valley and along the way Ditrau-Hagota, plagioclase feldspars of nephelinsyenite from the Ditrău valley and plagioclase feldspars from ultramafics cropping out in the right side of the Teasc valley were analyzed. As a result of these analyses we found that a great part of the studied crystals emphasis, zoning, corroding and varying degrees of structural disorder. These plagioclases are generally twin and the twins frequently are complex twin (57.6% of cases) supplemented by parallel and normal twins, equal among themselves in share (21.2% of cases). Contents in anorthite determined by US were verified and detailed by microprobe. They are in the range An 0.09% - An 55% and show numerous frequency peaks. This, in conjunction with succession relations observed microscopically highlighted the existence of several feldspar populations: First plagioclase population that appears in gabbro is represented by an up to An 50% plagioclase. In diorites only exceptionally is present: in zoning structures, or in armoured structures (just in plagioclase core). A second population of plagioclase has a maximum frequency around An 27% -An 30% and appears to be the centre of crystals or around the cores containing over An 40%. It is found in diorite mainly, but in monzodiorite, monzonite or syenite as well. The third plagioclase population has the content around An 20%. It is found mainly in monzonite, syenite, and granite. The fourth population of plagioclase forms a peak at around 14% anorthite. It is not represented in gabbros but since diorite and ending with syenite this is omnipresent. The fifth plagioclase population (albite/oligoclase) appears mainly in the nepheline syenite. Like in all other types of rocks, the nepheline syenite presents a progressive decrease in calcium of the plagioclase feldspars due to the presence of several plagioclase phases. Here, however, the difference in composition between the phases is much smaller. The nepheline syenite oligoclase, rarely exceeds the An 10% -An 12% content but remains at approx. six, seven percent away to the albite which came later. The sixth

plagioclases population (we consider the second plagioclase generation) has an albitic composition typically range between An 3% and An 8%. This albite is found in all the rock types from monzodiorite to syenite or nepheline syenite. The albite surrounds all other plagioclase crystals and edits the contact contour of early crystals.

The albite (the second generation of plagioclase) is in a microcline, perthite and sometimes nepheline association while the calcium plagioclase is in a hornblende, sphene and sometimes pyroxene association.

The process of reorganization of first plagioclase feldspars generation is developed to a high temperature level (between the “liquidus” and “solidus” lines of crystallizations diagram) so here an open system evolution process as magma mixing is. The existence of the high plagioclases (plotted on, or near the high temperature curves of the standard stereogram used in US determination) also the existence of the zoning structures, show that the process can not be a metasomatic one.

Measurements of personal UV doses at different human activities

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Ultraviolet (UV) solar radiation plays a very meaningful role in many processes in the atmosphere and biosphere, strongly affecting life on the Earth, and human health in particular. A long term overexposure to UV radiation may cause photoaging, suppression of immune system, skin cancer and cataracts. On the other hand, UV radiation is required for vitamin D₃ synthesis and its lack may lead to rickets and other diseases.

Standard measurements of UV radiation are performed with the aid of radiometers situated on the roofs of buildings or masts at the uncovered places, put out directly to the Sun. Data from these measurements are used as a measure of UV radiation influence on human being. Nevertheless, the human body is not a stationary flat surface put out directly to the Sun, so doses of UV radiation obtained from standard measurements do not describe the total UV doses absorbed by human body.

The main objective of this study is to present the results from the comparison of stationary measurements of personal dosimeters Gigahertz-Optik X2000-10 and Solar Light UV-Biometer, and results of measurements of personal UV doses at different human activities. Both meters are designed to measure the erythemal UV radiation.

The comparison of personal dosimeters Gigahertz-Optik X2000-10 and Solar Light UV-Biometer was performed at Legionowo, at different solar zenith angles (SZA) and total ozone (TO). For comparison the reference Solar Light radiometer SL 935, calibrated during international comparison campaigns, was used. The results of dozens measurements at SZA in the range 25-65° and TO from 274 DU to 339 DU, showed a significant dependence of dosimeters correction factor from solar zenith angle.

The measurements of personal UV doses at different human activities have been performed in the Tatra Mountains, during a few excursions at altitude 1000-2000 m above sea level. Measurements were performed simultaneously by two persons and the detectors were fixed on their arms. Personal UV doses were compared with daily doses of UV radiation measured by Solar Light radiometer situated at the IMWM station in Zakopane (855 m a.s.l.). Personal UV dose absorbed by human body during 7-8 hours mountain excursion in clear day is approximately 50% less than daily dose of UV radiation measured by Solar Light radiometer.

Other measurements took place in the eastern part of Poland, during a walk with a child. One detector was fixed to the baby carriage, the other on the arm of the baby-sitter. Detectors fixed to the baby carriage measured the UV dose 50% greater than the other.

Qanats between Menikion and Pangeon Mountains: A forgotten and endangered resource for local water supply

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Due to the growing water shortage in the summer-dry Eastern Mediterranean, the question of water supply has become an important issue. Since antique times subsurface channels (qanats) have been built, which gather groundwater and take it due to the natural slope to places, where the water is needed. In Greece qanat technology has definitely been used during the Ottoman period. After the liberation and the following Greek-Turkish population exchange the knowledge about the systems has disappeared. There is evidence that many of the subsurface galleries are decayed. On the foothills of the Menikion and Pangeon Mountains active qanate systems have been investigated only recently in order to check their activity, contribution to the local water supply and water quality. The results reveal still working qanate systems, which are endangered by regional land use as well as by system-destructive building measures.

Middle Pleistocene rodents (Rodentia, Mammalia) from the fissure filling Kamenjak on Venčac near Arandjelovac (central Serbia)

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In an abandoned limestone quarry (Kamenjak) near Arandjelovac (central Serbia), a fossiliferous fissure filling rich in vertebrate remains has been discovered. The quarry Kamenjak is situated on a ridge of the Venčac Mountains, 500 meters to the west of the top. The fissure is approximately 8 meters long with a maximum width of 70 centimeters, trending in north-south direction. It cuts the layers of weakly metamorphized slates and marbles of the Late Cretaceous age (Turonian-Senonian). The fissure is filled with bone breccia full of bone fragments in reddish matrix of clay, carbonates and limonite.

In this site several samples of bone breccia were collected in 1980 and 1989. Some bones of large and small mammals were extracted from these samples and preliminary described. In this work remains of the following species of rodents have been identified: *Spermophilus citelloides* (Kormos, 1916), *Microtus nivaloides* Forsyth Major, 1902, *Microtus (Terricola) arvalidens* Kretzoi, 1958, *Arvicola* sp. (cf. *cantiana-terrestris*), *Clethrionomys glareolus* (Schreber, 1780), *Lagurus* sp., *Cricetus cricetus* Linnaeus, 1758, *Mesocricetus newtoni* Nehring, 1898, *Cricetulus migratorius* (Pallas, 1773), *Apodemus sylvaticus* (Linnaeus, 1758), *Apodemus microps* (van Kolfshoten, 1985)/*A. maastrichtensis* (Kratohvil & Rossicky, 1952), *Mus* cf. *musculus* Linnaeus, 1758, and *Myoxus sackdilligensis* (Heller, 1930). Some other small vertebrates (insectivores, lagomorphs, amphibians, reptiles) have also been found in this site. The fossil collections are stored at the Museum of Natural History in Belgrade.

The absolute predominance (about 75% of all rodent remains) of only one species (*Microtus nivaloides*) suggests relatively harsh conditions during a cold (glacial) period. This species probably preferred open areas, so it can be concluded that such type of environment prevailed in the vicinity of the site. But some forest inhabitants were also present, as well as indicators of more humid conditions (such as shrews).

On the basis of fossil evidence a Middle Pleistocene age has been proposed for this site. The rodent fauna has been compared with the faunas of some neighbouring countries and it has been concluded that it shows most similarity to the Saalian localities from Hungary (Nagyharsanyhegy-6 and Solymar) and Bulgaria (Morovitsa).

This locality is very interesting because it is the first “fissure filling” site of the Pleistocene age in Serbia with small mammal remains. The second important thing is its Middle Pleistocene age – there are many occurrences of Late Pleistocene mammals in Serbia, but remains of Early and Middle Pleistocene age are rare and usually confined to isolated teeth. Many of the mentioned species are reported in Serbia for the first time. So the investigation of this locality will provide us with a better understanding of this period of Pleistocene.

In the preliminary investigations, the age of the fauna from Venčac has been considered as Late Pleistocene, because of morphological similarity between some extant species and their ancestors. An older age can also be rejected, because there are no *Mimomys* remains, while the genus *Arvicola* – a characteristic element of Middle and Late Pleistocene rodent faunas – is present. Unfortunately, remains of this genus are very scarce and poorly preserved, so they could not be precisely identified and assigned to a species.

The future investigations will hopefully reveal more about this very interesting and rich Middle Pleistocene locality.

Regional geology and correlation of the Eastern Circum-Rhodope Belt, Bulgaria-Greece

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We review on a regional-scale the distinct units of the eastern Circum-Rhodope Belt (CRB) in Bulgaria and Greece aiming to provide an up-to-date synthesis and correlation. The eastern CRB consists of Early-Middle Jurassic supra-subduction zone Evros ophiolite, the MORB related Late Jurassic Samorthaki ophiolite and Middle Triassic-Jurassic clastic, pelitic, carbonate and Cretaceous (?) flysch sedimentary successions. The Lower Cretaceous shallow-water Aliko Limestone seals part of these sedimentary successions already metamorphosed in greenschist-facies. Bulk stratigraphy in ascending order comprises a metasedimentary series overlain by a metavolcanic series. The metamorphic grade increases towards the high-grade basement northwards reaching upper greenschist to epidote-amphibolite facies, and decreases to very low-grade (prehnite-pumpellyite facies) and non-metamorphic stratigraphically upwards in the section. Trace element and REE comparison of the ophiolite basalts and underlying greenschist-facies metavolcanics of same composition reveals similar geochemistry within the distinct units, implying a regional-scale chemical continuity. The allochthonous eastern CRB units show N-directed internal shear deformation and thrust emplacement, obviously along rarely preserved thrust contacts, and record tectonic overprint by Tertiary collision and extensional tectonics in the region. Collectively, the onshore eastern CRB is a region-wide (180 km long along strike ×80 km wide along meridian) tectonic zone including correlative units with regard to their coherent and comparable stratigraphy, tectonics and geochemistry. These units testify for three paleogeographic domains that include Triassic-Jurassic near Rhodope continental margin shallow-water environment, adjacent to this margin Early-Middle Jurassic intra-oceanic arc system responsible for the generation of the supra-subduction zone Evros ophiolite and related to the ophiolite Middle-Late Jurassic trench-slope environment. Another MORB-related paleogeographic domain is indicated by the Samothraki back-arc ophiolite offshore.

‘Back to Nature’ in Conserving Museum Artefacts: Developing a methodology for the investigation of stone consolidants

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The British Museum has a large collection of stone artefacts, including limestone sculptures, from a range of geographical and historical sources. Many of these artefacts are deteriorating and exhibit structural decay, friable or delaminating surfaces, and complications involving soluble salts. The conservation of these artefacts is essential if they are to survive for future generations. Often conservators endeavour to alter a given artefact as little as possible, favouring preventative methods. However, in cases where decay progresses to a serious state where significant portions of an artefact may be lost, more interventive conservation methods may be sought.

The Back to Nature project is a Collaborative Doctoral Award between the University of Oxford and The British Museum. Funded by the AHRC, it is investigating two newly developed techniques; CIPS (Calcite in situ Precipitation System) and Calcium Oxalate treatment, to assess the feasibility of their use within the field of heritage stone conservation. These treatments involve the application of inorganic solutions that react with the stone to produce a consolidant, a material to strengthen and hold an artefact together. These novel techniques mimic natural rock hardening and strengthening processes, and this investigation is situated within a general trend in the conservation field as a whole, to discover treatments that only introduce new materials that are compatible with the original artefact matter. CIPS and Calcium Oxalate treatment are being analysed in comparison with the group of more traditional organic consolidants known as Organo Silanes.

This poster presents the pilot study of the Back to Nature project. Designed with the broad aim of trialling the conservation treatments and to highlight any possible issues with the experimental design, there are two specific objectives of the pilot study. The first is to examine the difference in a select set of measurements between fresh and weathered stone samples. This will examine the importance of the source of sample material, and the issue of whether fresh stone samples can really provide an accurate substitution for artefacts that may have undergone thousand of years of weathering. The second objective is to determine the minimum number of replicates required for an adequate and meaningful comparison of consolidation treatments. The results of these two objectives will provide a basis for the methodology adopted for the Back to Nature research, enhancing the value and reliability of data obtained from future experiment essential to the project, and the results may have wider reaching consequences for the interpretation of data from other stone conservation investigations.

A Mesozoic to Tertiary geodynamic evolution of the southern Dinaric-Hellenic belt: the ophiolites as tools for its reconstruction

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With this abstract we try to schematically reconstruct a portion of the long story of the southern Dinaric-Hellenic, basing our effort on the complex tectono-stratigraphic evolution of the Dinaric ophiolites. First of all, we propose a new classification of the ophiolites cropping out in Albania and Greece that includes seven different types of occurrences, which correspond to different tectonic “units”. From bottom upwards they are: 1- the Sub-ophiolitic Mélange (SOM); 2 - the Triassic Ophiolites (TOP); 3 - the Metamorphic Soles (MES); 4 - the

Jurassic Ophiolites with MOR and SSZ magmatic sequences (JOa); 5 - the Jurassic Ophiolites with only SSZ magmatic sequences (JOb); 6 - the Supra-ophiolitic Mélange (UOM); 7 - the Jurassic Ophiolites with BABB magmatic sequences (JOc). The features of these ophiolites (stratigraphy, geochemistry, tectonic setting and age), the same all over the southern portion of the Dinarids from Albania to eastern Greece, strongly suggest the existence of a single ocean located east of the Adria/Pelagonian continental margin: the Vardar Ocean. This ocean basin developed during the Middle Triassic and was subsequently affected since Early Jurassic by an east-dipping intraoceanic subduction leading to the formation of SSZ magmatism. This subduction was thus responsible of the birth of fore- and back-arc oceanic basins separated by a volcanic arc during Middle to Late Jurassic. This event was followed by the obduction during which a section of oceanic lithosphere thrust westwards onto the Adria margin at the Jurassic-Cretaceous boundary, and the ocean was completely effaced. From this period to the Eocene the westward movement of the Ophiolites on the Adria continental margin, for more than 200 kilometres, till the Pindos took place

We also believe that the model of geodynamic evolution presented herein can be extended to the all Dinaric-Hellenic orogenic belt.

Two partial melting events as recorded by the U-Th-Pb chronometer in monazite: LA-ICPMS in situ dating in metapelites from the Bulgarian Central Rhodopes

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In the Bulgarian Central Rhodopes, the lower part of the metamorphic pile is dominated by migmatitic orthogneisses having recorded fluid-assisted partial melting at 650-700°C / 6-8 kbar. Several zircon and monazite U-Pb ages around 36-38 Ma have been reported, interpreted as dating the crystallization of melts. In the area of Chepelare, this pile is exposed as a ~5 km-thick north-dipping monocline. Structures document top-to-SW shearing developed during and subsequent to anatexis. In the middle part of the section, the ~1 km-thick Chepelare Shear Zone (CSZ) reflects late Eocene syn-metamorphic thrusting and exposes a variegated rock assemblage of highly sheared migmatitic gneisses hosting discontinuous layers of marbles, garnet-kyanite gneisses, metabasites, and ultramafics.

In order to constrain the P-T-time evolution of this variegated rock assemblage, we present new petrological and geochronological data obtained from garnet-kyanite gneisses. The samples represent melt-depleted residual granulite composed of zoned garnet and kyanite porphyroblasts of centimeter size in a low-portion matrix of K-feldspar, quartz and biotite. The latter forms retrograde rims around garnet, and together with kyanite, defines a rough foliation. In some samples fibrolite partially replaces synfolial biotite. The accessory mineral assemblage comprises monazite (up to 400 µm), apatite, zircon, rutile, ilmenite, staurolite, and graphite, found in the matrix, and as single or polyphase solid inclusions in garnet and kyanite porphyroblasts. Polyphase inclusions mark core-rim boundary in zoned kyanite and consist of K-feldspar, quartz, monazite, apatite, rutile, graphite, ± zircon, ± biotite. Planar faces of mineral grains suggest crystallisation of trapped melt. Graphite nucleation indicates participation of carbon-saturated fluids.

U-Th-Pb analyses on monazite were performed by means of LA-ICPMS in thin sections. The results yield two age groups related to the textural position of the monazite grain (included in a garnet or kyanite porphyroblast vs. in the matrix). Mesozoic ages, between 137 and 142 Ma, are most common. They were obtained in all monazite included in garnet as well as in polyphase inclusions in kyanite. P-T estimates based on the metamorphic record preserved in garnet and kyanite suggest granulite facies anhydrous melting, or low $a_{\text{H}_2\text{O}}$ fluid participation, at > 800°C / > 1.2 GPa, that produced peritectic garnet (and probably

kyanite) together with a K-rich melt. In the same samples, Cenozoic ages between 38 and 42 Ma were obtained in the outer rim of monazite grains located in the matrix. These monazites also preserve Mesozoic ages in the grain core. The Cenozoic ages relate to the tectonometamorphic event that led to widespread fluid-assisted partial melting in adjacent orthogneisses. During this event, because they represent a melt-depleted residue with respect to a previous higher grade melting event, the garnet-kyanite gneisses remained unfertile and preserved good petrological and geochronological record of the older event. Nevertheless, they also recorded the Cenozoic event in at least two ways, namely the growth of fibrolite at the expense of biotite, and the partial recrystallization of monazite grains located outside large porphyroblasts.

Finally, an interesting result of this study is the first documentation, in the Bulgarian Central Rhodopes, of a Late Jurassic-Early Cretaceous high-grade metamorphic event that is also known from the Greek part of the Rhodopes Mountains (e.g., in the hanging wall of the Nestos Shear Zone).

Correlation of the Triassic rocks in the Moesian platform (Bulgaria-Romania)

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The Moesian platform occupies a large area in Bulgaria and Romania. A lithostratigraphic division of the cross-section of the Triassic system is performed for both countries. The applied methodology in defining the lithostratigraphic units is based on the "International stratigraphic Guide" by Hedberg. Although the present work aims to unify positions and technical usage of the lithostratigraphic units the latter are rather different in Bulgaria and Romania, which makes difficult the cross correlation.

The Bulgarian part of the Moesian platform is examined according "Regional lithostratigraphic scheme of the Triassic sediments on borehole sections in North Bulgaria".

The lithostratigraphic division for the Romanian part is based on publications.

The following lithostratigraphic units are determined in the Moesian platform:

In the Lower red colour complex: Bulgaria - Petrohan Group and Red colour sandstone unit, Stejerovo Fm., Alexandrovo Fm. and Dobrudja Fm.; Romania - Vedeia-Jiu Group (Carboniferous-Permian-Scythian), Rosiori Fm. (Permian-Scythian) and horizons Bradesti and Viisoara;

In the Carbonate complex: Bulgaria - Iskar Group, Doirentsi Fm., Mitrovtsi Fm., Russinovdel Fm., Preslav Fm. and Tulenovo Fm.; Romania - Alexandria Fm. (Permian-Scythian-Anisian), Putinei evaporites.

In the Upper variegated colour complex: Bulgaria - Moesian Group, Kozlodui Fm., Komshtitsa Fm., Gorni Dabnik Fm., Tuchenitsa Fm., Dulovo Fm., Kaliakra Fm. and Shabla Fm.; Romania - Oltet Group (Triassic-Lias-Dogger), Segarcea Fm., horizons Curmatura, Beiu and Teascu, Motoci complex.

The present correlation determines three type of units: A) Analogous units (subjective synonyms); B) Units defined on Bulgarian territory and probably present also in Romania; C) Units located only in Bulgarian and respectively in Romanian part of the Moesian platform.

The detailed research and well investigations demonstrate the following results:

A) Analogous units (subjective synonyms):

In the Lower red colour complex there are Red colour sandstone unit (Bulgaria) - Bradesti horizon (Romania); Stejerovo Fm. (Bulgaria) - Viisoara hor. (Romania); Petrohan Group (Bulgaria) - Triassic part of the Rosiori Fm. (Romania, Permian-Triassic) and Vedeia-Jiu Group (Romania, Carboniferous-Permian-Scythian).

In the Carbonate complex have been established Doirentsi Fm. (Bulgaria) - Anisian parts of the Alexandria Fm. (Romania, Permian-Scythian-Anisian).

In the Upper variegated colour complex there are Komshtitsa Fm. (Bulgaria) - Curmatura hor. (Romania); Gorni Dabnik Fm. (Bulgaria) - Beiu hor. (Romania); Dulovo Fm.

(Bulgaria) – Teascu hor. (Romania); Moesian Group (Bulgaria) - Segarcea Fm. (Romania) and Triassic part of the Oltet Group (Romania, Triassic-Lias-Dogger).

B) Units defined in Bulgaria and probably developed also in Romania:

In the Lower red colour complex there is Alexandrovo Fm.

In the Carbonate complex there are Mitrovtsi Fm., Russinovdel Fm., Preslav Fm. and Iskar Group.

In the Upper variegated colour complex there is Kozlodui Fm.

C) Units characteristic only of Bulgaria, respectively only of Romania:

In the Lower red colour complex have been established Dobrudja Fm. (Bulgaria), Scythian carbonates (Romania, part of the Alexandria Fm.).

In the Carbonate complex there are distinguished Tulenovo Fm. (Bulgaria), evaporites from Putinei (Romania).

In the Upper variegated colour complex there are Tuchenitsa Fm. (Bulgaria), Kaliakra Fm. (Bulgaria), Shabla Fm. (Bulgaria), Motoci complex (Romania, sedimentary-volcanogenic).

Kinetic and isothermal study of lead ion adsorption onto natural bentonites with different cation exchange capacity (CEC) from Milos Island, Greece

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A laboratory batch study has been performed to investigate the adsorption characteristics of lead (Pb^{2+}) metal ions onto natural bentonite samples (B1, B2, B3) with different cation exchange capacity (CEC) values. Bentonite samples come from Milos island, Greece and were supplied by S&B Industrial Minerals S.A. Bentonites consist mainly of Ca-montmorillonite (>85%) with minor and different amounts of kaolinite, calcite and quartz. The CEC values of B1, B2 and B3 were 86.5meq/100g, 95.7meq/100g and 67meq/100g, respectively. The specific surface area of B1, B2 and B3 was measured as 87.3 m²/g, 66.6 m²/g, and 80.1 m²/g, respectively. Equilibrium and kinetic experiments were performed. The effect of various physicochemical factors that influence adsorption, such as solution pH (2-6), amount of adsorbent (1-10g/L), initial metal ion concentration (5-150mg/L), and contact time (20-360min) were studied. The measured adsorption capacity was appreciably high for most experimental conditions. It has been found that the amount of adsorption of lead metal ion increases with initial metal ion concentration, contact time, solution pH but decreases with the amount of adsorbent. The adsorption process was strongly dependent on the pH of the medium with enhanced adsorption as the pH turns from acidic to alkaline side till precipitation sets in. The amount of Pb^{2+} adsorbed per unit mass (q_e) of the adsorbent decreased with an increase in the amount of the clay adsorbent. This may be attributed to two reasons: (i) a large adsorbent amount effectively reduces the unsaturation of the adsorption sites and correspondingly, the number of such sites per unit mass are reduced resulting in comparatively less adsorption at higher adsorbent amount, and (ii) higher adsorbent amount creates particle aggregation, resulting in a decrease in the total surface area and an increase in diffusional path length both of which contribute to decrease in amount adsorbed per unit mass. The removal rate of bentonite increased with an increase in the initial metal ion concentration. Both Langmuir and Freundlich isotherm models fit well ($R^2 > 0.93$) the adsorption process. By using the Langmuir isotherm, the maximum adsorption capacities for B1, B2 and B3 were found as 85.47 mg/g, 73.42 mg/g and 48.66 mg/g, respectively. In order to investigate the mechanism of adsorption, particularly potential rate-controlling step, the Lagergren pseudo-first-order kinetic model, the pseudo-second-order kinetic model and the intra-particle diffusion model were used to test the dynamic experimental data. Kinetic analyses not only allow the estimation of sorption rates, but also lead to suitable rate

expressions characteristic of possible reaction mechanisms. The calculated kinetic parameters are of a great practical value for technological applications, since kinetic modeling successfully replaces time- and material-consuming experiments, necessary for process equipment design. Kinetic experiments clearly indicated that adsorption of lead metal ion (Pb^{2+}) on bentonite was a two steps process: a very rapid adsorption of lead metal ion to the external surface was followed by possible slow decreasing intraparticle diffusion in the interior of the adsorbent which has also been confirmed by intraparticle diffusion model. Overall the kinetic studies showed that the lead adsorption process followed pseudo-second-order kinetics.

On the mineralogy, physical characteristics, and main elemental content of urban road dust particles from the historic centre of the city of Thessaloniki, northern Greece

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The objective of this study was to characterize urban road dust particles and to study their possible health effects. Road re-suspended dust has been recognized as one of the major contributors to TSP elevating concentrations in Thessaloniki. Eight samples of road dust were collected from the accumulated matter at the edges of major roads in the historic centre of the city of Thessaloniki. The predominant size fraction, according to mass, was 125–500 μm , while the mass fraction of the suspendable dust particles (20–63 μm and <20 μm) was the lowest. Special emphasis was given to the mineralogical characteristics of the urban deposits. Road dusts were mainly composed of quartz, calcite, while plagioclase, dolomite, K-feldspars, amphiboles, micas and chlorite were contained in minor amounts. Amorphous phase was also determined mainly in the finer fractions (20–63 μm and <20 μm). Scanning electron microscopy shows that dust particles consist of subhedral to anhedral crystalline grains, near-spherical and irregular agglomerates as well as few organic materials. EDS analyses reveal that the composition of dust particles is basically Ca-rich, Fe-rich and silicates.

Accumulation and distribution of organic matter in sediments of salt-affected shallow lakes at Szeged, Hungary

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The primary aim of the research is to investigate the accumulation and distribution of organic material [OM] in saline shallow lacustrine sediments. This study focuses on the OM parameters of sediments at two areas with different hydrology, land use, and vegetation cover. The study area is located at the Fehér Lake, Szeged (Hungary). The studied salt-affected lake system has been under intensive fish breeding from 1970. Sampling was made during the spring of 2007. In case of the profiles a 4 m deep 10 cm diameter sediment core was extracted. The OM data were measured with Rock-Eval pyrolysis, and the proportion of different OM groups was determined by the mathematical deconvolution of Rock-Eval pyrograms. It is showed that there are significant differences in OM distribution and characteristics if the different study sites are compared. In case of both profiles similar changes can be detected in the origin, quantitative and qualitative parameters of OM at depths of 15, 30, and 65–70 cm, which proves that the two sites belonged to the same depositional system, and similar changes affected them during sediment formation. Although both profiles have the same depositional environment, significant difference can be seen between the profiles. The profile 1 used to be located in coastal natural territory till 1970 and the profile 2

represents a constant water-irrigated fields. The fluctuation of F1+F2 and F3 values in Profile 1 suggests that the OM content of the marginal territory (both in its natural and present state) is determined by the alternation of dry and wet periods, sometimes with a high algae production in slack waters. Based on the quality parameters of OM, dry and wet accumulation periods can be separated, and signs of human influence can also be identified.

Middle and Late Triassic radiolaria from Kotel'nyi Island (New Siberian Islands, Russia, Arctic) and their paleobiogeographical significance

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Kotel'nyi Island is located in the Arctic Ocean near to the prolongation of Southern Anyi ophiolite suture zone which is supposed to be remnant of southern Anyi Paleo-ocean located between Eurasian and North American plates. Therefore the information on Early Mesozoic faunas of this area and their paleobiogeographic affinities represent high interest for paleogeography and paleotectonics. Triassic of Kotel'nui Island is represented by all three series that are well characterized by ammonites, nautiloids, coleoids, bivalves and radiolarians. Section is characterized by predominance of soft clays. Radiolaria are present in the Middle and Upper Triassic, from Upper Anisian to Middle Norian.

The Middle Triassic is represented by Anisian black clays with interlayers of bituminous shales, clayey limestones and phosphatic concretions with total thickness 30 - 140 meters. Ladinian is composed of similar clays with thickness 6 - 15 meters. Radiolaria were found in the Upper Anisian together with ammonites *Indigiophyllites popowi* Konstantinov. They are represented by *Glomeropyle clavatum* Bragin, sp. nov., *G. boreale* Bragin and others (11 species). Next radiolarian assemblage was found in the Upper Ladinian (with bivalvs *Daonella* sp. ex gr. *D. frami* Kittl.): *Muelleritortis firma* (Gorican), *M. kotelnyensis* Bragin, sp. nov., and others (10 species). Upper Triassic is represented by Carnian clays with siderite and phosphatic concretions (100 m) and Norian clays with siderite and phosphatic concretions (up to 500 m). Radiolaria are present in the Lower Carnian (with ammonoids *Discophyllites taimyrensis* Popov): *Pentactinocarpus colum* Bragin, sp. nov., *Glomeropyle cuneum* Bragin, sp. nov., and others (12 species); Upper Carnian (with ammonoids *Yakutosirenites yakutensis* (Kiparisova): *Pseudostylosphaera glabella* Bragin, sp. nov., *P. gracilis* Kozur et Mock, and others (34 species); and in the Lower Norian (with ammonoids *Striatosirenites kinasovi* Bytschkov): *Pseudostylosphaera glabella* Bragin, sp. nov., *P. gelida* Bragin, sp. nov., and others (10 species). Each radiolarian assemblage includes several forms know from low-latitude regions as Mediterranean and Japan. These taxa constitute from 25 to 40 % of all species present in assemblage/

These results allow making several conclusions:

1) The sections include several radiolarian assemblages ranging from late Anisian to the early Norian. Taxonomic diversity of the assemblages increases at the stratigraphic levels rich in phosphorites and bituminous shales, which probably correspond to transgression episodes and well correlate with intervals of abundance of cephalopods.

2) Triassic radiolarian assemblages from Kotel'nyi Island significantly differ from the coeval radiolarians of Pacific and Mediterranean. They are characterized by domination of genus *Glomeropyle* Aita et Bragin which is present only in Northern Siberia and in the New Zealand and displays bipolar distribution pattern. Triassic radiolarian assemblages of these regions display clear affinity. Radiolarians can serve as paleoclimatic indicators for the Triassic.

3) The Middle Triassic radiolarian assemblages from Northern Siberia and regions of Mediterranean and Pacific include a number of common species (25-40 %). Using them, we can correlate Triassic deposits. This approach is helpful for solving the basic problem of correlation between Triassic deposits accumulated in the high- and low-latitude zones.

4) The presence of low-latitude species in radiolarian assemblages is well correlative with constant presence of low-latitude taxa among cephalopods. Their assemblages include

several species known from Mediterranean and North America. These facts can be explained as results of marginal position of Kotel'nyi Island in the Boreal Realm and well connections between basins. We can interpret the appearance of warm-water taxa by the influence of warm current coming from Pacific via suspected North Anyi Paleo-ocean.

Radiolarian biostratigraphy of supraophiolitic Cretaceous metalliferous sediments of Cyprus (Perapedhi Formation)

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Sedimentary strata related with ophiolites commonly represent high interest for tectonostratigraphic reconstructions. Upper Cretaceous Perapedhi Formation represents lowermost part of sedimentary cover of Troodos Ophiolite Complex, and consists of umbers (sediments enriched by iron and manganese) and cherts with total thickness ranging from few meters up to nearly 50 m. These sediments are characterized only by radiolarians that still need detailed study.

Best section of Perapedhi Formation is known in the former Mangaleni quarry, Limassol District. Three lithological units can be distinguished in this section: 1 – dark-brown massive umbers (2-20 m), 2 – intercalation of brown umbers and brown radiolarian cherts (6-10 m), 3 – pink ribbon cherts (up to 6 m). All units are characterized by abundant well-preserved radiolarian assemblages. According to stratigraphic distribution of radiolarian taxa the following radiolarian zones and subzones can be distinguished in this section:

1. *Alievium superbum* Zone, Turonian, *Theocoronium subtriquetrus* Subzone. First occurrences (FO) of *Pseudodictyomitra* sp. A and *Theocampe cypraea* Bragina (middle part of unit 1).

2-3. *Alievium praegallowayi* Zone, Coniacian, subdivided into: 2. *Multastrum regale* Subzone, FO of *Archaeospongoprunum bipartitum* Pessagno, *Annikaella omanensis* De Wever (middle part of unit 1 – lower part of unit 2); 3. *Microsciadiocapsa quasisutterensis* Subzone, FO of: *Lipmanium* (?) *ovalum* Bragina (lower part of unit 2).

4-7. *Alievium gallowayi* Zone, Santonian – Lowermost Campanian, subdivided to: 4. *Quinquecapsularia* sp. A Subzone, FO of *Theocampe urna* (Foreman) (lower – middle part of unit 2); 5. *Dorypyle* sp. A Subzone, FO of *Acanthocircus* sp. A, *Dictyodedalus* sp. A (middle – upper part of unit 2); 6. *Multastrum mangaleniense* Subzone, FO of *Amphipyndax* sp. ex gr. *A. pseudoconulus* (Pessagno) (lower part of unit 3); 7. *Bisphaerocephalina* (?) *amazon* Subzone, FO of *Dorypyle* sp. B, *Neosciadiocapsa urquharti* Bragina, *Theocampe salillum* Foreman (middle part of unit 3).

8. *Crucella espartoensis* Zone. FO of *Dictyomitra koslovae* Foreman subsp. B, *Heliocryptocapsa* sp. B (upper part of unit 3). Therefore the total stratigraphic range of this section is Turonian – Lowermost Campanian

Another section of Perapedhi Formation was studied near Perapedhi Village, Central Cyprus. It is represented by umbers with recrystallized chert bodies and rare layers of pink radiolarian cherts with total thickness 10 m. These strata yield radiolarian assemblage of Subzone 6 only (*Multastrum mangaleniense*).

Therefore, the deposition of metalliferous sediments of Perapedhi Formation was diachronous. In the Mangaleni Section it starts in the Turonian, but in the Perapedhi Section it was considerably later (Santonian). This phenomenon can be interpreted as result of deposition of Perapedhi Formation in isolated small depressions of Troodos Ophiolite Complex that was completely formed in Turonian.

Geomorphologic landscapes of the central part of Northern Eurasia

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We define geomorphologic landscape (GL) as the complex of geomorphologic, tectonic, and landscape-climatic characteristics incident to a certain territory. Such complex includes absolute height, amplitude of neotectonic movements, their gradients, the depth of erosion dissection and its density, intensity of landslide, karst, thermokarst and glacial processes, the amount of woodlands and the degree of peat formation, precipitation, runoff, and frost-free period. The territory analyzed includes the East-European Plain, the Ural Mountains, and the Western Siberia. The 20'x30' spatial cells, described by the above mentioned 15 parameters, were clustered by k-means method with different k values. Euclidean distance was used. The results of clustering are represented as maps, where spatial distribution of different clusters, or GL, can be seen. Each GL is characterized by the set of parameter means, which determine the shape (the type) of a given GL. According to F-ratio the geomorphic parameters play the significant if not the main role in clustering. The set of cluster solutions with k=2, 5, 9, and 17 are represented.

The two plains have some common GLs only at rough division with small k values; at k=2 there are two variants of division: first – mountainous (The Urals) and plain GLs, second – GLs of the accumulative plain (the Western Siberia) and of the erosion-denudation plain. At k=5 the northernmost and the southernmost parts of the plains have common GLs: tundra GL of permafrost-erosion dissection and GL of semiarid plains with extremely low erosion and denudation correspondingly. GL of boggy lowlands with low neotectonic intensity and low erosion occupies the central part of the West Siberia while GL of neotectonic highlands with intense erosion dissection and complex of denudation processes occupies the most part of the East-European Plain. More detailed divisions (with k=9, 17 and more) show clear difference between the two plains, and at k=20 they have no common GLs. The GLs of the Western Siberia have less dispersion of parameters, i.e. they are more homogeneous, and their boundaries show stronger dependence on the latitudinal zonality than those of the East-European Plain. The latter reveals more diversity of GLs than the Western Siberia. The Urals having the GLs of the “mountain” type don't form the single area: the most part of the Middle Ural falls into the GLs of the East-European Plain types at any k value.

The tree clustering of the GLs themselves (Euclidean distances, Ward method) demonstrates their hierarchical structure, which is in good agreement with the results of k-means method. The spatial GL's boundaries are sufficiently stable to the changes of k values and to the variation of the set of parameters. The approach described can be used also as a method of typological regionalization in other geographic regions.

Age relations and volcanology of zircon bearing basalts from Eastern Saxony (Germany)

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In alkali basaltic rocks scarcely appear accessory minerals such as zircon and corundum. The origin of these mostly gem stone like mega-crystals is unknown and controversial. However, if zircon crystals present they are important tools to clarify petrogenetic questions of the host melts. Host magmas of the zircon mega-crystals are normally SiO₂ under saturated such as basanites and nephelinites.

In several localities we could observe some zircon mega-crystals and in a quarry in Saxony (eastern Germany) we collected 36 crystals up to 15 mm in size in situ from the

basanitic rock. Zircons occur in agglutinates of lower crater facies of a scoria cone. The related lava flows are almost free of zircons and their Zr contents reaches up to 900 ppm. There is a good correlation between Ar/Ar data of the basanites (30 to 31 Ma) and the zircon U/Pb data which show ages about 30.5 Ma.

A further known locality of zircon mega-crystals is the so called Seufzergündel placer in Elbsandsteingebirge / Saxon Switzerland (eastern Germany). There are observed zircon mega-crystals up to 9 mm in size. Their host rock is a lapilli bearing volcanic breccia, implying here a polyphase explosive volcanism. The age data of zircons have various values; while the Pb/Pb crystallization-ages range by 54 ± 6 Ma the U/Pb dating gets about 35 Ma.

Furthermore zircon mega-crystals were sampled from placers and residual soil of basanitic and nephelinitic as well as phonolitic rocks from different localities via heavy mineral separation techniques. The crystals show an intensive magmatic corrosion in alkalibasaltic rocks (including nephelinites), while zircons out of phonolites are mostly euhedral.

Thus the zircon mega-crystals were carried by alkali basaltic magmas but were not in equilibrium with these melts. Basaltic host rocks of the mega-crystals are developed of primitive mantle melts, implying a short residence time for zircons in the melt. The solution rates of zircon in such melts are possibly high which could be seen in the intense magmatic corrosion. Therefore zircon mega-crystals occur mostly in pyroclastic rocks and are scarce or absent in massive lava flows. The latter have a much longer cooling time.

Another possibility for enrichment of mega-crystals in pyroclastic rocks should be that the ascending bubbles in the vent carry away the solid parts, like xenocrystals or phenocrystals of the magma column. This could be the reason for lacking of in situ proofs of zircons in massive basalts.

The age data of the zircons in relation to that of the host rocks imply a cogenetic development of both.

Geology and tectonics of the Vršatec Klippen area (Pieniny Klippen Belt, Western Slovakia)

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The Pieniny Klippen Belt (PKB) is a narrow (merely several km), but lengthy (up to 600 km) zone dominated by Late Oligocene – Miocene wrench tectonics. It separates the Cenozoic accretionary complex of the External Western Carpathians from the Cretaceous nappe system of the Central Western Carpathians. Our investigation was focused on the tectonic structure and evolution of the Vršatec klippen area in the western Púchov sector of the PKB. The studied area includes the Oravic (Czorsztyń, Kysuca, Orava and Transitional Units) and the “non-Oravic” tectonic units (Klape and Drietoma Units). Detailed geological mapping and systematic field structural research of meso-scale deformational structures revealed the record of multistage tectonic evolution during Senonian-Pliocene times. The oldest recognized stage resulted in formation of the Mesoalpine fold-nappe system of the PKB due to subduction and closure of the Vahic Ocean during the Senonian – Early Eocene times. This compressive stage was accompanied by thrusting of the presently most external Kysuca Unit over the Czorsztyń and transitional units and by formation of macroscopic folds with the NNE-SSW to NE-SW trending fold axes. The main compression was oriented perpendicularly to the strike of the PKB recently trending in the SW-NE direction. The thrusting and folding were followed by several brittle deformation stages. The oldest stages (E-W to NW-SE oriented maximum compression) produced the NE-SW trending dextral positive flower structure along the western boundary of the PKB and resulted in the final morphostructural character of klippen with long axes oriented in the NE-SW direction. The dextral transpression was a result of the continuing shortening and relative counterclockwise rotation of the ALCAPA block in the Late Oligocene – Early Miocene. The younger N-S oriented compression (Early – Middle Miocene) produced mainly sinistral faults roughly

parallel to the strike of the belt in the sinistral transpression regime. The apparent shift of the main compression to the N-S direction was an effect of a rigid counterclockwise rotation of the ALCAPA block during the Early Miocene. Mostly strike-slip and normal faults were formed during the next two tectonic events (Middle to Late Miocene) as a product of the transtensive tectonic regime with NNE-SSW to NE-SW trending compression. Active clockwise rotation of the main compressional stress axis from N-S to NE-SW direction, and inversion from the older transpression to the younger sinistral transtension resulted from NE-ward translation of the ALCAPA block. The NE-SW trending normal faults were generated by the NW-SE extension during the final deformational phase under the extensional tectonic regime (Pontian-Pliocene).

Development of Lower Cretaceous deposits from Bihor-Pădurea Craiului unit (Apuseni Mountains, Romania): Comparisons with Villany region in Hungary

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The Lower Cretaceous deposits from Bihor-Pădurea Craiului unit follow a sedimentary gap due to the uplift of the region at the end of the Late Jurassic, when bauxitic rocks were formed. The succession consists of the following lithostratigraphic units: (1) Blid Formation, comprising two members: (1a) Dobreşti Member (Valanginian-Hauterivian) known in the old literature as “Limestone with characeans and gastropods”), and (1b) Coposeni Member (Barremian), the old “Lower Pachyodont limestone”; (2) Ecleja Formation, consisting mainly of marls, but containing also two lithologically different members: (2a) Gugu Breccia Member (Upper Barremian), and (2b) Valea Bobdei Limestone Member (Lower Bedoulian), corresponding partly to the old “Middle Pachyodont limestone”; (3) Valea Măgurii Limestone Formation (Upper Bedoulian), also corresponding partly to the old “Middle Pachyodont limestone”, and (4) Vârciorog Formation (mainly marls and sandstones, with limestone intercalations) (Gargasian-Albian) that correspond to the old “Formation of glauconitic sandstones and Upper Pachyodont limestone”. Of these lithostratigraphic units Dobreşti Member and Ecleja Marls have been often a subject of controversy. The age of Dobreşti Member proved to be Valanginian-Hauterivian. Regarding the Ecleja Marls, recent researches revealed that the succession of the startotype is younger as considered before (Late Aptian-Albian, instead of Late Barremian-Early Aptian). Other recent researches have shown the development of a large pile of Upper Aptian-Albian platform limestones, equivalent of limestone intercalations within the Vârciorog Formation. These new data change our understanding of the Bihor-Pădurea Craiului basin evolution during the Aptian-Albian time interval. At the beginning of Aptian, a deeper basin was formed. On local highs within the basin isolated carbonate platforms developed (Valea Bobdei, Valea Magurii, and Subpiatra Limestones). Material from these platforms can be found as debris flows (allodapic limestones) intercalated in the terrigenous succession of the basin.

Within the Villany Hills (Hungary) the Nagyharsány Limestone formed also on the Upper Jurassic Szársomlyó Limestone Fm revealing bauxite lenses (Harsányhegy Bauxite Fm) at its base. The age of the Nagyharsány Limestone which consists of four lithologic (calcareous) members is considered as Valanginian-Early Albian. It is covered by the Bisse Marls of Late Albian-Cenomanian age. No other marl intercalations were reported from the Nagyharsány Limestone.

The Bisse Marl is replaced at a marked contact by flysch type succession of the Bóly Sandstone Formation in the Late Albian. Based mainly on micropaleontological association the lower part of the Villány succession could be compared with the Dobrești and Coposeni members of the Blid Formation, while its middle and upper parts of the Nagyharsány Limestone could be correlated with Valea Bobdei-Valea Măgurii, and Subpiatră Limestones, respectively. The Vârciorog Fm is equivalent to the Bisse and Bóly Formations.

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Clay, secondary dissolution, and tectonic controls on the reservoir properties in Upper Eocene tuffs, West Thrace Basin, Turkey

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The diagenetic history of the Upper Eocene tuffs in the West Thrace Basin is based on petrological analysis of samples from six boreholes. Diagenesis in the tuffs principally involves the progressive development of various types of cements in the following order: quartz overgrowth, zeolite authigenesis, chlorite and illite authigenesis. After the formation of the cementation phases, there was a dissolution phase creating secondary porosity via the dissolution of volcanic glass and feldspars, accompanied by generation of analcime and a late mordenite cementing phase. The tuffs also have been affected by the following diagenetic processes; fracturing and calcite, quartz, and zeolite cementation.

Tuffs in the West Thrace Basin may contain significant amounts of secondary porosity owing to unstable grain and volcanic glass dissolution caused by relatively rapid rates of pore-fluid flow. Also tectonic stress appears to have controlled development of secondary porosity formation in the West Thrace basin which in turn might have been responsible for high porosity of the deep reservoirs. At depths greater than 2000 m, the porosity increases with depth due to secondary solution activities and fracturing in the West Thrace basin. Secondary Porosity is very important for hydrocarbon explorations in the Upper Eocene tuffs in the West Thrace basin. The dominant porosity type produced by dissolution processes (intragranular, intergranular). Fracture porosity also significantly increases reservoir quality. Authigenic clays may affect reservoir quality depending on type of clay and its distribution. However, dissolution and fracturing are generally a more effective diagenetic process than cementation in the tuffs of West Thrace basin.

Statistical tidal tomography of the Vrancea intermediate-depth seismic zone

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The aim of the study is to identify specifically temporal and spatial patterns of the intermediate seismic activity in Vrancea seismic zone using new approaches. We have investigated the influence of the principal lunar semidiurnal tidal component M2 on intermediate seismic activity in Vrancea (Romania) sub-crustal region from 1934 to 2009 with a special regard for the time series of events from 1980 to 2009. The constituent is assigned by HiCum stacking method according to the earthquake occurrence. “Schuster” and “Permutation” independent tests are applied to distributions found by stacking. Null hypothesis between seismic activities and selected tidal periodicities is rejected when the statistical p-values obtained by the two tests are less than 5% level of confidence in term of statistics. The stacking function is applied to time series of events belonging to windows

shifted in time and space, respectively, to evaluate the variability of correlations in both cases. In the case of 3D shifting domain, a specific algorithm, called “statistical tidal tomography”, is described. The results reveal important issues: a). There is a specific temporal footprint of the p-values around the larger earthquakes; b) A Fast Fourier Transform on the n-order polynomial least squares fit (LSF) of the p values variations emphasizes a long-term period about 17 – 18 years; c) Following the 3-D distribution of $p < 5\%$ values in different sliding time windows we observe a certain pattern confirmed by the CN algorithm for the earthquake prediction and the future strong Vrancea events monitoring; d) the statistical tidal tomography of M2 component has similar patterns with the analysis of seismicity patterns introduced by others for the Vrancea seismic region.

Combined petrological, geochemical, and statistical analysis of Eocene-Oligocene sandstones of the Thrace Basin, Greece and Bulgaria

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The Rhodopean Orogen developed since Late Cretaceous-Lower Eocene during accretionary processes following the closure of the Vardar ocean basin. We concentrate on Paleogene clastic sediments of the Rhodope area, developed synchronous to the post – Cretaceous collisional collapse and the subsequent Tertiary extensional phase. Throughout a multidisciplinary approach, including sedimentary petrology, sandstone geochemistry and compositional data analysis, we argue to reconstruct the unroofing history of the Rhodopian orogen and the abrupt onset of the volcanic activity between Late Eocene and Oligocene across the eastern and southern Rhodopian region. A total of 127 sandstone samples have been analysed. Sandstone detrital modes include three distinctive petrofacies, a quartzolithic, quartzofeldspathic and volcanoclastic. The major contributions are from the metamorphic basement units, represented mostly by low-medium grade lithic fragments for the quartzolithic petrofacies and high grade metamorphic rock fragments for the quartzofeldspathic petrofacies. Volcanoclastic sandstones recorded different composition between eastern Rhodopes and southern Rhodopes samples. Detrital mode evolution testifies contributions from three key source areas corresponding with the two main crystalline tectonic units of the Rhodope Massif, Variegated Complex and Gneiss-Migmatite Complex and from the Circum-Rhodope Belt. The volcanoclastic petrofacies is interbedded with quartzofeldspathic petrofacies reflecting superposition of active volcanic activity. Geochemical analyses for major and trace elements provide useful provenance informations. The Zr/Sc vs. Th/Sc and Cr vs. Cr/Ni plots suggest that sediment recycling is negligible. The use of geochemical diagrams for tectonic setting discrimination confirmed, in most of the cases, the inferred tectonic setting, corresponding mainly to an active continental margin and subordinately to a continental island arc. The idea of a multidisciplinary approach has been represented by the successful attempt to use together the information provided by petrographic and geochemical analyses. Compositional data from Eocene-to-Oligocene sandstones of the Thrace Basin were used to unravel the interplay between tectonics and sedimentation by means of multivariate statistical methods adapted to the particular nature of the available data (concentrations and percentages). The biplot was particularly useful in order to extract details in terms of source area evolution. The indications obtained call for a progressive enrichment from mafic to felsic elements, corresponding to increasing rates of supply from deeper levels of the crust. In conclusion, petrostratigraphic (detrital modes)

evolution and geochemical signatures of the Eocene-to-Oligocene sandstone suites of the western portions of the Thrace basin in Greece and Bulgaria is closely related to various geodynamic stages of the Rhodopian region, from collisional to post-collisional orogenic collapse and the superimposed volcanism related to extensional collapse. The type of sedimentary provenance of these Rhodopian Paleogene sandstones, provide an example of the changing nature of orogenic belts through time, and may contribute to the general understanding of similar geodynamic settings.

Underwater geoarchaeological survey in front of the Danubian Island “Pacuiul Lui Soare” (Romania) using Remote Sensing Techniques – Preliminary results

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On the Danubian island "Pacuiul lui Soare", between 355 and 357 km, there are the ruins of a Byzantine fortress from the X-XIII centuries, most of which has already been eroded by the Danube river. A seismoacoustic survey which was carried out along the Danube in front of the island, showed the presence of the fortress ruins under the river waters. Further geo-archaeological survey is required in the studied area, aiming to a better understanding of the island evolution and of the fortress history as well.

Geochemical survey – an optimal solution in environmental assessment on local and regional scale

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The quality of environment is extremely important for the human society development as well as for the entire biosphere equilibrium. In order to decipher the real status of an extended (regional) area and to rapport the print image of the local areas - subjects of development projects, a geochemical investigation have been performed in the Bucharest-Ilfov Region (Romania). The environmental factors (soil, underground and surface water and plants) evaluation on local or regional scale finds in geochemical survey (sampling, analyzing, mapping and reporting to national/international qualitative standards) an adequate solution. Taking into account the necessity of evaluating and monitoring the intensive populated areas, the exigency of such operation on height qualitative standards and at low costs increases. Admitting the European criteria to evaluate the water, soil and plants quality preservation as reasonable and averaging between national standards of EU community, the first observation regards the lowest possible price of sampling (proportional with sampling density, and increasing in case of difficult field access) and the highest accuracy/detection limits of final qualitative database acquisition. The necessary analytical diversity for a complex environmental investigation exceeds the classical routine of geological-geochemical one (usually limited to metalogenetic objectives) and includes various sophisticated categories (organic). For example the pesticides (a widespread category of biocides) investigation is an example of mostly refined and expensive analytical imperative. A systematic sampling must be performed at densities that ensure the representativeness on small surfaces (at least 4 soil samples/km², 1-2 underground water samples/km², 1 surface water sample/km², 2 samples of the same species of plant/km²) followed by physical-chemical analyses for specific categories (*soil*: As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, mononuclear aromatic hydrocarbons and poli-aromatic hydrocarbons BTEX, PAH, insecticide organic-

chloride; *vegetation*: As, Cd, Cr, Cu, Pb, Ni, Zn, Hg; *water*: pH, conductivity, soluble oxygen, NH⁴⁺, NO₂, NO₃, PO₄, Cl, SO₄, Ca, Mg, Na, As, Ba, Cd, Cr, Cu, Co, Pb, Mn, Ni, Fe, Se, Zn, Hg, Te, Tl, Sn, U, V, phenols, BTEX, PAH, policlorurate biphenyl, organic-chloride insecticides. The mono-compound maps for each analyzed category were performed. Looking to the toxic and undesirable categories for each factor, lots of polluted areas have been identified as well as the pollutant sources.

In order to evaluate less expensive solutions and the most relevant/representative mapping, the sampled/analyzed data were gradually reduced. The successive maps were analyzed in order to establish the proper sampling density for each chemical category. The quality of the environmental factors on the studied territory was affected by the lack of protection–prevention measures during the communist economy expansion and the massive post communist abandon of the industrial and agro-industrial units and by various polluting activities. This territory is undergoing an intensive developmental dynamic, the most intense of the entire national territory. Besides, the lack of a preliminary evaluation of the qualitative stage and the geographical extent of the polluting phenomena influences the environmental factors and will affect directly and essentially the quality of human life and socio-economic development. The elaboration of the cartographic image on the environmental pollution/preservation (the main purpose of this paper) supports both the necessary protection/prevention measures and the future socio-urban and cultural development plans for the target area (*Bucharest-Ilfov*). Meanwhile, it validates the geochemical systematic investigation as the main efficient and accurate methodology in assessment of environmental status of an area.

The Eocene-Oligocene geodynamic setting of the Thrace Basin (Turkey, Greece, and Bulgaria)

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The Thrace Basin is an important hydrocarbon province covering an area in excess of 15,000 sq. km in Turkey, Greece, and Bulgaria. The complex historical vicissitudes of the region have made collaboration among the researchers of the three countries difficult. Consequently, a unified and widely accepted geological interpretation of the Thrace Basin is still missing. Nevertheless, a great wealth of outcrop and subsurface data is already available from both academic and industrial sources. Integration of preexisting data (seismic and oil-well stratigraphy, geological-structural field maps) with new field mapping as well as new stratigraphic, sedimentologic, thermochronologic, petrologic, and radiometric data has provided significant constraints on the evolution of the basin.

The Thrace Basin developed during the complex transition between the collisional tectonic regime following the closure of Vardar-İzmir-Ankara oceanic realm and the extensional regime characterizing the Neogene evolution of the Aegean and periAegean regions. It was long interpreted as a forearc basin which developed in a context of northward subduction. This interpretation was challenged by more recent data emphasizing the lack of a coeval magmatic arc. The interpretation of the Thrace Basin as a forearc basin was also based on the occurrence, along its southern margin, of a belt of chaotic deposits interpreted as a tectonic mélangé formed in an accretionary prism. However, this tectonic mélangé may represent olistoliths in an Eocene sequence. All these elements along with the correspondence between subsidence pulses in the basin and lithospheric stretching in the metamorphic core complexes of southern Bulgaria and the northern Aegean region may indicate instead that the Thrace Basin was the result of either (i) post-orogenic collapse after the continental collision related to the closure of the Vardar ocean, or (ii) upper-plate extension related to slab retreat in front of the Pindos remnant ocean. Preliminary data indicate that initial subsidence (Ypresian-early Rupelian) was localized in small depocenters delimited by a system of strike-slip faults, probably during the late stages of collision. Further subsidence over a wider area

occurred during the rest of the Oligocene, in agreement with the timing and areal distribution of crustal stretching phenomena evident during this length of time over the entire northern Aegean region. This hypothetical two-stage evolutionary trend might represent a predictive tool in the tectonostratigraphic interpretation of similar sedimentary basins.

Seismic sections across the central part of the basin and the tectonostratigraphic interpretation of outcrops in the Gelibolu Peninsula and along the Greek-Turkish border show that between the Middle Eocene and the Early Oligocene important east-west-trending transcurrent faults cut the Thrace Basin, generating a series of depocenters and uplifts which deeply influenced sediment dispersal and the areal distribution of paleoenvironments. In addition to the "flower" structures seen on seismic lines, strike-slip tectonism induced also abrupt temporal and areal variations in subsidence rates, as well as dramatic sedimentological facies changes within coeval stratigraphic horizons. Such strike-slip-dominated tectonic scenario during the late- and post-collisional stages related to the closure of the Vardar-İzmir-Ankara ocean is further corroborated by the presence of an important strike-slip shear zone of crustal relevance in the region just south-east of the Marmara Sea. Such shear zone is at least 225 km long, has an horizontal offset of about 100 km, and has a trend similar to the the present-day North Anatolian Fault. A similar shear zone- although poorly studied- occurs in the Kapıdağı Peninsula south of Marmara Island. In addition, published thermochronological data demonstrate the existence of a praecursor of the North Anatolian Fault in the area of the present-day southern Thrace Basin active at least from the Oligocene.

The celestite mineralization of the Middle Miocene (Badenian) diamictites, Vrancea district, Romania

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The Middle Miocene (Badenian) celestite (sulphate) diamictites, genetically associated with Salt (Evaporite) Formation, occurs in the external last lineament of the Sub Carpathian Nappe.

The Middle Miocene is the stratigraphic correspondent of the early used term "Tortonian" of Vienna Basin and to present term "Badenian". It has been firstly separated and described in Muntenia Sub Carpathians and comprises four lithobiostratigraphic horizons: the "Tuff and Globigerina Marls" horizon; salt breccias with salt bodies or "Upper Saliferous" horizon; "Radiolarian Schists" and "Spiratella Marls" horizon. These horizons have been recognized under the same name or under different names all over the Carpathians domain and moreover these "horizons" were recognized, with some exceptions, in the whole extra Carpathian area, Transylvania and Maramures.

In Vrancea area the "Salt Formation" or the "Evaporite Formation" is represented by gravelly-sandy, gipsiferous lithotype respectively the sulphate diamictite, by the halitic-anhydritic lithotype and by the secondary carbonate lithotype, together being genetically related.

The components of gravelly-sandy deposits are bound by a brown-black, clayey matrix having with earthy appearance. The matrix is chiefly impregnated with bituminous organic matter and is considered to be an insoluble residue entrained from dissolving evaporite beds. Usually the matrix is dominating (matrix-supported texture) – ubiquitous feature observed especially in mines. In places the matrix could be absent (claste-supported texture), this being explained by removal due to meteoric leaching. Its high-degree of intercrystalline porosity makes it a potential subsurface reservoir for hydrocarbons or metalliferous solutions.

Referring to celestite-bearing ore on the Valea Sării-Andreiășu lineament (Vrancea district) the author separated in outcrops and in the mine (along Valea Sării brook) three types of mineralizations – petrologically and mineralogically different, but displaying continuous transitions between them. These are:

Mineralizations having impregnation character (mudstone-celestite using Dunham's, 1962 classification for carbonate rocks), in a matrix-supported fabric according to background/crystals ratio. This type is widespread, was separated in heavy minerals concentrates too. Also, it borders the massive type of celestite mineralizations and is characteristically closely related to gypsum and anhydrite. Also, it has been considered that the celestite appearing in evaporite sediments of an intertidal environment is primary or early diagenetic. It does not form accumulation of economic importance.

The second type is a massive mineralization of replacement character, a wackestone/packstone celestite, in a crystal-supported fabric. Other authors termed it as "blocky celestite" or "replacement-type celestite". Under the microscope some peculiar euhedral to anhedral shape of turbid-like methasoms of celestite, with a lot of inclusions and syntaxial rims showing an "intersertal texture" evidently disturbed by lack of space could be seen. The host-rock within multiangular space between crystals is subordinated. This type has been developed during diagenetic stage as a true irregular and concretionary celestite bearing ore by redistribution of materials within sediment (diagenetic metasomatism).

The third type is a secondary mineralization, known as "celestite infilling cavities and fractures". This type has been developed in a free space, with syntaxial rims and without inclusions and no host rock. It is white colored, in large fan-like or fibrous or long prismatic crystals or in collomorphous aggregates associated with sulphides. During epidiagenesis stage involving uplift and sub aerial exposure of diamictites as is observed on Valea Sării and Reghiu brooks – the evaporite re-enter in active phreatic zone and a secondary mineralization may develop.

Sedimentological characteristics of Oligo-Miocene coal succession at the North of İstanbul, Northwest Turkey

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The sedimentologic characteristics of coal-bearing Oligo-Miocene deposits occurring at the north of İstanbul have been examined in this study. The study area in Thrace Basin includes coal formations in deltaic deposits of Oligo-Miocene age. Coal-bearing deltaic deposits in this field have been evaluated in the Danişmen formation and the coal bed has been extensively exploited by open-cast methods.

The Danişmen Formation overlies the Eocene-Oligocene Ceylan Formation unconformably and consists of mudstone, sandstone, conglomerate and coal. It is unconformably overlain by the Pliocene deposits. Coal-bearing succession is composed of fining-upward interbedded facies. Five facies were identified in Coal-bearing sediments. These facies are; bedded conglomerates, thick bedded sandstones, organic rich grey mudstones, red mudstone and coal. These facies characterize delta plain deposits. The coal of the Danişmen Formation was deposited in swamps of delta plain. The coal bed in the Danişmen Formation has a thickness of 7.80 m, and the coal rank is of a lignite stage (soft brown coal).

Coal properties of the profile samples from the deltaic deposits of Oligo-Miocene age, Yeniköy-İstanbul, Thrace Basin (Turkey)

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The Yeniköy area in the Thrace Basin includes coal formations in deltaic deposits of Oligo-Miocene age. Coal-bearing deltaic deposits in this field have been evaluated in the Danişmen Formation and the lignite bed has been extensively exploited by open-cast methods. The lignite bed in the sampling point has a thickness of 7.80 m, and 9 profile samples were collected, from bottom to the top. The samples have been subjected to some analyses using standard methods. The coal samples, on an air-dried basis, average 11.02% moisture, 10.43% ash, 43.21% volatile matter, 35.34% fixed carbon, 1.93% total sulphur and 5221 kcal/kg net calorific value. The mineral matter of the selected coal samples that was identified by X-ray powder diffraction and SEM-EDX shows that the samples are mainly made up of clay minerals, quartz, and pyrite. The most abundant maceral group of the samples is huminite in which textinite, ulminite, and especially densinite are rich. Liptinite group macerals in all the samples, which are considerably higher than the inertinite group macerals. Elemental concentrations, which were determined by ICP-AES and ICP-MS, and Hg concentrations by Leco AMA254, have been evaluated in this study. The random reflectance values (%Rr, oil) of ulminite were measured in all the samples for the determination of coal rank, and the mean values of % Rr of ulminite indicate that the coal rank is of a lignite stage (soft brown coal).

Ground surface movements in the area of salt exploitation in Tuzla (Bosnia and Herzegovina)

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This paper focuses on surface movements determined by geodetic methods and occurred as consequence of brine extraction from Tuzla salt deposit (Bosnia and Herzegovina). Previous studies were mainly concentrated on vertical movements, but important information about behavior of the deposit is also available from horizontal movement data. In the case of Tuzla salt deposit the geometry and spatial location of leached/empty spaces are unknown and the comparative analysis of vertical and horizontal movement could be really significant. The spatial identification of points with high values of vertical and horizontal movements depends on the geometry of empty spaces. Investigation of horizontal movements has been carried out analyzing data collected by several geodetic measurements. The results obtained by the correlated spatial analysis of vertical and horizontal movements, can identify basic geometric characteristics of the leached/empty spaces. The discussed temporal intervals are two characteristic periods, referred to the capacity of the deposit exploitation. Movement rates per year and correlation between horizontal and vertical movements are considered as indicator parameters defining the

character of ground deformation. Spatial analysis of these coefficients values has identified high risk areas, and gives additional information in the geological structures definition.

Power plants ashes recovery in eco-friendly mortar compositions

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The paper treats the possibilities to recover the waste from coal combustion in some power plants in Romania. The greenhouse gas and the ashes have a huge impact on environment and the living species. The using of ash – recovered wastes – induces decreasing of the demand of natural resources. They also reduce the energy - intensive production of other concrete ingredients, leading to energy saving and decreasing the “greenhouse gas” emission. Replacing one tone of cement with fly ash it would save enough electricity to power an average home for 24 days, and reduce carbon dioxide emissions equal to a two months use of an automobile.

During the study, in the experimental work were compared the properties of five different compositions of masonry mortars were prepared replacing the cement with different amounts of ash. The setting time and the workability were determined on the fresh mortar. After 28 days of hardening in standard conditions (5 days in moulds at 20°C and 90% humidity; 2 days without moulds at 20°C and 90% humidity; 21 days without moulds at 20°C and 65% humidity) the density and water absorption of the mortars were determined using the methods indicated in the European standards. The flexural and compressive strength of the compositions were determined after 28 and 56 days of hardening.

The fresh and hardened mortars characteristics were investigated. The compositions (cement, Zalau ash, sand and water, in different proportions) were prepared by forced mixing using a laboratory mixer. The fresh mortar was cast in metallic moulds obtaining 160x40x40 mm prisms which were subjected to testing in hardened state.

The study demonstrated that it is possible to use ashes in the mortar compositions, by replacing a part of the cement by ashes. The replacement of cement in proportion of 5, 10, 20 and 30 wt% was experimented. Thus, the setting times of the mortars increases. The difference between the initial setting time of the composition without ash and the composition in which 5 wt% of cement was replaced by ash is only 5 minutes. The differences are bigger for higher ash content; it reaches 80 minutes for composition 5 in which 30 wt% of cement was replaced by ash.

The differences are more evident in the case of the final time of setting, where replacement of 5 wt% cement lead to a 30 minutes longer final setting time and replacement of 30 wt% cement with ash a 310 minutes longer time, which means an increase of 1,5 times.

In the case of mortars workability no differences were observed between the composition with no ash and the composition in which 5 wt% of cement were replaced, after that every 10wt% of cement replaced by ash brings 5 minutes in plus.

The density increases slowly by replacing 5% of cement, after that a decrease is observed, every sample densities being under the density of the standard composition. The water absorption is in agreement with the results obtained for the densities. The water absorption decreases from 8.96 % (in the standard composition) to 8.34% (for composition 2 with 5wt% ash). For the other compositions the value of absorption increases to 12.87%, while the ash proportion was increased to 30 wt%.

The values for the mechanical strength state the observations at the density and absorption determination. For the composition with 5 wt% ash was observed an increasing of flexural and compressive strength. While the ash content was increased the mechanical strength decreased and it is situated below the standard composition strength. The mechanical test after 56 day of hardening shows that the strength increase is higher for the compositions with ash.

It can be concluded that the Zalau power plant ash can be used in mortar compositions 5 wt% replacement of cement by ash brings both economical and qualitative benefits.

Protection measures against geological failures, during the construction of Thessaloniki - Kavala Section of Egnatia Highway in N. Greece

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The present paper refers to the major part of the Egnatia highway, about 100 km long, which connects Thessaloniki and Kavala cities in North Greece. Actually, it is divided in three parts: i) Nymphopetra-Asprovalta, about 40 km long, ii) Asprovalta-Strymonas, about 20 km long and iii) Strymonas-St. Andreas, about 40 km long. The highway has already been constructed. Driving from the west to the east, the highway, at the beginning of Nymphopetra-Strymonas part, passes nearby Volvi lake, at the foot of Vertiscos Mountains. Easterly, it passes through Kerdillia Mountains, Strymona's river and it leads to Pangeo's mountain, ending through Symbol Mountains. The highway also passes through five tunnels; i) Vrasna tunnel, which is located at Nymphopetra – Asprovalta's part, ii) Asprovalta's tunnels, which are three tunnels locating at Asprovalta – Strymona's part and iii) Symbol tunnel, which is located at the last Strymonas – st. Andrea's part. The paper describes the support measures against geological failures during the construction of the highway. For this purpose, the mechanisms of sliding and rock falling procedures were studied. As far as slopes concern, the orientation of the discontinuities and the poor quality of the rock mass, that creates cyclic sliding, were responsible for the instabilities. Rainfall also helps landslides to be occurred. During the tunnelling excavation, the sliding along a plane, the décollement from the roof and the fall of wedges were the common failure causes.

Historical faulting in Aghios Konstantinos area (central Greece), based on archaeological indications

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Aghios Konstantinos lies on the foothills of the Atalanti fault system scarps. The area is located in central Greece and the fault system is the primary morphology-controlling agent. It defines the west shoreline of northern Euboea gulf and is associated with several historical earthquakes.

Morphologically this zone forms steep high bedrock scarps, on the foot of which extensive colluvial deposits are observed. Several minor fault scarps have been mapped and they were classified in three classes: a) bedrock fault scarps with visible fault plane, b) soft-sediment scarps with visible fault plane and c) soft-sediment scarps with no visible fault plane. The minor scarps are generally aligned in an échelon pattern, following the general WNW – ESE trend of the major fault zones, while their general dip direction is towards the NNE. Fault analysis shows that there is extensive tilting of hangingwall blocks, as well as of the minor faults themselves. Faults tend to “lock” with each other forming a complex pattern that is inherited to the overlying Upper Miocene-Pleistocene and Holocene sedimentary cover.

A small settlement was found at “Karvouna” site, west of Aghios Konstantinos, during the works performed for the construction of a new segment of E75 highway. This settlement comprises of low-lying houses, storage rooms and a small temple. A larger and more

important temple was discovered in another location nearby. According to archaeological evidence, the settlement was active in classical and Hellenistic times, and sporadically afterwards. It was a rural settlement and numerous finds indicate at least three successive layers of buildings with stone foundations criss-crossing one another with no particular pattern.

The foundations of the buildings and the surrounding environs show many signs of episodic deformation, either direct or indirect. The most obvious cases are:

A surface rupture cutting through at least two foundations. It has a heave of up to 3 cm and a slight normal displacement.

Several basal walls and foundations have been found tilted and deformed. Tilting is as high as 30° off vertical.

A small temple that is located just outside the settlement shows signs of sudden destruction: roof tiles are being found in and around the temple. They are roughly retaining the space that they had on the roof, which is an indication that the wooden roof collapsed. Also, one of the entrance pillars seems displaced both vertically as well as left-laterally. This displacement vector is compatible with the general fault displacement vector in the area.

An artificial cross-section at the stream that bisects the settlement shows an exposure of a normal fault system that deforms a series of paleoseils and runs through the settlement, parallel to the main fault. Paleoseismological analysis of the cross-section shows that this fault system was not active in historical times, although the southwesternmost strand of the system roughly coincides with the surface rupture.

The position of the settlement on a rather steep slope, as well as the nature of finds, indicate a severe topographical amplification of the effects. Nevertheless, we believe that the primary deformational cause was faulting, evidence of which has been found in the cross-section that was consequently amplified by gravitational effects.

Urban paleoseismology: case studies from Thessaloniki, Greece

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Faults in urban areas pose a real danger for buildings and infrastructures, not only in the case of an earthquake, but also in such cases as differential sediment compaction, water overpumping, etc. Their importance is often underestimated with sometimes severe consequences.

Detection of faults is not easy in urban environments, as usually outcrops have been covered by built structures, prohibiting direct observations. Geophysical surveys are rare, but even in those cases the exact location of a surface-intercepting fault is not clear.

One of the most promising methods for acquiring quantitative information about faults in urban areas is paleoseismological investigation. It consists of an integrated set of methodologies that can provide hands-on data for displacement, timing, etc. In this paper we present two cases of paleoseismological applications in the metropolitan area of Thessaloniki. Two faults, one evident and one unknown, have been studied in Peraia and Kalamaria respectively.

Peraia fault: This fault defines the contact between the footwall Pliocene sandstone-marl series and the hangingwall loose Holocene deposits. It is a fault that coincides with the well known Anthemountas fault zone, a roughly E-W trending normal fault zone that is associated with several historical earthquakes. Its exact location through Peraia town was not known in much detail due to the lack of outcrops. Nevertheless, it forms a well defined scarp that divides the town into an upper (Ano) and lower (Kato) part. In 2005 and 2006 a set of surface ruptures along this fault caused significant damage on buildings and roads. Paleoseismological investigation with two trenches along the fault showed that faulting was not random, as a large displacement was detected, with successive steps of cumulative faulting. Borehole data confirmed that the total displacement was indeed large (35 m). Trenching showed that the fault has been continuously active during the Quaternary, with all

of its displacement on the same surface, posing thus a severe danger for the area in general and specifically for the buildings that are built along its trace. The 2005-06 surface ruptures are interpreted as a combination of overpumping, compaction and fault creep. The contribution of each factor is not possible to be calculated, as there are too many uncertainties concerning the deformation model.

Kalamaria fault: This fault was exposed during the construction of a multi-stored residence building in Kalamaria, a town located next to Thessaloniki city. This fault is displacing marls and a paleosoil that is located on top of the sedimentary sequence. Morphologically it is manifested as a gentle scarp, observable in roads that cut through the fault along at least 500 m. Paleoseismological analysis showed that the fault has been inactive during Upper Pleistocene – Holocene as there are no indications for recent reactivations. However, the existence of the morphological scarp suggests that it has probably been active during that period, but microstratigraphical evidence for this activity has been destroyed by anthropogenic factors. Even if it is not active, the fault zone exists and it can act as a weakness zone during a distant earthquake or in response to water level fluctuations.

In conclusion, paleoseismological techniques can be of great effectiveness in the study of urban faults, either active or not. Planners should take into account this methodology, because it can greatly enhance the understanding of ground response in abnormal conditions.

A proposed methodology for coastal risk management

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Coastal erosion is a gradual process that alters the distribution of sediments and modifies the geomorphology of the coasts. It may result in the destruction of natural coastal defences (sand dunes, cliffs, etc) and the increase in land instability which may in turn result in flooding of the hinterland and landsliding of coastal areas with steep slopes and unstable materials. The damages induced by such hazards include loss of life, property, infrastructure, and land. The costs of emergency action, remediation and prevention can often represent a significant burden to the communities affected and to national governments. According to predictions, climate change impacts, including sea-level rise and extreme weather patterns, will lead to the increase in the frequency and intensity of such hazards. Risk-based decision-making is seen to provide the means of addressing the challenges put forward by climate change. The complexity and interrelation of the processes acting on coastal locations call for an integrated framework for the assessment of coastal risks and the identification of the appropriate measures for the prevention and reduction of erosion, flood, and landslide risks. In this paper, existing models for the mapping of pressures on coasts and current development practices and tools will be reviewed, before a holistic methodology is proposed in order to assist decision-makers in effective coastal risk management.

Paleocene-Eocene migmatites in the Bulgarian Rhodope revisited

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Migmatites of proved Paleocene-Eocene age are widespread in several tectonic units of the Rhodope metamorphic complex (RMC). Most of the migmatitic unit precursors consist of orthogneisses. These were predominately felsic rocks of granite to granodiorite and diorite composition of late-Paleozoic (Arda unit) and late-Jurassic protolith ages (Madan, Startsevo, and Chepinska unit). Zones of post-anatectic extension outline the unit boundaries obscuring the melt-in isograd in the RMC. The peak metamorphic conditions correspond to kyanite-

sillimanite transition at 650 - 700°C / 0.6 – 0.8 GPa. The most common thermobarometric estimates are close to the water-saturated granite solidus in sillimanite stability field. The absence of clearly distinguished residuum and peritectic anhydrous minerals indicate fluid-assisted melting of metagranitoid precursors. Field observations distinguish metatexite and diatexite structural types. The metatexites occur in all migmatitic tectonic units. The diatexites occupy large domains in the Arda and Chepinska unit suggesting advanced melting within cores of regional thermal antiforms flanked by metatexite. The common constituents of metatexite sections are concordant to the foliation in situ leucosome ± melanosome, and mesosome. Discordant leucosomes fill decimetric scale shears and form vein-network together with concordant leucosomes, marking a transition to structurally disrupted diatexites. The latter include subautochthonous lens-like bodies and sheets of inhomogeneous granite. The mesoscale interconnected structures indicate syn-deformation melt flow. Different mechanisms of melt transfer resulted in injection of melt batches into metatexite and subsolidus sections of the RMC.

The rock-forming mineral assemblages comprise biotite, plagioclase, K-feldspar and quartz, plus amphibole in metagranodiorite and metadiorite mesosome, or muscovite in some diatexite (Arda unit). The leucosome is quartz-feldspar dominated and differs from mesosome and particularly from melanosome with lower mafic and accessory mineral proportions. Scarce amphibole-bearing leucosomes resulted from back-reactions between migrating felsic melts and refractory amphibole-bearing rocks. The normative mineral ratios span tonalite to granite field in mesosomes, and trondhemite to granite field in metatexite leucosomes, whereas granite bodies from diatexite domains correspond to low-temperature granite melts. The uniform accessory mineral assemblage includes: magnetite, zircon, allanite, apatite, ± titanite in metatexite; and magnetite, monazite, ± xenotime, ± garnet in diatexite. Inherited protolithic zircons dominate both metatexite and diatexite, while new Paleocene-Eocene zircon is scarce. The low temperature melts had little or no impact on dissolution and growth of zircon, however they were responsible for partial dissolution of allanite and apatite, and subsequent crystallization of Paleocene-Eocene monazite.

The geochemical features corroborate fluid-assisted low-temperature melting of felsic minerals and limited solubility of accessory phases in the melt. The felsic products of migmatization are depleted in Fe, Mg, Ca, HFSE (Zr, Hf, Nb, Ta, Th, and U), Y, and REE. The contents of Zr and LREE cluster close to felsic peraluminous melts saturation at 650 - 750°C. The REE patterns display general depletion, strongly variable LREE/HREE ratios, and $Eu/Eu^* \geq 1$ in leucosome and anatectic granite bodies. The systematic compositional changes in the succession concordant leucosomes - discordant leucosomes - subautochthonous granite bodies reflect anatectic melt fractionation and emphasize the most incompatible LILE enrichment during anatectic melt migration and crystallization: increasing LILE/HFSE, K/Ba, and Rb/Sr, and decreasing Ba/Rb ratios; positive correlation between K/Rb and Eu/Eu^* values of anatectic granite bodies. The elements ratios between the HFSE remain relatively unchanged overlapping mesosome ratios variation. For that reason the products of migmatization and precursors plot on the same fields of the discrimination diagrams and illustrate this way inheritance of geochemical features related to HFSE mainly.

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Late Triassic, Early and Middle Jurassic Radiolaria from ferromanganese-chert nodules (Angelokastron, Argolis, Greece): evidence for prolonged radiolarite sedimentation in the Vardar-Meliata Ocean

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In the Argolis, the Basal Sequence constituting the eastern Pelagonian margin which bordered the Vardar–Meliata oceanic domain, includes Late Triassic–Early Jurassic shallow-water carbonates, condensed pelagic limestones of Early–Middle Jurassic age, Late Jurassic radiolarian cherts, siliceous mudstones and sandstones rich in ophiolite fragments. Up-section, coarse breccias, also with clasts of boninites derived from a nearby ophiolite obducted onto the Pelagonian margin in Late Jurassic–Early Cretaceous times crop out.

Along the road from Angelokastron to Sofiko, about 2 km east of the village of Angelokastron, a small quarry exposes pervasively sheared dark reddish-brown, radiolarian-bearing cherty shales with disrupted fragments of chert and chert nodules impregnated by ferro-manganese oxides. These shales occur in the footwall of a thrust bringing them into contact with the Pantokrator Limestone of the Basal Sequence.

We collected more than 30 samples of the nodules and the shaly matrix. 13 nodules and one matrix sample yielded determinable radiolarians. 16 x-ray fluorescence analyses were carried out on 12 nodules that indicated a hydrothermal origin of the ferro-manganese mineralization.

The radiolarian taxa found indicate four age groups for the nodules that are embedded in the siliceous shale matrix that yielded a Middle Jurassic age (middle Bathonian). The first group includes nodules of Late Triassic age (late Norian–Rhaetian); the second group nodules of Early Jurassic age (early Pliensbachian and probably middle–late Toarcian); the third group nodules of early Middle Jurassic age (Aalenian–Bajocian); the last group finally includes nodules of late Middle Jurassic age (Bajocian–Bathonian).

The presence of Late Triassic to Early Jurassic Mn-impregnated chert nodules in a Middle Jurassic matrix indicates a deep oceanic environment prior to the tectonic emplacement of the succession onto the Pelagonian continental margin. We suggest that these nodules, more lithified than their matrix, were exhumed on the slope of an intra-oceanic accretionary wedge and were redeposited in the Middle Jurassic siliceous mudstones on the floor of the remnant Vardar–Meliata Ocean.

Radiolarian ages and geochemical data on the ophiolites from the Koziakas massif (Greece)

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The Koziakas massif, located at the western boundary of the Thessaly plain, consists of a stack of thrust units emplaced westward onto the Pelagonian (s.l.), which in turn thrusts

onto the Eocene Pindos Flysch. The dismembered units of the Koziakas are unconformably overlain by the Oligocene-Miocene molasse of the Mesohellenic trough.

In the Koziakas massif, at the top of the “Pelagonian” succession, three ophiolitic tectonic units crop out:

a) the “Mélange and Fourka Units”. At the base of the Fourka Unit scattered outcrops of ophiolite-bearing mélange are exposed. The Fourka Unit consists of thrust sheets and blocks of pillow lavas locally covered by radiolarian cherts.

b) an “Ophiolite Unit”, consists of slivers of sheared serpentinites, locally containing dunite bodies, plagiogranite and boninite dykes.

All volcanic rocks studied herein come from the “Fourka Unit” and consist of basalts and basaltic andesites. Six samples display a clear alkaline affinity and are similar to the alkaline within-oceanic plate (WPB) and are interpreted to have generated in a seamount setting. Two samples display similarities with enriched MORB (E-MORB) and are interpreted as formed from a N-MORB type mantle source slightly enriched in a plume component during the early stage of oceanic spreading or in an off-axis oceanic setting.

We examined 32 samples for radiolarian analyses. The assemblages of the samples collected near the WPBs indicate Middle and Late Triassic age, while the radiolarites collected near the E-MORBs indicate Late Triassic age.

The occurrence of Late Triassic WPBs and E-MORBs points to the existence of an oceanic setting in which the N-MORB asthenospheric source was influenced by a plume-type component and resulted in the off-axis eruption of enriched alkaline basalts and enriched MORB-type basalts. This conclusion is in agreement with similar results obtained from other sectors of the Hellenide ophiolites. During the post-Late Jurassic compressive tectonic phase, which affected the Internal Hellenides, the Mélange and Ophiolitic Units tectonically overthrust the “Pelagonian” continental margin represented by the sedimentary units of the Koziakas Massif. During the post-Late Eocene compressive tectonic phase all these units were refolded and thrust southwards onto the Eocene Pindos Flysch.

Water ages in thermal system of Podhale Basin, Inner Carpathians, southern Poland

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Fissured and karstified Eocene and Mesozoic carbonate formations of the Podhale Basin represent the largest reservoir of renewable thermal waters in Poland. They outcrop in the Tatra Mts. at altitudes of 1 000-1 800 m and deep to the north under the flysch formations of the basin. The main direction of flow is to the north for abt. 15 km where the impermeable formations of the Pieniny Klippen Belt divides it and diverts to the west and east, and next to the south to the Danube watershed in Slovakia. The temperatures range from abt. 20° C near the outcrops to abt. 85° C at the most northern wells. For a better understanding of the flow pattern, environmental isotopes ($\delta^{18}\text{O}$, $\delta^2\text{H}$, ^3H , ^{14}C , $\delta^{13}\text{C}$) have been used since early seventies and recently also gaseous tracers (He, Ne, Ar and SF_6) under the grant No N 525 402334 from the Ministry of Science and Education.

The C^{14} data of thermal waters change from 37 to 0 pmc with $\delta^{13}\text{C}$ from abt. -5 to 0‰; exhibiting the influence of isotopic exchange with carbonate minerals, which makes the quantitative dating difficult. The $\delta^{18}\text{O}$ and $\delta^2\text{H}$ are similar to those of modern waters in springs and wells with cold water, with several exceptions characterized by shift of $\delta^{18}\text{O}$ to heavier values, which are caused by isotopic exchange with carbonate minerals. The isotopic altitude effect was estimated from the data of springs and wells within the Tatras area. For $\delta^2\text{H}$, the mean altitude of recharge area reads: h_2 (m a.s.l.) = $-69.1 \cdot \delta^2\text{H} - 4054$, with the uncertainty of about 100-200 m. The most negative $\delta^2\text{H}$ values of thermal waters are similar to the values observed for large karstic springs in the Tatras, which may suggest their Holocene age. However, the spatial distribution of $\delta^2\text{H}$ values indicates that close to the recharge area, the thermal waters are similar to those of medium springs discharging at the

lowest altitudes. Thus, the most negative $\delta^2\text{H}$ values of thermal waters observed far in the basin most probably result from recharge under cooler climatic conditions. Very high He excess contents and negative noble gas temperatures (NGT) derived from Ne and Ar concentrations are in agreement with such interpretation. The lack of ^{14}C and $\delta^{13}\text{C}$ values close to 0‰ in these wells also confirms that hypothesis.

Tracer data indicate the presence of the oldest waters in the north-eastern part of the basin whereas in the western part the exchange of water is faster by one to two orders of magnitude. That unexpected flow pattern most probably results both from the presence of some karstic channels in the western part, which enhance regional permeability, and from obstacles to horizontal flow caused by fault zones in the eastern part.

Crystallization conditions of the Xanthi Plutonic Complex (Rhodope Massif, Northern Greece): Geothermometry and geobarometry

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The Xanthi Plutonic Complex (XPC) is one of a series of Oligocene subduction-related plutonic bodies comprising an “acid” group and a “basic” group. Based on mineral compositions and assemblages of the “basic” group, the XPC is assumed to have originally crystallized at a pressure of 5.4 kbar and at a temperature of 1300°C under relatively dry conditions and oxygen fugacity ($f\text{O}_2$) near the NNO buffer. As the basic magma migrates to shallower levels and at a temperature of about 870°C, water content increases and oxygen fugacity moves towards the MH buffer. The increase of water content could be the result of open system evolutionary processes. The “acid” group crystallizes at an average temperature of 729°C and at a pressure of 0.7 kbar under oxidizing conditions, between the NNO and MH buffer, suggesting a possibly different origin and/or evolution for the “acid” group.

The assessments of favorable UV conditions for human health over northern Eurasia

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UV radiation can have both positive and negative influence on human health. According to the classification of biological UV resources proposed by Chubarova (2007) we define favourable UV conditions as the conditions, when it is possible to get vitamin D3 at noon within an hour but when at the same time the UV index does not reach the high UV category. Different methods were used to estimate the thresholds for generating the vitamin D3 in the skin. One method was based on the approach, which has been proposed by Holick and Jenkins (2003), and another one was based on the recommendations given in the CIE 2006 publication. We compared both approaches by evaluating and comparing the year periods with the conditions favourable for vitamin D3 production. The periods were obtained through the calculation of biologically active irradiance using the TUV model with the 8 stream DISORT solver, and some other modifications described in Chubarova (2006). According to our estimates in midlatitudes the application of the second method leads to the increase in day number (approximately 18 days), when it is possible to get the vitamin D3 in clear sky conditions. It is necessary to emphasize that this difference takes place mainly due to the different thresholds of the skin exposure area recommended in these approaches, since both erythemally-weighted and vitamin D3 irradiance have similar absolute values at noon in spring and autumn, when a “jump” from unfavourable to favourable conditions and back for vitamin D3 production occurs. We have also revealed a large difference in sensitivity of erythemally-weighted and vitamin D3 irradiance to the changes in solar zenith angle, total

ozone content (especially, at high solar zenith angles), and quite similar aerosol influence on both types of biologically-active irradiance. Using the updated criteria for vitamin D3 threshold from CIE 2006 we estimated the biologically active UV irradiance over northern Eurasia. The spatial and seasonal distribution of UV favourable conditions has been analyzed both for the clear sky and for the cloudy atmosphere. The calculations were based on the TOMS/OMI total ozone and effective UV reflectivity datasets. The latter one has been used for estimating the effective transmittance in cloudy conditions. The aerosol parameters necessary for computations were taken from a specially developed aerosol climatology, which has been obtained on the base of ground-based AERONET dataset, radiometric Russian datasets and satellite MODIS retrievals (collection 5) over northern Eurasia. A special attention was paid to estimating the uncertainties of MODIS AOT dataset. We found the large AOT biases in spring conditions over Siberian area. The specific features of the defined favourable UV conditions for different time periods are discussed for the various types of human skin in the clear and cloudy atmosphere.

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Role of the olistostromes and olistoliths in tectonostratigraphic evolution of the Outer West Carpathians

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The oldest olistostromes in the Outer West Carpathians are related to the Late Jurassic-Early Cretaceous rifting and post-rifting stage in which the Outer Carpathian deep sea sedimentary basins were opening. Then forming the proto-Silesian Basin later was split into separate tectonic units – Silesian and Subsilesian nappes. In the Silesian Nappe the oldest deposits are represented by the Vendryně Formation (Late Jurassic) that consists in many places of clasts and olistoliths of shales and marls. The Hradište Formation (Early Cretaceous) often bears debris-flow deposits rich of exotic-rock pebbles, but also olistostromes with olistoliths or olistoplaques of the Cieszyn and Vendryně formations.

In the Late Cretaceous – Paleocene took place a contraction. It was a formation time of subduction zones along the active margins and development of deep-marine flysch basins. The Magura, Dukla, Silesian and Skole basins have been formed then. Ridges separated them supplying the basins with huge amounts of coarse-clastic material marked by numerous debris-flow sediments and occasionally olistostromes and levels with huge olistoliths. They occur in the Upper Cretaceous, Paleocene and Eocene strata of the Silesian, Subsilesian and Skole nappes. Specially known are large olistoliths of the Węgierka from the Upper Cretaceous deposits of the Skole Nappe Marls and the Frydek Marls with huge blocks of andesites and pebbles of other exotic rocks from the Subsilesian. In the Silesian Nappe the debris-flow with flysch olistoliths and exotics are frequent within the Godula and Istebna Beds (Late Cretaceous – Paleocene), the Ciężkowice Sandstones (Early – Middle Eocene) and occasionally within the Hieroglyphic Beds (Middle – Late Eocene). The Middle Eocene olistostromes are known also from the Bystrica and Rača subunits of the Magura Nappe.

A collision of the European Platform with the Inner Carpathian terrain took place in the Oligocene and Early Miocene stage causing a development of the Outer Carpathian accretionary prisms. Evolving prism supported olistoliths and olistostromes to the basins until their structural closure. Especially in the inner part of the Silesian Nappe the Krosno Beds (Oligocene – Early Miocene) are rich of olistoliths and in some places olistostromes with large olistoplaques occur. Olistostromes at the top of the section of the Krosno Beds has finished sedimentation in the Silesian Beds. In the western part of the Subsilesian Nappe section of the Krosno Beds is ended with olistostrome rich of huge olistoliths of the Jurassic,

Cretaceous and Palaeogene rocks as well as older crystalline. There occur spectacular blocks of Jurassic limestones forming the klippen of Andrychów, Pavlovske Kopce and Štramberg.

During the Miocene tectonic movements caused final folding of the basins' fill and created several imbricated nappes. The nappes are thrust one upon another and all together overthrust the marine molasses of the Carpathian Foredeep developed on the North European Platform. From thrusting nappes large olistoliths glided down into the foredeep. Recently they are known from deep boreholes from below of the nappes. In front of the thrusting Outer Carpathian the molasses of foredeep were partly folded. It occasionally caused the formation of olistostromes, e.g. the Badenian evaporites known from the salt mines of the Wieliczka and Bochnia.

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Sedimentary basins evolution and olistoliths formation: the cases of Carpathian and Sicilian regions

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The early stage of basin formation in carbonate platform settings, from rifting to further crustal thinning, is generally characterised by mass movements from the faulted margins towards the stretching and drowning sectors. Avalanches, debris flows deposits with extrabasinal blocks, olistoliths, olistoplaque and olistostromes mark the sedimentary record. Block tilting, related to the normal activity of faults, determines the uplift of basin margins, shedding material for the formation of olistostromes. The onset of basin dynamics could be also marked by magmatic upwelling. During the late rifting stage, mass movements decrease, sediments supply with huge olistoliths and olistostromes is less common and coarse-grained deposits prevail, alternating with periods of pelitic sedimentations. Such sedimentary evolution may be observed in several basin successions, independent of their age and geodynamic setting. Good examples are the Northern Carpathian Basin and the Sicilian carbonate platforms-basins system, compared here because of their similarities.

During the Late Jurassic-Early Cretaceous, the Southern European Platforms system topped by carbonate sedimentation experienced rifting and that resulted in opening of the proto-Silesian Basin. Crustal stretching was accompanied by andesitic-teschenitic intrusions. The Late Jurassic-Early Cretaceous sequences of the proto-Silesian Basin were later split into different tectonic units. Neritic grey, black or brownish marly mudstones deposited during the Kimmeridgian-Tithonian were locally associated with debris flows containing olistoliths derived from the adjacent carbonate platform. The mudstones evolve during Tithonian-Berriasian into pelagic limestones and shales with a complex of turbiditic limestones, suggesting a relatively quiet tectonics. Starting from the Valanginian, turbiditic and conglomeratic sandstones with exotic blocks appear within the calcareous shales. Locally, huge olistostrome appears, containing both extrabasinal olistoliths as well as olistoliths derived from the faulted flanks of the proto-Silesian Basin. These coarse sediments evolve upwards to Hauterivian-Aptian black shales. At the end of early Cretaceous (Barremian-Albian), compressional movements started, increased tectonic activity begun and uplift initiated denudation of the margins and ridges and resulting in very thick-bedded sandstones, conglomerates and occasionally olistoliths deposited during Late Cretaceous and Early Paleogene. An oblique collision of the Inner Carpathian terranes with the North European Plate during the Late Eocene-Early Miocene led to the development of accretionary prisms of the Outer Carpathians; numerous olistostromes were formed during this time.

In Sicily, the onset of basin opening (Imerese-Sicanian) occurred during the Triassic. It was interposed between carbonate platforms (Panormide-Hyblean-Pelagian). In the basal deep-water sediments, lenses of olistostromes with olistoliths and basaltic extrusions related to crustal stretching were deposited at the basin margins. These olistoliths were derived from mass-wasting of the Late Permian-Lower Triassic carbonate platform. Late Triassic sedimentation (pelagic marls and limestones) suggests relatively quiet tectonic activity, followed by increased crustal stretching, as suggested by olistoliths of Lower Triassic clastic limestones embedded upwards. Jurassic-Early Cretaceous sedimentation is represented by deep-water siliceous marls and radiolarites, containing several horizons of carbonate turbidites and breccias derived from erosion of the fault-controlled basin flanks. From the beginning of Late Cretaceous, deposition of basin-plain marls and limestones indicates the mature stage of basin dynamics. Upward in the succession, thick horizons of resedimented carbonate breccias are very common, indicating the onset of tectonic inversion, from pre-orogenic extension to the chain building.

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Pentlandite mineralization related to Albanian Ophiolites

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The Jurassic ophiolites in Albania are characterized by several mineralization types including chromites, Fe-Ni-Cu sulfides and arsenides, Fe-Ti-minerals and minerals of the Platinum Group Elements (PGE). Pentlandite-bearing mineralization is related to upper mantle serpentized harzburgites, chromitite deposits associated with upper mantle dunites, dunites of the supra-Moho zone, ultramafic-mafic intrusions (wehrlites, lherzolites, pyroxenites and gabbros) and to cumulate layered sequences of olivine-gabbros and gabbro-norites. Pentlandite occurs in several mineral associations including Ni-bearing sulfides, Fe-Ni-Cu-Co-PGE-bearing sulfides and chromite + Ni-bearing sulfides + PGM. It accompanies chromite, olivine, pyrrhotite, chalcopyrite, cubanite, magnetite, native copper, valleriite, mackinawite, heazlewoodite, millerite and PGM. The chemical composition of pentlandite (metal: sulfur ratios, Fe:Ni ratios and Co and PGE contents) is variable depending on the geological setting, mineral associations and textural relationships. It is suggested that the pentlandite-bearing mineralization hosted within chromitite deposits, related to upper mantle dunites and dunites of the supra-Moho zone, is of primary magmatic origin, but the one hosted within upper mantle serpentized harzburgites, ultramafic-mafic intrusions and to cumulate layered sequences of olivine-gabbros and gabbro-norites is genetically related to hydrothermal activity combined with serpentization processes, which played an essential role for the remobilization of some elements from the host rocks and the transformation of primary sulfides and PGM.

Maastrichtian dinosaurs in SW Transylvania (Romania)

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Although the first dinosaur discoveries from the Transylvanian Basin were made at Bărbant near Alba-Iulia as early as the end of the 19th century, the Latest Cretaceous Transylvanian dwarf dinosaurs gained their worldwide notoriety only after Baron F. Nopcsa reported his first discoveries in the Haţeg Basin. Nopcsa realized the dwarfing tendencies of these dinosaurs and related this tendency to their limited environment, which he called “the

Hațeg Island”. In order to defend the pattern he identified, he attempted to outline the spatial extension of this island, as supported by the distribution of illustrative non-marine sedimentary deposits. In this context, he discovered several new localities with dinosaur-bearing rocks. Among these, the most important ones are located in the Alba-Iulia area. These faunal assemblages seem to be coeval with those from the Hațeg Basin. The non-marine Maastrichtian deposits from Alba County accumulated after the Late Cretaceous “Laramian” tectogenesis, when a fluvial system evolved in the area of the present-day Carpathians. As a matter of fact, the sediments exposed in Alba County suggest similar environments to those from the Hațeg Basin. In the red mudstones and the channel sandstones of the Șard Formation, several vertebrate teeth and bones have been preserved. In this paleobiota, dinosaurs are well represented by the following taxa: titanosaurian sauropods, the basal hadrosaurid *Telmatosaurus transsylvanicus*, the euornithopod taxa *Zalmoxes shqiperorum* and *Z. robustus*, the nodosaurid ankylosaur *Struthiosaurus transylvanicus*, as well as various small theropods. Besides dinosaurs, there are crocodylians (*Allodaposuchus* and *Doratodon*), turtles, and lizards. Fishes, amphibians, birds, and multituberculate mammals are other vertebrates making up this assemblage. More often than not, the remains are fragmentary, scattered and weathered, except for those preserved within sediments of lacustrine origin.

Reverse fault system Cenade-Ruși-Veseud, effect of the Carpathian tectonic phases

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The Transylvanian Basin is surrounded by the Apuseni Mountains, the Eastern Carpathians and Southern Carpathians. It has a roughly circular shape with Upper Cretaceous to Upper Miocene sedimentary fill reaching in some place up to 8 km in thickness. It is a post-tectonic basin and represents a typical back-arc basin starting to the Upper Miocene. Geological and geophysical data show that the sedimentary cover of the Transylvanian Basin has formed during at least seven sedimentary cycles: Permian – Triassic, Jurassic – Lower Cretaceous, Upper Cretaceous, Paleogene, Lower Miocene, Middle – Upper Miocene and Pliocene. Structural elements of the Transylvanian basin basement belong to the Inner Dacides, Transylvanides and Median Dacides resulted from subduction and collision processes, especially collision between the Foreapulian block and Getic block during to the Austrian tectonic phase (Albian Collision) and pre-Gossau phase. These compressional tectonic phases have generated in the Transylvanian Basin the north-south overthrust lineaments with an eastward vergence by extensional reactivation of old structures from Middle Triassic-Lower Cretaceous (normal system faults generated by the Thetysian spreading processes). Later, the Carpathian tectonic phases (Laramian, Old Styrian, New Styrian, Moldavian and Wallachian Phase), recorded, especially, in the Eastern Carpathians through the emplacement of the other Carpathian nappes (Outer Dacides, Moldavides) contributed to the thrust reactivation, some with the appearance of the new structural elements, northwards tilting of the pre-Miocene basement, basin subsidence, uplift and erosions in the Transylvania Basin.

An example on this way is the system of Cenade-Ruși-Veseud reverse faults, which is a result of the Wallachian tectonic phase (Pliocene/Quaternary). The Middle Badenian Salt Formation overlies the Cenade-Ruși uplift and this uplifting was generated by the thrust Laramian tectonic phase. The system of Cenade-Ruși-Veseud reverse faults was activated at the beginning of the Pliocene and it was ruled by a combined tectonokinetic-halokinetic mechanism. The structural map with isochronous (TWT) of the top of Salt Formation shows that fault has a sinuous trend with three segments: the Cenade is on N–S direction, the Ruși segment becomes NW-SE orientated, and the last segment, the Veseud has a WNW-ESE trending with eastward vergence and affect sedimentary deposits, including Pliocene deposits. Along this system, the Badenian Salt Formation has a column diapiric shape. Due to the very

high uplift of Eastern Carpathians which occurred in the Late Miocene-Pliocene (about 4 km uplift and continues to the present day) and higher Upper Badenian-Pliocene sedimentation rates (recorded in the Eastern and Central parts of basin) combined with the Pliocene-Quaternary uplift of the Apuseni Mountains and the presence of the some strike-slip faults developed a pushing pressure of the Salt Formation toward the center and southwestern parts (salt sliding) of basin with the initiation of these reverse faults. Coevally with the Pliocene uplift of the South Carpathians (considerate as rigid fix block for the Miocene-Pliocene sediments of the Transylvanian Basin - after this uplift) were developed normal faults in the southern part of this basin, parallel to the orogen and evolution of the Cenade-Ruși-Veseud reverse system faults don't stop, it is still activate.

Comparison of characteristic and Gutenberg–Richter models for time–dependent $M \geq 6.0$ earthquake hazard in the Corinth gulf, Greece

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Earthquake forecasts have always been a difficult task because they can be affected by uncertainty in terms of the most appropriate model and the involved parameter values. The application of two quite different models to the same seismogenic area was explored. The first belongs to the category of the renewal models, based on the characteristic earthquake hypothesis, the necessary ingredients of which being historical or paleoseismic recurrence times, and a fixed geometry for the faults. The hazard rate so obtained is then modified by the inclusion of a permanent effect due to the Coulomb static stress change caused by failure of neighbouring faults that occurred since the latest characteristic earthquake on the concerned fault. The second model consists of a very simple earthquake simulator, which can be described by parameters taken from two data input classes, fault slip rates and adoption of a Gutenberg–Richter magnitude–frequency distribution. This information is commonly available even if historical and paleoseismic recurrence data are lacking. The intention is to develop and assess a simulator that has a very limited parameter set, which has the benefit of reducing and quantifying uncertainty. We apply both methods along the Corinth gulf extension zone, a place that is rich with observations of strong–earthquake recurrence behaviour, to assess their relative forecast applicability. We find that use of slip rate as a primary constraint allows the simulator to replicate the pattern of observed segmented rupture rates along the Corinth seismogenic zones. As they evolve through time, our rupture simulations preferentially fill slip gaps, enabling estimates of time–dependent segment recurrence. We conclude that very simple earthquake rupture simulations based on empirical data and fundamental earthquake laws can be useful forecast tools.

Along arc geochemical variations in hydrothermal activity in the South Aegean Volcanic Arc: ancient and modern

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Submarine hydrothermal mineralization occurs in at least five locations in the South Aegean (Hellenic) Volcanic Arc; from west to east of Methana, Milos, Santorini, Kos and Nissiros/Yali. Manganese and iron enrichments in seawater and marine sediments are sensitive indicators of the presence of this hydrothermal activity and are sometimes the only

obvious indication of it. Comparison of the Mn and Fe contents of hydrothermal waters from the five locations listed above show that those from the inner parts of the hydrothermal embayments of Santorini are more enriched in Mn and Fe than are those from almost all of the other hydrothermal locations studied, more than 400 ug/l Mn and 5000 ug/l Fe. Hydrothermal waters from the Santorini outer exhalative zone are much depleted in Mn and Fe (17 & 149 ug/l respectively) and fall within the range of values in hydrothermal waters found of Yali (4.5-28 ug/l Mn & 9-221ug/l Fe). Kephalos Bay, Kos contains hydrothermal waters averaging only 14 ug/l Fe while Mn there was beneath detection (0.5 ug/l). Milos offshore hydrothermal waters range from 21-522 ug /l Mn and 35-322 ug/l Fe, more similar to each other than at all of the other locations except Methana. Hydrothermal waters in Thiafi Bay, Methana, contain a relatively low 1-12 ug/l Mn & 7.5 -24.4 ug/l Fe. Fe/Mn ratios also vary in hydrothermal waters along the arc. Those from Santorini vary between 11 & 16 in the inner exhalative zones of the embayments, 8.7 in the outer exhalative zones (probably reflecting the selective precipitation of Fe over Mn with increasing distance from the vents), and 2.5 in the caldera. Off Yali, Fe/Mn ratios vary from 6-13. By contrast, of Milos and Methana they are much lower, varying from only 0.37 to 1.66 at the former and 2.4 at the latter. Clearly therefore, Mn is enriched relative to Fe in the hydrothermal waters of Milos and Methana compared with other hydrothermal locations along the arc. There are variable hydrothermal enrichments of other elements such as Zn, Cu and As along the arc too, highest of Santorini. Thus it appears to be an increase in hydrothermal inputs in waters from the ends of the arc towards the centre. Along arc comparisons of the composition of metalliferous sediments from near the hydrothermal vents is complicated by their variable detrital and volcanoclastic content. In order to eliminate this, all comparisons below are made on the basis of analysis of the sediment fine fraction in which the hydrothermal precipitates are concentrated. The greatest concentrations of Fe and Mn oxides in sediments along the arc occur at Santorini, where Fe/Mn ratios decrease away from the vents due to the selective precipitation of Fe relative to Mn. Lesser enrichments in both elements occur off Yali where the average Fe/Mn ratio falls within the range of that between the Santorini inner and outer exhalative zones. At Kos, Fe is less and Mn more than at Yali, while at Milos Fe is less and Mn mostly close to (with the exception of Mn in the Voudia Bay sediments) their Aegean Sea sediment average. This could be due both to the sub-surface precipitation of hydrothermal minerals and to the metal rich hydrothermal waters that emerge on the seafloor being dispersed over a wider area at Milos than at either Santorini and Yali due to the more topographically restricted settings of the latter relative to that of the former. Fe/Mn ratios in sediments of Milos are amongst the lowest encountered in the South Aegean Volcanic Arc, except at Voudia Bay, where the ratio is elevated principally due to very low Mn there. In Thiafi Bay, Methana, Mn varies from 578-1360 ppm and Fe from 5-8.6%. The former values are similar to those found in the Santorini exhalative zones and some locations at Milos, and the latter are between those occurring at Milos and Yali. There appears, therefore, to be no clear increase in Fe and Mn values in sediments from the ends of the arc towards its centre, although they are highest at Santorini. Much of the variation in the Fe/Mn ratio in the sediment fine fraction between the different hydrothermal locations along the arc can probably be attributed to where the waters from which the oxides precipitate lie in the Fe-Mn hydrothermal fractionation sequence. As far as the writers are aware, ancient hydrothermal mineral deposits have only been described from two of the South Aegean Volcanic Arc islands, Milos and Santorini. At Milos, there are several hydrothermal mineral deposits including the Vani manganese deposit. Santorini has a much more limited known fossil hydrothermal mineral assemblage, consisting of iron oxides and other minerals impregnating basement rocks in bands up to several cm thick at the base of the caldera wall near Thermia. The enrichment of Fe in the Santorini waters and sediments would be in keeping with the only known fossil hydrothermal mineral deposits there also being iron rich, suggesting that the Santorini hydrothermal system may be richer in Fe than those of the other islands. The large variability in the composition of the ancient hydrothermal deposits on Milos precludes detailed comparison with the hydrothermal waters and sediments there at the present time, but is a worthwhile subject for future research.

Jurassic to Early Cretaceous sediments of the Transdanubian Range, Hungary – a unique tectonic unit within the Alpine-Carpathian system and its palaeogeographic provenance

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According to the extrusion or escape model the Pelso tectonic unit should be palaeogeographically situated before Palaeogene and Early Neogene tectonic processes between the Eastern and Southern Alps (SA). In this long known palaeogeographic reconstruction the Early Cretaceous sequence of the south-western part of the Transdanubian Range (TR) (South Bakony and Zala Basin) should resemble the Maiolica/Biancone facies successions of the SA. In contrast the Early Cretaceous of the Gerecse Mts. should correspond to the Rossfeld sequence in the Salzburg Northern Calcareous Alps (NCA). It is not so well known that there are also significant facies differences between the south-western and the north-eastern segments of the TR and that these differences also correspond to those of the SA and the NCA. The basal Jurassic of the SA developed in huge areas on top of shallow-water carbonates, which were deposited in direct continuation of the Late Triassic platform in varied tectonic subunits: Friuli Limestone (Calcari grigi del Friuli), Misone Limestone (Calcari grigi), or San Vigilio Limestone (Calcare oolitico di San Vigilio). These formations correspond to the Kardosrét Lst. in the Bakony; in contrast this facies is missing in the NCA and also in the Gerecse Mts. One of the most typical facies of the Jurassic is the ammonite-bearing, red, nodular, clayey limestone (“ammonitico rosso”) both in the SA and the Bakony. It is called Tűzkövesárok Fm in the Early Jurassic, Tölgyhát Fm in the Middle Jurassic and Pálihálás Fm in the Late Jurassic in Hungary. A more deep-water formation is the radiolaritic Selcifero Fm in the Lombardy and the Lókút Radiolarite (Bakony Mts.) in the late Middle Jurassic to Oxfordian. The larger part of the Late Jurassic and the Early Cretaceous in the Lombardian Basin is represented by the Maiolica facies, while it is only developed in the Tithonian to Hauterivian and pinches out eastward in the Southern Bakony. Jurassic successions of the Gerecse Mts. show similarities to those known from the Tirolic units of the NCA. The base of the Jurassic in the Gerecse is represented by the Pisznice Lst., equivalent to the condensed red limestones of the Adnet Group of the NCA. Both of them cover the surface of the Dachstein Fm. with gentle angular unconformities. Sedimentation on submarine highs is characterized by condensed red limestones; in contrast in the basinal areas grey cherty limestones were deposited. On the Middle Jurassic highs, the red, nodular limestone is called Klaus Fm. in the NCA and Tölgyhát Lst. in the Gerecse. It is followed by the Ruhpolding Radiolarite in the NCA and Lókút Radiolarite in the Gerecse. In the Tirolic units of the NCA the radiolarite succession contain several olistromatic breccias, partly of exotic and partly of local provenance (Hallstatt and Tauglboden Mélanges). The Lókút radiolarite of the TR is followed by or include a breccia bed called „Oxfordian breccia”, which may correlate with the Tauglboden Breccias. The Agatha Fm. of the NCA mirrors the Pálihálás Limestone of Kimmeridgean–Early Tithonian age in the Gerecse, while the Oberalm Fm. matches the Szentivánhegy Lst. of the Tithonian-Berriasian. In the Early Cretaceous the carbonate succession is replaced by turbiditic siliciclastics (Bersek Marl Fm. in the Gerecse and Schrambach Fm. in the NCA). The sedimentation changed from carbonate into siliciclastics diachronously and the time equivalent Felsővadács Breccia Mb as a mass-flow deposit cuts this boundary in the Gerecse. This breccia is thicker and wider spread in the NCA and called Barmstein Breccia. This body is replaced by the lowermost coarse-grained turbidites of the lowermost Rossfeld evolution. Upsection the Bersek Marl is followed by the Lábatlan Sst in the Gerecse and the lower part of the Rossfeld Fm. by the upper one in the NCA. In both regions the Rossfeld coarsening-upward cycle was interpreted as expression of nappe thrusting, whereas for the NCA nowadays for the Rossfeld Basin fill a foreland-basin character (Molasse sediments) is favoured.

Conclusion: The TR is a special tectonic unit showing in part homogeneity to the SA (Bakony) and in part to the NCA (Gerecse). So its original palaeogeographic position has been situated between the NCA and the SA.

Introduction to the WG project on correlation of Mesozoic lithostratigraphic units of the CBGA area

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The main aim of the WG project is to identify and correlate lithostratigraphic units developed within the CBGA region. Although there are some lithostratigraphic units the names of which are used internationally within the region, the overwhelming majority of the units has special names from country to country in spite of the fact that many of the units are crossing one or several country borders. Therefore we want to identify and correlate major lithostratigraphic units in order to exclude unnecessary repetitions of names for well identifiable lithostratigraphic units. Calculating just 400 Mesozoic lithostratigraphic units by countries, in the CBGA region altogether there can be around 5000 units from which let us say 10% are common at least in two countries. This way the great amount of names could be decreased by 500. Supposing there are several units crossing 3-5 or even more country borders the number of lithostratigraphic units could be diminished by another 500.

What is the advantage of decreasing the numbers of names? It can promote a better understanding of the geological and geotectonic setting and via this the geological history of certain areas or broaden the frame of the known areas. Correlation of unified units from one segment of the Alpine orogen to the other will help in further understanding of the Tethyan closure and the Alpine mountain building. Besides that, how great advantage would it be for students if they could operate with fewer numbers of names.

Difficulties may arise while trying to correlate and unify lithostratigraphic units from country to country. We know that there aren't any formations with 100% identity; if we succeeded in correlating a few formations we shall select a common name from among those names used so far in one of the countries for the future to be accepted by the national committees. We shall agree in regulations in advance to follow it in those cases where the solution is not obvious for everybody. There can be several stand points such as: which name was given first; which formation was described most properly; which formation's stratotype is better and more easily accessible; which name can be written and pronounced more easily, etc.

Because of the great number of lithostratigraphic units, and in order to promote the successful correlation the WG is subdivided into sub-WGs: Triassic Sub-WG, Jurassic Sub-WG and Cretaceous Sub-WG.

The introductory talk wants to give general information about the aims and structure of the project, about the approach and steps to be used during the process and also wishes to introduce proper situation when the correlation was successful without forcing it.

Dating aeolian landforms using cosmogenic ^{10}Be in Hungary, Central Europe

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In the Western Pannonian Basin the widespread occurrence of ventifacts and large scale deflation features – like a system of yardangs, deflation hollows and basaltic buttes at least in part exposed by wind erosion – indicate strong wind activity during the Quaternary. This is supported by common presence of wind-blown sediments, like loess and aeolian sand. The Pleistocene glaciations are probably the most important periods of deflation, when the Pannonian Basin was a dry, periglacial area with scarce vegetation and strong winds. However, age of the wind-polished rock surfaces exposed on different geomorphic horizons of the Transdanubian Range – an uplifted low elevation (up to 750 m asl.) range in the Western Pannonian Basin – has remained unknown so far, although they can provide time constraints of landscape evolution. We used in situ produced cosmogenic ^{10}Be to determine exposure time and denudation rate of wind-polished rock surfaces and regional (basin) scale denudation rates are also inferred. In view of surface samples only, minimum exposure ages assuming no denudation are ranging from 0.09 to 1.3 My with most of the ages between 100 and 400 ky. Considering the maximum denudation rates assuming that steady state is reached, yield to rates ranging from 0.36 to 8.42 m/My. In both assumptions, allowing for all surface samples, there is a weak, maybe apparent correlation between age and/or denudation rates versus altitude; saying that the higher is older and/or more resistant. Allowing for the maximum denudation rates of samples from the depth profiles one can observe that for the uppermost samples these rates are the same within uncertainties. This evidences the fact that steady state has been reached. However, for deepest samples, denudation rates become higher. This thus implies that steady state has not been reached at those depths. Accordingly, depth profiles allow determining simultaneously both denudation rate and exposure age. Measurements of ^{10}Be concentrations along depth profiles of exposed, ventifacted rocks allow to derive a local denudation rate of 3.46-3.88 m/My and exposure ages as old as 1.5 My. Regional denudation, which occurred mainly via deflation of the loose sediments, varies between 40 and 80 m/My. Our results show that aeolian erosion in continental, periglacial areas of Central Europe played an important role in Quaternary landscape modification. Besides, the newly determined exposure ages are strong time constraints on the onset of denudation, exhumation of the Transdanubian Range, which is indicative of the minimum time of the uplift of the range.

Ecological aspects of the operational Hail Suppression Project in Serbia

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An analysis of the operational “Hail Suppression Project” in Serbia that used silver iodide dispensed from anti-hail rockets was performed for the period 1981-1986 in order to estimate the seeding agent amount reaching the surface of the target area in precipitation. The primary aim of our investigation is to estimate whether amounts of silver iodide exceeds the

threshold of $1 \mu\text{g}/\text{m}^2$ from one seeding event, which in turn, may be of importance for an analysis of apparent afterseeding effects and environmental pollution. This period is selected due to the largest amounts of the seeding amount performed (the maximum is over 103 kg per a season, 4.4 tones per a six-year period). Our analysis is performed for areas monitored by S band radars located near Valjevo and Užice. The radar observations give us the possibility to estimate the precipitation area associated with a seeded hail cell. It is well known that this area is often much smaller than the analyzed target area independently of a storm type. Our method is based on the next assumptions: each seeding operation was performed according to the seeding criterion; both activated and non activated agent particles reach the ground; analyzed precipitation area is associated only with a single hail cell which satisfies the seeding criterion; the hailstorm precipitation efficiency is 60%; the agent particles are uniformly distributed within the accumulated precipitation area at the surface. In such way, we performed estimates of the seeding agent amount reaching the ground after seeding.

We analyzed the seeded hailstorms tracking over analyzed area from NE, SE, SW and NW direction associated with the frontal passage and individual ones. The individual hail clouds from the north-western direction require the special treatment due to the formation of the hailstreaks along the major axis of the Western Morava valley. A hailstreak has the surface ranged in the interval between 100 and 500 km^2 . For each storm passage, they are observed at the approximately same locations. As expected, the tracks of the hailstorms associated with the frontal passage do not show regular spatial pattern. On the other hand, they are correlated with larger amounts of convective precipitation and silver iodide particles at the ground. Our calculations show that the amounts of the silver iodide at the ground in average are below the threshold in many cases. Our analysis, however, shows that these amounts may exceed the lower boundary more times for some frontal passages and over a single hailstreak associated with an individual hailstorm. In this occasion we must emphasize an important fact. The silver iodide amounts at the ground are underestimated due to the reason that the silver iodide particles are not uniformly distributed in the accumulated precipitation area as well as they do not fall down suddenly via precipitation after seeding starts.

Our preliminary results give the basis for further investigation of such a kind. In the next period, the total loss of the seeding material in the operational "Hail Suppression Project" was smaller. But, this does not mean that the critical threshold of silver iodide amount did not attain in some areas after one seeding event. This requires further detailed investigation for the whole target area and longer time period following the proposed method. The estimation of seeding agent amounts per seeding event only on the basis of total agent loss, the number of seeding events and for the whole target area is wrong for the reason of great underestimation of real seeding effects. Seeding scenarios with considerable amounts of the silver iodide at the ground after seeding are the warnings for ecologists to organize different observations after seeding events with extreme agent loss as well as for various microbiological observations associated with persistent effects of cloud seeding. We believe that the amounts of silver iodide may be decreased by the improvement of hail suppression methodology based on additional investigations.

The cloud drop size distribution effects on accumulated convective precipitation from a hailstorm due to the seeding performed

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Hail causes considerably damage to crops and property. In many areas of the world the cloud seeding with the goal of suppressing hail is common practice. The seeding agent is injected into the target cloud from aircraft, ground-based generators or the agent is injected into the cold peripheral parts of a cloud by rockets. The success of hail suppression activity is influenced by careful selection of seeding time, seeding dynamics, seeding agent amount and

location of initial seeding zone. In the last decade, the cloud-resolving mesoscale models become widely used in testing the seeding criteria with respect to above parameters. The simulation of seeding effects can be done by either explicit microphysics or bulk microphysics schemes. Bulk microphysics scheme is frequently used in the cloud-resolving mesoscale models due to lower computational cost. This scheme assumes a distribution function for the cloud and precipitation size particles. The variation in accumulated convective precipitation due to the uncertainties inherent in the selection of distribution functions and their parameters must be assessed. Until now the cloud-resolving mesoscale models are used in some studies that quantify considerable sensitivity of the amount of accumulated precipitation from a hailstorm on variations of cloud drop size distribution. Main consequence of the hail suppression activity is the accumulated convective precipitation change. The selection of cloud drop size distribution is therefore critical for an adequate treatment of seeding effects.

We use the numerical model of cloud with two microphysical schemes involving the unified Khrgian-Mazin size distribution of cloud drops and a scheme involving monodisperse cloud droplet spectrum and the Marshall-Palmer size distribution for raindrops, respectively. The unified Khrgian-Mazin size distribution approximates the entire drop spectrum that splits into cloud droplets and raindrops at diameter of 100 μm . This drop size distribution is a function of two parameters: total liquid water mixing ratio and mean cloud drop spectrum radius. Sensitivity tests with respect to the amounts of seeding agent, location, time and dynamics of seeding are performed in order to investigate accumulated precipitation change in comparison with an unseeded case using both microphysical schemes. Silver-iodide agent is used in all experiments. Three mean cloud drop radii of 10, 30 and 50 μm are used in sensitivity tests with the unified Khrgian-Mazin size distribution.

Our principal findings are as follows:

For an unseeded hail cloud, the unified Khrgian-Mazin size distribution with a mean cloud drop spectrum radius of 10 μm leads to the huge increase of accumulated rain precipitation (up to 275%) and decrease in hail precipitation (-71%) compared to the counterpart with the Marshall-Palmer size distribution of raindrops and the monodisperse cloud droplet spectrum. Comparison of seeded cases with an unseeded one show the maximum increase of rain precipitation (13.7%) and decrease of hail precipitation (50.2%) if the Khrgian-Mazin size distribution is used. In general, this precipitation changes are greater than those simulated using the alternative approach. Analysis of above results leads to the conclusion that the radar reflectivity criterion alone is insufficient for decision making about hail suppression. The drop spectrum must be also known just before the agent injection due to the optimal seeding agent consumption.

The Miocene granitoid rocks of Bukulja Mt.: evidence of lower crustal anatexis in the Southern Pannonian realm

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Peraluminous granites are often found in collision-related geotectonic frameworks and usually were attributed to various crustal melting. Their composition proved to be very important as an indicator of particular conditions or specific tectonic phases in the frame of the existence of an orogen.

The tectonic framework of the southern margin of the Pannonian realm and northern Dinarides was finally established during the Miocene. In this area, fingerprints of transitional

tectonics, from the Oligocene post-collision, which dominated in the Dinarides, to the Miocene extension, occurring predominantly within the Pannonian/Intra-Carpathian area, may be reconciled.

In this context, granitoid rocks of Mt. Bukulja show characteristics that should be linked to specific geodynamics: (1) it is situated at the very southern margin of the Pannonian Basin, (2) it is characterized by Neogene peraluminous granitic rocks, and (3) it shows Nb-Ta-Sn metallogenetic features. Therewith, they differ from the widespread plutono-volcano-plutonic provinces in Serbia, which are dominated by Late Oligocene, mostly calc-alkaline igneous rocks related to Pb/Zn±Ag±Sb metallogeny.

The granitic mass of Mt. Bukulja crops out about 60 km southern of Belgrade as an E-W laccolite-shaped igneous body covering an area of about 40 km². It is concordantly intruded into low-grade metamorphosed Devonian/Carboniferous schists in the West and into Cretaceous sandy marbles, clay sandstones and limestones in the East.

The bulk of the granitoid mass is represented by medium-grained to slightly porphyritic, slightly peraluminous two-mica granite (TMG). Metaluminous hornblende-biotite and biotite-bearing (H-BG) granite and rare aplitic granite are subordinate, and the former occur as patches or enclaves of various dimensions (from several decimeters to several tens of meters) or as isolated outcrops within deep creeks. The available radiometric age suggests that TMG was emplaced around 20 Ma whereas the age of H-BG is inadequately constrained. A lamprophyre dyke (BLD) similar in composition and age to other Serbian primitive minettes with a K/Ar age of 26 Ma has been found in the vicinity of Mt. Bukulja. TMG and H-BG show similar petrographic characteristics but the evidence of magma interaction processes are found only in H-BG. In comparison to H-BG, TMG are less enriched in most trace elements including REE and have a more fractionated REE-pattern and higher Eu-anomaly. TMG display a wider range of initial Sr-Nd isotope ratios normalized on 20 Ma (⁸⁷Sr/⁸⁶Sr_i=0.70652-0.71368 and ¹⁴³Nd/¹⁴⁴Nd_i=0.51223-0.51283) than do H-BG (⁸⁷Sr/⁸⁶Sr_i=0.70768-0.70781 and ¹⁴³Nd/¹⁴⁴Nd_i=0.51242-0.51256). Geochemical modelling suggests that H-BG could have derived from a BLD-like melt by mixing plus fractionation processes assuming a batch of TMG-like magma as the acid end-member. On the other hand, the geochemical variability of TMG is reproduced by an AFC model with assimilation/fractionation ratio r=0.5 and with high amount of crustal component (~20-50 %) starting from the least evolved TMG rocks. In the modelling, the average composition of the least evolved TMG samples were used to represent parental magma composition whereas the composition of adjacent metamorphic rocks was adopted as possible contaminant. The composition of the least evolved TMG implies that TMG parental magma likely originated by melting of a mafic lithology such as earlier basalts underplating in the lower crust. The high proportions of assimilation along with other geochemical and geological evidence suggest that the Mt. Bukulja TMG originated within the same geotectonic setting as acid volcanics of the north Pannonian Basin. The results of this study support the hypothesis that the Mt. Bukulja pluton is related to tectonomagmatic events controlled by the early extensional phases in the opening of the Pannonian basin.

Hydrothermal methane fluxes from the soil at Sousaki (Greece)

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Methane soil flux measurements have been made in 38 sites at the geothermal system of Sousaki (Greece) with the closed chamber method. Fluxes range from -47.6 to 29,150 mg m⁻² d⁻¹ and the diffuse CH₄ output of the system has been estimated in 19 t/a. Contemporaneous CO₂ flux measurements showed a fair positive correlation between CO₂ and CH₄ fluxes but the flux ratio evidenced methanotrophic activity within the soil. Laboratory CH₄ consumption experiments confirmed the presence of methanotrophic

microorganisms in soil samples collected at Sousaki. These results further confirm recent studies on other geothermal systems that revealed the existence of thermophilic and acidophilic bacteria exerting methanotrophic activity also in hot and acid soils thereby reducing methane emissions to the atmosphere.

A multi-source provenance for Eocene-Oligocene turbidites in the southern Thrace Basin

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The Thrace Basin (Turkey and Greece) is located between the Rhodope-Strandja Massif to the northwest, the Marmara Sea and Biga Peninsula to the south and the Black Sea to the east. It consists of a complex system of depocenters and uplifts with very articulate paleotopography indicated by abrupt lateral facies variations. Most of the basin fill ranges from the Eocene to the Late Oligocene and consists mainly of turbiditic deposits with a significant volcanoclastic component, evolving upwards to shelf and continental deposits.

Sediment source areas and paleodispersal pattern of the southern Thrace Basin were determined by studying framework and heavy-mineral compositions of arenite samples (78 samples for framework composition and 40 samples for heavy minerals). Samples were collected at six localities, which are from west to east: Gökçeada, Gallipoli and South-Ganos (south of Ganos Fault), Alexandroupolis, Korudağ and North-Ganos (north of Ganos Fault). The Thrace Basin fill is made mainly of lithic arkoses and arkosic litharenites with variable amount of low-grade metamorphic lithics (also ophiolitic), neovolcanic lithics, and carbonate grains (mainly extrabasinal). Picotite is the most widespread heavy mineral in all petrofacies.

The average values and distribution of several petrographic parameters discriminate six petrofacies. These parameters are: Q+F/NCE+CE (occurrence of granitic rocks in source area), OF/L (total of ophiolitic rock fragments), F+S/L (amount of metamorphic lithics), CE/L (quantity of carbonate extrabasinal grains), NEOV/NCE (presence of neovolcanic component, both single grains and lithics), CI/L (total carbonate intrabasinal grains), and the amount of the four principal heavy minerals (picotite, sphene, glaucophane and epidote groups).

Integration of the petrographic dataset (gross and heavy mineral composition) with stratigraphic analyses and paleocurrent measurements points to a complex sediment dispersal pattern in the southern Thrace Basin during Eocene-Oligocene times. The main sediment source area was located to the south, including the region of the İzmir-Ankara suture and another poorly dated suture located in the Biga Peninsula. Detrital input from this source area is characterized by the abundance of picotite and ophiolites with low-grade metamorphic rock fragments and extrabasinal carbonate grains. A possible secondary source area is represented by the Rhodope Massif to the west. Detritus possibly derived from this area is characterized by picotite with plutonic and metamorphic rocks. Such Rhodopian provenance, although quantitatively subordinate in the study area, seems to have played a significant role in providing detritus to the central and northern sectors of the basin. An important penecontemporaneous volcanic component is widespread in late Eocene-Oligocene times, indicating widespread post-collisional (collapse?) volcanism following the closure of the Vardar-Izmir-Ankara ocean.

In summary, the most important source area for the sediment of Thrace Basin in the study area was represented by the exhumed subduction-accretion complex along the southern margin of the basin (Biga Peninsula and western-central Marmara Sea region). Most measured paleocurrent indicators show an eastward paleoflow but this is most likely the result of gravity flow deflection. This is possible considering the strong control of the east-west-trending synsedimentary transcurrent faults which cut the Thrace Basin, generating a series of depocenters and uplifts, which deeply influenced sediment dispersal and the areal distribution of paleoenvironments.

Deciphering the geohistory of Armenian ophiolites based on Radiolarian biochronology

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A good understanding of the age and geodynamic evolution of ophiolite complexes is of key significance for the reconstruction of the past oceans. Since most extrusive events (i.e. lava flows) are often covered or intercalated with pelagic siliceous sediments, their dating provides a relatively detailed time frame to describe the magmatic events that took place in parts of the Tethyan oceanic realm. Radiolaria are often the only fossils preserved in these sediments. Therefore, Radiolarian biochronology has become an important tool to investigate the complex geodynamic evolution of Alpine mountain belts.

The main aim of our project is to specify the geohistory of ophiolites preserved in the Lesser Caucasus, a key area of the Alpine-Himalayan mountain belt. Improved knowledge on this subject will allow better lateral correlations of possibly equivalent suture zones and will help deciphering the geodynamic evolution of the greater area between Eurasia and the South-Armenian Block. The latter was a micro-continent that has become detached from Gondwana during the Late Palaeozoic – Early Mesozoic. It is considered as a part of the eastward extension of Taurides-Anatolides continental microplate.

Two main ophiolitic zones are recognised in the Lesser Caucasus:

- The Amassia-Sevan-Akera ophiolites (running from NW Armenia, through East of Lake Sevan to western Karabakh) represent the main suture zone in the Lesser Caucasus, including extensive outcrops of peridotites (often serpentinitized) and gabbros. The geochemistry of lavas suggests the presence of two distinct extrusive systems; i) a contaminated MORB series of basalts, bearing a slight calc-alkaline signature, is considered to be the result of a slow spreading ridge in a back-arc setting; ii) an alkaline OIB series of lavas considered to be the expression of a mantle plume event.

- The Vedi ophiolite, in the SE of Yerevan, is also composed of serpentinites, gabbros and a thick pile of massive and pillowed lava flows. It is considered as a folded klippe sequence that was thrust over Cenomanian-Turonian shallow water carbonates and flysch of the South Armenian Block.

New and revised radiolarian data point to the following working scenario:

(1) the initial phase of sea floor spreading took place during the Late Triassic (Carnian). Evidence for this comes from a single locality.

(2) The bulk of oceanic crust, preserved today in both the Sevan-Akera and Vedi ophiolite complexes, was formed during the Middle Jurassic (Bajocian, Bathonian-Callovian) in a supra-subduction zone (SSZ) setting;

(3) Submarine volcanic activity continued occasionally during the Late Jurassic and Early Cretaceous, as this is suggested by reliable radiolarian ages obtained on cherts intercalated with tholeiitic lavas from both the Vedi and Sevan ophiolites.

(4) Preliminary results on radiolarian cherts intercalated with alkaline lavas of the Sevan ophiolite suggest that a hot spot event took place during the Late Jurassic.

(5) Several tuffite levels, intercalated within the radiolarite sequence of the Sevan ophiolite, reflect a Late Jurassic subaerial volcanic. At the moment, it is unclear whether they are related with the emplacement of the SSZ ophiolites or with the mantle plume event.

Archaeological methodology and deep water archaeological surveys: challenges and perspectives

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We present an overview of the well developed and commonly followed standard methodologies in underwater archaeological research along with recent technological progress in deep water surveys. Our aim is to identify challenges posed by the state of the art marine engineering achievements and to explore perspectives towards an interdisciplinary methodology and concept for the benefit of underwater archaeological research and in the frame of the archaeological deontology.

Remote sensing marine geological-geophysical techniques enable quite high resolution mapping of the seafloor at almost any depth. Underwater vehicles, manned or unmanned, autonomous or remotely operated, equipped with highly sophisticated scientific devices extend the limits of underwater archaeology to include almost full ocean depths.

Mutual understanding and close collaboration between archaeologists, marine scientists and engineers is a prerequisite for the best use of technology and experiences for the benefit of deep water archaeology.

Morphotectonic analysis along the neotectonic faults of Geras Gulf of Lesvos Island (NE Aegean, Greece)

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The tectonic structure of Lesvos is characterized mainly by an extensional regime acting from Neogene to recent while it is also under the influence of the westward migration of the southern branches of the North Anatolian Fault and the North Aegean Trench (NAT). Some of the main active faults of Lesvos Island are extended along the Geras gulf, which form an area of particular importance due to its proximity to the town of Mytilene. At a primal study of faults, a rift zone was found by neotectonic mapping, with deep-slip to oblique-slip normal faults of general direction NW - SE and W - E, respectively. Afterwards, based on rural measurements, the stress pattern of the area was studied as the main directions of the strain-stress field trends (σ_1 , σ_2 , σ_3) were calculated. In some specific sites of fault surfaces overlapping generations of slickenside striae were observed, meaning that more than one field tectonic trends acted in the same position in different time periods. The results include two main distinct tectonic phases; the oldest one with extensional axis directed NE-SW and the newest trending NNW - SSE. The tectonic analysis and the interpretation of digital relief model (DEM), as well as the use of satellite imagery of the study area, have contributed significantly to the quantitative and qualitative analysis of morphotectonic characteristics of the faults. On the basis of the digital relief model, morphological sections were constructed perpendicular to the faults in order to extract information on the morphology of the slope. Moreover, profiles of morphological slope gradients were constructed along faults, based on the slip map of the digital relief model, with mean gradient ranging from 14° to 16° for most of the faults. These values seem to be related to the lithology of the rising block and the uplift rate. Shaded relief maps and three-dimensional imaging helped identifying faults. The determination of the effect of the tectonic geomorphological phenomena can be defined and quantified with morphotectonics indicators. In the present study five (5) morphotectonics indicators were applied: Stream Length - Gradient Index (SL), Drainage Basin Asymmetry Factor (AF), Hypsometric Integral (HI), Ratio of Valley - Floor Width to Valley Height (Vf), Mountain - front Sinuosity (S). The calculation of morphotectonic indicators in the regional faults confirmed the activity, and the recent action,

which gave rise to the tectonic structures observed today. The high values of the SL index are found in morphological slope of the faults. The AF index shows a river spin, possibly due to the influence of faults, which either lift or humiliate the respective pieces of the rift zone. The index Vf exhibits relatively low values indicating a strong, deep erosion of the streams rising in the piece. The estimates of Mountain – front Sinuosity index are ranging from 1.1 to 1.6 and characterize active faults, though not associated with any known historical earthquake. Finally using empirical magnitude - fault length relationships, for the Gera's Gulf area, the maximum expected magnitude earthquake for each fault or fault zone is calculated to $M_s = 5.7 - 6.3$.

Investigation of drinking water quality in Isparta, SW Turkey

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The studied area is located in the western part of the Tauride carbonate axis forming a north pointing cusp, so-called Isparta Angle, in SW Turkey. Autochthonous carbonates and flysch type sedimentary rocks form the basement of the area and are tectonically overlain by ophiolitic melange of the Lycian nappes. All these units are cut in some places by the Plio-Quaternary Gölcük volcanics and covered by Quaternary pyroclastic tuffs and alluvial deposits. Additionally, the rest of Isparta area is made up of sedimentary rocks (Jurassic to Oligocene) and Pliocene-Quaternary (6.75 Ma-24,000 year) volcanic rocks. Hydrogeologically, the rocks in the area are classified as permeable, semipermeable, slightly permeable, and impermeable. Among these hydrogeological units, the alluvium, volcanic tuffs, and limestones are considered as aquifers in the area. The groundwater flow direction in the Isparta plain is generally from SW to NE comparable with the gently slope of pyroclastic fall deposits extending from Gölcük caldera in the SW to province capital of Isparta.

The water is one of the most important basic resources for the human life. The drinking water must be of drinkable quality corresponding to drinking water standards. Therefore, the quality control of drinking water is very important. In this study, to determine the distribution of water in drinking water system, 46 samples were collected from town of Isparta and its surroundings accompanying with the *in situ* measurements of temperature, pH, electrical conductivity, total dissolved solids, redox potential, dissolved oxygen, alkalinity and acidity tests. 46 water samples have been analysed for their anions, cations and some trace element contents by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) and Ion Chromatography (IC). It was concluded that the results are comparable with national (Turkish Standards Institution – TS 266 2005) and international (World Health Organisation – WHO 2006, United States-Environmental Protection Agency – US EPA 2002 and European Union – EU 1998) drinking water standards. The waters in the studied area can be considered as Ca-Mg-HCO₃ and Ca-HCO₃ type exchange-waters. Until 1995, the drinking water for the people from the capital of Isparta have been supplied by water springs of Andık and Gölcük lake. Since 1995 due to increasing water requirements, drinking water system are ensured by Eğirdir lake waters. The results of hydrogeochemical analyses show that the Eğirdir Lake water dominates in drinking water system of Isparta. Nowadays, the high fluoride contents in drinking waters from Isparta and its surroundings are reduced by mixing process with the waters of Eğirdir Lake which reach sometimes standard fluoride values and lie under standard fluoride values (<0.5 mg/l). F-contents in waters below the standard value (<0.5 mg/l) may give rise to dental and medicine problems. Therefore, mixing operations for the drinking waters used in town of Isparta must be carried out very carefully.

Silicate and sulfide mineral chemistry of some carbonate-related Pb-Zn-Cu mineralizations and their effects on ore genesis in NW Anatolia, Turkey

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The studied Pb-Zn-Cu deposits are located between Çanakkale and Balıkesir provinces in NW Anatolia. Two deposits are investigated in these provinces, Lapseki-Çataltepe and Yenice-Kalkım deposits, situated to the northwest and southeast of Çanakkale, respectively. The main rock units in the region range in age from Paleozoic to Tertiary. Paleozoic rocks are generally characterized by Karakaya Complex units which are represented by Permo-Triassic metamorphic rocks consisting of schists and calcschists with lens- and/or band-shaped recrystallized limestones and/or marble intercalations. Tertiary rock units are represented by Eocene granitoids and volcanics in Lapseki area, and Oligo-Miocene granitoids and Middle Miocene volcanic rocks in the Yenice area. Mineralized zones in both deposits occur as hydrothermal veins in carbonate levels of metamorphic rocks or rarely in the fractures of other metamorphic rocks. The main ore mineral paragenesis for both deposits is galena, sphalerite, chalcopyrite, pyrite and arsenopyrite assemblage, while gangue minerals are garnet, epidote, quartz and calcite. Manganiferous hedenbergitic pyroxene and hematite are only found in the Yenice-Kalkım deposits.

According to EPMA studies, the garnets from Kalkım (Handeresi, Bağırkaç and Fırıncıkdere adits) are grossularite, andradite and hydroandradite in composition, while the garnets from the Çataltepe deposits are andradite and grossularite in composition. Pyroxene minerals are determined as manganiferous hedenbergite, johannsenite and diopside based on XRD, EPMA and Raman Confocal spectrographic analyses. EPMA studies of the ore samples of the Lapseki area show that there are two types of galena: (1) low Ag-Bi-Te bearing galena and (2) high Ag-Bi-Te bearing galena. Trace element mineral data indicate that sphalerite minerals can be classified as two groups according to Fe and Co contents: (1) low Fe and Co bearing sphalerite, and (2) high Fe and Co bearing sphalerite. Pyrite and chalcopyrite minerals are also divided into two groups; (1) Co rich pyrite and chalcopyrite and (2) Co-poor pyrite and chalcopyrite.

Trace element analyses of sulfide minerals in Yenice-Kalkım area show that there is only one type of galena, sphalerite and pyrite formations. Trace element contents of Yenice-Kalkım ores are similar to the low sulfide bearing galena, sphalerite and pyrite minerals of Çataltepe ores. According to both geochemical analyses and EPMA studies, Kalkım area deposits with low Ag-Bi-Te-Fe-Cu-Zn-Co contents seem to be compatible with low Ag-Bi-Te-Fe-Cu-Zn-Co contents in the Lapseki area. In conclusion, EPMA results show that there are, at least, two different ore forming fluids active during the ore forming processes in Lapseki-Çataltepe deposits. Similar metallic element interactions for ore forming fluids in Kalkım area, Pb-Zn-Cu deposits, cannot be found as in the Lapseki-Çataltepe Pb-Zn-Cu deposits.

An evaluation of the prospective archaeo-cultural heritage of the Northern Romanian littoral zone

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Large displacements of the Western Black Sea coastline have been encountered during the Late Pleistocene and Holocene due to the Danube Delta's lobs evolution in time which gradually restricted and finally closed the former Danube Estuary and Halmyris Bay. The notable consequences of this processes were the change of the number and position of the Danube River's branches discharging mouths and related human activities such as: habitation, navigation, trade, etc. According to ancient historians (e.g. Herodotus in the 5th Century BC, Polybius in the 2nd Century BC, Strabo in the 1st Century BC, Pliny the Elder in the 1st Century AD, Ptolemy in the 2nd Century AD and others), at that time, the Istros River (the ancient name of the Danube River) discharged its waters into the Black Sea through five to seven mouths (branches), among which the most important was the Hieron Stoma (Holly Mouth), identified today as being the Sfântu Gheorghe branch of the Danube.

The combined result of the coastal zone subsidence (estimated amplitude of -2 to -4 mm/y) and the accumulative sedimentary regime within the Danube Delta area place the prospective cultural layer corresponding to late Prehistory – Early Antiquity at a burial depth that now exceeds 4-5 m, the only feasible way to investigate its extension being provided by geophysics. The applicability of the geophysical methods is also very closely linked to the ability of ancient human beings to modify, through their past activities, the habitation environment by generating local petrophysical contrasts. Such contrasts of physical properties (density, magnetic susceptibility, conductivity, etc.), all of anthropogenic origin, on which existence beneath the earth surface all geophysical investigation methods rely on, were only generated when the ancient inhabitants started to use the fire in increasingly larger scale, to excavate, to build (especially when using materials of allochthon origin) and, never the less, to use metallic tools and weapons. According to information gathered on the archaeological sites excavated on the adjacent Northern Dobruja, all these steps toward a better geophysical discoverability have been concluded since Early Bronze Age (3rd Millennium BC). The deep burial of the past cultural layers, set close to the sea level in ancient time, could explain the lack of success of all archaeological works carried out during the last decades toward the discovery of the Histria's and Argamum's ancient harbors.

The present position of the inhabited areas suggests the ancient ones were also located along the paleo-branches of the Danube and in the vicinity of the shoreline, at a safe distance from the effects of sea storms. Therefore, the most promising areas in this regard should be of course located in the close vicinity of the Sfântu Gheorghe branch's paleo-banks, the most important distributor of the Danube River in Ancient times. Here, on several points located on the littoral sector confined by the present day Sfântu Gheorghe and Sulina branches' mouths, the sea waves bring on the beach pottery remains originating from undiscovered yet antique wrecks caught in the relict beach ridge system and dug out by the intense erosion that presently deepens the seabed by 0.25 – 0.5 m/y.

The possibility that the beach ridges system was born until approximately 500 years AD in the southernmost part of the Danube Delta, that gradually closed the former Halmyris Bay, partly covered today by Sinoie Lagoon and marine shallow waters, to host remains of fortified points and mostly wrecks of the ancient ships connecting Histria and Argamum fortresses with other harbours of the Black and Mediterranean Sea, must be considered. Numerous fragments of pottery brought today by waves on the beach south of Gura Portița could be reworked from the erosion submerged beach ridges and clearly sustain this hypothesis. This entire prospective archaeological load, with ages ranging from 8th Century BC to 5th Century AD, contained by the Împuțita - Câșla Vădanei and Coșna - Vadu littoral sectors, supposed to be represented mainly by wrecks of ancient ships, are in

an imminent threat of being washed out by the intense erosion that now affects the shoreline as well as the adjacent seabed.

The results from monitoring of the Krupnik seismogenic area in SW Bulgaria

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The new results from monitoring of the Krupnik seismogenic area in the Southwest Bulgaria are presented. Special attention is paid to the geodetic analysis using present-day GPS data and seismological modelling of regional stress field in order to constrain the kinematics and dynamics of the region. On the base of the complex analysis of the recent seismicity, geodetic data and fault plane solutions modelling we can conclude that the present tectonic activity in the Krupnik area in SW Bulgaria is associated with the main geodynamic processes in the central part of Balkan region.

The Black Sea – an energy crossroads and/or an unconventional energy and resource center in Europe

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The irregular geographic distribution of the raw materials for the energy industry such as oil and gas on the world geographic map creates a problem with their transportation to the end consumer. Nowadays hydrocarbons are transported by tankers or via pipelines. Pipelines are preferable due to a number of reasons. Their advantages make them very attractive and are expressed as follows:

- considerably shorten the distance to the end consumer;
- transport charges for the transit of the products are avoided;
- risks of pollution during this means of transportation are reduced.

Russia and the countries from the Caspian region, the Middle East, the North Sea and Middle Asia are seen as the natural centers of energy resources for Europe. Since these centers of energy resources are available the economic advantage of their use is determined mainly by the methods of their transportation to the end consumers. Two competitive projects - the South Stream and Nabucco – are launched.

Even today we can often hear apocalyptic prophecies of the near end of oil and gas era and appeals to industrial societies to quit the use of oil and natural gas and to start using alternative energy sources and raw materials.

The only outcome is the search for unconventional (alternative) sources of energy, moreover that the prices of these resources will continue to grow in the foreseeable future. The search for unconventional alternative (oil and natural gas) resources and the prospects for their use will bring reassurance for the future of humanity.

New results were obtained over the past 20 years in the sphere of unconventional resources of energy in the Black Sea and the sophisticated technologies that made possible the development of several pilot projects. The topmost is the project for research and production of methane gas from the gas hydrate deposits on the bottom of the Black Sea.

The studies of DSOMS as a complex resource have indicated broad perspectives for their application in the sphere of agrobiotechnologies, nanotechnologies, construction sector, medicine and other spheres. Under the conditions of chronic energy crisis and shortage of quality food products we have to pay special attention to unconventional raw materials and resources of energy. An important factor for the organic farming in Bulgaria is the use of the

practically inexhaustible reserves of natural ecological fertilizers found in the Bulgarian economic zone in the Black Sea.

The Black Sea is a powerful Natural Geobiotechnological Reactor, capable of producing various natural resources. The Black Sea is the biggest generator of H₂S in the world and is a global source for the production of hydrogen and sulphur.

The adoption of new, renewable sources of energy and the production of hydrogen and the accompanying products from the hydrogen sulphide extracted from the marine water and the sediments provides the hydrogen energy sector with a new perspective.

The unlimited reserves of H₂S in the Black Sea are an important challenge to the modern technologies for production of a new type of energy resources as H₂ and the accompanying products (S). The reserves of H₂S are evaluated to be between 2.88 and 4.18 billion tons or 169 – 245 million tons of H₂ and 2.7 – 3.9 billion tons of S.

Undoubtedly, the suggested energy corridors will contribute to the energy security of the Balkans. However, we should remember the immense potential of the unconventional resources of the Black Sea which studies and utilization will secure the future of the energy sector of Europe.

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Çamlıca High (South of Soma, Manisa): An important structure to understand the Neogene-Quaternary tectonics of the Central Western Anatolia

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E–W and N–S- trending cross grabens and horsts are the most important structures of Western Anatolia. Çamlıca High is a ~N–S-trending geomorphologic feature with a strong topographical manifestation. This feature, located at the northern tip of the Miocene Yuntdağı Volcanic Complex, is surrounded by Kırkağaç Graben to the east, Soma Graben to the north and Bakırçay Graben to the west. N–S- trending Kırkağaç Fault, E–W- trending Soma Fault and NE–SW-trending Kozanlı Fault set are the marginal faults of this structure. The lignite bearing deposits of N–S- trending Mio–Pliocene basin were elevated by these faults. These deposits and interior part of the High were also dissected by ~N–S and NW–SE- trending faults. To understand the tectonics of the region, field studies were carried out along the marginal structures and interior of the Çamlıca High. Based on the kinematic analyses, performed by using fault-slip data acquired from fault surfaces, the following results were obtained: i) NE–SW- trending faults have been formed under NW–SE extension and the principal stress distribution is $\sigma_1= 278^\circ/78^\circ$, $\sigma_2= 63^\circ/10^\circ$ and $\sigma_3= 155^\circ/7^\circ$ and the value Φ is 0.184; ii) NW–SE- trending faults have been formed under NE–SW extension regime and the principal stress distribution is $\sigma_1= 154^\circ/76^\circ$, $\sigma_2= 305^\circ/12^\circ$ and $\sigma_3= 37^\circ/6^\circ$ and the value Φ is 0.335; iii) for the formation of N–S- trending faults (Kırkağaç Fault), ENE–WSW extension is dominant. The principal stress distribution is $\sigma_1= 334^\circ/47^\circ$, $\sigma_2= 187^\circ/34^\circ$, $\sigma_3= 91^\circ/23^\circ$ and the value Φ is 0.609, and $\sigma_1= 166^\circ/81^\circ$, $\sigma_2= 335^\circ/9^\circ$, $\sigma_3= 65^\circ/2^\circ$ and the value Φ is 0.3 respectively. Under the light of these kinematic analyses, we can conclude that in the region two different tectonic regimes were revealed. The first one is NNE–SSW directed extensional regime resulted from WNW–ESE- trending compression. This tectonic regime was played an important role during the formation of N–S directed left lateral strike-slip faults with normal dip-slip component. The NW–SE- striking faults with normal dip-slip component and related

oblique faults were formed due to extension in this regime. The last tectonic regime affecting the region is NNE–SSW and WSW–ENE directed simultaneous extension which enabled the formation of approximately N–S-trending normal faults (Kırkağaç Fault) and E–W-trending normal faults (Soma Fault) controlling especially the boundary of Çamlıca High. This regime additionally reactivated older faults within the region.

Mesozoic radiolarians from the Dinarides (Serbia and Bosnia)

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The territories of Serbia and Bosnia are very interesting for studies of Mesozoic Radiolaria. Radiolarian ages determined in the Dinarides reveal the following age clusters: Middle to Late Triassic, Middle Jurassic, Late Middle to Late Jurassic, Late Jurassic to Early Cretaceous and Late Cretaceous. No Early Jurassic faunas were found.

In the internal Dinarides radiolarian cherts can generally be found in 3 different tectonic settings: (1) Radiolarian chert sequences which are a part of an ophiolitic mélangé formed during the Late Jurassic, underlying obducted (Dinaric or West Vardar) ophiolites of Jurassic age. Within blocks, the radiolarites are often in original stratigraphic contact with basalts. Therefore, such blocks either represent gravitationally emplaced olistoliths, or alternatively, tectonically emplaced slivers. Interestingly, the mélangés often contain Triassic (Ladinian and Carnian to Norian) as well as Jurassic radiolarite sequences, both occasionally associating with basalts. This indicates that the mélangé underlying the obducted Jurassic ophiolites also incorporated blocks that represent the remnants of Triassic in age ocean floor (Maliac-Meliata ocean). These occur side by side with blocks that are derived from the obducted Dinaric and West Vardar ophiolites. We interpret the Triassic and Jurassic ophiolites within the mélangé to be a part of one and the same Triassic-Jurassic oceanic domain. (2) Jurassic in age radiolarian cherts are also found as an integral part of a still preserved in situ passive margin sedimentary sequence in the footwall of the ophiolitic mélangé (East-Bosnian-Durmitor and Drina Ivanjica units). Deposition of radiolarites onto Triassic to Early Jurassic platform carbonates of the distal Adriatic margin indicates subduction of the platform below the CCD initiated during the Aalenian. The onset of subduction predates final obduction which occurred soon afterwards (i.e. at the end of the Jurassic). The radiolarian faunas from different localities in Serbia indicate ages that range from the Aalenian to the Tithonian. (3) Radiolaria may also occur within the so-called “Radiolarite Formation” and within the background sediments of the “Flysch Bosniaque” (or Vranduk Flysch) in Bosnia. The Radiolarite Formation represents a very thick sequence of radiolarites which were separated from their original substratum that belongs to the Adriatic margin. This formation yielded ages ranging from the Bajocian to the Berriasian and the earliest Valanginian. These radiolarites are tectonically overlain by the ophiolitic mélangé. In contrast to the mélangé no Triassic radiolarians were found. The radiolarite formation probably represents the detached cover of the East Bosnian Durmitor unit, since both directly underlie the ophiolitic mélangé formation. The radiolaria found within the Vranduk flysch, located in the footwall of the Radiolarite Formation are of Oxfordian age and indicate that this flysch basin, which is characterized by ophiolitic detritus, came into existence in the Oxfordian.

Radiolarites contained in Scaglia Rossa type sediments were dated as Campanian. These form the matrix of MORB-type pillow basalts that are part of the Sava Zone. The Sava Zone forms the suture zone between the Dinarides and the Tisza and Dacia blocks. This latter age group provides evidence that the final collision between Adria and Tisza did not take place before Latest Cretaceous times.

The geotourist development on the example of the area of Jasieniowa Mt. (Western Carpathians Flysch, Poland)

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The interpretation of geo(morpho)logical phenomena and processes as well as the transmission of geoscientific knowledge to the general public are the essential tasks of geotourism. The proper development of the geotourist sites is a tool for their accomplishment. This paper presents the model of geotourist development which consists of planning and creation of infrastructure (basic and supporting) and the promotion of sites. The basic infrastructure includes the interpretative materials, geotourist trails as well as technical facilities ensuring the safety and comfort of sightseeing. The elements of proposed model are shown on the example of the area of Jasieniowa Mt. (Cieszyn Foothills). The outcrops located in the selected region represent the oldest sedimentary rocks in the Polish Carpathians Flysch, which are the Vendryne Formation and the Cieszyn Limestone Formation. Within the scope of geotourist development, the geotourist trail and information panels were designed, as well as the location of the protective and supporting facilities was proposed.

Geological and geomorphological values of the Castle Hill geological and educational trail situated in Szanda (Northern Hungary)

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This article is about results of cadastre of unique geological and geomorphological values in the Castle Hill, in Hungary. The Castle Hill situated in Szanda (528,6 m) has preserved the remnant of the dyke ridge developed during the Miocene volcanism (16-14 Ma) in the Cserhát Mts., the special geological structure and landforms of the dyke and anthropogenic aspects of the mining activity. We would like to show these particular geological structures and landforms with a geological and educational trail extended new stages for tourists today. During our field works, geological and geomorphological values of the Castle Hill have been mapped and surveyed by the Cadastre data sheet of unique landscape values. We have made detailed description of different objects, we have taken photographs of them and we have mapped the route of the new, more detailed geological trail and the topographic situation and landscape values of the stages. Where it was possible, we have measured dips and strikes. Our aim was to cadastre and survey unique geological and geomorphological values of this important nature protection territory. Our investigation has explored 28 new geological outcrops and landform values and these can be built to the route of the older geological and educational trail.

Middle Triassic mud-mound limestones from Mahmudia, Tulcea Unit – North Dobrogean Orogen, Romania

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For nearly three decades, mud-mounds were thought to be essentially a Paleozoic phenomenon. Buildups composed of a mosaic of facies, like for instance the widespread

Carboniferous Waulsortians and the Belgian Devonian *récifs rouges* were virtually considered as mud-mound archetypes. It is only since the middle of nineties that the term mud-mound is widely applied to Mesozoic sponge mounds.

In the north-eastern part of Tulcea tectonic Unit from North Dobrogean Orogen, around the Mahmudia village are cropping out Middle Triassic limestones, described in the literature as the first occurrence of Middle Triassic mud-mound deposits in Romania. Associated with zebra and stromatactis typical mud-mound structures, there are some carbonate crusts whose origin seemed to be microbial, but are clues to assume that are similar with cemented grainstone crusts.

The aim of the study is to separate the carbonate microfacies and it will include as methods, optical microscopy, staining and UV fluorescence as keys for sedimentary structures and frequency of allochems, cathodoluminescence (CL), scanning electron microscopy (SEM) and stable isotopes (C, O) analysis for microstructures and diagenetic features and petrography of fluid inclusions for paleoenvironmental conditions. In addition to the optical methods we have also investigated the geochemical composition of selected particles or lamina directly from polished slabs using a microXRF device (Horiba XGT 7000).

Among the carbonate microfacies separated so far, we can include Tubiphytes boundstone, radiolarian and sponge spicule wackestone with stromatactis, bioclastic grainstone to packstone, dolomitised bioclastic grainstone and laminitic mudstones.

The microbial nature of the mud-mound is sustained by the abundance of Tubiphytes, which dominate some areas resulting true boundstones, and the presence of *Baccinella*, a real microbial product. Metasomatism, dolomitization and cementation which affected the primary fabrics given by early marine diagenesis are proved also by the stable isotope analyses. A deep water environment (internal shelf – 70-100 m water depth) for the mud-mound is suggested by the typical wackestone with sponge spicules and calcified radiolarians or calcispheres.

U/Pb zircon geochronology on TTG rocks from South Carpathians (Romania): Insights into the geologic history of the Getic Crystalline Basement

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In situ U/Pb zircon geochronology was carried out on some minor granitoids intrusions from the western Getic domain (Buchin and Slatina-Timis intrusions) and on the swarm of trondhjemitic dikes, sills and small granodiorite bodies from the northern Getic domain - South Carpathians. According to previous petrological studies these intrusions are related to partial melting of a thickened continental crust. Most of the dated zircon crystals are composite, with xenocrystic cores surrounded by multiple overgrowths. Age results on inherited cores of the Buchin and Slatina-Timis intrusions reveal ages from Neoproterozoic to Late Proterozoic-Cambrian that represent inheritance from old crust. As revealed by ages from zircon overgrowths characterised by oscillatory zoning, the intrusion occurred in the Upper Cambrian-early Silurian. The outer rims of the Buchin zircons record the Variscan metamorphic peak conditions suffered by the Getic basement. The U-Pb ages on inner cores from rocks of the northern Getic domain reveal Paleoproterozoic to Neoproterozoic inheritance. Prevalent ages in zircon cores and rims are in the range 539-428 Ma and seem to date a major component forming the Caledonian crustal basement of the South Carpathians. Scarce but ubiquitous ages of 320-214 Ma on rims overlap the ⁴⁰Ar/³⁹Ar ages on mylonites from the shear zone and indicate imprints of the Late Variscan dynamic retromorphism. The magmatic intrusion occurred between 110 Ma and 105 Ma in agreement with previous Ar/Ar ages (109-108 Ma).

The best geotouristic objects of the Silesian Unit, Outer Flysch Carpathians in the vicinity of Krakow, Poland

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The Outer Carpathians are built up of a stack of nappes and they are thrust over the southern part of the North European Platform. The Silesian Nappe occupies central part of the Outer Carpathians and it is built of sedimentary facies represented continues succession of Late Jurassic to Early Miocene times. In sedimentary profile are written successively stages of development of Silesian Unit on the background of evolutionary stadia of the geodynamic development of the Northern Carpathians from syn-, post-rift to synorogenic phase. The best outcrops (legible, good-preserved and accessible for the group of tourists) to examine the Silesian rocks are presented and included into the trail. The sites highlight stratigraphy and sedimentology of Silesian Unit, from Jurassic to Neogene, elements of structural geology, petroleum systems (source rocks, reservoir rocks, seals), geotouristic important objects and history of human activities in the Carpathians, especially of mining and oil industries. The proposed trail traverses the Silesian Nappe in Polish sector of West Carpathians between Kraków, Cieszyn and Ciężkowice area.

The management of a sustainable touristic activity at the Lacu-Roșu Touristic Resort – within the “Bicaz Gorge - Hășmașul Mare” National Park

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The “Bicaz Gorge – Hășmașul Mare” Natural Park belongs to the Central Group of the Eastern Carpathians, it is located in the Hășmașul Mare Mountains. Due to its natural characteristics, geological, biological, zoological, components, these 2128 ha, in 1980, then in 1995, were denounced as Natural Reservation by the County Council. In 2000, under the 5th law, 3rd paragraph, of National Territorial Planning and Administration, the 6575 ha, of the “Bicaz Gorge – Hășmașul Mare” region was declared a Natural Park along with the Lacu Rosu Lake Tourism Resort. In the management of the “Bicaz Gorge – Hășmașul Mare” Natural Park we should consider three points of criteria: the management of the inland, the management of border areas (buffer areas), the management of the surrounding settlements, around the national park.

Geomechanical Database – description of rocks properties with GIS application

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Geomechanical Database developed by Department of Geomechanics at University of Warsaw until recently, collected nearly 200 000 parametric data for Poland’s rock properties as well as respective non-parametric informations (descriptions, graphics) have been collected. The data concern rocks of different age and lithology from various regions of

Poland such as Holy Cross Mountains, Sudetes Mountains, Cracow - Czestochowa Upland, Carpathians, etc. The geological regions are subordinated to physical and geographical sub-provinces according to the Kondracki division system. The main purpose of Database is systematization and integration of geomechanical rock properties, and their quick search option for large multi-subject data sets. Each component of the Database is identifiable geospatially by means of the material (“rock object”) source location in the geographical coordinate system. With that, all data collected in the Database meet the GIS system requirements and allow co-operating with other information sets within the system.

Based on the unified research procedure adopted by the Department of Geomechanics UW, test results the BDG contains more than 50 000 strength and strain parameters; nearly 100 000 parameters of ultrasonic tests; and more than 40 000 parameters of physical features. Besides in database the data from special tests are collected such as surface roughness for rock fractures; long-term rock deterioration susceptibility under influence of weather or chemical factors. The base deals with data of rocks used currently as raw materials as well as not used recently for industrial purposes for various reasons, for instance due to the location within national parks.

The BDG operates basing on two systems cooperating with each other: The General Database system collecting data on the server, and The System of Applications for viewing the collected data, acquiring new data and for generating reports responding to queries.

The System of Applications consists of three modules: Main Module (MM), Search Module (SM) and Report Module (RM). The Main Module is intended for viewing the entire data base content and for entering new data. The Search Module provides with information selection required by the user. The Report Module presents reports in tables or graphics according to the available options.

The MM structure consists of seven hierarchic information levels in the following sequence: rock origin region, data of the object, rock type, geomechanical parameter, type of examination, data for sample group and data for single rock sample.

Created by Department of Geomechanics the Geomechanical Database operates based on the SQL programming language, which guarantees the system architecture compatibility with different up-to-date data bases. The applied information technologies provide with a full exchangeability of geomechanical data with other GIS systems, where UML, GML, GeoSciML, or XMMML language was applied.

The BDG ‘foundation stone’ was the need for a quick search solution for data contained in large multi-subject data sets. Such solution was necessary for publishing the catalogues for Polish rock properties in the regional division. That is why the adopted internal database structure allows presenting selected information in tables or diagrams as well as quickly selecting information for scientific researches thanks to the in-built search module.

The Database layout allows presenting the data either against the background of well-known geomechanical classification systems, or in needed sets of results. The Database is open and being permanently extended. Parts of the Database are available on the <http://www.geo.uw.edu.pl/geomechanika>

Photogeological interpretation – an efficient tool for tectonic analysis. Study case – the Oas-Gutai Mts. (NW Romania)

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Besides the detailed photogeological and volcanological maps, the geological photointerpretation on the Oas and Gutai Mountains (OGM) led to the detailed deciphering of the fractural elements which affected the area following the lower Miocene obduction of the Pienidic Units from the Central-East Carpathians. The photogeological interpretation reveals the *nappe* units disposal of the Pienides system (Botiza, the Wildflysh and some other already mentioned units in the area like Magura, Babesti-Tiacovo, Kricevo, with different spatial and structural disposal from author to author). The slides structure composed by imbricate entities

WSW/ENE oriented, with maximal development on 300-400 m width and 1-2 km length within an entity with frequent sequences of discordance is revealed. This image closely fits to the structural model of the frontal Nappes of the Botiza Unit as outlined in the area of maximum outcropping and is extended upon the entire Botiza and Wildflysch Units (conformable to the main entity of the nappe units upon which sporadic outcropping and consistent Upper Miocene sedimentary cover are observed). The development of the crystalline rocks assigned to the Internal Dacides Units vs. Tisia-Dacia as well as of the Cretaceous, Paleogene and Upper Miocene deposits and mostly of the Badenian-Pannonian volcanics have defined a crustal puzzle difficult to decipher, which favored different cartographic and structural interpretations. Based on the photogeologic image, the tectonic interpretation evidenced the major fractures in OGM area: 1. *NE Gutai Fault*, 2. *Dragos Voda-Bogdan Voda Fault*, 3. *Suior-Baia Sprie Fault* (the last two ones being frequently taken one for another), all sinistral strike-slips. We designed also the corresponding sintetic/antitetic faults, as well as other minor faults with considerable structural effects.

The statistic analyses of all fractural alignments quantified by discordant measurable segments (considered proportionally with the value of the fractural amplitude) led to the vectorial representation of the major fractures and their associated syntetic/antitetic secondary faults (1., 2., 3.) advancing the cinematic model (translational and rotational) of the analyzed tectonic block (OGM). The model indicates northeastward movement and counterclockwise rotation (45° - 60°) as compensation (retreating) effect of the convergence generated by the oblique collision of the major tectonic plates (East European Plate/African Plate). This cinematic hypothesis (collision at open angle to WSW) seems to infirm the closing sense of the oceanic basin, illustrated by the migration of the foreland basin depocenter in front of the Carpathian arc from W to SE and can be explained only by a specific oblique collision of this tectonic area. The reconciliatory advanced solution of the two interpretative scenarios regarding the Miocene kinematics of the area is a NE peninsula part of the Tisia-Dacia block or of a distinct crustal entity with its own kinematics (Zemplin), at northern joint of the Alcapa / Tisia-Dacia Units. A detailed evaluation of each fractural entity including compressive/distensive associated assembles (pull apart, positive flower structure, double compressive bands, bypass bends, distensive and compressive bends etc.) has been performed.

Post-subduction Pliocene-Quaternary magmatism in the south-east part of the Carpathian-Pannonian Region: tectonic significance

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The SE part of the Carpathian-Pannonian region records the cessation of convergence between the European platform/Moesia and the Tisza-Dacia microplate. Pliocene-Quaternary magmatic activity in this area, in close proximity to the 'Vrancea zone', changed from normal calc-alkaline type to much more diverse magma compositions at approximately 3 Ma, suggesting a significant change in geodynamic processes. We review the tectonic setting, timing, petrology and geochemistry of the post-collisional volcanism to constrain the role of orogenic processes such as subduction and collision on melt production and migration. The calc-alkaline volcanism (5.3-3.9 Ma) marks the end of normal subduction-related magmatism along the post-collisional Călimani-Gurghiu-Harghita volcanic chain in front of the European convergent plate margin. In South Harghita magma compositions changed at 3 Ma to adakite-like calc-alkaline and continued until recent times (< 0.03 Ma) interrupted at 1.6-1.2 Ma by generation of Na and K alkalic magmas, signifying changes in the source and melting mechanism. We attribute the changes in magma composition in front of the Moesian platform

to two main geodynamic events: (1) slab-pull and steepening with opening of a tear window (adakite-like calc-alkaline magmas) and (2) renewed contraction associated with deep mantle processes such as slab steepening during post-collisional times (Na and K alkalic magmas). Contemporaneous post-collisional volcanism at the eastern edge of the Pannonian Basin at 2.6-1.3 Ma was dominated by Na alkalic and ultrapotassic magmas, suggesting a close relationship with thermal asthenospheric doming and strain partitioning related to the Adriatic indentation. Similar timing, magma chamber processes and volume for K-alkalic (shoshonitic) magmas in the South Apuseni Mountains (1.6 Ma) and South Harghita area at a distance of ca. 200 km imply a regional connection with inversion tectonics.

Hierarchical mapping of landforms from Digital Elevation Models (DEMs)

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Digital Elevation Models (DEMs) are used for the extraction of land-surface parameters and objects through geomorphometric analysis. Landforms are examples of objects that can be extracted or mapped through wall-to-wall classifications and further used in any application where discrete representations of land surface might serve as variable of interest. In a somehow counter-intuitive manner, most of landform classification systems work through the classification of cells, which could be further clustered to define the borders of objects. This approach is limited in several aspects, including the scattered aspect of classification in the so-called ‘salt-and-pepper effect’, tying the scale of analysis by the raster resolution, difficulties in including topological relationships in classification and also in developing hierarchies of landforms.

This work aims at investigating methods of producing hierarchical mapping of landforms from DEMs. In our approach, homogeneous objects are produced first through image segmentation of DEMs and their derivatives, which are further used as building-blocks in classification/mapping of landforms. Image segmentation is coupled with multi-scale pattern analysis so that the objects are delineated at characteristic scales in a data-driven fashion. Thus, land-surface parameters as derived from DEMs are segmented into relatively homogeneous areas with eCognition Developer[®] at a range of scales. At each scale level, local variance (LV) is calculated as the mean value of standard deviation of segments. The values so obtained are plotted against scale levels. High values of LV and its rate of change (ROC-LV) indicate scale levels where objects are associated in patterns of land-surface parameters satisfying the condition of maximizing internal homogeneity while maximizing external heterogeneity. The whole procedure has been implemented as an algorithm called Estimation of Scale Parameters (ESP). This procedure produces homogeneous spatial entities with boundaries such that coarser scale entities have precise boundaries within which finer scales entities nest perfectly. This is a condition for developing hierarchical classifications of landform elements.

We are currently investigating two methods of developing such hierarchies:

1. Breaking down complexity through segmentation and successive partitions by nested means. The initially segmented DEM at the scale corresponding to the maximum value of LV is classified in two areas separated by the mean value of elevation. Each area is extracted as independent layer on which segmentations are performed again at the scale indicated by the maximum value of LV and then partitioned at the mean value of another land-surface parameter. This procedure is iterated to produce the third level of the hierarchy. This method is being applied at macro-scale to classify the physiographic units of Africa, as well as at micro-scale to classify landform elements in a flat Dutch landscape for archaeological purposes. Both applications have produced encouraging preliminary results.

2. Semantic modeling. Real-world features and relationships between them (both horizontal and vertical) are conceptualized based on pre-existing knowledge about morphology, morphometry, and spatial context. Characteristic scales selected as above are integrated within a hierarchy where shape attributes and topologies are formalized so that targeted landforms are extracted or classified. This method is being applied to classify glacial landforms.

Benthic environmental changes in SE Aegean Sea during the last 26 ky BP: preliminary results

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Foraminifera (single-celled protists that secrete a shell-like test) are among the most abundant organisms in the deep sea (the largest habitat on Earth), and are recognized to be highly sensitive to environmental changes due to both natural and man-induced factors in marine and transitional environments. In particular, the potential of benthic foraminifera has long been recognized for their use in marine paleoenvironmental studies.

The present study focuses on a high resolution analysis of the distribution of benthic foraminifera from one SE Aegean Sea core. The main aim is to describe the impact of the environmental changes on the marine ecosystem through the study of proxies related to the benthic environment. With this goal in mind, one site was selected to investigate spatial and temporal variability as recorded by the benthic microfauna.

Detailed analysis of the benthic foraminiferal content of the core M22-18 in NE Cretan Sea, allowed its palaeoenvironmental reconstruction. The core, 270 cm long, was drilled at 360 m water depth and 39 samples (1 cm thick) were taken. Each sample was washed, sieved at 125 μm and then dried at 60°C. Quantitative analysis was carried out on aliquots separated from each sample by means of a microsplitter, in order to obtain at least 250 – 300 benthic foraminiferal specimens. The number of planktonic foraminiferal tests was also recorded during picking. Based on the faunal counts, benthic foraminiferal numbers (BFN; number of specimens per gram dry sediment) were calculated. This number gives information on the taphonomy of the original living assemblage, the oxygen level, the energy level in which the sediments were deposited and to a minor extent the productivity or organic flux. The percentage of planktonic species in the total foraminiferal association (%P) was calculated as $100 \cdot P / (P+B)$. Raw data were transformed into percentages over the total abundance of benthic foraminifera. Reconstruction of bottom water conditions concerning oxygen content was based on the presence of the dysoxic indicators in the assemblage. For this purpose, the percentage occurrence of the well established redox fauna front dwelling taxa (*Bulimina*, *Uvigerina*, *Fursenkoina*, *Globobulimina* spp. and *Bolivina* *spathulata/dilatata*) which is related to disturbance and/or environmental stress was calculated. Two radiocarbon ages indicate that the studied sequence covers the last 26 ky BP.

BFN remains relatively stable exhibiting low values apart from the basal part of the record where BFN shows an abrupt increase. Planktonic/benthic ratios vary between 16 and 95% of the benthic assemblage.

A decrease in BFN and an increase of low oxygen indicators (infaunal taxa) suggest a strong decrease in oxygen concentrations. Poor ventilation created dysoxic condition allowing the presence of stressed benthic microfauna.

The group of low-oxygen taxa shows high percentages from the bottom to 240 cm, but its abundance strongly decreases between 240 and 40 cm. At 30 cm this group increases again and then remains in constant percentage values in the upper part of the core. The strong decrease of BFN and the increase of the benthic foraminifera deep infauna in the lower part of the core suggests extremely low oxygen values on the sea bottom.

On the heavy elements content of sediments and rocks from two semiclosed ecosystems: proglacial lake Bâlea (Fagaras Mountainins) and crater lake St. Ana (Harghita Mountains)

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Within a complex scientific program of surveying the Alpine semiclosed ecosystems, the content of seven heavy elements (Sc, Cr, Co, As, Sb, Br and Se) as determined by Instrumental Neutron Activation Analysis in 29 samples of sediments and adjacent rocks from proglacial lake Bâlea (Fagaras Mountainins) and crater lake St. Ana (Harghita Mountains) has been used to establish at which extent these elements could be considered as having an anthropogenic nature. Sc is used as reference elements, as its content was not influenced by any anthropogenic activity. Digital radiography as well as sediments granulometry were also used to get more quantitative data about investigated sediments. Principal component analysis performed in Q as well as R mode was used to evidence the relationship between sediments and neighbour rocks as well as between heavy elements themselves.

Bâlea Lake with an area of 19.5 ha is a typical high altitude (2050 m) proglacial lake while St. Ana Lake area of 4.6 ha and situated at an altitude of 950 m is the unique crater lake in Romania. Although Bâlea as well as St. Ana lakes have different location and origin, they are characterized by a total absence of any source of industrial pollution.

Both lakes collect pluvial water from relative restricted areas (about 234 ha in the case of lake Bâlea and 147 ha for the lake Sf. Ana) so the mineralogical and element composition of their sediments will reflect the geochemical characteristics of surrounding geological formations. Accordingly, the sediments of Lake Bale are expected to reflect the mineralogical composition of the neighbour Suru formation, mainly consisting of metamorphic rocks such as amphibolitic schists, quartzo-felspatic gneissic rocks and mylonites as well as limestones. The sediments of Lake St. Ana, which occupies the bottom of now extinct Ciomatu volcano, mainly consists of fragments of weathered andesite together with an appreciable amount of vegetal detritus, the last one originated from the coniferous and deciduous forests that cover the caldera walls. It is worth mentioning that in the case of Bâlea Lake, the maximum thickness of sediments is not greater than 85 cm, while in the case of St. Ana Lake, sediments thickness is greater than 4 m. This fact reflects the environmental peculiarities of both lakes.

Final data showed that the average content of all seven elements was different for the two lakes, sediments content being relatively closed to average content of surrounding formations. PCA allowed us to establish that in the case of R-mode analysis, all elements form two similar clusters, regardless the lake, while in the case Q-mode analysis, the samples form few clusters, reflecting their location.

At the same, by comparing the sediment contents with those of surrounding rocks as well as with the numerical values stated by Romanian Regulations concerning the Environmental Pollution, it was established that, although their average content was different for the two lakes, all considered heavy elements could be regarded as natural, without any visible traces of anthropogenic influence.

Preliminary investigations of inclusions in some topaz crystals from Volodarsk-Volynski Massif (Western Ukraine)

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The aim of this paper is the gemmological and microthermometric studies of colour types of topazes (colourless, light pink and blue) from pegmatites of the Volodarsk-Volynski massif (Western Ukraine). These topaz crystals are characterized by the presence of numerous solid and fluid inclusions, mainly of a secondary origin as well as the abundance of micropores. The solid inclusions include mainly albite, tourmaline, Fe-bearing mineral phases and probably organic matter. Among the groups of fluid inclusions, secondary two-phase (liquid-vapour) inclusions distinctly dominate over sparse inclusions of a primary origin. The measured values of temperature homogenization (Th) for selected primary and secondary fluid inclusion assemblages range from 350-380°C and 322°C, respectively. Topaz from Volodarsk-Volynski Massif crystallized during hydrothermal stage in medium temperature conditions. The presence of different secondary and pseudosecondary fluid inclusions together with the traces of necking down processes, point that after the crystallization the topaz was also affected by mechanical, thermal and metasomatic processes.

Geodiversity in the Natural Park “Porțile de Fier”: cave mineralogy and mineral deposits

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The Iron Gates (“Porțile de Fier”) Natural Park is located in South-Western Romania and extends along the Danube Gorges and the affluent valleys. The Park is one of the biggest in Romania, having a surface of 115665.8 hectares and including 18 Natural Reserves. The geodiversity of the Iron Gates Natural Park is given by the distribution of a large variety of magmatic, metamorphic and sedimentary rocks, and particularly of limestones of Jurassic and Cretaceous age, affected by a large number of karst phenomena: caves, swallow-holes, gorges, dolina, lapies, uvalas.

The most representative caves in the Park are those from Gura Ponicovei, Padina Matei and Gaura cu Muscă. All of them contain important deposits of fossil bat guano, with a large diversity of phosphate species, including apatite-(CaOH), taranakite, ardealite, brushite, monetite, francoanellite and leucophosphate. These mineral species generally occurs as crusts of yellow cream or reddish brown color deposited on the cave floor or on some speleothems, or, rarely, as earthy masses of white or white cream color. They were identified using a combination of X-ray powder diffraction, Fourier-transform infrared absorption and electron microscopy.

In the upper basin of Mraconia Valley, a system of galleries opened a tungsten-bearing skarn deposit, which develops at the very contact between crystalline limestones and a porphyric granodiorite of Mesozoic age. The skarn is mainly andraditic, but also contains plagioclase, potassic feldspar, ferroactinolite, magnetite, epidote, apatite, vesuvianite and wollastonite. Four stages of mineralization overprint the primary skarn: (1) a high temperature stage conducted to the deposition of scheelite in the mass of skarn; a parallel deposition of quartz and molybdenite on cracks affecting the granodiorite mass is likely; (2) a second hydrothermal stage conducted to deposition of pyrite, chalcopyrite and calcite on the cracks and of impregnations of pyrite and chalcopyrite in the skarn mass; (3) a third hydrothermal stage conducted to the massive deposits of chalcopyrite, pyrite, sphalerite, galena, scarce pyrrhotite and tertahedrite, as veins and lenses in the skarn mass; (4) a low temperature

hydrothermal stage yields the formation of bornite and covellite on chalcopyrite but also of hematite (specularite) on magnetite.

Use of the optical porosimetry for monitoring of deteriorative laboratory tests impacts on natural and agglomerated stone

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Determination of the resistance against freezing water and salt crystallization are two important standard deteriorative tests of building or decorative stones. These tests partially simulate the influence of weather and polluted environment on rocks and check their durability. Impact of the tests on the pore structure of selected natural and agglomerated stone types have been studied by means of optical porosimetry. The optical porosimetry is a technique of a detailed study of porosity in discontinuous materials. Dried porous samples were fully saturated with blue coloured resin, and after hardening, thin cuts were prepared. Effective pores could be well recognized by the colour in thin cuts under microscope (visual analysis - VAO), but also in pictures taken by a digital camera, that were statistically analysed by the computer (digital analysis - DAO). Visual and digital analyses have been carried out before and after the frost resistance tests (25 cycles of freezing/thawing) and before and after the salt crystallisation tests (15 cycles of immersion into a salt solution and drying). Mineral composition, pore network, and selected physical properties have been studied on both, untreated samples and on samples after mentioned laboratory destructive tests. Changes in rock microstructure predominantly in the pore network due to laboratory weathering tests were identified and illustrated.

Seven types of sandstones from a territory of Slovakia, one type of rhyolite and of travertine, as well as one type of agglomerated stone VASPO simulative various types of natural stones (a Slovak product widely used as exterior and interior cladding stone) have been selected for the research.

Optical porosimetry analyses refer to both realised laboratory tests had destructive effects on studied stones. The degradation due to the salt crystallization was more intensive. The used salt was hydrate phase of sodium sulphate, mirabilite ($\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$). According to VAO, micro-cracks were formed, predominantly near the samples surface, pore spaces were enlarged by chemical dissolution of some minerals reacting with the salt solution and existing fractures were opened. These visual signs of the stone decay and weakening were confirmed by changes of physical-mechanical properties after tests. Changes in values of total porosity, water absorption, velocity of ultrasonic pulses and uniaxial compressive strength were recorded.

Statistical parameters determined by DAO, i. e. total optical porosity, size-count parameters and erode-dilate parameters, confirmed changes in the rock pore networks after laboratory deteriorative tests.

In general, presented results of both, visual and digital porosity analyses after laboratory degradation tests demonstrate the applicability of the optical porosimetry method in a research of weathering of natural and agglomerated stones or building stone generally, under experimental or natural conditions, especially in cases when the effective (open) porosity of stones is higher than 5 %. More accentuated visual readable demonstrations require the realization a greater number of cycles of freezing/thawing than have been realized in our research.

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First occurrence of rodingite in Central Serbia

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During the field geological mapping and accompanied laboratory studies of the samples for the Basic Geological Map in the wider area of the town of Valjevo (Central Serbia) were distinguished serpentinites, gabbros, peridotites, andesites, diabases and amphibolites. In addition, at one locality within the area (i.e. the village of Danilović, site Suva česma), there was detected one unusual rock in the contact with serpentinite, which is in this paper further determined by the optical microscopic, XRPD and chemical methods, as rodingite.

Rodingite is characterized with a massive structure and granoblastic texture. It has mostly white color, with unevenly distributed concentrations of a green mineral.

Rodingite dominantly consists (over 80 %) of macroscopically white, microscopically transparent, and slightly anisotropic grossular, close to the end member with Grs98Adr2 composition. Grossular appears in a coarse-grain granular form, with size from 0.5 to 1.5 mm.

Green Mg-Al-Fe chlorite occupies interstitials between the grossular grains. This chlorite was most probably formed as secondary phase replacing pyroxene, which is preserved as relic pseudomorphic forms with size up to about 0.5 mm.

Up to now, there were not registered the appearances of such kind of rocks on the territory of Serbia. Nearest sites of rodingites have been previously registered in Bosnia and Herzegovina (11 localities from Brnača at NW to Rijeka at SE; belonging to the Outer Ophiolite Zone), and in FYR Macedonia (1 locality-Raduša; which belongs to the Inner Ophiolite Zone).

According to this classification, discovered rodingite in the area of Valjevo also belongs to the Inner Ophiolite Zone. It occurs in contact with gabbro and peridotite rocks, and most probably originated from veined gabbro by subsequently metasomatic processes.

Unraveling the time of formation of potassic-alkaline rocks in the Variscan edifice in Stara planina, Bulgaria: ID – TIMS and LA – ICP-MS study

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Vaiscan magmatism is ubiquitous in Western and Central Stara planina, Bulgaria. Its composition is calc-alkaline and essentially acid, as granitoids predominate. Occasionally but with outstanding position, in the Variscan orogenic edifice in the Stara planina, are the rocks of the potassic-alkaline association. From west to east three alkaline plutons crop out: Svidnya, Buhovo–Seslavitzi and Shipka. The plutons intrude Ordovician, Silurian and Devonian low-grade metasediments. The plutonic rocks comprise potassic monzonites and syenites, evolving toward peralkaline acid species (quartsyenite and granite). Based on the isotope and trace elements composition, an enriched source was supposed for the magmas. Their geodynamic position is assumed as postcollisional.

In order to establish the time of formation of the rocks from mentioned plutons ID – TIMS and LA – ICP-MS comprehensive study on zircons were performed.

ID – TIMS analyses for plutonic rocks (syenite) from Buhovo-Seslavitzi display clustering around 340 - 325 Ma, and no reliable isochrone can be defined. LA – ICP-MS analyses yield similar results: 350 – 325 Ma. For the peralkaline dykes from Buhovo-Seslavitzi ID – TIMS age determinations cluster in two time intervals: 318 – 312 Ma and 460 – 435 Ma, with a substantial discordance. LA – ICP-MS results for the dyke rocks are mainly in the interval 470 – 430 Ma, as one analysis gives 310 – 303 Ma. Intrusive rocks from

Svidnya plot in two separate time intervals: 315 – 305 Ma and 455 – 440 Ma (ID – TMS). Surprisingly LA – ICP-MS show considerable scattering, as the results cover very large time span: 840 – 388 Ma. Both ID – TMS and LA – ICP-MS for dyke rocks from Svidnya plot mainly in the interval 460 – 450 Ma. Perfectly concordant ID – TMS ages for the intrusive rocks from Shipka delineate two intervals: 555-506 Ma and 303 Ma. LA – ICP-MS determinations are grouped in several narrow intervals: 345-335 Ma, 319-326 Ma and 309-307 Ma. At the same time LA – ICP-MS data for dykes from the pluton show much older age: 462-454 Ma.

Ages as 450 Ma could not indicate the time of intrusion of plutonic rocks, because such ages are older than the host metasediments (Ordovician, Silurian and Devonian). Thus, Variscan ages in the interval 350 - 303 Ma would represent the time of formation of the potassic-alkaline rocks. This time interval is too large and it is not possible to determine precisely the position of these rocks in the frame of the Variscan orogeny. Very striking feature is the ubiquitous presence of inherited cores in the studied zircons. It was to some extent unexpected, because zircons are highly soluble in hydrous and peralkaline magmas (according to the experimental data). The fact, that were found complex zircons with strong inheritance even in most alkaline rocks is surprising and requires more attention.

Up to now rest unclear the relationships between the potassic rocks and the calc-alkaline granitoids, as well as the successiveness of magma formation. The results show that both rock types are generally contemporaneous, so they belong to one tectonic event. The marked differences in their composition should be attributed to the sources.

The zircons show a multistage origin, attesting for overlapping variable geological events. The frequent presence of inherited cores in the zircon testifies for multiple recycling of older material, involved in the generation of the potassic magmas. At this moment we are not able to specify the nature, origin and mechanism of involvement of these older materials in the source. The results show that material segregation from source and crystallization histories of the magmas were very complex.

Underground geotouristic routes in the Małopolska District

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In the Małopolska District two underground routes located in old mine workings have been opened to the public. They were developed in the Forecarpathian Basin, in the salt mines in Wieliczka and Bochnia. The salt deposits are hosted in Tertiary - Miocene formations accompanied by anhydrites, gypsum and clays. From the south, these formations are surrounded by the sandstones and shales (flysch), which belong to the Carpathian Foredeep. In both the salt mines in the tourists visit the old mine workings, mainly in the form of spacious chambers and galleries. In those mines the visitors experience a small boat trip across the underground sweet lakes. In Bochnia's salt mine visitors are also carried by the historical underground railway along 1km distance. Those salt mines are very popular underground health resorts. People ill of breathing system can spend there some time for inhalation.

Micas and clay minerals of muddy to clayey sediments from the Paleogene variegated shales, Polish Carpathians

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The research was carried out on shales and mudstones of the Hieroglyphic Beds in the eastern part of the Dukla Unit. Samples of shales and mudstones were examined using optical microscopy, X-ray powder diffraction (XRD) and scanning electron microscopy (SEM). The

chemical composition of minerals was studied by energy dispersive spectrometry (EDS). In order to obtain clay fractions of $<2\ \mu\text{m}$ and $<0.2\ \mu\text{m}$ the samples were prepared according to the standard Jackson method. Clay minerals preparations were air-dried, glycol vapour saturated and heated at 330°C and 550°C .

Muscovite is the most common detrital mineral and the main component of the analyzed sediments. It occurs as mangled flakes, which underline the lamination of the host rocks. The EDS analyses have revealed fengite character of muscovites, which contain up to 5.27 wt% of the Fe_2O_3 . Biotite grains in most cases underwent chloritisation.

The XRD analyses of the $<2\ \mu\text{m}$ have revealed the presents of illite, chlorite and mixed-layer minerals: illite/smectite and chlorite/smectite. Illite, in most cases, is the component of cement. Detailed characterization of illite/smectite was based on the diffractograms of the $(0.2\ \mu\text{m})$ fraction obtain from the XRD studies of glycol vapour saturated oriented preparation. The type of layer ordering in the mixed layered minerals was established according to the position of 001 reflection. R1 and $R>1$ are the characteristic types of the ordering in these minerals. They contain up to 30% of smectitic component in their structure. The presence of 1M and 2M1 polytypes confirms the existence of both authigenic and detrital illite in the analysed clay material. The EDS investigation showed different amounts of Fe (from 5 to 30 wt% of Fe_2O_3) in illite or illite/smectite mixed layers.

It was determined that only detrital chlorites appear in the studied sediments. They are often products of chloritisation of biotite. The XRD studies of the $<2\ \mu\text{m}$ fraction displayed presence of chlorite and mixed-layer chlorite/smectite. It was confirmed during the EDS examinations, which revealed a considerable amount of K, which may derive from smectitic layers. Moreover, the EDS studies showed that chemical composition of chlorites varies considerably and that it is comparable to the composition of chamosite and ripidolite.

The chemical composition of minerals occurring in the studied rocks indicates the complex diagenetic environment. The composition of the pelitic fraction (illite, illite/smectite, chlorite and chlorite/smectite) and a small amount of smectitic component in the ordered illite/smectite interstratifications (R1 and $R>1$) in particular, indicate the advanced degree of diagenesis.

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Environmental impact of Pt, Pd, Rh and Au from catalytic converters along roadsides: The case of Attica, Greece

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Platinum (Pt), palladium (Pd), rhodium (Rh) and gold (Au) were investigated along high-ways of Attica, Greece, with varying traffic, like Katehaki, Messoghion, the intersection between Katehaki, Messoghion and Acharnon avenues, and residential roads, like Pindos and Navarinou roads. Platinum ranges between 110 and 960 ppb in dust samples and from 44 to 820 ppb in soils, Pd ranges between 90 and 1300 ppb in dust samples and from 36 to 1100 ppb in soils. The analysis of dust collected from parts of the roadsides closed to water sewerages reached as high as 2070 ppb Pt and 1980 ppb Pd contents. Gold ranges from 14 to 990 ppb Au (average 230) in dust samples and from 27 to 160 ppb Au (average 95) in soil ones. Any relationship between Au and Pt or Pd is not obvious. The significant fraction of the traffic-related emissions, reaching values over 4 ppm (Pt+Pd), suggest that they may be concentrated into local water systems resulting an environmental risk. Palladium was the most abundant PGE in the grasses ranging from 0.6 to 23 ppb (average 6.8 ppb), Pt ranges between 2.3 and 6.6 ppb (average 4.2 ppb) while Rh is < 0.1 ppb. Average values of the $\text{Pd}/(\text{Pd}+\text{Pt}+\text{Rh})$, $\text{Pt}/(\text{Pd}+\text{Pt}+\text{Rh})$ and $\text{Rh}/\text{Pd}/(\text{Pd}+\text{Pt}+\text{Rh})$ ratios decrease from 0.62 to 0.33 and 0.05 respectively, suggesting the $\text{Pd}>\text{Pt}>\text{Rh}$ bioavailability order.

Synergy of ASAR and RADARSAT-2 ultra-fine acquisitions for ground deformation monitoring by means of DInSAR and PS. Case study gulf of Corinth - town of Patras, Greece

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The Gulf of Corinth presents a major scientific and/or socio-economic interest such as the Patras broader area, the Psathopyrgos fault zone which is considered to be a presently active structure, the Rion-Patras fault zone, the town of Patras and the Rion-Antirion bridge. Patras is the third most populated town of Greece with more than 200,000 inhabitants. The bridge of Rion-Antirion is 2,880m long (its width is 28 m) and connects the eastern and western Greece. The bridge has been designed and constructed taking into account the increased seismicity of the area. Psathopyrgos fault zone which is acting as a transfer zone between the Corinth and Patras rift as well as the Rion-Patras transfer fault zone are investigated for any detectable ground deformations that could be indicators/precursors of inter-seismic accumulation processes before a main seismic event. The town of Patras is investigated for any detectable ground/buildings deformation due to human impact or geophysical processes. The potential of Rion-Antirion bridge and surrounding area deformation monitoring is also investigated and assessed.

The studied area presents major difficulties for DInSAR/PSI applications, due to its intense vegetation coverage and abrupt topography presenting, high slopes and shadowing effects. Moreover the nature of the topography and the location of the study area, between Aegean and Ionian seas, result to high precipitation rates and extended cloud coverage. All these characteristics contribute to high decorrelation of the interferometric products. For the estimation of the occurred deformations a series of ASAR/ENVISAT (image swath 2) data are processed by means of PSI and DInSAR techniques, but RADARSAT-2 (ultra-fine beam mode) data are processed only by means of DInSAR technique due to its lack of historical data. The processing is carried out exploiting commercial and in-house software. The medium and high ground resolution added-value products are combined in thematic level and discussed.

Arsenic distribution in laterite deposits of the Balkan Peninsula

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The laterite deposits (Fe–Ni-laterite and bauxites) in the Balkan Peninsula are mainly located in the Mirdita–Sub-Pelagonian and Pelagonian geotectonic zones and are of great economic significance. These deposits have been affected by intense tectonism, which has created overthrusting, foliation, folding, and faulting. The investigation of arsenic in laterites is thought to be important for the ferronickel smelting process and the serious affect of the health. Minerals such as iron oxides and pyrite are of particular significance in controlling arsenic mobility, and hence aquifer contamination. Laterite samples from Ni-laterite deposits of Greece (Lokris, Vermio, Edessa, Olympos, Kastoria), Albania (Bitinca and Gouri-Perjegjiun), Serbia (Rzanovo and Topola), bauxitic laterites and the Parnassos-Ghiona bauxite deposit were analyzed for major and trace elements, including arsenic (As). Arsenic concentrations for all laterite samples from the Balkan Peninsula range from < 2 ppm to a few decades ppm. However, arsenic concentrations for the individual laterite occurrences and deposits from Aghios Ioannis vary significantly from <2 ppm to 2600 ppm. Arsenic in the

Parnassos-Ghiona deposit ranges from <10 ppm in typical red colored ore to 900 ppm in yellow-grey colored ore. The latter type occurs along and near faults and constitutes a significant (approximately 30 vol. %) portion of the bauxite ores. They are characterized by the presence of abundant pyrite and micro-organisms. Elevated arsenic contents are mostly associated with Fe-oxides/hydroxides in Ni-laterites, showing enrichment in REE, Co, Ni, Th and U contents, and with Al-oxides in bauxites. The sulphur isotope compositions of Fe sulphides from the bauxite deposit show a range from +10.2 to -30.2 per mil. Most negative values were obtained from grey-coloured ore samples. The organic matter may be related to the source of arsenic and play a major role in controlling the redox conditions, since they can drive the formation of pyrite or Fe-oxides.

On groundwater resources available in Oltenia Plain, Romania

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The Oltenia Plain occupies ca 8,400 km² in the SW Romania. With decreasing altitudes from north to south, it includes three W-E elongated subunits: a High Plain (210-110 m elevation), followed to the south by the Danube Terraces (140-35 m) and by the large Danube Floodplain (40-25 m). The fresh groundwater resources are located in the Pliocene-Quaternary formations. The oldest Berbesti Formation consists of lacustrine sands (50-150 m thick) and is overlapped by the Jiu-Motru Formation composed of swampy clays and coal beds with sands insertions (150-300 m). The next lithostratigraphic unit, the Lower Member of the Danube Formation (15-20 m) was built during the Early Pleistocene. Finally, the Danube River moulded Valley own profile. As a result, the higher relief of the Oltenia Plain formed repeated down-cuttings of five-stepped terrace sequence and the Floodplain (Upper Member of the Danube Formation).

The Berbesti Formation is a continuous multilayered aquifer, the hydraulic conductivity of 0.2-15 m/day and specific capacity values of 0.05-4.0 l/s/m. The Jiu-Motru Formation is the discontinuous multilayered aquifer (sands) on the mainly aquiclude clayey-coaly background. The specific capacity values of the lens-shaped tested sands are in the range of 0.01-0.25 l/s/m. The fine sands inserted on the aquiclude background are characterized by low Na⁺, K⁺, I⁻ contents and by higher contents of organic substances, CO₂, Fe₃₊, SO₄²⁻, NO₂⁻ and Br⁻. The hydraulic conductivity determined through tests in situ has values between 0.1 and 5.0 m/day. The specific capacity has a large variation interval from 0.2 to 5.0 l/s/m.

The Lower Member of the Danube Formation, represented by the alluvial fan, is discordantly disposed over the previous two formations and bears a continuous extended phreatic aquifer. Its potentiometric contour lines decrease from 200 m to the north to 95 m to the south. Despite the high hydraulic conductivity values (10-55 m/day), being situated at 40-60 m over the local base level of the floodplains, this aquifer discharges on the slopes of the main valleys and has limited resources.

The six mono-layer aquifers bear in the Upper Member of the Danube Formation with 5 terraces and the floodplain of the big watercourses (Danube, Jiu and Olt). Within the Upper Member, there is a N-S increase of productivity (from 1-3 l/s/m in the N strip, to 3-6 l/s/m in the middle one and > 6 l/s/m within the whole Danube Floodplain).

In the eastern subunit of the studied area – the so-called Leu-Rotunda Plain – the Danube Formation is covered by a continuous pile of the Aeolian Formation (30-35 m thick of loose wind-blown silts, clayey sands, fine to coarse sands, having like insertions fossil soils at different levels). Field investigations carried out during April 2010 in accordance to “Climate Change and Impact on Water Supply” Project (see logo) showed that the phreatic aquifer of the Aeolian Formation constitutes the historical source to feeding the people of 15 localities. In large areas, the depth of the water table ranges from 0.5 to 3 m, being vulnerable to estimated climate change. Its resource is contaminated by domestic seepage and fertilizers only within the perimeter of localities. There, the public fountains have around 1,200-2,100 µS/cm Electric

Conductivity, 85-225 mg/l Cl⁻ and around 50-290 mg/l NO₃⁻. Outside of localities, the studied aquifers of the Aeolian Formation match drinking standards.

Morphotectonic analysis of Stavrakia fault scarp with emphasis on seismic risk assessment, Heraklion, Crete, Greece

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Stavrakia fault scarp occurs along the Heraklion – Mires highway adjacent to Stavrakia and Siva villages, forming the western slopes of a valley. The fault scarp is developed mainly in Tortonian marly, conglomerate and sand intercalations of the Ampelouzos formation and to the north, in Pliocene marls. It is NNE – SSW trending and southeast-dipping at 70°. Its apparent length is about 7.5 km fading out northwards in the river valley, whereas it is geologically unclear if it continues further to the south. In few places flat surfaces can be found with microstructures which indicate a normal sense of movement under an E – W extensional regime, whereas a vertical slip of about 30m can be determined.

Using GIS software, topographic maps of 1:5000 and satellite images we mapped 33 streams and small catchments that drain the footwall of the fault which appears as an elongated range at about 7,8 km at the study area. Basins develop almost perpendicular to the main valley and are elongated in shape, but quite small in size (about 90.000 m²) with high mean slope values. 23 triangular facets of various sizes occur along the range formed by stream down-cutting and fault activity. In order to study uplift rates and erosion style of the footwall, as well as fault activity we have calculated three morphometric indices of the footwall catchments, i.e. the hypsometric integral (HI), the basin asymmetry (AF) and the valley width-to-height ratio (Vr). Additionally, we have also calculated the range sinuosity (S) as well as the facet size and mean slope (MS).

Although studied basins have a very small size and thus stream development and erosion are not so profound, several important results can be extracted from the morphometric analyses. Sinuosity value is $S=1,11$ indicating thus an actively deformed range for the footwall, which is in contrast with the opposite range sinuosity ($S_e=1,63$) occurring at the hanging wall. The hypsometric integral of catchments shows generally values around 0,41 to 0,72 which indicate a high mean topography as a result of high rates of tectonic uplift. The higher value was observed for the B5 catchment at the southern edge of the fault scarp, whereas a strong trend for smaller values appears towards north. The basin asymmetry study didn't show any certain erosion pattern along the range. Values vary significantly among catchments from $AF=80$ to 24, however the higher values appear at the southern part and the lower at the northern indicating probably a decrease of erosion rate to the north. Except of few extreme values, the valley width-to-height ratio Vr is relatively very low (<1) in most catchments with an average of $Vr=0,5$ indicating high incision rates due to tectonic uplift. Rate values are randomly distributed along the range presenting no specific erosion pattern. Morphometric analyses of the facets indicated also that the largest facets appear at the southern edge of the fault scarp, whereas they become smaller towards north. The mean facet slopes, except three, vary generally between 22 – 30°, without presenting any spatial distribution.

All the above observations indicate that: (1) the study area is actively deformed; (2) the higher uplift rates occur about 1 km away from the southern edge of the fault scarp and; (3) uplift decreases gently towards the northern edge. The uplift pattern along the studied fault represents thus a half elliptical structure, leading us to suggest that the fault might extend 5 more kms to the south. Hence, in a possible reactivation its length can be a serious seismic threat for the nearby towns of Heraklion, located 6 kms to the north and the adjacent villages of Stavrakia and Siva.

Purification of municipal wastewaters and production of odorless and cohesive zeo-sewage sludge, using Hellenic Natural Zeolite

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Treatment of municipal wastewaters (pH_{initial} 8.2-8.9) with 7.5 g of Hellenic Natural Zeolite (HENZA) of a grain-size < 1.5 mm, gave overflowed clear water of pH 7.3-7.8, free of odors and improved quality parameters by 89.9-96.7 % for the color, 89.0-98.5 % for the suspended particles, 93.7-97.2 % for the chemical oxygen demand (COD), 92.9-99.3 % for the P₂O₅ content and 98.3-99.9 % for the NH₄ content. The improvement of the quality parameters for the clear water increases with increasing stirring time of the treatment experiments. The correlation coefficient is 0.9423 for the P₂O₅ content, 0.9323 for the suspended particles, 0.9282 for the chemical oxygen demand (COD) and 0.8854 for the color. The correlation coefficient for the NH₄ content and pH are < 0.60. The HENZA comes from Ntrista stream of Petrota village of Trigono Municipality of Evros Prefecture, North-eastern Greece. HENZA contains 89 wt. % HEU-type zeolite and exhibit an ammonia ion exchange capacity (sorption ability) of 226 meq/100g. The mineralogical composition and the unique physico-chemical properties, make the HENZA suitable material for numerous environmental, industrial, agricultural and aquacultural applications, such as: animal nutrition, soil amendment for agriculture, pH soil regulation, greenhouse and flowers substrates, durability and health improvement of lawn, purification of industrial and municipal wastewaters, treatment of sewage sludge, odor control, fishery and fish breeding, gas purification and drying systems, oxygen enrichment of aquatic ecosystems, improvement of drinking water quality, constructed wetlands and wastewater treatment units. The treatment gave as precipitate odorless and cohesive zeo-sewage sludge, suitable for safe deposition and also for the reclamation of agricultural soils. The zeo-sewage sludge produced either from the municipal wastewater treatment or from the mixing of HENZA and sewage sludge, can be used for the reclamation of agricultural soils. The presence of HENZA in the agricultural soils, increases the crops yield by 17-66 % and improves the quality of agricultural products by 4-46 %, reduces the use of fertilizers by 56-100 %, reduces the usage of irrigation water by 33-67 %, prevents the seepage of dangerous species into the water environment (e.g., NO₃⁻ by 55-92 %), protecting thus the quality of surface and underground waters. The usage of HENZA in vivarium units and in the animal nutrition increases the production and improves the quality of the relevant products, reduces the feed cost, the animal diseases and medication, the new-born animal's death-rate and the malodor, converting thus the manure to odorless fertilizer.

Origin and deformation of the Thrace Basin: constraints from fault-slip analysis

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The origin and deformation style of the Thrace Basin, NW Turkey represent the target of ongoing debate. Uncertainties are partly due to imprecise knowledge of the stratigraphy of basin-fill sediments. In our contribution we report surface structural data including fault-slip analysis which are important for understanding the origin and structure of the Thrace Basin. Measurements were executed along the northern, north-eastern and south-western margin of the basin. The data from the SW margin also contribute to characterisation of the surface segment of the North Anatolian Fault between the Marmara and Aegean seas.

The earliest detected deformation occurs just SW from the Thrace basin, in the Gelibolu peninsula, along the shore of the Aegean Sea. Folding and faulting of Palaeocene to early Eocene sequence was associated with very low-grade metamorphism. Middle Eocene succession seals the deformation features.

Small-scale syn-sedimentary structures (sedimentary dykes and faults) indicate NE-SW to E-W extension along the NE margin of the basin in the Bartonian to Priabonian. Gradual tilting of the beds could occur in map-scale tilted blocks of extensional origin. The repeated normal faulting is deduced from fractures which formed before, during and after the tilting. This deformation process is reflected by progressive transgression on basin margin and intra-basin block margin.

Extensional fractures were also observed in Eocene sequence near the SW margin, in the Ganos Mountains. The age of faulting is not precisely constrained but pre-dates the latest Oligocene – early Miocene folding and related uplift.

All data on early deformation phases point to extensional deformation along both the north-eastern and south-western margin of the basin. Regional geodynamic considerations would agree with fore-arc origin of the Thrace basin.

Before the folding in the Ganos Mountain a strike-slip type deformation occurred during the Late Oligocene - Early Miocene. The E-W compression could induce dextral faulting along the ENE trending southern margin of the Ganos Mountain, the Ganos fault, a precursor of the North Anatolian Fault. This confirms the suggestion that dextral faulting parallel to the NAF could be active already in the late Oligocene-early Miocene.

The large-scale folding itself occurred in a slightly different stress field, in NNW-SSE compression. Progressive fracturing and folding happened in a coaxial deformation process. The folding and related uplift is constrained by fission track data as ~16 Ma.

Post-early Miocene deformation history can be detected south from the Ganos fault, in the Sarköy area. Before the tilting of mid- to late Miocene sediments, a peculiar stress field with SE-NW extension and NNE-SSW compression occurred. This deformation was already observed, but its geodynamic interpretation is not clear. Strike-slip type deformation with E-W to NW-SE compression is connected to dextral faulting and folding (transpression) along the Ganos segment of the North Anatolian Fault. This is in agreement with Pliocene-Quaternary dextral faulting along the North Anatolian Fault. A slight change in compression direction can be suspected during the progressive deformation; this non-coaxial character can also be connected to strike-slip faulting.

Study of a mesoscale convective complex over Western and Southern Balkans

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The purpose of this study is to thoroughly examine the conditions leading to the development of a mesoscale convective complex (MCC) on 24 May 2009 that affected the western and southern Balkan Peninsula, its features and the manifestation of its activity at the surface. To this end, data from a variety of sources were used, such as weather maps, surface records and upper-air soundings, a hailpad network, satellite, lightning, precipitation and radar data. First, the evolution of the system was described, in terms of the track, timing, and areal extent. Second, the synoptic and thermodynamic environment that favored its development was studied. Special features at the surface, such as a cold pool and a mesohigh, were documented by surface observations. Finally, successive satellite, lightning and radar imagery revealed the organization of the system. All data together document well the categorization of this system as an MCC.

Forearc-dipping normal faulting in Central-Western Peloponnesus, Greece

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Forearc-dipping, orogen-parallel low-angle extensional faults have been described in various orogens, including the Apennines, Italy and, recently, southern-central Crete, Greece. Such a fault system is also present in the central-western Peloponnesus, in the south-western Aegean Arc. It comprises low- and high-angle normal faults which control the western border of Mt Mainalon. The Alpine nappe sequence of the studied area includes the metamorphic rocks of the Phyllites-Quartzites Unit (PQ), overlain by the carbonates and flysch of the Gavrovo - Tripolis Unit, which also overlies the Ionian Unit to the west. The uppermost nappe is the Pindos Unit, which is a sequence of Mesozoic pelagic limestones and clastics, topped by a Paleocene flysch.

Most of the extensional structures were previously thought of as the original thrust contact between the Pindos and Tripolis Units. However, our geological mapping and the cross-cutting relationships among these structures indicate that these are SW-dipping faults – their dip, in other words, is towards the arc- and they downthrow the original Pindos thrust by a few tens or hundreds of meters each. Some of these faults sole into the underlying thick Tripolis flysch, but most of them reach deeper, affecting the contact between the flysch and the carbonate platform. In SW Mainalon we mapped low-angle normal faults that juxtapose the metamorphic rocks of the PQ Unit against the non-metamorphic sequence of the Tripolis Unit. High-angle normal faults found further to the west have truncated or even sole to the low-angle ones. The whole extensional fault architecture has resulted in the Pindos thrust stepping down from altitudes higher than 1000 m in Mainalon, to negative heights in North Messinia and southern Iliia; and the gradual disappearance of the Phyllite-Quartzite metamorphics of Mainalon towards the west.

In the north-west, these faults are truncated by NE to NNE-striking, NW-dipping faults, which transfer the whole fault system towards the north, where it forms the eastern boundary of the Pyrgos graben. On the other hand, the south-eastern members of this fault system are truncated by E-W to ENE-WSW faults, which relay fault activity to the eastern boundary of the Megalopolis basin. All these extensional structures form the eastern boundary of the Megalopolis-Lycaion-Minithi-Tetrazion (MeLyMiTe) and the Pyrgos tectonic depressions, which in turn are separated by the E-W Lapithas horst, at the western end of which the Ionian Unit crops out. The northern and southern boundaries of these tectonic depressions are controlled by oblique-normal faults, perpendicular to the eastern boundary. The throw of these faults increases towards the west and the interplay of all these faults has led to the composite deformation pattern of the MeLyMiTe, which displays extension on its flanks and compression in its centre.

The combination of these extensional faults (which may reach down to the Ionian decollement) with the low-angle floor thrusts of the Pindos, Tripolis and Ionian Units leads to additional ENE-WSW shortening, normal to the Hellenic Arc, west of the Peloponnesus.

The origin of color in minerals and gems

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We explore the cause of color in the mineral world from the smallest (isolated ions) to the largest (a full crystal). Many mineral colors originate in absorption but occasionally

physical optics get involved. Several causes are usually mixed together, however often one dominates the others, which then merely provide a nuance to the general color appearance.

Isolated ions from the first series of transition elements are undoubtedly the most common cause of color in minerals and gems. They may be a component of the mineral, which is then intrinsically colored, or simply appear as impurities, which is often the case in gems. The major elements involved are vanadium (V), chromium (Cr), manganese (Mn), iron (Fe) and copper (Cu), and to a much lesser extent cobalt (Co) and nickel (Ni). Rarely, rare earth ions may also be at the origin of the tint (mostly cerium (Ce), praseodymium (Pr), neodymium (Nd) and uranium (U)). At planetary scale, iron dominates by the sheer volume of rocks it colors. Important factors include the identity of the element, its valence state, the nature of the ligands (mostly oxygen, though), the coordination (octahedral, tetrahedral or otherwise) and the details of the environment of the ion at the atomic scale (the “crystal field”). For example Fe_{2+} often gives a bottle-green tinge to minerals (such as peridot and some amphiboles) and Cr_{3+} emerald-green colors, but both may also induce a purple-red tint (respectively in garnet and ruby).

Color centers result frequently from natural irradiation, and may be treated as pseudoatoms. They could be intrinsic defects (for example a vacancy: the neutral carbon vacancy colors diamond blue). But often, such defects trap impurities. Diamond and fluorine are colored almost exclusively by color centers. One of the most complex examples is amazonite, the turquoise-blue potassium feldspar, colored by a combination of lead and water.

There is a charge transfer when several atoms forming molecular orbitals are involved in light absorption. It may happen between two atoms (oxygen-“metal”) or a more extended cluster. These processes are often very directional, inducing strong pleochroism. They are also very efficient: a small concentration of clusters (10 to 100 ppm) may induce a strong, broad absorption, as is the case for the blue color of sapphire caused by Fe-Ti charge transfer. However, on the contrary to common belief among gemologists, the Fe-Ti charge transfer confers more often a brown tint. The $Fe_{2+} - Fe_{3+}$ charge transfer gives a blue color to many minerals and gems (cordierite, some aquamarines and sapphires, blue amphiboles, etc.)

A small number of gems have invariable intrinsic colors explained through band theory, which involves all atoms in the crystal: these could be metallic gems (“marcassite”, actually pyrite), semimetals (graphite, a common inclusion) or semiconductors (cuprite or red sulfides).

Relatively rarely, the electronic structure is not involved, but rather the texture of the mineral, through optical effects. Diffraction is well-known in opal and labradorite, but scattering may be comparatively more common in gems (moonstone, blue chalcedony and agate, blue and violet halite, etc.) or even contribute to some rock tints. Finally, a mineral might color another as an inclusion (hematite makes near-colorless feldspars and quartz red) and poorly crystallized silica (agate, common opal) is almost only colored by inclusions.

Types of lithological sequences and successions in the tuff and gypsum subformations of low Badenian from Piatra Verde (Slănic-Teișani)

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This paper presents the diagnosis and interpretation of the sulphatic-evaporitic facieses from the Southern side of Eastern Carpathians, Slănic syncline, in Badenian deposits at Piatra Verde. The succession of evaporitic facieses, with different gravity flow stages facies modelling and basin evolution by means of sequential stratigraphy.

Volcaniclastic rocks in the geological record of the Oaş and Gutâi Mts., Eastern Carpathian: fragmental and reworking processes

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Oaş and Gutâi Mts. are part of the inner volcanic arc of the Eastern Carpathians built up during complex Miocene subduction processes. The suite of different extrusive and intrusive deposits attributed to the felsic, extensional-type volcanism and the intermediate, arc-type volcanism, respectively, comprises abundant volcaniclastic deposits often in connection with coeval sedimentary deposits. Fragmental processes, both explosive and non-explosive, provided the volcanic debris consolidated partially as primary volcaniclastics such as pyroclastic, hyaloclastic and talus breccia deposits.

The pyroclastic deposits identified in Oaş and Gutâi Mts. belong to both felsic and intermediate magmatic suites. The rhyolitic ignimbrites from Gutâi Mts are the exponents of the felsic, caldera-related volcanism. Andesitic block and ash flow deposits occur in Gutâi Mts. and dacitic pyroclastic surge deposits in Oaş Mts. All of them accounting for both magmatic and phreatomagmatic explosions are related to the collapse of growing volcanic structures. The hyaloclastic deposits developed extensively in both Oaş and Gutâi Mts., by the quench fragmentation undergone by andesitic and dacitic lavas emplaced under water. The talus breccias formed on the steep slopes of the volcanic forms in Gutâi Mts., involving the unstable part of the lava pile prone to gravitational collapse.

Most of these primary volcaniclastic deposits are spatially connected with secondary volcaniclastic deposits involving the same loose volcanic debris emplaced by subsequent reworking. Commonly they are interbedded with sedimentary deposits. The felsic volcanism from Gutâi Mts. provided abundant rhyolitic, ignimbrite-related pyroclastics which underwent repeated reworking mostly by mass flow processes, slides/slumps before emplacing in submarine, deep water setting. A similar succession was identified in drill cores in Oaş Mts., but lacking the primary pyroclastics.

The hyaloclastic deposits are usually passing to resedimented hyaloclastites and frequently they suggest reworking altogether with the pyroclastics provided by phreatomagmatic rootless explosions, mostly by mass movements. Thick debris flow deposits and slides or slumps involving the volcanic debris are very common in the geological record of Oaş and Gutâi Mts. The identification and proper classification of these deposits play a major role in understanding the evolution of the volcanic phases, usually followed by subsequent, sometimes dramatic reworking processes. These processes developed in a syn-eruptive stage seem to contribute much more to the actual volcanic morphology of Oaş and Gutâi Mts than the long lasting post-volcanic erosion.

Fragmental processes, whether explosive or non-explosive, followed by reworking episodes contributed essentially to the build up of the Oaş and Gutâi Mts. They were triggered and controlled by the active tectonics and subsidence as well as by the submarine setting, predominant throughout the volcanic area and the time span of the volcanism.

Besides the geotectonic setting controlling the evolution of the volcanism and the style of eruption, the submarine setting had a major input in some of the fragmental processes and in the emplacement of the volcaniclastic deposits. Considering the processes controlled by the submarine, mostly deep water setting, may be useful when reconstructing the volcanic forms of the Oaş and Gutâi Mts. which is a real challenge as far as most of the volcanic morphology was substantially altered by syn-eruptive subsequent processes followed by post-volcanic erosion.

Orogenic evolution of Polish and Slovak Outer Carpathians revealed by a 2D kinematic modeling

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Middle Eocene – Late Miocene (36 to 11 Ma) orogenic evolution of north-eastern Outer Carpathians and their foreland basin has been simulated by a kinematic modeling. The model is based upon a new balanced and restored cross section integrating structural (surface and subsurface), seismic and stratigraphic data. It illustrates the internal kinematics of the Outer Carpathian accretionary wedge and the evolution of the wedge-foreland system as a whole.

Restoration of the balanced cross section indicates at least 496 km of post-Middle Eocene convergence between the Inner Carpathians and European Plate, which is more than most of previous estimates. The higher shortening results from application of more accurate thicknesses of lithostratigraphic units in most cases smaller than in previous works. However, we believe this number to be still the minimum value.

The restored section illustrating the Middle Eocene configuration of sedimentary basins is used as a starting point of the 2D kinematic model. Successive stages of the model are constrained by syn-orogenic sedimentary record and reproduced by kinematic algorithms relevant for thin-skinned deformation. Its quality is evaluated by comparison of successive intermediate geometries with available geological data (stratigraphy, provenance and transport directions of syn-orogenic deposits, palaeobathymetric estimates etc.). Ultimate verification is performed by a comparison of the model's final geometry with the present structure in the balanced section.

The model shows a migration of the Outer Carpathian accretionary wedge towards the foreland and its growth by a successive accretion of new thrust sheets. Position of deformation front in particular time-steps is constrained by stratigraphic data, in particular onset of syn-orogenic deposition, getting progressively younger towards the foreland. However, the kinematic simulation suggests that evolution of the Outer Carpathians cannot be consistently explained by a uniform in-sequence nucleation of successive thrusts. Significant repetitive out-of-sequence thrusting is needed in order to maintain geometry of the modeled accretionary wedge in agreement with existing stratigraphic and sedimentological data as well as with the critical wedge theory. This conclusion is consistent with the present structure of Outer Carpathians, composed of groups of thrust sheets emplaced one on top of the other. The most important of the inferred out-of-sequence events was an emplacement of the Magura Unit on top of previously deformed and partly eroded Dukla imbricates between 20.0 and 17.5 Ma.

Integration of geometries, kinematics and sedimentation into a single model offered us a possibility for tracing evolution of a convergence rate. Relatively low shortening rate of 10 mm/y between 36 and 25 Ma was followed by its increase first to 19.8 and ultimately to 34.1 mm/y since 19.2 Ma until locking of deformation front at around 11 Ma. However, the variations in convergence rate are not directly reflected in a migration of the deformation front of the Outer Carpathians. Propagation of the leading edge towards the foreland was controlled simultaneously by large-scale processes and a mode of shortening accommodation within the accretionary wedge itself. A shift from frontal accretion to out-of-sequence thrusting was resulting in stagnation of the deformation front, regardless the rate of shortening.

The deduced acceleration of convergence coincides well with an onset of back-arc extension in the Pannonian Basin, commonly related to the roll-back of the subducted lithosphere.

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The Certej hydrothermal ore deposit (Apuseni Mts., Romania): fluid inclusions, types and age of the related hydrothermal alteration

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An important low sulphidation type epithermal Au deposit occurs at Certej in the southeastern part of the Apuseni Mts., Romania in a small Neogene intramountain basin (Brad-Săcărâmb).

The ore bodies are hosted in Miocene amphibole andesite and Cretaceous and Neogene sandstone, micro-conglomerate and black claystone as well as in their brecciated counterparts. K-Ar ages for the magmatic rocks in the region are between 12.58 – 10.27 Ma. The characteristic mineral association of the studied ore deposit is pyrite, sphalerite, galena, chalcopyrite, tetraedrite-tennantite series minerals, bournonite, arsenopyrite, boulangerite, pyrrotite and mackinawite accompanied by quartz, calcite and barite. Two ore-forming stages have been distinguished based on ²⁰⁴Pb/²⁰⁶Pb isotope data: 1) syngenetic disseminated Pb-Zn ore in Cretaceous sedimentary rocks, and 2) the main breccia pipe hosted gold-polymetallic ore bodies formed during the Neogene volcanic activity. Hydrothermal alteration products were analyzed by optical microscopy, while selected hydrothermal minerals were determined using XRPD.

Pyritization, silicification, adularization, carbonatization and sericitization are the prevailing hydrothermal alteration types in relation to the main mineralization stage. The XRD study revealed the presence of the following hydrothermal phase minerals: illite, smectite, kaolinite, adularia, barite. Based on K-Ar dating of illite and adularia, the hydrothermal alteration in the Certej occurred between 11.86 (+/-0.52) and 12.29 (+/-1.56) Ma, within the time interval of magmatic activity.

Primary and secondary fluid inclusions in quartz and sphalerite were trapped from a heterogeneous (boiling) fluid. Homogenization temperatures range between 186 – 355.4°C, however, due to the occurrence of heterogeneous entrapment, the temperature of ore forming processes is most probably around 180 – 200°C. The determined eutectic temperatures of the fluid inclusion brines range between -19.3 – -24.4 °C, while freezing point depressions from -4.1 to -0.1°C. The final melting temperature mostly occur between -0.2 and -3.3°C and thus fluid inclusion salinities are in the range 0.35–5.41 eq. wt. % NaCl.

Depth zones of the Dead Sea rift as a possible source of hydrocarbons

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Interest to deep sources of hydrocarbons has appeared after the finding of oil/gas fields in magmatic rocks. For research of oil/gas bearing deep layers, the Polycyclic Aromatic Hydrocarbons (PAH) in basalt rocks of Dead Sea Rift have been studied. The samples were selected both to the north and south from Kinneret Lake in a few ten kilometers distance from

it of separate batholiths intruded in sedimentary stratum. There were analyzed non-altered basalts, altered basalts, tuffs. Identification of the PAH have been carried out in Biosphere's Carbonaceous substances Laboratory of Lomonosov Moscow State University (Russia) by "spectroscopy of E. Shpolsky" using a "Fluorat-Panorama" spectrofluorometer (LUMEX, Russia).

GOLAN HEIGHTS.

There are 16 associations of PAH. 4 associations form 51, 5% all samples. Most spread associations are: 1) Naphthalene/ Phenanthrene / Pyren (SUM of PAH from 28,3 to 117,5 ng/g, Naphthalene from 51,2 to 80,9%). Presents in Basalts and Tuffs. Locate in West, Center, South /West and South of North Batholith. 2) Phenanthrene/ Naphthalene/, Pyren. (SUM of PAH from 52, 6 to 124, 5 ng/g, Phenanthrene from 47 to 60, 2 %). Presents in Basalts. Locate in West, Center, South /West and South of North Batholith. 3) Naphthalene/Phenanthrene/ Benzo(ghi)perylene (SUM of PAH from 53,3 to 87,5 ng/g, Benzo(ghi)perylene from 1,9 to 10,5 %). Presents in Basalts. Locate in West and South/West of North Batholith. 4) Naphthalene/ Pyren/ Chrysene (SUM of PAH from 81, 1 to 95, 5 ng/g, Chrysene from 0, 25 to 0, 52, Pyren from 4, 6 to 57, 3). Presents in Basalts. Locate in the Center of North Batholith. All 4 associations belong to higher temperature formations (Naphthalene and Phenanthrene). And Pyren and Benzo (ghi) perylene belong to lower temperature formations. In the same time existence such components as Phenanthrene, Chrysene, and Pyrene probably pointed on migrations of Hydrocarbons from depth.

BASALT WEST.

There are 8 associations. 3 associations form 70% all samples. Most spread associations are: 1) Naphthalene/ Phenanthrene/ Pyren. Presents in Basalts. Locate in: West of North Batholith; West of South Batholith; West of separate dyke. 2) Naphthalene/ Phenanthrene. Presents in Basalts. Locate in: West of North Batholith ; West and South of South Batholith ; West of Separated dyke. 3) Naphthalene/ Pyren. Presents in Basalts and Tuffs. Locate in: West of North Batholith ; West of South Batholith ; in West of separated dyke.

All 3 associations belong to higher temperature formations (Naphthalene and Phenanthrene). And Pyren and Benzo (ghi) perylene belong to lower temperature formations. In some samples Phenanthrene, Chrysene, Pyrene was identified.

Presence of diverse groups of PAH in the rocks of highly fractured and secondary basalts altered, point at migrations of Hydrocarbons through faults from possible deep reservoirs/source of Dead Sea Rifts.

Upper Triassic (Norian) sedimentary evolution of the Slovenian Basin (eastern Southern Alps, W Slovenia)

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The Slovenian Basin represents a Mesozoic deep-water sedimentary environment, located on the south Tethyan passive continental margin. Its history can be divided into two parts: from the initial opening during late Anisian/Ladinian to progressive shallowing in the Carnian, and from a marked deepening, which started in late Triassic/early Jurassic, to the final closure at the end of Cretaceous. Upper Triassic deposits comprise Carnian "Amphicline beds", followed by Norian-Rhaetian "Bača Dolomite", which in the northernmost part of the basin laterally passes into non-dolomitized Slatnik Formation.

The "Bača Dolomite" due to strong late-diagenetic dolomitization represents a very poorly investigated segment in the history of the Slovenian Basin. In order to resolve its depositional characteristics, an incompletely dolomitized succession outcropping on Mt. Slatnik (south-eastern Julian Alps, W Slovenia) has been studied in details. The Mt. Slatnik section structurally belongs to the Tolmin Nappe, which is a part of easternmost Southern Alps. The Norian age of the "Bača Dolomite" in this section has been established on the basis of superposition, foraminifers and conodont data.

The Mt. Slatnik section starts with 75 m of mud-supported massive channelized slump breccias with laminated intraclasts and chert clasts, indicating an inner apron environment. They are followed by 19 m of medium-thick amalgamated, partly bioturbated beds of marly dolomite with parallel lamination and chert nodules. Non-dolomitized parts are represented by spiculite packstone. Slump breccias are rare. Deposition took place in an outer apron. The following 10 m of the succession are composed of several up to 1 m thick sedimentary cycles starting with thin-bedded cherty limestone and ending with more prominent marlstone layer. Limestone is texturally thin-shelled bivalve coquina pack- or wackestone, or very fine-grained peloidal and fine-grained peloidal-bioclastic packstone. In the latter grains are mostly of shallow-water origin. These beds are interpreted as distal turbidites intercalated within basin plain deposits. In the next 23 m the marly content markedly decreases. Beds are thicker. Among dolomite, limestone beds are preserved, texturally being mudstone or wackestone, with intercalated very fine peloidal and fine-grained peloidal-bioclastic packstone. Amalgamation is common as well as chert nodules and sedimentary structures, namely normal and inverse grading, parallel, cross and convolute lamination, geopetal structures and load casts. These beds were deposited in the outer apron. Massive clast-supported slump breccias in the next 13 m contain laminated dolomitic intraclasts and chert clasts. The first are concentrated near the lower bed-boundary and sometimes imbricated. Breccias indicate an inner apron environment. Next 20 m of medium-thick dolomite beds with subordinate laminated limestone with wackestone to packstone textures again mark the outer apron. They are followed by 17 m of dolomite with chert nodules, indicating deposition on a basin plain. Dolomite beds in the next 80 m thick interval in places exhibit convex lower boundaries, indicating occasional slumping in the lower part of this interval. Upwards, limestone predominates. Amalgamated beds show parallel, cross and convolute lamination, and grading. Texturally they are wacke- to packstone. This interval shows deposition in an outer apron. Mudstone in the uppermost part could indicate the beginning of the next deepening phase.

In summary, the bulk sedimentation of the Norian “Bača Dolomite” took place via slumps and sediment gravity flows. Two “retrogressive-progressive” (?) cycles can be deciphered, each with shifting of the place of deposition from an inner apron to basin plain environment.

Neoproterozoic and Paleozoic suprasubduction regional metamorphism, granitoid magmatism and geodynamics of the Caucasus

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The Caucasus represents complicated polycyclic geological structure involving mountain fold systems of the Greater and Lesser Caucasus and adjacent foredeeps and intermountain troughs. Paleomagnetic, paleokinematic and traditional geological data indicate that within the oceanic area of Tethys in geological past relatively small continental or subcontinental plates (terranes) were situated having various geodynamic nature and characterized by specific lithologic-stratigraphic section and magmatic, metamorphic and structural features. During the Neoproterozoic, Paleozoic and Early Mesozoic they underwent horizontal displacement in different directions within the oceanic area of Proto-, Paleo- and Mesotethys (Neotethys) and as a result of Variscan, Early Kimmerian, Bathonian and Austrian orogeny underwent mutual accretion and ultimately joined the Eurasian continent. South of the Scythian platform (Sp) the Greater Caucasian (GC), Black Sea-Central transcaucasian (BC), Baiburt-Sevanian (BS) and Iran-Afghanian (IA) terranes are identified in the Caucasian segment of the Mediterranean mobile belt, which in geological past represented island arcs or microcontinents.

In modern structure they are separated by ophiolite sutures of different age, which mark the location of small or large paleoceanic basins. All terranes of the East order

(superterrane), as well as the southern edge of Sp are characterized by manifestation of polymetamorphism, though in various terranes, separate stages of regional metamorphism established by geological observation, but mostly confirmed by isotopic-geochronological data (K-Ar, Ar-Ar, Rb-Sr, U-Pb, Sm-Nd), became unequally apparent. For instance, Grenville regional metamorphism is observed only in GC (T-700-750°C, P-3.2-3.5kbr), BC (T -600-700°C, P-3.2-3.5kbr) and IA (T -500-550 °C, P-3.8kbr) terranes, whereas the Baikalian - only in Sp (T-300-400°C, p-6_5-s_51<bf) and IA (T-460°C, P-4kbr) terrane. Late Baikalian metamorphism took place only in GC (T -430-540°C, P-3.3-3.5kbr) and BC (T -540-570°C, P-2.5kbr) terranes. Caledonian regional metamorphism strictly characterizes Sp (T 700+-50°C, P-17.8+-4kbr) and GC (T -500-620°C, P-2.2-2.8kbr) terranes. Early Variscan (Bretonian) metamorphism is observed almost in all terranes of the Caucasus: GC (T -350-630°C, P-1.35-2.7kbr), BC (T -320-380°C, P-1.5-1.8kbr), BS (T -330-550°C, P-1.5-2.6kbr) excluding IA terrane, and southern edge of Sp. Late Variscan metamorphism also comprises almost the whole Caucasus (T <4 30°C, P< 1.4kbr) excluding Sp and IA terranes. Within separate terranes, as well as in Sp, synchronously or almost synchronously with principal stages of metamorphism (connected with main phases of tectogenesis) formation of pre-syn- and postmetamorphic granitoids of different type took place. Based on a vast analytical material concerning the petrogenic and rare elements in pre-Alpine granitoids of the Caucasus, it is established that the Neoproterozoic granitoids, occurring in all terranes excepting SP, are represented mainly by the crustal and upper crustal formations of the subduction mantle-crust and mantle island arc categories.

The Late Baikalian granitoids are developed in GC and BC only. They are represented by the subduction mantle-crust and crust-anatectic categories. The Caledonian granitoids, cropping out only on SP, are represented by the subduction mantle-island arc formations formed with participation of the mantle and lower crustal material, and also subduction granitoids emerging due to melting of the immature continental crust. The Bretonian granitoids appear only in GC and BS. Granitoids of GC as whole correspond to the upper crustal granitoids of the other regions of the world, whereas the granitoids of BS are represented by the subduction formations of the mixed mantle-crust category; sialic part of the continental crust has an insignificant role during their formation. The late Variscan (Sudetic) granitoids are present in all terranes, excluding IA. The Sudetic orophase is the time of post-metamorphic potassium granitoid formation and consequently of true continental crust. The Sudetic granitoids of all exposures are characterized by similar composition, petrogeochemical parameters and geodynamic conditions of formation. Their major part corresponds to the upper crustal formations, and the minor part - to the common crustal ones. The observed occurrence of different age and diversity of endogenic activity in various terranes of the Caucasus show asynchronism of episodic activity of subduction zones on different sides of oceanic basins separating these terranes.

Geomorphological and geological observations at the coast of Tripiti Hill (Heraklion Harbour, Crete), in relation to reported active faulting

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Heraklion is a fast-growing urban centre where knowledge of active faulting is necessary for city planning and infrastructure projects. Neotectonic faults (not all necessarily active at present) most probably traverse the built-up coastal part of Heraklion, but they require subsurface geological and geophysical studies to be precisely located and characterised. In the frame of a research project assigned to the Institute of Geodynamics by the Heraklion Municipality, we made detailed geomorphological and geological observations in the coastal area of the Tripiti Hill, where previous workers report a NNW-SSE trending, WSW-dipping, presently active normal fault crossing the port of Heraklion as well as a

densely built-up part of the city. Based on our observations, we conclude that this fault does not exist. In support of our conclusion, we discuss: (1) the nature of a steep contact between Neogene bedrock and Quaternary deposits exposed at a roadcut along the coastal avenue, (2) the depositional environment of Quaternary deposits at the above outcrop and surrounding area, (3) the buried relief and stratigraphic features exposed in a trench excavated by previous workers across the alleged fault trace, and (4) the geomorphological context of coastal deposits and marine terrace remnants used by previous workers for fault slip rate estimation. This case study is presented as a vivid example of the importance Geomorphology and Quaternary Geology have in studies of active faulting.

Geochemical and climatic parameters of environment versus isotopic composition of travertine in northern Slovakia

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Isotopic studies on carbonates and lake sediments are a major source of paleoclimate and paleoenvironment data from continental records. Studies on recently deposited travertines from Northern Slovakia were basis for correlation of isotopic record with recent climate changes.

Many sites with presently deposited travertine are located in North Slovakia and they annual sedimentation rate is up to several tens of centimetres. The geochemical and isotopic measurements give possibility to precise description of deposition process and its relation to air and water temperatures. This was useful for revision of paleotemperature records obtain from fossil travertines in the region.

Two sets of data were collected for realisation of the project: water samples of stream flows through travertines cascades and samples of travertine. Actinide activity and stable isotope composition were measurement for both sets of data.

The results point to: (1) a high sedimentation rate of travertines – 1 mm of sediment is deposited during 2-4 days, (2) a high activity of actinides in water and travertine samples, (3) changes of actinides' activity during the year, probably related to changes in metabolism of algae growing in travertine cascades, (4) no correlation between oxygen isotopic composition and changes in air temperature in annual scale.

Persistent synmetamorphic thrusting in the Rhodope until 33 Ma: evidence from the Nestos Shear Zone and implications for Aegean geodynamics

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The Nestos Shear Zone (NSZ), mostly on the Greek territory, is recognized as one of the major structures of the Rhodope Metamorphic Complex (RMC). It consists of a thick NNE-dipping pile of mylonites with top-to-SW kinematics encompassing the contact of the 'Sidironero Unit' (SU) onto the 'Pangaeon Unit' (PU, the lowest exposed unit of the RMC). For most authors, the top-to-SW shear fabric of the NSZ reflects synmetamorphic thrusting.

The main argument is the report of an inverted metamorphic gradient across the shear zone. As it is described in the literature, however, this gradient remains difficult to interpret. In contrast, for other authors, top-to-SW shearing across the NSZ reflects extensional shearing. This view relies on the apparent structural continuity and the consistency of fabrics between the NSZ and a domain of Neogene ductile extension further southwest. Based mostly on K-Ar Hbl ages, it is usually argued that shearing across the NSZ persisted until ca. 37 Ma. If so, support to the second interpretation may be found in the growing number of studies suggesting that post-orogenic extension started in and around the RMC during the Eocene or before.

We carried out a structural, petrological and geochronological (U-Pb and ^{39}Ar - ^{40}Ar) study of the NSZ. Inverted metamorphism is confirmed and is found to be coeval with top-to-SW shearing. The whole SU (including its base, overlapping with the NSZ) experienced the conditions of advanced partial melting at $T > 650^\circ\text{C}$. Leucosomes that locally crosscut the main fabric crystallized between ≥ 50 and ca. 40 Ma (U-Pb zircon and monazite ages), just before cooling of the metamorphic pile. This shows that at least part of the migmatization is not an old event but is part of the syn-shearing metamorphic evolution. In contrast, rocks of the PU right beneath the SU do not show any evidence that they ever reached the conditions of anatexis. In orthogneisses, microstructures document amphibolite facies shearing. Although relatively rare, metabasites and Grt-bearing micaschists keep the record of a prograde metamorphic path culminating at $T \leq 620^\circ\text{C}$ (at $P \sim 8\text{-}10$ kbar). Thus, higher-grade rocks were emplaced onto lower-grade rocks during top-to-SW shearing, attesting for synmetamorphic thrusting along the NSZ. Hornblende ^{39}Ar - ^{40}Ar single-grain plateau ages from the NSZ are between 39 and 37 Ma, which we interpret as dating amphibolite facies shearing. Later strain increments have produced greenschist facies mylonites and ultramylonites subconcordant with the earlier fabric and with identical kinematics. White mica ^{39}Ar - ^{40}Ar single-grain plateau ages from these rocks are between 36 and 33 Ma, which we interpret as dating mylonitization. With respect to peak conditions in the PU, this deformation occurred at lower grade conditions, therefore inverted metamorphism cannot be invoked in this case. Nevertheless, several lines of evidence indicate that this deformation reflects thrusting as well. Consequently, our study documents persistent synmetamorphic thrusting along the NSZ as late as ca. 33 Ma. This is consistent with results obtained from the Chepelare Shear Zone, in the Bulgarian Central Rhodope (Gerdjikov et al., this volume), and contradicts the view that post-orogenic extension was already active in pre-Oligocene times in the northern Aegean. Our analysis of the RMC further indicates that post-orogenic extension did not start before ca. 27 Ma. Hence, it started at about the same time than it did further south in the Cyclades and Menderes region, at variance with the statement in some recent geodynamic syntheses. The picture arising from the RMC is consistent with a change in the geodynamic setting of the whole Mediterranean at around 30 Ma, from strongly compressional (i.e. Alpine collision) to a situation dominated by trench retreat and post-orogenic extension.

Biostratigraphy and palaeoenvironment of the Upper Cretaceous flysch sediments of the Mestia-Tianeti Zone of the Greater Caucasus Fold System

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For the detailed stratigraphic division of the Upper Cretaceous sediments of the Zhinvali-Gombori subzone of the Mestia-Tianeti zone GCFS, and for specifying the volume and age of the formations, in the facies of Sadzeguri-Shakhveli and Zhinvali-Pkhoveli nappes the sections of the Ksani and Aragvi river basins (the rivers Aleura, Sakanaphe, Arkala, Didi

Jakha, Patara Jakha; near the villages Sadzeguri, Korinta, Ananuri, Muguda, Avenisi, Pavleuri) have been studied.

Detailed study of the assemblage composition of calcareous plankton contents (calcareous nannofossil and planktonic foraminifera) of the Late Cretaceous sediments of the Zhinvali-Gombori subzone of the Mestia-Tianeti zone of the Greater Caucasus fold system (GCFS) has been carried out for the first time in this region to define biozonation. Within the limits of the Cenomanian-Maastrichtian 9 small foraminiferal and 19 nannoplankton biostratigraphic units (zones and subzones) have been established. Here are specified volume and age of lithostratigraphic units (successions) composing the Upper Cretaceous of the Mestia-Tianeti zone of GCFS: the Ukughmarti succession – CC9 (Early Cenomanian); the Ananuri succession – CC9-CC11 (Early Cenomanian-Early Turonian); the Margalitisklde succession – CC12-CC13 and planktonic foraminifera zones *Marginotruncana pseudolineiana*-M. *lapparenti* and *Marginotruncata sigali*. (Late Turonian-Early Coniacian); the Eshmakishevi succession - CC14-CC19 (Late Coniacian-Early Campanian) and zones *Archaeoglobigerina basquensis* and *Globotruncana arca* (upper part of the succession); the Jorchi succession – CC20-CC25a (Middle Campanian-Lower Maastrichtian), in the sediments of CC22c is established the small foraminiferal zone *Globotruncana ventricosa*-*Rugoglobigerina rugosa*; the Sabue succession – CC25b-CC26 and foraminiferal zone *Gansserina gansseri* (Late Maastrichtian).

The analysis of the Late Cretaceous nannoplankton and foraminifers association of the Zhinvali-Gombori subzone of the Mestia-Tianeti zone of GCFS has shown the existence of four sedimentary cycles: Cenomanian-Early Turonian, Middle Turonian-Early Campanian, Late Campanian-Early Maastrichtian and Late Maastrichtian. On the territory of Georgia contained in the Late Albian pool there were established some large sites of a land, where the Cenomanian sediments with the washout rest on the underlying formations. In the Cenomanian-Early Turonian there was a basin of isolated, regressive sea in the southern part of the moderately cold-water belt. From the Late Turonian the boundary between the warm- and moderately cold-water belts moved to the north. Transgression that started in the Late Turonian lasted till the Early Coniacian. In the middle part of the Early Coniacian is outlined shoaling of the basin. From the Late Coniacian to the end of the Santonian sedimentation took place in the shallow, calm marine basin. The omission of the nannoplankton CC19, CC20, CC21 and CC22a, b zones from the sections of the Zhinvali-Pkhoveli nappe and the analysis of the redeposited forms enables to admit break in sedimentation caused by Early Campanian regression and Late Campanian transgression. At the end of the Middle Maastrichtian took place a short-term regression that was replaced by the Late Maastrichtian transgression.

A latest Anisian radiolarite event in the High Karst Nappe in the Dinarides (Montenegro)

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In the High Karst Nappe in southern Montenegro radiolarites of unknown age topped the Upper Anisian Bulog Limestones (Late Pelsonian to Illyrian) in the investigated sections Boljevici near Virpazar and Obzovica on the road Budva to Cetinje. Radiolarian faunas from the radiolarites as well as conodonts from the overlying red hemipelagic limestones prove an Illyrian age of the radiolarites. The time interval of the deposition of the up to 5 m thick radiolarite successions is relatively short and started and ended in the Illyrian.

In the section Boljevici the hemipelagic succession starts with red hemipelagic Bulog Limestone on top of shallow-water limestones equivalent to the Ravni Formation (Dedovici Member) in the Outer Dinarides or the Steinalm Formation in the Eastern Alps/West

Carpathians. The drowning of the platform sediments can be dated by the occurrence of *Nicoraella germanicus*, *Nicoraella kockeli*, *Gondolella bulgarica*, and *Gondolella cf. bifurcata* as Late Pelsonian; these conodonts derive from the overlying Bulog Limestones. Deposition of the Bulog Limestones in this section lasted until the Illyrian, proven by the occurrence of *Gondolella excelsa*, *Gondolella trammeri*, and *Gondolella liebermanni*. Following radiolarians from the reddish laminated radiolarites on top of the Bulog Limestones prove an Illyrian age (Spongosilicarmiger italicus Zone to lower part of Ladinocampe multiperforata Zone; equivalent of Reitziites reitzi Ammonoid Zone): *Baumgartneria cf. retrospina*, *Cryptostephanidium cornigerum*, *Oertlispongos inaequispinosus*, *Paroertlispongos multispinosus*, and *Triassocampe scalaris*. The directly overlying sequence of the radiolarite is not exposed, but upsection follow Late Ladinian to Early Carnian shallow-water limestones and dolomites.

In the section Obzovica the drowning sequence of the carbonate platform is not exposed. Red limestones below the radiolarite succession belong to the Bulog Limestone. Upsection follows a five metre thick succession of red and partly grey well-bedded radiolarites. From the red radiolarites we isolated a well preserved Illyrian radiolarian fauna (Spongosilicarmiger italicus Zone; equivalent of Reitziites reitzi Ammonoid Zone) with: *Baumgartneria bifurcata*, *Baumgartneria cf. yehae*, *Cryptostephanidium cornigerum*, *Eptingium manfredi*, *Eptingium ramovsi*, *Falcispongos calcaneum*, *Hozmadia sp.*, *Oertlispongos inaequispinosus*, *Parasepsagon asymmetricus*, *Pseudostylosphaera japonica*, *Pseudostylosphaera tenuis*, *Spongostephanidium sp.*, *Triassocampe deweveri*, *Triassocampe scalaris*. In the upper part of the radiolarite sequence up to ten centimetre thick intercalated hemipelagic filament-bearing limestones are of latest Anisian to earliest Ladinian age, proven by the following conodonts: *Gondolella excelsa*, *Gondolella trammeri*, and *Gladigondolella tethydis*. Upsection the radiolarian cherts decrease rapidly and the following hemipelagic red limestones are of earliest Ladinian age, proven by conodonts. These red limestones pass continuously into grey hemipelagic limestones of Late Ladinian age (with *Gladigondolella tethydis* and *Gondolella foliata*), topped by shallow-water dolomites of Late Ladinian to Early Carnian age.

This short-lasting latest Anisian radiolarite event in the succession of the High Karst Nappe is contemporaneous with the complete demise of shallow-water carbonate production in the whole western Tethyan realm and corresponds to the onset of the first radiolarites on the Neotethys Ocean floor, as proven in Albania and northern Croatia as well as in the Meliata Unit in Slovakia and Hungary. In the late Anisian the huge parts of the passive margin facing the newly formed Neotethys Ocean became flooded and volcanic ashes and radiolarites were deposited in the whole Dinarides reaching the palaeogeographic realm of the High Karst Nappe. Obviously, volcanics in our sections are preserved only as some thin intercalations of metabentonites. The latest Anisian radiolarite deposition corresponds also to the onset of intense volcanism in the Dinarides more to the north and in the southern Alps in Italy. The studied successions are nice examples of short-lived hemipelagic basins that formed on continental margin during the late Anisian rifting and were later, in the Ladinian and Early Carnian, completely infilled with sediments of prograding carbonate platforms.

Palaeoenvironment of the Eocene-Oligocene of the northern Ukraine in the light of palynological analysis and comparison with coeval Carpathian strata

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Eocene-Oligocene sequence of the northern Ukraine consists of diversified, mainly non-calcareous clastic deposits representing following lithostratigraphic units: Kanev Formation (?Ypresian), Buchak Formation (Lutetian), Kiev Formation (Upper Lutetian-

Bartonian), Obuhov Formation (Priabonian), Mezhygor Formation (Rupelian) and Bereka Formation (?Chattian).

We compared results of palynofacial analysis (i.e., composition of organic remains of marine and terrestrial origin) and taxonomical diversity of aquatic palynomorphs representing both marine and freshwater taxa. Our palynological analysis revealed variable sedimentological settings of these deposits reflecting various palaeoenvironments.

The oldest investigated strata (the Kanev Formation) contain high ratio of marine dinoflagellate cysts (occasionally up to 90%) pointing to marine environment optimal for development of rich and diversified dinoflagellate flora during the Early Eocene (Ypresian). Younger strata (the Buchak Formation) contain already palunofacies that could be interpreted as indicative to deposition in more proximal setting than Kanev Formation. It contains higher ratio of terrestrial plant remains, whereas dinoflagellate cysts are dominated by near-shore species *Homotryblium tenuispinosum*.

Bartonian strata (the Kiev Formation) yield rich and diversified dinoflagellate cysts assemblages, which are indicative for marine environments. Taxonomical richness and occurrence of an oceanic genus *Impagidinium* suggests offshore sedimentary setting during Bartonian. A gradual sea withdraw can be interpreted as Priabonian: diversified assemblages in basal part of the Obuhov Formation, become relatively impoverished in the upper part of this unit where representatives of the genus *Deflandrea* and Prasinophyta algae (*Pterospermella*, *Tasmanites*) occur. Land-influences are markedly evident in Lower Oligocene Mezhygor Formation: palunofacies is dominated by sporomorphs and land plant tissue remains. Moreover, freshwater algae also frequently occurs.

Preliminary comparison of our data with palynology of coeval strata from Polish part of epicontinental sea and Carpathian basins suggests that these basins were presumably connected during the Middle and Late Eocene. This is based on general taxonomical composition similarity of our assemblages to those known from Middle and Upper Eocene strata of the Flysch Carpathians (e.g., the Variegated Shale, the Hieroglyphic Beds). Throughout Early Oligocene, however, epicontinental basins were rather separated from Carpathian ones. Dinoflagellate cysts from the Mezhygor Formation are relatively diversified, whereas the ones from coeval Menilite facies of the Carpathian basins are almost absent.

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Revisiting the source characteristics of Quaternary monogenetic basalts in Central Anatolian Volcanic Province: asthenospheric or lithospheric melts?

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The Neogene-Quaternary Central Anatolian Volcanic Province (CAVP) is characterized by widespread polygenetic and monogenetic volcanism. About 800 monogenetic volcanoes were identified within the CAVP and these mainly include scoria cones and related flows (basaltic and andesitic), with subordinate maars (of both basaltic and rhyolitic composition), and domes (generally rhyolitic in composition).

Despite the occurrence of q-normative, ol-hy-normative, and ne-normative basalts, CAVP monogenetic basalts (*s.l.*) have been generally considered as alkaline. Based on this fact, they are recently evaluated as tholeiitic, transitional, and mildly alkaline (<5% normative ne), respectively. Similar patterns and HFS anomalies of monogenetic basalts on mantle-normalized diagrams to CAVP calc-alkaline lava flows from the polygenetic volcanoes were also noted. These andesitic-dacitic lava flows from the CAVP stratovolcanoes display orogenic trace element fingerprint, reflecting enrichment of their source regions by subduction-related fluids. So, this brings about the need for revisiting the source characteristics of CAVP monogenetic basalts. Compilation and re-evaluation of all available

geochemical data from previous studies, and interpretation of our own data from monogenetic volcanoes enabled us reviewing source characteristics of monogenetic basalts in CAVP.

CAVP monogenetic samples are transitional to calc-alkaline according to their Zr and Y contents. All CAVP monogenetic basalts display similar variably enriched LIL/HFS patterns and HFS anomalies on mantle-normalized diagrams. They all have incompatible element ratios intermediate between orogenic andesites and within-plate basalts. High La/Nb (>1.6), Al_2O_3/TiO_2 (10-17) and low Sm/Yb ratios (<2.5) imply that the melts must have been derived from shallow depths (<80 km), that is within the lithospheric mantle, just like the calc-alkaline volcanics of CAVP. There is also evidence which might account for crustal contamination such as highly variable range in HFS and other incompatible element ratios Zr/Nb, Y/Nb, La/Yb, and presence of slight negative Ba anomaly on multielement diagrams. Presence of U peaks on mantle-normalized multielement diagrams for most monogenetic CAVP basalts, and variation in $^{87}Sr/^{86}Sr$ ratios reported for monogenetic volcanoes in the western part of CAVP imply crustal contribution as well.

The driving mechanism for generation and ascent of Neogene-Quaternary volcanism in the CAVP is the transtensional and rotational tectonics in central Anatolia from Miocene onwards. This is evidenced by exposure and vent distribution of the central Anatolian volcanics confined to two major fault zones namely, the Central Anatolian Fault Zone (or Ecemis Fault Zone) and the Tuz Gölü Fault Zone. In a wider regional context, CAVP monogenetic basalts are comparable to Apuseni Mountains (Romania) and Big Pine (Basin and Range) volcanics, except CAVP basalts have depleted Ba contents. There is a need for systematic petrological study to expand the database and have a better picture of monogenetic volcanism within the CAVP.

Eocene post-collisional volcanism in the Central Anatolian Crystalline Complex, Turkey: Petrology and geodynamic significance

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In the Central Anatolian Crystalline Complex (CACC) the Late Cretaceous post-collisional granitic magmatism is followed by Eocene extension, resulting in formation of roughly E-W trending transtensional basins. The volcanic rocks, mainly submarine lava flows and subareal domes are concentrated along these Middle Eocene (Bartonian) basins. The volcanic rocks are basic to intermediate and are classified as basalt, basaltic andesite and rarely alkali basalt and trachy-andesite. Petrographically they are generally plagioclase + pyroxene \pm olivine \pm hornblende \pm biotite pyrrhic, indicating a shallow crystallization level. They are characterized by several disequilibrium textures, which may suggest role of magma mixing/mingling process during their evolution. Eocene volcanic rocks are characterized by high phenocryst contents, low but variable MgO concentrations (0.54- 9.30 wt %), low Mg numbers (19.57- 55.57) and low compatible trace element concentrations (Ni 5-166 ppm; Co 7-32 ppm), which provide strong evidence for the mafic mineral fractionation. Their relatively high Zr and Y contents provide strong evidence for their transitional to mildly alkaline nature and also point out their within-plate characters. All studied samples are strongly and variably LREE enriched relative to chondrite with the (La/Sm) N ratio of 2.26- to 6.17 and show small negative Eu anomalies ($Eu/Eu^*=0.65-1.00$), suggesting plagioclase fractionation. The REE patterns of the studied rocks are consistent with the derivation from a shallow depth (e.g. spinel lherzolitic source). They have negative Nb-Ta and Ti anomalies in the primitive mantle normalized diagram and are characterized by low Nb/La (0.21 to 0.62), Ce/Pb (3.70-34.90) and Nb/U ratios (1.11-30), which may indicate an interaction with the Late Cretaceous granitic host rocks in the course of their ascent.

The volcanic rocks display similar but variable ranges of Sr, Nd and Pb isotope ratios. ϵNd values range from 0.12 to 4.06, which is indicative of an isotopically depleted mantle source. They have relatively high and variable LILE/HFSE, LILE/LREE ratios (e.g. Ba/Nb

32- 208 and Ba/La 16-46) and relatively radiogenic Sr, Pb isotope compositions (0.70404-0.70559 and 18.62 - 19.17 for $^{206}\text{Pb}/^{204}\text{Pb}$ 15.58 – 15.68 for $^{207}\text{Pb}/^{204}\text{Pb}$ and 38.65 – 39.00 for $^{208}\text{Pb}/^{204}\text{Pb}$), indicating that they were derived from a heterogeneous lithospheric mantle that had been metasomatised by subduction related agents such as fluids and/or melts during a previous geodynamic event. On the other hand, high LILE and LRE contents of the rocks point out fluid dominated metasomatism rather than melt metasomatism.

Eocene volcanic rocks are supposed to be formed as a result of post-collisional lithospheric extension that followed the Late Cretaceous thickening of the Central Anatolian Crystalline continental crust, related to the closure of the Neotethyan Izmir-Ankara branch of Neotethys. Geochemistry and geotectonic setting point out that lithospheric delamination was the most likely mechanism to generate these calcalkaline to mildly alkaline volcanic rocks in the CACC.

Contribution to the mineralogy of wollastonite from the contact aureole near Xanthi and Kimmeria (N. Greece)

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The studied area belongs to the Rhodope Massif and is located approximately 1km north of town of Xanthi, where a plutonic body of mainly granodioritic composition and Oligocene age intrudes into marble. It is generally medium-grained, composed mainly of plagioclase, orthoclase, quartz, biotite and hornblende.

Three samples of the skarn formation were collected; two from the aureole near Xanthi (samples WXT1 and WXT2) and one from the aureole near Kimmeria (sample WXB1). Thin sections of the samples were prepared in order to determine their mineralogical and textural characteristics. Furthermore, X-ray powder diffraction (XRPD) study was performed using a Philips PW1710 diffractometer with Ni-filtered CuK_α radiation. Representative quantity of the samples was treated chemically. In this way the organic matter, fine carbonates and iron oxides (COI) were removed. The abundance and semi-quantitative estimates of the mineral phases present was determined from the untreated samples, whereas the form of the wollastonite present along with its unit cell properties were established from the treated ones (31 lines each). Finally, chemical analyses of the wollastonite were carried out using a JEOL JSM-840A Scanning Electron Microscope (SEM) equipped with attached Energy Dispersive Spectrometer.

All the samples are in general of massive fabric, forming fibrous aggregates with no distinct spatial orientation. Samples WXT1 and WXT2 are coarser grained compared to WXB1. The samples from Xanthi reveal elongated crystals of wollastonite with fractures parallel to the secondary cleavage (001), mainly filled with fine micritic calcite. The sample from Kimmeria reveals finer and elongated crystals of wollastonite, as a sample being also richer in calcite in aggregate form.

The samples are mostly composed of wollastonite (73-80%), along with considerable amounts of calcite (3-13%). Andradite is found in considerable amounts (up to 18%) only in the samples from Xanthi, while quartz is present only in Kimmeria samples. Clinopyroxene is not always found, as well as feldspars. The COI amount is greater in Kimmeria samples, showing an increasing tendency with the calcite content present in the samples.

From the unit cell data obtained from the chemically treated samples it is shown that all the samples are of triclinic structure, being in general very close to the wollastonite nominal structure. These from Xanthi show generally a slightly lower (a) angle. The wollastonite from Kimmeria demonstrates a more complex chemical content, which does not affect its crystal structure. The mean chemical formula of wollastonite in sample WXT1 is $(\text{Ca}_{5.895}\text{Mn}_{0.100}\text{Fe}_{0.017})\text{Si}_{5.994}\text{O}_{18}$, in sample WXT2 is $(\text{Ca}_{5.846}\text{Mn}_{0.152})\text{Si}_{6.001}\text{O}_{18}$ and in WXB1 is $(\text{Ca}_{5.833}\text{Mn}_{0.120}\text{Mg}_{0.045})\text{Si}_{6.001}\text{O}_{18}$. The wollastonite from Kimmeria incorporates Mg^{2+} in its structure, whereas wollastonite from Xanthi Fe^{2+} . Both demonstrate substitution of Mn^{2+} for Ca^{2+} .

The absence of vesuvianite and plagioclase, along with the presence of clinopyroxene, garnet, minor calcite and traces of quartz, indicates $0.05 < X_{\text{CO}_2} < 0.2$ and temperature range of approximately 650-700°C at 3 Kbar (corresponding to 10-20 km depth). This also implies a volumetric H₂O wollastonite ratio of greater than 7:1. The skarn formation was not the same around the granodiorite, with reaction $\text{CaCO}_3 + \text{SiO}_2 \leftrightarrow \text{CaSiO}_3 + \text{CO}_2$ reaching almost completion to its western margin, rather than its northern one, possibly due to insufficient amount of time and the type of marble permeability. The magmatic fluids interacting with the marble wall rock were gradually depleted in silica content and subsequently enriched in Al, Fe and Mg, forming andradite garnet and clinopyroxene.

Permanent GPS array in Bulgaria with impact on the geodynamics in East Mediterranean

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The presentation outlines results from four years of processing data from permanent GPS stations in Bulgaria and the Balkans. Data from eight stations from the HemusNET network, joint Greek and Bulgaria project, along with another 21 GPS permanent sites on the territory of Bulgaria and another 11 located in the Balkan Peninsula are included in the routine processing. Twelve EPN stations for defining the terrestrial and kinematic frames are included in the solution. The processing is making by the state-of-art GAMIT/GLOBK GNSS software developed in the Massachusetts Institute of Technology. Time series of the coordinates and horizontal velocities of the permanent stations are obtained by processing and analyzing more than three years of data. The obtained horizontal velocities of the stations and the strain rate are in good agreement with the tectonic model of the Eastern Mediterranean and are contribution to the kinematics in the East Mediterranean region.

Separate Eocene-Early Oligocene and Miocene stages of extension and core complex formation in the Western Rhodopes (Bulgaria)

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The basement of the Rhodope Metamorphic Province comprises four groups of tectonic units forming the Lower, Middle, Upper and the Uppermost Allochthons which were emplaced onto each other during a protracted orogenic history from Late Jurassic to Eocene. The Lower Allochthon includes the Pangaion-Pirin Complex, and the Arda, Kardamos/Kesebir, and Byala Reka/Kechros units. The units consist of Variscan basement and, partly, a metasedimentary cover dominated by marble. The overlying Middle Allochthon comprises slivers of both oceanic and continental crust and, in addition, orthogneisses derived from Late Jurassic to Early Cretaceous arc granitoids. It includes, among others, the Kerdilion unit in the Serbo-Macedonian Massif and the Sidironero-Mesta, Starcevo, and Asenica units in the Western and Central Rhodopes. The Middle Allochthon was thrust towards southwest over the Lower Allochthon during the Palaeogene along the Nestos Shear Zone. The Upper Allochthon crops out most extensively in the Eastern Rhodopes (Kimi Complex) and in the Serbo-Macedonian Massif (Vertiskos/Ograzhden unit). These units represent Variscan continental crust which was affected by HP and partly UHP metamorphism in the Jurassic to Early Cretaceous. The Uppermost Allochthon (not exposed in the Western and Central Rhodopes) consists of low-grade metamorphic (greenschist facies, locally blueschist facies) sedimentary and volcanic rocks, partly of oceanic affinity. It includes the Circum-

Rhodope Belt along the SW border of the Rhodope Metamorphic Province and the Mandrica greenschists in the Eastern Rhodopes.

The Rhodope Metamorphic Province includes, in addition to the Rhodope Mountains proper, also the Rila and Pirin Mountains and the Serbo-Macedonian Massif. These different massifs are separated by basins of Paleogene and Neogene age. The Rhodope Metamorphic Province in Bulgaria and Northern Greece has been affected by significant extensional tectonics since the Middle or Late Eocene. An important fault system active in the Eocene and Early Oligocene includes the Ribново Fault on the eastern side of the Mesta Basin in Bulgaria and the Vertiskos-Kerdilion Fault in Greece. Together with several minor normal fault relicts identified during our studies, these represent an originally west-southwest-dipping, low-angle (at least at the end of faulting) normal fault with greenschist facies mylonites in the footwall and cataclasites along the fault plane, the Mesta-Kerdilion Detachment, exposed over ca. 150 km along strike and about 50 km parallel to the slip direction. The Mesta-Kerdilion Detachment system removed the Vertiskos-Ograzhden Unit from the top of the Sidironero-Mesta Unit. The along strike horizontal displacement amount was more or less constant. The Ribново, Vertiskos-Kerdilion, and Alikochov faults accommodated the collapse of a thickened orogenic wedge above the subduction zone in which the Apulian plate is retreating. In that sense, the Late Eocene Mesta-Kerdilion Detachment system corresponds to the onset of Aegean extension. During the intrusion of several plutons in the Pirin Mountains at ca. 32 Ma, the footwall of the fault was uplifted to form a large anticline parallel to fault strike, and the fault was offset by a system of antithetic, northeast-dipping normal faults along the northeastern flank of this anticline (Dobrotino and Breznica faults). The Mesta-Kerdilion Detachment was later, in the Miocene, again crosscut and offset by the southwest-dipping Strimon Valley Detachment which accommodated important, core-complex-like exhumation to the south, strongly diminishing and finally ceasing towards north. This rotational activity of the Strimon Valley Detachment represents the onset of the extension that led to opening of the Aegean Basin. The Mesta-Kerdilion Detachment can be viewed as a precursor of this, but with slightly different kinematics (i.e. not involving significant vertical-axis rotation) and separated in time from the following events by a phase of relative tectonic quiescence in the Late Oligocene.

Petrological and petrochemical characteristics of the rocks of the Kushla caldera, East Rhodope massif

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The Kushla caldera is located in the East Rhodope massif, in the border area of Bulgaria and Greece. The volcanic activity is realized during the Early Oligocene in subaerial environment. Several volcanic stages are distinguished: pre-caldera – dacite-trachydacite, latite and trachyte; syncaldera – acid pyroclastic rocks (mostly ignimbrites), and post-caldera – elongated subvolcanic bodies and dykes of basaltic andesite and shoshonite. Different tendencies of magmatic evolution are found which is probably related to magma differentiation in comparatively isolated core chambers that are settled at different level. Despite the fractional crystallization as the main process of magmatic differentiation for the separate tendencies, the processes of contamination and mixing are also important. The mixing is probably the triggering mechanism for the acid ignimbrite caldera-forming eruption. The magmatic evolution of the volcanic rocks of the Kushla and Ostren Volcanic Subcomplexes is due to fractionation of plagioclase, sanidine and in less extent of hornblende, biotite and pyroxene as well as the fluid factor that controls the P₂O₅, K₂O and Na₂O. The magmatic differentiation of the Gorski izvor and Uchkaya shoshonite is related to the fractionation of pyroxene, plagioclase, olivine, magnetite and apatite. The lower pressure of the hornblende from the acid pyroclastics of the Ostren Volcanic Subcomplex (1.4-1.9 kbar)

supports the idea for the presence of shallow magmatic chamber after which emptying the main caldera-forming eruption is realized. The pressure of the Chatalalmdere Volcanic Subcomplex is comparatively higher (2.2–2.6 kbar) which is in accordance with the later eruption of deeper levels of the same chamber.

The Moho's structure in West Bulgaria obtained from receiver function

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In September 2005 Geophysical Institute of Bulgarian Academy of Sciences after procurement procedure selected the Refraction Technology, Inc. to upgrade the existing National Operative System for Seismological Information (NOTSSI) to a modern digital seismological network. At the beginning of December 2005 all the equipment supplied were installed on seismological stations and acquisition and processing software was operating in the data center. The network became operational on 08.12.2005. The Bulgarian Seismological Network was equipped with broad-band sensors and digital acquisition systems. It enabled application of modern techniques of analysis of the velocity structure in Bulgaria. This study presents one of the first results from application of the receiver function technique. The Receiver functions were computed using scripts written on Seismic Handler program by Sodoudi F. The Western part of Bulgaria is characterized by mountains, river valleys and small fields between the mountains. Two stations of the network Musomishte (MMB) and Krupnik (KKB) were chosen in south-west of Bulgaria and also station Vitosha (VTS) which is close to Sofia and known as the station with lowest noise. These sites are located in areas of complex tectonic structures manifesting high seismic activity during recent years. As starting models we used shear wave velocity models for the territory of Bulgaria, obtained in Raykova R, 2004. For the study were used earthquakes in epicentral range 35 - 90o and with a magnitude more than 5,5 – 6 also with clear P-onset. All earthquakes from the end of 2005 to the summer of 2009 were used and a good azimuthal covering was reached. From the seismic survey and gravimetric measurements is determined a Moho depth between 30 km and 50 km. The crust is shallower in the north-eastern part of the country and thicker in the south-western part. The obtained results show thicker crust than expected Earth crust. This can be an effect of reflections/refractions on the object close to the station. They show only the main trends of the Moho depth for the whole country but not local effects in some part, beneath the mountains for example. Further detailization of the structure of the Moho boundary could be done after estimation of receiver functions for other stations of the network. The results show also very good the faults close to stations KKB and VTS.

Metabasic rocks from the Chepelare variegated complex, Central Rhodope massif, Bulgaria – preliminary studies

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Metabasic rocks in the Chepelare area occur in two different tectonic settings. Lenses of garnet amphibolites are part of Chepelare mélange embedded in migmatic gneisses of Arda 1 tectonic unit. They reach length up to 15 m and in the variegated complex closely associate whit garnet-kyanite schists, impure marbles and granitoid migmatic gneisses. Whereas numerous small bodies of retrogressed eclogites trace out the ductile shear zone between Arda 1 and Arda 2 tectonic units.

Garnet, amphibole, plagioclase, ± diopside, ± quartz constitute the main minerals in garnet amphibolites from the Chepelare mélange. Accessory minerals are rutile, titanite, ilmenite ± apatite. Garnet occurs as lobate and resorbed porphyroblasts, up to 5 mm in

diameter, containing inclusions of amphibole, plagioclase, epidote, quartz, titanite and abundant rutile. Many porphyroblasts have overcrowded by undistinguishable small inclusions core, often surrounded by inclusion-free rim. In finegrained samples garnets rarely include amphibole or quartz. It is almandine-rich (Alm 41-58, Grs 23-34, Pyr 18-30, Sps 1-3 mol%) with weak prograde zonation and almost lacking retrograde alternation to the rim. Porphyroblastic garnet is commonly surrounded by corona-like symplectites of sodic plagioclase (An₂₇₋₃₀) and paragonitic amphibole, indicating retrograde metamorphic reactions at expense of garnet and omphacitic clinopyroxene. Amphibole inclusions in garnet have higher Al and Ti content and are mainly tschermakites. In some samples pseudomorph replacement of amphibole by K-feldspar, chlorite and andesitic plagioclase close to garnet porphyroblasts suggests further decompression reactions at active fluid regime. Pale green diopsidic clinopyroxene (Na₂O = 0.7-2 wt%) in the matrix associates with oligoclase and is partly resorbed and enveloped by amphibole. In samples where abundant leucocratic material is present and close to almost completely resorbed garnet it includes unoriented small idiomorphic amphiboles. Incomplete replacement of rutile by ilmenite and titanite in matrix reflects the decompression path. The assemblage without the presence of Opx should reflect metamorphism in the HP granulite facies.

P-T estimates using Fe-Mg exchange equilibrium between garnet and clinopyroxene or amphibole and Al-in-amphibole and Grt-Hbl-Pl barometers indicate that the amphibolites reached at least pressures of 12-14 kbars and temperatures of 700-750°C for garnet inclusions and 750-800°C for the matrix assemblage. These new P-T data are consistent with previously reported for the garnet-kyanite gneisses from the Chepelare mélange.

Preliminary major and trace elements geochemistry plotted on discrimination diagrams suggests MORB affinity for the studied garnet amphibolites. Enrichment in Zr, Y, Nb, Ta, TiO₂, LREE and more pronounced Eu anomaly of two samples from the southernmost outcrops do not precludes the possibility of incorporation in Chepelare mélange of metabasics with different protoliths or stronger interaction with the host migmatitic gneisses of granite composition. The later is supported also by high variability in LREE patterns. Additional geochemical studies are planned to reveal the possible connection with retrogressed eclogites from the ductile shear zone to the north, which according to the previous publications also show MORB-type geochemistry.

Petrological observations and P-T data support the metamorphism at least in HP granulite facies for the rock of variegated complex. We do not refer these new estimations as peak metamorphic conditions, as the HP/UHP metamorphic records could be completely erased by observed late high-temperature metamorphic overprint involving hydration reactions during the exhumation.

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Late Eocene synmetamorphic thrusting and syn-orogenic extension across the metamorphic pile of the Bulgarian Central Rhodope

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In the last few years, a consensus has emerged according to which the Rhodope Metamorphic Complex (RMC) has started undergoing post-orogenic extension in the early Late Eocene or before. Hence, no significant compressional structure younger than the Middle Eocene should be observed in it. In the Bulgarian Central Rhodope, the lower part of the metamorphic pile is mostly made of migmatitic orthogneisses from which several zircon and monazite U-Pb ages around 36-37 Ma have been reported. This may suggest that the structures formed during migmatization and subsequent cooling of this part of the

metamorphic pile result from post-orogenic extension, which indeed is the interpretation now dominating in the literature.

Our analysis in the area of Chepelare documents the following. The metamorphic rocks are exposed as a ~5 km-thick north-dipping monocline defined by foliations and lithological contours. In the largest part of this pile, structures consistently document top-to-SW shearing developed during and subsequent to anatexis. The middle part of the section shows a more variegated rock assemblage that coincides with a ~1 km-thick zone of intense strain here termed the 'Chepelare Shear Zone' (CSZ). The CSZ has previously been interpreted as a synmetamorphic thrust of presumed Mesozoic age. From a strongly sheared synfolial pegmatite sampled within the CSZ, we obtained a monazite U-Pb age of 36.3 ± 0.4 Ma (weighted mean age upon 16 analyses) and a muscovite $^{39}\text{Ar}/^{40}\text{Ar}$ single-grain plateau age of 34.9 ± 0.2 Ma. These results are consistent with published ages for the broader area and indicate that the CSZ was active during the time interval from 36 to 35 Ma (at least). Higher levels of the monocline, above the CSZ, show a domain of less severe strain and lacking pronounced stretching lineations, then a domain of higher strain that includes ~1-3 m-thick shear zones with low dips toward the north. The shear zones bear N-S-trending stretching lineations and display top-to-N shear criteria. Some of them are underlined by a synkinematic pegmatitic or granitic vein running along their axis. The top of the monocline is defined by a north-dipping fault zone (with ultramylonitic marbles and thick cataclasites) that also displays top-to-N shear criteria. This well known low-dipping fault zone, initially described as a thrust, has later been reinterpreted as an extensional detachment. Together with the domain of top-to-N ductile shearing in its footwall, we refer to this fault zone as the 'Mihalkovo-Drianovo Shear Zone' (MDSZ). Within the MDSZ, from one shear zone bearing a syn-kinematic pegmatitic vein, we obtained a monazite U-Pb age of 38.0 ± 0.1 Ma (weighted mean age upon 58 analyses) and two muscovite $^{39}\text{Ar}/^{40}\text{Ar}$ single-grain plateau ages of 34.2 ± 1.2 Ma (large flake) and 32.3 ± 1.2 Ma (recrystallized flake). From another shear zone, we obtained two muscovite $^{39}\text{Ar}/^{40}\text{Ar}$ single-grain plateau ages of 34.4 ± 0.2 Ma (granitic vein) and 34.4 ± 0.4 Ma (host gneiss). These results indicate that the MDSZ was active during the time interval from 38 to 34 Ma (at least).

As a consequence, the MDSZ and the CSZ were synchronously active, at least during the period from 36 to 35 Ma. Because the two shear zones have opposite kinematics but fairly identical dips (the difference is 10° at most), this synchronism implies that one of them was initially a thrust and the other was normal-sense, whatever the amount of tilting the metamorphic pile may have undergone subsequently. Of the two solutions left, the one where the underlying CSZ was a thrust and the overlying MDSZ was normal-sense is, by far, the most likely. Consequently, our study documents synmetamorphic thrusting in the Bulgarian Central Rhodope during the Late Eocene. This is consistent with the picture arising from the Nestos Shear Zone, in Greece, and confirms that the onset of post-orogenic extension in the RMC occurred in post-Eocene times. In addition, syn-orogenic extension, so far suspected, is now well established and appears to have developed within the RMC while it was the hot core of the Alpine orogen.

Overview of the UV activities in Belgium since the end of the eighties

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An overview of the UV activities in Belgium is presented including the balloon borne, Space borne and ground based measurements (at 5 stations) of the global and direct Solar irradiance. Main results in terms of biologically active UV are discussed in relationship with the main factors of influence as Ozone, Clouds and Aerosols. Positive UV effective doses trend ($+0.6\%$ /Year) is discussed in correlation with the ozone negative trend (-0.2% /year) and more favorable meteorological conditions. Finally, some information is on the future activities namely, the UV indices predictions in real conditions.

Assessment of heavy metals concentrations in sediments of Bogdanas river at the Assiros-Lagadas area, Northern Greece

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Bogdanas river flows east of Thessaloniki in Northern Greece. Its sources are found at the western part of the Vertiskos mountain and flows along the Assiros and Lagada plane towards Koronia lake. In this study, variations of the heavy metal concentrations in Bogdanas river sediments have been evaluated. Sediment samples were collected at 8 representative sampling sites along the river, during two sampling periods. Chemical analysis indicated that the sediment samples show variable concentrations of heavy metals. Sediment quality assessment according to the limits determined by the European Community's legislation indicated that the river sediments were not contaminated, apart from 3 samples and 1 sample concerning Zn and Cu, respectively. On the other hand, sediment quality assessment according to the US EPA Sediment Quality Guidelines (SQG) revealed that there was heavy metal pollution with respect to especially Zn, Cu and Ni. Concerning Zn, only 1 sample is close to the EPA's moderately polluted level, while 10 samples surpass it and 5 samples exceed the EPA's heavily polluted level. Concerning Cu, 7 samples are classified as moderately polluted and 9 samples as heavily polluted. Finally, no pollution is defined for Ni, apart from 2 samples which are classified as moderately polluted. In conclusion, the research showed that the revealed heavy metal pollution is more attributed to the lithology of the area and less to human activity.

Morphotectonic analysis and branching for Mygdonia active fault system (Macedonia, N. Greece)

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The Mygdonia basin is considered to be of a rather moderate seismicity rate area, with strong earthquakes occasionally occurring and affecting the northern Greek mainland. It corresponds to a complicated extensional setting bounded from normal faults that reveal a characteristic S – shape development. According to previous studies, the central part of the basin which mainly consists of faults trending E – W, are active structures that played a basic role in the formation of the basin. Both active faults and earthquakes appear in populations, characterized by certain spatial properties. A composite examination is attempted in order to investigate both earthquake and fault population properties taking into account all the available information that can be extracted from the correlation of seismicity and topographic data of the broader Mygdonia domain. It is known that the establishment of a dense seismological network contributes to the detailed analysis of the majority of the active structures since the distribution of the earthquake foci reveal the presence and particular properties of the active seismogenic zones. All earthquakes with magnitude $M \geq 1.0$ which were recorded during the time period 2007 to 2009 from the National Greek Seismological Network are thoroughly examined. For this reason, arrival times of well recorded events that occurred in the basin were taken into account. The Wadati method was applied, to compute the V_p/V_s ratio and the origin times of the earthquakes with adequate data. Using the origin times derived from the best fitting data, travel times of the P waves were constructed to define the crustal structure in the area. In addition, time residuals were calculated in order to take into account the lateral variations of velocities. According to the results, all earthquakes that occurred in the area were relocated and their focal properties were determined again.

Hypocentre determination was improved with the use of the VELEST algorithm. Cross sections perpendicular to the fault zones were plotted in order to approximate their depth. It is also known that innovative advanced tools lately applied in geosciences, provide a versatile approach in studying active fault systems. For this reason, high quality topographic maps along with any available tectonic data regarding active faulting were also used in order to investigate the properties of the faults population that dominates in the study area. Fault outcrops with a wide range of sizes are depicted as tectonic lineaments and GIS methodology is used for their analysis. Accurate digital elevation models (DEMs) of the area were constructed, while, cross sections and topographic profiles were produced mainly where seismicity is clustered. Similarities extracted from both methods, give combined interpretation about the fault possible segmentation or linkage either at the surface or at depth. The combined results from such an investigation provide important contribution to fault interaction, fault segmentation, seismotectonic zoning and seismic hazard assessment.

Neogene andesite intrusions along the Carpathian calc-alkaline volcanic arc

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Numerous magmatic intrusions follow the Inner-Carpathian calc-alkaline volcanic arc with decreasing age towards the East-Southeast. At the West Carpathians intrusions located: in south-eastern Moravia (internal Biele Karpaty nappe of the Magura flysch unit); and in the Pieniny Mts. between the Magura flysch unit and the Pieniny Klippen Belt. At the internal East Carpathians a big volume subvolcanic body (Țibleș-Toroiaga-Rodna-Bârgău) found between the Gutâi and the Călimani volcanic massifs.

The Moravian high-K pyroxene-amphibole basalt and andesite intrusions extend southeast of the Morava River. They are sills, dykes and irregular bodies. Emplacement of intrusions was post-tectonic, and the intrusive rocks have been generally affected by post-magmatic alteration. Towards the east at the Slovakian/Polish border, products of intrusive activity form approximately a 20 km long belt of the Pieniny Andesite Line. It post-dates the Early Miocene folding and strike-slip movements. The magma made its way along tensional fissures that opened above a steeply bent downgoing North European Plate. Emplacement of intrusions took place in two phases: 1st phase intrusions are mostly dykes, parallel with the strike slip fault at the northern part of the Pieniny Klippen Belt; the 2nd phase intrusions are restricted to the westernmost part of the Pieniny Andesite Line and follow transversal faults that cut the 1st phase andesites. The Toroiaga intrusive area situated north of the Rodna Mts., consist of a complex subvolcanic intrusions with pierce metamorphic rocks and its southern part, Paleogene to Miocene sedimentary deposits, suggesting a multiphase intrusive activity. Hydrothermal activity and mineralisation processes are related to the 2nd and 3rd phase intrusions.

Major and trace element chemistry of the examined intrusive rocks are indicating subduction-related magmas. Compared to the Pieniny intrusives, the Moravian and the Toroiaga intrusive rocks are relatively enriched in potassium, sodium and other incompatible elements. These latest are lying at the boundary of high-K calc-alkaline- and shoshonitic suites. The LILE enrichment reflects the contribution from the subducted slab, at least the parental magma derived from metasomatised subcontinental lithospheric mantle. Source composition and partial melting was more important than the FC, AFC processes and/or crustal contamination. Partial melting process was triggered by the flux of heat coming from the rising asthenospheric material once the delamination of the subducting European Plate occurred. The B content of the Pieniny andesites is between 2.97 and 29.5 µg/g. The western and the eastern part of the Pieniny Andesite Line can be well separated by the geochemistry. The heat of the 2nd phase intrusions hydrothermally modified the 1st phase intrusions, enriched

the fluid mobile element content of the rocks. Excluding the enriched B data, the B content in the Pieniny area is not higher, then 10.7 $\mu\text{g/g}$. The examined Moravian and Toroiaga rocks have higher B content (9.9-20.8 and 6.3-21.5 $\mu\text{g/g}$ respectively). This correlates with the higher K_2O content of these rocks, referring to fluid originating from the crust, while the fluid added to the source of the Pieniny rocks are originating more probably from the subducted sediments. The B data of the Moravian rocks overlap with the B content of West Carpathian andesites (11.1-29.8 $\mu\text{g/g}$), while the B content of the Toroiaga samples overlap with the Călimani and the Gutâi boron data (4.9-30.2 $\mu\text{g/g}$). The lower values of the Pieniny area is more in the range measured in back arc, intraplate basalts of the Bakony-Balaton Highland volcanic field (1.6-12.9 $\mu\text{g/g}$). There is a tight connection between the calc-alkaline volcanism and the intrusive magmatic body formation. In absence of biostratigraphic evidence, a comprehensive K-Ar age study of the intrusive whole rocks was carried out, which was driven to the following origin history: from Moravia until the bend of the Carpathians the magmatism was parallel (~13.5-11 Ma). In the subvolcanic zone of the East Carpathians the intrusion took place between 11.3–7.6 Ma.

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Rheological analysis of a sub-marine landslide in the Marmara Sea (Turkey)

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When seismic and multi-beam bathymetric data from the northern shelf and slope of the Cınarcık Basin are interpreted, some sub-marine landslides are observed clearly. Additionally, seismic data indicate that upper surface of the submarine extension of the Paleozoic aged rocks has NNE-SSW oriented basin and ridge type morphology controlled by the secondary faults of the NAFZ. Basins are fulfilled by Pliocene-Quaternary sediments, which are cut by strike-slip faults on the shelf and slope. Thickness of these deposits increases up to 130 m toward the concave shaped northern slope of the Cınarcık Basin. A relatively recent sub-marine landslide, Tuzla Sub-marine Landslide, cuts the concave slope of the Cınarcık Basin. Detailed morphological investigation indicate that Tuzla Landslide is a deep-seated rotational landslide, which possibly triggered by the NAFZ. Morphological analyses also indicate that thick Plio-Quaternary deposits on the Paleozoic basement were slid during the Tuzla Landslide event. This landslide is considered as a key event for modeling the future landslide potential of the northern shelf and slope of the Cınarcık Basin. For this reason, the main purpose of the present study is to perform some rheological analyses to understand the behaviour of the events. As the main results obtained from the analyses, the runout distances and the velocities were calculated.

Olistostromes of the Pieniny Klippen Belt, Northern Carpathians

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The existence and transformation of the accretionary wedge in the Carpathians are documented by occurrence of olistostromes. The size of olistoliths varies, from centimeters to kilometers. Very large blocks could slide independently into the Carpathian basins, unaccompanied by easily distinguishable matrix. The matrix in presented case is the flysch sequence or even entire sedimentary-tectonic unit. Olistostrome bodies form two belts within the Pieniny Klippen Belt in Poland and Slovakia and mark an early stage of development of the accretionary prism. The first belt was formed during the Late Cretaceous as a result of subduction of the southern part of the Alpine Tethys. A fore-arc basin originated along the subduction zone with synorogenic flysch deposits known under different names: Złatne, Klape, Drietoma, Myjava or Manin Succession. Huge olistoliths deposited within the Cretaceous-Paleogene flysch of the Złatne Successions in the vicinity of Haligovce village (eastern Slovakia). They contain the Middle Triassic-Lower Cretaceous sequence of carbonates and siliceous rocks. In Slovakia, the fore-arc olistostromes belong to the so-called peri-Klippen zone. Huge olistoliths of Triassic – Lower Cretaceous carbonates were deposited within Klape and Manin Cretaceous-Paleogene flysch (“wildflysch”) sequences in the Považie area. The largest olistolith occur in Butkov and Manin. Narrow carbonate platforms originated along the margin of the fore-arc basin during the Paleocene times. Within these platforms complex reef systems developed (so-called Kambühel limestones). Large fragments of these reefs occur in Haligovce, Vělký Lipník and in Považie area in the Pieniny Klippen Belt in Slovakia forming olistoliths within flysch deposits of the Žilina Formation.

The second belt is related to a movement of the accretionary prism, which overrode the Czorsztyn Ridge during the Late Cretaceous-Paleocene. Destruction of this ridge led to formation of submarine slumps and olistoliths along the southern margin of the Magura Basin (Outer Flysch Carpathian basin). This olistostrome belt is well developed in the Polish sector of the Pieniny Klippen Belt at its border zone with the Magura Nappe. The olistoliths and large clasts are represented by igneous rocks (including basalts) as well as a variety of carbonate rocks of the Triassic - Cretaceous age representing the Alpine Tethys basal and ridge sequences as well as the Inner Carpathian terrane sequences. The large Homole block in Jaworki Village is an olistolith. The famous tectonic fold and thrust structures, that originated due to slumping, can be observed in the Czajakowa Skała Klippe in the upper part of the Homole Gorge where the Niedzica Nappe is thrust over the thick Czorsztyn Unit. Carbonates and radiolarites of the Niedzica Succession, which were originally deposited on the southeastern slope of the Czorsztyn Ridge form a submarine slump emplaced on the Czorsztyn Succession, originally deposited in the central part of the ridge. The Biała Woda basalt klippe near Jaworki also represents an olistolith probably derived from the Czorsztyn Ridge. Between Krościenko and Polish-Slovak border the Magura olistostromes contain a variety of various successions representing ridge and slope facies of the Czorsztyn Ridge. Famous Sobótka Klippe below the Czorsztyn Castle and Rogoża Klippe (near Rogoźnik) represent the Czorsztyn Succession deposited on the axial zone of the ridge. Large Zawiasy and Łupisko olistoliths belong to the so-called Branisko Succession deposited on the northern slope of the Czorsztyn Ridge. Numerous small olistoliths like Tylka or Stare Bystre represent different transitional successions deposited between the ridge and a slightly deeper transitional zone. It is thought that at many localities (e.g. between Szaflary and Stare Bystre in Poland or in Eastern Slovakia the Pieniny Klippen Belt is represented entirely by the Złatne and Magura parts of the accretionary wedge with olistoliths embedded in the flysch sequences. Some klippen surrounded by the Magura flysch in Orava and Považie region in western Slovakia may represent olistoliths as well. There is also a possibility of olistolithic origin of some klippen in the Magura flysch in eastern Slovakia sector of the Pieniny Klippen

Belt. It is also considered that numerous klippen surrounded by the Magura flysch in Orava and Považie region in Slovakia may represent olistoliths. Also possibility of occurrence of olistoliths in the Ukrainian and Austrian sectors of the Pieniny Klippen requires further research.

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Effects of high temperatures in building granites: micro-cracking patterns and ultrasound velocity attenuation

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Fire is one of the most important catastrophic decay agents of building stone because of the severe mineralogical and physical modifications that generates within them. Fire causes decay due to the heat and the solid fraction contained in the fumes produced during fire. The impact of these two components is different depending on the location of stone in relation to fire. However, in low porosity, dense materials the effects of heating can easily override those of the fumes. Accordingly to this, granite will be, during a fire, mostly affected by the quick heating and the high temperatures reached, and experience physical breakdown due to the micro-cracking generated by the differential thermal expansion of minerals. Especially, in granites, cracking will occur if the thermal gradient is higher than 2°C/minute. The very low initial porosity favours this process due to the dense packing of minerals with different thermal and structural properties in the stone.

The aim of this research is to characterize the micro-cracking patterns of granites, commonly used internationally as building stone, when heated in furnaces to temperatures ranging from 100 to 900°C, simulating the temperature increase that these materials could undergo during a fire. Thirteen building granites were selected on the basis of their petrophysical characteristics, such as grain size, mineral grain size ratio, mineral anisotropy, mineral composition and porosity. Some of them also showed prior cracking. Non-destructive methods were used to characterize the changes at different temperatures within this range. This allows repeated measurement in the same samples before and after being exposed to high temperatures. This methodology was also selected as it can be used for the on-site characterization in heritage buildings without sampling and allows comparing the laboratory results to real fire damage found in buildings. 3-D topography was used to evaluate surface changes and it was measured by means of a TRACEiT® Portable Optical Surface Analyser and a Leica confocal binocular microscope with stereoscopic software. Variations in roughness parameters evidence damage patterns. In polymineral rocks, such as granites, each mineral behaves in a different way when exposed to weathering agents. Average roughness gives an indication of surface variations, but in this case, peaks or valleys provide more information on the damage processes. Peaks represent minerals pulled out due to the expansion and the internal pressure generated. Valleys correspond to cracks and the measurements before and after the tests show differences in their deepness and quantity. Ultrasound propagation velocity (Vp) as well as ultrasound attenuation was measured with a CNS Electronics Pundit tester with an attached Tektronix oscilloscope. This research also analyzes the advantages and shortfalls of these techniques and parameters to evaluate fire decay.

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The Unitary Association Method: introduction and applications to radiolarian biochronology

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The Unitary Associations (UAs) method is a deterministic mathematical model designed to construct concurrent range zones. The basic idea of the method is to construct a discrete sequence of coexistence intervals of species. Each interval consists of a maximal set of intersecting ranges (= intervals of minimal duration or UAs). Each of these units is characterized by a set of species or species pairs allowing us to identify it in the stratigraphic sections.

The basic steps of the method are summarized as follows. We start by establishing the neighborhood of each species, based on biostratigraphic observations from several sections. For example, species "1" may be present or absent in the sections, and may co-occur or not with species "2", "3", "4" etc. The observed inter-species coexistences are compiled in a species-species matrix. This matrix can be organized by a permutation of its rows and columns to allow the appearance of sets of mutually coexisting species. From this reorganized matrix we can extract maximal sets of intersecting species' ranges and represent them in a table called a UA range chart. This chart is used to go back to the data and assign relative ages to the fossiliferous beds of the different sections.

Biostratigraphic data are usually complicated by the fact that species' ranges are highly conflicting from place to place. As an example, consider two pairs of coexisting species (1, 4) and (2, 3). We say that their ranges are conflicting if species "1" occurs below species "3" and if species "2" occurs below species "4" in some localities. Such stratigraphic relationships mean that either the range of "1" virtually overlaps that of "3" or that the range of "2" virtually overlaps that of "4".

The computer program UA-Graph (<http://folk.uio.no/ohammer/uagraph/>) optimizes the constructions of such virtual coexistences and produces range charts where the conflicting stratigraphic relationships are expressed as virtual co-occurrences. This method is especially advantageous in establishing global zonations because it compiles co-occurrences of all taxa in all samples and produces range charts with the maximum range of each species. In this way UA successfully integrates a large number of different localities among which the observed FADs and LADs are highly diachronous.

The UA method has been efficiently applied to radiolarian biochronological correlation for nearly 30 years and has become the standard method to construct reliable radiolarian zonations. In the Mesozoic, a continuous interval from the Rhaetian to the Turonian has now been covered by UA radiolarian zonations. These are largely employed by radiolarian paleontologists worldwide because, in comparison with other zonations, the number of included taxa is generally higher and the stratigraphic ranges are less truncated.

A recently established global Pliensbachian to Aalenian radiolarian range chart will be used as an example to demonstrate the application of the UA-Graph computer program. This biochronological scale integrates radiolarian-occurrence data of 197 species in 220 samples from measured sections in Queen Charlotte Islands, B.C., Williston Lake, B.C., east-central Oregon, Baja California Sur, southern Spain, Austria, Slovenia, Turkey, Oman, Japan and Argentina.

The geotourist assessment of the volcanic sites in Vtáčnik Mts. (Slovakia, Western Carpathians)

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The evaluation of resources is one of the most important tasks of geotourism research. This paper presents the method of geotourist assessment, which was applied on the example of sites presenting the Neogene volcanic activity within Vtáčnik mountain range. Two stages of assessment are proposed: inventory and valorization. The inventory includes identification of resources, initial selection and characterization. During the valorization, a researcher uses the point bonitation method and takes into account the following indicators: scientific value, location and additional values. The result of valorization process is presented in table which allows comparison and categorization of the selected sites. The assessment of considered region revealed, that selected sites like rock walls, rock forms, abandoned quarries and hills with ruins are characterized by high or medium geotourist value. Consequently, Vtáčnik is an example of area of a great potential for geotourism development.

Microfacies analyses of the Middle Jurassic hardgrounds from the Bucegi Mountains (SE Carpathians)

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The microfacies and diagenetic features of the hardgrounds occurring in the Middle Jurassic carbonate rocks from Bucegi Mts (SE Carpathians) are studied in the present paper.

These hardgrounds have been already recognized by previous authors but no detail study exists so far. They described the hardgrounds as indurated surfaces with limonitic crusts, and assigned them to several condensation levels formed at sea bottoms.

We conducted the microfacies analysis on thin sections, polished slabs or acetophane peels, incorporating the frequency and types of allochems, as well as sedimentary structures where they were dominant. Scanning electron microscopy (SEM) and cathodoluminescence (CL) were applied to identify the microstructures and diagenetic features. In addition to the optical methods we also investigated the geochemical composition of selected particles or lamina directly from polished slabs using a microXRF device (Horiba XGT 7000).

Several different microfacies have been distinguished in the studied sections: bioclastic grainstone/packstone, ooidal grainstone, bioturbated wackestone/packstone, stromatolitic mudstone serpulid bafflestone and more or less brecciated and mineralized laminated crusts. Endolithic organisms were responsible for the bioerosion and particle's micritisation, while the bacterial activity for the frequently clotted and stromatolitic structures as well as for mineralization. Laminated crusts are formed by microbial iron mats dominated by filamentous bacteria as revealed from SEM investigation. Limonite crusts on hardground surfaces indicate relatively long omission phases and low-energy hydrodynamic conditions. The investigated hardgrounds are heavily mineralized with Fe and Mn oxides as well as phosphates. Many minor elements are also concentrated in these hardgrounds.

The coexistence of borings and burrows in a sedimentary deposit has been considered a criterion of hardgrounds. Both of them are present in our sections. Serpulid bafflestones are frequently associated with the stromatolitic layering.

Diagenetic features include fibrous marine calcite cement, minor compaction, selective dissolution of aragonite leading to moldic porosity and several generations of late diagenetic cements as revealed by CL observations.

This is the first detailed complex microfacies study accomplished for the Middle Jurassic hardgrounds from Bucegi Mountains and the results allow some refinements for the interpretation of the marine depositional environment during the Bathonian – Callovian interval of this part of the Getic geotectonic unit.

Analysis of the ambient seismic noise at the Romanian BB stations for estimating the crust structure

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In the last five years the National Institute for Earth Physics (NIEP), Romania, has developed its real-time seismic network. At present, NIEP operates 75 seismic stations equipped with both velocity and accelerometer sensors. Among these, 34 stations are equipped with broadband velocity sensors (CMG3ESP, CMG40T, KS2000, KS54000, STS2). The data are continuously recorded and transmitted to the Romanian Data Centre (RONDC) where Antelope 4.11 is running for acquisition and processing. In this study, we use ambient seismic noise recorded during one year (2009) at the Romanian broadband network to investigate the characteristics of ambient noise cross-correlations at more than 500 station pairs, distributed at distances between 10 and approximately 600 km. To lower the influence of the earthquake-related signals a nonlinear procedure is applied. The day traces are processed in 23 one-hour segments starting at 00:30 and ending at 23:30 to avoid possible data loss at the beginning and end of the day due to the start and end time of the original raw data. The one-hour segments are spectrally whitened to produce a flat amplitude spectrum in the 0.02–5 Hz band. All 23 one-hour cross correlations are stacked to create a day cross correlation and all available day stacks for a given station pair are stacked to produce the empirical Green's functions. If the seismic noise was isotropic, the Green's function would show symmetry around $t=0$. Such symmetry is present in some cases, especially for longer periods (> 20 s). To get the 'symmetric' component of the Green's function we average the positive and negative parts of the cross-correlation. The analysis of the 'symmetric' cross-correlations shows that it is possible to identify a wave which is coherent over the whole distance range, in the period range 6-30 s. As the vertical components of ambient noise are cross-correlated, this wave is identified as the fundamental mode of the Rayleigh wave. FTAN analysis is used to extract the group velocities of the estimated dispersive waves.

For five stations we check the variability of the cross-correlations over a period of time of 4 years (2006-2009). We perform the analysis for the two spectral bands corresponding to the primary (10-20 s) and secondary (5-10 s) microseism and also for the 20-30 s band. We observe no variations from one year to another and smaller amplitudes for the noise cross-correlations during the summer time (April-September) than those obtained for the winter time (October-March), indicating the stability of the noise sources over time.

This work provides very useful data for future tomographic studies in Romania at crustal level, considering that new data from other 32 temporary broadband stations (South Carpathian Project – SCP, 2009-2011) deployed on the Romanian territory will become available.

Environmental synergy in the Romanian Plain (to the East of Olt river)

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The objective of the study is the detection of areas and the functioning mechanisms of the oropedo-hydro-geographic and hydrogeologic systems within the Romanian Plain. Geological conditions, especially the hydrogeological ones (groundwater depth and flow) largely influence superficial and underground drainage system. The influence of groundwater dynamics in the padding interfluvial microrelief in direct connection with the thick of loess deposits, is a conditional variable in the occurrence and development of microdepressions towards drainage systems. The analysis of data shows a discrepancy between the supply of the maximum piezometric levels and rainfall, so the groundwater level oscillations are influenced by overlapping rainfall in previous years. To highlight the close link that exists between the microforms of relief and soil covering there have been made correlations between reappearance of padding soils with the distribution of compaction microdepressions. The large arteries assert the direction drainage of the groundwater and the groundwater depth climbs as it bears away from the hydrographic arteries; it results that density relief's fragmentation is directly proportional with the increasing of the groundwater depth.

Tectonic deformation in the East European Craton (Baltica) and Malopolska Block (European Palaeozoic Platform) border zone (TESZ) – The structural evolution of Cambrian sediments in the exploration boreholes

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The boreholes Wola Obszańska-8, Książpol-12 and Dzików-17 are located in the NE marginal zone of the Małopolska Block. It is situated beside the Holy Cross dislocation, which probably continues in this region and divides the Małopolska Block from the Łysogóry Block. The Malopolska Block occurs at south western foreland of the East European Craton within the Central European part of the Palaeozoic Platform. They are components of a collage of crustal blocks of various age and origin (Trans-European Suture Zone).

The exploration boreholes Wola Obszańska-8, Książpol-12 and Dzików-17 were drilled of the Cambrian and were cored in part. The exploration borehole Wola Obszańska-8 was drilled to 1100m. Was cored examine in parts: 1100,0 – 1093,0, 1069,0 – 1060,0, 1012,0 – 1003,0 (The Upper Cambrian). The borehole Książpol 12 was drilled to 978m and was cored in part to -in interval 946,0 – 955,0 are measures The Upper Cambrian. The borehole Dzików-17 was drilled to 1108m and was cored in part: 1108-1099, 1040-1031 and 1031-1022 (The Middle Cambrian)

These sediments are poorly and strong involved tectonic. Sediment layers are mostly placed horizontally, vertical and sub vertical. These sediments in these boreholes display large variability of pitch of sedimentary surfaces. Angle of fall oscillates within bounds: 0-90 degrees. In the borehole Książpol-12 angle of fall oscillate within bounds: 5-65 degrees (layers are inclined high – pitched) and in the borehole Wola Obszańska 8, layers fall into in generally to angle 0-20 degrees (are display horizontal, subhorizontal fall). In the exploration borehole Dzików-17 angle of fall oscillate within bounds: 30-90 degrees.

The main part in sediments of the Cambrian is dark gray mudstones. In their area are situated into some centimeters interval alternate thin layer dark gray claystones and mudstones, light gray sandstones. Sediments of the Upper Cambrian in the borehole Wola

Obszańska-8 are represented by middle and thick granular quartzites and argillie and slime lithofacies. Quartzites have mild and mosaic texture. Their development point out to high-energy environment of sedimentation. In these sediments dominate cracks which angle of pitch oscillate between: 70°-90° (high-pitched, subvertical, vertical) -D₁. Younger, subhorizontal cracks (D₂) which displace older cracks rarely appear. On surfaces of cracks there are lots of minerals of iron and sometimes in places where sandstone contact with argillie beds there are horizontal cracks with slips. Dominant role in the Cambrian sediments perform argillie and slime sediments within which appear very thin laminas of light gray sandstones which course is very perturbed (disrupted and folded). Within these sediments dominate interlaminar, horizontal and subhorizontal cracks. In the exploration borehole Książpol-12 are dominate cracks younger, subhorizontal D₂. Subhorizontal cracks often displace vertical cracks. On surfaces of cracks there are lots of minerals of iron. Sometimes in place where sandstone contacts with argillie beds there are horizontal cracks with slips.

In works of the centre Cambrian the following structural result was stated (for example the exploration borehole – Dzików 17) : 1 - coming into existence of sedimentary areas of S₀ and diagenetic structures, 2 – being formed in conditions subhorizontal of countermove of the macrocrease, into which steep wing an analysed hole was carried out, 3 – activity of susceptible-brittle normal-slip faults, which transfers stole according to previously steeply adjusted lamellose areas, 4 – developing in reversed conditions occur of complementary teams of cutting, of chaps extraction and low-inclined reverse faults with tectonic breccias accompanying them, of which crumbs stayed locally combined through rust-coloured carbonate veins, 5 – being formed in conditions extraction mezofaults of normal or normal-slip and of breccias accompanying them of tectonic and rust-coloured and white carbonate veins, 6 – activity very steep or threshold downthrow mayofaults of rust-coloured carbonate veins causing wide-radiant bending earlier incurred.

The mudstone sediments generally characterize smudge structure and banded structure – of generate confluence. Locally in their area appear structures with buried all group current ripples marks, which were line of true dip.

However in interval, where thin layers claystone, mudstone and sandstone appear opposite is disturbance bearing of still characterize. Above into thin layers light gray sandstone there is older primeval structures of characterize cross lamination and isolation structures, drop structures and buried structures.

In thick beds sandstones appear initiator tension fissures generate of diagenesis and intracell of mudstones. In other place of sediments the Upper Cambrian are thin layers intraformation conglomerate – light gray sandstone with much intracell darkgray mudstones.

Chromites from Vourinos complex mines and their alteration

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Chromite ore deposits have been largely exploited in Greece and the presence of tens of abandoned mines witnesses the important role of the country in the chromite mining industry past scenario.

Numerous studies about the geochemical and textural features have been carried out so far of different ores. With this contribution we attempt to summarize the main geochemical and textural features of Vourinos ophiolite complex chromite deposits focusing our attention on new data on the later alteration processes occurring in almost all ores.

Vourinos complex covers 400 km² and in spite of predominating mantle outcrops it shows a full ophiolite sequence with a well exposed petrographic Moho. The crustal sequence comprises mafic and ultramafic cumulates, gabbro, dykes, some pillow lavas and a carbonatic sedimentary cover. All chromite bodies are set in dunite bodies or in dunite enveloped by harzburgite and are concentrated within the metalliferous zone. Geochemically, Vourinos chromite presents quite homogeneous features, among the different mines, with Mg# and Cr# ranging between 0.45 and 0.64 and between 0.75 and 0.83 respectively. Cr₂O₃ contents range between 57 and 60 wt%. No differences in primary chromite between the different mines

were detected except for a generally lower Cr# for Rizo mine. All chromitite bodies independently of their texture (massive, schlieren or disseminated) are made of euhedral to subeuhedral chromite crystals with size varying mainly between 0.1 and 2 mm, with some rare nodular textures showing crystals of up to 5 mm in size.

Chromite from all studied mines shows some important features highlighting the presence of Fe-chromite and magnetite alteration. Sometimes completely altered chromites where only the shapes of the habits were preserved were detected. Fe-chromites show a wide range of compositions. They are characterized by an increase in Cr# and/or a decrease in Mg# compared to their chromitic cores. In spite of the low range of primary chromite compositions, Fe-chromite can span over the full range of possible Cr# increase and Mg# decrease. Extreme compositions comprise virtually MgO-free Cr-magnetites and virtually Al₂O₃-free chromites s.s. Anomalous compositions were also detected in few samples with high NiO and MnO contents. MnO content of primary chromite is very low and no MnO has been detected in silicate phases. Cr₂O₃-free magnetites are often found as small crystal within the serpentinite matrix and are not a product of alteration of chromite but are related to release of iron during serpentinization.

Fe-chromite always grows at the expenses of primary chromite as chromite and Fe-chromite together, drawing the shape of the original chromite crystal. The close association of Fe-chromite and chromian-chlorite (kammererite) independent of the degree of serpentinization of chromitite silicate matrix and peridotite host rock suggests that alteration of chromites pre-dates serpentinization.

Preliminary data on an anomalous chrome-spinel assemblage from Amanos Mountains serpentinites (Turkey)

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The present work deals with an anomalous spinel assemblage detected within serpentinite rocks, whose peculiar textural and geochemical patterns can provide new information on spinel genesis and transformation within mantle peridotites and serpentinites.

Spinel is an important accessory phase in mantle peridotites and serpentinites. It shows a wide range of compositions related to different processes and has been largely used as a petrogenetic indicator. Due to its refractory character spinel has long been considered to reflect magmatic conditions of its formation, but in the last years studies pointed out changes in its composition also related to metasomatism, metamorphism and alteration.

Spinel occurring as an accessory phase within mantle peridotites is dominated by a strong Cr-Al trend, from Al-rich spinel ss. in high-pressure lherzolite to Al-poor chromite in massive chromitite bodies. The main controls on magmatic spinel composition are Cr exchange with pyroxene and re-equilibration with olivine. During metasomatic and metamorphic events the most common change in spinel composition is a depletion in Al associated with enrichment in Fe and/or Cr. When this process affects Cr-rich spinel (chrome-spinel or chromite) it leads to the formation of ferritchromite, usually as alteration rims around chromite grains. Ferritchromite can further evolve to chrome-magnetite and magnetite, always associated with the formation of kammererite (chromian-chlorite) in the silicate matrix.

The spinels described in this study were found during exploration for chromite ore in the Amanos Mountains, about 15 km NE of Iskenderun, Southern Turkey. There ophiolite slices crop out below Mesozoic carbonates and cherts. Ophiolitic rocks are mainly composed of a serpentinite melange with some strongly tectonized gabbros. Serpentinites host several small chromitite lenses that underwent limited exploitation in the last century.

All but one of the chromitite bodies detected show a massive to densely disseminated texture with 30 to 80% modal spinel and the composition of a typical chromite from podiform chromitite bodies within ophiolite peridotite. Alteration to ferritchromite is widespread even if it never completely obliterates primary spinel composition at the crystal cores.

The exception to the described outline comes from a sample of chromitite which shares texture at the cm-scale with the other chromitites, i.e., millimetric euhedral spinel grains densely disseminated within a completely serpentized matrix. Microscope observation shows a complex texture with strong zonation related to alteration of the primary spinel. The spinel crystals perfectly preserved their original shapes in spite of deep alteration and transformation occurred from rim to core. Primary spinel is preserved only as irregular core portions and is an Al-rich chrome-spinel with about 41 wt% Al₂O₃ and 27 wt% Cr₂O₃. The Al-rich core is surrounded by a porous rim of about 200-300 micron in thickness composed of Fe-rich chromite, with about 9 wt% Al₂O₃, 40 wt% Cr₂O₃ and 35 wt% FeO_{tot}. A second alteration rim, closer to the original crystal border, is highly porous and is made up of ferritchromite, with 5-7 wt% Al₂O₃, 30 wt% Cr₂O₃ and 31-35 wt% FeO_{tot}. Finally a thin rim, external and developed also in the fractures cutting the original crystal, consists of very anomalous Cr-magnetite. This Cr-magnetite shows a composition different from any spinels described in literature, with 35-37 wt% Cr₂O₃ and about 45 wt% FeO_{tot}, but still with 4-5 wt% Al₂O₃.

The silicate matrix is mainly fine-grained chlorite that is found also in the porosity within the original spinel crystals. Chlorite Cr₂O₃ content (1-1.5 wt%) is lower than that of kamaererite usually associated to ferritchromite. Relics of serpentine are found only in the matrix.

Tertiary magmatism in SW Bulgaria and Eastern FYR Macedonia: geochemistry, geodynamic setting and relation to mineral resources

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In the frame of an international joint research project SCOPES IZ73Z0-128089 of the Swiss National Science Foundation, we started a collaborative study of the geological processes in SW Bulgaria and Eastern FYR Macedonia and Serbia that are responsible for the Tertiary magmatism and the formation of important copper, gold, iron and lead/zinc ore deposits. The project is leaded by Dr. A. von Quadt and a team of the Institute of Geochemistry and Petrology, ETH-Zurich, Switzerland. It comprises three additional teams from Serbia (Belgrade University), FYR Macedonia (Stip University) and Bulgaria (Geological Institute of the Bulgarian Academy of Sciences).

The planned major tasks of the project are four: i) Fluid processes at the magmatic to hydrothermal transition in porphyry-style Cu-Au-(-PGE) deposits and in meso- and epithermal deposits in Eastern Serbia, FYR Macedonia (e.g. Buchim, Ilovitza, Kadiitza) and Western Bulgaria/Central Rhodopes; ii) Geochronology, magmatism and large-scale metallogeny of the Cretaceous ABTS belt and the Paleogene Serbian-Macedonian-Rhodope zone; iii) Deposit-scale geochronology, magma characteristics and mineralization; iv) Impact of the mining activity on environment and the social life.

Our work as part of the project is concentrated on the second and third tasks and will build the basis of two PhD theses. On the regional scale, together with our Bulgarian supervisors and consultants from the FYR Macedonian team, we want to understand the geodynamic environment and the generation of mineralizing magmas, using extensive radiometric age dating, igneous geochemistry and petrology. We started the sampling of magmatic and volcano-sedimentary rocks along two main E-W transects: i) from the region of Kyustendil in SW Bulgaria through the whole Kratovo-Zletovo magmatic complex (transect Ruen-Kratovo-Zletovo); ii) from Simitli and Petrich region in SW Bulgaria to Buchim and Alshar in FYR Macedonia (transect Sandanski-Alshar). The sampling aims to include the oldest and the youngest varieties, as well as representative samples for the whole geological

succession. So we can test some existing ideas for the zonation of magmatism and mineralization along NW-SE structures and provide new data for a substantiated geodynamic model of the Tertiary evolution of the region.

On the scale of a single ore-forming magmatic-hydrothermal systems we will concentrate on two or three important deposits (e.g. Buchim, Ilovitza) applying mainly the following methods: i) precise age dating (Ar-Ar on magmatic and alteration minerals, Re-Os on molybdenite, U-Pb on zircons from magmatic dykes that bracket the ore formation); ii) stable isotope analyses; iii) isotope-geochemical tracing (Sr, Pb and Nd). They will help us to constrain or to refine the genetical models of the deposits. Analytical works will be performed mostly in the labs of ETH, Zurich and in the new LA-ICP-MS laboratory at the Geological Institute of BAS.

First field results, isotope-geochronological, isotope-geochemical and petrological data will be presented and discussed during the CBGA-Congress.

Reconstructing the rotational landslide near Frixia (Greece, Peloponnese) with a combination of different geophysical methods and terrestrial laser scanning

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After the 2007 wildfires in the western Peloponnese (Greece) we started an investigation in 2009 in this area at different sites, aiming at the reconstruction of different landslide types and to investigate the relation between fire-induced deforestation and landslides. The village Frixia, particularly its southern part, has massive problems with big rotation slides, shallow slides and erosional features. Tertiary Flysch units and Neogene deposits in the Pyrgos area are generally landslide prone. The slopes in the area have the typical morphological features of a “landslide landscape”. Many recent effects from landslides like slope failures, cliff break ups, road failures, destroyed retention walls, and cracks in houses (structural damage) can be observed in the burned areas even 2 years after the great fires. We assume that the intensity and the frequency of shallow landslides and rotation slides are increasing due to the wildfires, since the lack of vegetation results in a lowered retention potential.

In this case study we present our preliminary results of the slide investigations in Frixia near the ancient city of Olympia. For the study we used different geophysical methods (the capacitive coupled DC geoelectrics system “OhmMapper” and Ground Penetrating Radar, GPR) and a remote sensing tool (ground based t-LiDAR). The terrestrial laser scanning (TLS) is an effective remote sensing technology for reconstruction and observation of natural phenomena or geohazards as it is well founded of high spatial and temporal resolution. TLS was used for the reconstruction of the landslide geomorphology. To ensuring the complete recording of the landslide morphology it is necessary to scan the object from different angles. The entire scan sequence in this case study includes six different scan positions with approximate 2.5 million points with around 4 cm point distance. The t-LiDAR data allowed achieving a 0.5 m digital terrain model after the data processing (alignment the different scan windows, data filtering and cleaning, data interpolation).

We used 100 MHz and 270 MHz antennae and the SIR-3000 data collection system (GSSI) for the GPR investigations. Since penetration depth and spatial resolution depend on the antenna frequency, we used two different antennae that cover a depth of up to 7 m and a resolution of up to 7 cm, depending on the underground conditions. Penetration depth is in inverse ratio to conductivity, so clayey and humid materials lead to a high attenuation of the radar waves.

The OhmMapper was used to determine the resistivity distribution in the soils up to a depth of approx. 5 m. Layer depths determined by GPR can be used to improve geoelectrics data inversion, while information from geoelectrics measurements help to interpret the GPR signals. The combination of geophysical surveying and remote sensing allows mapping the surface topography and the thickness of the landslide bodies, thus enabling us to create a three-dimensional model of slides.

EuroGeoSource – a web GIS system harmonizing geo-energy and mineral resource databases in Europe

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The EuroGeoSource is a project co-financed by the European Union under the Information Communication Technologies Policy Support Programme (ICT PSP), part of the Competitiveness and Innovation Framework Programme (CIP). The project started in 2010 and will last for three years, having the objective of making up a web Geographical Information System (GIS) regarding geo-energy resources (oil, gas, coal etc.), metallic and non-metallic minerals, as well as construction materials (gravel, sand, ornamental stone etc.) from twelve countries: Denmark, the Netherlands, Belgium, Portugal, Spain, Italy, Slovenia, Bulgaria, Romania, Hungary, Poland, Estonia.

The web GIS will incorporate a set of spatial data services according to Open GIS Consortium (OGC) specifications. The system will allow users to identify, access, use and reuse in an interoperable and seamless way and for a variety of uses, aggregated geographical information on geo-energy and mineral resources, covering a significant part of Europe and coming from a wide range of sources.

The project uses spatial and attribute information in GIS format on oil, gas and mineral fields in the participating countries, which is typically maintained and stored by the geological surveys. The data will have to be harmonized by defining a common set of attributes for geo-resources objects of the same type. For the key economic and geological parameters, an exchange format has to be agreed, taking into consideration the recommendations of the INSPIRE Directive 2007/2/EC (Infrastructure for Spatial Information in the European Community), as well as existing operational geo-data exchange formats, implemented in previous geo-data projects (e.g. eEarth, eWater, Geomind, OneGeologyEurope).

The system will include three main layers: 1) a central web GIS application, providing access and visualization of the spatial data sets; 2) data delivery services, including Web Map Service (WMS) and specialized web services for translation and delivery of spatial objects attributes; 3) a national database, storing spatial data sets and spatial object attributes.

Typical usage of the EuroGeoSource system based on preliminary analysis of the potential user needs comprises the following steps:

- starting in the central geo-source data catalogue application, where the user can search the available maps from all countries participating in the project and select the language;
- browsing the search result (a list of available maps), consultation in detail of the metadata associated to the data set of interest, followed by adding the data set as a layer to the geo-data viewer;
- consulting the data set layers at different scales and within different contexts (extent, background layers, etc.) in the map viewer;
- gathering detailed economic/reserve information, accessible either free of charge or based on the 'data delivery cost recovery' pricing model, depending on the provider.

A special group of users (e.g. Institute for Energy of the Joint Research Centre of the European Commission or commercial companies) will be able to incorporate the data provided by the EuroGeoSource system into their decision processes or models using special

web services that can be offered based on their needs. This option will be made available using advanced content-specific and user-oriented web services in the system.

By developing web services for sharing spatial data between public organizations and authorities (including EC and EU research and policy making institutions), as well as commercial stakeholders, the project will enable the creation of value-added services (such as demand-supply modelling) for the sustainable geo-energy and mineral supply of Europe.

Sources of base, precious and rare metals during the Tethyan Phanerozoic Evolution of the Caucasus and Pontides

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Base, rare and precious metal deposits are widespread in the Caucasus and Pontides regions. They are the result of the Phanerozoic evolution of the Tethys Ocean, of various geodynamic settings, including oceanic, intra-arc, back-arc and island arcs. The various types of mineralization are discussed in terms of the participation scale of sialic, basaltic crusts and mantle sources. In oceanic settings, cupriferous Cyprus-type deposits occur, where the source of Cu is the mantle. In intra-arc settings, Beshi type Cu-Zn deposits were formed; the source of Zn is interpreted to be basaltic crust. As for the island arc and back-arc settings, Cu-Pb-Zn porphyry, stockwork, VMS and vein deposits are common. The source of Pb is interpreted to be the sialic crust. The rare metals (Hg, W, Sb) are related to post-collisional settings, where sialic crust is important. Mo is also related mainly to post-collisional settings, and it subordinately participates in the island arc settings. Precious metal mineralization (Au and Ag) predominantly developed in island arc and post-collisional settings. Therefore, in the process of mantle depletion and crust formation precious metals (Au and Ag) mainly accumulated in the sialic crust.

Geochemistry and petrogenetic features of the Early Cambrian volcanism in Telbesmi Formation, Mardin-Derik, SE Turkey

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The Late Neoproterozoic/Early Palaeozoic successions in Southeast Anatolian Autochthon Belt, representing the northern edge of Arabian Plate in SE Turkey, occur in Derik (Mardin), Tut-Penbegli (Adıyaman), Samur Dag (Hakkari) and Amanos (Hatay) areas. In the Mardin-Derik area the Early Paleozoic rock-units are composed from bottom to top of Telbesmi, Sadan, Koruk, Sosink and Bedinan formations, respectively. The Telbesmi Formation is made up of slightly metamorphosed fluvial sandstone/ mudstones alternating mainly with andesitic and rarely spilitic lava flows and pyroclastic rocks. The base of the formation includes andesitic/spilitic lavas, tuffs and agglomerates with rarely rhyolitic lavas, interlayered with mudstones. The upper part of the formation includes very thin-layered cherty recrystallized limestones and red, violet meta-sandstones/meta-siltstone alternations. The ichno-fossils (*?Teichnus* isp., *Treptichnus rectangularis*, *Cocchlichnus* isp.) near the transition to the Sadan formation indicates to the Early Cambrian. Upwards, the formation is transitional to Early Cambrian siliciclastic rock of Sadan Formation. The discontinuous conglomeratic band near the transitional between the Telbesmi and Sadan Formations is a channel-fill and does not correspond to an unconformity, as previously suggested. The succession is conformably overlain by Middle Cambrian Koruk Formation, and Upper

Cambrian Sosink Formation. Trilobite bearing Late Ordovician Bedinan Formation unconformably overlies older units.

The Derik volcanics are geochemically grouped as basalts, andesites and rhyolites and display a continuous evolutionary trend from transitional to calc-alkaline affinity, which are related to magmatic differentiation. N-MORB normalized multi-element and REE diagrams reveal that Derik volcanics show clear negative anomalies for Nb, Ti and Eu with enrichment in Th, La, Ce and LREE and have similarities with arc-related Late Neoproterozoic lower crustal rocks of the Arabian Plate. The negative Nb and Ti anomalies imply the involvement of a subduction-modified mantle source, whereas the Eu anomaly clearly indicates the fractional crystallization of feldspar minerals. Derik volcanics have LREE >85 times chondrite (85-120), whereas HREE is <25 times chondrite (20-24) times, probably generated outside of the garnet stability field. The $(La/Yb)_N$, $(La/Sm)_N$ and $(Gd/Yb)_N$ ratios vary from 3.29-3.92, 1.91-2.96, 0.85-1.51 for basalts, 3.88-6.53, 2.59-4.14, 1.00-1.53 for andesites and 5.68-5.92, 3.03-4.17, 1.00-1.07 for rhyolites, respectively. The negative Eu anomaly $(Eu/Eu)_N$ in basalts (0.54-0.84), in andesites (0.51-0.72) and in rhyolites (0.57-0.59) probably reflects the result of crystallization of the feldspar minerals from the melts at the source following the partial melting. The LREE/HREE, Nb/Zr and Nb/Y ratios of the studied rocks imply that Derik Volcanics may be differentiated from mafic lower crustal Arabian source. Petrogenetic modelling of Derik volcanics indicate that the initial stages of partial melting of the Arabian LC-source about 8-12 % produced a rhyolitic melts and followed by the partial melting of LC of about 9-18 % and 16-21 % to generate andesitic and basaltic melts.

The volcanics have isotopically lower $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ values than MORB and can be correlated well with the Early Proterozoic mafic granulites (lower crustal) of Tanzania. Four point whole-rock Rb-Sr isochron data of the volcanics reveal 533+/-25 Ma with an initial $^{87}Sr/^{86}Sr$ value of 0.7057.

Based on the geology, geochemistry and petrogenesis, Derik volcanics may be related to an extension and subsequent rifting in the northern edge of Gondwanan Arabia, which resulted in opening of a new oceanic branch to the north of the Gondwana.

The cadastral survey of Earth scientific values in the protected Hegyes-kő Hill situated in Demjén and questions of its buffer zone in concept of the “Thermal valley” Tourist Development Plan (North Hungary)

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The Hegyes-kő Hill (220 m) is situated in North Hungary, in the Heves County, 7 kilometres far away from Eger, in the northeastern part of Demjén. This territory lies next to the “Thermal valley” (wellness) tourist development area. The territory is a part of the Egri-Bükkalja Foothill Microregion. This area was declared as a Local Nature Conservation Area (as the cultural heritage) by the local government in 1979, because of the hivestones and different anthropogenic niches, which were carved into the rock surface. Lots of geological and geomorphological values can be found in this territory, but these values did not mentioned before. The “Thermal valley” touristic wellness development began in 2007 and new apartments, park places, swimming pools and swimming caves under the surface were built up. The buffer zone and the Earth scientific and cultural values of the study area can be endangered by this building and development activities.

Our research aim is to survey geological and geomorphological fundamentals of the Hegyes-kő Hill, to do the cadastral survey of geological and geomorphological unique values and to reveal anthropogenic factors endangered the buffer zone of the protected area. At the first stage of our investigation we gathered the geological, geomorphological and topographical maps and bibliography of the study area. We have done the research work on the field, where we have surveyed the unique geological and geomorphological values of the Hegyes-kő Hill, we have filled in the form of the Cadastre data sheet of unique landscape

features (Hungarian Standard No. 20381/1999), we have made detailed description of different objects, we have taken photographs of them and gathered sedimentological samples for the laboratory investigation. The geological maps and DDM were created by the Golden Software SURFER 8.0 and the CorelDRAW 12. programs.

The main geological value of the Hegyes-kő Hill is the Miocene Gyulakeszi Rhyolite Tuff Formation: non-welded rhyolite tuff layers and its special geological structure. Somewhere, we can find Pleistocene slope clays at the top of the rhyolite tuff surface. Holocene fluvial sediments build up the alluvium of the Stream Laskó. Non-welded rhyolite tuffs build up the hives too and their environments were investigated in details. We have categorised as a geological value the rhyolite tuff layers appeared in the surface, thin and thick layers of the rhyolite tuffs, its special geological structure and the special (bio)crust appeared on the surface of stones (8 pieces). We have gathered 10 sedimentological samples on the barren rock surfaces or rhyolite tuff surface covered by soils. Therefore these samples were few centimetres thick only; their appearance and genetical development were diversified. The physical parameter and granulometric investigation of the sediment samples can show strongly mechanical and chemical weathering processes. The frost weathering was strong here, but the formation of soil has begun at the top of the hill and environments of cliffs.

In the Hegyes-kő Hill, the most frequently geomorphological values (27 pieces) are periglacial landforms/cryoplanation walls (23%), special cliff forms (15%), derasional valleys (12%) and erosional rills (12%) here. The forms of gelifluction and rock-falls are as different types of mass-movement processes (8%). Water cuts (8%), dissected surface with microvalleys appeared on the rhyolite tuffs (4%) and eroded rhyolite tuff surfaces (4%) are in the hill. Different Pleistocene fluvial terraces (4%) can be investigated in the environs of the hill. After the cadastral survey of the unique natural values, we could find that this territory is rich in geological and geomorphological values and the protected status could be reached into these value categories too.

Next to the study area, significant landscape changes appeared because of the buildings and the development of „Thermal valley”. The original landscape, the buffer zone and natural values are in danger of buildings, human impacts, illegal dumping of waste and trample erosion.

Subduction-related Jurassic gravity deposits in Bükk-Darnó Area, Northeast Hungary

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Jurassic sedimentary sequences of pelagic basin facies and slope-related gravity deposits occur in several places in North Hungary (Bükk Mountains, Darnó area, Rudabánya Hills). The aim of the paper is to characterise the Jurassic formations of the study area with special regard to the redeposited sedimentary rocks in order to get information on the provenance of the clasts, and the mode and time of their redeposition. In the Bükk Mts., the Mónosbél Group contains various redeposited sediments showing an upward coarsening trend. They were deposited in Bathonian in subduction-related basins formed in the course of subduction of the Neotethys Ocean. The lower part of the complex is typified by pelagic carbonates, shales and radiolarites with andesitic volcanoclast intercalations. The higher part is characterised by polymictic olistostromes. Large olistoliths that are predominantly blocks of Bajocian shallow marine limestones (Bükkzsérc Limestone) appear in the upper part of the

sequence. Evolutionary phases of the sedimentary basins were defined from an early extensional stage of the subduction, through island-arc formation, to the compressional stages when onset of nappe stacking gave rise to formation of polymict olistostromes and then redeposition of large blocks derived from out-of-sequence nappes of the previous platform foreland. Remarkable differences between the composition of the redeposited clasts in the olistostromes of the Bükk and Darnó area indicate deposition in different subduction-related subbasins.

Hydrothermal Pb-Zn-Au-Ag and Cu-Au mineralisation in the Kassandra mine district, N Greece: a metallogenetic model with regional economic implications?

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Mining has a long tradition in SE Europe, is important for today's regional economies, and will play a key role in helping secure future supplies of raw materials in Europe. Of particular importance is the Serbomacedonian–Rhodope metallogenetic province developed throughout Serbia, Kosovo*, FYROM, Greece and Bulgaria. The Kassandra mine district (KMD) in N Greece is part of this economically important region and since ancient times one of Europe's largest Au and Ag resources. The close proximity of different types of magmatic-hydrothermal deposit of known economic importance makes the KMD an ideal location for studying the genesis of base and precious metal deposits in the context of the regional geodynamic evolution. However, despite available data, the knowledge about the timing of magmatism and mineralisation is limited and an overarching, genetic district model is distinctly lacking.

Mineralisation in the KMD is related to Tertiary (Oligocene - Miocene) I-type, calc-alkaline magmatism in the metamorphic hinterland of the Hellenic orogen. The crystalline basement of the KMD is characterised by a tectonic nappe stack of Palaeozoic to Precambrian gneisses and marbles of the Kerdillion Formation and an ophiolitic mélangé unit consisting of peridotites, dunites and amphibolites. Olympias and Mavres Petres are Pb–Zn (Au–Ag) carbonate-hosted massive sulphide replacement deposits. Both are interpreted to represent the distal and proximal part of a structurally controlled, skarn-type ore system on the footwall of the main detachment for the Southern Rhodope metamorphic core complex (SRMCC) — the Tertiary transtensional Stratoni–Varvara Fault. Recent work has made a step change in understanding the geological evolution of the N Aegean and suggests the SRMCC as a controlling factor in the regional mineralisation, requiring a reinterpretation of existing mineralisation models in this geodynamic setting. Skouries is a nearby Cu–Au porphyry resource and is part of a suite of mainly unmineralised porphyry stocks that intruded the hanging-wall of the same fault. The syenitic and dioritic to andesitic stocks were emplaced in a local intrusive belt, presumably along deep seated faults. The geodynamic–tectonic setting of this emplacement, subduction, continental arc or orogenic collapse, is hypothetical and not proven. PGE concentrations in the ore concentrates from the Cu–Au porphyry at Skouries and Fe–Ni–Co–V sulphides in a porphyry-style alteration system in vicinity to Skouries suggest an ultramafic/ophiolitic component to the mineralisation. The role of ophiolites in the hydrothermal mineralisation processes is a new angle that has not been previously considered and could have important applications in future exploration strategies.

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This multidisciplinary study seeks to develop a new metallogenic model that correctly places the mineralisation in the regional context of extensional magmatism and core complex exhumation. This includes a new interpretation of old and the generation of new isotope and fluid-inclusion data in order to determine the origin and evolution of mineralisation-related magmas, fluids and ore components. Set against a refined understanding of the spatial and temporal distribution of magmatic–hydrothermal ore deposits in the south Balkan region, this will enhance our knowledge of ore generation processes in post-collision, orogenic belts and significantly aid future exploration. Our work will inform current exploration models through improved understanding of magma processes and hydrothermal systems associated with mineralisation in a province which has a particular complexity reflected by the uneven distribution of deposits in time and space. The KMD is ideal for developing such models due to the juxtaposition in space and time of a range of mineral deposit types; all with known economic importance.

New results and assessment of the geochronology of the youngest volcano of the Carpathian region: Ciomadul (Csomád), East Carpathians

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In the Carpathian-Pannonian region volcanic eruptions of various magmas have occurred for about 20 Ma. The last eruption took place at the Ciomadul (Csomád) volcano, Southeastern Carpathians, a lava dome complex with two explosion craters. The lava domes are built up by potassic dacites with fairly homogeneous composition. Plagioclase, hornblende and biotites are the main phenocryst phases in addition to less amounts of apatite, sphene, clinopyroxene, quartz, K-feldspar, FeTi-oxide, zircon and occasional olivine. The lava dome rocks are crystal rich with up to 40-50vol% crystal abundance sitting in a glassy matrix. The pumices formed during the explosive phases show similar bulk chemical composition and mineral assemblage, but significantly less crystal volume.

The precise chronology of the volcanic activity is still unclear. Previous K/Ar radiometric data suggested that an earlier effusive phase at about 900-500 ka was followed by explosive volcanic eruptions at least in two stages (about 220 ka and 10-40 ka, respectively). Combined petrographic and mineral chemical investigations have revealed, however, that most of the volcanic products consist of a mixture of mineral phases formed at different time and different stage of magma evolution. The reconstructed magma chamber evolution before formation of one of the lava domes (Kis Csomád) involves remobilization of an older crystal mush by fresh magma. This fact limits the traditional radiometric age determination of the volcanic eruptions. On the other hand, occurrence of charcoal fragments in two localities of pumiceous pyroclastic products helps to determine the age of the youngest eruptions. Former radiocarbon measurements from the Tusnad locality (western margin of Ciomadul) provided ambiguous results between 10-40 ka. Our new high-precision AMS radiocarbon data of a charcoal sample from the pyroclastic flow deposit in this locality give 41,300 cal (BC) In addition, we found further charcoal samples at another locality (Bixad) at the southern margin of the volcano. Here, three samples provided consistent ages of 29,500 cal BC. These data suggest that the product of the youngest eruption is exposed at the southern margin of the volcano (Bixad locality) and not at the western one (Tusnad locality) as was previously thought. Furthermore, it indicates volcanic activities with fairly large, distinct periods. The

youngermost 30 ka age of the final eruption is implicitly indicated by lake succession analysis and palynological data obtained by new drillings made in the ≤ 20 m-thick loose lake sediments of the younger crater (St. Ana). As for the character of the final explosive activity, volcanological observations imply that both volcanic products could somehow belong to lava dome activities, i.e. explosive collapse of growing lava dome rather than collapse of an eruption column.

In order to constrain the age of the eruptions more directly we carried out U-He measurements on zircons. The obtained U-He ages for zircons separated from the pumices of the Tusnad and Bixad localities reproduced those ages obtained by radiocarbon dating. These data can be accepted as eruption ages only in the case if the zircons were crystallized at least >200 ka. Our interpretation based on the combined textural and geochemical observation seems to fit with this requirement. In agreement, new biotite Ar-Ar ages from Tusnád, Bixad and other localities that yielded apparently older ages (of 270 to 470 ka) suggest that magma crystallization started to occur significantly earlier than the final eruptions. As for zircon formation we suggest that they were growing in a granodioritic crystal mush and their margins were crystallized at low temperature from a rhyolitic melt. If this hypothesis is correct, then we can assume long-lived magma chambers beneath Ciomadul. Age of the main lava dome formation is still unclear, but it could be much younger than previously thought.

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Submerged Holocene Baltic landscapes (The SINCOS project)

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Sea level change has to be regarded as a global problem, influencing the human population not only in present days. Even in early phases of cultural development human populations have been faced with marine transgressions and changes of climate and the natural environment.

In order to investigate longer termed trends (on the millennial time scale) the Baltic Sea has been selected as a model region for an interdisciplinary research project SINCOS (Sinking Coasts – Geosphere Ecosphere and Anthroposphere of the Holocene Southern Baltic Sea) because changes in crustal vertical displacement interacting with eustatically driven sea level rise and climatic–meteorological influence to coastal morphogenesis can be studied in an exceptional manner, here. In the southern Baltic area where sinking coasts cause permanent transgression of the sea, remnants of human settlements are preserved under water, recording the reaction of the human population living in the ancient coastal zones since Mesolithic times.

As study area served the southern coast of the Baltic Sea where the process of a retreating coastline initialized by the Littorina transgression about 8 000 cal. BP that shifted the environment from fresh water to brackish/marine conditions can be studied here directly in relation to global sea level rise.

For the development of a model first, proxy data have been acquired in order to reconstruct the process and the effect of Littorina transgression within the research area. Data acquisition was mainly bound to sea expeditions. By methods of marine geology and underwater archaeology samples and information have been acquired which did provide the proxy–data for the reconstruction of palaeoclimate, sea level rise, palaeoecology and socio-economic development of the human population having lived along the palaeo–coastlines.

Modelling procedures have been used for the historical reconstruction of palaeolandscapes submerged by the Holocene sea level rise.

For the historical reconstruction a GIS approach was deployed to derive transgression–regression scenarios for the development of the Baltic Sea basin after the Littorina

transgression. Regional and local models have been elaborated for the time span between 8 000 and 3 000 cal BP – a time of rapid sea level rise. As key areas for local models served the Wismar Bight, the Darss–Zingst Peninsula, and Rügen Island.

Rockslide mechanics reconstruction using FEM and photoplastic modelling

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On a steep eastern slope under a Celtic site of Obří Hrad in the Šumava Mts. (South Bohemia), a complex, multi-generation rockslide was identified. Detailed mapping of the site revealed several systems of rockslide scarps, corresponding to respective deformation generations. Following research was aimed to assess the current behaviour of the slope and likely mechanics of the rockslide. Reconstruction was difficult as the rockslides were not very fresh, and the accumulations were practically removed by the fluvial processes from the narrow valley floor. Numerous research methods were applied. The depth and profile of the potentially unstable slope was investigated using geophysical methods. Several monitoring systems to assess the current movements were installed, including automatic extensometers, rod dilatometers and steel tape extensometers. Detailed measurements of tectonic joints and foliation structures were performed to investigate geometrical predispositions for sliding. Relative dating of the scarps was performed using the Schmidhammer test, comparing the scarps to other exposed rocks. Based on these analyses, a hypothesis on the rockslide formation and mechanics was formulated and tested using two independent methods: FEM calculations in the FLAC software, and photoplastic models, simulating the behaviour of the tectonically fractured rock massif. The preliminary results of these techniques illustrate the possible mechanics of the sliding while the monitoring systems offer a frame for the timescale of the events.

Changing seasonality patterns from Miocene Climate Optimum to Miocene Climate Transition deduced from the *Crassostrea* isotope archive

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The Western Tethyan estuarine oyster *Crassostrea gryphoides* (Schlotheim, 1813) is geologically long lived. Appearing in the Oligocene it persists up to the Pliocene in the entire Western Tethys. With sizes of over 80 cm length, it is the largest Miocene bivalve in the Western Tethys Region. Its modern congeners are economically important in shellfish farming. Therefore, numerous studies focused on the biology and ecology of *Crassostrea* including several sclerochronological studies. Herein we measured 5 shells from the Miocene Climate Optimum (MCO) and the subsequent Miocene Climate Transition (MCT) to evaluate changes of seasonality patterns.

MCO shells exhibit highly regular seasonal rhythms of warm-wet and dry-cool seasons. Optimal conditions resulted in extraordinary growth rates. Estuarine waters during the MCO in Central Europe display a seasonal temperature range of c. 9-10°C. Absolute water temperatures have ranged from 17-19°C during cool seasons and up to 28°C in warm seasons. Already during the early phase of the MCO, the growth rates are declining. Still, a very regular and well expressed seasonality is dominating, but extreme climate events did occur. The seasonal temperature range is still c. 9°C but the cool season temperature is slightly lower

(16°C) and the warm season water temperature does not exceed c. 25°C. At 12.5-12.0 Ma. The seasonality pattern is breaking down and is replaced by successions of dry years with irregular precipitation events. The amplitude of seasonal temperature range is decreasing to 5-8°C. No clear cooling trend can be postulated for that time as the winter season water temperatures range from in Central Europe instead of a simple temperature decline scenario.

Hydrochemistry and isotope composition of spring waters in Aydıncık, Mersin (Turkey)

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The increasing population, agricultural areas and summer houses increase water demands in Aydıncık area and Soğuksu Spring is the major source for providing drinking, domestic and irrigation water needs in Aydıncık and its vicinity. However a detailed hydrogeological investigation has not been done up to the present. In order to establish a sustainable water management plan it is required to characterize hydrogeologic structure and to determine of the conceptual hydrogeologic model. For this purpose hydrochemistry, stable isotopes (^{18}O , ^2H), and tritium isotope (^3H) were used for assessing groundwater recharge sources, flow paths, and residence times of Soguksu Spring and other small springs in Aydıncık area. The study area is situated between 33°25'N and 33°37'N latitudes and 36°12'E and 36°26'E longitudes in Aydıncık district of the Mersin Province and it covers approximately 120 km². This area comprises a rough hillside area that is bounded by the Mediterranean Sea to the south and the Taurus Mountains to the north. Rough structure is formed depending on both tectonic features and rock type. The topographic elevation changes from 0 m to 1000 m. This area has a complicated tectonic structure and geological units deposited during the Infra-Cambrian (Precambrian) to recent. These units includes calcshist, cloritshist, limestone and metaconglomerate, quartzite, dolomitic limestone, shale basal conglomerate and sandstone. Average discharge of Soguksu Spring is 1.8 m³/s between 1999 and 2009. Its max discharge is reached 13.5 m³/s in 2007 and minimum discharge is 0.1 m³/s in 2006. Other small springs also supply water needs in rural areas. The occurrence of groundwater is mainly associated with fracture and joint systems in this area. Due to major joints associated with the Alpin Orogeny, the formations of the area have been fractured, making these formations good aquifers as a result of secondary permeability. Hydrochemical evaluations on this study are based on field and laboratory data collected from 11 springs from May 2009 to March 2010 in four periods. According to in-situ measurements spring waters temperature, pH and specific electrical conductivity are found to range between 12.7-19.8° C, 6.16-7.27 and 331-829 mS/cm, respectively. These field parameters of the samples show a narrow change interval in four periods. Low temperature and specific electrical conductivity reveal that groundwater water-rock interactions at limited level. The groundwater compositions fall into two groups based on the major cation and anion. These are: Ca-HCO₃, which is prevalent in most of the spring waters, and Ca-Mg-HCO₃. The formation of these groups is basically a consequence of the dissolution of carbonate and dolomite minerals. Oxygen-18, deuterium and tritium analyses are performed for May 2009 samples. The stable isotope compositions for this period range between -5.73 and -7.02 ‰ V-SMOW for oxygen-18 and between -27.92 and -34.90 ‰ V-SMOW for deuterium. The stable isotopes show the predominance of low elevation precipitation. Tritium concentrations between 2.87 and 4.25 TU suggest recent recharge. Local recharge indicates potential groundwater susceptibility to surface contamination. However, only one sample has greater nitrate concentration than EPA Drinking Water Limits and maximum level of nitrate is 16 mg/l.

Uranium and Thorium content in bone phases studies – a step to U-series dating of fossil bones

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Direct dating of fossil bones using the U-series method is considered impossible because of the processes of accumulation and diffusion of uranium during the time when bone is buried in sediment. Commonly applied mathematical models allow the evaluation of the environmental influences and capability of bone, as a whole, to exchange uranium isotopes. In our research, a different solution of Uranium uptake problem has been elaborated. By considering a bone as a complex system of organic and inorganic phases, an attempt to estimate the capacity of the Uranium and Thorium uptake of the phases was made. This method showed that collagen, in comparison with other bone phases, has extremely low values of uranium content and, additionally, that these values do not exceed the range of uranium concentrations in recent bones (i.e., less than 0.2 ppm). According to this data, we presume that pure fossil collagen is not subject to uranium accumulation. Furthermore, some U-series dates of fossil collagen extracted from *Ursus spelaeus* bones collected in Magurska Cave (Tatra Mts, Poland) were calculated, and comparison of these dates with radiocarbon ones seems to show acceptable accordance.

Recognition and decay of the Upper Devonian dolomite lithological morphological types in Architectural Heritage

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In Latvia local dolomite has been used for architectural buildings that nowadays are a significant part of Cultural Heritage. However there is a lack of scientifically founded and appropriate methodology on recognition of dolomite lithological types in Architectural Heritage. The current work is aimed to evaluate application in situ of methodology on recognition and identification of the Upper Devonian dolomite lithological types and to study decay forms of individual lithological type in order to evaluate decay processes of dolomite in Architectural Heritage. Methodology is based on structurally genetic classification system according to in situ simply readable complex of rock's macroscopic features: texture, fabric, colour and related physical/mechanical and durability properties. Expression of results is based on cartographical method used in conservation practice. Methodology on recognition and identification of lithological types of the Upper Devonian dolomite has been appropriate and could be recommended as the non-destructive preliminary rock's investigation method in Architectural Heritage Monuments. Study of decay forms of individual lithological dolomite type concludes that correlation between rock's intrinsic properties could be established, however up to date obtained results are insufficient to recommend this methodology for evaluation of weatherability of lithological dolomite types.

Triassic ‘ophiolites’ and related rocks in Eastern Carpathians (Romania)

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In the Eastern Carpathians (EC), ultramafics (Iherzolites and harzburgites) to FeTi gabbros, dolerites and volcanics occur in three areas, from north to south: Rarău, Hăghimaş and Perşani Mts. They are embedded in the Lower Cretaceous Wildflysch formation, as both centimetre-sized clasts in breccias, and meter- to kilometre-sized blocks. The volcanics comprise highly-depleted (HDBA), depleted (DMORB) and normal (NMORB) basalts/andesites, to enriched type mid-ocean ridge basalts (EMORB). Additionally, ocean island basalts (OIB), calc-alkaline basalts/andesites (CABA) and trachytes occur. Many volcanics have a distinct supra-subduction zone signature. No direct geological field relation could be established among the isolated occurrences. Thus, it is difficult to assign ultramafics, Fe-Ti gabbros and basalts to a coherent ophiolite assemblage. Nevertheless, we will use the term ‘ophiolites’ for a part of the rocks, because several basalt groups indicate an oceanic origin and ultramafics with basaltic dykes occur.

Based on primary interfaces between volcanics and sediments such as radiolarites and limestones, a Middle to ?Late Triassic age of the Eastern Carpathians “ophiolites” and a separation from the Southern Apuseni Mts. ophiolites and island arc volcanics are envisaged. In all cases where we observed interfaces with basalts, the sediments proved to be Triassic.

In the Rarău area (northernmost part of the EC), Ladinian and Lower Carnian red cherts are in direct contact with basaltic rocks of NMOR- and EMOR-type, respectively. One olistolith shows a succession of CABA, Werfenian sandstones and shales, and Upper Anisian–Lower Ladinian limestones. In the Perşani Mts. (southernmost part of the EC), a direct contact of basaltic rocks and limestones displaying a Late Triassic facies is exposed.

When combining the basalts ages with the geochemical grouping, it is clear that at least one or more samples from the following groups are Triassic: OIB, CABA, and EMORB. For the NMORB and HDBA this is also probable since Mid-Triassic radiolarites were previously found in close vicinity. No stratigraphic assignment can be made for the moment for the UMs, Fe-Ti gabbros and the DMORBs, but none of these shows any close connection to Jurassic or Lower Cretaceous sediments. Taken all the arguments together, it is highly probable that a vast majority of the magmatic rocks, maybe even all, are of Triassic age.

For long time, the Eastern Carpathians “ophiolites” were believed to have been formed in the Eastern Vardar Ocean (Main Tethyan Suture Zone), being thus partly time-equivalent to the Middle to Late Jurassic ophiolites and island arc volcanics found in the Southern Apuseni Mts. and in the basement of the Transylvanian Depression. Most of the ‘ophiolites’ were believed to be thrust on top of the Eastern Carpathian Bucovinian nappes during the Mid-Cretaceous orogeny forming the so-called “Transylvanian nappes”.

Based on the new data, a model is developed, which accounts for the existence of a Triassic ocean connected with the Meliata-Hallstatt Ocean. This ocean closed most likely in the Late Triassic to Early Jurassic. During the closure ultramafics and basic magmatic rocks together with sediments were obducted, subsequently eroded and transported as blocks of different sizes into the Lower Cretaceous Wildflysch basin.

Lake Ohrid Basin (FYROM/Albania): a seismogenic landscape

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The Former Yugoslavian Republic of Macedonia and Albania share the Lake Ohrid Basin (40°54' – 41°10' N, 20°38' – 20°48' E) stretching over a length of c. 30 km and a width of c. 15 km. Clearly the strike of the basins (N-S) does not correspond to the strike of

the major tectonic and geological units (NW-SE). This already gives evidence that the basin is formed due to a younger deformation stage. In addition, the area meets all criteria of an active, seismogenic landscape with linear step-like fault scarps on land and within the lake. In general, the faults and fault scarps are getting younger towards the basin centre, as depicted on seismic and hydroacoustic profiles. Post-glacial (or Late Pleistocene) bedrock fault scarps along the steep flanks of Mokra and Galicica Mountain chains are long-lived reflections of repeated surface faulting in tectonically active regions, where erosion cannot outpace the fault slip. Others like wind gaps, wineglass-shaped valleys and triangular facets, are accompanying morphological features of a tectonically active area. Additionally, mass movement bodies within the lake and also onshore (rockfalls, landslides, sub-aquatic slides, homogenites, turbidites) are likely to have been seismically triggered. Multichannel-seismic studies reveal evidence for wedge-like growth strata incorporating mass movement bodies, rather pointing to sudden earthquake-triggered events than to fault creep. Earthquakes larger than magnitude M 6.0 at Lake Ohrid may also be accompanied by secondary effects like liquefaction, seeps, dewatering structures, rock falls and landslides and others. These morphotectonic observations correspond to focal mechanisms of earthquakes in the greater Lake Ohrid area. An integrated multidisciplinary approach was chosen to investigate the neotectonic history of the basin, using tectonic morphology and a variety of geophysical and remote sensing methods.

Tectonic evolution of the Lake Ohrid and Prespa Basins (FYROM/Albania)

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The region of the Lake Ohrid and Prespa Basins is located at the Greek/ FYROM (Former Yugoslav Republic of Macedonia)/Albanian border. The neotectonic and landscape evolution of the southern Albanian fold-and-thrust belt and the Albanian-FYROM extensional back-arc area (basin and range type) are directly linked to subduction and subduction roll-back within the Hellenic trench system. The initiation of the Ohrid Basin is estimated between 2 and 8 million years. The deformation can be divided in three major deformation phases (1) NW-SE shortening from Late Cretaceous to Miocene with compression, thrusting and uplift; (2) uplift and diminishing compression during Messinian - Pliocene; (3) vertical uplift and (N)E-(S)W extension from Pliocene to recent associated with (half-) graben formation. This latter phase of an orogenic collapse is related with a seismogenic landscape with linear step-like fault scarps on land and offshore, wineglass shaped valleys and triangular facets. The geomorphology also points to rotated and tilted blocks. Seismic and hydroacoustic data of Lake Ohrid show that the faults and fault scarps, in general, are getting progressively younger towards the basin centre. A tectonic multi-proxy approach (palaeostress analysis, remote sensing) has been made to reveal the stress history of the region. Furthermore, apatite fission-track (A-FT) analysis and t-T-paths modelling was performed to constrain the thermal history, and the exhumation rates.

For fission-track analysis apatites were separated from a suite of granitoid rocks from basement units and from flysch- and molasse-type deposits of Paleogene to Neogene age. Apatites show a range of the apparent ages from 56.5 ± 3.1 to 10.5 ± 0.9 Ma. The spatial distribution of ages suggests different blocks with a variable exhumation and rock uplift history. Fission-track ages from molasse and flysch sediments of the basin fillings show distinctly younger ages. Generally, the Prespa Basin reveals A-FT-ages around 10 Ma close to normal faults, whereas modelling results of the Ohrid Basin suggest a rapid uplift initiated around 1.4 Ma associated with uplift rates (? rock uplift rates or surface uplift rates?) on the order of 1 mm/a. As a conclusion we observe a westward migration of the extensional basin

formation, i.e. the initiation of the Prespa Basin occurred well before the formation of the Ohrid Basin.

The stable isotopic composition of cryptocrystalline magnesite occurrences in Turkey and Austria and implications for their origin

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Cryptocrystalline magnesite occurs predominantly in ultramafitic rocks of ophiolite sequences and associated sediments. Two types are recognized, the Kraubath type (KT), which occurs – tectonically controlled – in ultramafic rocks as veins, networks and zebra ore, and the Bela Stena type (BST), which occurs as nodules and layers in sediments.

The two types not only differ by the nature of their host rock but also by their C and O isotopic composition. The KT has lower C isotope values (-18 to -6‰ VPDB) than the BST (-1 to +4‰ VPDB). $\delta^{18}\text{O}$ values of both types overlap, whereby the KT shows a tendency to lower values (+22 to +29‰ VSMOW) than the BST (+26 to +36‰ VSMOW).

This study is based on extensive fieldwork and a total of 320 samples from Austria (Kraubath) and Turkey (western and eastern Anatolia).

Kraubath (Austria) contains the lowest C isotope values (-22.5 to -11.3‰ VPDB). Turkish KT magnesite contains higher C isotope values (-12.7 to -3.1‰ VPDB). Turkish BST magnesite contains mainly positive C isotope values (+1.5 to +6.9‰ VPDB) with the exceptions of Dutluca and Bahtyiar (Eskişehir/Western Anatolia)

In the operated magnesite deposit of Dutluca (Eskişehir/Turkey) KT magnesite and zebra ore (-10.6 to -7.8‰ VPDB) are covered by sediments with BST magnesite, which occurs as nodules and layers (-6.5 to -5.8‰ VPDB).

The deposit of Bathyiar (Eskişehir/Turkey) shows a transition from network to iron-rich zebra ore and BST. The network shows normal isotope values, but the $\delta^{18}\text{O}$ values of the zebra ore are extraordinary high (+29 to +35‰ VSMOW).

The $\delta^{18}\text{O}$ values of KT magnesite suggest general formation temperatures between ca. 60 and 70°C. Exceptions are the deposits of Tavşanlı/Turkey, which formed at temperatures of ca. 80°C. Zebra ore of Bathyiar (Eskişehir/Turkey) formed at temperatures below ca. 30°C.

The range of the $\delta^{13}\text{C}$ values (-22.5 to +6.1‰ VPDB) suggests that CO_2 was derived from several sources (biogenic – atmospheric, decarboxylated, mantle-derived or magmatogene) and was transported by meteoric waters. Supergene water with dissolved HCO_3^- invaded the serpentinite and leached Mg^{2+} . The release of Mg^{2+} and OH^- into the solution raised the pH. Extension of strike-slip system provided pathways for migration and the formation of hydrothermal convection cells. At shallow levels the drops in pCO_2 due to outgassing caused supersaturation and formation of magnesite.

The Tokaj Mts. obsidian – its use in prehistory and present application

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Homogeneous acid volcanic glass of low water content has been an object of human attention since the prehistory. There exist archaeological evidences dealing with the use of obsidian from the Tokaj Mts. (eastern Slovak Republic and the north-eastern part of Hungary, as well) Late Tertiary volcanic province in the Late Palaeolithic. There at present exist

attempts to use it as a jewellery raw material. Obsidian namely in combination with silver, nickel alloys and gold can be effectively used as a modern jewellery material.

Dating of the landslide activity in the Czech part of the Outer Western Carpathians and its palaeoenvironmental significance

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The Outer Western Carpathians characterised by flysch structure are prone to the development of various types of slope deformations. Landslides are typical and abundant phenomena of this mountain relief. The study brings new information on the predisposing factors for landslide evolution in the studied area and it focuses on the time constrains of these slope deformations during the Holocene. The interrelationship between slope deformations and fault-induced weathering as a preparatory factor for the development of sliding has been analysed in several case studies from the Western Carpathians in the Czech Republic. The study area comprises flysch nappes with alternating sandstone and shale of different permeability. These lithological structures are affected by systems of faults. Recurring slope instability is found as associated with zones of deep weathering in tectonically weakened areas. Climatic variability of landslide activity during the Holocene can be identified by means of radiocarbon dating and pollen analysis. The age of landslide evolution is analysed by radiocarbon dating of sediments preserved in selected places of the deposition: near-scarp depressions, inter-colluvial depressions, landslide dammed-lakes, and organic material buried under the landslide body. Using this sampling strategy we were able to establish landslide chronology in the studied area. By means of pollen data sets we can analyse palaeoenvironmental conditions of the studied areas and bring new light into the predisposing and triggering factors. Areas affected by recurring landslides suggest both gradual and cyclic landslide frequency. We determined the following landslide phases within the studied area: Older Dryas – Alleröd, Boreal, AT1, AT2/AT3, AT4/SB1, SB2/SB3, and SA1/SA2. The first very important phase is identified with the turn of the Last Glacial (Kotelnice landslide, 11813 ± 383 ^{14}C BP). This phase is connected with crucial environmental changes at the end of the last glacial period. Cyclic landslide frequency was confirmed in the case of complex landslide areas (e.g. Velká Čantoryje landslide). A highly fragmented zone of overthrust sandstone-dominated nappe, which lies on a weathered claystone-dominated sequence, contains numerous multiple rotational slides. Basal peat bog deposits situated in the vicinity of the main scarp depressions of these landslides show minimal ages of 3540 ± 80 ^{14}C BP to 3680 ± 350 ^{14}C BP (late Subboreal) and a further reactivation in approximately 2400 ± 70 ^{14}C BP to 2890 ± 90 ^{14}C BP (Subatlantic). Recent (rather minor) mass movements have occurred only sporadically throughout the last 100 years (e.g. during an event in July 1997). Another example is connected with the evolution of a catastrophic rockslide of Mt Ropice. The first event occurred at 1450 ± 100 ^{14}C BP (Subatlantic age of a basal sediment layer of a former landslide-dammed lake). Another smaller flow-slide (identified on the basis of a change in sedimentation within the impoundment) probably postdated 310 ± 60 ^{14}C BP. Special attention was paid to the research of the palaeoenvironmental significance of landslide dammed-lakes. Radiocarbon dating together with palynological and sedimentological analyses detected repeated changes in depositional conditions connected with the palaeoenvironmental changes during the Holocene. Results of the radiocarbon dating of the basal parts of lake sediments show that landslides causing the valley damming originated throughout the whole Holocene with significant increase in the landslide activity in the Subatlantic chronozone. Linear lake sedimentation rates and minimum average catchments denudation for selected contributing catchments in different time spans were calculated in order to understand the relief development dynamics throughout the Holocene. Minimum mean mechanical denudation of landslide-dammed catchments varies between 2.5-13.4 mm.ky⁻¹.

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The reconstruction of the Late Miocene flora and climate from the Sofia Basin (South-West Bulgaria) based on palynological data

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In this study, we reconstruct the Late Miocene palaeoenvironmental conditions for the Sofia basin (South-West Bulgaria) based on palynological data. The investigated samples originate from freshwater sediments of core C-14 and outcrop PG-1. The age of sediments was determined as Pontian to Dacian on the basis of molluscs, mammals and diatoms. For the vegetational reconstructions we analyzed 145 pollen samples aiming to identify plant communities and their temporal and spatial distribution. Dominant plants in the zonal vegetation were floristic elements growing under warm-temperate climatic conditions (species of the genera *Quercus*, *Ulmus*, *Zelkova*, *Fagus*, *Carpinus*, *Betula*, *Castanea*). Significant role in the composition and structure of the fossil vegetation also played swamp forests (Taxodiaceae, *Alnus* and *Glyptostrobus*), herbaceous palaeocoenoses (Chenopodiaceae, Poaceae, Asteraceae and Apiaceae) and aquatic vegetation (*Typha*, *Sparganium*, *Potamogeton* and Nymphaeaceae). We applied the Coexistence Approach method to obtain quantitative palaeoclimatic data. Four climate variables are considered for climate reconstructions, namely: mean annual temperature (MAT), temperature of the coldest month (CMT), temperature of the warmest month (WMT) and mean annual precipitation (MAP). Quantitative climate data derived from fossil floras indicate warm temperate climatic conditions, with mean annual temperature of 12.9-17.2°C, temperature of the coldest month 1.7-6.6°C, temperature of the warmest month 23-27.8°C and annual precipitation between 828 and 1308 mm. The climate parameters have been compared with those from the paleoclimatic investigations of other Neogene basins in South Bulgaria which show similar results. Thus all the data contribute to better understanding of climate evolution in the Southeast Europe during the late Miocene.

Tertiary lignoflora in Carpathian Curvature

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A new collection of Oligocene fossil woods coming from the Great Curvature of Carpathians, Romania, define a very new area for petrified woods occurrence which deserves a special interest because its age and its novelty. Beside this, it's a region where amber appears within formation of the same age and a relation between is to be searched since a clear connection of amber and amber-generator tree never has been found. Previously in this area only some Oligocene petrified woods found and identified as species of *Sequoioxylon gypsaceum* (GOEPP.) GREGUSS, *Laurinoxylon murgoci* PETRESCU and *Icacinoxylon* sp. were cited. Also by the analysis of pollen grains preserved in amber, beside conifers, oaks and elms have been identified within that forest (*Cupuliferoidaepollenites liblarensis*, *Ulmipollenites undulosus*) indicating a Mixed Mesophytic Forest – otherwise a typical Oligocene Carpathian vegetation. The new collection of petrified woods found in a large area within Carpathians' Curvature have been studied and identified as morphotaxa belonging to Conifers or Angiosperms and recent field trips in that area let us to hope more than this.

The Late Oligocene-Early Miocene Petrified Forest in Evros and its paleoclimatic significance

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Closely related to the development of post alpine back-basin, in Evros a significant Cenozoic calc-alkaline, high-K calc-alkaline to shoshonitic magmatic activity has manifested as plutonic-subvolcanic (monzonites, monzodiorites, granodiorites, microgranite porphyries) and volcanic rocks (banakites, trachytes, andesites, dacites, rhyolites accompanied by volcano-sedimentary formations (composed of marls, sandstones, clays and intercalations of volcanic rocks as lavas, tuffs, pyroclastics) discordantly covering the basement rocks of the Rhodope massif and Circum Rhodope Belt. New K/Ar ages of volcanic rocks in this area range from 33.5 to 19.6 Ma, establishing an Oligocene and a Lower Miocene period of magmatic activity. The lower series starts with a basal-clastic formation, composed of conglomerates and sandstones which continues a Priabonian clay-marl formation including marls alternated with sandstones and conglomerates and intercalations of lignitic horizons at the upper levels, associated with some andesitic lavas and overlaid by pyroclastics and lavas of dacitic to rhyolitic composition with intercalated sediments of Lower-Upper Oligocene age. The volcanics include pyroclastic flows, air fall deposits, as well as lava flows and domes. The stack continues with Upper Oligocene shallow marine sediments dominated by sandstones, marls and conglomerates (Provatonas series) discordantly covering the volcanics. The area is also dominated by ignimbrites of several meters thickness. A lot of vegetal remains especially as petrified woods have been preserved by the volcano-sedimentary rocks and in Evros there are several occurrences known, east of Alexandroupolis, around Trifili, Fylakto and Lefkimi and north of Alexandroupolis, around Aetochori and Sappes. Hundreds of samples have been studied and tens of arboreal taxa defining the Oligocene Forests covering the region have been identified. Published papers showed the presence of two types of evergreen oaks – *Lithocarpoxyton helladae* PETRESCU, VELITZELOS & STAVROPODIS, 1980 and *Quercoxyton intermedius* PETRESCU & VELITZELOS, 1981 – with, probably, a similar type of leaf described as *Eotrigonobalanus furcinervis* (ROSSM.) WALTHER & KVACEK. Another associated fossil vegetative plant parts found in this region represents Pinaceae, Cupressaceae, Lauraceae, Betulaceae (*Alnus* sp.), and Palmae. A number of 20 samples of oak fossil wood from this region have been studied by Selmeier and have been attributed to *Quercoxyton* genus of evergreen type and with this occasion it seems that the authors no more agree *Lithocarpoxyton* as valid genus. As a preliminary results we found a number of 28 taxa of conifers and angiosperms in which the cupressaceae (*Cupressus*, *Tetraclinis*, Taxodiaceae) are prevalent and also Fagaceae (*Quercus*, *Lithocarpus*) and Juglandaceae (*Carya*). The list of new identified vegetal fossil taxa in Evros define a Mixed Mesophytic Forest of warm temperate climate of Mediterranean type, proved especially by the presence of Palms, even if only locally, for Late Paleogene-Earliest Miocene.

Magnesite deposits of Serbia: An overview

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Magnesite deposits of Serbia are related both spatially and genetically to the Jurassic ophiolite belt of the Inner Dinarides (including the Vardar zone). In the frame of this belt they occur in various geological environments (in ultrabasites, in sedimentary series of freshwater Neogene basins lying on or by ultrabasites, and in Quaternary placers linked to adjacent primary source magnesite deposits) and they belong to different genetic (hydrothermal, weathering infiltration, sedimentary) and structural-morphological types (veins, stockwork, layers, irregular bodies). But regardless the aforementioned differences, all the deposits contain dense (micro- to crypto-crystalline) magnesite that represents favourable raw material for manufacturing of refractories.

The exploration, study and exploitation of magnesite in Serbia have a hundred-year-long tradition. They date back to the beginning of 20th century, and were intensified after World War II for the needs of the Magnohrom, a newly-developed refractory material manufacturer in Kraljevo. They reached their climax in the period from 1950 to 1990, when they satisfied the needs of this manufacturer for 500,000 to 900,000 tons of the magnesite ore (namely from 300,000 to 500,000 tons of magnesite concentrate) annually. In that period the largest number of geological reports and feasibility studies on magnesite reserves were completed, as well as mining projects, technological and techno-economic studies. The largest number of scientific papers from the mentioned fields was also written then. At the same time Serbia (as integral part of the SFR Yugoslavia) became a significant world manufacturer of high-quality refractory materials (bricks and grain products) on the basis of magnesite (which were exported to the USA, Germany and many other countries). It also became known for the results of exploration and study of magnesite deposits. Besides well-known vein and stockwork deposits in ultrabasites (as Brezak, Milichevci, Koviljacha, Razhana, Liska, Krive strane, Masnica, Chavlovac, Bogutovac, Trnava and Goleš) new types of magnesite deposits were discovered and studied in Serbia: sedimentary or Bela Stena type in freshwater Neogene basins (as Bela Stena, Shilopaj, Kacher, Kremna and Beli Kamen) and detrital type in freshwater Neogene basins, too (in Razhana, Pranjani and Chachak-Kraljevo Miocene basins) and Quaternary placers (around magnesite deposits of other genetic types).

As the result of long-lasting exploration, significant balance (economic) reserves of magnesite of A, B and C₁ categories, according to the national classification, were established (A, B – Proved Reserves, C₁ – Probable Reserves according to United Nations – UNFC and Australian – JORC classifications) of over 5 million tons, as well as out-of-balance (intrinsically economic) “reserves” of the same categories (A and B – Measured Resources, C₁ – Indicated Resources according to the classifications) of about 10 million tons (by detailed exploration), as well as potential “reserves” of C₂, D₁ and D₂ categories (Inferred Resources according to the classifications) of over 218 million tons (by basic exploration, reconnaissance, prospecting and preliminary exploration) thus total magnesite resources of Serbia are estimated to be over 233 million tons.

Large mammal footprints from the Late Miocene of Western Crete

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Although terrestrial Miocene deposits as well as faunal and floral findings are numerous and widespread in Greek Neogene sedimentary rocks, trace fossils are sparse and are limited mainly to casts of roots and invertebrate ichnofossils. No footprints of terrestrial vertebrates and especially of mammals have been reported from the Greek Neogene to date. This is fairly strange considering that there are several important Miocene mammal localities such as Pikermi, Samos, the Axios valley localities and many others found all over Greece. Terrestrial mammal localities of Miocene age have also been reported from the island of Crete. Although not many, still their number is considered adequate and they are located all over the island. Until now nine localities have been traced; five in Lassithi prefecture, one in Heraklion prefecture, two in Rethymnon prefecture and one in Chania prefecture. Their age spans from the Middle to the Late Miocene. The oldest one is Melambes in Rethymno and the youngest one Vrysses in Chania.

Although the identified terrestrial deposits and findings are very sparse in Western Crete, a new locality has been discovered recently where footprints of terrestrial mammals were exposed. The actual locality is situated near the village Vouves, to the west of the city of Chania. The ichnofossils come from lacustrine deposits that belong to the Roka Formation. The identified footprints were exposed at a low section located in a cultivated area. Two ichnotaxa are represented in the findings so far. The first and more impressive finding is a very well defined footprint that can be related with an average sized felid (ichnofossil *Felipeda*). The second group of footprints are the traces of Ruminant hoofs. More specifically the “hoof” traces belong to a large sized ruminant. The felid footprint has a maximum anteroposterior diameter of 126 mm and a transverse diameter of 95 mm. It constitutes a cast where not only the imprint of the foot with the four fingers is well preserved, but also the full traces of the claws of all four fingers. They have also been cast and preserved, indicating that the claws had been drawn out of their sheaths at the time of the imprint’s formation. The size of the largest ruminant footprint has an anteroposterior diameter of 115 mm and a transverse diameter of 93 mm. These footprints were moulds of the original hoofs, clear but not so well defined as the felid one. The age of nearby marine deposits of the Roka Formation is considered as Tortonian. Therefore, an equivalent age can also be inferred for the fossiliferous layer with the footprints. This is the first recorded case of footprint trace fossil findings from Neogene sedimentary deposits of Crete and Greece in general. In addition these findings provide more evidence for the presence of well established terrestrial environments and faunas in the area of Crete during the Late Miocene.

Slovak gemstones

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In present-day Slovakia the survey in gemology has been oriented to searching for new gemstone deposits and to proving their quality. Suitable kinds of siliceous materials, which have not been examined for these purposes until now, have been discovered. *Obsidians* were found in eastern Slovakia, with their qualities predetermining them for use as chipped stone implements far in the past. In addition to sharp chipped edges that were used to function as various cutting implements, obsidians are attracting our attention by their black colour and

remarkable lustre. Also in the present obsidian lumps of different size can be found on clayey sediments in vineyards at the position of Viničky. Interesting remains of trunks of Tertiary trees, which were devastated by volcanic activities, are known as *wood opals*. One part of their wooden mass burned; the other was buried in volcanic ash and gradually impregnated with opal mass to give rise to attractive colourful remains with characteristic structure of original woods - chestnut trees, laurel trees and other thermophilous plants as well. Polished opals have impressive appearance and like obsidians, they can be used for jewellery. When set in jewels, their banded structure becomes apparent in play of colours. This quality is specific with embossed cuts. The site of Veľký Ďur-Rohožnica is a typical deposit. Wood opals from Povrazník are those with nice colours. They are of brown, orange, orange-red colours and have bright glassy lustre. Wood opals occur in positions of pyroclastic rocks of stratovolcanos. *Common opals* occur at several places in Slovakia as well, often accompanying wood opals and chloropals. They have glassy to dull lustre and different colour variations. Rather big accumulations were unearthed e.g. near Mochovce (Dobrica) in vein fillings of andesite rocks. Another type of opal is the one from the crust of a weathering ultrabasic body near Hodkovce, eastern Slovakia. It also occurs in a variety of colour variations, from light yellow to green (colouring due to Ni mixtures).

Attractive stuff for cabochon cuts and minute embossed cuts are *fuchsites* or fuchsitic quartzes (occurring at Rudňany). They make altered rims of ultrabasic bodies and at some places they are rather thick. Their negative feature is that they have been secondarily fractured to a high degree.

Fractions of exclusive high-quality *epidotites* are suitable for decorative purposes as well. They are vein fillings in granitoid rocks of the Trábeč hills. Epidote veinlets are solid and massive and they can be as thick as several centimetres. Interesting pebbles can be found in alluvia of brooks crossing the mountain range. Being cut and polished, initially modest boulders obtain attractive structure and lustre. The *Levice travertine*, known as “golden onyx” for its remarkable colouring and banded structure, has been used for decades traditionally. First it was used for interior facing of noble mansions and burial vaults. Later utility artefacts, such as bowls and writing sets were made of it. In present tiny gemstones and accessories are made of its waste.

The Vth century AD jewellery from Cluj-Napoca (Romania): a non-destructive investigation

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The 2007 archaeological excavations carried out at the Polus Centre 5 km west of Cluj-Napoca (Romania), exhumed among others a princely tomb containing gold jewellery. It belongs to the Gepids, an East Germanic tribe which settled down in the nowadays Transylvania, in the second half of the Vth century AD. Nine gold pendants inlaid with a total of 45 slices of red gemstone were subject of a non-invasive (nor sampling neither dismounting of the gems from the jewels) and non-destructive (no damage to the gem) study. Previously, the gemstones were macroscopically assigned to the ruby variety of corundum.

Each pendant has a total length around 3.85 cm and consists of two parts: a leaf-shaped lower one, with four tablet-cut gemstones and an upper part, half moon shaped, with one gemstone. The stones are mounted in the cabochon technique and backed by a *paillon* – a reflecting layer of thin golden foil, stamped with a very regular and small cross-hatched pattern. Tiny gold balls decorate the pendants.

The observation with a stereomicroscope under normal light shows that gemstones consist of a highly transparent, dark red material. Almost each piece has a number of tiny inclusions, such as crystallographically oriented rutile needles intersecting at 70°, rutile „dust”, negative crystals, and probably apatite. Black, sometimes hexagonal-shaped, platy crystals are most likely ilmenite and occur frequently. The VIS spectra revealed absorption

bands in the violet and the blue/green transition zone, which can be assigned to Fe. The refraction index of some gemstones, measured with a Standard refractometer, is 1.78. The gemstones are isotropic.

The X-Ray diffraction and X-Ray fluorescence analyses on the pendant inner side showed only Au lines. No traces of other elements such as Ag, Te, Cu, Hg, Sb, Pt, Sn, which might allow tracing the origin of the gold, were seen. The pendant face containing gemstones additionally produced Fe lines. The Raman spectroscopy analysis in respect to the gemstones shows the typical spectrum of almandine, with the 350, 500, 550 and 915 cm^{-1} bands.

Based on optical characteristics, inclusion types, as well as the XRD, XRF and Raman spectroscopy data, the gemstones from the Vth century AD Gepidic pendant are most likely garnet group minerals, *i.e.* almandine.

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Microchemical and microstructural characteristics of cystine (a renal stone)

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Cystine is a rare renal stone (less than 2% of the patients forming urinary stones), an organosulphur amino-acid compound with a chemical formula $(\text{SCH}_2\text{CH}(\text{NH}_2)\text{CO}_2\text{H})_2$. Cystine stones are produced by an inherited disorder of the transport of amino acid cystine that results in excess of cystine in the urine. And thus may present a significant problem in urinary tract. Characteristic white calculi was provided by a male patient living in Kozani's area. These calculi were not previously identified, and thus was not determined as cystine stones. A comprehensive analytical study took place, employing the following analytical techniques: Electron Probe Micro-Analysis (EPMA), X-Ray Diffraction (XRD), thermal analysis (thermogravimetry TG/ Differential Thermal analysis DTA) Environmental Scanning Electron Microscopy (ESEM) coupled to a Cathodoluminescence (CL) tube. A characteristic concentric texture is clearly shown under the Electron Microprobe and the ESEM, with thick cystine layers inter-bedded with thin calcium hydroxyl-apatite layers. The elevated concentrations of sulphur are clearly shown under electron microprobe, while calcium and phosphorous prevail within the apatite regions. Characteristic hexagonal cystine crystals are observed under higher magnification. The mineralogical (XRD) analysis revealed a clear L-cystine structure (the less soluble amino-acid found in the urine). The thermal analysis revealed the characteristic endothermic peak at 248 °C found in L-cystine and a high amount of mass loss (90%), as expected for such an organic compound. Cathodoluminescence spectra were obtained from several areas of the stone. Some peculiar luminescence was observed on specific spots and is probably related to the cystine. Unfortunately, there are no relevant CL spectra of cystine samples found in the literature, thus preventing a comparative study. Nevertheless, our CL experiments are launching cathodoluminescence technique as a significant analytical technique for biomaterials characterization. In conclusion, our study proves that bio-geochemistry and the application of powerful analytical techniques could substantially help the medical advisors. In particular, having a thorough micro-chemical and structural analysis of an urinary stone, the medical treatment of diseases related to stone formation could be better scheduled. Knowledge of the precise stone composition may allow physicians to recommend an appropriate prophylactic therapy for the patient and thus prevent or delay the cystine stone recurrence.

FTIR study of archaeological organic residues from ancient Upper Macedonia, northern Greece

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The aim of this study is the application of Fourier Transform Infra-Red spectroscopy (FTIR) to the characterization of archaeological organic remains, collected from Aiani archaeological site, northern Greece. FTIR spectroscopy is a widely used analytical method in the study of complex biological material, and is commonly used in art and archaeology for the initial identification of compound classes. Aiani is located approximately 20 km south of the city of Kozani, western Macedonia (Greece). Aiani was within the region of the ancient kingdom of Elimeia which, together with the rest of the Greek kingdoms (Tymphaia, Orestis, Lyncestis, Eordaia, Pelagonia) constituted the ancient Upper (i.e. mountainous) Macedonia. The systematic excavational research, which began in 1983, has revealed the architectural remains of both large and small buildings, rich in small finds, and groups of graves and organized cemeteries dating from the Prehistoric to the Late Hellenistic period. Amongst a variety of pottery residues provided by the local archaeological authorities, two types of organic residues dated from prehistoric (ca 5000 BC) to Hellenistic times (2nd century BC), were chosen for this study: carbonized particles (one from the interior of a vessel and another from the exterior of a different vessel) and a cream-coloured non-carbonized residue. Due to the inhomogeneous nature of the solid residues, samples were ground and intensely homogenised prior to use.

Specimens for FTIR were prepared using potassium bromide (KBr) pellet technique. The samples were measured as they are found and partly the samples were carefully extracted with methanol. Some drops of these extracts were poured on KBr and left in an oven (50 °C) for two days, and after grinding, KBr pellets were prepared. The insoluble matter left from the extraction was also analysed by FTIR. Fourier Transform Infrared Spectroscopy analysis was carried out on a Bruker Tensor 27, equipped with a DTGS-MIR-detector and controlled by Bruker's OPUS software. Spectra were recorded by co-adding 16 scans at a resolution of 4 cm⁻¹ for as well the background (just KBr) as the sample. The infrared signal was recorded between 400 and 4000 cm⁻¹. Bands were identified by comparison with published assignments.

IR spectra of the organic residue samples reveal an abundance of C=O and C-O-R structures (1800-1000 cm⁻¹ region), while clay and silicate minerals predominate in the 400-600 cm⁻¹ and 3600-3800 cm⁻¹ zone. There are distinct peaks in the aliphatic stretching region (3000-2800 cm⁻¹), attributed to symmetric and asymmetric -CH₂ stretching. The C-O groups in the 1115 cm⁻¹ and 1040 cm⁻¹ region are also obvious. The 1040 cm⁻¹ band may also result from silicate minerals (Si-O bonds). The intense bands at 3400 cm⁻¹ are attributed to -OH stretching from H₂O or phenol groups. The fairly sharp band at 1370-1490 cm⁻¹ and the sharp transmission at 870 cm⁻¹ are ascribed to the presence of precipitated calcium carbonate. Aliphatic (3000-2800 cm⁻¹) and aromatic (1600-1700 cm⁻¹) bands show higher intensities in the dried extract samples compared to raw organic residue and insoluble matter samples. The intensity of the mineral bands (in the 400-600 cm⁻¹ and 3600-3800 cm⁻¹ zone) was preferentially increased in the FTIR spectra of the insoluble material. FTIR spectra of the carbonized residues show the presence of aliphatic and aromatic moieties and confirm the aromatic nature and the degree of dehydration that has taken place. Cream-coloured residues have a much lower organic content than the carbonized ones, with an overwhelming presence of precipitated calcium carbonate, as well as the presence of silica. Despite the fact that FTIR spectroscopy is mostly limited to initial identification of compound classes of unknown solids, it gave valuable information in our study and helped us to schedule the ongoing research on archaeological food remains from this area.

Palaeoclimate reconstructions for the Late Miocene in the Southeast Bulgaria using pollen data from the Tundzha Basin

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The results of palaeoclimate reconstructions of Neogene freshwater deposits of the Tundzha Basin (South Bulgaria, SE Europe) are presented. We analysed pollen and spores complexes with the aim of obtaining data about the climate conditions. The palynological analysis was performed on clayey sediments of the Elhovo Formation intercalated between coal layers from core C-432 situated in the central part of the Basin. The climate data reconstructed by the Coexistence Approach indicate a warm temperate climate with mean annual temperatures around 16 °C and with mean temperature of at least 5 °C during the coldest month. With annual precipitation rates commonly around 1000 mm climatic conditions were overall humid. Partly seasonally drier conditions suggested for the topmost part of Elhovo Formation by previous studies, were not evident from recent analyses. The Early Pontian climate was about 3-4°C warmer than today, with rainfalls at least 300 mm higher. These data coincide with the warming trend recognised in other regions in Bulgaria during the Early Pontian. Thus the data from current study contribute to the elucidation of the evolution of the local and regional Late Miocene climate patterns and contribute to the palaeoclimate model for the Balkan Peninsula.

Upper Jurassic – Lower Cretaceous platform-to-basin integrated stratigraphy across the Bulgarian/Serbian border

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This report presents the results of integrated microfossil biostratigraphy, facies and microfacies analyses with the purpose of age determination, correlation and tracing out of the carbonate platform-to-basin transition in the Callovian to Valanginian carbonate sequences across the Bulgarian – Serbian border.

The Upper Jurassic and Lower Cretaceous are of wide occurrence in the western Bulgaria and eastern Serbia. The sediments deposited in a bathymetrically differentiated basin, associated with the gradual emergence of the southern landmass and the formation of the Central Moesian Basin. The shallow-water sections are located in the southwestern prolongation of the Western Moesian Carbonate Platform and belong to the West Srednogorie Unit (Bulgaria) and Vidlič/Tepoš Zone (Serbia). The main part of the carbonate platform is represented by the limestones of the Slivnitsa Formation (Bulgaria) and the Crni Vrh Limestones (Serbia). Both formations are built up by thick-bedded to massive light grey to whitish organogenic and less common micritic limestones containing a large number of benthic foraminifers and algae, colonial corals, rudists, brachiopods, crinoids, gastropods and other benthic forms. The age interval is Callovian to Valanginian based on foraminifera and calcareous dinocyst. Six successive foraminiferal zones are recorded. Seven facies (facial zones) with specific microfacies types are superposed within the platform carbonates: homoclinal ramp (peloidal); reef and perireef (bioclastic); subtidal lagoon (nonfossiliferous and oncoidal), intertidal flat (fenestral and foraminiferal); subtidal lagoon (foraminiferal); reef

(*Bacinella* and *Lithocodium*) and slope (bioclastic). The carbonate platform deposits are covered by the clayey limestones and marls of the Salash Formation of Valanginian to Early Hauterivian age.

The Callovian to Valanginian peri-platform pelagic carbonates were deposited on the northern Tethyan continental margin. In the Western Balkan Unit (Bulgaria) the pelagic record consists of the sediments of the Yavrets, Gintsi and Glozhene formations. Their correlatives in the Stara Planina-Poreć Zone (Serbia) are Kamenica, Pokrovenik and Rosomać formations. These are micritic and clayey nodular pelagic limestones formed in relatively deep basin conditions under quite low rates of sedimentations. Starting from the Late Berriasian, the basinal carbonate accumulation was quickly replaced by hemipelagic alternation of clayey limestones and marls which continued up to the Hauterivian (Salash Formation in western Bulgaria and Ržana Formation in eastern Serbia). Diverse ammonites and planktonic microfossils such as calcareous dinocysts, calcareous nannofossils and calpionellids were applied for detail zonations, stage and substage subdivisions. For the Oxfordian–Valanginian interval twelve calcareous dinocyst zones, five calcareous nannofossil zones and seven calpionellid zones are recorded. In the basin facies six microfacies within the pelagic carbonates are superposed: filamentous, *Globuligerina*-Radiolarian, *Saccocoma*, *Globochaete* and calpionellid and spicule microfacies. Stable sedimentary environment persisted during the whole Late Jurassic. Since the Late Berriasian a clear bathymetrical tendency occurred in the pelagic carbonates from west to east – platform slope, basin and a periphery of flysch trough.

The carbonate platform sedimentation started with the formation of a homoclinal ramp in the Callovian and passed through a rim platform during the early Kimmeridgian. The platform evolution includes three main stages – stepwise progradation, aggradation and retrogradation during the late Kimmeridgian to Valanginian. The phase of platform drowning started in distal portions of the platform. The drowning phases are documented by erosional surfaces, hiatuses and condensed glauconitic beds. The drowning of the platform shows westward younging from the earliest to Late Valanginian.

Fossilized microorganisms preserved as fluid inclusions in epithermal veins, Vani Mn-Ba deposit, Milos Island, Greece

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Fossilized microorganisms preserved as fluid inclusions are found in barite–silica–Mn oxide veins in the marine rift basin-related Quaternary Mn-Ba deposit of Vani, Milos. Basin fill consists of 35-50 m thick sequence of glauconitic sediments sandwiched between volcanoclastic sandy tuffs, and bedding-parallel barite–Mn oxide(–silica) horizons, pebble horizons, and massive gravel. Exhalative barite-rich deposits characteristic of sea-floor venting, such as white smoker (sulphate) structures in glauconitic sediments, feeder veins, bedding-conformable horizons, and extensive microbial mat-related structures in sandy tuffs, were recognized. The feeder veins host the microfossils and consist chiefly of banded barite and minor colloform quartz, Fe-oxyhydroxides, and hollandite-group minerals and MnO₂ phases, and display epithermal textures characteristic of open-space precipitation. Curvilinear, branched filamentous microfossils with distinct segmentation of septa and a turgid appearance of knob-like outgrowths occur associated with spheroidal spore-like microfossils and small twisted microstructures. Both filamentous and spheroidal microstructures are filled with aqueous (liquid ± vapour) and/or hydrocarbon phases. Oil and solid hydrocarbons in the fluid inclusions may represent decomposed biological material. Chitin was detected by the pigment Wheat Germ Agglutinin conjugated with Fluorescein Isothiocyanate (WGA-FITC) in

some of the microfossils, indicating that they are fossilized fungi; a fungal interpretation is further supported by microfossil morphology. Smaller, often twisted filamentous microfossils with a simpler morphology in which chitin was not detected probably represent fossilized prokaryotes and, if so, prokaryotes and eukaryotes co-existed in the geothermal system of Vani. Fluid inclusion microthermometry shows that microfossils were trapped at temperatures of ~100°C in boiling water, probably evolved seawater. Preservation of microfossils occurred at shallow sub-marine conditions of <10 m depth. Our results show that fluid inclusions may contain valuable palaeobiological information and can be used both for establishing biogenicity but also for the reconstruction of the palaeoenvironment of fossilized microorganisms.

Structural and geochronological evidence for Palaeogene shearing in the Rhodope Mountains (SW Bulgaria)

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The basement rocks of the Rhodope Metamorphic Province (RMP) in SW Bulgaria and NE Greece belong to a synmetamorphic, eastern Mediterranean nappe stack with layers of continental crust and ophiolites. It has been assembled during a complex history in an Alpine active continental margin realm along the southwestern border of Moesia. During late and post-collisional stages, deeper levels of the nappe stack have been exhumed as metamorphic core complexes along low-angle detachment faults. The late stages of extension were associated with rift basin formation, volcanism, erosion and sedimentation.

On the basis of lithotectonic and palaeogeographic considerations the present-day structure of the RMP can be generally subdivided into a lower, middle and an upper tectonic level. Lower and middle levels are jointed along the top-to-the-SW Nestos shear zone, middle and upper levels probably along the top-to-the-NNW Borovica Shear Zone.

We combine structural, metamorphic and U-Pb zircon geochronological datasets in order to unravel the complex history of the RMP. U-Pb zircon geochronology by LA-SF-ICP-MS was carried out on samples from pegmatite veins and granitoid intrusions from the Rhodope Mountains in Bulgaria.

One study area is a broad profile in the Western Rhodopes. The section cuts the eastern part of the Neogene Struma Graben, the Palaeogene Mesta Graben, the basement of the southern Pirin and western Rhodope Mountains, intrusions therein and extension-related structures (e.g. Strymon Valley Detachment, Ribново Low-angle Normal Fault). In the basement, lower (Pangaion-Pirin Complex) and middle (Sidironero-Mesta Unit) levels of the nappe stack are exposed. The main shearing event within the two levels is top-to-the-SW and related to the activity of the Nestos Shear Zone. U-Pb zircon geochronology by LA-SF-ICP-MS was carried out on samples from three granitoid intrusions.

The undeformed and therefore post-tectonic Teshovo (South Pirin) Pluton intruded into the lower level and gives zircon crystallization ages of 32 ± 0.2 Ma. Both the Dolno Dryanovo and Spanchevo plutons intruded into the middle level and are syn-tectonic to the main foliation. Their single-phased magmatic zircons and magmatic rims yield ages of ca. 56 to 55 Ma, whereas inherited cores display ages of ca. 143 to 145 Ma. Variscan zircons, which are typical for basement rocks from the Pangaion-Pirin Complex, are not present in samples from the Spanchevo and Dolno Dryanovo plutons. These results indicate that at ca. 56 to 55 Ma the Sidironero-Mesta Unit was not yet placed upon the Pangaion-Pirin Complex. Therefore, the southwest directed thrusting of the middle level over the lower level took place between ca. 56 to 55 Ma and ca. 32 Ma.

The second study area is situated in the eastern part of the Central Rhodopes in Bulgaria. Rocks from the lower tectonic level (Arda Unit) are overlain by rocks from the

middle tectonic level (Starcevo Unit) along the Starcevo Fault. More to the east the Starcevo Unit is juxtaposed to overlying rocks of the Borovica Unit along the Borovica Fault, which probably represents the border between the middle and the upper tectonic level.

U-Pb zircon geochronology was carried out on samples from deformed and undeformed pegmatite veins which were taken a) in the border area between the Arda and Starcevo units in the hanging-wall of the Starcevo Fault near Nedelino, and b) in the area of the Borovica Shear Zone at the western flank of the Pripek Granite along the road to the village Dolen east of Zlatograd. For a) preliminary results show a zircon crystallization age of around 36 Ma for an undeformed vein, for b) preliminary results show zircon crystallization ages of around 44 Ma for mylonitic veins and therefore suggest a Lutetian age for the activity of the Borovica Shear Zone.

We propose a model where the lower tectonic level of the RMP is Apulia-derived and where the present-day structure of the Rhodopes can be explained by a subduction polarity reversal from SW-dipping in the Jurassic and Early Cretaceous to NE-dipping in the Late Cretaceous and Palaeogene.

A petrologic examination and detailed mapping of the tectonic margin between the Jurassic Pindos-Vourinos ophiolite and metamorphic Triassic-Jurassic Pelagonian platform carbonates in West Macedonia, Greece

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At the end of this decade, the Ilariona hydroelectric dam will be completed in west Macedonia (Greece). The Aliakmon, the longest river in Greece, will be dammed and its valley will be flooded. Within the area to be flooded the Aliakmon has cut a valley deep into the contact zone between the mid Jurassic Pindos-Vourinos oceanic lithosphere complex and the Paleozoic-mid Jurassic continental Pelagonian margin. In order to preserve as much information as possible, the Aliakmon Legacy Project aims to gather geological data from the future flooded areas. In the framework of this project, a detailed geological map has been prepared and rock samples have been analyzed in the lab.

The Pindos-Vourinos Ophiolite is a spoon-shaped ophiolitic nappe that was obducted in Jurassic time. The Vourinos Ophiolite is located at the leading edge of the nappe whereas the Pindos Ophiolite is located at the trailing edge. According to the fracture pattern with a common dip of 40° to the SW, the mapped area can be located in a central position at the leading edge of the Pindos-Vourinos Ophiolite.

Various techniques have been used to analyze collected rock samples. In addition to petrographic and a reflected light microscope techniques, data has been acquired using electron microprobe analysis (EMPA). For the ophiolitic section, it could be shown that the degree of serpentinisation increases with proximity to the contact zone. Relicts of olivine and pyroxenes can be found together with chromite and magnetite. EMPA displays high content of oxygen, magnesium and silica for the peridotites. Furthermore, a relative accumulation of chromium relative to magnesium (10:1) can be found in the altered outer zones of chromite minerals compared to less altered inner zones (3:1). Towards the thrust sole, increasing shear strain causes tectonic brecciation (deformed host rock remnants in highly sheared matrix) as well as mylonitic occurrences of peridotite.

The Pelagonian carbonates of the Vounassa vary from microcrystalline over sugary-grained to granular crystalline rocks. Intermittently, brownish, reddish or white bands cut through the carbonates. Close to the shear zone, the carbonates have been metamorphosed to marble. Thin sections of the granular crystalline carbonates display angled crystals, partly with twin lamellae distorted by kink bands. The mylonitic marble contains larger-grained

calcite crystals with kink bands and smaller included quartz grains. Overall, the Pelagonian carbonates have been subjected to an early ductile deformation that is crosscut by a subsequent brittle deformation.

Between the ophiolitic nappe and the Pelagonian carbonates lies a 400 m – 600 m thick wedge of phyllitic to schistose sediments with intercalated fault wedges, the Zavordas Mélange (ZM). The main part of the ZM is formed by the Agios Nikolaos Formation. This formation is predominantly composed of phyllitic, pebbly mudstones and carbonate mylonites. The carbonate mylonites are very soft and easy to erode. Thus, the Aliakmon mainly cuts its valley into this unit. It contains microcrystalline as well as granular crystalline calcite with kink bands running through twin lamellae. Furthermore, a minor amount of quartz can be found. The fault wedges, intercalated in the ZM, consist of autochthonous as well as allochthonous rocks. The allochthonous rocks are meta-diorite, pillow lavas and the so-called “rainbow rocks“. The meta-diorites contain twinned plagioclases and grain size grades to gabbroic. The pillow lavas exhibit intersertal mineral laths and few epidotes. The “rainbow rocks” include interbedded strata of quartz-bearing micritic carbonates, volcanic ashes and tuffs and detrital silts.

Large parts of the mapped area are covered by young conglomerates, breccias and rock slides either from Vounassa or Vourinos mountains.

Lithostratigraphy of the Pleistocene deposits of Georgian sector of the Black Sea

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Researches took place in the South of Georgia (Guria region). Studied geological sections lie 1.5-4 km from the present Black Sea coastline. Pleistocene marine sediments are represented by terraces located at different hypsometric levels with maximum height 120 m on the mountain of Tsvermaghala. Due to neotectonic movement, the Old Euxinic sediments are located at the higher hypsometric level than the younger Uzunlarian and Karangatian. In the region under study the background sediment of the base of Old Euxinic sections, are mud deposits, upward they gradually pass to fine and middle size sands. The base sediment probably was deposited in offshore zone at a depth until approximately 50 m. The Uzunlarian and Karangatian sediments are represented by typical shore zone sediments. Uzunlarian sediments unconformably overlie the inverted Miocene. The base of these sediments contains abrasion clay blocks of the before Pleistocene age. Chemical analysis of the Pleistocene and contiguous recent Black Sea shore sediments on metal content reveals similarity of feeding provinces. The higher contents of manganese and Nickel in the recent sediments are caused by anthropogenic factor. Stratigraphy of the studied region is based on the mollusk and ostracode faunistic complexes. Old Euxinic sedimentation conditions were more favorable for the fauna conservations than Uzunlarian and Karangatian ones, which contains very poor fauna and boundary between them is conventional.

Results of advanced mineralogical and geochemical studies in the Carpathian mélangé zone and selected units (Polish-Ukrainian-Slovak “triangle”)

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The research concerns fracture fillings from the tectonic mélangé zones in the Carpathians and the tectonic units in the area of the borderland of Poland, Ukraine and Slovakia, as e.g. in the south-easternmost part of the Polish Carpathians (within a sort of a Polish-Ukrainian-Slovakian territorial “triangle”). Samples from two localities have been studied in detail. The following research methods were applied: polarizing microscope (cathodoluminescence analysis – CL, fluid inclusion studies - FI), scanning electron microscope (SEM), X-ray diffraction analyses (XRD) and isotopic analysis, as well as the gas chromatography and Rock-Eval studies of the organic matter. The stress has been recently put onto the geochemistry of the bitumens – both in the association with the minerals and in the rocks. The advanced analyses concerned also whole minerals and the inclusions in them. The minerals, as carbonates, quartz, dark bituminous matter as well, have been filling in fractures and “pockets”. The results obtained are light isotope data for calcite that fall into intervals between 20.6 ‰ and 28.6 ‰ and from -1.4 to +0.5 ‰ for oxygen ($\delta^{18}\text{O}_{\text{SMOW}}$) and for carbon ($\delta^{13}\text{C}_{\text{PDB}}$), respectively. They point to at least two calcite generations. The quartz (the Marmarosh diamonds) displays a wide range of $\delta^{18}\text{O}_{\text{SMOW}}$ values from 14.9 to 22.4 ‰ as it results from point data, and from 23.2 to 27.6 ‰, shown by determinations by a classic method. An increase in almost all determination results towards SE may be noticed. Geochemical analyses of bitumens show a great differentiation in three regions almost in all data. XRD studies of black organic aggregates in the form of lenses point to the presence of the following minerals: quartz, dolomite, calcite, clay minerals, gypsum with anhydrite admixture, traces of pyrite and siderite. Feldspars are also present. The pyrolytic Rock-Eval analysis of samples from the Jablonki region showed a variable TOC in the interval from 0.77 to 35.83% TOC, dependant on the sort of material analysed, generally between 0.77 and 4.44 %, with a low HI (from 30 to 116 mg HC/g TOC). Samples display high degree of thermal evolution, which corresponds to the end of generation processes (the end of the oil window). In the composition of the extractable organic matter, the saturated hydrocarbons constitute a majority of 61.3%, that points to adsorption of the generated or migrating oil. Due to the fluid inclusion studies conducted under the microscope in thin sections (calcite) and in glued wafers or loose crystals (quartz), inclusions were characterized in minerals.

Due to the geochemical analyses of the inclusions in the minerals, it can be concluded that the mineral-forming palaeofluids were light mineralized of the chlorine-sulphate-carbonate type. They were the carrier medium for light and gaseous hydrocarbons. In the localities studied, the mélangé zone near Jablonki - Rabe is the most specific area as for its mineralogical – geochemical complexity. As it further results from FI, the formation conditions for the studied members of parageneses and associations in the regions under research were temperatures of about 240-250 °C and diversified pressures. The formation waters must have had composition higher than 10‰ $\delta^{18}\text{O}_{\text{SMOW}}$. The migrating fluids were mineralized waters and hydrocarbons of different composition. On the base of complex studies and fluid inclusion analyses it may be concluded that the mélangé in the Jablonki region is the most specific zone and a hydrocarbon migration path. Hydrocarbons were generated from the terrigenous organic matter which corresponds to the menilite schists, multifold studied within the Silesian unit.

Petrological studies, isotopic and fluid inclusion relations in the Miocene sandstones in the Polish segment of the Carpathian Foredeep

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The study concerns the Sarmatian, deltaic sandstones from the eastern part of the Carpathian Foredeep basin. Samples from five boreholes: Chalupki Debnińskie 1, Jodłowska 18, Kupno 2, Nowosielce 3 and Pruchnik 22 have been studied. The following research methods were applied in rock observations: polarizing microscope (dyeing analysis, cathodoluminescence studies – CL, fluid inclusion studies - FI), scanning electron microscope (SEM) investigations and energy dispersive spectrometer studies (EDS ISIS), X-ray diffraction analyses (XRD) and isotopic analysis.

Petrographically, these sandstones are medium- to very fine-grained – sublithic and subarkosic arenites and wackes. The main component of the sandstone grain framework is quartz (19.7 – 70.6 vol. %) with predominance of mono- to polycrystalline quartz. Feldspars (1.7 – 12.3 vol. %) are often represented by potassium feldspar and rare by acid plagioclase, which in CL have blue and green luminescence, respectively. Among lithoclasts (0 – 18.3 vol. %) fragments of carbonate rocks are predominating over clastic rocks, granitoids, volcanic rocks and quartz-mica schists. Micas (0 – 14.0 vol. %) are represented mainly by muscovite, sporadically by biotite. Among bioclasts (0 – 3.3 vol. %) shells of foraminifers, bivalves and brachiopods and fragments of echinoderms and bryozoans have been identified. Glauconite (about 1 vol. %) forms oval-shaped grains of different size. Heavy minerals are rare. Porosity of the sandstones is often of about 30% (primary and secondary porosity).

In the sandstones cement, matrix composed of mud quartz and detrital clay flakes was described, being locally impregnated by iron hydroxides, organic matter and pyrite. XRD analyses show mainly the presence of smectite, illite and chlorite. Booklets of kaolinite vermiform crystals and Mg/Fe-chlorite rims on quartz grains have been observed in SEM investigations. Authigenic quartz mostly forms thin overgrowths on quartz grains or singular, euhedral prisms in the pore space of rocks. Carbonate cements are represented by common calcite (micrite and spar) and subordinate dolomite/ankerite and siderite. The chemical composition of calcite is: 92.7 – 98.8% mol. CaCO₃, 0 – 4.6% mol. FeCO₃, 0 – 1.8% mol. MgCO₃ and 0 – 2.5% mol. MnCO₃. Calcite becomes purple in Evamy's solution and is characterized by red-orange and orange-yellow colours in CL. Fluid inclusions observed in the calcite cement in the Pruchnik 22 borehole are distinctly one phase. They are of two types – transparent (L1) and dark (L2). Their size oscillates from < 1 μm to small (1 – 2 μm). Some of them do not show any characteristic feature in the heating-freezing mode. The inclusions do not create a bubble when freeze, however, their one phase character points to low temperatures of the cement formation – below 50°C. The eutectic temperatures of about (-39°C) point to the NaCl-CaCl₂-MgCl₂-H₂O system, that means they characterize chemical system of dissolved ions of Cl⁻, Ca₂⁺, Mg₂⁺, Na⁺ and Fe₂⁺, while the ice melting temperature of -9.6°C proves the fluid salinity of 13.52 % NaCl eq. The δ¹⁸O data from calcite vary from -8.61 to -5.51‰PDB. They show that calcite precipitated from pore water which was a mixture of marine and meteoric waters. The δ¹³C values are in the interval of -5.72 to -1.71‰PDB and suggest inorganic origin of carbon. Dolomite/ankerite very often forms rhombohedrons. Some of crystals show zonation. The chemical composition of dolomite minerals is: 52.4 – 61.4% mol. CaCO₃, 18.1 – 44.3% mol. MgCO₃, 0 – 21.0% mol. FeCO₃ and 0 – 1.6% mol. MnCO₃. Microcrystalline siderite occurs as scattered crystals in sandstones. Siderite varies widely in composition, being enriched in magnesium and represents sideroplesite.

Nuclear magnetic resonance (NMR) and mercury porosimetry measurements for permeability determination

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Permeability, the most important reservoir property of rock can be directly measured on samples and determined using various statistical relationships between petrophysical parameters. We tested usefulness of Swanson parameter obtained from the mercury porosimetry results and T2 relaxation time from the Nuclear Magnetic Resonance (NMR) to find adequate formulas to improve permeability determination. We used the Devonian carbonates and the Carboniferous mudstones from the Western Carpathians and the Rotliegend sandstones from the Foresudetic Monocline in Poland. New factors as Swanson parameter or T2 relaxation time in NMR are effective in creating empirical relations describing reservoir parameters of rocks. Precision of measurements and features of rock decide about quality of the relations and their effectiveness.

Statistics to improve results of well-logging interpretation in reservoir rocks: Two cases from the Carpathian Foredeep

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Principal component analysis, cluster analysis, and discriminant analysis were applied to well-logging data from the Miocene clastic formation in the Carpathian Foredeep, Poland. The main goal was to improve the results of interpretation of well logging in terms of determining gas-saturated horizons. The presented examples illustrate how statistical methods help limit the number of log data while preserving sufficient information. In addition, the two cases illustrate the grouping of data into clusters to reveal sets of features attributed to reservoir horizons and sealing layers and construction of discrimination functions to distinguish between gas- or water-saturated beds of sandy-shaly lithology.

Preliminary results about a new locality with micromammals from the Early Miocene deposits of the Kazan Basin (Central Turkey)

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A new fossil micromammal locality was discovered within the framework of the EU VAMP (Vertical Anatolian Movements Project) Topo-Europe Project. The locality is an old quarry situated in the area of the village Gökler, in the southeastern part of the Kazan Basin, N of Ankara. The section is characterized by few coal horizons and by alternate whitish, greenish and pinkish silty mudrocks, partly laminated. During summer 2009 field campaign, the section was sampled for ostracodes, pollen, small mammals and for magnetostratigraphy. Unfortunately, the signal from paleomagnetic samples was weak, but few samples showed

normal polarity. Ostracodes are abundant through all the section and they are typical for a lacustrine environment.

The testing samples for small mammals came from two horizons rich in organic material and yielded very promising content of small mammals. Both rodents and insectivores were recovered. The insectivores are not yet processed whereas here we present the first data about the rodents. The assemblage of rodents is characterized by the dominance of three species of *Eumyarion*. Very abundant is also *Democricetodon* aff. *franconicus*, whereas *Cricetodon* sp., and *Vallaris* sp. are not very common. Gliridae are represented by *Glirudinus* cf. *haramiensis*. The presence of three species of *Eumyarion* is very unusual. The only locality with so diversified genus *Eumyarion* is Sabuncubeli (lower part of MN3). During the MN4, in Anatolia, small forms of the genus *Eumyarion* were replaced by *Anomalomys*. The general composition of the fauna shows very close relationships with the Keseköy locality (lower part of MN3). Therefore, we conclude that the age of the Gökler assemblage best fits to the lower part of MN3. During the next field season we are planning to perform main sampling of the locality and we are expecting to recover more specimens and to get a more detailed frame of the Gökler assemblage.

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Evaluation of present day seismicity in the Aegean Region using Kaltek Method

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The relative size distribution of earthquakes is an essential input parameter needed to perform probabilistic seismicity analysis. In this analysis, the basic well-known equation of Gutenberg-Richter relation ($\text{Log}N=a-bM$), one of the well-fitted empirical relations in seismology, the frequency of occurrence of earthquakes as a function of magnitude is explained. Many researchers accepted that the b-value in this equation reflects the region seismicity. For the calculation of a and b parameters, many methods are used such as Maximum likelihood, least-square, weighted least-square, Kaltek method, etc. We used newly developed Kaltek method. This method is constituted one assumption and one hypothesis for the calculation of b-values. *Assumption*, The a-value in the Gutenberg-Richter relation demonstrated exponential distribution of the earthquakes that are zero magnitude. *Hypothesis*, Under this assumption; the a-value calculated from the whole region data set can be accepted as a constant value for the calculation of new b-value belonging to each subregion, which are included by the main region. On the other hand, the number of earthquakes that have zero magnitude is equal to the constant value for each subregion or every point of the whole region.

In this study, the spatial distributions of seismicity and seismic hazard were assessed for Aegean Sea and its surrounding area. For this purpose, earthquakes that occurred between 1964 and 2010 with magnitudes of $M \geq 4$ were used in the region ($32-42^\circ\text{N}$ and $20-30^\circ\text{E}$), selected from International Seismological Centre (ISC) catalogues. For the estimation of seismicity parameters and its mapping, the Aegean Sea and surrounding area are divided into ($0.25^\circ\text{N} \times 0.25^\circ\text{E}$, $r=0.25^\circ$) 1,681 circular subregions. The a and b-value from the Gutenberg-Richter frequency magnitude distributions is calculated by the classic way using the least-squares technique. In this calculation, the minimum, maximum and average a-values are found to be equal to $a_{\min}=1.08$, $a_{\max}=10.98$ and $a_{\text{avr}}=5.22$, respectively, in the 1,681 subregions. Variance and standard deviation of the a-value are estimated to be $v=2.0$ and $q=1.4$. we calculated new b-values for every subregion taking a constant a-value which is equal to $a_{\text{avr}}=5.22$ according to Kaltek procedure.

Our results and the seismicity map obtained from the Kaltek method showed very good consistency with the tectonic and earthquake activity in the region. The minimum, maximum and average b-values are determined as $b_{\min}=0.65$, $b_{\max}=1.30$ and $b_{\text{avr}}=1.05$, respectively. From the map view of the b-value, we distinguished two aseismic zones of different sizes in the Aegean Sea. These zones are characterized by high b-values ($b=1.15-1.25$). First zone locates off the Crete Island between $23.4-25.6^{\circ}\text{E}$ and $35.4-36.4^{\circ}\text{N}$. The second zone is placed between $23.4-26.6^{\circ}\text{E}$ and $37.0-38.4^{\circ}\text{N}$ on the Cycladic units in the Aegean Sea.

Bolkardağı bauxite deposits at Ayrancı, Karaman, Central Turkey. Part 2. Mineralogical and petrographical studies

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The studied area is located 15 km southeast of Ayrancı (Karaman) district, covering an area of about 300 km². The aim of this study is the petrographic definition of the bauxite. For this purpose thin and polished sections of over 30 samples from bauxite were examined that and X-ray Diffraction (XRD) analyses were carried out. In the area, there is a Permian - Cretaceous aged rock of the Bolkardağı unit which is one of the tectonic nappes, overburden by Miocene aged formations. The bauxite ore bodies are observed between dolostone and limestone which belong to the Upper Permian Dedeköy Formation. The bauxite is thought because of it became terrestrial emerging during Late Triassic-Early Jurassic (?) period. The bauxite consists of different amounts of diasporite, hematite, and clay minerals. Ore paragenesis is reported as diasporite, hematite, kaolinite, anatase, rutile, sphene, calcite, muscovite, magnetite, quartz, goethite, chlorite, amorphous iron- and aluminum-hydroxide, gibbsite, boehmite, illite, specularite, epidote, chalcedony, amphibole and psilomelane. Inside bauxite, different ore types which have different appearance can be defined. These different appearances emerge essentially depending on the prevalence of diasporite, hematite and clay minerals, and they pass into vertical and horizontal transitions to each other. These ore types are black bauxite, brown bauxite, oolitic bauxite and clayey bauxite.

Continuous extra-framework Na⁺ release from Greek analcime-rich volcaniclastic rocks on exchange with NH₄⁺

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The continuous extra-framework cations release from Greek analcime-rich rock sample was studied, upon ammonium acetate exchange experiments (agitation time 0.25-720 hours), using atomic absorption spectrometry. The analcime-rich material was examined by X-ray powder diffraction, scanning electron microscopy equipped with energy dispersive micro-analytical system and atomic absorption spectrometry. Its sorption ability was measured using the Ammonium Acetate Saturation method. The monovalent cations K⁺ and Na⁺ after 720 hours, show only 7 and 10% of exchange, respectively. No steady state achieved for Na⁺. The bivalent cations Ca²⁺ and Mg²⁺ show better exchange, 97% for Ca²⁺ and 62% for Mg²⁺. The calculated rate of ion-exchange was 0.01 ppm/h for K⁺ and Mg²⁺, while 0.13 ppm/h for Na⁺ and Ca²⁺. The recorded behaviour on the multi-component ion-exchange system and the linear release of Na⁺ over NH₄⁺ observed at a slow rate of ion-exchange, can allow us to propose studied analcime-rich rock as a potential material for waste-water purification and pet litter.

Late Eocene-Oligocene palaeogeography of Thrace Basin and its relationship with Eastern Thrace Basin

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Thrace Basin is an area of interest for many studies since it bears a significant natural gas and oil potential. There are two prevailing views with the development of the basin. One of these views is that Thrace Basin was a fore-arc basin, generated by the northward subduction of Inner-Pontide Ocean during Middle Eocene – Oligocene. The second view assumes that Thrace Basin was an either intermountain or collisional basin.

Sedimentological studies and facies analysis conducted in Thrace Basin indicate that there are 13 distinct facies. It is revealed that Late Eocene-Oligocene sediments were deposited under shallow marine, lagoon and terrestrial environments by means of lateral and vertical facies associations. It is observed that the sequence commenced from a deep marine environment and upward passed to shallow marine and terrestrial environments from Eocene onwards in general. Besides, the presence of volcano-clastic materials within the sequence implies that the sequence was accompanied by a volcanism during the deposition. In the light of these data, it is considered that the fore-arc basin model will be appropriate.

Thrace Basin is separated from the basin in the east by Çatalca and Istranca uplift. This basin is known as “Eastern Thrace Basin”. The fill of this basin is composed of Oligocene marine Karaburun formation, overlying unconformably reefal limestones of Middle-Late Eocene unconformably. Karaburun formation begins by beach clastics as a transgressive series, and lasts by shallow marine and pelagic clastics and carbonates, and upward passes to deep marine clays bearing olistostromal units. These are overlain by deep marine channels, followed by uppermost coaliferous delta plain facies. This sedimentary succession shows that this basin is distinct from Thrace. Resting on Karaburun formation, delta plain sediments are characterized by lagoonal and some fluvial inputs, and have an age of Early-Middle Miocene based on mammalian fossils. Since it lies unconformably over beach deposits, it is differentiated here as a new unit, the Ağaçlı formation. It has an extent between Ağaçlı and Akpınar villages. Lithologically it includes claystone, marl, coal and some conglomerate and sandstone levels, and its thickness is up to 55 m. The sequence has a lagoonal character, and its lower levels bear fluvial inputs. The mammalian fossils such as *Cricetodon meini*, *Democricetodon* sp., *Microdyromys* sp., Rodentia indet., *Alloptox* sp. are collected from mudstones in these levels, and an age of Early-Middle Miocene is given to this unit. Its age is Oligocene-Early Miocene according to pollens from these levels. We confirm the view that Thrace Basin is a separate basin from the Eastern Thrace Basin, and they do not form terrestrial basin occasionally intruded by marine inputs.

The Isparta Angle and its relationship with Aegean-Cyprus Tectonic Arcs, SW Turkey

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Recent active tectonics of the southwestern Anatolia region is very interesting and complex for academic studies. It has been studied about plate tectonics especially for 20 years. Taurus Mountains in Turkey which are located in Alpine-Himalayan orogenic belt, are one of the most active tectonic region in this orogenic belt.

Although the Taurus Mountains generally run in approximately east-west direction, this order is interrupted in Isparta-Burdur Region (Lakes Region). They locally bend and form an inverse V shaped angular deformation which is formed around the lakes region located in the north of Antalya Bay. This tectonic structure is known as the Isparta Bend or the Isparta

Angle in geological literature. Isparta Angle is a big active tectonic structure in the Southwestern Turkey. It is related with subduction zone located between African and Eurasia in Mediterranean Sea at south of Turkey. Subduction zone is the most important convergent plate boundary in the region and is divided into two parts in the south of Turkey. These two parts are called Aegean and Cyprus tectonic arcs. They extend from the Eastern Mediterranean Sea towards the Aegean Sea along the southwestern coast of Turkey. Main reason of the seismicities that occurred in the region are these subduction zones.

Southwestern Anatolia is under the influence of N- S compressional forces along the Aegean and the Cyprus tectonic arcs due to the African–Anatolian Plate's activities and also southwestern part of Taurus Mountains includes lots of enigmatic structures. These subduction zones have different seismotectonic and seismicity characteristics particularly in the east and west of Fethiye Bay. This difference has formed structurally large-scale tectonic fracture zones and big important tectonic structures for example Isparta Angle in the region. This angle is bordered by Aegean-Cyprus tectonic arcs in the south, Southwestern Anatolian Fault at the west and Kirkavak Fault at the east. Southwestern Anatolian Fault is one of the most important NE-SW direction and left lateral slip fault which is located between Fethiye Bay and Eğirdir Lake. On the other hand, Kirkavak Fault is one of the most important NNW-SSE direction and right lateral slip fault which is located between Eğirdir Lake and the Mediterranean Sea. These are conjugate faults and syntectonic deformations in the region. This large-scale structural deformation, which has played an important role in the geodynamic and geotechnical revolution of the region, is located in the Lakes Region in the north of Antalya Bay, Southwestern Turkey.

The Aegean Arc is higher seismicity than Cyprus Arc. This arc differentiates in direction toward NE and NW in south of the Crete Island because of it locally bends an edge around south of island. It caused a forming of a big tectonic line in the region known as Southwestern Anatolian Fault also known as Fethiye-Burdur Fault Zone. On the other hand, it is believed that this bending is responsible for the extension in Western Anatolia since at least the middle-Upper Miocene. Isparta Angle has formed during the Paleotectonic Period (Middle Miocene time), and its evolution continues up until the present time since Upper Miocene. Even today it is the most important active tectonic deformation in the region. During the Neotectonic Period, many interesting events and structures are resulted due to this active tectonic deformation since the Upper Miocene. Examples of these events include active faulting, seismicity, volcanism and continental/lacustrine deposition in southwestern Turkey. On the other hand, The Central Anatolia moves westward along the North Anatolian Fault, relative to Eurasia. However, the Western Anatolia (west of the Isparta Angle) moves in a SW direction along the Southwestern Anatolian Fault. These are major evidence for active tectonic in the region. One of the significant deformations in the Mediterranean Sea is the Pliny-Strabo Trench that has a left lateral slip, extends as the Southwestern Anatolian Fault between the Fethiye Bay and the Eğirdir Lake in southwestern Turkey. Western and the Central Anatolia were separated from each other with the Southwestern Anatolian Fault.

Main purpose of this study is to present the effects of the Aegean and the Cyprus tectonic arcs on the Isparta Angle at the southwestern Taurus and all tectonic structures during the paleotectonic and neotectonic periods.

Non-destructive study on objects from Benedictine Abbey of Einsiedeln

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During this study, chalices made about start of 17th century were investigated. This is the first time that these objects were studied from people outside the Abbey. The goal of the study was to characterize the gems of these items and to compare them with the observation

of Father Eustach Tonassini at the end of 18th century. The examination of these chalices took place in the Laboratory for research in conservation at the Centre of collections of the Swiss national museum using only non-destructive methods. More precisely, binocular microscope on a modified stand was used to observe the internal features of the stones, long- and short-wave ultraviolet lamp to see their luminescence, x-ray fluorescence (XRF) for chemical and Raman spectrometer associated with a microscope for spectroscopic/vibration analysis.

After the examination, it is found that all studied gems are natural; neither imitations nor synthetics were identified. It seems also, after studying pearls' chemistry, that all are of saltwater origin. Moreover, comparing our results with those observed by Father Tonassini, it appears that what he had correctly all the rubies, except of some which are dark coloured almandines. He had correctly identified all diamonds too, amethysts (except of two which were dark coloured almandines), sapphires (except of one which is olivine) and emeralds (except for the big stones which are olivines). All the stones that he called "chrysolith" are olivines (the gems quality is a.k.a. peridot), these called "Hyakinths" grossulars and those called "Topaz" are either citrine or grossulars. Finally, Father Tonassini in his manuscript mentioned that the gems are "orientalisch", *i.e.* from oriental countries. Studies of gems inclusions did not exclude this possibility. However, more research is needed in order to study better the possible geographical origin of these stones.

Shear-wave Q determination for the Upper Crust of Western and Central Slovenia

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We have estimated the quality factor, Q_{β} for shear-waves for western and central Slovenia for five frequency bands centred at 0.8 Hz, 1.5 Hz, 3.0 Hz, 6.0 Hz and 12.0 Hz. We used 150 high quality broadband waveforms, from 15 shallow (depth \leq 8Km) aftershocks of the 2004 (M_w 5.2) krn mountain earthquake sequence in NW Slovenia. Magnitudes (M_L) range from 2.5 to 3.5 and epicentral distances from 16 to 138 km. Our results show that Q_{β} varies with frequency f according to the power law $Q_{\beta}=83f^{0.80}$ or $Q_{\beta}^{-1}=0.012f^{0.80}$. Comparing our results to those previously obtained for the region of Friuli-Venezia-Giulia in the Southern Alps, both show high values of seismic wave attenuation that is typical of seismogenic active regions and among all sets of data we can observe a good agreement.

Polygenetic history of the Chasanbali opicalcite breccias in Thessaly, Greece

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The "opicalcite" of the Chasanbali area in Thessaly, central Greece is a characteristic element of the Eastern Thessaly ophiolite complex, which is mainly regarded as constituting a segment of the Mesozoic Vardar Ocean overthrust onto the Pelagonian continent during the Eohellenic orogenic phase of the Hellenides. It is located in stratigraphic contact with the

underlying serpentinitized peridotites (mostly harzburgites) and is structurally overlain by Upper Cretaceous crystalline shallow-water carbonates. In this study, the formation processes of the “ophicalcite” are thoroughly investigated since various and often conflicting interpretations exist concerning these. Detailed macroscopic and petrographical analysis revealed that the “Chasanbali ophicalcite” in fact comprises polymictic, polygenetic mud- to clast-supported ophicalcite breccias consisting primarily of serpentinite, carbonate and ophicalcite clasts and secondarily of dispersed fragments of block-sized marbles and much smaller gneiss, granite and fossiliferous carbonates originating from the Pelagonian continental basement, as well as of composite clasts from the breccias themselves. Their formation encompasses complex and multiphase sedimentary, tectonic and metasomatic/hydrothermal processes that operated separately and/or contemporaneously as from their earliest evolutionary stages up until much later, and even during their post-orogenic deformation history. Specifically, the preserved primary sedimentary textures and structures in combination with the spatial distribution of the various constituents clearly reveal the principal resedimented character of these breccias and, furthermore, a diversity of gravitational processes determining their deposition. In total, the Chasanbali ophicalcite breccias comprise exclusively deep-water mass flows that were deposited within a steep and dynamic slope setting at the foot of the eastern Pelagonian continental margin towards the Almopia basin (western Vardar Ocean). However, a prolonged high-angle extensional synsedimentary tectonism, activated after the emplacement of the underlying serpentinites on the seafloor, was the major triggering mechanism for the initiation of the various resedimented deposits, this being strongly indicated by the prevalent resedimented-types (grain flows, rockfalls/talus and olistholiths), while it concurrently and continuously reconfigured the final depositional basin of the breccias, bringing about the gradual denudation and collapse of the latter’s margins. Subsequently, the repeated reworking and redeposition of large amounts of the underlying serpentinites and ophicalcites, coupled with the incorporation of the continental allochthons and also of some portions of the newly established breccias, produced these polyphase tectono-sedimentary deposits. On the other hand, the presence of the composite breccia clasts, particularly in their uppermost parts, besides the obvious reworking of the breccias themselves, clearly indicates their rapid and strong lithification from the very early diagenetic stages. This latter, however, also contributed significantly to the creation of the numerous and often complex fissures, fractures and veins, these arising from synsedimentary tectonic/hydraulic fracturing, which took place throughout the duration of the breccias evolution, as this is suggested via the study of the cross-cutting relationships between their multiple-generation infillings. Moreover, the formation of the ophicalcite breccias is effectively connected with the extended phenomena of serpentinitization, calcitization and recrystallization, which have brought about substantial textural, mineralogical and chemical alterations in many of their components. Even though the calcitization follows in the main the serpentinitization, the abundant serpentinite rims that surround many of the carbonate clasts as well as the characteristic composite rims around some large exogenous fragments reveal an overlap and/or repetition of these processes. Of all the above, the Chasanbali ophicalcite breccias are of a composite and polyphase tectono-sedimentary origin that has come about through the repetition of the resedimentation, cementation and fracturing processes accompanied by extensive metasomatic alterations, the which further point to, and particularly those of calcitization, considerable contemporaneous low-temperature hydrothermal activity directly linked to the earlier exhumation and alteration of the underlying serpentinitized mantle rocks.

Deep-marine carbonates of the northeastern flanks of the Parnassus Platform, central Greece

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An Upper Campanian-Lower Paleocene sedimentary succession, cropping out in the Agios Nikolaos area on Mt. Parnassus, NE of the town of Arachova in central Greece, displays almost continuous and well developed deep-marine carbonate facies of the northeastern flanks of the Parnassus platform, a major Late Triassic-Late Cretaceous shallow-water carbonate platform of the Hellenides orogen. This succession constitutes one of the few locations where the broader eastern margin of the Parnassus platform, towards the adjacent Beotian basin, is exposed and, moreover, it records significant tectono-sedimentary characteristics that mark the definitive interruption of the long-lasting and relatively persistent carbonate sedimentation, before the main entrance of the deep-water clastic sediments of the flysch deposits. Detailed macro- and microfacies analysis revealed that these carbonates are mostly composed of pelagites and lesser calciruditic resedimented facies, though a few very thin intercalations of calcareous mudstones to mudshales are intergraded within the central parts of the pelagites. In particular, the Upper Campanian to Late Maastrichtian carbonates are mainly represented by thin- and lesser medium- to thick-bedded pelagic mudstones-wackestones with abundant planktonic foraminifera, locally laminated and bioturbated, while they are regularly interbedded with nodular and bedding cherts. The widespread presence of various sized slumps throughout this facies documents the intense reworking of the sediments on the deep seafloor. The high instability of their depositional setting is further confirmed by the occurrence of a few intercalations of cm- to dm-scale calcarenites to calcilutites that are considered as having been deposited and reworked under the influence of relatively deep bottom currents. In fact, they comprise bioclastic grainstones to packstones-wackestones with erosive lower surfaces, faint grading, cross-lamination and thorough bioturbation, features indicating them to be calcareous contourites. The pelagic carbonate sedimentation continued throughout the Lower Paleocene with the deposition in the main of thin-bedded and locally nodular pelagic mudstones-wackestones with cherts, which were finally covered by the first flysch sediments. However, immediately after the C-T boundary, these pelagites are interbedded with two discrete coarse- to very coarse-grained carbonate units, of a few meters' thickness, consisting exclusively of resedimented pelagic carbonate materials. Specifically, they comprise gray to locally reddish, massive, very poorly sorted and chaotic calcirudites represented by intraclastic pebble- to cobble-sized oligomictic paraconglomerates and cobble- to boulder-sized polymictic and mostly clast-supported breccias, respectively. Their various pelagic intraclasts, together with a few bioclastic lithoclasts, are of an almost contemporaneous and also Upper Cretaceous age, obviously suggesting an origin for them from the Early Paleocene slope itself as well as from the paleoslope. The deposition of these intraformational carbonates was mostly brought about by cohesive debris flows, while some very large components comprising composite breccia clasts may have been deposited as rockfalls. Overall, the facies association and their organization clearly indicate the base of a steep slope, proximal to the adjacent basin, as the depositional setting for the studied carbonates. Although, their development was controlled by a range of triggering mechanisms, such as the relative sea-level changes and the activity of undercutting bottom currents, nevertheless, a major synsedimentary tectonism seems to have remarkably prevailed over their final depositional pattern, causing the retreat of the broader eastern margin and conducting to the final foundering and demise of the entire Parnassus platform.

The behaviour of amorphous silica-rich rocks as cementitious additives in screed mortars

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The aim of the present study is to test Greek amorphous silica-rich rocks used as partial replacements of cement [25 and 50%] in cement mortars. The raw materials studied were diatomite rocks occurred in Zakynthos, Milos and Samos islands, and tuffite located in Milos Island. Cement substitutes participated in screed materials in percentages of 5% and 10% of the total dry mass. The raw materials were characterised chemically, mineralogically and technically. Microstructural analysis of raw materials and screed pastes was performed in order to specify reactions of silica phases in hydrated systems. The relationship between reactive silica of raw materials and compressive and flexural strength of the final products was also investigated. Properties of final products were examined and compared with commercial one. The water demand of pastes was increased by the addition of the siliceous raw materials, whereas their compressive and flexural strength was decreased. Conclusively, the siliceous rocks studied can be used as partial substitutes of cement in mortars only in ratios raw materials/cement lower than 1/2.

Archaeo-geophysical investigations in Acmonia Antique City (Western Turkey) using magnetic methods

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The location of the Acmonia Antique City is situated near Banaz-Uşak in the west of Turkey. It is claimed that Acmonia was founded at B.C. IX century by Phrygians. Akmonia had been in a state of economic prosperity since it is located on the "Royal Road" connecting the cities of Sardes, Susa and Persepolis.

In archaeological sites, there are buried objects such as walls, metals, grave jars and burnt ceramics. Buried burnt objects can acquire their magnetization at the time of earth's magnetic field. Thus, magnetic surveying was carried out in the Acmonia Antique city in five selected areas to locate buried materials. Magnetic method effectively detects the locations of these buried objects. Magnetic data acquisition in archaeological surveys can be performed by accurate magnetic gradiometer instruments.

Magnetic data were collected using gradient measuring technique in the archaeological area. The main goal of the present gradiometer survey is to detect the ancient remains as well as other archeological features which can be found in such historical areas. Our gradiometer measurements were carried out by using Geometrics G-856 gradiometer having a resolution of 0.1 nT at a 1 m. sampling intervals. The detectors measure the vertical vector of the magnetic field and the instrument displaying unit shows the gradiometer reading between the lower and the upper detectors. If there are magnetic materials such as iron artefacts or fireplaces in the ground, the magnetic field strength shows the higher value at the lower detector than the upper one, because the magnetic field decreases quickly with increasing distance from the source. This gives a positive reading in gradiometer measurements.

In the Acmonia antique city, pure magnetic and gradiometer data were collected at totally 1908 points. Obtained data were processed and mapped by using signal and image processing techniques. The processing was carried out by MagMap 2000 software programme.

Although appearance of the magnetic anomalies gives some ideas about buried objects in the subsurface, the advanced spectral methods were applied to the magnetic anomalies in order to identify subsurface objects such as walls, metals, grave jars and burnt ceramics. The residual magnetic anomalies mostly orientated in the N-S direction, implying the presence of remanent magnetization. RTP (Reduction the Pole) transformation could not entirely remove disoriented polarities arising from the effect of remnant magnetization. Therefore, analytical signal technique decreases the distortions caused by the remanence effects. The analytic signal of the magnetic anomalies was calculated to delineate the source fields of these anomalies. The boundaries of the various archaeological features can be identified based on the analytic signal of the magnetic data. The magnetic signatures were appeared to be well correlated with the walls, metals, grave jars and burnt ceramics. Results of this magnetic survey can be used to guide the archaeologist and give some ideas about the planning of an excavation in the future, and so provides decreasing the cost and time for excavation.

Geological settings and conditions of genesis of volcanogenic deposits of non-ferrous metals in Paleo-Island arc environments

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By the example of the Pontian-South Caucasian paleoisland arc actively functioning during the whole Mesozoic the authors consider the main peculiarities of spatial-temporal relationships between ores of non-ferrous metals and enclosing rocks, and discuss the conditions of the evolution of ore-magmatic systems. The authors' conclusions are substantiated by data on ⁸⁷Sr/⁸⁶Sr ratios, concentration of rare elements in enclosing volcanogenic rocks, isotopic ratio of sulphur and oxygen in ores, and results of thermobarogeochemical studies. The authors hold the opinion shared by many mining geologists that the main part of ore components in non-ferrous metal deposits was extracted from nearby magmatites enclosing and underlying mineralized zones. The solutions from which ores precipitated were, by their salinity, very close to sea water. The maximum temperature of ore formation at epigenetic deposits reached 400°C for copper ores and 280°C for barite-polymetallic ores, whereas the pressure did not exceed 200 bar. As for hydrothermal-sedimentary ores, they could most likely form at the sea bottom, at depths of 2-3km and maximum temperature no more than 300°C.

Volcanic architecture, eruption mechanism and landform evolution of a Plio/Pleistocene intracontinental basaltic polycyclic monogenetic volcano from the Bakony–Balaton Highland Volcanic Field, Hungary

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The Bakony–Balaton Highland Volcanic Field (BBHVF) is a Miocene-Pleistocene, small-sized (~50 eruption centres) typical continental basaltic monogenetic volcanic field. Recently however, several papers have revealed that there are examples of small-volume basaltic volcanic remnants closely resemble complex polycyclic nature of their eruption history among the volcanoes of the BBHVF. Bondoró Volcanic Complex (BVC), the subject of this study is one of the most complex eruption centres of BBHVF, which made up from basaltic pyroclastics sequences, a capping confined lava field (~4 km²) and an additional scoria cone with a preserved diameter of ~1200 m and height of ~60 m. The scoria cone is well-preserved, in spite of its age of about 2.9–2.3 Ma. Its crater and cone flank are still recognisable. Here we document and describe the main evolutionary phase of the BVC on the basis of its large erosional remnant and provide a general model for complex monogenetic volcano eruption style on the basis of volcanic facies analysis, drill core descriptions and geomorphic studies. We distinguished 13 individual volcanic facies on the basis of sedimentary descriptors such as bedding, grain size, gradation, component and general 3D architecture. Based on textural appearance (including bedding type, existence of accidental lithic from the underlying strata etc.) of volcanoclastic rocks, we infer that the eruption history of BVC contained several phases: (I) basal pyroclastics, which generated by the initial magma/water interactions driven phreatomagmatic eruptions; (II) reworked basalt debris, which infilled the previously formed crater and built up almost 30 m thick sequence with intercalated scoriaceous and lava units; (III) coherent lava flow units; and (IV) the final capping Strombolian-type scoria cones and associated lava flow unit.

The existing and newly obtained K-Ar radiometric data have confirmed that the entire formation of the Bondoró volcano finished at about 2.3 Ma ago, and the time of its onset can not be older than 3.8 Ma. Furthermore, the thick reworked unit (phase II) between the initial and the capping units are inferred to be deposited during relatively long period of time (from several decades up to hundreds of thousands years). Still K-Ar ages on neighbouring formations (e.g. Kab-hegy, Fekete-hegy, Agár-tető) do not exclude a long-lasting eruptive period with multiple eruptions and potential rejuvenation of volcanic activity in the same place indicating stable melt production beneath this location. The prolonged volcanic activity and the complex volcanic facies architecture of BVC suggest that this volcano is a polycyclic volcano, composed of at least two monogenetic volcanoes formed more or less in the same place, each erupted through distinct, but short lived eruption episodes. The total estimated eruption volume, the volcanic facies characteristics and geomorphology also suggests that Bondoró is rather a small-volume polycyclic basaltic volcano than a polygenetic one and can be interpreted as a nested monogenetic volcanic complex with multiple eruption episodes. It seems that BVC is rather a “rule” than an “exception” in regard of its polycyclic nature not only among the volcanoes of the BBHVF but also in the Neogene basaltic volcanoes of the Pannonian Basin.

Late Miocene environmental changes in an embayment of Lake Pannon on a decadal-scale

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Lake Pannon is a well documented lake system, which covered south-eastern Europe for approximately six million years. Although the basic processes of lake evolution, its faunistic inventory and its surrounding vegetation zones are understood, the pace of environmental changes is still poorly constrained. Especially, the linkage between climate change and shifts in lake environments is still a matter of ongoing research.

The clay pit Mataschen (SE Austria) exposes lowermost Tortonian (= lower Pannonian) deposits of Lake Pannon along its north-eastern margin. Due to its laminated sediments and the aspect, that former studies already reported a relatively warm regional climate, Mataschen offers ideal conditions for high-resolution analyses based on palynomorphs. Furthermore, geophysical data (magnetic susceptibility and gamma ray) reveal several highly significant cyclicities and point to astronomical forcing throughout the 30-m-thick section. Within this study, two consecutive 50-cm-long cores were studied with a sample distance of 10 mm and analysed for pollen and dinoflagellate assemblages. Based on preliminary estimates of sedimentation rates, the studied cores encompass environmental changes within only few hundreds of years during the earliest Late Miocene. Despite rather stable lake level conditions, as indicated by constant amounts of *Pinus* and *Impagidinium*, shifting patterns within both palynomorph groups are evident. Dinoflagellate cysts show re-occurring short-time events with blooms of heterotrophic taxa. These events may point to significant increases of nutrients in the surface water due to variations in the mean annual precipitation as indicated by the pollen data. Within the pollen record, the lake shore vegetation is most sensitive to alternations in climate. Lake Pannon was surrounded by Taxodiaceae swamps and wetlands of *Sparganium*, *Typha* and species of Poaceae and Cyperaceae, whose expansion is significantly varying within few decades whilst the hinterland vegetation displays a delay as it needs more time to react.

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“Green Walls”: Microbiology of algae growing on sandstone walls and implications for the impacts of climate change on cultural heritage

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Recent observations have shown that many sandstone buildings, including important components of the UK’s cultural heritage, are becoming covered with green algal growths. This is likely to result from recent changes in air quality and the impacts of a changing climate. The precise influences of these growths on the stone surface and sub-surface are under considerable debate. The underlying question is whether they are benign and indeed bioprotective, or conversely if they are detrimental and biodeteriorative. To approach this question, there is a need for interdisciplinary studies linking geomorphological expertise with that of molecular microbiology and climatology.

The 'Green Walls' project contributes to this question by drawing together state of the art methods from each of these disciplines, as part of a larger project on sandstone heritage and climate change. The overall aim is to form a multi-faceted analysis of the current and future nature of algal greening on sandstone heritage in north-west Britain.

In order to better understand the interplay between climate change and the growth and impacts of green algae (chlorophyta), three phases of study have been adopted within an integrated overall methodology. Linked field and laboratory experiments, microbial species identification as well as impact and bioreceptivity analyses of sandstone contribute towards achievement of the project aim.

Northern Ireland has an abundance of sandstone heritage and given the likelihood of warmer, wetter winters; algal growth on vulnerable monuments is likely to become a primary conservation concern in the next 50 years. It thus makes an ideal major field location for the project. As a point of comparison, a satellite study is being conducted at Sheffield Cathedral. This will form an interesting comparison given the difference in climatic conditions and pollution history. Key foci for study are the impacts of stone aspect and angle of inclination on degree of algal colonisation.

Phase One of the study involves sampling from purpose-built test walls in Derrygonnelly, Northern Ireland as well as sandstone buildings in central Belfast and Sheffield. Novel, non-destructive biological sampling is conducted twice yearly, alongside measurements of moisture movements within stone facades. The rate, extent and composition of biological coverage is and will be closely monitored over the 3-year assessment period.

Phase Two encompasses laboratory analysis of these samples; standard gene profiling and sequencing techniques are used to establish community composition and abundance.

In order to contextualise this information, Phase Three involves laboratory simulations of algal growth on sandstones under likely, future climatic conditions. Composition and growth rates of algal biofilms and their impacts on sandstone will be compared to results from field studies. In effect, this allows for a comparative simulation-based study between present and future climatic conditions.

Investigation of the nature and impacts of algal soiling, as provided by this project, will supply invaluable information for those managing our sandstone cultural heritage. This will enable more informed decisions to be made over appropriate management and conservation strategies for the future.

Architecture of kinematics and deformation history of the Tertiary supradetachment Thrace basin (NE Greece)

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Detailed tectonic analysis on the Tertiary molassic and volcanosedimentary rocks of the Thrace basin allowed us to reconstruct the architecture and structural evolution of the basin, as well as the orientation of the regional paleostress field. The Tertiary molassic sedimentation of the Thrace basin was linked by a calc-alkaline magmatism associated with the Tertiary syn-orogenic extension in the Rhodope province. The Thrace basin was initially developed on the hanging wall of a low angle extensional detachment fault system of Mid-Late Eocene age simultaneously with uplift and exhumation of the Rhodope metamorphic rocks in the footwall. We interpret the molassic Tertiary Thrace basin as a supra-detachment basin associated with intense magmatism. Five (5) deformational events (T1 to T5) have been distinguished related to the basin evolution from Eocene to Quaternary time. T1 is related to low angle normal detachment faults with a mainly toward SW to SSW sense of movement of the tectonic top and subsidence of the initial Thrace basin during Mid-Late Eocene time. T2 is evolved during Oligocene-Miocene time. It is characterized by transpressional tectonic and formation of big strike slip faults and extensional fractures, as well as conjugate thrust faults

and folds with N or S to NW or SE sense of movement. During Miocene-Pliocene the third T3 event is taken place. It is responsible for the high angle normal fault dismembered the Eocene-Oligocene molassic basin into Neogene grabens. A local T4 event has been recorded affecting also the Neogene sediments of the basin with minor reverse strike slip faults as well as normal faults. The following T5 event is related to big normal active faults. They are coincided to the active tectonic of the study area defined by the earthquake focal mechanisms.

Sedimentary setting of Adriatic flysch formation (Middle Eocene-middle Miocene), Southeastern Montenegro as revealed by turbidite sequences

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A 750 m long outcrop of Middle Eocene-Miocene flysch is exposed in an asymmetrical syncline in Crnjak Cove, south of Bar, Montenegro. Texture, physical sedimentary structures, petrography, and trace fossil studied in these sediments allowed the recognition of turbidite facies that display various members of the Bouma sequence (Ta,b,c,d,e). These are interpreted in order to reconstruct the depositional setting of these gravitational deposits. Predominantly clastic lithologies in this 300 m thick sequence are arranged in seven distinct turbidite facies, which represent three superimposed submarine fans. The oldest fan consists of: 1) basal marl (T₁: 0-30 m), which indicate basin to marginal-fan deposits; 2) thin to medium bedded graywackes intercalated with thin mudstones (T₂: 30-140 m), which represent mid fan; and 3) thinly bedded graywackes intercalated with mudstones (T₃: 140-160 m), which indicate outer fan deposits. The second fan is comprised of: 1) thin to medium bedded, coarsening upward graywackes (T₄: 160-190 m) that represent mid fan environment; 2) conglomerates (T₅: 190-200 m) which, in addition to carbonate clasts, also contain large rip-up clasts of siltstones, indicating locally derived channel deposits; and 3) thinly bedded graywackes intercalated with mudstones (T₆: 200-230 m), which represent outer fan deposits. The youngest submarine fan is made of thin bedded graywackes intercalated with mudstones (T₇: 230-300 m) that represent mid fan environment. The graywackes from mid fan facies consist of Bouma's Tb,c,d sets, and at their bases contain flute casts, prod casts, and scour marks. Thin greywackes from outer fan facies contain abundant and diverse *Nereites* ichnofacies.

Mineralogical evolution of contaminated granitic pegmatites hosted in marbles. The role of CO₂ rich fluids on phase relationships of crystallizing granitic melts. An example from the Intermediate Unit of the Central Rhodope Metamorphic Province, Greece

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The Intermediate Unit of the Rhodope Metamorphic Province in Greece intervenes between the Lower (Pangaion) Unit with continental passive margin affinities, composed of orthogneisses of Permo-Carboniferous magmatic age overlain by amphibolite facies marbles and minor schists, and the Upper Unit dominated with 150 Ma metagranites. The Intermediate Unit is an assemblage of strongly deformed and variably migmatized lithologies of oceanic and trench affinities. An important component of the Intermediate Unit is a migmatized (diatexitic) biotite-plagioclase gneiss, intercalated with marbles, calc-silicate rocks and minor garnet-amphibolites. The leucosome components of the migmatites, representing in situ melts, with granitic and quartz monzonitic compositions and of pegmatitic or aplitic textures, are hosted in the surrounding parental gneisses or in the neighbouring marbles. In the cases they

are hosted in marbles they have the anhydrous assemblage: quartz + plagioclase + Kfs + diopside-hedenbergite cpx + titanite + scapolite + zircon. This paragenesis is interpreted to arise from the interaction of silicic magma with the carbonate host rock. In carbonate rich environments the fluid phase composition should be rich in CO₂. Fluid phase compositions X_{CO₂fl}>0.5 have been reported in analogous cases where silicic melts are in contact or intrude carbonate rocks. Under these circumstances, imposing nearly anhydrous conditions of crystallization, silicic liquids of extremely high temperature are required in order to crystallize rocks with pegmatitic texture. It has been experimentally established that for P=5 to 10 kb and X_{CO₂fl}=0.7 the granitic T_s is 800 °C, whereas it is above 950 °C for X_{CO₂fl}=0.9. This implies that melting of the gneisses took place at a temperature well above the wet granitic solidus. It is suggested therefore that (HP?) granulite facies conditions existed during the partial melting of the gneisses and the formation of the studied granitic and monzonitic leucosomes in this part of the Rhodope.

Partial melting and genesis of HP graphite-bearing granulites in the Intermediate Unit of the Central Rhodope Metamorphic Province, Greece

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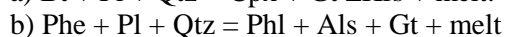
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Three main tectono-lithostratigraphic Units are piled up in the Greek part of the Rhodope Metamorphic Province. The Lower Unit (Pangaion complex), with continental passive margin affinities, is composed of orthogneisses of Permo-Carboniferous magmatic age overlain by amphibolite facies marbles and minor schists. The Intermediate Unit is an assemblage of strongly deformed -in parts ultramylonitic- and variably migmatized lithologies of oceanic and trench affinity (amphibolites, eclogites and metatrandjemites bearing MORB and arc signatures, metacherts, phengitic quartzites, biotite gneisses, pelites, psammites and calcsilicates), into which large pods of ultrabasites and ~300 Ma orthogneisses are tectonically intercalated. Biotite (± amphibole) gneisses, dominating the upper part of the Intermediate Unit, are interpreted as trench filling metagreywakes of mainly volcanic origin, dragged down and accreted to the overriding plate of a subduction zone active during the Late Jurassic. Above them, the Upper Unit is composed of orthogneisses of Late Jurassic magmatic age, probably the edifice of a volcanic arc built above this subduction zone.

Although HP (kyanite field) amphibolite facies parageneses characterise the ITU, some evidence of UHP metamorphism has been reported from ex-eclogitic pods and some pelites in it. These may represent samples of deeply subducted material returned by some mechanism from mantle depths and tectonically emplaced at shallower levels. Evidence however also exists that the dominantly HP amphibolite facies parageneses in the ITU overprint earlier HP (kyanite, cpx) granulite facies ones, which were imposed coevally with partial melting in this unit. For the now exposed subducted oceanic and trench lithologies of the ITU, this implies a prolonged residence and thermal relaxation near the base of an overthickened crust, apparently after continental collision. This could only be achieved by an abnormally slow collapse and levelling of the orogen above, probably as a result of preserving a high crustal relief due to Cretaceous shortening (?thrusting) in the Rhodope.

Focused in an area near Sminthi village, partial melting phenomena in the ITU related with the HP granulite event are examined in some detail. The dominant rock type in this area is a migmatized dark coloured Bt-gneiss. Leucosomes of variable sizes and distribution forms have been separated from the mesosomatic gneisses and are interbedded with or cut as veins the surrounding gneisses and marbles. (?)Syn- to post-melting intense deformation affects both the mesosomatic gneisses and the leucosomes forming boudins and tight isoclinal folds. From the migmatitized gneisses two representative rock types bearing evidence of an early HP granulite facies event have been studied in more detail. The first is a medium grained, mesosome dominated metatextitic migmatite with Bt + Pl + Qtz + Kfs + Cpx(Amp) + Gt + accessories (All, Ttn, Ap, Gr, Py(Ght), rounded zircons). The second is a coarse grained

metatextitic paragneiss with Phl + Gt(Bt) + Ky(minorSill) + Pl + Qtz + Kfs + Rt + Gr. Melting should have been anhydrous; likely dehydration melting reactions are:



The leucosomes are anhydrous pegmatites or aplites, bearing mostly Di-Hd cpx (when hosted in marbles) or garnet (when hosted in biotite gneisses). Graphite and sulphides are ubiquitous in both mesosomes and leucosomes, suggesting highly reduced conditions during melting.

Correlation of Neotethyan rifting related peperitic basaltic occurrences in the Dinarides, displaced fragments of the Dinarides and in the Hellenides

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Volcanological, mineralogical, petrological and geochemical studies on pillow lavas, peperites and hyaloclastite breccias as parts of basaltic extrusions of Triassic age into unconsolidated deep water sediments were carried out in the Jurassic mélange of the Darnó Unit (NE Hungary), which is a displaced fragment of the Dinarides. The results were compared with similar occurrences in the Kalnik Mts. (Croatia) and Vareš-Smreka (Bosnia and Herzegovina) in the Dinarides and in the Stragopetra Mts. (Greece) in the Hellenides. Earlier sedimentological and lithostratigraphical studies suggested advanced rifting-related origin to these formations; however petrological and petrochemical comparisons are made in the framework of the present study.

At the studied localities at most six different volcanological facies can be distinguished (coherent pillow, closely packed pillow, in-situ hyaloclastite breccia, pillow fragmented hyaloclastite breccia, isolated pillow breccia and peperitic basalt); in the Kalnik Mts., a complete submarine lava mould-flow complex with all of these facies is known. Comparing the other localities to this complete system, the volcanological facies can be identified even in occurrences characterized with small blocks. In the studied Darnó Hill quarries, the closely packed pillow, the hyaloclastite breccia and the peperitic facies were observed, suggesting an originally distal position in the submarine lava flow. At Vareš-Smreka and Stragopetra only the peperitic facies is known. This facies bears high importance, as it forms when the lava arrives into the water soaked sediment; mingling the basalt with the limey mud is a clear evidence of early rift-type formation (i.e. formation above the CCD level), and this can be used in the field to distinguish these associations from the Jurassic ophiolites (formed below the CCD level) occurring in the same mélange.

Petrographic features show similarities among the basalts of the studied localities; the textures are sphaerolitic and variolitic, while the main rock forming components are albitized plagioclase with skeletal crystal habit, calcite/chlorite/serpentine pseudomorphs after olivine, opaque minerals (pyrite, chalcopyrite, hematite) and microcrystalline material as groundmass while clinopyroxene and glass are rare.

Results of the fluid inclusion studies and examination of the hydrothermal minerals at all the studied localities show that extended fluid circulation system did not develop, but rapid cooling was characteristic in the seawater-dominated hydrothermal system. Several stages of the alteration can be distinguished; after the chloritization of the groundmass, the hydrothermal infillings (quartz, chlorite, epidote, prehnite, pumpellyite, calcite and zeolite) of the amygdales, veins, pyjamas-type basalts' mineral bands and earlier feeding channels of lava lobes have formed, then finally the low-temperature layer-silicates precipitated. Fluid inclusion and chlorite thermometry data suggest shallow depths of 1.4-4 km for the fluid/rock

interaction processes. Hence the advanced rifting-related origin is also more supported than the mid-oceanic ridge-related setting.

Petrochemical features of the studied rocks show mainly within-plate basalt characteristics, while the MORB-features are subordinate. The studied Triassic basalts are forming a group easily distinguishable from the Jurassic basalts of the same mélange on the different discrimination diagrams. The high Zr/Y ratios (above 4) are also characteristic to the within plate basaltic volcanics. Thus the geochemical data also support that the Triassic pillow basalts, containing pelagic carbonate peperitic facies, are related to the advanced stage rifting of the Dinaridic-Hellenidic Neothethys. However the good correlation among the different studied occurrences and their genetic relationship are also shown with the help of the REE pattern which show slight enrichment from La to Gd in comparison to the Jurassic ophiolites.

Petrochemical signatures of Sarmatian volcanic rocks in the mineralized and unmineralized areas of the Tokaj Mountains, NE-Hungary

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The Tokaj Mts. is located in northeastern Hungary and is a part of the Inner Carpathian Volcanic Arc. This Arc was formed from the Lower-Middle Miocene to almost recent times. In the Tokaj Mts., medium to high K intermediate and acidic calc-alkaline volcanic rocks have been accumulated during the Middle-Upper Miocene (Badenian-Sarmatian-Pannonian) in an N-S oriented volcanotectonic graben that is underlain by Proterozoic to Mesozoic crystalline rocks.

Although a huge number of K/Ar age data is available for the igneous rocks and hydrothermal processes in the Tokaj Mts. no modern systematic geochemical database has existed up to now. In this study, we used rhyolite, dacite and andesite samples of Sarmatian age selected from the K-Ar database and new samples from outcrops were also investigated. The samples were selected on the basis of their K-content and their relationships to hydrothermal mineralization. In the southern part of the mountains, high K rhyolites are laden with shallow levels of low sulphidation type epithermal systems. Opposite to this, rhyolite field with lower K-content in the northern part of the Tokaj Mts. have no hydrothermal mineralization.

There are differences not only in major, but also in trace element geochemistry between the samples from the northern and the southern part of the Tokaj Mountains. Previous papers determined that the southern rhyolites contain K-feldspar phenocrysts in accordance with the significant potassium enrichment (whole rock K₂O content varies in between 4.35–5.61 wt%) while rock forming K-feldspar is absent in the rhyolites from the North (where their K₂O content is 3.28–5.1 wt%). Dacites also show some differences and they were formed in the same time as rhyolites and andesites (in between 11–13.4 Ma) in the northern Tokaj Mts., while they are much younger (10.1–10.57 Ma) than those rocks in the southern Tokaj Mts. Both the boron content (10.1–68.1 µg/g) and the spider patterns of other trace elements in the volcanic rocks show typical subduction related features, however the direct influx of the subduction related fluids during magma generation can be excluded. Rather possible explanation for the magma genesis is decompression melting of a previously metasomatised mantle, enriched with subduction related components. The presence/absence of rhyolite-connected epithermal systems appears to be correlated with the Cl content of the rocks: samples from the unmineralized northern rhyolite field contain much less Cl (below 0.2 wt%) than high-K rhyolites in the southern part of the Tokaj Mts. (more than 0.2 wt%)

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Multi-proxy analyses of subatlantic peat bog sediments from the Western Tatra Mts. (Poland)

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The main aim of our study was to analyse local slope processes, vegetation changes and human impact during the last millennium in the Pyszniańska Valley (Western Tatra Mts.) on the basis of palynological and lithological analyses combined with radiocarbon datings from a small peat bog in the Pyszniańska Valley. These data were supplemented by a lithological analysis of cirque bottom-slope deposits from a depression within the Pyszniański cirque. Sedimentation at the site probably began in the 14th-15th century, which is suggested by pollen analysis. The sediments are dominated by fine grain material (sands and silts) transported by surface and linear slope washing with the interbedding of distinctive layers of coarse clastic material, which are indicators of high-energy geomorphic processes. The first phases of vegetation development (TZNP-1,2 zones) are characterized by visible deforestation caused by fire clearances and/or development of mining and metallurgical centers. The high number of hazel (*Corylus avellana*) pollen grains is probably the effect of the redeposition of sediments originating in the Boreal or Atlantic period from the higher elevation of the valley. In the TZNP-3 zone the Pyszniańska Valley was affected by a most catastrophic high-energy geomorphic event, recorded as a continuous layer of coarse material. The upper phase (TZNP-4a subzone) signifies pasture development based on animal husbandry. Regular determination of *Ambrosia artemisifolia* type pollen combined with radiocarbon data points to the 19th-20th century. The TZNP-4b subzone reflects the succession of *Carex rostrata* on the peat bog and reforestation in the vicinity of the site caused by the establishment of the Tatra National Park in 1954. The cirque floor sediments consist of massive, 1.65 m thick, very coarse layers of gravels and boulders, which represent dynamic sedimentation caused by the activity of high magnitude slope processes (debris flows).

Decision support system for landslide hazard mitigation on rock slopes

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Slope movements on the rock slopes (e.g. rock falls or rock slides) belong among the most dangerous slope processes since even small volume events (involving single boulders) may have largely damaging effects on infrastructure or may cause serious injuries. This phenomenon is very often also highly localized problem, which demands for local solutions by local governments which rarely include experienced personnel. Rather high costs of almost any structural mitigation measure possibly applied on rock slopes makes mitigation process subject to many political and economic interests which not always result in the best and most effective slope stability solution. The project NEMETON aims to provide easy to use and free web based tool for local authorities and also for project companies to provide basic information about degree of hazard, possible mitigation measures and their basic technical and economic characteristics. The system includes interactive interface for intuitive description of rock slope stability problem allowing even inexperienced user to provide sufficient information to be advice for future steps leading to cost effective solution of the problem. At the same time, the basic information will help the project and technical companies to get a basic idea about probable cause of the problems, possible slope stability solutions and the technical conditions of the solution. In the second step, more detailed

geotechnical information are inserted to provide detail information for geotechnical professionals to assess the slope stability conditions and to select the best suited mitigation solution using the best suited technology. The success of the decision support system is ensured by involvement of wide spectrum of professionals for its design and the result verification. System is designed to accommodate any technical solution provided by otherwise competing companies to find the best mitigation option for defined problem. The presentation will introduce you into the rock slope stability problems in the Czech Republic, their typical technical solutions, basic database structure of the NEMETON system, results of its implementation and further research steps leading to the full operation of the NEMETON program welcoming broader European cooperation.

Geology and minerals of Kosovo* – Perspectives for national development

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In 2002, the UN Kosovo administration has identified the key economic potential of the mineral industry for the further sustainable development of Kosovo. Consequently, between 2003 and 2009, under supervision of the Directorate of Mines and Minerals (DMM) (now Independent Commission for Mines and Minerals of Kosovo (ICMM)), Pristina/Kosovo, a comprehensive review of the geology and mineral potential of Kosovo was carried out. The results have been stored in the GEO-Database Kosovo (GDK) – a customised geo-scientific information management system, powered by ESRI ArcGIS 9.2 and Microsoft SQL 2005. The GDK comprises of a system of primary and derived geo-scientific and geo-economic data, such as mineral concessions, drill holes, geochemistry, field observation data, reports and documents, and a wide variety of thematic maps at scale 1:50,000 – 1:200,000. The database, reports and maps are currently used as the key working tools for the management of the mining sector of Kosovo and its further development.

In 2003, the activities have been launched by digitalisation of the existing geo-scientific maps, followed by the implementation of a unified national geological legend and the creation of a reviewed seamless national geological map at scale 1:100,000 (finalised in 2008). Extensive field work was executed in order to investigate thematic geological issues and to evaluate the mineral potential of the country.

An atlas of new thematic maps at scale 1:200,000 covers the most important geo-scientific and geo-economic issues: Metallogenic / Minerogenic Map, Map of Minerals, Geological Map, Hydrogeological Map, Tectonic Map, Quarry Map, Map of Construction Raw Materials, Map of Mineral and Thermal Waters, Morpho-Orographical Map, Soil Map, Satellite Imagery Map, Maps of Mineral Prospectivity for Au, Pb/Zn and Cr.

Detailed maps have been created in order to investigate special issues of key economic importance: Map of Construction Raw Materials and related maps of land use conflicts (Kosovo Quarry Plan) 1:50.000, the Kosovo Mineral Resources Management Plan 1:50.000, the Geohazards Map of Planned Kosovo Highway 1:25.000, the Geochemical Survey Maps of gold prospective areas 1:50.000.

Between 2007 and 2008, as part of the field mapping and sampling campaign, a stream sediment sampling survey was executed with main focus on precious metals (Au, Ag), base metals (Zn, Pb, Cu) and rare metals. As result, high-grade Au-anomalies (up to 11 g/t in stream sediments) were found at different locations, proven by findings of native gold in heavy concentrates and Au recorded in hard rock samples. In 2009, the existing knowledge and data was used for the creation of national mineral prospectivity maps for Pb/Zn, Au and Cr. These maps have been produced by support of the newly developed– advangeo® - software, which uses neural networks technology based on artificial intelligence. The

* under UNSCR 1244.

resulting prospectivity maps set the basis for further detailed exploration activities in the country.

Developed in 2009, the Kosovo Mineral Resources Management Plan (KMRMP) targets on the sustainable utilisation of the high mineral potential of the country in the given economic and social framework. All known mineral deposits and occurrences were ranked with regard to their economic potential and legal status. The KMRMP clearly outlines the prospective areas and describes steps for further investigation. It forms the basis for the development of the mining industry of Kosovo, the implementation of improved land use planning procedures and environmental protection as well.

Data Management System GEORIOS – Documentation and evaluation of natural hazards

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Natural hazards and their effects on the population and economy are for the Austrian Alpine region of increasing relevance. The events of the last years have shown that high meaning is to be attached to a comprehensive scientific understanding of mass movement processes. The quest for security gives rise to develop strategies and measures to counter the threats and to protect the people and the infrastructure. To determine where protective measures are necessary, we produce landslide inventory and risk assessment maps for many areas in Austria.

Since the foundation of the Geological Survey of Austria (GBA) in 1849 have been received a lot of data or knowledge about geogen natural hazard into the archives of the department of engineering geology.

To manage this data diversity and to make this entire pool of data available for everyone is necessary to develop a row of policies and strategies. Three main steps are followed in order to create this management system: (i) the development of spatial database, (ii) the development of an integrated procedure for design of susceptibility maps, (iii) and development of a tool set for the visualization and web-enabled data query. The final application based on the concept of Landslide Information Systems, will be used as an additional tool for risk and emergency assessment as well as for planning and decision making purposes.

Landslides unfortunately, do not display a clear relationship between magnitude and frequency as do for example floods. Landslide studies are challenging to scientists, due to the difficulty to represent landslide hazards in quantitative terms over large areas.

To be able to clarify which method to which conditions (scale of area, quality of data, area heterogeneity) and for which questions /objectives is suitable in the different measure, a classification of the areas to be modelled is necessary. However, this also means that the modelling results must be judged concerning their statement quality for different objectives (at least semi quantitatively). Otherwise it would be unclear furthermore for what, the produced maps (e.g., hazard potential maps, susceptibility maps) by means of different methods and data quality, are to be used generally.

Experience has shown that in this regard the following criteria should be used:

- Relative size of area
- Data quality (the quality of process data, the quality of the parameter maps)

Nevertheless, all these criteria cannot be quantified. Therefore, different areas with regional variety and different data quality are very important for model calculations. Only different models and methods, can be tested concerning their usefulness for the production of maps as bases for spatial planning, and estimated, under which conditions which method is for which question more suitable

In addition, the GBA is also keen to apply methods and to develop strategies, through which an evaluation of existing data towards large scale maps (for example hazard potential maps).

For one project area were used in addition to the simple heuristic method also a neural networks method to produce a susceptibility map. From the visual comparisons of the results can actually see any big differences. A comparison with the results of other methods shows only small differences exist, however, all validation results using artificial neural networks are slightly better than those using heuristic method.

However due to the random and selective available process data, there is a risk, that the generated susceptibility maps lead to good validation results. This means that the causes of the well-validated results are not clear and further developments are necessary.

Isotopic tracking of the Western Carpathians Hercynian granitic rocks sources

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The present-day structure of the Western Carpathians was derived from Late Jurassic to Tertiary (Alpine) orogenic processes connected with the evolution of the Tethys Ocean, in a long mobile belt sandwiched between the stable North European Plate and continental fragments of African origin. A typical feature of this mobile belt is the presence of huge reworked slices of Hercynian crystalline basement within the Mesozoic and Cenozoic sedimentary successions that have been deformed into large-scale nappe structures. Granitic rocks of various origins form an important constituent of these basement fragments. The Hercynian granitic rocks were related to distinct sources and/or geotectonic position. They present spatially developed granitic suites from subduction-related I-type, through syn-collisional S-type to late- and post-orogenic A-type granites. The genesis and history of the local crust sampled by the granitoid rocks can be traced back to the Early Palaeozoic and/or Neoproterozoic times, consistent with a derivation from the north-Gondwanan margin. A complex study integrating petrological, geochemical and/or isotope data have been performed during last decades, resulting in distinguishing of following rock suites: *a*) the older sheared granitic rocks – orthogneisses (OG) with intrusive age 495–475 Ma; *b*) related mafic suite gabbros & diorites rocks (M-s) intrusive age 370 Ma; *c*) biotite granodiorite to hornblende-biotite tonalite (I-s) with intrusive age 365–355 Ma; *d*) two micas granodiorites to granites (S-s) intrusive age 360–350 Ma; *e*) biotite granodiorite to granite (A-s) intrusive age 270–260 Ma; and *f*) suite of specialised ore-bearing, biotite granodiorite to biotite-muscovite granite (S_s-s) intrusive age 265–250 Ma. The Sr isotopes with $^{87}\text{Sr}/^{86}\text{Sr}_{(i)}$ values 0.707–0.720 (OG), 0.702–0.706 (M-s), 0.704–0.709 (I-s), 0.706–0.714 (S-s), 0.705–0.709 (A-s), and 0.715–0.730 for S_s-suite suggest for significant crustal recycling and mantle related influence for mafic varieties of Carpathians granites. Similarly Nd isotopic characteristics with $\epsilon\text{Nd}_{(i)}$ values -7.4 to -2.0 (OG), +0.9 to +5.8 (M-s), -2.8 to +2.2 (I-s), -7.0 to -1.3 (S-s), -3.1 to +1.9 (A-s), -4.4 to -0.2 (S_s-s) indicate recycling of vertically zoned lower and/or middle crust with significant contribution from basic metagneous rocks. The stable isotopes with $\delta^{18}\text{O}_{\text{SMOW}}$ (in ‰) for OG = 11.0–11.7; M-s = 6.6–8.4; I-s = 7.6–9.9; S-s = 9.0–11.3; A-s = 7.8–8.0; and S_s-s = 9.9–11.5 together with $\delta^{34}\text{S}_{\text{CDT}}$ (in ‰) for M-s = +0.3 to +0.8; I-s = -2.9 to +2.6; S-s = -1.0 to +5.7; A-s = -2.0 to -0.7; and S_s-s = +4.5 suggest for mixed sources in metasedimentary and basic metagneous rocks. The OG suite has $\delta^7\text{Li} = -4.5$ to +1.6‰ indicating crustal source. Mafic rocks (gabbros and diorites), associated with several occurrences of granites, are uniformly Li-rich and isotopically light ($\delta^7\text{Li} = -0.5 \sim -3.7$ ‰), precluding a direct derivation from the mantle, and require an explanation invoking an initial loss of original Li inventory, followed by a secondary enrichment in light Li via ingress of diffusing or percolating fluids. The Carpathian I-suite granites ($\delta^7\text{Li} = -1.2$ to +0.5 ‰) are on average isotopically lighter and show minimal scatter pointing to a homogeneous meta-igneous source; the S-type granites on the other hand ($\delta^7\text{Li} = -3.2$ to +7.0 ‰) testifying to highly variable meta-sedimentary/igneous precursors. The A-type granites are systematically heavier than the other types or even Earth's mantle ($\delta^7\text{Li} = +4.7 \sim +6.6$ ‰), which could hint to a significant role of a material processed in a subduction event modified by slab-derived fluids. The S_s-suite of the ore-bearing granites with $\delta^7\text{Li} = -0.42$ to +1.22 ‰ looks to have a metapelitic parentage. The

zircon Hf isotope study of the Western Carpathians granitic and related rocks brings following average $\epsilon\text{Hf}_{(t)}$ values: OG = -4.50 ± 1.38 (*St.dev.*); M-s gabbro = $+0.54 \pm 2.1$; I-suite tonalites = -0.34 ± 2.18 ; S-suite granites = -1.69 ± 2.64 ; A-type granites = $+0.55 \pm 1.65$ indicating substantial crustal recycling and/or significant participation of mantle material as potential source for M-s, I-s, and A-s rocks types. Noteworthy, that mantle contribution to their genesis has rather character of melted mantle derived mafic lower crust than fresh input of mantle melt to the Devonian (Permian) subduction zone what suggest the Hf model ages of zircons from these rocks.

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Magnetic properties of soils around local pollution sources (Crete, Greece)

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The main scope of the present study is to investigate the spatial and vertical distribution of the magnetic susceptibility in an area of possible industrial pollution and heavy traffic. For this purpose, a power plant with a dense traffic net around it, located in the SE section of Chania city was selected as the investigated area. In the context of the present work magnetic susceptibility measurements have been conducted in two phases. Surface soil samples have been collected in 2008 from the area under investigation and they were analyzed in order to estimate the spatial distribution of the magnetic susceptibility. Loci of high values of magnetic susceptibility within the study area gave rise to further proceed to coring up to a depth of 120cm at selected sites of the study area. GIS techniques were used for mapping the magnetic measurements on the various topographic and geological features of the area. Maps were created through interpolation algorithms indicating the spatial distribution of the above measurements. Spatial tools and statistical analysis proved the correlation between magnetic properties and the terrain attributes. Both investigations indicate high values of the magnetic susceptibility especially in the eastern part of the investigated area and along the main traffic branch.

Application of skeletonization on geophysical images

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Skeletonization has been a part of morphological image processing for a wide variety of applications. The skeleton is important for object representation in different topics, such as image retrieval and computer graphics, character/pattern recognition and analysis of biomedical images. The purpose of the present work is to apply a sequential skeletonization algorithm on geophysical images, resulting from shallow depth mapping of archaeological sites. The accurate identification of curvilinear structures in geophysical images plays an important role in geophysical interpretation and the detection of subsurface structures. Experimental results on real data show that skeletonization comprises an important tool in image interpretation.

Carnian Pluvial Event in the Mežica area, Karavanke Mts., Slovenia

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The Carnian Pluvial Event (CPE) denotes a wet climatic interval. This phenomenon was first identified in the Northern Calcareous Alps and was later recognized throughout the Tethys. A short humid event characterizes one of the most severe ecological crises and it corresponds to a sudden input of siliciclastic sedimentation. The causes of the CPE are still not well explained, but it seems they are all associated with the rifting of Pangaea. In order to make paleoenvironmental reconstruction of the region several biostratigraphic studies have been carried out more recently. The study area is situated north of the Periadriatic Lineament in the Northern Karavanke Mts., Eastern Alps. Carnian rocks of the “Raibl Beds” in the Mežica area are characterized by three clastic horizons of marly-shaly rocks positioned within dolomite-limestone succession what means the carbonate sedimentation was three times interrupted. The cyclicity of the “Raibl Beds” is explained as eustatic sea-level fluctuations. An increase of carbonate amount is evidenced from the first clastic horizon to the third clastic horizon. Differences are observed also in composition of the three palynological assemblages and a decreasing deltaic influence parallel to an increasing marine influence is evidenced from the first, through the second and to the third horizon. The obtained assemblages belong to the northern palynofloras of the wide equatorial palynofloristic domain. Quantitative palynological analyses of the first and the second clastic horizons indicate hygrophytic associations, whereas the third clastic horizon is marked by prevailing xerophytic elements. The Julian age of the first clastic horizon is dated by ammonoid *Carnites floridus*. Based on the typical Carnian sporomorphs the CPE is constrained to the hygrophytic associations of the first two clastic horizons in the study area, and their age is confined to the Julian, but the second clastic horizon might be partly Tuvallian. Macrofauna of the second clastic horizon is rare. It is limited to the two thin beds with frequent bivalves *Hoernesia sturi*. The footwall of the second clastic horizon is marked by diversified invertebrate fauna that includes bivalves, gastropods, crinoids, brachiopods and others. Crinoid fauna is characterized by the prevailing *Laevigatocrinus* and *Tyrolecrinus*, and the absence of encrinids is obvious. Within the second clastic horizon particular layers and lenses of limestone occur. Several limestone samples were treated for conodonts, but a single one was productive. Well preserved elements are represented by the monospecific conodont fauna of *Nicorella? budaensis* that also enables apparatus reconstruction. *Nicorella? budaensis* has been hitherto known only from few locations where it appears in a muddy bituminous limestone in an oxygen deficient sediment demonstrating stressed conditions, where conodonts could still live. The presence of a short-lived conodont species *Nicorella? budaensis* is important tool for a better understanding of the CPE in the Northern Karavanke Mts.

Permo-Triassic and Jurassic palaeomagnetic components in the Greek Pelagonian and sub-Pelagonian zones: Implications for successive counterclockwise and clockwise rotations

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During the last three decades, comprehensive palaeomagnetic investigations have been conducted in North and North – Western Greece. A variety of formations ranging in age from Cenozoic to Paleozoic/Mesozoic were analyzed. These reveal the existence of an “ancient”

component directed WNW, acquired probably in Late-Jurassic/Cretaceous times. A younger ENE direction of Tertiary age has previously been reported from Western /South Western and Northern Greece. In order to further extend this dataset, we have sampled systematically along the Greek Pelagonian and Sub/ Pelagonian zone. Emphasis was placed on the Vourinos and Orthrys ophiolites and nonophiolitic accompanying sediments and lavas.

The Vourinos Ophiolite is one of the best documented ophiolitic complexes on global scale. It comprises a continuous ~12km thick Jurassic lithospheric section relatively unbroken by late intraformational tectonism. The entire pseudostratigraphic section, in today's geologic setting, is oriented (from east to west) steep westward dipping – vertical – overturned to east-dipping. Much of the rotation of this lithospheric section occurred previous to the upper Cretaceous, and an internal “bowing” in the ophiolitic section could represent inhomogeneous strain recorded during transport from spreading center to initiation of obduction. The sampling localities in Vourinos represent two depths within the oceanic lithosphere and a later, post-emplacement, formation.

The Jurassic-aged Orthris ophiolite is a thrust disrupted lithospheric section. A continuous section is lacking, though some nappes include over-lapping pseudo-stratigraphic elements. None of the composite nappes are overturned, and a reverse lithospheric-stratigraphic order is observed. The entire nappe sequence is emplaced above older lava-sediment sections and in the east, the Pelagonian margin. Western Othris, like the Pindos ophiolite, is in its entirety re-thrust above the Pindos flysch (late Cretaceous – Eocene). This latter backthrust occurred approximately 100 My later than the original ophiolite obduction.

In many areas, the standard palaeomagnetic and rock magnetic procedures revealed the presence of westward directions grouping around $D=330^{\circ}$. Secondary overprints correspond to the Tertiary clockwise rotation and often masked the older component. Inclinations are very low for the Permo-Triassic, implying an almost equatorial position for the area, in contrast to the ones corresponding to Jurassic / Cretaceous which are not far from the present position.

These results, together with previous research, are analyzed within the geotectonic framework of the broader area, providing an opportunity to compare palaeomagnetic directions during different stages of ophiolite emplacement.

Magnetic signature of plutons and implications for emplacement conditions: examples from Northern Greece

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The magnetization of batholiths is often unstable as a result of slow cooling and unroofing during their formation. These factors favour crystallization of coarse grains and mineralogical changes. Nevertheless, numerous studies have revealed the existence of stable magnetic recordings in batholiths, which can help to unravel the history of the pluton as far as its stability, translation or tilting is concerned. When an accurate isochron is established, it is possible to date the magnetic components through to blocking temperature spectra since isotopic and magnetic closure temperatures can be compatible. Finally, additional examination of other geophysical data and estimation of cooling rates can help the detection of burial conditions of the pluton. The majority of the above conditions apply successfully to large plutonic bodies. The present study focuses on Tertiary plutons in Northern Greece, covering more than 1200 km², classified from intermediate to large (70-430 km²), where extensive paleomagnetic and rock magnetic studies were carried out. Accurate radiometric ages are available for all studied plutons. The new data (Symvolos and Vrondou), along with previously published results (Elatia, Samothraki, Sithonia, Symvolos, Vrondou and Xanthi) compiled a detailed paleomagnetic dataset which constitutes an important step towards

distinguishing local rotations from the regional ones. The mean direction values from nearby volcanics were also used in the compilation for an additional test. A major point of attention for this study was the establishment of reliable inclination values, which would reflect the latitudinal variations, if important tiltings could be discarded. Thus, we scrutinized all palaeomagnetic results, by a closer examination at the site level and in comparison with the numerous available radiometric, geothermometry and geobarometry data. Finally, an attempt was made to quantify cooling rates in the area and make precise correlations with the big dataset of laboratory blocking temperatures.

The quality of the magnetic signature was, in general, satisfactory and the obtained directions (mostly clockwise) could be interpreted in the regional kinematic frame. The information provided by the paleomagnetic and rock magnetic studies has been used in various ways to assess the history of the plutons: (1) Dominance of magnetite, hematite or maghemite with estimation of grain size entails information on cooling rates and mineralogical transformations. The medium to coarse-grain granodiorites and monzonites of Elatia and Vrontou yielded the less reliable results of this study. (2) Laboratory blocking temperatures range from 350-600°C. For a slow cooling of 3°C/Ma this gives a range of natural T_b of 150-400°C which could be compared to detailed radiometric data in Sithonia and Symvolos, enabling us to accurately date the magnetic components. (3) Demagnetization diagrams and stereographic projections suggest minor or no tilt for some of the plutons (Symvolos, Xanthi) and possible tilting during emplacement for Sithonia. (4) The anisotropy of magnetic susceptibility was studied to assess the possible deflections of the palaeomagnetic vectors; in most cases AMS was relatively low while in plutons with higher anisotropy no systematic correlation was observed between irregular directions and increased AMS. The potential field data, where available, gave additional constraints to the above results. For instance, the Xanthi pluton has proved to have a 6-7km lower depth and a shape of a truncated pyramid. Assuming world-wide standard batholith burial depths versus critical isotherms we can estimate that the whole body has cooled ~above 13.5 km, which converges with the Curie isotherm for the area and crystallization depth calculated from geothermobarometry.

Acid Miocene volcanism in the Eastern Slovakia, variable sources and magma forming processes: constraints from petrology and geochemistry

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Young Middle Miocene (Badenian to Sarmatian) highly silicic volcanism is evolved in the region of the East Slovakia Depression (ESD). Four areal regions were sampled: 1) extrusions outcropping on the north of the ESD (Merník and Beňatina), 2) few bodies on the northern part of the ESD around Lesné, 3) small bodies on the south in the region of Zemplin and 4) bodies near southern continuation of the Slanské vrchy mts (Byšta). Variability in mineralogy reflects magma composition and stages of magma evolution. Highly siliceous rocks (70.7-77.3 wt. % SiO_2) occupy rhyolite field in TAS diagram. Rhyolite mineralogy is in part regionally dependent. The most striking feature is presence of almandine garnet ($\text{Alm}_{76}\text{Pyr}_{9,6}\text{Gross}_{6,9}\text{Spess}_{5,2}$) in extrusions at Merník, Beňatina and Lesné. Almandine phenocrysts with fairly homogeneous composition across the grain and with inclusions of zircon and apatite are presumed to be of magmatic origin. Presence of highly to moderately corroded garnet is suggestive of its instability at low pressure during ascent. High pressure garnet fractionation is recorded by intensive whole rock HREE depletion and steep REE profiles. Suppressed plagioclase fractionation indicated by absence of Eu negative anomaly and low $\text{Rb/Sr} = 0.66$ and corroded quartz phenocrysts is consistent with quick magma evacuation without essential low pressure fractionation/assimilation in the upper crustal magma chamber(s). Rhyolites from Byšta can be recognized by presence of orthopyroxene. Plagioclase, biotite, K-feldspar and \pm quartz are surrounded by fully crystallized matrix (feldspars and quartz) with only minor glass abundance. Complex plagioclase zonality

(hybrid cores resulted from mixing of two contrasting magmas, events of drastic corrosion, development of more basic in composition thick rims with numerous melt pockets entrapped), presence of large relic clinopyroxene (presumed to be a remnant after fractionation from more basic magma), disintegrated intergrowths of biotite-plagioclase-ilmenite cumulates indicate evolution of magma likely via AFC in shallow magma chamber which developed in the upper crust. Rhyolites from Zemplin area are compositionally heterogeneous, but neither contains garnet or orthopyroxene. Almandine garnet is common in banded metapelitic rocks trapped as xenoliths. Inclusions of quartz, ilmenite, Mg-chlorite, graphite, biotite and typically spessartine enriched margin of host garnet are evidence of its metamorphic origin. Most of extrusions or dykes are autometamorphosed. Matrix is replaced by K-feldspar, quartz and clay minerals; Fe released from mafic biotite fills cavities or armor phenocrysts. Rhyolite bodies have variable mineral proportions, crystallinity of the matrix and phenocrysts that is unique for each body. Peraluminous rhyolites from Eastern Slovakia are characterized by low content of Nb (10-19 ppm), Rb (120-159 ppm) and Y (5-37 ppm). Position on tectonic discrimination diagram corresponds to felsic magmatites evolved on the volcanic arc. Negative Nb, P, Ti anomalies and Pb peak on multi-element diagram indicate evolution with contribution of continental crust. Almost identical shape as for rhyolites from Central Chilean Andes suggests their origin in subduction regime with volcanic arc developed on thin continental crust. Rhyolites were analysed for Nd and Sr isotopic ratios ($^{143}\text{Nd}/^{144}\text{Nd}$ 0.51223- 0.512484 and $^{87}\text{Sr}/^{86}\text{Sr}$ 0.708163-0.715491). Variations in isotopic ratios are compatible with crustal component involved in petrogenesis of rhyolites. Three domains can be identified: 1) more $^{143}\text{Nd}/^{144}\text{Nd}$ and less radiogenic $^{87}\text{Sr}/^{86}\text{Sr}$ rhyolites from Merník (δNd -3.0, δSr 52), 2) lower $^{143}\text{Nd}/^{144}\text{Nd}$ and higher $^{87}\text{Sr}/^{86}\text{Sr}$ ratios from Beňatina and Byšta (δNd -7,5, δSr 92,9), 3) $^{143}\text{Nd}/^{144}\text{Nd}$ as with 2-nd domain but more radiogenic $^{87}\text{Sr}/^{86}\text{Sr}$ from Zemplin area (δNd -7,5, δSr 156). Position on the δNd vs δSr diagram scatters along trajectory from MORB to upper crust. Merník with the least crustal influence overlaps with fields of A-type and I-type granites; Beňatina and Byšta cluster in the intersection of I-type and S-type granites and Zemplin area is in the field of S-type granites. Dependence of variations in Nd-Sr isotopic ratios on areal distribution is attributed to different source composition and/or type and intensity of interaction with country rock during formation of partial melts.

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Paleovolcanological reconstruction of the Vepor andesite stratovolcano (Central Slovakia)

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In the region of the Hercynian crystalline massive of the Veporic unit (East of the Central Slovakia Volcanic Field, CSVF) denudation remnants of the intrusive-extrusive bodies and volcanoclastic rocks of supposed Neogene age have already been identified in the past. Paleovolcanological reconstruction has been done of former extensive andesite volcano, later removed by intensive erosion, on the basis of the recent mapping (in the scale 1:3 000 – 1: 10 000), petrological and radiometric data.

The region of central volcanic zone is exposed by deep denudation cut around the Magnetový vrch hill. The subvolcanic multi-stage diorite intrusion-pluton of cedar shape (K-Ar age: 12.08 ± 0.47 and 12.28 ± 0.42 Ma, respectively) in its lower part in the valley at the level of the Rimavica river (500 m altitude) steeply intrudes into the complex of the Hercynian granite and metamorphic rocks. On the western margin the intrusion transforms into several sub-horizontal apophyses emplaced in form of the sills along the lithological boundary between Hercynian granite and Middle Triassic limestone and dolomite and higher within the Mesozoic complex (Magnetový vrch hill, 960 m altitude). Zones of magnetite scarns are evolved at the contact of carbonates with the diorite intrusion. The intrusion is later

crosscut by dyke swarm of W-E to ENE-WSW direction. The dykes (K-Ar age: 11.94 ± 1.0 Ma) are mostly formed by coarse grained amphibole hyperstene andesite porphyry. Dyke swarm of basaltic andesite to basalt (K-Ar age: 12.02 ± 1.05 Ma) of ENE-WSW orientation at the SW slope of the Magnetový Vrch hill is most probably related to small parasitic volcano.

Proximal volcanic zone. Deeper levels of the complex of intrusive-extrusive bodies of hyperstene amphibole andesites \pm garnet (K-Ar age: 12.10 ± 0.38 Ma) characterised by autometamorphic alteration are exposed by erosion. Direction of steep fan-like lineation (fluidality) and zones with autoclastic breccias near the margins indicate forms of dome-type alternatively tholoide-type. Another small-sized of amphibole andesites (K-Ar age: 12.25 ± 0.5 Ma) to rhyodacites (K-Ar age: 12.53 ± 0.42 Ma) in the northern part of the proximal zone confirms the presence of small parasitic volcanoes in the region of the former volcanic slope. One small parasitic volcano that survived denudation represented by volcanic neck and adjacent remnant of cinder cone (agglutinate pyroclastic deposits) was found.

Distal volcanic zone of the Vepor stratovolcano is represented by denudation remnants of the volcanoclastic rocks that filled former paleo-valleys (canyons) of radial orientation with respect to central volcanic zone. More extensive remnant of NW-SE orientation is the Hajna Hora hill complex located on the NW from the proximal zone. A study of the paleo-valley filling formed by pyroclastic and epiclastic volcanic rocks (block-and-ash flows, ash-pumice flows and lahars) alternating with layers of epiclastic volcanic sandstones and conglomerates enable reconstruction of eruptive cycles and volcanic events. The filling of another radial paleo-valley on the west from the central volcanic zone represented by erosion relict of the lava flow of pyroxene andesite (K-Ar age: 11.56 ± 0.43 Ma) of WSW orientation cover the peak area of the Klenovsky Vepor hill. The lava flow overlaid basal fluvial sediments. Pokorádž complex, formed by volcanoclastic and volcanosedimentary rocks, is located SE from central volcanic zone. Deposition of the volcanic material took place in the shallow fluvial-limnic environment. Tuffitic-sandy sedimentation with conglomerate layers was episodically interrupted by a mass transport in the form of gravitational flows, lahars and block-and-ash flows.

On the basis of the field observations and K-Ar data it is possible to reconstruct the complex succession of the volcanic and intrusive events of the Vepor stratovolcano. The K-Ar ages suggest that the stratovolcano was active for a relatively short time during Lower Sarmatian, between $12.53 - 11.56$ Ma. The radiometric ages are in a good agreement with biostratigraphic data.

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A problem of rigidity of the Eurasian lithospheric plate in the light of data on age and dynamics of the Cenozoic intraplate deformations in different regions of the Northwestern Eurasia

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Now it became obvious that Cenozoic intraplate deformations of the Northwestern Eurasia were connected with the Alpine plate collision. However, areas of dynamic influence of plate-indenters, such as the Periapulian, Periarabian and Periindian “collisional areas”, as well as relations of the Cenozoic intraplate deformations with the contemporary spreading in the north and transcontinental shears along the Tornquist line and Urals must be determined more exactly. Besides, some paleomagnetic data does not correlate well with an uniform rigidity of the Eurasian lithospheric plate. These questions are discussed here in terms of evolution and dynamics of the Cenozoic intraplate deformations in different regions of Northwestern Eurasia. In West Europe, the aulacogen covers were crumbled in the Paleocene (the Laramic orogeny) simultaneously with the plate collision in the Alps. A spreading axis propagated from the Northern Atlantic into the Arctic at the same time, which allows

suggestion on interrelation of these events. On the contrary, in East Europe the moderate Laramic compression took place in the southernmost areas only whereas major activity went on much later, in the terminal Early Miocene-Quaternary, periods of the activity being coincident with those in the Caucasus and the phases of the Red Sea opening. In addition, an evidence that the southern East European craton belongs to the Periarabian collisional area is provided by the orientation of stresses which is the same in the intraplate structures and the Caucasus (e.g., submeridional compression) as well as by similarity of structural patterns. A character of the post-Cretaceous deformations in the northern East Europe is less clear. First, their upper age limits are still unknown. Second, a compression axis orientation was sublatitudinal there. This allows suggestion that the deformations were originated under pressure of the adjacent Urals. The recent Uralian orogen began to grow at the Eocene-Oligocene boundary, i.e., much earlier than the formation of the East European intraplate deformations during the Arabia/Eurasia collision. Accordingly, it could not be related to the Periarabian collisional area. On the other hand, the beginning of its growth coincided with a reinforcement of the India/Eurasia collision. Hence, the Urals may be considered to be a peripheral part of the Periindian collisional area. From the dynamic aspect, the Recent Urals was formed as a result of sublatitudinal shortening caused by an underthrust of lithosphere of the West Siberian platform. The uplift of the Uralian Mountains was accompanied by thrust-fold deformations and strike-slips, which were predominantly sinistral. So, compressional intraplate deformations occurred in the northern periphery of a collisional power area of every plate-indentor simultaneously with its northward movement. In addition, the essential changes of the collision zone regime in the south coincided with those of the spreading system in the north. The data generalized allow reconstructing the following scenario of the events. After the West European part of the Eurasian plate and corresponding segment of the spreading zone were blocked by the Paleocene collision in the Alps-Dinarides, the spreading propagated into the Arctic. As a result, East Europe together with Siberia moved southeastward, to the relic Neo-Tethyan subduction zone. They were separated from West Europe by the dextral shear along the Tornquist line. The East European platform was separated from Siberia by sinistral shear along the Urals only in the Oligocene, most likely due to interlock of the Asia movement by Indostan. In the Pliocene, the independent East Europe movement was ceased by the Arabia-Eurasia collision, and since that time Northwestern Eurasia was entirely in compression. Thus, the present view of unity and rigidity of the Cenozoic Eurasian plate is correct only at the first approximation. In reality, the Eurasian plate represented a time-varying kaleidoscope of subplates that moved at different velocities from the Atlantic-Arctic spreading axis. The greatest acceleration was experienced by the Eurasian fragments whose general southeastward motion was in the least degree restrained by the Gondwanian relics colliding with Eurasia.

Seismogenic magnetic activity study

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The earthquakes (EQ) are one of the most devastating natural hazards and their study is a permanent challenge of geophysics. The EQ often occur in Carpathian-Balkan region and any progress in the study of the possibility to predict them is welcome. It is known that seismic, in spite of numerous experimental attempts and theoretical considerations, is not efficient for short-term prediction of EQ. Much more chances have the registration of electromagnetic (EM) radiation. It is experimentally confirmed that the most advantageous for study of magnetic variations accompanying the EQ preparation process is ultra-low frequency (ULF) band (0.001-0.5 Hz), and namely the monitoring of ULF signals is believed to be efficient for the EQ forecasting problem. There are numerous observations of ULF magnetic field enhanced activity before EQ as well as many approaches to construct a credible physical model of this phenomenon. The greatest problem which arises at the attributing of the observed ULF activity to the EQ under preparation is the necessity to separate the seismogenic signals from the natural fluctuations of ionospheric origin which

fully coincide as to the frequency band with seismogenic ones being much more powerful and often occurred. Several methods of their separation proposed in the literature proved to be not enough efficient. This work describes still one attempt to select the candidates for EQ precursors, basing on the experimental data, collected in India and China by multi-point synchronized observation magnetometer network. The temporary network in India was formed by specially developed for EQ-related magnetic signals measurement low-noise magnetometers LEMI-30, installed near the EQ focal area. For study of pre EQ magnetic activity in China the stationary flux-gate magnetometer network was used. The data from these magnetometers spaced by distances 50-100 km collected during observation campaigns have been analyzed. The wave forms, dynamical Fourier spectra and polarization ellipse parameters of signals from magnetometers pairs have been studied and compared with seismic activity and natural magnetic field variations data. A complete analysis of these multi-points data allowed us to propose a new criterion for the extraction of seismogenic ULF signals from the interference background. It was shown that the controlled by the orientation of seismogenic faults resulting seismo-EM field would have definite orientation in comparison to the isotropic direction distribution of highly variable natural signals arising from complex ionospheric-magnetospheric interactions. Basing on these physical considerations, it was revealed that the intersection lines formed by the planes of polarization ellipses calculated for the magnetic fields measured at minimum two sites, define the azimuth to seismo-EM source. Further, ratio of major axes of these polarization ellipses above certain threshold was taken as second selection value helping to distinguish ULF signals dominated by seismo-EM origin from those associated with ionospheric origin. The details of the method and obtained experimental results for two EQ occurred in India and China are discussed in the report. These works were partially supported by STCU grant 3165.

The palaeogeographic position of the Jadar Block (Vardar Zone, NW Serbia) in the Early Carboniferous

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The Milivojevića Kamenjar section in Družetić (NW Serbia) is the most diverse Carboniferous ammonoid occurrence on the Balkan Peninsula. It contains two faunal complexes, an early Late Viséan and a fauna from the Viséan-Serpukhovian boundary. The early Late Viséan assemblage is similar to time equivalent occurrences of the North Variscides and north-western Africa. It is integrated in a cosmopolitan ammonoid distribution of this time interval. The Viséan-Serpukhovian boundary assemblage is very different to its time equivalents from the North Variscides and as a result indicates provincialism; it belongs to the South Variscan–North Gondwanan faunal realm and is closely related to the occurrences in the Cantabrian Mountains of Spain and the South Urals.

Contrasting plutonic bodies in the northern Dinarides-south Pannonian basin: petrogenetic and tectonic implications inferred from the study of Mt. Cer granitoids (West Serbia)

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The central parts of the Balkan Peninsula in Serbia are characterized by extensive Tertiary calc-alkaline magmatism. Along with widespread volcanic rocks, there are numerous granitoid plutons occurring within the composite terranes of the Vardar Zone and Serbo-Macedonian Massif. They represent part of a regional Tertiary plutonic-volcanic belt stretching from the Periadriatic tonalite line in the North, through Serbia and further to the SSE in the F.Y.R.O.M. (Former Yugoslav Republic of Macedonia), south Bulgaria and northern Greece. Oligocene plutons are predominant in the area and they are mainly of I-type characteristics. They originated during post-orogenic dextral transpressional movements associated with wrench tectonics and formation of lacustrine basins along the central axis of the Balkan Peninsula.

The Miocene Mt. Cer and Mt. Bukulja plutons are located in the southern Pannonian area. These rocks show both I- and S-type characteristics and are distinguished from the Oligocene granitoids of the Dinaride suite on the basis of age, petrography, geochemistry, and metallogeny.

The Mt. Cer pluton is a complex laccolith-like intrusion (~60 km²), comprising both I- and S- type granitoid rocks. It intrudes Palaeozoic metamorphic rocks causing weak to strong thermal effects. It is situated at the junction between the northern Dinarides and the southern margin of the Pannonian Basin, and is, hence, a key point for elucidating the geodynamic significance of the Tertiary granitoid magmatism in this part of the Balkan Peninsula.

Based on modal and chemical compositions four rock-types can be distinguished: (1) metaluminous I-type quartz monzonite/quartz monzodiorite (QMZD), (2) peraluminous S-type two-mica granite (TMG), which intrudes QMZD, (3) Stražanica granodiorite/quartz monzonite (GDS), and (4) isolated mafic enclaves (ME), found only in QMZD. ⁴⁰K-³⁹Ar dating and geological constraints indicate that the main QMZD body of Mt. Cer emplaced not later than 21 Ma, whereas the emplacement ages of the GDS and TMG are estimated at around 18 and 16 Ma, respectively. The Mt. Cer pluton is similar to the Mt. Bukulja pluton occurring some 80 km southwestwards.

Genesis of QMZD cannot be interpreted by fractional crystallization coupled with mixing or assimilation. It is best explained by a convection-diffusion process between a mantle derived minette/leucominette magma and a GDS-like magma followed by two end-member magma mixing. The composition of GDS rocks suggests that GDS-like magmas could have formed by melting of lower crustal lithologies similar to amphibolite/metabasalts. The geochemistry of TMG is reproduced by an AFC model with an assimilation/fractionation ratio (r) of 0.4, using the compositions of the least evolved TMG of the Bukulja pluton and adjacent metamorphic rocks as proxies for the parental magma and contaminant, respectively.

The origin and evolution of the Mt. Cer and adjacent Mt. Bukulja plutons provide new constraints on the Tertiary geodynamics of the northern Dinarides-southern Pannonian region. The QMZD is interpreted as a result of the Oligocene post-collisional Dinaride orogen-collapse, which included a limited lithosphere delamination, small-scale mantle upwelling, and melting of the lower crust. By contrast, the TMG and GDS magmas formed via melting in shallower crustal levels during the extensional collapse in the Pannonian area.

Geochemical evaluation of the Veřovice Shales in the western part of the Carpathians

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The Veřovice Fm strata occur in the Silesian and Subsilesian nappes of the Western Outer Carpathians from Veřovice (south of Štramberk, Moravia) up to the area south of Kraków. Among the Veřovice Fm rocks, predominant are black claystones, often siliceous, with layers and concretions of sphaeroidite. Their thickness reaches 250-500 m. The rocks under the studies constitute the uppermost part of the formation and are dated as the Late Aptian – Early Albian. The Veřovice Fm strata represent the global anoxic event OAE 1b. Anoxic conditions of sedimentation, together with low sedimentation rate and low supply of terrigenous material, were advantageous for deposition and preservation of organic matter.

The Veřovice Fm rocks were sampled in the Silesian Unit. Measured total organic carbon content (TOC) is significant and exceeds 4%, with the mean of about 1%. Particularly high TOC was observed in sections of Lipnik near Bielsko-Biała. Comparably high values were recorded in sections of Rzyki near Andrychów where TOC ranges from 0.38 to 3.0 %. The obtained results correspond to the known measurements carried out for the Veřovice strata in Zasań near Myślenice (1.56 to 3.72%) and in Veřovice (0.31 to 3.66%). Such organic carbon contents, as well as the hydrocarbon contents (S₁+S₂) reaching 7 mg/g rock, evidence good source potential of this formation. Results of the Rock-Eval pyrolysis matter in the Veřovice Fm reveal Type III kerogen with exceptionally low hydrocarbon potential determined by the hydrogen index. Results of the analysis of *n*-alkanes and isoprenoids suggest admixture of Type II kerogen. This has been indicated, among others, by maximum in the range of long-chain hydrocarbons and values of CPI lower from one or equal to one, which are characteristic of hydrocarbons generated by organic matter deposited in sediments having acid matrix. Thermal maturity of the claystones indicate a very wide range of maturity, from the initial stage of the “oil window” (435 – 450 °C) up to the initial stage of the “gas window” (>465 °C). Also values of reflectance R_{cal (MPI)} calculated on the basis of the aromatic compound analysis are varying widely, from about 0.9 to 1.5%. The values of thermal maturity univocally indicate effective source potential of the Veřovice Fm.

The above results of geochemical studies evidence that the Veřovice Fm. may represent potential source rocks for systems that comprise reservoir rocks of different ages in the Outer Carpathians.

Gem minerals and materials from the Neolithic and Chalcolithic periods in Bulgaria and their impact on the history of gemmology

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Studies of prehistoric (Neolithic to Chalcolithic period) artefacts from the territory of Bulgaria during the past decade revealed a lot of specific gem and decorative minerals and materials: nephrite, malachite, serpentinite, turquoise, jadeite, jet, carnelian, agate and jasper (including heliotrope). Nephrite artefacts in Bulgaria, as well as in some other countries on the Balkans, are widespread during the Neolithic and rare during the Chalcolithic – the nephrite sources are under discussion. A Balkan “nephrite culture” is introduced, which is supposed to be the earliest in the world, compared to the well known Chinese “nephrite cultures”. The Varna Chalcolithic necropolis (middle of the V mill. BC) is known with the earliest and largest amount of gold artefacts in the world, including also some copper objects from the copper mines near Stara Zagora. A large amount of beads are also identified as made

by malachite (in rare cases with azurite), serpentinite, carnelian, agate, coal (jet), marble and shells. Some of the carnelian beads from Varna display 16+16 facets along their elongation, which is the first record for a constant and complex faceting of hard mineral known so far. An early prehistoric weight system links mineral beads and gold artefacts (the weight unit “van” is introduced, 0.4 g = 2 carats). The first report of turquoise beads for SE Europe is related to the Orlovo prehistoric site (Haskovo district). The “Thracian stone” in ancient sources is identified also as heliotrope, which is known since the Chalcolithic in the Eastern Rhodopes. Some of the artefacts are masterpieces of art and as stage of perfection, thus pointing to the Balkans as a cradle of prehistoric gemmology.

The use of GNSS technologies for application in mining, geology and geodesy in Bulgaria

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A review on the use of GPS technologies for application in mining and geology on territory of Bulgaria is presented in this paper. Some particular results concerning the application of GPS in opencast mining in Bulgaria are presented and analyzed. The essentials of them are periodical survey of mine working; investigation of slope strain; management of output and transportation of mining mass. In the area of geology and geophysics are discussed some results on application of GPS on: geological mapping and assaying; gravity investigations; deformation of earth’s crust; investigation of landslide processes; coordination of platforms for oil and gas production etc. Plans for future work on the above issues are discussed too. The problem of the combined processing of GPS and other types of classical geodetic measurements concerning the higher accuracy of the result is still topical. In the proposed paper a better accuracy in the vertical component of the GPS-networks has been sought. It is suggested that the results from the spirit levelling expressed by heights should be used. Observation equations of heights (orthometric or normal) can be included in the mathematical model for processing of GPS measurements. In these equations a simplified model of geoid (quasigeoid) is involved. A numerical example for the combined processing of GPS measurements with EDM and spirit levelling heights has been presented. The results confirm the expected higher accuracy of the height component.

Efficiency of the Chiprovtsi mining site remediation with regard to heavy metal and arsenic environmental pollution

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A Program for the liquidation of the inefficient ore-mines in Bulgaria was started by the government in 1992. One of the main goals of the program is to eliminate the negative consequences of the mining industry to the environment. Restoration and remediation measures are envisaged for the mining sites only but not for the affected areas outside as the heavy metal polluted rivers and their floodplains. Evaluation of the efficiency of the environmental recovery of the mining affected landscapes in the upper part of the Ogosta River basin, NW Bulgaria, is the overall purpose of this study. Three mines (Au; Fe; Pb-Ag)

operated in the region from 1951 to 1999 and the remediation activities ended in 2004. The levels of As, Pb, Zn, Cu and Cd were determined in the river water (109 samples), floodplain ground water (3 samples), river channel (97 samples) and floodplain sediment (44 samples), haplic Luvisols, LVh, FAO, 1998 (16 samples), grass vegetation (25 samples), sheep's milk (6 composite samples from 800 animals) and goat's milk (1 composite sample from 19 animals). Seven sampling campaigns were carried out in the period 2005-2007. The studied trace elements were measured with the means of AAS-GF, ICP-AES/OES/MS and XRF in the laboratories of the University of Mining and Geology of Sofia, Humboldt University of Berlin, Acme Laboratories (Canada) and the Ministry of agriculture and food of Bulgaria. The results show As and Pb as the main contaminants in the local environment, associated mostly with the river channel and floodplain sediments along the Ogosta River and its initial tributary Chiprovtska River. The mean As value (median) for the channel sediment is 1170 mg/kg (min 16 mg/kg; max 80390 mg/kg) and 1117 mg/kg for the floodplain sediment (min 43 mg/kg; max 26946 mg/kg). The mean Pb levels for the same media are 178 mg/kg (min 10 mg/kg; max 15205 mg/kg) and 282 mg/kg (min 43 mg/kg; max 2982 mg/kg), respectively. The mean As value exceeded the Dutch intervention value 21 times for channel sediment and 20 times for floodplain sediments. The same quantities for Pb were 0.3 and 0.5 times, respectively. Levels above the imperative values of the EU directive 75/440/EEC were detected in river water mostly for As, which ranged between 0.002 mg/l and 0.621 mg/l, with mean value of 0.053 mg/l. Two general patterns of vertical metal and arsenic distribution were revealed in the polluted floodplains. Type 1 is typical for the floodplain sections lower than 1m where the contaminants increase in depth and ground water pollution with As is established. Type 2 is the common one for the floodplain between 1-2.5 m above the usual river level. Trace element accumulation in the upper sediment layers is typical in these areas. Lead concentrations above the EU threshold of 0.02 mg/kg were established in 5 samples from sheep's milk (min 0.0036 mg/kg; max 0.077 mg/kg), as well as in the goat's milk (0.052 mg/kg), produced in the Chiprovtsi mining area. As the studied grass samples from the grazing areas were not rich in Pb, other paths of lead transfer to the milk should be suggested. Though some of the remediation measures were successful, it can be concluded that the negative environmental legacy from the mining is still present in the Ogosta River basin. Better results can be expected if all the contaminant accumulation zones and the path-ways of the pollutant dispersal in the mining affected area are taken in account when environmental recovery measures are designed.

Palaeoenvironment of the Eastern Mediterranean Miocene hominoids

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During Miocene several hominoids were living in Eastern Mediterranean (Balkans, Black Sea, Asia Minor). The known middle Miocene hominoids are *Griphopithecus alpani* and *Kenyapithecus kizili*, known the previous one from the localities of Çandır and Paşalar (Turkey) and the second from Paşalar; both localities are dated either to MN 5 or to MN 6. The late Miocene hominoids include the following taxa: a. *Ankarapithecus meteai* from the early Vallesian (MN 9) localities Sinap-12, 8A (Turkey); b. *Ouranopithecus macedoniensis* from the late Vallesian (MN 10) localities of Xirochori-1, Ravin de la Pluie and Nikiti-1 (Greece); c. *Ouranopithecus turkae*, found in the early Turolian (MN 11) locality of Çorakyerler (Turkey); d. *Udabnopithecus garedziensis* known from the latest Vallesian (MN 10) locality of Udabno I (Georgia); e. *Graecopithecus freybergi* discovered in the late Miocene locality of Pyrgos Vassilissis (Greece), and f. a single premolar is known from the middle Turolian (MN 12) locality of Chirpan (Bulgaria); the sole premolar has similarities with *O. macedoniensis*.

The faunal composition, diversity and similarity of the hominoid bearing mammal assemblages of Eastern Mediterranean are analyzed by various techniques. The faunal

composition of the middle Miocene hominoid bearing assemblages indicates closed environment with warm/humid conditions, while during late Miocene the environment was relatively open/dry. The analysis and comparison of the hominoid bearing mammal assemblages with other Eurasian middle and late Miocene ones, as well as with modern faunas from known environments indicate that all the European middle Miocene faunas and the Vallesian ones of Western Europe can be correlated to the modern closed assemblages (tropical/subtropical forests, seasonal forests) indicating similar palaeoenvironment. On the other hand, all the late Miocene with or without hominoids assemblages of Eastern Mediterranean (except Udabno I) are correlated with the modern open assemblages suggesting relatively open landscape with warm and dry conditions (wooded savannah, savannah with shrubs, savannah with grass). The habitat of *Griphopithecus alpani* and *Kenyapithecus kizili* was similar to that of a monsoon forest with meadows. The hominoids *Ankarapithecus metei*, *Ouranopithecus macedoniensis*, *Ouranopithecus turkae* and the Chirpan hominoid were living in open landscape (savannah with trees, bushes, shrubs and grass) under warm/dry conditions. The palaeoenvironment of *Udabnopithecus garedziensis* seems to be more closed and humid than the other late Vallesian ones and closer to that of the middle Miocene assemblages.

Late Miocene Carnivores from the Greco-Iranian Province: comparisons, guild structure, palaeoecology

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The Greco-Iranian Province (Balkans, Turkey, Iran and Afghanistan) includes numerous mammal localities, which provided a significant number of carnivores. Although there are several taxonomic studies concerning them, their guild structure and relationships were never studied in details. The present study is a preliminary effort to give some data about their relationships, guild structure and their palaeoecology

The carnivores of the studied area are separated in groups, including the taxa of each MN zone of the Greco-Iranian Province. The faunal similarity of the defined groups is analyzed, indicating that Vallesian (MN-9 and MN-10) assemblages are well separated from the Turolian (MN-11 and MN-12) ones. Their faunal similarity is low, suggesting different taxa. The MN-13 assemblage is separated from the others due to its limited faunal data.

The guild structure (comparing body mass, locomotor pattern and diet class) of each MN assemblage is also studied and the diagrams indicate differences between the Vallesian and Turolian carnivoran assemblages. The absence of arboreal forms in all assemblages, as well as the relative abundance of the hyaenids and the cursorial forms suggest a possible open environment. The multivariate analysis of the studied carnivoran assemblages in comparison with the recent ones from known environments confirms their open character. These palaeoecological results fit quite well with the known palaeoenvironmental conditions of the Greco-Iranian Province.

Preliminary results of the palynological investigation of the Toarcian deposits of Ionian Zone (Western Greece)

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In this study we present preliminary palynological data from Lower Toarcian deposits of the Ionian Zone (Western Greece). The Ionian Zone belongs to the external Hellenides and during the Mesozoic constituted part of the southern Tethyan margin. The initially shallow

carbonate platform of the Ionian Basin began to break up in the early Pliensbachian. The first deepening of the basin has been recorded in Siniais Limestones that are followed by Posidonia Beds. The occurrence of macroremains of the conifer *Brachyphyllum nepos*, together with geochemical and palynological studies of Toarcian deposits of the Ionian Zone, suggested the presence of a tropical biome in the broader area.

The 20-m outcrop examined (Toka section) begins in the upper part of the Siniais Limestones and continues into the lower part of the overlying Posidonia Beds. In the studied deposits previous research has documented the local expression of the global Toarcian Oceanic Anoxic Event. The Early Toarcian Oceanic Anoxic Event has been associated with exceptionally high rates of organic-carbon burial, marine anoxia to euxinia, sea transgression, high palaeotemperatures and mass extinction and is generally considered as a significant climatic driven event.

Palynological investigation of the deposits aims to contribute further to our knowledge about the Toarcian palaeoenvironmental conditions, while the resulting dataset is an additional contribution to the Jurassic biostratigraphy of the Ionian Zone. Most studied samples yielded a considerable amount of palynological residue, including moderate diverse and fairly well preserved palynomorph assemblages of pollen, spores and dinoflagellate cysts. Additionally in palynospectra from organic rich horizons a significant quantity of amorphous organic matter has been recorded.

Fission-track constraints on the thermotectonic evolution of the Apuseni Mountains (Romania)

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The Apuseni Mountains, located inside of the Carpathian arc and bounding the Transylvanian basin to the west, constitutes the largest outcropping part of the Tisza block. This crustal fragment consists of a stack of several nappe sequences formed in response to continental collision, which followed the closure of the Neotethys Ocean. The northwestern part of the Apuseni Mountains represents a coherent nappe sequence consisting of the Bihor and Codru nappe systems. The tectonically highest Biharia nappe system, previously considered as part of Tisza plate, is attributed to the Dacia Mega-Unit. The assignment of the Biharia nappes to Dacia is made on the basis of the fact that both structurally underlie the obducted remnants of the Neotethys (Transylvanian Ophiolitic unit) leading to the assumption that an oceanic suture needs to be placed between Biharia nappe system and the Tisza block.

The main high-grade metamorphic event in the basement rocks, outcropping in the Apuseni Mountains, is of pre-Mesozoic age because the metamorphics are covered by Triassic or Jurassic non-metamorphic sediments. The first Alpine tectonic event was probably related to the obduction of the Eastern Vardar Ophiolitic unit (Transylvanides) onto parts of the Dacia Mega-Unit (Biharia) in the latest Jurassic. This was followed by late early-Cretaceous final closure of the Neotethys remnants and the collision between Tisza and Dacia blocks producing top-E nappe stacking. The final emplacement of the nappes in the Apuseni Mountains involving top-W to NW superposition of the Biharia, Codru and Bihor nappe systems did not occur before Turonian time as documented by the late Turonian “Gosau” unconformity. Subsequent compressional deformations in the area are reported for the end of the Cretaceous and the Eocene.

The Jurassic volcanics of the Transylvanides and their sedimentary cover, as well as the underlying Baia de Aries nappe (the highest structural unit of the Biharia nappe system) exhibit late early-Cretaceous zircon fission-track (FT) ages (Aptian and Albian, 120-103 Ma). The more westerly and structurally lower units (Biharia nappe of the Biharia nappe system, Codru and Bihor nappe systems), however, exhibit Late Cretaceous (Turonian to Campanian, 95-71Ma) zircon FT ages. The late early-Cretaceous zircon FT ages from the Baia de Aries nappe, together with the Jurassic ophiolites and their sedimentary cover, suggest that these rocks must have been buried to a minimum of 8 km during this time. Such associated

temperatures have probably been attained during underthrusting of these units below the Tisza megatectonic unit (thrusting being top-east). The ages obtained from the Bihor, Codru and Biharia nappes (Turonian to Campanian, 95-71Ma) correspond to the age of the late Cretaceous top-NW event that led to the present-day nappe stack in the Apuseni Mountains. The internal parts of the Baia de Aries nappe and the overlying Transylvanides were not reheated during this second event since they occupied the highest tectonic position.

Zircon FT age distribution, combined with thermal modelling of the apatite FT data, show that rapid post-tectonic cooling of the area during the late Cretaceous was followed by relatively slow cooling during the early Paleogene.

Role of climate and carbon dioxide in tree-ring growth of Greek firs from Ainos Mountain, Western Greece: 1820-2007 AD

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Nine billion metric tons of carbon are emitted annually by human industrial activities around the world. Approximately 30% of this is taken up by the oceans, and another 20% by the land biosphere. The land uptake has long been known as the “missing carbon sink” and has remained elusive, in that the underlying processes remain unidentified. A major mechanism contributing to this uptake is thought to involve enhanced growth of forests as a consequence of increased photosynthesis due to elevated atmospheric CO₂. This mechanism, known as the CO₂ fertilization effect, is well documented in controlled laboratory and field studies but remains controversial in natural forests bathed in ambient air. If CO₂ fertilization is indeed operating in natural ecosystems it could have important implications for terrestrial ecosystem and carbon cycle dynamics around the world.

Here I present tree-ring evidence for CO₂ fertilization in Greek firs (*Abies cephalonica*, Loudon) growing at 1300-1600 m elevation on the Ainos Mountain forest on the island of Cephalonia (Kefalonia) in western Greece. Core samples were collected from firs growing near the peak of the mountain, and ring widths were measured and processed into a master chronology extending from 1820 to 2007 AD. Standardized ring-width variations were regressed with instrumental records of temperature, precipitation and Palmer Drought Severity Index (PDSI) to identify growth-climate relationships. It was found that growth is favoured by late spring and early summer moisture availability, with wet and cool June conditions being optimal for growth. Surprisingly however these relationships have degraded or vanished in recent decades, indicating that growth sensitivity to moisture has declined. This is an unexpected finding in light of recent trends toward aridification of the background climate extending over the entire Mediterranean basin. In addition to loss of moisture sensitivity, the tree-rings from Ainos firs indicate significant acceleration of radial stem growth, which is especially pronounced after 1990 AD. The combination of enhanced growth and loss of moisture sensitivity despite increased aridity are diagnostic of a CO₂ fertilization effect operating via a “water use efficiency” mechanism. Elevated CO₂ induces stomatal closure, which helps conserve leaf water by limiting evapotranspiration, thus allowing greater growth and reducing sensitivity to moisture. This effect is predicted to be strongest in moisture-stressed, arid and semi-arid environments such as the eastern Mediterranean basin. Its detection in greek firs from western Greece may not be an isolated process, but possibly indicative of broader forest responses to elevated CO₂ over the greater Mediterranean basin. Further tests are needed to establish the spatial extent and regional or global significance of this effect.

The geochemistry and petrogenesis of volcanic rocks within ophiolitic formations at the Northeast Othris Region, Greece

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Volcanic rocks from ophiolitic formations in northeast Othris region are categorized based on their geochemical characteristics in two distinct groups. The first includes volcanic rocks from the ophiolitic formations of Eretria and Velestino, which, as their immobile element chemistry and geochemical plots indicate, seem to have formed in an N-MORB environment with 5-15% partial melting of a fertile or moderately depleted mantle source and extensive fractional crystallization processes. The second group is exclusively from the ophiolitic formation of Aerino having rocks with generally higher MgO contents, subduction related features (e.g. low Ti/V<10) and having been derived from a highly depleted mantle source but with similar partial melting degrees (10-20%). These differences may reflect an evolution from an earlier MORB to a latter IAT volcanism within the same oceanic basin or correspond to two separate oceanic environments.

Database of geomagnetic induction vectors across the Carpathians and modelling of the regional conductivity distribution

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Study of the geoelectrical structure of the Carpathians has a long history. The first induction studies performed in the late fifties revealed reversals in orientation of the geomagnetic induction vectors. Until the nineties, geoelectric groups from former Czechoslovakia, Poland, Hungary, Ukraine and Romania carried out a series of deep induction experiments and covered the whole Carpathian region by number of field stations clustered along profiles crossing the Carpathian arc. The collected long period electromagnetic induction data made it possible to map the surface trace of the Carpathian geoelectrical anomaly and to estimate the depths range and conductivity of the causative electrical conductor in the crust. Various methods were applied to model the electrical structure beneath the Carpathians. Based on a compilation of previous results as well as on our original modelling experiments we present a generalized conductivity model of the Earth's crust of the western, northern and eastern parts of Carpathians. Electromagnetic induction data from the period range of 400 to 6000 s collected on the territory of former Czechoslovakia, Poland, Hungary and Ukraine were used to study the crustal structure of the electrically anomalous zone. Along several profiles, magnetotelluric data were acquired which provided information on the directional properties of subsurface structures and on their directionality. 2D electrical cross-sections along the magnetotelluric profiles were constructed by stitching formal 1D anisotropic inverse models obtained from complete magnetotelluric impedance tensors and, further, by employing the 2D REBOCC inversion procedure. The obtained models were used as pilot conductivity distributions for a subsequent quasi 3D modelling. 3D modelling and inversion aimed at fitting the geomagnetic induction data across the whole area by a regional distribution of the integrated electrical conductivity (conductance) and was carried out by applying a thin sheet approximation of the crustal structures as well as by utilizing results of numerical simulations of the horizontal magnetic

tensor (HMT) obtained from the observed induction vectors. The electrical model of the Carpathian region is presented and discussed in relation to other geophysical data available and with respect to the basic regional geological units. The modelling allowed us to constrain both the geometry and electrical properties of the anomalous electrical structures beneath the Carpathians. The models show significant spatial variability of the geometry of the Carpathian conductivity anomaly along the Carpathian arc. Particularly, according to the modelling results the maximum width of the electrically anomalous zone reaches 50 to 60 km and the depth of the crustal conductors varies between 10 and 30 km in the West Carpathians and between 6 and 25 km in the northern and eastern part of the Carpathians. A special character of the induction vectors is observed in the western part of the Carpathian region where it makes contact with the Variscan structures of the Bohemian Massif and shows a complex 3D structural pattern generated most likely by a couple of pronounced but discordant anomalous induction features.

An integrated study on the Late Miocene Tuğlu formation – palaeoecological, palaeoclimatic and palaeogeographical interpretation (Çankiri Basin, Central Anatolia, Turkey)

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Within the framework of the EUROCORES Topo-Europe programme the VAMP (Vertical Anatolian Movements Project) Project, an international and interdisciplinary research team (APVV-ESF-EC-0009-07 and IGAG-CNR TA.P05.009.003) has achieved detailed sampling and study of key stratigraphic sections in the Çankiri Basin (Central Anatolia). Ostracods, benthic foraminifera, nannoplankton, charophytes, molluscs, fish remains, palynomorphs and micromammals have been recovered from the 21m thick Tuğlu section. Biostratigraphy based on small mammals is still in progress, because new data from VAMP sampling during last year point to an age of rodent assemblage (MN7-8) older than the previously published data (MN10). The rodent assemblage composition is characterized by the dominance of *Byzantinia* cf. *bayraktensis* and unusually diversified Gliridae (genera *Myomimus*, *Myoglis*, *Muscardinus* and *Glirulus*). The genus *Myoglis* was not previously known from Anatolia. The less common taxa are *Democricetodon*, *Keramidomys* and *Spermophilinus*. The association of rodents from Tuğlu suggests humid and forested environment. Insectivores have not yet been processed. Both magnetic mineralogy and magnetic susceptibility analyses were carried out and the variations of magnetic parameters (SIRM, SIRM/k, IRM_{1/0.1}) along the section were studied. These parameters display a link with the distribution of freshwater ostracods probably related to humid climatic inputs. Most likely, the Tuğlu formation deposited in a continental setting characterised by permanent water bodies affected by strong salinity and depth oscillations. The molluscs from the middle and upper part of the section are characterised by terrestrial, freshwater and low-oligohaline gastropods and bivalves represented by the genera *Lymnaea*, *Bithynia*, *Melanopsis*, *Dreissena*, *Potomida* and Helicidae, showing alternating open land, lacustrine and fluvial conditions. A diversified charophyte assemblage (*Nitellopsis*, *Lychnothamnus* and *Chara*) confirms the existence of a permanent water body in the middle part of the section. Since dating is still in progress, it is difficult to estimate sedimentation rates and to distinguish seasonal or inter-annual salinity changes from changes in salinities due to other inputs. To better understand such oscillations, high-resolution sampling of a 350-cm-long section has been performed. The palynological record documents subtropical climate (*Cathaya*,

Engelhardia) and in the lower part of the profile changes in low sporomorphs concentration (Pinaceae) are recorded opposite to higher percentages of halophytes (Chenopodiaceae) and dinoflagellates. Ostracods, benthic foraminifera, molluscs, charophytes, fish remains and pollen have been recovered. Palaeomagnetic sampling was also performed and all samples display a normal polarity. The ostracod assemblage is characterised by the alternate dominance of *Cyprideis* sp. and *Ilyocypris* spp., with *Leucocythere* sp., *Zonocypris membranae quadricellae*, *Heterocypris salina* and *Candonidae* as accompanying species. The benthic foraminifera appear suddenly in the *Cyprideis* dominated samples and disappear as much abruptly. *Quinqueloculina*, *Miliolina Trisegmentina* and *Varidentella*, tolerating hyperhaline conditions, dominate the foraminiferal assemblage. Species rapidly increase in size with aberrant coiling up to top of profile. In the lowermost part of the profile, abundant exemplars of *Perfocalcinella fusiformis* and Palaeogene and Cretaceous redeposited calcareous nannofossils were recovered. Foraminifera and calcareous nannoplankton presence in the lower part of the profile provide two hypotheses about this sequence origin.

Seismic anisotropy and deformation patterns in upper mantle xenoliths from the central Carpathian-Pannonian region: indications for a collision driven asthenospheric flow?

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The Cenozoic geodynamic evolution, including basin formation, volcanism in the Carpathian-Pannonian region (Central Europe, CPR for short), has been interpreted in many different ways. A review is presented on deformation patterns in mantle xenoliths from the central part of the Carpathian-Pannonian region and seismic anisotropy data which appear to support the existence of an E-W directed asthenospheric flow underneath the study area. The E-W oriented asthenospheric flow and accompanying horizontal extrusion of lithospheric blocks from the Alpine orogen, as well as extension was the result of the collision between the European and Adriatic units in the Eocene. The eastward directed asthenospheric flow may be an additional driving force to the previously proposed slab-rollback and gravitational instability models for the formation and deformation of the Carpathian-Pannonian region. The existence of such a flow beneath the CPR may also generally confirm that the asthenosphere does not only have a passive role in tectonically active zones (i.e., orogen belts) but can be an important driving-force for the formation of marginal basins.

Late Neogene red clay in the Carpathian basin and its paleoclimatological implications

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The red clays in Hungary (Tengelic Red Clay Formation: TRCF; Kerecsend Red Clay Formation: KRCF) is overlain by loess paleosol sequences. The thickness of the red clay (in general) ranges from 4 to 90 m. The red clay sediments in the Carpathian basin are known from both exposures and boreholes. The age of these formations is ~3.5–1.0 Ma. Elemental oxide analyses of red clays were determined by x-ray fluorescence (XRF), and x-ray powder diffraction (XRD) was used for mineral identification. The degree of chemical weathering in soils by hydrolysis increases with available precipitation and temperature. Both water and

warmth serve to accelerate the depletion of alkali and alkaline earth elements (Ca, Mg, Na, K) at the expense of refractory elements such as aluminum (Al). These relationships within soils have been used to derive transfer functions for estimating paleoclimatic variables from paleosols of comparable parent material composition and degree of development. This study extends these techniques to paleosols formed during the Late Pliocene–Early Pleistocene in the Carpathian basin. The chemical index of alteration without potassium ($CIA = 100 \times mAl_2O_3 / (mAl_2O_3 + mCaO + mNa_2O)$ in mol) increases with mean annual precipitation in modern soils. Paleotemperature of paleosols can be derived from alkali content ($C = (mK_2O + mNa_2O) / mAl_2O_3$, in mol) which decreases in modern soils with mean annual temperature. The equation for mean annual temperature is: $MAT (^{\circ}C) = 46.94C + 3.99$ ($R^2 = 0.72$, standard error ± 182 mm); for mean annual precipitation is: MAP (mm) = $14.265(CIA - K) - 37.632$ ($R^2 = 0.96$, standard error $\pm 0.6^{\circ}C$). The older type (Beremend Member, age ~ 3.5 – 2.0 Ma) of the TRCF is red kaolinitic clay containing typically disordered kaolinite, mixed-layer smectite/kaolinite, smectite and little gibbsite. It was formed in the local subaerial weathering crust in warm, humid, subtropical or monsoon climate (MAT : 13 – $15^{\circ}C$; MAP : 1200 – 1400 mm). The younger member (age ~ 2.0 – 1.0 Ma) of the TRCF contains red (or “reddish”) clay beds. It contains relatively fresh material (illite, chlorite), the weathering products are predominantly smectite and goethite formed under warm and drier climate in environmental conditions of savannah and steppe or forest steppe (MAT : 10 – $13^{\circ}C$; MAP : 1100 – 1300 mm). The basal red clay layers of the Paks Loess Fm. and KRCF (age ~ 1.0 – 0.5 Ma) contain similar material as the underlying red clays belonging to the younger member of the TRCF. The slightly but significantly lesser degree of weathering (more illite and chlorite, less smectite) indicates cooling of the climate (MAT : 8 – $10^{\circ}C$; MAP : 900 – 1000 mm). It appears from the sedimentological data that the main part of the red clay is of wind-blown origins, other is weathering crust of the underlying material. The Neogene red clay accumulated under persistent weak winds and a rather steady warm–arid climate. This material later was modified by post-depositional weathering under warm–humid climate.

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Time and space distribution of the Neogene intrusive magmatism from Oaş-Gutâi Mts., Eastern Carpathians, Romania

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The Oaş-Gutâi Mts. (OG) belongs to the Eastern Carpathians Neogene-Quaternary volcanic chain. Two types of calc-alkaline volcanism took place during the Middle-Miocene (15.4 – 7.0 Ma): a felsic explosive extensional type and an intermediate arc type of extrusive and intrusive origin, respectively. Gold-silver and base metal epithermal ore deposits are associated with the intermediate type of volcanism.

Subvolcanic and shallow-level intravolcanic intrusive rocks of irregular shapes and various sizes (from tens of metres up to 6 km long) developed on more of 3000 m vertical extent (based on drill core data). They suggest morphologies of dykes, sills and apophysis of microlaccolites crosscutting the Paleogene flysch-type basement, the Neogene sedimentary deposits, as well as the volcanic suite; hundreds of intrusions outcrop mostly in the south-eastern part of Gutâi Mts. Despite the relationships of the intrusions with different volcanic complexes, they can be hardly attributed to some individual volcanic structures. Among the various compositions and textures of rock types (from gabbros to microgranodiorites), the andesites and the porphyritic microdiorites, quartz diorites and quartz monzodiorites are the most abundant. Hornfelses and sometimes skarns formed at the contact of the intrusions with the sedimentary deposits.

The spatial distribution of the intrusions in the Gutâi Mts. suggests a possible connection with the major transcrustal fault/ tectonic system Bogdan Vodă-Drăgoș Vodă, developed in the southern part of the volcanic area, as well as with some tectonic alignments showing the same orientation as most of the hydrothermal veins. The inception of the intrusive phases can be related to the change of the regional tectonic regime from transpressional to transtensional at 12 Ma, as it was recently invoked in the case of the “Subvolcanic Zone” of the Eastern Carpathians. It ended at 9.2 Ma, except for the late mafic/basaltic phase from Gutâi Mts. (8.1-7.0 Ma) ceasing the magmatism. In Oaș Mts. the intrusions were emplaced exclusively in Pannonian (10.8-9.6 Ma), while in Gutâi Mts. the intrusive magmatism started in Sarmatian (11.9-11.4 Ma) postdating the Sarmatian volcanism (13.4-12.1 Ma). Along with the emplacement of the Pannonian volcanics, intrusive rocks with different K-Ar ages (11.7-9.2 Ma) were also emplaced, being attributed to different volcanic phases. The main intrusive magmatism occurred contemporaneously with the paroxysm of the OG volcanism. The time intervals of the intrusion emplacement in OG and Poiana Botizei and Țibles from the “Subvolcanic Zone”, respectively are similar except for the mafic intrusive phase from OG.

Important veins are hosted by the intrusions from OG. Comparing the age intervals of the mineralisations with those of the intrusions, seems that the radiometric data achieved on adularia and illite from the epithermal ore deposits are consistent with those of the intrusions identified all over the metallogenic fields: e.g. the Ilba-Nistru base metal metallogenic field from the south-western part of Gutai Mts. shows 11.9-11.4 Ma interval of K-Ar ages for the intrusive rocks, 11.6-10.7 Ma interval for the K-Ar ages of adularia and illite and 10.6 Ma Ar-Ar age for adularia, exclusively. Except for the basaltic intrusive complex, the intrusions from OG are older than the epithermal mineralisations from all the ore deposits.

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Tectonostratigraphic terranes in the Circum-Pannonian region (pre-Neogene basement of the Pannonian Basin and its Alpine-Carpathian-Dinaridic frame): a school example of exotic terranes

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Tectonostratigraphic terrane maps of the Circum-Pannonian region showing paleoenvironments from the Devonian to Jurassic were published by the Hungarian Geological Institute in 2004 on the occasion of the Geological Word Congress held in Florence. The explanatory book of these maps in form of a monography is going to be published by the Geological Institute of the Slovak Academy of Science on the occasion of the present congress of the Carpatho-Balkan Geological Association. We shortly present the essential principles of the maps and related monography chapters, and implications for the terranology of the area concerned.

Obducted remnants and suture zone(s) of the NW part of the Mesozoic Neotethys Ocean can be found in the internal zones of the Hellenides–Dinarides and then as small, dispersed blocks in the Circum-Pannonian region more to the North. The European (Carpatho-Balkanide) margin of this ocean was formed upon the Variscan Moldanubian Zone and Mediterranean Crystalline Zone, respectively. On the other hand, its Adriatic margin was formed upon the eastern part of the Variscan Carnic–Dinaridic microplate. Its rifting began in the early part of the Middle Triassic, whereas in the Hellenides already in the late Early Triassic. Moreover, the Main Vardar Zone is supposed to have existed already in the Paleozoic, thus representing an inherited Paleotethyan domain. This pattern of deformed continental margin zones and remnants of one/or two oceanic zone(s) inbetween them is preserved until the southern margin of the Pannonian Basin, until the Bosnian–Serbian sector.

Further to N, in the basement of the Pannonian Basin this pattern is completely changed due to intervening of the large Tisia Megaterrane. Small displaced Neotethyan remnants can be followed from the NW Dinarides (Medvednica, Kalnik Mts. in NW Croatia) through the Mid-Hungarian Zone up to the Bükk-Darnó area in NE Hungary and Jaklovce Subunit of Meliaticum in SE Slovakia (Zagorje-Bükk-Gemer Composite Terrane). Another branch of these remnants can be followed E of the Tisia Megaterrane to the Transylvanides of Romania.

On the other hand, the northern part (Mecsek Zone) of the Tisia Megaterrane was formed on the Variscan Moldanubian Zone, whereas its southern part on more southern Variscan crystalline—granitoid complexes comparable with those of the Eastern Alps and West Carpathians (Mediterranean Crystalline Zone). It was part of Europe until early Middle Jurassic and became separated from there in the Bathonian due to the beginning of Penninic rifting.

The present terrane pattern of the Pannonian basement was then formed later due to late Mesozoic and early Tertiary rotational and strike slip movements. As a result of them, units/terrane of opposite origin became juxtaposed in the central part of the Pannonian basement, thus this area can be considered as a school example of exotic terranes. On the other hand, small Neotethyan remnants (Meliatic, Transylvanide), which became separated from the main Neotethyan trunk already in the Late Jurassic to Early Cretaceous times and became involved in Middle to Late Cretaceous nappe stackings of the Carpathians, represent typical disrupted terranes.

Metaophiolite association in the Rhodope Massif as a stratigraphical and structural marker

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The paper is a brief survey of the geological setting and metamorphism of the Metaophiolite Association within the metamorphic basement of the Rhodope Massif on Bulgarian territory. It emphasizes the stable stratigraphic level of metaophiolites in the lower layers of the Variegated Formation of the Rhodopian Supergroup. Usually, they crop out in deep tight synclinal folds between anticlinal structures. On the basis of new geological arguments and lithological analysis that take into consideration the syn-metamorphic deformation and metamorphic changes, an attempt is made to reconstruct the primary lithostratigraphy of the metamorphic complex. In addition, some corrections of the current stratigraphic column and geological map of the Rhodope Massif are also made. The view that fold structures dominate instead of thrusts is affirmed. Geological relationships assume that the most likely way for the integration of serpentinites into the Variegated Formation of the Rhodopian Supergroup was obduction of fragments of serpentinitized oceanic crust onto an ancient continent consisting of gneisses of the Prarhodopian Supergroup. The ophiolites have undergone various metamorphic changes: hydrothermal ocean and regional metamorphism in the amphibolite facies, culminating in migmatization. It is suggested that eclogitization occurred in local shear zones within the crust, and not along thrust surfaces or within subduction zones to mantle depth. The Metaophiolite Association is an important marker for the stratigraphic correlation of the metamorphic terranes as well as for the structural and metamorphic evolution of the Rhodope massif basement.

Diagenesis of the Lower Jurassic sandstones in Central Poland

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Sandstones from boreholes located in the zone Toruń – Radom have been petrographically and petrophysically studied. The Lower Jurassic sediments in the area of research occur at depths ranging from 800 to 2100 m. The following research methods were used in sandstone observations: polarizing microscope (PL), cathodoluminescence studies (CL), scanning electron microscope (SEM) investigations and energy dispersive spectrometer studies (EDS ISIS), X-ray diffraction analyses (XRD) and petrophysic laboratory studies.

Sandstones are represented mostly by quartz arenites and wackes, from very fine to medium grained. The main component of grain framework is quartz, which in average is about 70 volume % of rocks. However, feldspars (representing mainly potassium feldspar) and lithoclasts most often occur approximately in 1 volume % of rocks. Plate micas (mainly muscovite, less biotite) and chlorite occur in sandstones in varying quantities. Organic matter and heavy minerals constitute a small percentage.

The main type of cement is matrix which is a mixture of detrital clay minerals, quartz dust, iron hydroxides and organic matter. In addition, there is a cement in sandstones, which is built by diagenetic minerals. Quartz, carbonates, clay minerals, and locally pyrite were distinguished among them.

Quartz cement is the most important in the Lower Jurassic sandstones ranging in content from 0 to 23.7 volume %. It creates syntaxial rims developed on quartz grains and partly fills the sandstone pore space. Authigenic quartz overgrowths are very well visible in the CL image. They are characterized by dark brown luminescence, differentiating itself from the quartz grains which show blue-violet or brown luminescence.

Carbonate cements are represented mainly by siderite (and another minerals of siderite-magnesite series) and Fe-dolomite/ankerite. Their content ranges from 0 to 31.7 volume % of rocks. Siderite represented by siderite and sideroplesite often creates very fine-crystalline grains. They fill the pore space in the rock and are found in clay laminae enriched in organic matter. Locally, coarse-crystalline siderite is also present, sometimes in the form of rhombohedrons. It is represented by sideroplesite, sporadically by pistomesite. In comparison to the fine-crystalline siderite, the coarse-crystalline one is characterized by higher content of $MgCO_3$. Ankerite creates spar cement, often in the form of isolated euhedral, rhombohedral crystals. Because of the large content of Fe^{+2} , ankerite in CL studies does not show luminescence.

Authigenic clay minerals are represented mainly by vermiform kaolinite, reaching up to 14.0 volume % of rocks. Most commonly kaolinite occurs in the form of platy aggregate, which in the scanning electron microscope can be seen as pseudo-hexagonal crystals forming characteristic booklets forms. In the CL image kaolinite is characterized by a dark blue color. The occurrence of authigenic illite was found locally by SEM examination. Illite crystallites usually take the form of filaments, which grow over the pore spaces of sandstone.

The Jurassic sandstones are characterized by very good and good filtration properties. Their porosity often exceeds 20% and permeability ranges from 0.001 to 1930.756 mD. The porous space parameters measured in porosimeter show the following trend: factor of dynamic porosity 6.28-29.94%, average amount of pores > 1 mm 8-99%, threshold diameter 0.2-90.0 mm and hysteresis 6-76%.

Lake Van Drilling Project “PaleoVan”

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Lake Van is the fourth largest terminal lake in the world (volume 607 km³, area 3,570 km², maximum depth 460 m), extending for 130 km WSW-ENE on the Eastern Anatolian High Plateau, Turkey. The annually-laminated sedimentary record of Lake Van promises to be an excellent palaeoclimate archive because it potentially yields a long and continuous continental sequence that covers several glacial-interglacial cycles (ca. 500 kyr). Therefore, Lake Van is a key site within the International Continental Scientific Drilling Program (ICDP) for the investigation of the Quaternary climate evolution in the Near East. Based on the high-resolution seismic data and multidisciplinary scientific work, it is planned to drill a series of sites in Lake Van in the frame of ICDP in summer 2010. The geochronological precision on a decadal or even annual scale will allow comparisons not only with astronomical cyclicity but also signals below the frequency of Milankovitch cycles, such as North Atlantic Oscillation, which may have also affected the past climate system of the eastern Mediterranean region. As a closed and saline lake, Lake Van reacts very sensitively to lake level changes caused by any alterations in the hydrological regime in response to climate change. Tephra layers, documented in short cores and also expected in the deep drill cores of Lake Van sediments, allow reconstructing larger volcanic events and environmental impacts. The short cores from Lake Van show also strong evidence of earthquake-triggered microfaults, interpreted as seismites. Similar features are expected to be found in the deeper sections. The unique setting of Lake Van, which records simultaneously the volcanic as well as the earthquake history, will also allow establishing possible coincidence between larger earthquakes and volcanic events.

Based on high resolution reflection seismic data, four sites have been selected for the drilling campaign. The ‘Ahlat Ridge’-Site is the most important site. It is the deepest site (water depth ~375m) where we plan to recover a complete sedimentary section for paleoclimatic investigations. The ‘Northern Basin’ Site is located in a small basin close to the northern shore of Lake Van. The proximity to the Quaternary volcanoes will allow studying major eruptions of the volcanoes and associated volcanogenic hazards. Two sites in different water depths of the Ereğli Fan are planned to investigate lake level fluctuations and the evolution of Lake Van. Additionally all sites will allow to identify seismites for analyzing the seismic activity in the past. The rise of the human culture and the transport of mantle fluid through continents are additional questions, which will be addressed by the drilling campaign. Drilling will take place during three months during July, August and September 2010. We will be able to present the first initial results of this campaign during the meeting in Thessaloniki.

Tectonometamorphic evolution of the Rhodope orogen: Constraints from macro- and microstructures, petrology and geochronology

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Tectono-stratigraphy, macro- and microstructures, petrology and geochronology have been combined into a comprehensive model for the tectono-metamorphic evolution of the Rhodope orogen from the Jurassic to the Early Paleogene. High-grade deformed and metamorphosed continental and mantle rocks in two study areas in the Central and Eastern Greek Rhodope are part of a suture zone (Rhodope Suture Zone: RSZ) which extends over at

least 120 km from the W to the E. It is structurally underlain by a Lower Unit consisting of Pangeon gneisses with Variscan age and a metasedimentary cover of marbles with Triassic(?) age and overlain by the Upper Unit, a Late Jurassic sequence consisting of orthogneisses at the base, discordantly covered by (meta-)ophiolites (Circum Rhodope) on top. Considering our proposed model, the Lower Unit was derived from the Apulian plate during the Paleogene whereas the Upper Unit indicates calc-alkaline magmatism which took place during the early exhumation phase of the suture zone rocks. (Meta-) ophiolites are related to a rifting stage within the southern Neotethyan Ocean and have been obducted in north direction during Jurassic/Cretaceous time. The material from the investigated suture zone most likely originated as an extensional allochthon south of the European continent during Permo/Triassic time was subsequently subducted beneath Europe in the Early Jurassic (≥ 180 Ma). On the basis of comparable metamorphic ages and coherent structures but differences in metamorphic conditions and lithologies the rocks of the RSZ are subdivided into an Upper and a Lower Part. The P-T-d history of both parts differs due to the relative tectonic position within the exhuming wedge. Information for the prograde history is derived from subduction-related structures within quartzites in the Lower Part. Metapelites marking the transition between both parts contain microdiamonds and indicate that central parts of the RSZ experienced UHP conditions before exhumation started. Exhumation was controlled by buoyancy-driven normal displacement with SW-shearing at the base (Lower Part) and NE-shearing on top (Upper Part) indicating an early activity of a deep crust shear zone (Nestos Shear Zone) from the Late Jurassic to the Late Cretaceous. An intervening stage of mineral re-crystallization and thermal re-equilibration from partial anatexis in the Upper Part probably decreased exhumation rates and rocks experienced long-lasting overprinting at mid-crustal levels. Because of slow exhumation rates, peak indicators of a probable UHP stage were almost totally obliterated. A common exhumation history of both parts at pressures lower than about 12 kbar (35 – 40 km depth) is proposed. During this stage, rocks of the RSZ experienced their main ductile overprint due to southwest-directed shearing and folding. Differences in the deformation overprint of both parts are indicated by plunge angles of the stretching lineation which are steeply dipping to the NE in the Lower Part and subhorizontally dipping to the NE in the Upper Part. The Lower Part experienced long-lasting retrogression due to SW-directed shearing with the lack of partial anatexis and thermal re-equilibration. Upper crustal structures evolved most likely due to slab retreat and point to tectonic erosion as a final exhumation mechanism for the units of the Upper Part. Late stage shear activity at the Nestos Shear Zone accompanied with magmatism dominated in the footwall units of the Lower Part. This late tectonics is considered as coevally with the formation of Variscan basement domes originating from the underthrust Lower Unit, thus making the Rhodope orogen a classic core complex juxtaposed to former structurally higher units.

Latest Jurassic – Earliest Cretaceous mass movements in the Polish part of the Pieniny Klippen Belt and Silesian Unit (Outer Flysch Carpathians)

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Distribution of sedimentary breccias, mass flows; redeposited clasts, which indicate time and mechanisms of origin of tectonic movements within sedimentary basins, are the main objects of the presented paper. These types of tectonic activity in Polish part of the Carpathians are well documented both in the Outer (Flysch) Carpathians and in the Pieniny Klippen Belt. Neo-Cimmerian tectonic events took place both in the Alpine Tethys and Proto-Silesian Basin. A big geotectonic reorganization, known as the Walentowa Phase, took place in AT during the latest Jurassic-earliest Cretaceous (Neo-Cimmerian) movements resulting in extensive gravitational faulting. Several tectonic horsts and grabens, documented by facies diversification, were formed. These rejuvenated some older structures and Middle/Late Jurassic (Meso-Cimmerian) faults which caused uplift of the shallow intrabasinal Czorsztyn

pelagic swell. The over-regional significance of this geodynamic episode in the northernmost margin of the Tethyan Ocean is documented also by foundation of the Proto-Silesian Basin. Chaotic type of sedimentation dominated during Late Jurassic times indicating early stages of the Proto-Silesian Basin opening with increased tectonic activity. The detritic material was supplied from two sources: from the Baška-Inwald uplift separating the Proto-Silesian Basin and the Bachowice Basin located within the North European Platform, and from the island arcs within the Silesian Ridge separating the Proto-Silesian Basin and the Alpine Tethys. The biogenic material originated within shallow-water reefal and carbonate platform zones was transported by turbiditic currents from the uplifted structures on the Proto-Silesian Basin margins into the deeper zones of this basin. Both the calciturbidites and calcifluxoturbidites formed, constituting the main lithosome within the younger lithostratigraphic unit – the Cieszyn Limestone Formation. These deposits represent the oldest turbiditic currents sedimentation known from the Polish Outer Carpathian Basin.

Miocene Charophyta of Maoče, Pljevlja (Northern Montenegro)

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The siliciclastic sediments of Maoče, with its sand beds and sand lenses of fluvial origin, as the clearly featured former shoreline, characterize this remote gulf of DS Lake. Its shallow water is corroborated by the frequent appearance of desiccation cracks. The lacustrine influence is mirrored in rare marly interbeds. Gyrogonites with mostly smooth spiral cells also indicate a low water mineralisation. An age is determined by *Rhabdochara langeri*, the key fossil for Burdigalian equivalents of W Europe, found both in Maoče and close lying Pljevlja. *Nitellopsis merianii* is an Euroasian Miocene species. A large mammal, from Pljevlja - *Chalicotherium grande*, a small morph – indicates the Lower Miocene. An entire herd of *Chalicotherium* was killed by a catastrophic earthquake cutting forest they inhabit. The tuff of Maoče was destroyed by fluvial and wave actions; in mineralized lakes, as Pljevlja is, tuff was transformed into siderite. Basaltic flows cannot support age because of the melting of the lower crust part. So, the biostratigraphic age is the upper part of Lower Miocene.

Shows of lithospheric plates collision in region of Eastern Carpathians

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Classical shows of lithospheric plate collision in Carpathian region are known in the backside of Ukrainian Folded Carpathians and Trans-Carpathian flexure. These shows are: 1. Presence of sima (ophiolites) fragments in allochthonous occurrence. These are the complexes of basalts, andesite-basalts, trachytes that showed during the Upper Triassic – Lower Cretaceous. Fragments of ophiolites are known in the base of the Trans-Carpathian flexure, Marmarosh cliff zone and in the band of the thrust of Rakhiv-Burkut zone over the Krosno-Chornogora zone, as well as in the frontal part of the Marmarosh crystalline massif. 2. Post-orogenic magmatism is pronounced by Vygorlat-Gutyensk volcanic chain composed of basaltic andesites (70%), basalts (20-25%) and acidic differentiates (2-6%). Volcanic ridge stretches along the Trans-Carpathian flexure from the border with Slovakia to the town of Khust, where its strike changes to meridional and continues on the territory of Romania. 3. Increased heat flow in Trans-Carpathian flexure (more than 2 mkcal/cm²/sec) in

comparison with 1,2-1,6 mkcal/cm²/sec in Folded Carpathians; - considerable emergence of Moho border up to 25-30 km in Trans-Carpathian flexure in comparison with 55-65 km near Folded Carpathians and Carpathian foredeep. In Trans-Carpathian flexure the heat flow sharply increases to over 2 mkcal/cm²/sec. Such values are characteristic to the Slovakian, Pannonian and Transilvanian depressions. 4. Variety of fluid shows on Carpathian border and in Trans-Carpathian flexure (gas fields, shows of oil, big amount of mineral water springs). In Trans-Carpathian flexure during the last time 5 gas fields have been discovered: Rusko-Komarivske, Stanivske, Solotvynske, Korolivske, Dibrovske and one carbon dioxide field (Martivske). Oil shows have been observed in salt mines near the towns of Solotvyno and Khust and in 6 wells at prospects of Solotvyno, Nonkove, Makarove etc. 5. Presence of gravity markers of collision area by which in Trans-Carpathian flexure is clearly fixed Maximum connected with marginal swell of Eurasian plate, Minimum connected with deep-sea gutter and again Maximum connected with plate plunge in flat area of subduction under Pannonian microplate. 6. Presence in Badenian and Sarmatian deposits of Trans-Carpathians flexure intrusion - granite-diorite-porphyrines. 7. Ore mineralizations (basemetal and gold deposits): Biganske basemetal and Muzhyivske gold field in the zone of Beregiv horsts, as well as Saulyak gold field in the Marmarosh crystalline massif. 8. Thrust and fold structure of Carpathians. Presently the thrust and fold structure of Carpathians raises no doubts of the investigators. The Moho boundary shows a significant uplift (to 25-30 km) in Trans-Carpathian flexure comparing to its subsidence (to 55-65 km) below the Folded Carpathians and Carpathian foredeep along the line Beregove-Dolyna-Vyshnevets. The corresponding values are along the line Chop-Sambir-Gorohiv – 28-32 km in Trans-Carpathian flexure comparing to 55-65 km in the folded part of the Carpathians and Carpathian foredeep. The above-stated indicates that in Trans-Carpathian flexure there is collision and flat subduction of Eurasian plate under Pannonian microplate.

Geodynamics of Carpathian and Crimean fold belts formation

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Carpathian arched fold-and-thrust belt has formed as a result of its occurrence at the beginning of its formation within the rigid limits of Precambrian geo-structural units: Czech massif, Volyno-Podolian and Moesian plates, Pannonian middle massif with a consequent collision of a number of plates and microplates: of East-European microplate with African plate, which moves from south-west through the intermediate Adriatic and Pannonian microplates, of West-European microplate, which moves from west-north-west, with Pannonian microplate and of Arabian plate, which moves from south-south-east through Anatolian and West-Black Sea microplates with microplate of Transilvanian and Pannonian depressions. Differences in mass of plates and microplates are not big, that is why their collision occurs according to the scheme of collision and low-angle subduction under Pannonian and Transilvanian depressions of somewhat heavier and cooler plates from north-west, north-east and south-east. Collision belts of these plates and microplates are limited by fold-and-thrust subduction zones. Collision and low-angle subduction caused heating of the mantle mass, forming of the mantle asthenolith and its uplift, which resulted in intense heat flow and crust thickness reduction under Pannonian and Transilvanian depressions. This explains the high position of Moho under these depressions. As a result of subduction of the European plate under the Pannonian and Transilvanian microplates during Late Cretaceous till present, about 150 linear kilometers of substrate have been assimilated, and the Cretaceous-Paleogene flysch has been displaced from its platform basement and intensively deformed into structures of north, north-east and south-east vergence.

In front of the Crimean fold belt, on the north-east, the platformian part (Skythian microplate) is distinguished, further southwards – the system of depressions and somewhat

uplifted structures of latitudinal extension and more southwards the mountains of Crimea and Caucasus formed during the Kimmeridgian and Alpine folding phases. Southwards from these mountains the Paleogene depression of Black Sea has formed, in which the West- and East- Black Sea parts are distinguished. Southern coast of the Black Sea is represented by the mountain massifs of the Pontian Mountains (Pontides) formed during the Alpine folding and with a convex part of the arc directed to south-east. System of Crimean and Caucasus Mountains, taking into consideration their both subairial and submarine occurrence, has an arched shape and with its convex part directed to south-east. It has formed as a result of collision of the Eurasian plate with the plates of the present-day East- and West-Black Sea depressions. The beginning of collision is referred to Triassic (Kimmeridgian folding). During Triassic, Jurassic and Cretaceous a system of depressions, Crimean and Caucasus Mountains, Black Sea depression has been formed. During Jurassic-Cretaceous-Paleogene the process of denudation of the Crimean Mountains took place. At the end of Cretaceous the tectonic movements of the Alpine orogeny recommenced, which is evidenced by the laccoliths in the internal ridge of the Crimean Mountains.

During the Alpine folding cycle as a result of the movement of Arabian and Anatolian plates to south-west their movement has been transferred to the west of the Black Sea plate, which as a wedge along the Teisseyre-Tornquist line is pressed into the body of the Eurasian plate. This movement is observed till the Baltic Sea region. At the present epoch the movement of the Eurasian plate to south-west and its collision with the East-Black Sea plate continues. As a result was formed the Azov Sea depression, Indolo-Kuban depression continues to be formed, Sivash lagoon has been formed. The present-day Sea of Azov is an external part of the foredeep where the molasse deposits are formed. The present-day Black Sea is an intramontane depression.

At the present epoch the movements along the Trans-European tectonic activation zone – the Teisseyre-Tornquist zone have activated. This is confirmed by a number of earthquakes, existence of “hot” points and GPS measurements.

Structure and Miocene evolution of the frontal Polish Carpathians: a synthesis

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The Polish Outer Carpathians comprise several thrust sheets composed mostly of Cretaceous through Paleogene deepwater siliciclastic flysch. The most external units in the nappe pile is built of the Miocene sediments of the Carpathian foredeep basin. The lower plate (i.e. the sub-Carpathian basement) consists of the generally flat-lying Mesozoic to Permian sedimentary rocks, underlain by tilted blocks of Carboniferous, Devonian and Early Palaeozoic strata that rest on top of Precambrian basement. Top of the lower plate is very rugged; the youngest event that has shaped it was significant erosion post-dating Late Cretaceous – Palaeogene inversion of the Carpathian foreland. This widespread erosion resulted in incision of deep valleys generally directed towards S - SE. The morphology of the sub-Carpathian basement top and the distribution of the Badenian foredeep evaporites were two important factors that have influenced the evolution of the Carpathian orogenic front. A new structural model of the orogenic front and its basement has been recently constructed using outcrops, numerous wells and high quality 2D/3D seismic data.

In its western segment (Andrychow – Krakow) the Polish part of the Carpathian wedge is characterised by a flat sole thrust located above mostly undeformed Miocene foredeep sedimentary infill overlying faulted Precambrian to Palaeozoic basement.

Within the tectonic “Gdow embayment” (i.e. tectonic re-entrant), located in the central part of the study area (vicinity of Krakow), thick-skinned structures rooted in the Mesozoic basement influenced Miocene evolution of the Carpathian front. Miocene compression led to localised inversion of early normal faults, responsible for the formation of small local basin filled by the lower Badenian siliciclastics. Thick-skinned thrust faulting in the pre-Miocene basement was accompanied by thin-skinned back-thrusting and formation of a triangle zone along the Carpathian front within the most external unit built of the Badenian foredeep sediments.

The central-eastern part of the Carpathian front in Poland between Bochnia and Pilzno is dominated by thin-skinned wedge tectonics induced by combined effect of diverse erosional morphology of the pre-Miocene basement and the areal extent of the Badenian foredeep evaporites. Wedging along the Carpathian front produced well-developed triangle zones of the Miocene Zglobice unit, frequently cored by highly deformed salt succession, including world-famous Wieliczka Salt Mine near Krakow.

In its eastern segment, the Carpathian orogenic front is defined by shallow-dipping foreland-verging thrusts overlying undeformed Miocene foredeep deposits. In the vicinity of Rzeszow a system of deep paleovalleys has been described, filled in their axial part by the Badenian evaporites.

Within the easternmost segment of the study area (vicinity of Przemyśl) the final stage of evolution of the orogenic front was strongly influenced by the Miocene normal, reverse and strike-slip faulting within the pre-Miocene basement. This complex faulting was caused by Miocene reactivation of the Teisseyre – Tornquist Zone, i.e. crustal-scale boundary between the East European (Precambrian) Craton and the West European (Palaeozoic) Platform.

Radiolarian dating of Lower Cretaceous carbonate gravity-flow deposits from Bohinj area (NW Slovenia): significance for reconstruction of a lost carbonate platform in the Internal Dinarides

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Carbonate gravity-flow deposits at Srednja vas near Bohinj have been studied for radiolarian dating and composition of resedimented limestones. Paleogeographically, the area was part of the Bled Trough, which had a relatively distal position on the Adriatic continental margin and was rather far from the stable Dinaric Carbonate Platform. The Jurassic to Lower Cretaceous succession of the Bled Trough consists of: Lower Jurassic limestone with echinoderms (Hierlatz facies), Middle and Upper Jurassic bedded radiolarian cherts and shales, Biancone limestone, alternation of marls and shales, and finally siliciclastics with limestone olistoliths and ophiolite debris. This research is focused on the Biancone limestone, an approximately 40 m thick series of well bedded pelagic limestone, which includes intercalations of resedimented carbonates.

The lower part of the studied section consists of radiolarian packstone with chert nodules and layers, and in places contains thin interlayers of marl. Radiolarian assemblages from these beds indicate an Early Cretaceous age (Berriasian – early Valanginian). The age assignment is based on the following species: *Archaeodictyomitra apiarium* (Rüst), *Cinguloturris cylindra* Kemkin & Rudenko, *Dicerosaturnalis dicranacanthos* (Squinabol), *Hiscocapsa pseudouterculus* (Aita), *Mirifusus minor* Baumgartner, *Pantanellium squinaboli* (Tan), *Pseudodictyomitra carpatica* (Loznyiak), *Ristola cretacea* (Baumgartner), and *Tethysetta boesii* (Parona). The upper part consists mainly of carbonate breccias. Microfacies analyses showed angular to subangular shallow-water grainstone lithoclasts, ooid grains, fragments of calcareous algae, miliolid foraminifera and various other skeletal fragments of

different size. Clasts of pelagic limestone are also present and contain *Calpionella alpina* Lorenz whose range is late Tithonian to earliest Valanginian. The matrix of breccias is radiolarian-rich lime mudstone. The age of the platform carbonates is determined on the basis of calcareous alga *Clypeina jurassica* Favre which is characteristic of late Kimmeridgian to earliest Berriasian. In the uppermost part, carbonate breccias alternate with calcarenites. Slump folds are common.

Extraclasts and calcareous debris undoubtedly prove a platform origin of resedimented limestone. The Biancone limestone of the Tolmin Trough, which occupied an intermediate position between the Dinaric Carbonate Platform and the Bled Trough, consists of micrite without resedimented limestones. Therefore we conclude that the Dinaric Carbonate Platform could not be the source of shallow-water carbonates in the Bled Trough. We believe that these breccias represent evidence of a carbonate platform which must have been located more internally but is now not preserved. This inferred platform may have developed on top of a nappe stack, which formed during the early emplacement of the internal Dinaric units onto the continental margin.

Genetically similar isolated carbonate platforms of more or less the same age are known from several localities in the Alpine - Dinaride - Carpathian mountain belt. The Oxfordian / Kimmeridgian to Berriasian Plassen Carbonate Platform of the Northern Calcareous Alps in Austria and the Kimmeridgian? – Tithonian Kurbnesh Carbonate Platform from the Mirdita Ophiolite Zone in Albania have so far been the best documented. Other examples include Upper Jurassic reef limestones unconformably overlying the Vardar ophiolites in Serbia and the South Apuseni ophiolites in Romania.

Time constraints and plate tectonic controls for lateral extrusion in the Eastern Alps

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Late-orogenic normal faulting subsequent to the juxtaposition of European and Adriatic continental margins has been documented along the entire length of the Alps and there is a broad consensus that much of the exhumation history of deep seated rocks is related to slip along these normal faults. The structure of the Eastern Alps is characterized by a system of fault zones that developed during late Oligocene to Miocene times. This fault system is related to orogen-parallel escape of Austroalpine units towards east, a process also termed lateral extrusion. Lateral extrusion encompasses tectonic escape (plane strain horizontal motion of tectonic wedges driven by forces applied to their boundaries) and extensional collapse (gravitational spreading away from a topographic high in an orogenic belt). Northward oblique indentation by a rigid crustal block (the so-called Adriatic indenter represented by the Southern Alps) caused thickening in front of the indenter and east-directed tectonic escape. This study comprises a review and discussion of the classical model of lateral extrusion in the Eastern Alps, including the evolution of the confining fault systems in space and time. Distinct phases of extrusion are discerned by thermochronological data from the area of the Eastern Alps east of the Tauern Window. During Mid Miocene times the extrusion of the Central Austroalpine orogenic lid was not only lateral in terms of parallel to the trend of the orogen, but was characterized by a displacement vector at high angle to the strike of the orogen. This resulted in the exhumation of the so called Schladming block to the east of the Tauern Window and detachment of the Gurktal Block along the Katschberg - Niedere Tauern Southern Fault System. The eastern termination of the Gurktal block is defined by the Pöls-Lavanttal Fault System. Simultaneously the Pohorje Pluton intruded an extensional bridge at the southern termination of the Pöls-Lavanttal Fault System. The Dinaric trench holds a prominent position with respect to the East Alpine extrusion corridor because it separates the wedge into two domains with distinctly different evolution. The domain to the west of the trench, i.e., to the west of the Pöls-Lavanttal fault system, was continuously under compression, the area to the east was continuously under extension. The early phase of the

Adriatic or Southalpine plate motion (30-15 Ma) resolved in SW-NE compressive stresses and NW-SE tension. This released initial sinistral shear along the Oligocene Periadriatic lineament, which is in concordance to kinematic studies, and sinistral shear along the Inntal fault. Simultaneously Oligocene plutons, that are exclusively found to the west of the Pöls-Lavanttal fault system, intruded along the Periadriatic fault. From Mid-Miocene times onwards stresses released by the Adriatic plate became N-S compressive leading to shear reversal along the Periadriatic fault system that now became dextral. Direction of compressive stresses during this period was fairly orthogonal to the Periadriatic fault. Thus we suggest that dextral displacement is to a lesser extent stress induced but much more controlled by eastward motion (extrusion) of Austroalpine units that experienced enhanced extension between 15 and 12 Ma. During this phase the Periadriatic fault may therefore be visualized as a southern boundary fault (i.e., stretching fault) of the extruding East Alpine wedge that accommodated extrusion. Interestingly, deposition of intramontaneous basins commenced at this time (*ca.* 15 Ma) suggesting onset of enhanced extrusion induced exhumation within eastern sectors of the central Austroalpine realm. By contrast, the domain to the east of the Adriatic – Pannonic plate boundary (east of the Pöls-Lavanttal system) remained under extension throughout time.

Geocology of the Black Sea Coast of Georgia

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The combined geocological works, carried out within the bounds of Black Sea coastline (Georgian Section) in 2008, gave the following results: contamination of sea water surface with oil products does not exceed the regulatory values; Hydrochemical parameters of sea and the rivers discharging into the sea were determined. High concentrations of magnesium and arsenic were observed in the bottom sediments of sea and Rioni River in Poti water area; the composition of copper, lead, zinc, magnesium and arsenic highly exceed the Dutch Norms (Fomin, Fomin, 2001) in some samples of topsoils taken along the agricultural terrain and motor road. As a result of radiation measurements carried out in the Black Sea coastline, the sites are allotted where radiation is higher than the accepted norms; the concentration of magnesium in the biosamples (tea and eucalyptus) highly exceeds the maximum permissible concentration.

East Taygetos Fault Zone (Peloponnesus, Southern Greece): Dormant fault zone bordering awake neotectonic structure

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The eastern flank of Taygetos Mountain (southern Peloponnesus) is bordered by a normal fault zone striking NNW-SSW from Megalopolis basin to Lakonikos gulf near Gythio town, with a total length of about 80 km. A segment of this fault zone forms an impressive morphotectonic feature that is known as Sparta fault and it is located between Sparta town and Potamia village. The total length of this segment is about 20 km. Though this fault zone seems to be active since Pliocene, its present seismicity appears to be very low and sparse.

In order to assess the geometrical parameters of this fault zone, a morpho-structural analysis was carried out using combinations of Landsat ETM+ panchromatic and multi-spectral images (bands 1, 3, 4, 5 & 7) filtered with edge enhancement 3x3, the geological

maps covering the area from Megalopolis basin to Lakonikos gulf and the Global Elevation Model (GDEM) derived from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) imagery. The GDEM has a nominal 30 meter cell size, but its effective spatial resolution is estimated between 100 and 120 meters. All these data were integrated in a GIS environment using the Greek coordinate system EGSA 1987.

The kinematic analysis based on field observations shows the following multiple reactivations with a dip-slip movement of the entire fault zone since Pliocene: 1) an E-W extension during upper Pliocene 2) a NE-SW extension during lower Pleistocene and 3) a NW-SE extension during middle Pleistocene to the present. Assessment of the seismicity associated with this fault zone and the seismic potential based on its geometric and kinematic characteristics shows that it is a seismically dormant fault zone segmented into at least 3 segments of a length of about 20-25 km.

The strong earthquakes of VI and V century BC which struck Sparta town seem to be associated with the central segment of the zone known as Sparta fault. Based on morpho-structural analysis, the average slip rate since Early Quaternary could be estimated as 0.5 mm/yr, which allows us to characterize the fault as of moderate activity. Mmax for the fault of 20 km length could be estimated as M=6.5 and the corresponding Recurrence Time as 2,000 years average.

The results of the estimated fault potential (Mmax, RT) using calculations of slip-rate model (slip rate 0.5 mm/yr) and EZ-FRISK software (Risk Engineering, 2005) fit to the parameters derived from empirical relations.

The great destruction that Sparta town suffered at 550 B.C. and 464 B.C. could be attributed to high values of acceleration due to the close proximity to seismogenic fault (near field effect) as well as to the amplification of the strong ground motion due to loose quaternary deposits lying under Sparta town.

Variscan transpression and related voluminous magmatism in Central Strara Planina Mountain, Bulgaria

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In the area of Central Stara Planina Mountain and northernmost parts of Central Sredna Gora the pre-Mesozoic basement of Balkanides is largely exposed. Despite Alpine tectonic overprint the area provides unique chance to deciphering the Variscan history. Of greatest interest is the contact juxtaposing two contrastingly different units (terrains): i) the basement of Central Sredna Gora, comprising high-grade metamorphites (paragneisses, amphibolites, minor orthogneisses, and schists as well as isolated bodies of metagabbros and eclogites) migmatized at 336.5 ± 5.4 Ma; ii) the basement of Central Stara Planina Mountain consisting of Early Paleozoic low-grade metasediment-dominated complex (locally named Diabase-Phyllitoid Complex). Recently, we carried out detail structural observations along this E-W trending contact designated as the Stargel-Boluvanya Tectonic Zone. All features suggest it is related to transpressive crustal-scale deformation. The zone is traced for about 40 km and its general thickness reaches up to 4 km. It accommodated an intense ductile deformation, which is prograde for the low-grade metamorphites and retrograde for the high-grade rocks. The detail mapping of continuous profiles across the zone, where indications of Alpine overprint has not been established, clearly demonstrates that the syn-metamorphic shearing caused a juxtaposition of both contrast metamorphic units or an emplacement of the high-grade on to the lower-grade rocks. Within the zone, a W-SW trending foliation is ubiquitous, moderately to steeply dipping to the south or sub-vertical. This fabric associates with less pronounced S-SW-plunging or sub-horizontal stretching lineation. The observed sense of shear criteria indicate: i) top-to-north tectonic transport in sectors where the foliation is moderately dipping to the south and the lineation is SW-plunging; ii) dextral (?) shearing in sectors of the zone where the foliation is sub-vertical and the lineation is sub-horizontal. The observed field

relations suggest that the zone was active shortly after the thermal peak of metamorphism of the gneiss-migmatite basement of Sredna Gora at 336.5 ± 5.4 Ma, but before the post-tectonic emplacement of one of the largest Late Carboniferous (314 ± 4.8 Ma) granitoid pluton (the Vezhen pluton), which sealed the zone-related fabric of the low-grade metamorphites.

The continuation of the Stargel-Boluvanya Tectonic Zone eastwards (in the area of Karlovo, Central South Bulgaria) is problematic due to the emplacement of Late Variscan syn- to post-kinematic granitoids as well as the Late Alpine thrusting. Nevertheless, in this segment the geometry and kinematics of the penetrative deformation fabric, again suggest transpressive shearing. Here, no direct contact between the high- and the low-grade metamorphites has been observed. It is “obscured” by voluminous granitoid magmatism represented by batholitic-scale, foliated to isotropic granitoid bodies. The foliated bodies (Karlovo-Ribaritsa granitoid suite) represent NW- to W-trending granite sheets concordantly emplaced into low-grade metamorphites. The granitoids exhibit a steady S-dipping solid-state foliation and very rarely magmatic layering and foliation. The stretching lineation is dominantly strike-parallel - E-wagnerW to SW-NE oriented. Along the contacts of the bodies evidences of a “lit-par-lit” emplacement have been observed. In the immediate host rocks, widespread granitoid dykes are intensively mylonitized. Meso- and micro-scale observations indicate mid- to high-temperature greenschist facies conditions of the solid-state overprint. Up to now none of these bodies have been precisely dated but the preliminary results of U-Pb dating of zircons (oral communication, Albrecht von Quadt) point to Late Carboniferous emplacement. Rather similar is the age of the unfoliated granitoid bodies post-tectonically emplaced into both the low-grade and high-grade metamorphites.

On the bases of the available structural and age data we can speculate that during the Mid and Late Carboniferous the transpressive shearing along the Stargel-Boluvanya Tectonic Zone led to: i) final exhumation of the high-grade basement of Central Sredna Gora shortly after the migmatization process; ii) formation of the syn-metamorphic fabric of the low-grade metamorphites; iii) creation of pathways for emplacement of voluminous magma batches. The zone played a major role during the amalgamation of two pre-Mezozoic terrains with contrastingly different evolution.

First report of *Stromatocystites* (Echinodermata) from the Middle Cambrian of Turkey: Palaeobiogeographic implications

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Stromatocystites is one of the oldest and most primitive known echinoderms. This genus is relatively common in early to middle Cambrian deposits of Baltica (Sweden) and Gondwana (Australia, Bohemia, Newfoundland, Spain). It possibly also occurs in younger (Late Cambrian) strata of Montagne Noire (S. France). *Stromatocystites* is characterised by rounded to slightly pentagonal outlines, a flattened, biscuit-shaped body consisting in 1) a domed, polyplated, oral (upper) surface bearing five ambulacra and numerous respiratory openings (sutural pores); and 2) a slightly concave aboral (lower) surface. Such a morphology is extremely plesiomorphic within echinoderms. *Stromatocystites* differs from basal blastozoans (e.g., *Lepidocystis*) by the absence of free ambulacra (brachioles), from basal crinoids (e.g., *Titanocrinus*) by the absence of body wall expansions (arms), and from basal edrioasteroids (e.g., *Cambraster*) by the absence of a well-differentiated marginal ring. We report here on the recent discovery of two well-preserved specimens of *Stromatocystites*, collected within a shale interval in the upper part of the Middle Cambrian (Drumian) Koruk

Formation of Hakkari-Çukurca area (southeastern-most Anatolia, close to the border with Iraq). One specimen shows an almost complete oral surface, whereas the other one exhibits a typical lower surface. These two specimens are the oldest fossils of echinoderms ever reported so far from Turkey, and the first record of *Stromatocystites* in this part of the world. From a palaeobiogeographic point of view, the new Turkish fossils are particularly interesting, as they occur in a peri-Gondwanan region intermediate in latitude between western (Bohemia, Newfoundland, Spain) and eastern (Australia) occurrences of *Stromatocystites*. The morphology of the two Anatolian specimens is apparently closer to *S. pentagonalis* (Bohemia, Newfoundland, Sweden), than to *S. flexibilis* (Bohemia), *S. reduncus* (Australia), or *S. walcotti* (Newfoundland). The occurrence of *Stromatocystites* in southeastern Turkey is in good accordance with the Mediterranean-Acado-Baltic affinities observed for other faunal elements reported from the same area (e.g., trilobites). It also confirms the existence of regular faunal exchanges, and thus the palaeogeographic closeness, of Baltica and various peri-Gondwanan regions in middle Cambrian times. As a consequence, future field work in the middle Cambrian of Hakkari-Çukurca area will possibly yield additional echinoderm taxa typical of Mediterranean-Acado-Baltic regions, as for example the eocrinoid *Cigara* and/or the stylophoran *Ceratocystis*, which both occur along with *Stromatocystites* in both Bohemia and Sweden.

Some remarks on the biostratigraphy and paleoecology of the Middle Miocene Machów Formation (Carpathian Foredeep, Poland)

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The Polish Carpathian Foredeep Basin (PCFB) is the northern part of a large foreland basin system that surrounds the Carpathian orogenic belt. Like other foreland basins, the PCFB is asymmetric and filled mostly with clastic sediments of the Miocene age up to 3,0 km thick at the Carpathian front and to few hundred meters in the northern marginal part. Molasse deposits of the PCFB, underlain by the platform basement, dips southward underneath the Outer Carpathian napes to a distance at least 50 km. The PCFB is subdivided into two sub-basins: the inner and outer ones, located respectively south and north of the Carpathian frontal thrust. The outer sub-basin is composed of Middle Miocene autochthonous marine strata. The Miocene succession is subdivided into three formations: the Skawina Fm-sub-evaporitic, Wieliczka/ Krzyżanowice Fms.- evaporitic and the Machów Fm- supra-evaporitic. The last one is predominantly represented by siliciclastics sandstones and shales couplets. The age of this formation traditionally was assigned as Late Badenian and Early Sarmatian on the basis of foraminiferal research mainly. Our studies of the Machów Fm were concentrated in the eastern part of the PCFB, north of the Rzeszów. In this area we collected samples from five boreholes, in following depth intervals: S-2 (Stobierna): 1016-1338 m; S-3: 715-1669 m; S-4: 1016-1238 m; SB-1(Stara Brzóza): 350-356 m and 1043-1667 m; P-2 (Pogwizdów): 1161-1390m. The uppermost (above 350 m) and lowermost (beneath 1669) part of Machów Fm. was not studied because of the lack of core material. The aim of the study was to provide the biostratigraphic and paleoecological analyses for the Machów Fm. For this purpose smear slides from all collected samples were prepared using the standard method, and analyzed under light microscope Nikon Eclipse E600POL (LM, 1000x magnification) at normal and crossed nicols. The qualitative analysis were carried out for all the samples whereas the quantitative analysis only for the chosen boreholes S-3 and S-4. The obtained biostratigraphic data gave evidence for the upper part of the NN6 (the Early Sarmatian) and for the NN7 (the lowermost part of the Late Sarmatian) Zones. The whole sections investigated in S-2, S-4 and P-2 were classified to NN6 Zone. In S-3 interval 1669-1113 m was assigned to NN6, whereas section 843-715 m to NN7 Zone. In SB-1 interval 1667-1043 m belongs to NN6 Zone, interval 350-356 m was classified to NN7 Zone. The *Discoaster exilis* Zone (NN6) was defined by the presence of *Reticulofenestra pseudoumbilica*, *Sphenolithus abies*, *Helicosphaera walbersdorfensis* and absence of

Discoaster kugleri. Besides the listed species, the typical association of this zone was also represented by frequently occurring *Coccolithus pelagicus*, *Cyclicargolithus floridanus*, *Helicosphaera carteri*, *Sphenolithus moriformis* and *Umbilicosphaera rotula* and sporadically observed *Calcidiscus leptoporus* and *Calcidiscus premacintyreii*. The *Discoaster kugleri* Zone (NN7) assignment was based on the abundance of *Coccolithus miopelagicus* ($>10\mu$), used as an alternative species essentially confined to that interval, and absence of *Catinaster coalithus*. The NN7 Zone is difficult to distinguish because of absence or scarce abundance of significant marker species such as discoasterids and *C. coalithus*. The paleoecological preferences of nanoplankton species in S-3 and S-4 were considered in regard to temperature and nutrient availability (trophy). The enrichment of *C. pelagicus* and *C. floridanus* in sediments could indicate the nearshore eutrophic environment with high nutrient levels in surface water and upwelling paleoconditions. To upwelling-preferring group belong numerous *H. carteri* and small *Reticulofenestra*. The scarcity of discoasterids, which are more common in open ocean assemblages, could confirm shallow and coastal paleoenvironment as a negative indicator however its distribution depends on paleogeographical settings. It occurs much more often in Mediterranean area than in Paratethys. Deposition near the coast and relatively shallow water depth could result in high percentage of reworked specimens, which prevails over autochthonous ones in most samples from S-3 and S-4 boreholes. The percentage of autochthonous specimens is less than 50% and fluctuates between 40-50%. Reworked material, of the Cretaceous and the Paleogene age, comes from the south, from eroded Carpathian orogene.

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Study of time dependent earthquake occurrence in Greece: Relationship between seismicity rate changes and stress transfer and implications for time dependent seismic hazard assessment.-

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The relationship between changes of seismicity rate and static Coulomb stress is investigated at different sub–regions of the broader Aegean area. Seismic activity is studied at specific areas of interest, which are characterized by intense seismic activity and strong earthquake occurrence, known from both historical and instrumental data. The division of the area is based upon seismotectonic criteria, considering the regional kinematic properties, local seismicity and the available fault plane solutions. Coseismic stress changes are modeled and along with the tectonic loading are taken into consideration for stress change calculations. Data used for modeling contain events with magnitude greater or equal to a threshold magnitude, M_c , separately identified for each sub–region and time period. Simulations are done considering either the influence of aftershocks or declustered data. The spatial distribution of seismicity is translated into earthquake probability for both the observed and expected seismicity rates, by the application of a probability density function (PDF). Statistical process requires a normal grid superimposed on the study area. Spatial variable model parameters are calculated and then are linearly interpolated at the center of each cell of the normal grid. The dimensions of the cells are chosen in regard with the epicentral location error and the size of the catalog, such that a sufficient number of events being present in each cell and a realistic estimate of seismicity rate is done. Different values of model parameters are tried, with their limits being defined by physical and observational constraints, in order to test the sensitivity of the model in their fluctuation. Values for which results are closer to the observations are considered to express better the physical conditions and processes of the regional tectonic regime. Qualitative and quantitative correlation between the observed and the expected seismicity rates provide a test for the validity and sufficiency of the model.

Qualitative correlation is done by comparing the mapped patterns of observed and expected seismicity rates, while quantitative correlation is calculated by the application of statistical tests, i.e. calculation of the correlation coefficient, r . Once the model is tested in previous cases, an estimation of the expected number of small earthquakes or the probability of a large shock to occur in the future is performed for each one of the studied sub-regions. An earthquake forecast for shocks with magnitude greater than or equal to a minimum magnitude M , is attempted for specific regions and for a settled time period, contributing to a more reliable time-dependent seismic hazard assessment.

Larger foraminiferal stratigraphy and paleoenvironments of the Middle Eocene to Lower Oligocene shallow-marine units in the northern and eastern parts of the Thrace Basin, NW Turkey

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Several sections of the shallow-marine Eocene Soğucak Limestone and one of the Oligocene Ceylan Formation were studied with detailed biometric analysis of the full spectrum of larger benthic foraminifera (mainly nummulitids and orthophragmines). This allows us establishing a high-resolution biostratigraphy in the context of the shallow benthic zonation (with SBZ zones) of the Tethyan Paleogene since larger foraminiferal assemblages show a very strong Western Tethyan affinity. Only two species (*Heterostegina armenica* and *Orbitoclypeus haynesi*) cannot so far be traced to the west of the Thrace Basin.

The age of particular larger foraminiferal sites is determined based on (i) the occurrence and developmental stage of different species of *Heterostegina*, (ii) the presence/absence of giant *Nummulites*, (iii) the presence/absence of *Spiroclypeus*, (iv) the developmental stage of reticulate *Nummulites*, (v) the occurrence and developmental stage of orthophragmines, (vi) the occurrence of particular *Operculina* and radiate *Nummulites*.

Six larger foraminiferal horizons could be established. They correspond to (i) the vicinity of the early/late Bartonian boundary (SBZ 17/18), (ii) the middle late Bartonian (SBZ 18B), (iii) the latest Bartonian (SBZ 18C), (iv) the early Priabonian (SBZ 19), (v) the late Priabonian (SBZ 20) and (vi) the early Rupelian (SBZ 21).

Three main shallow-water depositional environments could be recognized in both the late Bartonian and Priabonian: two of them took place in the inner shelf: one with low, and another with high water-energy, whereas the third one refers to the outer shelf.

Biostratigraphical and paleoenvironmental observations allow us to reconstruct three subregions with different depositional histories. (i) The eastern part of the territory with a basement of the İstanbul zone was transgressed at the beginning of the middle late Bartonian (SBZ 18B) followed by the drowning of the carbonate platform still in the latest Bartonian (SBZ 18C). (ii) The Çatalca block lying on the Strandja Massif formed a paleohigh at whose peripheries a similar depositional history can be reconstructed as for the former subregion, however the central part was transgressed only in the (early) Priabonian and was not drowned at all. (iii) The northern margin of the Thrace Basin (also lying on the Strandja Massif) was transgressed only in the latest Bartonian (SBZ 18C) or in the early Priabonian (SBZ 19) and the Priabonian carbonate platform has only partly and moderately been drowned. This subregion very probably formed the northern margin of the whole Thrace Basin in the Paleogene.

Neogene-Quaternary volcanic forms in the Carpathian-Pannonian Region: a review

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Neogene to Quaternary volcanic/magmatic activity in the Carpathian-Pannonian Region (CPR) occurred between 21 and 0.1 Ma with a distinct migration in time from west to east. It shows a diverse compositional variation in response to a complex interplay of subduction with roll-back, back-arc extension, collision, slab break-off, delamination, strike-slip tectonics and microplate rotations as well as in response to further evolution of magmas in crustal environment by processes of differentiation, crustal contamination, anatexis and magma mixing. Since most of primary volcanic forms have been affected by erosion, especially in areas of post-volcanic uplift, based on the level of erosion we distinguish: (1) areas eroded to the basement level, where paleovolcanic reconstruction is not possible; (2) deeply eroded volcanic forms with secondary morphology with possible paleovolcanic reconstruction; (3) eroded volcanic forms with remnants of original morphology preserved; (4) least eroded volcanic forms with original morphology quite well preserved. The large variety of volcanic forms present in the area can be grouped in: a) monogenetic volcanoes and b) polygenetic volcanoes and their subsurface/intrusive counterparts that belong to the major groups of various rock series found in the CPR: calc-alkaline magmatic rock-types (felsic, intermediate and mafic varieties) and alkalic types including K-alkalic, shoshonitic, ultrapotassic and Na-alkalic. The following volcanic/subvolcanic forms have been identified: (i) domes, dome/flow complexes, lava fields (in grabens), shield volcanoes, effusive cones, pyroclastic cones, various stratovolcanoes and calderas and associated intrusive bodies (necks, dykes, sills, laccoliths, stocks, plutons) for intermediate and basic calc-alkaline volcanism; (ii) domes, dome/flow complexes, calderas, ignimbrite/ash-flow fields with known or unknown eruption centers for felsic calc-alkaline volcanism and (iii) dome flows, shield volcanoes, maars, tuff-cones/tuff-rings, lava lakes, scoria-cones with or without related lava flow/field and their erosional or subsurface forms (necks/plugs, dykes, shallow intrusions, diatremes) for various types of K- and Na-alkalic and ultrapotassic magmatism. Finally, we provide a summary of the eruptive history and distribution of volcanic forms in the CPR using several subregion schemes (1 – Styermark + Burgenland + Balaton Highlands; 2 – Central Slovakia Volcanic Field + Börzsöny-Pilis-Visegrád + Cserhát + Mátra + Bük foreland + Southern Slovakia – Northern Hungary; 3 – Moravia + Pieniny; 4 – Tokaj-Zemplín + Slanské vrchy + Vihorlat-Gutin + Beregovo + Oas + Gutâi; 5 – Tibles-Rodna; 6 – Călimani + Gurghiu + Harghita + Persani; 7 – Apuseni) following our previous reviews.

Investigation of mass movement deposits within Lake Ohrid (FYR Macedonia/Albania) using high resolution acoustic methods

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Lake Ohrid (FYR Macedonia/Albania) is situated within a tectonically active region on the Balkan Peninsula, and is most likely one of the oldest lakes in Europe (2-5 Ma). Its

bathtub shaped basin is filled with over 700 m of partly undisturbed sediments. Lake Ohrid has been found as an important archive to study the sedimentary evolution of a graben system over several million years. Furthermore, with more than 210 endemic species, the lake is a unique aquatic ecosystem that is of worldwide importance. A drilling campaign within the SCOPSCO ICDP Project is scheduled for summer 2011. Here we present results from hydro-acoustic surveys carried out in between 2004 and 2008 by means of sediment echosounder and multichannel seismic data proving that the lake experiences several mass wasting events mainly in the southern area. Transparent units can be found in cross sections up to a depth of 0.8 sec TWT. In combination with new acquired bathymetric data from 2009 covering almost the entire lake we are able to characterize the most recent events in terms of their morphological structure. The main focus is on two individual slide events: the Udenisht slide and the Struga Slide. The Udenisht slide complex covers an area of about 27 sqkm in the southwestern part of the lake. First age estimation of the Udenisht slide revealed that it is most likely younger than 1000 years suggesting that it had an environmental impact on the populated areas along the coastlines. Deposits of the Struga slide located in the northern part of the lake cover the northern shelf area of Lake Ohrid. A prominent head scarp within this area is observable in bathymetric data. Additionally, several slides are located close to normal faults. By tracing selected horizons across the entire lake, it was possible to obtain a relative stratigraphy showing that mass wasting events cluster at specific horizons, and hence had been occurred at the same time. Such sliding events occurring at the same time but at different locations in the lake most likely had a common trigger. We assume earthquakes as such a trigger mechanism. Subsequently, ages for older events can be used to reconstruct the earthquake activity in the area or in other words, slides can be used as proxy for paleo-seismicity.

Petroleum exploration in the Krasta-Cukali Basin: a review

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Based in a considerable number of geological fieldworks as well as a large number of geochemical analyses, geophysical interpretations, published papers and reports, combined with the enormous knowledge and experience in the surrounded area, concludes very importantly the prospective for hydrocarbons exploration in the so-called Krasta-Cukali basin.

In this publication a major effort has been done to better position the area under evaluation in a clear geological and tectonic concept, always with regard to oil and gas exploration. Another effort is done to better distinguish the lithotypes present and their stratigraphic and geochemical contribution closely related to petroleum potential.

The Krasta-Cukali as a tectonic zone within the Albanides it is identified as a basin during the Late Triassic and Early Jurassic (Lias) properly as an extension result of the tectonic regime. During the rifting this basin is breached into different paleogeographic horst-graben structures.

The interpretation of all the data available together the new seismic data acquired recently in the area, clearly demonstrate that Krasta-Cukali basin has all the necessary conditions for oil and gas accumulations likewise the nearby famous Ionian basin.

Sarmatian Heraclites, migration bitumens, fault tectonics, and hydrocarbon potential offshore Crimea

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For a long time the territory of the SW Crimea and adjacent shelf was considered as an area with uncertain or negative prospectivity for hydrocarbon exploration. Recent findings of clastic material called “heraclites” southeast of Sevastopol that derived from carbonate mats and buildups and related to submarine outgassing in the Lower Miocene sediments can speak quite the reverse. Heraclites upon the area of their first findings in the Heraclea Plateau in the SW Crimea are coarse clastic sediments inside Sarmatian sequence derived from destroyed calcareous hardground, i.e. proximal conglomerate tempestites, products of storm destruction of layered carbonate crust enriched with bituminous matter. Morphological attributes, mineralogy, geochemistry, and gas content of heraclites (carbonate angular and resin-like pebbles with high bituminous content) evidence their paragenetic relations to methane-derived authigenic carbonate mats and mud volcanism. Heraclites are characterized by higher porosity (5-10%), unusual black or brown-black color, specific composition, silification and skeletal remains of benthic fauna. The main peculiarity of heraclites is their higher gas content and impregnation with residual oil. In the vicinity of Sevastopol heraclites occur mainly within the linear zones related to fault planes (Georgievsky, Chersonesos and Sevastopolsky faults) and contact zones of the overthrusts to outcrop in the area of 50 sq. km with estimated volume of 1.8 million of cubic meters. Along the Crimean South Coast several seams inside the Mid-Sarmatian bentonite-montmorillonite claystones (up to 6 separate layers) with sharp stratigraphic top and bottom contacts containing black gravels and angular limestone pebbles are traced starting from Streletskaya Bay to Cape Chersones and further to the south till Cape Phiolent. It is interesting to note that on the opposite side of the Black Sea were also described 6 levels of carbonate tempestites from Sarmatian (Bessarabian) sediments at Cape Kaliakra in Bulgaria. The analyses made have shown that gases contained in heraclites are identical upon their composition to modern mud volcanoes and white smoker cones related submarine gas seeps and speak in favor of their common paragenesis. Carbon dioxide presence in all samples and isotope composition of the carbonates under investigation allow assumption that Neogene outgassing is related to thermogenic processes accompanied by upward fault-controlled flux of deep fluids including hydrocarbons. Presence of hydrogen sulphide indicates that euxinic conditions were characteristic of the Black Sea from Neogene times. Methane dominates in heraclites, however, those ones enriched with paraffinic bitumens (0.12-0.14%) contain ethane and propane. Some traces of nitrogen testify that some intraclasts were exposed in subaerial environment. The fluid sources that responsible for formation of heraclites in the area broad Heracleian anticline are most probably are deep-seated organic source rocks or even paleo- or recent hydrocarbon pools. There is also a concept that a flat-like intrusive magmatic body detected in that area on the depth of 10-40 km characterizing by intensive magnetic anomaly is contributing to fluid generation and migration. Recently the sign of the same process was recognized on the top of the Yayla Range near the Ai-Petri peak where it was found numerous black fibrous microsparite occurrences upon tension gashes and shear fractures pervading the Upper Jurassic limestone platform. The bituminous content of that microsparite testifies that those features are traces of paleo-hydrocarbon system (Miocene?) that now sealed by calcite of the latest generation. Recent drilling offshore Sevastopol has shown that Jurassic carbonates are full of the same migration bitumens upon fractures, sometimes manifesting live oil. This substantiates new perspectives for oil and gas exploration offshore the SW Crimea.

Geology and alterations of Tekyeh Bala Iron Deposit, Kurdistan, West Iran

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The Tekyeh Bala Iron deposit is located in West Iran (southeast of Kurdistan Province). This region is situated in the Sanandaj-Sirjan structural zone of Iran. The Sanandaj-Sirjan zone has length about 1200 km and width about 150 to 250 km. This zone is generally composed of metamorphic rocks intruded by acidic to intermediate igneous rocks. At the northern part of the Sanandaj-Sirjan zone iron mineralizations (e.g. Baba-Ali Fe deposit, Tekyeh Bala Fe deposit, and Galali iron deposit), gold and gold-antimony (e.g. Dashkasan Au-Sb deposit) are common.

Triassic-Jurassic andesite and trachyandesite are the oldest rocks in the Tekyeh-Bala area that are located in the south of iron deposit. Jurassic-Cretaceous rhyolites, rhyodacites and a complex of volcano-sedimentary rocks composed of rhyolitic, rhyodacitic and lathitic tuffs are also spread out at the south. The youngest igneous rocks in this area are Eocene-Oligocene igneous complex comprising of granite, granodiorite, monzogranite, quartzmonzodiorite, diorite and dioritic gabbro. The main trend of the faults in this area is NW-SE.

Quartz monzodiorite exists adjacent to the iron deposit and it seems that it is the host of iron mineralization. This rock is milky and middle to fine grain in hand specimen. General textures are anhedral granular to subhedral granular and in the some points intergranular. Main minerals are plagioclase (about 35%), orthoclase (about 20%), hornblende (about 10%), biotite (about 8%) and quartz (about 8%). Accessory minerals are epidote and zoisite (about 8%), chlorite (about 4%), sphene (about 4%), apatite and opaque (about 4%).

Iron mineralization occurred as three individual lenses in Tekyeh Bala iron deposit composed of magnetite and hematite. Iron content in this deposit is about 45% Fe₂O₃. The ore of this deposit has a little value of phosphorus and sulfur (less than 3%).

Alteration is in the form of pervasive, vein-veinlets and selective. The most important alteration types are saussuritization, sericitization, chloritization and propylitic alteration. Iron mineralization is directly related to these alterations.

Epidote and adularia formed from breakdown of the anorthite during saussuritization. Ca⁺² released from the anorthite was not only incorporated into epidote but participated also in formation of calcite (with addition of CO₂ from the hydrothermal fluid) whereas some Ca⁺² participated in the formation of titanite lenses within adjacent pseudomorphically replaced biotite crystals.

This reaction explains the chloritization of biotite: $2.8 \text{ Biotite} + 7.4 \text{ H}_2\text{O} + 2.2 \text{ Fe}^{+2} + 0.8 \text{ Ca}^{+2} \rightarrow 1.6 \text{ Chlorite} + 0.8 \text{ Adularia} + 0.8 \text{ Titanite} + 3.3 \text{ SiO}_2 + 4.8 \text{ K}^+ + 1.4 \text{ Mg}^{+2} + 0.4 \text{ H}^+$

Biotite broke down in the presence of H₂O, Fe⁺² and Ca⁺² forming chlorite, adularia and titanite with release of SiO₂, K⁺, Mg⁺² and H⁺.

During chloritization addition of Fe⁺² from the environment and in the presence of H₂O, hornblende broke down to the chlorite and epidote.

According to geology and mineralogy of the Tekyeh Bala iron deposit, it can be inferred that the iron mineralization caused by quartz monzodiorites which intruded in the area.

Is the Lower tectonic unit (Lower terrain) in the Rhodope a monolithic tectonic unit

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The geological correlation of high grade metamorphic rocks across the Rhodope massif in Southern Bulgaria and Northern Greece has been controversial for decades. Two different models with contrasting approaches to correlation are employed today. According to the first model, the Rhodope massif is viewed as a stable crustal fragment of Precambrian age. Proponents of that model use a lithostratigraphic approach to sub-divide and correlate metamorphic rocks across the massif. The second model considers the Rhodope massif a stack of tectonic plates that consists of two major tectonic units (a.k.a. the Upper and Lower terrains) separated by several mylonitic zones and "intermediate" tectonic units. Supporters of the latter model employ lithotectonic principles to subdivide and correlate metamorphic rocks across the massif.

Both models, however, correlate massive marbles that crops out near the villages of Trigrad and Yagodina, i.e., in the southern section of the massif to marbles cropping out to the north near the town of Assenovgrad. According to the different classification schemes applied by the two models, marbles are either a part of the Dobrostan Formation (model 1) or the Asenitza lithotectonic unit (model 2).

We use stable isotopic determinations and microscopically characteristic of marbles from three different localities to examine the application of this investigation for tectonic correlations.

Locality 1 (L1) - Aseinitza lithotectonic unit. The investigated marbles are massive, poor calcite with a medium grained equigranular texture. Rare xenoblastic quartz and white mica (colorless phlogopite ?) grains are observed, too. The calcite grains contain numerous lamellar or intersecting deformation type III twins. Calcite MgO contents vary in a narrow range (0.68-0.81%), hence, the minerals can be classified as low-Mg calcites. Samples from this location have nearly identical $\delta^{13}\text{C}$ compositions, i.e., from +0.14 to +1.57 ‰ (average +0.66, n=4). The $\delta^{18}\text{O}_{\text{marble}}$ values range from -5.50 to -6.40 ‰ (average -5.88, n=4), respectively.

Locality 2 (L2) - Lower terrain. The samples comprise massive, poor calcite marbles. In contrast to the samples from L1, L2 samples have unequigranular texture. Relatively big calcite grains "float" in fine-grained recrystallized matrix. The large crystals have lobate outlines and core-mantle texture is a specific feature of these rocks. Wide lamellar and intersecting deformation twins are characteristic features of the big calcite grains. The MgO content of matrix calcite is 0.75-0.86%. L2 samples exhibit significant isotope variability with two samples having higher ^{13}C and lower ^{18}O compositions, respectively. As a result, the $\delta^{13}\text{C}$ values of the samples vary from +2.16 to +4.21‰ (average +3.18, n=4), while their $\delta^{18}\text{O}$ vary from -2.40 to -10.60 (average -6.61, n=4), respectively. If previous data are considered, average $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values are +1.96‰ and -1.98‰, respectively. The cause of the significantly different isotope values of the two L2 samples is likely related to localized water-rock interaction.

Locality 3 (L3) - Asenitza lithotectonic unit. The samples were collected along the road to the Yagodina cave. These have massive structure and, in contrast to the L1 and L2 samples, contain dolomite. Texturally L3 samples are similar to L2, however, matrix calcite in L3 samples is slightly coarser. The large clasts in the L3 samples contain up to 3.30 % MgO, while matrix calcite MgO contents vary 0.77-1.67 % and are, thus, comparable to these of L1 and L2 calcites. The $\delta^{13}\text{C}$ values range from +1.03 to 2.07‰ (average +1.67, n=5) and the $\delta^{18}\text{O}$ from -2.00 ‰ to -4.30‰ (average -3.65‰, n=5). The $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values of these samples do not vary significantly.

Metamorphic P-T conditions in the marbles and the enclosing lithologies are estimated using calcite-dolomite solvus thermometry and other conventional thermometers. For chloritoid-bearing metapelites from the area of the village of Byala Cherkva (Asenitza unit) the results are: 330-360 °C at 5 kbar (Bt-Ms thermometer) and 350-370 °C at 5 kbar (Grt-Bt thermometer). The calcite-dolomite solvus thermometry of dolomite-bearing marbles from L3 yields 360-470°C at 5 kbar for the matrix calcite and 560-610 °C at 5 kbar for the large calcite clasts. Those PT conditions are comparable to values determined from metapelites from the Lower terrain in northern Greece.

Marble samples from the three different locations in the Rhodope massif exhibit significant mineralogical, textural and stable isotope differences. While L2 and L3 samples have similar textural characteristics and stable isotope compositions, these differ from the Asenitza unit (L1) samples. That indicates that marbles from the southern part of the Rhodope massif (i.e., the Yagodina and Trigrad area) are part from the Lower terrain (Lower tectonic unit) or Pangeon unit i.e. they present a tectonic window.

Recent tectonic activity of the Polish Western Outer Carpathians: Geomorphic and gravimetric constraints

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Two geodynamic test transects across the Polish segment of the Western Carpathians, crossing the Orava Basin in the west (KO) and the Pieniny Klippen Belt and Magura Nappe along the Dunajec River valley in the east (DD) have recently been analysed. Multidisciplinary studies conducted along these transects included gravimetric, geodetic, geologic and morphostructural investigations. Gravimetric and geodetic results appear to suggest recent subsidence of the Orava Basin, particularly intensive in the Wróblówka Graben, confirming conclusions derived from geomorphic analyses. Data obtained for the Dunajec River transect do not show any particular differentiation among individual benchmarks, what can point to either minor uplift of the entire area (already suggested by the results of geomorphic and morphotectonic studies), minimal differences between successive slices of the Magura Nappe and the Pieniny Klippen Belt, or both. Horizontal displacements of benchmarks, different for the KO and DD transects, towards the west and SW as well east and SE, respectively, can result from general uplift of the area comprised between these transects, i.e. the Gorce Mts. A new geodynamic transect DS, running along the Soła River valley cuts several units of the Outer Western Carpathians of Poland. These are, from the south, the Magura Nappe, Fore-Magura group of nappes, as well as the Godula and Cieszyn units of the Silesian Nappe, sub-Silesian Nappe, Skole Nappe, and the Carpathian Foredeep. Within the Magura Nappe, thrust faults of subordinate units (slices) are of the order of a few kilometres, and individual slices are composed of strongly imbricated anticlines and synclines striking SW-NE. The Fore-Magura group of nappes is composed of thrust sheets including both Magura- and Silesian-type lithostratigraphic members that build strongly imbricated folds of northern vergence. The Silesian Nappe is subdivided in this portion of the Western Carpathians into the Cieszyn (northern part) and Godula (southern part) units. In a tectonic window close to Żywiec, the Godula unit is underlain by the Cieszyn unit which overlies the sub-Silesian Nappe. Strata belonging to the latter nappe are exposed farther north in a number of small-scale outliers in front of the Silesian Nappe, north of Bielsko-Biała and close to Kęty-Wadowice. The nappe is composed of several north-verging imbricated folds, thrust one over another. All these units are cut by strike-slip and oblique-slip faults oriented roughly N-S. One of the most prominent fault zones accompanies the Soła River valley, dextrally offsetting the Carpathian frontal thrust. These faults were mainly formed during final stages of thrusting of the flysch nappes, postdating Burdigalian time. The discussed western portion of the Outer Carpathians is traversed by several sets of regional and local photolineaments, coinciding to a large extent with the Soła River fault and associated subordinate faults. In the

Pliocene and Quaternary, the area witnessed differential vertical and some remnant horizontal movements resulting in the formation of elevated and subsided areas. In the study area, the Soła River valley separates two prominent elevated regions that were uplifted in the Pliocene and early Pleistocene. A probably younger episode of Pleistocene and Holocene uplift is marked by the presence of two, nearly E-W trending, zones of abnormally high river bed gradients: one associated with the Jabłonków Depression in the south, and another one situated north of Żywiec, in the Beskid Śląski and Beskid Mały Mts. dissected by the Soła River water-gap. Recent uplift is usually observed in frontal parts of nappes, slices and imbricated folds and probably results from buckling induced by the ongoing thrusting.

Phenomenon of mud volcanoes in western Romania as a geotourism object

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The biggest mud volcanoes in Europe are located in eastern Romania, in the center of the Carpathian Foredeep, in the anticline structure called Berca-Arbanasi extending for 20 km north-southward. The volcanoes are located there in four zones: Beciu, Paclele Mici (PMI), Paclele Mari (PMA) and Fierbatori at a distance about 20 km northwest from Buzau. In 1924 the volcanoes PMI and PMA received the status of geological reserve, and nowadays are one of the major geotourism attractions in the country. The volcanoes in both regions are either cone- or pie- shaped. In the mud samples drawn from both regions the separation of fractions was carried out. It indicates that the muddy substance is composed mainly of grain fraction of 0.5-0.18 mm and 1.0-0.5 mm. The mineral composition, determined by means of polarizing microscope on fraction 0.5-0.18 mm in both regions, indicates that prevailing, however distinct in percentage share, minerals are the following: quartz grains, claystones and mudstone fragments. This identification was confirmed by X-ray pattern, which showed the mud volcanoes transport mostly mud composed of clay minerals represented by illite-smectite. Chemical analyses performed using ICP method showed that volcano waters are composed of mud mixed with salty waters. Moreover, chemistry of these waters collected from the two separate volcanoes are different too, and the main elements are the following: B, Ba, Br, Ca, I, K, Li, Na, Mg and Sr. Results of chemical analyses confirm various sources of salty waters as well as their migration across various evaporites present below volcanoes. The research shows significant differences between these two apparently identical objects, making them even more attractive as far as geotourism values are concerned. Establishing an appropriate geotourism infrastructure would serve at least three purposes: enriching the aesthetic impressions after visiting the region, allowing tourists to get to know the differences and enhancing the educational offer of the reserves.

The uranium capturing by Fe/Mn glaeboles of some Quaternary paleosols of Italy

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As it is well known, uranium is now recognized as a ubiquitous element, easily recognizable also in small occurrence. Their concentration in carbonate rocks is of the same order of magnitude as the lithospheric content (2.2 ppm). Uranium can replace calcium in the lattice of calcite or be adsorbed by the principal phosphate minerals. The large uranyl ions are adsorbed easily and can form the soluble complex

$\text{UO}_2(\text{CO}_3)_2^{4+}$. The Uranium ionic radius (1.05 Å) is almost similar to one of Calcium (1.06 Å). Uranium is assumed to move freely in the water of soil profile after the processes of dissolution and precipitation of carbonate parent material occurred. It is claimed that its mobility is favoured by acid conditions, whereas in an alkaline pH the adsorption of its oxide would be increased. Until now very few papers studied natural Uranium in soils. Recently, the concentration of naturally occurring radionuclides (^{238}U , ^{232}Th , ^{40}K) was measured in some Red Mediterranean soils from carbonate rocks in Spain, Italy and Turkey using gamma-ray spectrometry at the Gran Sasso National Laboratory of INFN (Italy). The Uranium content ranges from 1 to 5 ppm, the content for Thorium ranges from 3 ppm up to 30 ppm, whereas for Potassium varies between 0.13% and 1.3%. The results indicated that soils characterised by absence or scarcity of 2:1 clay minerals are poor in uranium, whereas soils with illite-smectite as the dominant minerals in clay fraction are noticeably richer.

Continuing some previous study on the paleosols natural radioactivity, this research demonstrated that soil Fe/Mn glaebules (nodules and concretions as well as the related coatings) are able to capture and include significant uranium contents together with some rare heavy metals. The research was carried out using thin section autoradiography by CR 39 transparent plates in order to locate the alpha track emitters. Transparent plates of CR 39 (artificial poly carbonate) were placed for exposition on the glaebules polished section for several months. After a chemical etching (by a NaOH solution) of CR 39 detectors to show alpha tracks damage, their location on thin section by overlapping of CR 39 transparent plates and the corresponding density of tracks (proportional to % of U (being assumed the thorium absence) was performed by an image analysis software (Image J). Some results were validated by the gamma-ray spectrometry and also suggested useful application to identify the uranium movement along soil profile and as strong relationship which are like to exist between uranium and some component of organic matter as well as the phosphate material and natural bitumen in both soils and some carbonate rocks.

First results of a geophysical Pre-Site Survey in the Philippi peat basin, eastern Makedonia, northeastern Greece

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Under the administration of the Centre of Quaternary Science & Geoarchaeology (QSGA) the Collaborating Research Centre (CRC) 806 „Our Way to Europe“ started in summer 2009. The project is founded by the German Research Foundation (DFG). In this CRC the QSGA is concerning about the dispersal of modern Man from Africa and the permanent establishment of Man in Central Europe (QSGA, 2009). The fieldworks, done during the summer 2009 in Greece by the Institute for Geology and Mineralogy from the University of Cologne, was targeted as a pre-site survey to find therein after a location for a drilling. This drilling is aimed as an extended paleoclimatic research analog to the works of Müller but with the intention to drill at greater depths. With different geophysical methods (TEM, VES, RMT) the quality of the Tenaghi-Philippon-Basin as a historical climate archive should be evaluated. The Tenaghi-Phillipon Basin is the south-west part of the larger Drama Basin. The Drama Basin is an intermontane basin lying in-between the metamorphic rocks of the Rila-Rhodope-Massif. It was generated during a late brittle deformation in Miocene times after the exhumation of the Southern Rhodope Core Complex (SRCC) in middle Eocene times. Therefore, the SRCC and the associated Neogene sedimentary basins offer the most complete record of the about 40 My of Aegean extension. The dimension of the basin and its sediment deposition is tectonically as well as climatically controlled. The sedimentation of peat endured over the last 700 000 yr until the drainage of the basin in 1931 to 1944 for

agricultural usage. The sediments of the Philippi Sub-Basin covers an area of about 55 km² and reaches a thickness of about 400 m, thus it is the thickest known peatland in the world. The sediments can be divided in two Beds. Bed I is a peat free of intercalations with a thickness of about 190 m. Bed II are limnic sediments with a lot of intercalations and a thickness up to 400 m.

The location for the measurements was placed at the largest extension of the basin between the villages Krinides and Eleftheroupolis. This poster presents the first results of the TEM-Fast measurements along two profiles. One profile was conducted from the north (Krinides) to the south (Eleftheroupolis), to verify the overall basin's structure. The second profile was arranged rectangular to the first one and stretches from the west (Stathmos) to the east (Dato). The results of the pseudo 2D inversion show a general conductivity distribution of a basin structure: A max. 100 m thick 7 Ω m layer (Bed I) over a more resistive (> 100 Ω m) half space which can be assumed to be Bed II. This finding correlates with cores that were drilled and analysed by Melidonis. The thickness of Bed II could not be verified from the data, due to the fact that the depth of penetration is not sufficient to detect the top of the bedrock. Plotting the data shows a general basin structure from the north to the south with its declining towards the centre and a possible thickness of the peat of Bed I.

How many “black flysches” can be distinguished in the Grajcarek thrust-sheets of the Pieniny Klippen Belt in Poland

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The age of the “black flysch” deposits occurring in the contact zone of the Magura Nappe and the Grajcarek thrust-sheets of the Pieniny Klippen Belt (PKB) in Poland has been a matter of a long lasting discussion. In the PKB, black shales (“Black Cretaceous”) of a Barremian to Albian age with intercalations of thin- to thick-bedded muscovite sandstones and spotty marls, overlain by the Upper Cretaceous red shales were distinguished in the 30-ties of the last century. Later on, basing on some macrofauna evidence, these beds were assigned to the Middle Jurassic. In stratigraphical scheme of the PKB these beds were called the “Aalenian Flysch” and described as the Szlachtowa (Toarcian-Aalenian) and Opaleniec (Bajocian) formations. Another black flysch deposits were distinguished as the Wronine (Lower Albian) and Hulina (Albian-Middle Cenomanian) formations at the base of the Upper Cenomanian-Campanian red shales. Such a division has been established by Birkenmajer in a standard scheme for PKB. The presence of two black flysches was already questioned by Sikora in 1962, who documented that the beds assigned to the Aalenian Flysch, represented Albian-Lower Cenomanian deposits, passing upwards into the Upper Cretaceous red shales. For the last few years, the authors have studied and sampled several sections which record the relation between the “black flysch” and Cretaceous red shales in the Grajcarek thrust-sheets. In all the studied sections “the black flysch” appears in the core of imbricated folds or thrust-sheets, whereas the limbs are composed of the Upper Cretaceous deposits. The transitional beds between the “black flysch” and the Upper Cretaceous red shales are composed of green and black, bituminous shales with manganese oxide coatings, green radiolarites with pyrite framboides, cherty limestones, and finally very thin layers of dark, non-calcareous shales. In the cherty limestone the Albian-Cenomanian calcareous nannoplankton was found. Biostratigraphical investigations have revealed similar type and sequence of microfauna assemblages in all the studied sections. It should be stressed that significant redeposition of Jurassic? calcareous benthic foraminifera, molluscs, sponge spicules and elements of crinoids has been observed in the microfaunal assemblages recovered from the black flysch turbiditic sequences. The Cretaceous age (Albian-Cenomanian) of the black flysch is confirmed by the presence of agglutinated foraminifera such as *Hippocrepina depressa*, *Trochammina abrupta*, *Bulbobaculites cf. problematicus*. The green shales with manganese coating contain abundant radiolaria in various state of preservation and finely, the Cretaceous red shales the assemblages with characteristic agglutinated taxa *Tritaxia gaultina* and

Uvigerinammina jankoi. Taking into account both the lithostratigraphical and foraminiferal data, the authors conclude that only one Albian-Cenomanian black flysch complex should be distinguished in the Grajcarek thrust-sheet of the Pieniny Klippen Belt in Poland. Such a sequence of deposits is typical of the Outer Carpathian basins and records the global Mid-Cretaceous phenomena in the world ocean followed by the Cretaceous Oceanic Red Beds (CORB) deposition.

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The analysis of reservoir heterogeneity from Well Log DATA

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All reservoirs are characterized by a sum of matrix and fluids properties. They are evaluated by a complex investigation consisting of core sampling analysis, geological, geophysical and hydrodynamic investigation and production data. These properties can be constant for the whole field when the reservoir is a homogenous one, or these properties can be variable and the reservoir is a heterogeneous one. But, what is the reservoir heterogeneity and how we can find its magnitude? According to Jensen et al (1997), "Heterogeneity is the property of the medium that causes the flood front, the boundary between the displacing and displaced fluids, to distort and spread as the displacement proceeds". There are more statistics methods (static and dynamic) for determination of reservoir heterogeneity. The static methods are: The Coefficient of Variation, Dykstra-Parsons Coefficient, Lorenz Coefficient and Gelhar-Axness Coefficient. This work is focused on the static methods, more specifically on Lorenz coefficient, while the dynamic methods are not discussed. For calculation the Coefficient Lorenz is necessary to know porosity, permeability and thickness of the reservoir. The number of values has to be enough and have a uniform distribution on the field for a statistical calculus. The following aspects of this application are emphasizing: wide domain of values for permeability data, the number of permeability values is not always enough for statistical analysing methods; the parameters from well logs are more representative and easy to obtain for the whole reservoir. This paper presents a new mathematical model and a novel practical method to evaluate the reservoir heterogeneity with Lorenz Coefficient using properties of rocks determined from well logs. The mathematical model uses field parameters, such as reservoir porosity, porosity of shale, shale volume and thickness to evaluate the reservoir heterogeneity. The technical contribution of this paper consists not only in a novel practical method to evaluate reservoir heterogeneity, but new challenges are expected from a technological point of view. The application data are provided by the wells from the oil structure named Barbucesti (Beca, C., Prodan, D., 1983). Barbucesti structure is situated in the southern part of the inner (folded) flank of the Eastern Carpathians foredeep, known as the Mio-Pliocene or Diapiric Folds Zone.

Biometrical study of post-cranial deer material from the Late Pleistocene of Crete and Karpathos

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A characteristic endemic fauna, restricted to the island of Crete occurred during the Middle and Late Pleistocene, consisting of cervids, small sized elephants, dwarf hippos and

mammoths, giant murids, shrews, birds and reptiles but almost lacking carnivores (only a lutrinid has been discovered). This rather unbalanced fauna, typical for oceanic and oceanic-like islands, is related with the tectonic processes that led to the final configuration of Crete in the late early Pleistocene. It evolved as only a few vertebrate groups, capable for migration via open sea, colonized the virgin island and underwent genetic changes after their forced settlement in terms of 'sweepstake dispersal', adapting to the insular isolated environment. Examples of insular evolution can also be found in the fossil record of other islands of the Greek archipelago and the Mediterranean basin.

In the endemic mammal fauna of Crete, the ungulates were by far the most successful forms during Late Pleistocene (0.3-0.01 My). Cervid fossils have been known since the end of 19th century and different taxonomic units have been described based on the dental, cranial, post-cranial and antler morphology of the remains. The Cretan deer has been represented by some eight species or morphotypes ranging from dwarf to relatively gigantic size, which adapted to different habitats and probably occupied different ecological niches indicating an adaptive radiation of the ancestral stock that probably resulted from sympatric speciation. However, the strong endemism, induced by insularity, the overall higher diversity than on mainland and the poor stratigraphic record make their taxonomy, ancestry and evolutionary history rather problematic. Different hypotheses concerning the phylogenetic and systematic relationship of the Cretan cervids have emerged. All these taxa belonged either to one genus (*Candiacervus*) on the basis of monophyly or to more implying different ancestors. Two other endemic Pleistocene cervids, with size resembling that of the dwarf Cretan forms, have been mentioned from the nearby island of Karpathos since the early seventies. The smaller species was defined as *Candiacervus cerigensis* while a larger species named *C. pygadiensis* was recognized from different antler morphology.

In the present study, the biometrical analysis of size variation and limb morphology of the Cretan deer and comparison with Karpathos findings were attempted. The studied fossil material, currently stored in the Natural History Museum of Crete, was originally collected from numerous cave localities in the late sixties and early seventies by the German palaeontologist S.E. Kuss, and is part of the so called Kuss collection formerly housed in the Natural History Museum of Karlsruhe. The two smallest size groups (size 1 and 2) and partly the mid-sized morphotype (size 3) of De Vos classification were distinguished in the material from Crete as scatter plots of combinations of several measurements on full grown bones have shown. The most typical forms are the dwarfed species being widely spread and abundant while the larger sizes are extremely rare. These likely last representatives of the Cretan deer had short and massive limbs displaying a much greater degree of robustness than continental cervids and probably occupied a niche similar to that of the wild goat of Crete today. Furthermore, multivariate analysis (PCA) resulted in a definite morphological distinction between the post-cranial material from the two islands. The Karpathos endemic cervids differ significantly from the deer remains found on Crete both in size and morphology, bearing unique anatomical features, and implying no direct link with the Cretan stock. Therefore, the original deer genus determination is certainly under question. However, despite insufficient evidence, the existence of two different species in Pleistocene Karpathos, as Kuss originally concluded, is also suggested.

Trace element and isotopic constraints on the genesis of the cumulitic xenoliths from the alkaline basalts in the eastern Rhodope metamorphic core complexes

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Oligocene within-plate alkaline basalts, intruded in the Eastern Rhodope metamorphic core complexes Kesebir and Biala Reka, carry ultramafic and mafic xenoliths, consisting of clinopyroxenites, websterites, orthopyroxenites, 2-pyroxene- and clinopyroxene gabbros. The xenoliths are interpreted as samples of layered intrusions formed at upper mantle-lower crustal depths as the results of mafic magma underplating. This process might be an attractive potential source for the heat required for thermal modification and extension of the lower and middle crust in the metamorphic core complexes.

We present LA ICP-MS trace element analyses of minerals from the xenoliths, along with limited whole rock ICP and Sr and Nd isotope analyses. All ultramafic clinopyroxenites, except high-Fe varieties, exhibit convex-upwards C-normalized REE patterns, similar to those of clinopyroxene mega/phenocrysts of the host alkaline basalts. Calculated parental liquids from the trace element analyses of clinopyroxene indicate that clinopyroxenites may have formed from melts with clear Nb and Ta positive anomalies, similar to composition of the host alkaline basalts. The clinopyroxene REE profiles of the orthopyroxenite and olivine websterite suggest that they also might have crystallized from an alkali-basaltic melt, but the slight Eu anomalies suggest either plagioclase fractionation or contamination by a crustal component. The most Mg-poor websterites, which have flat to “W”-shape REE profiles, are the result of strong differentiation, producing depletion in the MREE, flat negative slope and slight positive Eu anomaly. Gabbros and high-Fe clinopyroxenites and their melt inclusions indicate that these rocks appear to be the most differentiated product of the same parent. Their calculated parental liquids are more enriched in REE, with pronounced negative Eu, Nb-Ta and Ti anomalies and positive Pb anomaly on their Primitive-mantle normalized diagrams, as commonly observed for typical subduction-related rocks. This transition from within-plate to subduction-related signature can be related to fractionation of amphibole and other Ti-bearing phases. In addition, evolved websterites and gabbros have slightly higher Sr and almost identical Nd isotopic ratios compared to those of the host basanites. The most reasonable explanation for the isotopic offset of the cumulates is interaction of alkaline basaltic magma with lower/middle crustal wall-rocks.

In the light of our new data, the most mafic xenoliths are interpreted as cumulates originated from melts of alkaline magma, whereas the progressive change of the mineral and isotopic compositions in more evolved lithologies is consistent with extensive transformation through fractionation and a small percentage of assimilation of lower crustal material.

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Application of regionalized variable theory in analysis of morphological phenomena of the Herzegovina karst

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This paper presents an interpretation of results of a long-lasting scientific investigation of the Herzegovina karst using the methods of Regionalized Variable Theory, i.e.

Geostatistics. Throughout the geological history of karst, its morphological phenomena (doline, polja, sinkholes, obodine) were filled by sedimentation processes and hence conserved only to some extent in their particular development phases, subsequently being subjected to further morphological development in such conditions. Data on these phenomena were carefully collected for twenty years. As the number of studied elements exceeded 100000, the collected database is very large and these data are all the more significant because these morphological elements were accessible for observation and measurement only for a short time before being filled again. A geostatistical model of soil was developed using the variographic analysis on soil samples taken in three characteristic glacial areas. Scientifically established relations between the geomechanical model and parameters of geological origin were defined.

Shallow ground waters and the formation of carbonate soils in southeast Bulgaria – a study in progress

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Carbonate soils and indurate calcrete horizons are common in southeast Bulgaria. The carbonate accumulations are of variety of micro-structural and textural types. The calcrete usually forms lens or disk-like bodies on flat hills. The carbonate soils are observed on top of porous sediments but not on crystalline rocks. In the study area, where calcrete is common, the pH value of the agricultural land is usually above 7.5 and the surface, shallow ground and deep ground water is saturated with respect to calcium carbonate. Chemical analyses of indurate calcrete horizons, carbonate soils, rain water and ground water from southeast Bulgaria are commented in the text. It appears that competing processes of leaching and re-precipitation from waters oversaturated with respect to CaCO₃ are responsible for formation of transitional compounds - calcrete precursors, which further are transformed to calcrete. Because the rain water's acidity and ground water's degree of over-saturation, with respect to CaCO₃, vary with the season, it appears that seasonal variations in the water composition and the temperature control the net balance of soil carbonates.

Geochemical characteristics of organic matter from overcoal sediments and dump materials (Maritza-East Coal Basin, Bulgaria)

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The aims of the study were to characterize the geochemistry of organic matter from dump materials and overcoal sediments (Maritza-East Coal Basin, Bulgaria) as well as to try to find some differences among them from a chemical point of view. Three samples were studied: Sm. 1 – dump materials from “Iztok” Dump composed of a mixture of black clays and coals; Sm. 2 – gray schist-like clayey dump materials from “Staroseletz” Dump; Sm. 3 – overcoal massive black clayey sediments from “Trojanovo-3 mine”.

The samples were subsequently extracted by chloroform and ethanol-benzene (1:1, v/v). After asphaltene precipitation by *n*-hexane (1:50, v/v), the extracts were concentrated and subjected to Silicagel column chromatography separation. Solvents with increasing polarity were used for fractions preparation: *n*-hexane, for elution of alkanes/cycloalkanes (F. I); benzene for aromatic components (F. II); acetone for polar resins (F. III). Sulphur was removed from the first fraction by Cu grit treatment and thus cleaned F. I was studied by

GC/MS. By specific m/z fragment monitoring different homologue series were detected, i.e. *n*-alkanes, steranes, hopanes, tricyclic terpanes, *seco*-hopanes, diterpanes, etc. The relative content of *n*-alkanes as well as their patterns of distribution was determined. CPI values and ratios of the regular isoprenoids Pristine (Pr) and Phytane (Ph) were calculated.

The highest total, soluble and non-soluble organic matter (OM) content was obtained with dump materials from “Iztok” Dump (Sm. 1), lower values - were obtained with Sm. 2, and negligible ones - with Sm. 3. The same order kept the values for the yields of chloroform and ethanol-benzene bitumen A. Typical for all extracts is a domination of asphaltene over resins content. In Sm. 1 the aromatics content is higher compared to the alkane/cyclane fraction content. As for the other two samples - a reverse relation was established. For Sm. 1 and 2, short chain alkanes (nC_{15} - nC_{20}) content was lower than mid-chain alkanes (nC_{21} - nC_{25}) content, and the highest values were calculated for the sum of long chain homologues (nC_{26} - nC_{33}). For Sm. 3 - a reverse distribution pattern was observed, namely the lowest contents of long-chain alkanes was calculated. In all samples studied, the highest rel. % for *n*-alkanes was determined in the range nC_{23} - nC_{29} which is an indication for terrestrial input in OM formation. This observation was also supported by the high values for the CPI ratio. The low content of the regular isoprenoid, i.e. Pr and Ph, and the low Pr/Ph ratio (< 1) were a hint to assume reductive conditions by the primary sediments deposition.

Hopanes traced back by m/z 191 characteristic fragment show low (< 2 rel. %) content. It should be emphasized that hopane distribution strongly differs for Sm. 1 and 3. In the first one (dump materials) “bio”- hopanes with $\beta\beta$ configuration and unsaturated hopanes dominate, and both feature to immature OM. For Sm. 3 (black clayey sediments) preponderant H27 β hopane and H29 $\beta\beta$ -H31 $\beta\beta$ hopanes series were accompanied by hopanes with $\alpha\beta$ configuration. In addition, in Sm. 3 only, tricyclic terpanes (6.6 rel. %) maximizing at C_{23} homologue were registered. In the same sample only, a tetracyclic terpane, 17,21-*seco*-hopane, C_{24} , M^+330 and steranes in the range of C_{27} - C_{29} were recognized.

In all samples studied the content of tetracyclic diterpenoid 16 α (H)-Phyllocladane, M^+274 (ca. 30 rel. %) is the highest among the diterpenoids. Simonellite ($C_{19}H_{24}$) was the other abundant (12.7 rel. %) tricyclic diterpenoid. The diterpenoids assemblage established could be interpreted as an indicator for gymnospermous *Cupressaceae*/*Taxodaceae* presence in the former mire as a predominant palaeocommunity.

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Organic matter composition and maturity of the Callovian (Middle Jurassic) sediments from Lithuania

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In both the terrigenous Papilė Formation (Lower Callovian) and shallow- to deeper-marine facies of the Papartinė and Skinija formations (Middle and Upper Callovian, respectively), terrestrial organic matter predominates. This is emphasized by the carbon preference values higher than 1 for all samples and in some cases higher than 2, as well as the occurrence of characteristic higher plants biomarkers like cadalene, dehydroabietane, simonellite and retene. Fragments of charcoal found in the samples of the Papilė Formation indicate wildfires that took place in the early Callovian of Lithuania. Unlike the Callovian of Western Europe, in the Middle Callovian of Lithuania there is no evidence of anoxic conditions occurring in the water column. Measured values of huminite reflectance (R_h) for selected samples are in the range of 0.21% to 0.31%, what is characteristic for immature OM. This indicates that investigated deposits during their whole diagenetic history laid nearly on the surface and the thickness of younger cover does not exceed 500 m. This is supported by biomarkers analysis. In the all Callovian samples less thermally stable $\beta\beta$ -hopanes significantly dominated what suggest immature character of the samples.

Seismic image of the top of Jurassic structure under Polish Outer Carpathians in the zone Southeast of Krakow

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The modeling is a method well supporting seismic research during projecting, processing and interpretation of seismic data. In the presented paper, the multivariate seismic modelling was used for evaluation of influence of changing structure of Carpathian flysch on the seismic image of Upper Jurassic (Malm) rocks. This research investigated Podgrodzie structure in the marginal part of the Outer Carpathian fold-and-thrust-belt. The gas deposits in this area are localized on tectonic uplifts, bounded by thrust dislocations. The complex structure and tectonics of the Carpathian flysch makes the interpretation of seismic image of the reservoir Upper Jurassic carbonates somewhat difficult. The poor recognition of velocities of flysch sequences makes this interpretation even more difficult. The multivariate seismic modelling is necessary in this situation. It allows evaluation of influence of selected model elements of the originating wavefield. It is possible finding the model correctly approximating investigated orogen by matching registered and theoretical field. The Outrider (*Divestco Inc.*) and Omega (*WesternGeco*) system were used for offset and zero-offset modelings. The performed modelling shows that influence of changing velocity and geometry of reflecting boundaries on underlying stratigraphic stages is insignificant. This influence is only significant in the zones of steep dipping flysch layers where large horizontal contrast of velocity significantly influences the seismic image of Jurassic rocks. Outside these zones the seismic image of the top of Jurassic reliably restores the real boundary. The obtained results show that the multivariate seismic modeling is a method, which can be used with good results, under the complex seismogeological conditions. The modelling could be also helpful evaluating the reliability of register seismic data.

On the link between the formation of the Pannonian basin and the extensional collapse of the Dinarides

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Classical models of evolution in the Alps-Carpathians-Dinaridic domain assume that the formation of the Pannonian back-arc basin is related to the rapid roll-back of European slab and the invasion of the Tisza-Dacia and Alcapa upper plate blocks into the so-called Carpathians embayment starting at ~20Ma. The general mechanism assumes a gradual evolution, an initial mechanical phase of extensional detachments being recognized near the transition between the Alps and the Pannonian basin, which was subsequently followed by upper crustal normal faulting and a thermal phase during the Middle-late Miocene, observed in the central part of the Pannonian basin. Hence, an always standing contradiction existed between the limited amounts of extension recorded in the crust and the large scale asthenospheric upraise which took place beneath the basin centre. This apparent contradiction can be mechanically resolved by the existence of large scale extensional structures in other areas neighboring the Pannonian basin, such as the Dinarides. These structures can be large scale extensional detachments, unroofing the footwalls over the orogenic structures of the Dinarides and collapsing the hanging-walls in the area of the Pannonian basin. Our study demonstrates the existence of three such major extensional detachments in the central Serbian

part of the Dinarides, at the transition towards the Pannonian basin. These Miocene detachments were mapped and dated in the areas of the Cer, Bukulja and Fruska Gora Mountains and in all cases follow a major weakness zone, inherited from the Cretaceous-Paleogene stage of mountain building, i.e. the contact between the Dinaridic upper plate (Tisza-Dacia) and lower plate (Adria) along the Alpine Tethys (Sava) subduction zone. The footwall of these detachments exhumed Jadar (Adria) basement and its Triassic-Jurassic cover (including obducted ophiolitic zones), altogether metamorphosed during previous phases of Cretaceous and/or Eocene crustal shortening. Detachment zones seem to be developed mainly in the Late Cretaceous-Eocene flysch of the Sava zone, which can be found metamorphosed in their footwall and non-metamorphosed in their immediate hanging-wall. The regional hanging-wall of these detachments is in all cases the Pannonian basin with its observed upper crustal extensional structures. In Cer and Fruska Gora Mountains these accommodate a Middle-late Miocene normal faulting, while the Bukulja detachment accommodates the formation of the lower Miocene Morava basin (or “peri-Pannonian” depression). By correlating these observations with other recent research in areas of Southern Serbia and Bosnia-Croatia, an overall image of large scale extensional collapse along detachment zones is observed along the entire central and internal Dinarides during the Miocene. Therefore, a full mechanical explanation can be provided for the Pannonian basin extension by incorporating this Dinaridic collapse. Two directions of extension were observed by field kinematic mapping, and initial Early-Middle Miocene top-N was followed by subsequent Middle-late Miocene top-E direction of extensional movement. While the second direction of movement is compatible with the invasion of the Tisza-Dacia block into the Carpathians embayment, the first might alternatively suggest the existence of a phase of Dinaridic extension driven by the roll-back of an Adriatic slab, prior to its detachment somewhere after the late Miocene.

The Early Miocene Carnivores from Sabuncubeli, Turkey

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Thanks to collaborative studies that have started from 1970's, numerous Early Miocene localities that have produced abundant micromammal fossils were found in Turkey. These micromammal fossil discoveries have added greatly to our knowledge in terms of distribution and paleoecology of these taxons. However, due to substantial sampling and collecting bias against macromammals, only very limited and somehow diverse artiodactyl fossils from the localities Hancili (MN1), Harami (2), Kilcak (MN1), Keseköy (MN3b) and Semsettin (MN4) are the total findings. This case has changed as a new locality, Sabuncubeli, which is situated along the road between the village of Sarnic and Sabuncubeli crossroad, 15 km NW of Izmir, was exposed near a small valley after an artificial cutting for the construction of the road in 1998. Collecting procedure from fine conglomerate lenses during 2000-2006 yielded numerous carnivore and relatively rich artiodactyl and perissodactyl fossils. Based on its previously collected micromammal assemblages, Sabuncubeli fauna is dated as Early Miocene (MN3a). Here, three new and three common taxa of carnivorous mammals from Sabuncubeli will be described.

The carnivore fauna comprises of an amphicyonid (*Cynelos* nov.sp.), a procyonid (*Broiliana* nov.sp.), three viverrids (Viverridae, new genus, new species; *Euboictis aliveriensis*, *Semigenetta elegans*), a mustelid (*Palaeogale* sp.) and undetermined Felidae which can not be yet formally assessed to any genus. European originated *Cynelos* is the widespread genera common to localities around Eurasia, Africa and America throughout Early-Middle Miocene. The new Sabuncubeli *Cynelos* has common similarities with *Cynelos macrodon*, *C. helbingi* and *C. bohemicus*, but has proportional as well as morphological differences in dentition. So far, *Euboictis* is a unique faunal element which has a sole record from the middle Orleanian (MN4) locality of Aliveri, Evia Island, Greece. For the first time, Sabuncubeli fossils provides lower dentition of this genera which remarks on the affinities between *Euboictis* and *Sivanasua* ssp. The oldest procyonid *Broiliana* is not a common

element of Orleanian localities and hereby its represented by a new species. *Semigenetta elegans* from Sabuncubeli is similar to the holotype from Winterhoft-West (MN3a) but is slightly smaller. Besides *Euboictis*, *Palaeogale* is the second genera that have records in both Aliveri (MN4) and Sabuncubeli. Most interesting part of Sabuncubeli carnivore fauna is the new Viverrid genera which closely resemble that of enigmatic viverrids *Kichechia* and *Legetetia* and marks clear affinities with *Euboictis-Sivanasua* group. Although, Creodonts are quite common in Early Miocene faunas of Africa and somehow Europe, they are absent in Sabuncubeli

Although, small mammals clearly show that Anatolia and Europe were different bioprovinces during the Early Miocene, the carnivore fauna of Sabuncubeli marks a unique composition in having European and African (?) (Viverridae, new genus) affinities together. In the light of new taxa, different migration scenarios will be discussed in terms of faunal similarities.

Factors influencing sandstone response to changing environmental conditions in Northern Ireland

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The built environment will respond to climate change. Evidence already suggests that the 'greening' of sandstone masonry reflects recent atmospheric changes in moisture and pollution. This emphasises the importance of changing environments as a key controller on stone decay processes. As such, there is a need to understand decay, not just in a dynamic environment, but in a world where the nature of the dynamics themselves are changing. The current study investigates how changing future meteorological conditions impact upon the underlying drivers of stone decay – specifically, the thermal and moisture cycles experienced at and below the stone surface. To evaluate the nature and scale of future damage to masonry knowledge of the current interplay of water, materials and surroundings is required. Environmental monitoring of both meteorological and internal sandstone conditions will satisfy this need. The construction of test-walls embedded with sensors will record temperature and wetness profiles with depth from the surface. This is relevant for identifying internal moisture cycles which have influence the deliquescence, movement and precipitation of hygroscopic salts, the swelling of clay minerals and on associated stress gradients. Both heat and moisture are monitored in real-time, an approach that will consider the synergies between the two variables. Logging stone moisture contents will allow the 'time-of-wetness', a variable of importance for biological colonisation, to be quantified. The presence of a weather station mounted to the test walls permits measurement of the 'perturbed' situation. The observed microclimate will be linked to conditions recorded within the stone. Matching stone response to changing meteorological parameters will provide an understanding into the scale interaction between, and lag-structures associated with, seasonal, daily and sub-hourly cycles. It will also allow the identification of potential feedbacks (such as stones with high surface wetness will have a lower albedo, therefore altering the thermal regime, and perhaps resulting in less marked temperature ranges between the surface and sub-surface) between atmospheric and stone decay processes. Few studies consider the influence of climatic change on stone decay processes. Where studies exist, they all neglect the uncertainty inherent in climate modelling. This research employs a modelling structure that allows the development of multiple, equally plausible futures and at a finer resolution than previous stone decay-climate change studies. Future projections for; temperature, precipitation, wind speed, relative humidity, potential evapotranspiration, and solar radiation, will be made using the Statistical DownScaling Model 4.2. This involves establishing relationships between observed surface stations and large-scale atmospheric variables. The model is then forced under future emissions scenarios to produce a daily time series for a 30-year time-slice. Uncertainty is catered for by using multiple climate models and emission scenarios and also an ensemble of model runs. It is necessary for model outputs to be made relevant to factors affecting decay processes. Therefore, rather than investigating annual sums of rainfall, the intensity, duration

and frequency of fall events are of more importance. Future climate scenarios are yet to be downscaled, however, expected results are the increased contrast between winter and summer rainfall, and also increasing night-time temperatures (due to increased atmospheric moisture, hence greater cloud cover). This research into stone response to environmental condition will feed into the development of a new model of sandstone decay that considers increased winter wetness and the implications this has for deeper-penetrating moisture (and therefore salts) and increased algal colonisation.

Climate change and wet winters: Testing the diffusion of soluble salts in building stone under saturated conditions

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Controls on stone decay processes are rapidly changing as a result of changing climate. As such, there is a need to understand decay, not just in a dynamic world, but also in a world where the nature of the dynamics themselves are changing. Future climate change scenarios for the northwest of the United Kingdom (NW UK) typically project both increased short-term uncertainty in day-to-day weather conditions and an underlying trend towards wetter, warmer and longer winter conditions. The result of this is that natural stone used in buildings and monuments is wet for long periods of time – over a wet winter, it is possible that entire blocks become saturated. Usually the movement of salts is associated with moisture flux, but this paper investigates an alternative mechanism of salt movement – when blocks are saturated and a concentration gradient is set up, ions must move by diffusion. Because of the increasingly likely scenario of block saturation (in NW UK), this paper proposes a way of testing salt diffusion through natural building stones, modified and refined from studies testing chloride diffusion in concrete, to determine how quickly salts may diffuse through natural stone and any associated deleterious chemical effects. A concentration gradient is set up, whereby salts diffuse through a saturated sandstone sample from a ‘cell’ containing a 0.55 molar solution to another ‘cell’ containing de-ionized water. The increase in concentration in the cell containing de-ionized water can be measured at intervals using Ion Chromatography. Preliminary tests have shown that both salt and stone types are important controls for the rate of diffusion. Emphasis is placed on the need to adapt laboratory studies to more accurately reflect the environmental conditions under investigation.

Spatial distribution of salt penetration in weathered sandstone

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This research investigates the importance of the spatial distribution of salts in the weathering process of stone decay. The relationship between salt penetration and the intrinsic rock property, permeability, is examined to elucidate the ingress and egress of salt solution in masonry sandstone. The accelerated weathering trial simulates pre-loading a sandstone block with a 10% salt solution (equal parts NaCl and MgSO₄) during a wet winter followed by dried out in summer. Permeability data measured from horizontal slices through the block are correlated with salt data from IC analysis. Results indicate relatively high surface permeability values and salt crystallization on exposure to air. The effect of salts blocking pores and reducing permeability is evident in a reduction in permeability in the near surface

zone where permeability and (sulphate and chloride) salt data are correlated. At greater depth, continual wetting with salt and subsequent heating increases permeability and pore connectivity of the sandstone block. Salt crystallization enlarges and fractures pores, enabling the ingress and movement of soluble chloride salts. The stone's intrinsic properties (permeability and porosity) have been changed by salt weathering, ultimately leading to deterioration and accelerated stone decay.

Age and provenance of Palaeozoic and Mesozoic sediments from Northern Greece: Constraints for palaeotectonic reconstructions

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The Internal Hellenides of Greece are part of the Alpine–Himalayan orogen. The relationships between different pre-Alpine crustal fragments of the Internal Hellenides are now masked by younger (Mesozoic to Cenozoic) complex tectonic and metamorphic events. This, together with the scarcity of biostratigraphic, geochronological and palaeomagnetic data, has given rise to equivocal palaeotectonic models and interpretations. The age and origin of pre-Alpine basement units in the Internal Hellenides has however important implications for our in-depth understanding of the evolution of North Gondwana-derived terranes and consequently for alternative palaeotectonic reconstructions for the Palaeozoic and Mesozoic. A multidisciplinary sediment provenance study was undertaken since sedimentary rocks can provide information about rock lithologies in the source area, which have often been destroyed and recycled during ancient plate tectonic processes. Palaeozoic and Mesozoic sedimentary rocks from key areas of the Internal Hellenides in northern Greece were analysed using whole-rock major- and trace-element geochemistry (XRF, ICP-MS), detrital mineral chemistry (EMP), detrital zircon geochronology (SHRIMP, LA-ICP-MS) and biostratigraphic analysis. In particular, detrital zircon ages are useful to evaluate potential source regions and ancient magmatic events. Furthermore, in the absence of fossil and other stratigraphic data, the youngest grain (e.g. zircon) in a sedimentary rock can indicate a maximum limit for the age of deposition.

Quartzite samples from the Pirgadikia Terrane of the Serbo-Macedonian Massif are correlated with Ordovician overlap sequences at the northern margin of Gondwana on the basis of their maturity and zircon age spectra. The Pirgadikia Terrane can be best interpreted as a peri-Gondwana terrane of Avalonian origin, which was situated close to the Cadomian terranes in the Late Neoproterozoic–Early Palaeozoic, very much like the Istanbul Terrane of NW Turkey. Metasedimentary rocks (e.g. garnetiferous mica schists) from the Vertiskos Terrane of the Serbo-Macedonian Massif probably represent an Ordovician active-margin succession of the Hun superterrane, comparable to successions of the Intra-Alpine terranes.

Clastic metasediment samples investigated from the Circum-Rhodope Belt west of the Serbo-Macedonian Massif belong to the Permian–Triassic Examili Formation, the Early–Middle Jurassic Melissochori Formation (former Svoula flysch) and the early Cretaceous Prinochori Formation. Clastic sediments studied from the Circum-Rhodope Belt of the Thrace region come from the Early–Middle Jurassic Makri Unit and the Late Jurassic–Cretaceous Melia Formation. The rocks of the Circum-Rhodope Belt record Mesozoic rifting, related to the opening of a Neotethyan Ocean, Middle–Jurassic intraoceanic subduction, attendant volcanic-arc magmatism, ophiolite emplacement, and finally oceanic basin closure. Polyphase tectonics and metamorphism complicate palinspastic reconstructions.

Fluids related to remobilization of Mesozoic sulfide mineralization in the Eptadendro-Rachi region in Eastern Rhodope, Thrace, Greece

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The copper sulfide mineralization in the Eptadendro and Rachi areas is hosted in the Upper Tectonic Unit of eastern Rhodope in Thrace. The orebodies are found along the contacts between granitoid intrusions and meta-ultrabasic-basic rocks, as well as within meta-ultrabasic-basic rocks. Two stages of mineralization have been identified: an initial stratabound stage which is considered to be of submarine volcanosedimentary origin and a later vein-type stage formed during a hydrothermal episode, related to the intrusion of the granitoids (trochjemitites and pegmatites), during Upper Cretaceous-Early Tertiary. It consists of pyrite, chalcopyrite, sphalerite, galena, hessite, bismuthinite, emplectite, tetradymite, aikinite, wittichenite, siegenite, millerite, bornite, pyrrotite, covellite, magnetite, hematite and goethite, with chlorite, quartz, calcite and sericite being the main syn-ore gangue minerals. The mineralization has been affected at least by a greenschist facies metamorphic episode during Eocene-Oligocene. Although the sulfide mineralization is partly deformed and shows recrystallization textures, the data obtained from fluid inclusions demonstrate well the physical and chemical parameters of ore-forming environment during the latest hydrothermal event, caused by intrusion of the granitoids. Microthermometric studies showed three groups of fluid inclusions, corresponding to the distinct fluids involved in the mineral deposition and the pegmatite formation. The first group of fluid inclusions hosted in syn-ore quartz is characterized by relatively high homogenization temperatures (300° to 380° C, with a peak at 330° C) and low salinities (1.6 to 7.2 wt% NaCl equiv) and corresponds to the fluids of the main ore stage. The second group is distinguished by a drop in T_h (210° to 260°C) corresponding to the late ore stage associated with calcite formation, and salinities (3.2 to 6.3 wt% NaCl equiv) similar to the first group. The third group of fluid inclusions in the pegmatite is characterized by temperatures ranging from 300° to 390°C, and variable salinities (6.9 to 8.9 wt% NaCl equiv and 34.7 to 58.5 wt% NaCl equiv) suggesting a magmatic origin. The composition of these fluids is dominated by NaCl+KCl. Most probably these fluids were not related to the ore mineralization process.

Palaeoavian remains from the Late Miocene localities of Pikermi, Chomateri and Kerassiá; palaeoecological implications

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The Late Miocene avian record of Greece is rather poor. Three Late Miocene Greek localities have yielded palaeoavian remains until now: Pikermi, Samos and Perivolaki. In the present paper we describe some additional specimens from Pikermi (Attica), as well as some from the Late Miocene localities of Chomateri (Attica) and Kerassiá-4 (Euboea).

Among the aforementioned localities, the classical Pikermi locality is the most diverse taxonomically and has yielded the greatest number of specimens. However, the precise systematic position of some Pikermi avian taxa needs to be further explored. For example, Mlíkovský in 1996 reported seven different genera, while in 2002 he recognized five species belonging to five genera. Boev and Koufos recognized six species distributed in five genera. *Struthio karatheodoris* and *Ciconia gaudryi* are generally accepted to be present in Pikermi, even if the Pikermi struthioniform is sometimes assigned to the oospecies *Struthio*

chersonensis. *Grus pentelici* is also an accepted name for the Pikermi gruiform, even though it is sometimes referred to the poorly defined *Pliogrus*. Most problems concern the taxonomic status of the galliforms. Gaudry (1862-67) recognized two size groups of galliforms, and referred the smaller specimens to *Gallus aesculapii* and the larger to *Phasianus ? archiaci*. *Gallus aesculapii* was included to *Pavo* by Jánossy and was followed by Boev and Boev and Koufos. Mlíkovský combined *G. aesculapii* and *Phasianus archiaci*, introducing the name *Pavo archiaci* adopted also by Boev and Koufos. The latter, also reported the presence of *Pavo bravardi* in Pikermi. Finally, Mlíkovský and Boev and Koufos also reported *Phoenicopterus* sp. in Pikermi.

The new specimens described herein are tentatively assigned to five species. The species recognized in Pikermi include *Struthio karatheodoris* (lateral tarsometatarsal trochlea), *Grus pentelici* (proximal humerus, two distal ulnae), *Pavo archiaci* (proximal femur, distal tibiotarsus), *Pavo* sp. (distal humerus), and *Gyps* sp. (distal ulna). Within the Pikermi findings, *Pavo* sp. is much larger than *P. archiaci*, approaching the size of *P. bravardi*. The recognized Chomateri palaeoavian remains are assigned to *Pavo archiaci* (proximal humerus, distal humerus). Finally Kerassiá-4 has yielded a tibiotarsus assigned to *Pavo archiaci*.

Extant representatives of *Struthio* are adapted to open environments and a similar ecological adaptation can be inferred for *Struthio karatheodoris*. The presence of *Gyps* sp. in Pikermi is important, as scavenging bird finds are relatively rare. Paleoecologically, an open environment is further supported since vultures depend on a large supply of carcasses, a condition met primarily in such environments. *Grus pentelici*, being a wading bird, requires the presence of bodies of water. Extant *Pavo* species live in open forests, often along watercourses, conditions that would have been preferred by the *Pavo* species found in Pikermi, Chomateri and Kerassiá-4.

Deformation phases and ophiolites emplacement in the Hellenides

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The terms ophiolites, ophiolite nappes and ophiolite bearing sedimentary formations in Greece, refer to outcrops of mainly peridotites, but also of basaltic rocks with eventual sedimentary formations. Based on the present-day scientific knowledge, the ophiolites as a whole are characterized by high variability regarding: a) their petrological signature, from their petrography, their mineral chemistry up to their alterations, b) their deformation pattern ranging from plastic to brittle, including both compression and extension phases, c) their emplacement characteristics, involving extensive nappes, lithostratigraphic alternations and melanges. Detailed analysis of a large number of ophiolite outcrops demonstrated their occurrence in different geotectonic conditions (tectonic windows, nappes and clastic sedimentary complexes), in variable geometric forms (isolated bodies, lenses and interlayers), in various composition and deformation configurations (harzburgites, lherzolites, meta-gabbros and amphibolites, basalts and sedimentary formations). The ophiolites experienced a continuous deformation from the Late Jurassic phase (EoHellenic) up to the Eocene-Oligocene alpine orogeny (HoHellenic). Their evolution involved different emplacement mechanisms, producing a significant thickening in the oceanic and the surrounding environments and an extensive thinning in the continental margin environment.

Tectonic deformation and hydrogeological pattern in fissured rocks and karstic systems. Examples from the Pelion Mt and Mani peninsula, Greece

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Tectonic deformation exerts a significant role in the hydrogeological pattern, because water flow either follows or is severely influenced by the tectonic structures of all scales. Two examples are displayed: one in a fissured rocks media (Eastern Pelion) and another one in a karstic system (Mani peninsula).

In the area of Pelion, schists and gneisses are considered of low permeability and negligible primary porosity, nevertheless water recharge and percolation occurs mainly through fractures. The hydrogeological pattern is highly controlled by the tectonic deformation both in the Micro-Mesoscopic (fracturing within the schist) as well as the Macroscopic scale (several km long faults where the springs are aligned). Subsurface flow occurs towards the northeast following the eastern limb of the Pelion mega-anticline, the topographic inclination, the direction of foliation and a major set of faults at this azimuth. Springs are aligned to the faults and three dominant sets of faults are observed. Two of them are NE-SW trending ($N 030^{\circ} \pm 10^{\circ}$ and $N 050^{\circ} \pm 10^{\circ}$), forming a 20° angle of tectonic wedge, whereas the third set is NW-SE trending ($N 320^{\circ} \pm 5^{\circ}$).

In the case study of Mani the karstic path is highly related to the tectonic structures and in particular:

- a) towards the mountain area it follows the anticline megastructures with a NNW-SSE trending fold axis that are plunging towards south;
- b) towards the hilly area and the lower slopes it strikes west following the transverse fault structures that form oblique normal faults that are E-W trending;
- c) towards the lowland, shoreline and offshore area the karstic water produces gushing springs along strike the NNW-SSE trending normal faults that were formed during the recent extensional field and predominantly towards their intersection points with the transverse E-W trending oblique normal faults.

However, the impact of the tectonic deformation is different within these two systems. In the karstic system major structures predominantly control the water flow which is characterized by high velocities. Water flow involves major localized pathways that are elongated with high seasonal variations in discharge rates. In fissured rocks the microscopic scale plays the predominant role in infiltration and flow processes, whereas the macroscopic structures control mainly the spring's distribution and the localities where the hydraulic head of the aquifer intersects the surface and springs discharge. In fissured rocks, based on our estimates the maximum depth where water penetrates does not exceed 300m and water flow is characterized by slower velocities, involving a time delay mechanism. Finally, several minor and widespread pathways are formed, so that the thickness and the overall pattern of the heterogeneous aquifer changes spatially over short distances not only due to lithology, but predominantly due to the tectonic deformation.

Foraminiferal biofacies analysis and paleoecological data on Upper Cretaceous sediments of the Gagra-Java zone (Western Georgia)

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The paper deals with actual questions concerning biofacies and paleoecology of the Gagra-Java zone. The Gagra-Java zone extends along the Southern slope of the Greater Caucasus, in its turn subdivided into three facies types: Abkhazia-Racha, Odishi-Okriba and Dzirula. The Cretaceous sediments have developed mainly in the junction area of the

Georgian block, from the Western Georgia up to Upper Racha. The Upper Cretaceous sediments consist predominantly of terrigenous-volcanogenic (Cenomanian-Lower Turonian) and marly carbonate limestones with the layers of variegated flints (Upper Turonian-Maastrichtian). According to planktonic and benthic foraminifera in the Abkhazia-Racha sediments have been distinguished 14 foraminifera complexes. The detailed analyses have proved that: 1. The lower boundary of the Upper Turonian is connected to the massive occurrence of the genera *Marginotruncana pseudolinneiana*-*M. schneegansi*-*M. lapparenti*; 2. The Turonian/Coniacian boundary is based on the occurrence of *Marginotruncana coronata* Bolli; 3. The Coniacian/Santonian boundary - *Dicarinella concavata* (Brotzen); 4. The lower boundary of the Upper Santonian is based on the appearance of *Contusotruncana (Rosita) fornicata* (Plummer); 5. The Santonian/Campanian boundary is based on the presence of *Globotruncana arca* (Cushman); 6. The Campanian/Maastrichtian boundary, based on the occurrence of *Globotruncanita stuarti* (Lapparent). In the Odishi-Okriba facies type has been distinguished the suite "mtavari", investigated in detail by planktonic foraminifers. The analyses made possible to establish 5 foraminiferal zones in the studied sections. These complexes have been correlated with macrofauna and nannoplankton complexes to specify the age of the suite. At present, there exists a definite methodology for the reconstruction of some parameters of the paleobasin that is based on quantitative interrelations of foraminifer associations. This technique is based on actual data of contemporary water areas. The PF (Planktonic Foraminifer) data can be used for the interpretation of the fossil material data applicable in paleogeographic reconstructions. The relation of planktonic and benthic foraminifera and the content of planktonic complex enable to define depth of the basin. According to the percentage of the left- and right-coiling species of Globotruncanidae, there have been estimated the temperature conditions of the Late Cretaceous basin. The question on the parity of left- and right-coiling foraminifera is a part of big problem of coiling directions in the nature.

Gemstone deposits of Lece volcanic complex (South Serbia)

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Gem raw materials do not have a long tradition in Serbia, neither concerning their geological exploration nor their utilization. Nevertheless, few relatively modest exploration campaigns discovered number of gemstone deposits and occurrences grouped into several regions. One of the most important regions is Lece volcanic complex which is situated in the southern part of Serbia and covers an area which exceeds 700 km². This volcanic complex, formed as a result of Tertiary volcanic (intermediate) activity, is a part of Serbo-Macedonian metallogenic province, i.e. Lece–Chalkidiki metallogenic zone. It comprises mostly andesite rocks and their pyroclastic equivalents.

Gemstone deposits of Lece volcanic complex became the subject of interest after the World War II, although on the basis of certain archeological finds, we can assume that the Ancient Romans beside gold exploited amethyst and agate as well. The first modern explorations were carried out during 1970`s and at the beginning of 1980`s, when several deposits with calculated reserves were defined. The exploration was continued in 2002 and 2003. Laboratory analyses – at first micropetrographic, were followed by chemical and gemological (refractive index). Apart from the above mentioned investigations, in order to establish whether silica minerals have real gem quality gemstone processing (lapidary) was conducted.

This paper deals with explored deposits (having reported reserves according to Serbian laws). There are two basic types of deposits: primary (hydrothermal) and secondary (sedimentary).

Rasovača deposit. Precious minerals in this deposit occur in the same fracture zone together with metallic ore mineralization of Pb, Zn, Ag and Au (Lece underground mine). It is a quartz-brecciated fracture zone, with hydrothermal (epithermal) mineralization, a few

kilometers long. Numerous intensive tectonic movements made space for the circulation of hydrothermal solutions which deposited not only galena, sphalerite, pyrite and gold but gem minerals as well. Precious silica minerals are represented by amethyst, amethyst-agate, and agate. Red jasper appears only in small quantities. Amethyst is characterized by a fine dark purple colour. Chalcedonic agate is represented by concentric bands of grey, bluish, brown, purple and red chalcedony.

Bučumet deposit. In the succession of andesite lava flows and pyroclastic material, silica masses formed as plate-like ore bodies. These masses are result of depositing silica around thermal springs and geysers. This type of deposit is known as siliceous sinters or geysers and represents second type of primary gem deposits in this volcanic complex. Siliceous mass, represented by fibrous chalcedony, granular quartz and relict opal, has very heterogeneous colour varieties. Basically, a very wide range of colours appears in short range. Chalcedony is represented by dominantly mixed and uniform colour varieties of white, bluish, gray, brown, red and black colour. Jasper is yellowish-brown to reddish-brown. Vrtače and Kameno rebro deposits. These deposits belong to the group of secondary deposits – placer type deposits. While Vrtače is an eluvial deposit in pyroclastic material with partially preserved primary ore body, Kameno rebro is a completely delluvial deposit formed beyond the volcanic complex in the surrounding Proterozoic metamorphic complex. Gem minerals which occur in these two deposits are of the same type as in the Bučumet. It is assumed that the material in the deposit of Kameno rebro mostly originates from the eroded part of Bučumet deposit.

Apart from the above mentioned deposits with defined reserves, there are also numerous insufficiently explored occurrences, mostly placer ones (eluvial, delluvial, proluvial and alluvial). These occurrences are mostly concentrated out of the volcanic complex, i.e. on its eastern rim.

Geomorphological characteristics of Kratovo-Zletovo palaeovolcanic area

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Kratovo-Zletovo palaeovolcanic area is known as one of the largest in the F.Y.R. Macedonia and wider, covering a total of 970.1 km². A huge amount of pyroclastic material is expelled here, with an average depth of about 700 m. According to Serafimovski, Arsovski etc., volcanic activity in Kratovo-Zletovo area started at the end of Eocene or lower Oligocene, and with some pauses last up to lower Pliocene. In that period, volcanic activity successively moved from north-east to south-west, with changes in volcanic intensity (violent eruption followed by expel of pyroclastic material; with silent phases followed by lava flows). The volcanism in the region was generally caused by deep sub-meridional dislocations, activated by Paleogene east-west extension. To the end of Miocene, volcanic activity is reestablished by longitudinal neotectonic dislocations, started with younger north-south extension. Geomorphologically, in Kratovo-Zletovo area there are about 20 volcanic cones and calderas, highly eroded by post-volcanic fluvial-denudation processes. Only Plavitsa cone (1297 m) and Lesnovo cone (1167 m) are better preserved, as well as their calderas on the top. These two volcanic centers, together with Uvo-Bukovets cones, Zdravchi Kamen, Zhivalevo and other volcanic necks, belongs to the older volcanic phases, while younger centers are located in the south and west part of palaeovolcanic area (Crni Vrv (1115 m), Preslap (1117 m) and Rajcani (867 m) cones with some remnants of calderas). After finishing of the volcanic activity, due to strong erosion, volcanic forms subdue significant morphologic modifications. Today, on the remnants of palaeovolcanic cones, there are many fluvial, denudation landforms and even fossil coastal terraces. For that reason, the recent nature of Kratovo-Zletovo palaeovolcanic landscape is polygenetic.

Landslide risk mapping by Remote Sensing and GIS in Gevgelija-Valandovo Basin

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The objective of this work is a presentation of GIS and Remote Sensing mapping procedure of potential landslide areas assessment, based on digital elevation model (DEM), satellite imagery and other digital data analyses. The research area is Gevgelija-Valandovo basin (1077.0 km²), which is located in the southern part of the FYR of Macedonia, on the border with Greece. This basin is very heterogeneous in regard to topography and vertical relief (44 m to 2112 m), geology (from erodible clastic sediments to very solid limestones), climate (especially with altitude), vegetation, and human impact as well. Thus, as a consequence of suitable natural-geographic factors (geology and soil structure, topography, climate, vegetation) and significant human impact, some sites in this area have severe erosion with numerous landslide occurrences. For that reason, in GIS and Remote Sensing mapping procedure several landslide-related factors are weighted and analyzed, and with cluster classification, areas with different potential to landslides are identified. Landslide risk assessment in study area of Gevgelija-Valandovo Basin is performed through the detailed analyses of several digital datasets: DEM (Digital elevation model) for topography acquired from 3" SRTM DEM; raster grids for vegetation cover acquired from Landsat ETM+ satellite imagery and from Corine Land Cover 2000-CLC2000; digitalized geologic (lithology) map etc. It was estimated the influence of most relevant topographic indices (hypsoetry, slopes, curvatures, aspects), vegetation index (vegetation cover) and lithology hardness. With usage of clustering module incorporated in SAGA GIS software, and superimposing of several layers, sites (clusters) with different potential of landslides were identified, especially showing high risk areas. As a result of those GIS computations was made digital mapping of landslide potential. The results shown on maps, compared with the real indicators and measurements show satisfactory fitting. Certainly, many other factors influenced risk of landslides, but because of avoiding complexity, they are not considered here. However, previous procedure may be helpful to relatively fast and accurately predict landslide risk in the landscape. According to the produced model (with SAGA GIS), about 1/3 of the Gevgelija-Valandovo basin area is under higher treat of landslide occurrences. That are hilly areas with moderate to steep slopes and concave shape (where surface water percolate faster), sparse vegetation (usually weak grasslands), and cracked, weathered or even very soft rocks. Field research confirms that in those areas most of the landslides occur or that there are many potential landslides. Certainly, these results must be validated with very detailed field research, but generally this approach is acceptable on large-scale level. Main factor of such landslide potential is a natural environment, but human activities (such as cutting and filling along roads and the removing of forest vegetation) may increase the natural tendency for a landslide to occur. This is the case also in in Gevgelija-Valandovo basin.

New geological and geochronological data of granitic and metamorphic rocks from SW Bulgaria, sheets Berovo (K-34-82-G) and Kresna (K-34-83-W) of the new geological map 1:50 000

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The distinction of geological units in metamorphic terrains is usually complicated by the tectonic overprint of the rocks. The magmatic age of the protoliths and the timing of metamorphism is very helpful for their correlation. We present new field and U-Pb zircon age data for several metamorphic rocks and cross-cutting granitoids from a region in SW Bulgaria (Ograzhden, Maleshevska and Pirin Mountains). They crop out in the area of sheets Berovo (K-34-82-G) and Kresna (K-34-83-W) of the new Bulgarian geological map 1:50000. Age analyses were performed at IGP, ETH-Zurich as part of a collaborative work between the Research Institute "Geology and Geophysics" Corporation and ETH-Zurich during the new geological mapping of Southern Bulgaria.

Generally, the Late Alpine frame of the Maleshevo-Ograzhden and Pirin mountains in SW Bulgaria is well known, but their pre-Alpine evolution is still ambiguous. Two samples of the metamorphic basement in Maleshevo-Ograzhden Mountains represent the weakly deformed Rakovo granite (metagranite) from the Struma Unit (P787) and the gneiss-schist (P709a) from the Ograzhden Unit. The metagranite P787 is dated at 543.5 ± 3.9 Ma by ID-TIMS U-Pb zircon analyses. In the same range are also the majority of the in-situ LA-ICP-MS data. This age is in agreement with published data for other granitoid and gabbro bodies of Struma Unit in the range 540-560 Ma.

The zircons of the gneiss-schist P709 reveal solid-state recrystallized cores (usually with still preserved magmatic oscillatory zoning) and metamorphic rims. Both, the cores and the rims are dated by the in-situ LA-ICP-MS method. The detritic zircons of the cores are older than 600 Ma with ages of 620-740, 900-1100 and up to ≈ 2400 Ma. These ages give evidence for a possible Gondwana-derived source of the resedimented zircons. The metamorphic rims yielded Variscan ages at around 330-340 Ma (mean $^{206}\text{Pb}/^{238}\text{U}$ age 338 ± 22 Ma, 95% conf.). The data infer a Carboniferous high-grade metamorphism of the Ograzhden Unit.

During our field work we observed xenolites of tourmaline-garnet schists in the metagranitoids of the Ograzhden Unit. Geochemical analyses of the Budiltsi metagranitoids define them as peraluminous calc-alkaline granites and granodiorites and thus, we can consider both as a S-type source.

The cross-cutting magmatic rocks of the Krupnik pluton were dated using the accessory minerals zircons, xenotimes and monazites. Zircons and xenotimes yield a magmatic U-Pb age of 32.99 ± 0.39 Ma. The monazites show a small lead-loss and show ages between 30 and 22 Ma, which can be interpreted as a result of a long-term hydrothermal resetting along the Strimon fault.

In the Pirin Mountain only the Kapatnik pluton was sampled for U-Pb dating. Conventional and LA-ICP-MS analyses yield Palaeocene ages 56-62 Ma. The mean $^{206}\text{Pb}/^{238}\text{U}$ value defines an age of 60.7 ± 1.7 Ma, but the majority of zircons with ages ≥ 60 Ma are slightly discordant. Consequently, the most probable time of granitoid formation is 56-58 Ma.

Metallogeny of the Făgăraş Mountains (South Carpathians, Romania): an overview with focus on the gold-bearing rocks

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This study evaluates the relationship between the metamorphic and mineralization processes in the Făgăraş Mountains (South Carpathians, Romania). Recent emphasized gold-bearing areas are discussed in this work. We present the preliminary data on the gold contents in different rocks and minerals, in relation with their geologic and tectonic setting.

The Făgăraş Crystalline, representing the crystalline basement of the Făgăraş Mountains, is the eastern sector of the Getic Crystalline, the only one affected by Alpine low grade metamorphism (M_3). There is a lithologic contrast, with genetic connotation, between the lower (gneissic) and the upper (mostly micaceous) structural levels and the Pre-Alpine metamorphic history with two medium grade events of regional metamorphism, M_1 (Cadomian) and M_2 (Variscan). Within Făgăraş Crystalline, the upper structural level corresponds to the Făgăraş Series, comprised of two formations, Şerbota (micaceous and phaneroblastic) and Suru (quartz-micaceous and microblastic, plus interlayered amphibolites closely associated with carbonate rocks). The lower structural level corresponds to the Cumpăna Series, also comprised of two formations, Cumpăna (augen gneisses) and Topolog (mica gneisses with lenses of amphibolites closely associated with quartzo-feldspathic gneisses).

On the basis of the published data and our observations, the mineralizations from Făgăraş Mountains could be classified as follows: A. premetamorphic regionally metamorphosed (A.I. Pb-Zn stratiform mineralization within carbonate-dominated rocks; A.II. Ni-Cu-Co mineralization associated with bodies of metabasic and metaultrabasic rocks); B. Alpine or Alpine remobilization in metamorphic domains (B.I. polymetallic mineralization: Pb-Zn-Cu, Pb-Zn \pm Au, Ag; B.II. mineralization of Fe-Ti oxides, graphite \pm sulfides and Au); C. associated to post-metamorphic (post- M_3) tectonic planes (C.I. sulphide \pm Au mineralization associated to major faults from Făgăraş Mountains).

Concerning the gold concentrations, we analysed representative samples from: 1) both levels of Făgăraş Crystalline; 2) hydrothermalized tectonic breccias from major tectonic nodes (e.g., Perişani, Nucşoara); 3) quartz segregations from Cozia-Lotru and Sebeşul de Jos-Nucşoara major faults; 4) basalt dyke from a NW-SE strike fracture.

The analyses show gold presence (as “invisible gold”) within rocks and minerals belonging to the Făgăraş Series: up to 3.12 ppm Au in quartz segregations within the mylonitic rocks of the Suru Formation and up to 0.98 ppm Au in quartz segregations within the micaceous rocks of the Şerbota Formation. The concentration of the gold is higher (5.46 ppm) in graphitic mylonites occurring on the Suru Nappe overthrust plane. According to the above classification, the mineralization associated with these mylonites is of type B.II (related to a shear zone). Unmineralized amphibolitic and carbonatic rocks exhibit very low contents of gold. The basalt dyke contains 0.005 ppm Au. Gold concentrations in rocks belonging to the Cumpăna Series are lower than of rocks from the Făgăraş Series. However, some of the orthoamphibolites (+ sulfides) lenses from Topolog Formation have significant gold values. The highest gold contents were found in hydrothermalized tectonic breccias generated at the intersection between the Palaeogene longitudinal faults and Miocene – Quaternary transversal faults. The mineralization associated with these breccias is of type C.I. (see above) and consists of pyrite \pm galena, sphalerite, marcasite, etc. Thus, on the Curmatura Oticului Fault, the Cernat Valley sector, a sample of hydrothermalized breccia contains 4.47 ppm Au. The matrix of the breccia consists of chlorite, sericite, clay minerals and fine disseminated pyrite; the composition of the clasts is dominated by quartz. On the Cozia-Lotru Fault, in a hydrothermalized breccia from the Perişani tectonic node, a content of 29.97 ppm Au was determined in the sulphide mineralization (predominantly pyrite and marcasite) and 0.98 ppm Au in the adjacent chloritic zone.

Further research is necessary to understand the relationship between the gold-bearing mineralizations and their settings.

Age and evolution of the Wetterstein Carbonate Platform in SW Serbia (Zlatibor Mountain)

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Triassic shallow- and deep-water carbonates occur together with Triassic radiolarites widespread as olistoliths and slides in the Middle to early Late Jurassic mélangé of the Dinaridic Ophiolite Belt in the Zlatibor Mountain. These slides occur tectonically on top of the Drina-Ivanjica Palaeozoic and the late Middle to early Late Jurassic ophiolitic mélangé respectively the ophiolites and not below as interpreted before. These slides were interpreted to derive from the Drina-Ivanjica Unit, where they should have formed the original sedimentary cover, disintegrated in the Late Jurassic. According to our investigations the slides of this carbonate-clastic mélangé differ in age, facies and palaeogeographic origin. The carbonate rocks are originated from a relatively broad shelf in the Triassic facing the Neotethys Ocean to the east, maybe also from the adjacent Drina-Ivanjica Unit and from further east. In contrast, the Triassic radiolarites and the ophiolitic rocks, which occur mostly below the carbonatic mélangé, derive from the Neotethys Ocean basin floor. These mixtures of different rocks forming mélangés are part of the Dinaridic Ophiolite Belt.

The key for the reconstruction of the Jurassic history of mélangé formation is the knowledge of the palaeogeographic derivation of the different slides in the Triassic passive continental margin arrangement facing the Neotethys Ocean further to the east. Especially for the Late Triassic the facies zones arrangement (Hauptdolomit [Dolomia Principale]/Dachstein Carbonate Platform and equivalents to the hemipelagic Hallstatt Facies belt facing the Neotethys Ocean) is proven from the Austroalpine/Western Carpathian domain to the Albanides.

A kilometre-sized block in the Zlatibor carbonate mélangé provides a complete succession of the Wetterstein Carbonate Platform (WCP) evolution, dated by means of conodonts. The complete section of the WCP evolution starts in the Klisura Quarry with bedded cherty limestones on top of a bentonite layer, which forms a thrust on top of Late Anisian Bulog Limestones and can be followed along a forest road in westward directions and than along the road from Sirogojno to Rožanstvo. The lower part of the succession is preserved in the Klisura Quarry and the upper part of the succession including the drowning event is preserved in an old quarry and few other places along the main road in direction Rožanstvo. The age range of the Wetterstein Formation as part of Wetterstein Carbonate Platform remains until now enigmatic and is estimated as Ladinian to Late Carnian. The Wetterstein Formation should pass directly in the Norian/?Rhaetian Dachstein Limestone without interruption of e.g., siliciclastics, drowning-sequences or longer lasting gaps.

According to our new data the platform starts to prograde in Early Carnian times over hemipelagic Late Ladinian cherty limestones with fine-grained allodapic limestones (Trnava Member of Grivska Formation). Shallow-water reef-slope and reefal limestones still evolved in the Early Carnian (Wetterstein Formation). The top of the platform is recrystallized by karstification and partly dolomitized. After a period of omission caused by uplift, new subsidence started in early Late Carnian. This is documented by a drowning/flooding sequence of same age. The evolution of the onset and the drowning of the Wetterstein Carbonate Platform prove a palaeogeographic derivation of this block in the mélangé from the

outer shelf area, but still in a shallow-water carbonate platform position; this palaeogeographic position is especially confirmed by the new pulse of subsidence in the Late Carnian after a long lasting phase of omission. The evolution of the Wetterstein Carbonate Platform in the Inner Dinarides corresponds perfectly to successions known from the southern parts of the Northern Calcareous Alps or the southern West Carpathians.

Main structural features of the coal-bearing Ptolemaida basin (north-west of Greece)

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More than of 100 measurements of the strata and fault elements have been performed in every outcrop during several field trips. The processing and the interpretation of the geological data completed the field researches. The results have been represented on the rose diagrams that have been superimposed on the geological map of the studied area.

The interpretation of the results shows that the synorogenic movements of the Neoalpine folding created at the end of the Tertiary period a large tectonic graben. The prevailing faults of the area have NW - SE and NE - SW directions. The former of these are considered as the marginal faults, which formed the original tectonic graben, the latter ones caused the traverse, to the general graben trend, fragmentation and formed subgrabens and small horsts, which give today's picture of Ptolemaida basin. From south to north five grabens are divided: Kozani - Servia, Sarigiol, Ptolemaida, the lake Petron - Limnihoriou and Florina. These grabens are separated by the horsts: Kila – Galani - Proskinatariou, Sf. Hristoforou - Komanou, Klidi - Xino Nero - Aetos.

The faults with direction NW - SE formed due to extensional forces, which activated on NE - SW direction in Upper Miocene - Pliocene. The faults with NE-SW direction formed because of extensional forces on NW – SE direction, which activated in the Lower Pleistocene. Younger faults than the previous with directions N-S and E-W to ENE-WNW are also observed in basin and at its margin as well. From those above it is observed that the action field of extensional forces presents from Miocene superior to Pleistocene inferior, a rotation on NE-SW to NW-SE direction. All these faults are normal faults with the greatest jump of faults until 60 meters, without to be constant on the whole long of fault. The changes of jump are explained by continue activity of faults, due to plasticity of sediments and of compressions and curvatures suffered by these when they are changing the place. The faults NW-SE are developed vertically until some meters over to geological roof of lignite, those on E-W direction until in the floor of Quaternary sediments yellow sandy, and those NE-SW until the floor of Quaternary sediments of red colour or a little above of them. Due to the tectonic movements the lignite beds as well as the sediments above and below them show a slight folding and in places, have a slight dip (3 to 5 degrees) to the SW, while they are almost horizontal in the greatest part of their extent. The observed erosion of the Neogene and Quaternary sediments is also a result of these movements. Rupture tectonic conditions prevail in the marginal rocks with the faults of the mentioned directions. The Triassic - Jurassic rocks are traversed by faults of NNE-SSW strike and WNW dip, and the Upper Cretaceous rocks by faults of NW-SE strike and NE dip. The geometrical result is that the Upper Pliocene sediments follow the morphology of the metamorphic basement, forming a mega-flexure with axis striking NE-SW and presenting large radius of curvature. This macrostructure is also accompanied by the significant presence of reverse faults. These appear before and after a big normal fault. The reverse faults are of the second order and originate in forces of compression, which acted in different zones.

Pollution with arsenic and heavy metals of soils and some components of the food chain in the environment of Goliam Bukovets mine tailings impoundment, Chiprovtsi mining area, NW Bulgaria

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The Chiprovtsi mining area is contaminated as a consequence of past mining. The 20-year existing of Goliam Bukovets mine tailings impoundment has affected all elements of its surroundings. As a result elevated concentrations of arsenic and heavy metals in upper soil layers and in grass are established. The low distributions of arsenic and heavy metals in depth allow assuming their low mobility which restricts their unfavourable environmental impact. The sheep's milk has elevated Zn and Cu contents and so it transfers them to the humans. The carry-over of Pb, Cd and As from grass to the milk is low. Metal concentrations in livestock's excrements are low and seem not to pose risk for secondary soil contamination if used as organic fertilizer. Although the tailings impoundment is almost recultivated and the dust pollution is finished the contaminated soils of the surroundings contain arsenic and heavy metals and continue to transfer them through the food chain. Besides, the soil cover of the impoundment is not sufficient to avoid the penetration of grasses root to the mine tailings.

The effect of montmorillonite modification by Cr(III)-compounds on its microcrystalline structure and electro-surface properties

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Modification of clay minerals by nanoclusters of hydroxycations Cr(III) opens the perspectives for development of a new materials (catalysts, adsorbents, pigment concentrates, leather fillings) and nanocomposites. In order to examine the effect of montmorillonite modification by Cr(III)-compounds with different basicity on its electro-surface properties the dependences of ζ -potential and the stability of MMT dispersions on pH medium and concentration of chromium nitrate have been studied. For pH 2-12, three zones of stability are observed, which alternate with three zones of coagulation. The triple change of MMT charge sign in Cr(NO₃)₃ solutions and alternation of stability and coagulation zones of dispersions are explained by hydrolysis, complex formation of Cr³⁺-ions and ionization of hard phase groups. Charge reversal of MMT surface and appearance of the second zone of stability of positively charged sol are conditioned by excess adsorption) of polymerized cationic species of chromium. The adsorption of polymeric hydroxychromium cations depends upon the basicity of Cr(NO₃)₃ solution exceeds the CEC of MMT by 2-5 times. Hydroxychromium-montmorillonite (Hydroxy-Cr-MMT) has high positive charge (tens or hundreds $\mu\text{C}/\text{cm}^2$) and highly developed accessible specific surface area (95-260 m^2/g). Modification of MMT by hydroxychromium cations was accompanied by increase of the interlayer space along *c*-axis up to $d_{001} = 1.68$ nm and appearance of highly developed micro- and mesoporous turbostratified (disordered) structure.

Upper Cretaceous magmatic evolution of the Timok magmatic complex (TMC) and Ridanj-Krepoljin zone (RKZ), East Serbia: Implications from geochemistry and geochronology

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Volcanism in East Serbia can be linked to the northward subduction of the Vardar ocean beneath Europe in the upper Cretaceous, followed by major continental collision between Africa and Europe. This mineralized magmatic arc of East Serbia developed along two belts, the Timok magmatic complex (TMC) in the east and the Ridanj-Krepoljin Zone (RKZ) in the west. The composition for the calc-alkaline rocks is ranging from basaltic andesite to granite, and clearly shows subduction zone signatures, i.e. depletion in Nb and Ta, and enrichment in Th, U and Pb.

Literature K/Ar data imply that the magmatic activity extended over the period of 94-60 Ma (Late Cretaceous to Paleocene). However, these ages are not very precise. First high-precision U/Pb single zircon analyses indicate an age of 86-84 Ma for the initial volcanism in the eastern part of the TMC. New obtained LA-ICPMS U/Pb ages show a general younging from east to west in the TMC. Volcanism in TMC ceased with 78 Ma in the Valja Strz area, indicating that magmatism lasted at least 8 m.y. The RKZ in contrast shows ages ranging between 71 and 74 Ma. This new age data clearly represent a time gap of 4 m.y. between these two volcanic complexes.

This time difference can also be seen in the geochemistry of the volcanic rocks. ⁸⁷Sr/⁸⁶Sr values in TMC are ranging from 0.70339 to 0.70482 whereas RKZ samples have higher isotopic values (0.704156-0.705513), displaying increasing upper crustal component. ¹⁴³Nd/¹⁴⁴Nd ratios show the same trend. TMC volcanics are ranging between 0.512695 and 0.512535. RKZ volcanics show lower ratios (0.512658-0.512469) and therefore also indicate the increasing upper crustal contamination. In both volcanic provinces it is noticeable that crustal assimilation increases rapidly with SiO₂ contents above 60 wt%. Intense crustal assimilation particularly took place in RKZ which is, besides the isotopes, also notable in trace elements (high Th/Yb ≥ 5). The TMC in contrast shows low Th/Yb ratios (≤ 5) but high Sr/Nd (≥ 30) ratios indicating a more subduction zone fluid dominated origin.

As can be seen in other mineralized volcanic arcs, volcanic rocks from eastern Serbia also show adakite-like signatures (e.g. high Sr/Y and low Y). EC-AFC-modelling at a depth of 40 km indicates that amphibole fractionation is most likely to have produced this signature in the majority of the cases. Later upper crustal (10 km depth) fractionation of apatite, clinopyroxene, amphibole, plagioclase and magnetite produced the other trace-element signatures.

A review of age constraints of epithermal precious and base metal deposits of the Tertiary Eastern Rhodopes: coincidence with late Eocene-early Oligocene tectonic plate reorganization along the Tethys

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The Tertiary Eastern Rhodopes are a major ore province within the Tethyan metallogenic belt. ⁴⁰Ar/³⁹Ar age data obtained in the past ten years are overviewed and discussed. It allows us to address some of the open questions and shed some new light on the sequence of ore-forming, magmatic and tectonic processes throughout the Eastern Rhodopes. Small to moderately sized ore deposits and prospects in the Rhodope Massif are hosted by high-grade metamorphic, continental sedimentary and igneous rocks. Sedimentary rock-hosted gold epithermal prospects are the earliest hydrothermal systems, hosted by Maastrichtian-Paleocene clastic rocks. Their ⁴⁰Ar/³⁹Ar ages vary between 37.55 ± 0.44 Ma and 34.71 ± 0.16 Ma, with the waning hydrothermal activity overlapping with the start of the oldest volcanism in the Eastern Rhodopes yielding ⁴⁰Ar/³⁹Ar ages ranging between 34.62 ± 0.46 Ma and 32.97 ± 0.23 Ma. Within a very short time between 32.13 ± 0.20 and 31.2 ± 0.4, Pb-Zn-dominated and Cu-Au-dominated epithermal prospects, respectively in the northern and the southern parts, were formed, and coincide with rhyolitic dikes emplaced at about 31.5 Ma. The Late Eocene-Early Oligocene post-orogenic magmatic and ore-forming evolution of the Eastern Rhodopes coincides with the time of collision at about 30-35 Ma of the African and Eurasian plates in the Caucasus and the Rif-Betic belts, when a dominantly subduction-dominated tectonic regime changed to a collision-dominated system, and the northward motion of the African plate slowed down, accompanied by an increasing southward slab retreat velocity in the Aegean Sea.

Remnant mineral assemblages in the garnet porphyroblasts from the Rebra Group micaschist used for establish metamorphic PT path (Rodna Mountains, East Carpathians)

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The Rebra Group terrane from the Rodna Mountains is part of the Rodna Variscan nappe which was remobilized during Alpine cycle (Austrian phase). Its rocks are polymetamorphic and polydeformed, which mainly consist of: micaschist and gneisses (with garnet, ± kyanite, ± fibrolite), marbles (± tremolite, ± fucshit, ± diopside), amfibolites (± garnet, ± epidot), pegmatites (± garnet, ± turmaline) and Nichitas granitoid. The rocks are S and L-S tectonites with 3 main foliations, the last (S3) being of crenulation type due to retrogression and S1 was transposed after S2 by isoclinal folding. The penetrative lineations are trending NW-SE. The metamorphic peak was attained under amphibolite facies (medium pressure), and corresponds to the staurolite – almandine and kyanite – almandine – muscovite

subfacies, retrogressive mineral assemblages are indicative of greenschist facies, particularly of quartz – albite – biotite – muscovite – chlorite, and locally, quartz – albite – epidote – almandine subfacies conditions. To understand the complex PT path of this group, we used the petrographic microscopy combined with microprobe analyses of some mineral pairs and geothermobarometrical calculations. The data presented in this paper set new petrological constraints for the interpretation of the tectono-metamorphic history of the Rebra Group. The garnets of the Rebra Group rocks display a large dimensional variation (submillimetric to centimetric sizes) and they have a prevalently almandinic composition. The garnets from Rebra Group could grow in three main phases. The first generation garnets grow prekinematic (68-77% almandine, 10-20% grossular) in relation to the penetrative S₂, enclosing relic isoclinal fold-marking trails of quartz and ilmenite grains, followed by syn-kinematic second generation garnets (55-75% almandine, 15-25% grossular), which overgrew, partly simultaneously with Fe-Mg chloritoid, epidote core and tourmaline grains. More or less before the garnet overgrowth, could be active a boron and sodium rich solution transport with dravit- schorl series tourmaline grains genesis. The garnet 3 blasthesis was postkinematic in relation to S₂ and was observed on corroded rims of earlier ones. The centimetric sized garnet porphyroblast from micaschists may preserve some remnant minerals from the prograde phase and peak conditions, which are missing in the rock matrix. Such minerals are: chloritoid, REE- rich epidote, Cr-spinel.

Using garnet – biotite geothermometry for Rebra Group rocks temperatures of 425 – 550 °C were calculated. Calcite – dolomite solvus geothermometry indicated 350–430 °C (retrogressive conditions), while amphibole – garnet geothermometry and phengite geobarometry for the Rebra Group amphibolite yielded temperatures between 550 and 630°C (peak conditions). Using Ca-amphibole – plagioclase geothermometry for the same samples 550 °C and 7 ± 1 kbar were calculated. The garnet porphyroblast of metapelites are the most indicative for PT path evolution and their matrix minerals (fengit, ilmenite, albitised oligoclase, zoned epidote group minerals with La, Cr, Y, chlorite, and apatite), because may contains beside the quartz inclusion trails, some other minerals such as: ilmenite, ilmenite-magnetite intergrowth, Cr spinel, apatite, tourmaline (dravit- schorl series), fengite, epidote group minerals and chloritoid (the first record of it in this metamorphic group garnets). Geothermobarometric calculations using microprobe data on centimetric sized garnets and its inclusions from Valea Blazna Gallery micaschists samples evidenced: by garnet- ilmenite geothermometry 678 ± 30 °C and phengite geobarometry 7 kbar for the metamorphic peak conditions; the garnet-tourmaline, tourmaline-muscovite thermometry evidenced a prograde phase temperature of 450 °C and a minimum pressure of 4Kb (phengite geobarometry). The garnet rim-ilmenite (matrix) pair outlined 498 ± 30 °C, and plagioclase- muscovite pair data 422 °C and 3.5 kbar pressure for retrogression conditions.

High-precision P-T estimates for retrogressed kyanite eclogites from Thermes, central Rhodope (Greece)

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The Rhodope massif in northern Greece and southern Bulgaria constitutes the hinterland of the Hellenide orogen. It exposes low- and high-grade metamorphic rocks and their sedimentary cover. Kyanite eclogites from Thermes-Rhodope (northern Greece) belonging to the structurally upper unit were studied in order to constrain their metamorphic conditions. The kyanite eclogites are boudins enclosed in quartzofelspathic gneisses. They experienced a polyphase metamorphic history involving equilibration at granulite-, amphibolite- and greenschist-facies conditions successively. Textural relations reveal the successive equilibrium mineral assemblages and provide constraints that very local, domainal equilibria were attained during metamorphic evolution. Omphacite formed symplectites of

diopsidic pyroxene and plagioclase during decompression while garnet formed coronas of two amphiboles (ortho- and clino-), plagioclase and magnetite. The orthoamphibole is sodic gedrite with the most sodic composition found in the literature. Symplectites of plagioclase, spinel and corundum formed at the expense of kyanite suggesting some metasomatic process. During metasomatism the mineral chemistry and the local composition of the equilibration volume were modified by diffusion processes, thus nullifying any assumption that the system was closed. Conventional geothermobarometric methods and thermodynamic modelling were combined to decipher the evolution in the rock mineral assemblages as a response to P-T conditions. Modelling revealed that the formation of sapphirine, corundum, spinel and plagioclase symplectites after kyanite is only possible during decompression at pressures less than 0.8GPa.

Joint inversion of compressional and shear wave traveltime data, using velocities-ratio constraint with spatially variable weighting

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In order to improve the resolution of traveltime seismic tomography surveys, P and S-wave traveltimes can be used complementary under a joint inversion scheme. Usually both P and S arrivals can be obtained with minimum additional effort; therefore joint inversion of these datasets offers an inexpensive and efficient way to improve their interpretation. A joint inversion algorithm of P and S traveltimes can maximize useful information from existing datasets and enhance the effectiveness of seismic refraction tomography surveys. In this work we present a joint inversion algorithm that inverts the two different datasets subject to a velocity ratio linking constraint. This constraint could be constant for all model parameters or could vary spatially, depending on the available information. The compressional to shear waves velocity ratio value can be roughly estimated from existing a-priori information, based on well logging or lab measurements or even can be estimated from geological information. A critical issue regarding joint inversion schemes is the significance of the constraint equations in the overall inversion procedure. If this constraint is too loose then the cross-correlation between the parameters of different type is negligible and the two models vary independently, degrading the joint inversion scheme in two separate inversions. On the contrary if too heavy weighting is applied, the solution is strongly biased towards the a-priori assumption, neglecting the actual data information. The participation of linking equation is controlled by a Lagrangian multiplier, which is usually defined empirically (i.e. extracted from a trial and error procedure) and is adopted as uniform for the whole model area. We introduce a spatially variable Lagrangian multiplier vector instead of a scalar one that scales differently the ratio constraint for each pair of parameters. The weighting is based on the parameter resolution matrices of the two models and spread function analysis. For highly resolvable parameters, a small value of the Lagrangian multiplier is assigned and the parameters are allowed to vary almost independently. For poorly resolved parameters, the Lagrangian multiplier that is assigned is large and due to the lack of information the specific parameters are forced to follow the ratio constraint. This method allows areas of the models with high information density values to vary based on this information rather than the ratio constraint equations, preserving the information content and the contrast that separate inversions would provide. At the same time the areas of the models which are lacking of resolving power and introduce instability under independent inversions, are constrained under the joint inversion scheme. Additional regularization is used and spatially variable smoothness is also applied to the models parameters. Testing with synthetic and real data suggest that the presented joint inversion algorithm can lead to improved results, stabilize the inversion process and reduce the non-uniqueness of the problem.

Record of two Alpine high-P metamorphic events in the Titaros ophiolite complex of the Pelagonian zone (Greece)

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We present new petrological data of the Titaros ophiolite complex and discuss their significance for the Alpine geodynamic evolution in the Pelagonian realm. There are two Alpine high-P metamorphic stages. The first stage, at pressures between 0.8-1.4 GPa and minimum temperatures 570-610 °C occurred in late Jurassic/early Cretaceous and is associated with the obduction of the ophiolite complexes onto the Pelagonian crust. At this stage the Titaros ophiolite was subducted together with crustal rocks of the Pelagonian zone as a result of tectonic erosion of the ophiolite margin. The second stage occurred in the Eocene at much lower temperatures (about 400 °C and minimum pressure ~0.7 GPa). It is interpreted to reflect the final closure of the Vardar-Axios ocean and collision/underthrusting of the Apulia microcontinent under Europe.

Alpine polyphase metamorphism in metapelites from Sidironero Complex (Rhodope Domain, NE Greece)

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Metamorphic mineral ages from garnet-kyanite gneisses in the area north of Xanthi documented a Jurassic and an Eocene metamorphic event in the Sidironero complex of the Rhodope domain. The two metamorphic events are well imprinted in the mineral assemblages, mineral compositions and textural relationships of metapelites within the Nestos Shear Zone in the Sidironero complex. The Jurassic event at HP-UHP metamorphic conditions is characterized by the mineral assemblage garnet-kyanite-Ti-rich phengite at the peak pressure. The Eocene metamorphic event at moderate HP conditions and minimum pressure > 0.9 GPa is characterized by the mineral assemblages St-Grt-Ms-Ky-Bt with garnet growth at the expense of kyanite or staurolite, and Grt-St-Ky-Bt with peak P-T conditions within the St+Bt+Ky stability field.

Numerical analysis of shallow landsliding – an option to substantiate mass movement hazard assessment (case study in Beskid Niski, Polish Flysch Carpathians)

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Mass movements have adverse effect on environmental assets but they are also devastating to elements at risk associated with landuse and man-made structures or even lead to casualties. For the purpose of loss reduction current Polish legislative regulations require local and regional authorities to establish registers and maps denoting areas prone to mass

movement hazard and to take them into account in guidelines for landuse planning and management. Although Poland is still lacking an officially recognized methodology, the first attempts towards landslide hazard and risk assessment at medium scale survey (1:10 000) has been undertaken in a test study area near Szymbark (Bystrzanka and Biczyska catchments), Beskid Niski Mts., Outer Carpathians.

The test area, historically known as prone to slope failures, is located in the contact zone of Magura and Silesian nappe structures with typical flysch formations (alternated sandstones, conglomerates, claystones, mudstones and shales) of Cretaceous to Oligocene age. The flysch is often mantled with weathered material forming slope covers (clays, loams, silty sands and debris). Lithologic setting combined with tectonics contributes to a wide array of gravitational mass movements. Due to climatic setting, rain- and snowmelt induced failures are typical. Owing to coupled effects of environmental and triggering factors, slow deep-seated slides (rotational, translational and compound slides) as well as reasonably fast shallow slips (or even earth flows) are observed.

Statistical relationships between past landslide occurrences and conditioning variables were used to make predictions for areas currently free of landslides and for their likely distribution. Analysis involved usage of GIS techniques in Bystrzanka-Biczyska test area, landslide susceptibility assessment was performed using empirical likelihood ratio functions in frames of spatial predictive modelling procedure. Having data on landslide occurrence for 35 years, time-based cross-validation was possible, and the generated susceptibility map was transformed to a hazard model for a given period. The collected data on direct damages due to landslides and corresponding vulnerability provided basis for potential losses estimations in monetary terms and, then, to risk mapping.

The maps of landslide phenomena and potentially endangered areas, which are welcomed by policy makers and stakeholders, often are not appreciated by a local society. As some landslides move imperceptibly downslope, a potential danger is often ignored, the maps are perceived as unjustified and imposed bans are considered too restrictive.

To dispel such reservations, inclinometer monitoring was used to provide better evidence on actual displacements and numerical modelling was performed for evaluating stability conditions of a slope located in a selected zone assigned as hazardous on the elaborated map. To make this example more appealing a focus was on the SW-facing slope (sandstone-shale complexes of Krosno beds) in the Biczyska stream valley, where landsliding was observed in 1974. Since then, the terrain was recognised as stable. The inclinometer readings taken during 20 months (from 13.09.2004 to 13.05.2006) revealed an active slip surface (zone) at the depth of 2.5–3.5 m and cumulative displacement of an order of 72-75 mm. The measured displacement rate has an increasing tendency in spring-summer seasons, declines in autumn-winter period and generally correlates with changes in groundwater level (GWL). The numerical modelling has been carried out using FLAC 2D code based on finite difference method. Simulation of material behaviour comprised a visco-elastic part represented by Burger's model as well as a plastic component described by Coulomb-Mohr law. Although only "average GWL" conditions were concerned, simulations revealed deformations in a near-surface zone which in consequence might result in destroying objects to be potentially located on the examined slope. With this example a complimentary approach to landslide danger assessment is shown.

Late Miocene Formations from As Sahabi area, Sirt Basin, Libya in correlation to isochronous SE Europe deposits: A paleoclimatic approach

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As Sahabi area has yielded a rich Neogene vertebrate fauna that aids in understanding evolution and paleoenvironments. Stratigraphically, it consists of three stratigraphical superposed lithological units, from bottom to top; Formation "M", Formation "P" and Sahabi Formation. Formation "M" which forms the base of the exposed section in the As Sahabi area consists of semi-consolidated sandy bioclastic carbonates enriched by warm water organisms such mollusks, bryozans, and corals. The presence of the ostracodes and the foraminifera are strong indicators of shallow warm environments. Formation "P" consists of a lattice of monocrystalline gypsum crystals infilling desiccated cracks of siliclastic clays and sands, with no in-situ fauna reported so far. Formation "P" has been attributed to the Messinian crisis in the Mediterranean. These two formations are followed by the vertebrate fossil-bearing rock unit called the Sahabi Formation, which displays a different depositional setting of continental to semi-continental terrestrial tropical paleoenvironments through fluvial, lacustrine and deltaic water bodies. Two subsurface boreholes from As Sahabi area (Sirt Basin) have been investigated lithologically and micropaleontologically. The upper siliclastic part of these wells is assigned to Sahabi Formation. The lower thin carbonates are assigned to both Formation "M" and Formation "P". Two subsurface boreholes (A1-NC214 water well and Sahabi Borehole 1-2) have been lithologically described and investigated for their micropaleontological content. The carbonates at the lower depths belong to Formations "M" and "P" respectively. The microfossil bearing interval of the A1-NC214 water well (interval between 165 and 175m) contains rather well preserved calcareous nannofossil assemblage with common-abundant *Helicosphaera stalis* and *Reticulofenestra pseudumbilicus*, accompanied by *Coccolithus pelagicus*, *Calcidiscus macintyreii*, *Helicosphaera carteri*, *Sphenolithus moriformis*, *Discoaster cf. calcaris*, *Discoaster cf. challengerii*. The increased relative abundance of *H. stalis* (>10%) implies a biostratigraphic correlation with nannofossil biozone NN8/MNN8b, i.e. the interval of common presence of *H. stalis* below the First Occurrence of *Discoaster bellus* group. Therefore the carbonates below the Sahabi Formation, at 165m below the surface, are assigned to early Late Miocene (Early Tortonian), ranging between 10.71-10.40 Ma. Concerning Sahabi Borehole 2 the microfossil bearing interval (interval between 72 and 100m) contains a well preserved nannoflora marked by the presence of *Discoaster neoerectus*, *D. berggrenii*, *D. bellus*, *Helicosphaera stalis*, *Reticulofenestra pseudumbilicus*, *Calcidiscus miopelagicus*, and therefore is assigned to Late Tortonian nannofossil biozones NN10b-NN11a. The First Occurrence of *D. berggrenii* recorded within this interval provides a datum event with a fixed age of 8.23 Ma. The presence of common Mediterranean benthic foraminifer *Borelis melo* along with a few planktonic representatives indicates a shallow marine environment and warm paleoclimatic conditions. The abundance of large specimens of *R. pseudumbilicus* is indicative of warm and stratified waters. Several Greek marine sites span the Tortonian-Messinian time interval providing a useful framework for biostratigraphic correlations in the eastern Mediterranean area, e.g. Potamos section/northern part of Gavdos island (NN6 - NN9, 13.28-9.61 Ma), Vassiliki section/E. Crete (NN9, 10.18-9.61 Ma), Skoloudhiana section/W. Crete (NN11, 8.68-7.41 Ma), Kastelli section/central Crete (NN11, 8.68-6.79 Ma), Limin Keri section/southern coast of Zakynthos (NN9, 10.18-9.53 Ma), Ag. Sostis section/southern coast of Zakynthos (7.22-6.52 Ma), Kokkino Rema section/ southern part of Kassos island (NN11, 6.79-5.35 Ma). Although none of these locations bears any terrestrial fauna like the Libyan site, based on their

micropaleontological content they confirm the warm climatic conditions prevailing during that time. A particular location that contains vertebrate fauna of equivalent age (including primates) is the Axios Valley in northern Greece.

Nonstationary stress-strain perturbations migrated from mid-ocean ridges and the asthenosphere viscosity

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The plot of temporal variation in the seismic activity level of the 40°–80°N segment of the Mid-Atlantic Ridge over the period from 1917 through 1987 is rather similar in shape with an analogous plot for Fennoscandia and, as is shown in the present work, for the eastern part of the North American platform (NAP). However, the characteristic features of the Mid-Atlantic Ridge plot are repeated with an ~3-yr delay in Fennoscandia and with a 4–8-yr delay in the NAP. This positive phase shift is consistent with the hypothesis on significant dynamic control of a mid-ocean ridge (MOR) over seismic activity in adjacent platforms. This control is realized via the MOR push force. Variations in this force induced by the nonstationary process of dike intrusion in the axial zone of the ridge bring about migration of perturbations in the stationary stress–strain state of the lithosphere away from the MOR and induce seismic activity variations in platform regions adjacent to the MOR. The positive time shift in plots of platform seismic activity relative to the corresponding MOR plot is explained in terms of the delay in the arrival of the stress wave at the platform; due to energy dissipation in the asthenosphere, the amplitude of the wave significantly attenuates during its propagation from the MOR. Using the Elsasser model and the observed time shift, an estimate of $\eta = 10^{17}$ Pa s accurate to within $\pm 30\%$ is obtained for the asthenosphere viscosity in the case under consideration. Such values of the viscosity are sufficient to bring about the triggering effect of stress–strain state perturbations on platform seismicity. An increase in the obtained value of η by a few times would lead to overly large travel times of the stress wave, so that seismic activity would remain unaffected by such a wave at distances of the order of 2000 km. The examined numerical model is indirectly supported by the variation amplitude of seismic activity: as compared with Fennoscandia, this amplitude is lower in the central and eastern NAP, located farther from the Mid-Atlantic Ridge. On the other hand, the stationary seismicity level on the NAP is higher than in Fennoscandia, which can explain the difference between stationary values of shear stress intensities τ in the regions considered. The smaller stationary values of τ in Fennoscandia are due to the higher curvature of the Mid-Atlantic Ridge encompassing this region. The results of this work not only confirm the idea previously proposed by the authors according to whom the MOR push force affects the stationary level of seismic activity in adjacent platform regions but also provide new insights into the mechanism of this effect in a nonstationary state.

The exposed base of a collapsing wedge – the Nestos Shear Zone (Rhodope Metamorphic Province, Greece)

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The Nestos Shear Zone (NSZ) in the Rhodope Metamorphic Province is a major high-strain zone between two metamorphic terranes. Microdiamond-bearing ultrahigh-pressure

(UHP) rocks occur in the NSZ which was therefore interpreted as a suture zone where subduction and exhumation of these rocks and terrain accretion occurred during the Mesozoic. Our petrological study of samples from the lower part of the NSZ, together with monazite dating of a microdiamond-bearing schist, structural observations, already published results from the upper part, and other published timing constraints, results in a fundamentally different picture: The NSZ is the base of an Eocene-age thrust wedge which included not only the structurally higher parts of the Rhodope Metamorphic Province but also the entire Internal Hellenides. The UHP rocks, for the peak pressure of which we derive an age of ca. 200 Ma by monazite dating, are unrelated to the tectonic processes in the NSZ and probably represent slivers of a higher tectonic unit captured by thrusting along the NSZ. Pressure decrease in the footwall samples and regional extension and basin formation in the hanging wall during the activity of the NSZ show that the overlying thrust wedge was collapsing in late Eocene times.

Amber on the Romanian market

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Since 1989 there was a little call for amber on the Romanian market in comparison with our days. Ironically, the Romanian amber was almost absent, despite that an unique Amber Museum was opened in 1980 at Colți (Buzău County), in the Eastern Carpathians. After the year 1990 the European amber market is dominated by Russia, Poland and Germany. Samples examined in this report were pieces of amber-like material from Romania, sold as Romanite, and from Russia, Lithuania, Germany and Poland, sold as Baltic amber or Succinite. All this amber-like material is used in ornamental, gemological and curative purposes. They can be found on the Romanian market. For the present study, Fourier transform infrared spectroscopy (FTIR), X-ray diffractometry (XRD) and optical microscopy are methods of choice in amber-investigations. By now, our measurements demonstrate that all material is amber, ambroid or copal. The infrared transmittance spectra were recorded with a JASCO FT-IR 4100 spectrometer using KBr pellet method, with the main specifications: Peltier detector thermostatted DLATGS as standard, Ge coated KBr beam splitter, spectral resolution 0.9 cm^{-1} , spectral range $7,800\text{ to }350\text{ cm}^{-1}$, Jasco software. For certifying the results we used another Bruker Tensor 27 FT-IR spectrometer, using both ATR accessory with a diamond crystal and KBr pellet method. The main technical specifications are: DTGS detector, KBr beam splitter, spectral range $7,500\text{ to }370\text{ cm}^{-1}$, resolution $\pm 1\text{ cm}^{-1}$, $\pm 2\text{ cm}^{-1}$, OPUS software. The FTIR spectra show the bands corresponding to the alkyl stretchings between $3000\text{ and }2800\text{ cm}^{-1}$, with a characteristic pattern with a maximum intensity near $2923\text{-}2924\text{ cm}^{-1}$ for the methyl and methylene groups, and two bands of similar intensities at 2866 cm^{-1} for the methyl group and $2847\text{-}2848\text{ cm}^{-1}$ for the methylene groups. The bands due to the carboxylic acid groups have been observed near $1706\text{-}1707\text{ cm}^{-1}$. The transmittance range is higher in the case of romanite, meaning that it has more carboxylic groups than succinite, probably because of a stronger oxidized process. Four bands appear near $1734\text{-}1735$ in all the spectra, due to ester groups. A strong band at $1155\text{-}1157\text{ cm}^{-1}$ is always observed and is attributed to the C-O simple bond stretching of esters. In the 'Baltic shoulder' region situated from $1250\text{ to }1150\text{ cm}^{-1}$, the shoulder is very distinct in the case of Lithuanian and Polish amber varieties and doesn't appear at Romanite. Other bands can be to the alkyl groups: $1448\text{ and }1444\text{ cm}^{-1}$ for CH_2 and CH_3 bending, $1374\text{ and }1373\text{ cm}^{-1}$ for CH_3 bending. There are also spectra with bands at 1642 cm^{-1} attributed to the out-of-plane CH ethylenic bendings. The presence of a clear, intense band near 887 cm^{-1} because of the exocyclic methylene is an argument for a copal spectrum. No aromatic bands are observed, indicating that aromatic structures are absent.

X-ray powder diffraction analyses was performed on a Bruker D8 Advance automated diffractometer equipped with a graphite-diffracted beam monochromator ($\text{CuK}\alpha$ radiation,

$\lambda=1.54056 \text{ \AA}$), at an operating voltage of 40 kV and a beam current of 40 mA. Baltic ambers exhibit the same XRD pattern comprising of a broad peak centered at $2\theta=15^\circ$. They are in the amorphous state. The records seem to indicate for Romanite and Lithuanian amber some internal crystallization tendency, confirmed also by microscopically studies. These have been marked up using a PANPHOT microscope transmitted light. On the Romanite thin sections a weak anisotropy with grey-yellowish to light-blue colors was observed, although in literature is mentioned that amber does not present crystallization tendencies. Baltic amber studied with this occasion revealed no anisotropy.

Preliminary results on xenoliths in basaltic andesite subvolcanic body in the vicinity of Kroumovgrad, eastern Rhodopes, Bulgaria

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The studied basaltic andesite subvolcanic body belongs to the Paleogene post-collisional volcanism of the Eastern Rhodopes Momchilgrad-Arda volcanic region. It intrudes acid and intermediate pyroclastic, epiclastic rocks as well as concomitant sedimentary rocks. The subvolcanic rocks are with dense porphyritic texture and glassy (hyalinic) ground mass. Phenocrysts are represented by clinopyroxene, orthopyroxene and plagioclase. The rocks are medium-K to high-K, Q-normative and with $Mg\# = 65-72$. Their geochemical peculiarities are similar to those from subduction related magmas, with negative anomalies for Ta, Nb, Ti, P in primordial mantle normalized spidergrams, but are probably influenced by lower crust material. Three different types of deep xenoliths of granulites, plagioclasites and cumulate clinopyroxenites are established. Granulites are metabasites with $MgO = 7.15 \text{ wt. \%}$. Basic granulites (pyriclasites) are composed by clinopyroxene and plagioclase where titanomagnetite is an accessory phase. Plagioclasites are composed exclusively of oligoclase with a small amount of chlorite. And finally clinopyroxenites are monomineral but with a transitional peripheral zone, where plagioclase (anortite) appears as a reaction product. Pressure estimations for granulites and clinopyroxenites are 8-14 kbars corresponding approximately to the crust – mantle boundary. Both xenolith types show petrographic evidences for rock transformations and initial melting. They were probably the result of an interaction with the ascending-basaltic to basaltic andesite mantle-derived and lower crust modified magma.

Volcanic glass textures, shape characteristics and compositions from phreatomagmatic rock units of the western Hungarian monogenetic volcanic fields and their implication to magma fragmentation

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Mio-Pliocene (~8 – 2.3 My) monogenetic volcanic fields in western Hungary (Bakony-Balaton Highland and Little Hungarian Plain Volcanic Fields) consist of eroded maar, tuff ring and scoria cones. Erosion advanced in many cases, and today the crater and volcanic conduit filling pyroclastic assemblages are preserved. The majority of the volcanoes had at least in their initial eruptive phase phreatomagmatic eruptions that produced pyroclastic beds deposited mainly from base surges and subordinate pyroclastic falls. These phreatomagmatic rock units are rich in well-preserved volcanic glass shards. Electron microprobe studies on fresh volcanic glass revealed that they are primarily tephritic in composition. Textural analysis of the shape parameters of the glass shards were carried out with an aim to determine the magma fragmentation style was responsible for their formation. The shape analysis indicated that the majority of the magma was fragmented in a brittle fashion. Not only the fine ash

fraction but the coarse ash fraction of the phreatomagmatic pyroclastic rocks suggested brittle fragmentation style of the magma due to thermohydraulic magma and external water interaction triggered eruptions. The glass shards are primarily blocky in shape, low in vesicularity and have low to moderate microlite content. The glass shape analysis was supplemented by fractal dimensions calculation of the glassy pyroclasts. The fractal dimensions of the glass shards range from 1.06802 to 1.50088 with an average value of 1.237072876 and a mean value of 1.24521 based on fractal dimension test on 157 individual glass shards. The average and mean fractal dimension values are similar to the theoretical Koch-flake (snowflake) value of 1.262 suggesting complex boundaries but bulky shape of the majority of the glass shards inferred to be typical for pyroclasts formed by the brittle fragmentation of hot melt through explosive magma and water interaction. Light microscopy and backscattered electron microscopy images show well the bulky, fractured and complex particle outline of the individual glass shards. Abundant and complex micro-fractures, low vesicularity and the complex, moss-like particle boundary of the studied glass shards are characteristic features of both laboratory generated and natural glass shards as a result of hot melt and external water interaction. The similar textural features identified in fine and coarse ash particles, suggest that the particles were formed by processes that triggered brittle fragmentation of the melt in the hot melt and water interface (active particles) as well as in the vicinity of the interaction interface (non-interactive particles). Such scenario can be envisioned where hot melt rapidly penetrate abundant water-rich zones such as a) water-saturated soft-substrate, b) surface water body, or c) quickly recharging fracture-filled ground-water and the melt quickly cooled down to a temperature where it has been fragmented in brittle fashion and dispersed quickly from the explosion locus by the kinetic energy released in the magma – water interface. The variety of moss-like, blocky, bulky and heavily fractured complex glass particles all attest the phreatomagmatic fragmentation formed the pyroclastic deposits from where the studied volcanic glass particles were collected.

Interconnection of the regional-tectonic geological research and the applied technological research: The case study from the Gemeric zone, the Inner Western Carpathians

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The recent economic relations and the request of the European Union for the close interconnection of the scientific research with the practical applicability of obtained results initiate the changes in the methodical approach also in the geological activities. New regional geological projects should be supplemented with the technological and environmental researches much extensively than before. The presentation demonstrates some examples of such interdisciplinary geological, technological and environmental approach in Slovakia.

The Western Carpathians were formed in two orogenic cycles – Paleozoic Variscan cycle and Mesozoic-Cenozoic Alpine cycle. The recent tectonic setting (the course of lithological units, the character of the ore veins, etc.) is strongly affected by the Alpine overprint and segmenting the former Variscan setting. Despite, the role of Variscan evolution is of the high importance for the metallogenic processes by the late Variscan-early Alpine post-collision thermal processes.

The Variscan exhumation and the south-vergent obduction of the former Lower Paleozoic oceanic crust (incomplete ophiolite suite) on the marginal sedimentary flyschoid and volcanosedimentary sequences is well demonstrated in the Gemeric Unit of the Inner Western Carpathians (deformation phase VD; pre-Stephanian age; the Rakovec suture zone). It consists of the south-vergent compression-collision phase VD₁ (323-275 Ma) with the pressure metamorphic peak at 275 Ma and the pressure release at 275-262 Ma. The main extension and unroofing phase VD₂ (262-216 Ma), located in the South-Gemic zone led to the origin of the Meliata-Hallstatt oceanic domain.

During the Alpine tectonometamorphism the kinematic regime has changed from the transpression to the north-vergent compression-overthrust kinematics AD₁ (141-114 Ma) related to the closure of the Meliata-Hallstatt domain to post-collision unroofing kinematics in the phase AD₂ (107-82 Ma) and, finally, to the origin of conjugated shear zones trending NE-SW and NW-SE in AD₃ (75 Ma-recent).

During both orogenic processes the high pressure rocks and ultramafics were exhumed, recently occurring along the Rakovec and Meliata suture zones. A newly developed technology for the use of ultramafics in CO₂ liquidation has confirmed the effectivity 3 : 1 of the process, i.e. 3 tons of ultramafics liquidate 1 ton of CO₂. Revealed methodology of mineral sequestration (carbonatization) produces carbonates nesquehonite and hydromagnesite, being stable and safe for the environment. Technological research recommends to use studied ultramafics is for obtaining of Co, Ni, SiO₂ (optical fibres), Fe concentrate, Mg(OH)₂ fillings, basic heat-resistant building materials, and those for shielding of radioactivity.

The genesis of the magnesite and talc is a reflection of the complex, above described, Variscan and Alpine geodynamic processes. The magnesite has originated during Permoscythian post-collision (post-VD) and pre-AD₁ evolution. The talc is a product of Alpine tectonic overprint (shearing) and the fluid migration through the magnesite bodies in AD₁ and AD₂. The majority of occurrences of the magnesite and talc are located in the wider surrounding of the contact zone of Gemic Unit with northern and underlying Veporic Unit. This magnesite is relatively rich in Fe₂O₃ (8-4 %), and the magnesite products (87.5-89 %) can reach the higher quality by the nitrate treatment (up to 99.5 % MgO). The main products of such treatment are Mg(OH)₂ and MgO. Technological research recommends using magnesite for the production of Mg and its compounds (brucite, periclase and MgCl₂). Another use of magnesite is in agriculture (the nitrogen fertilizer) and environmental protection (ecological sorbent). The industrial use of talc can benefit from improved methodology of flotation and milling. The flotation concentrates with the high fineness (50 % beneath 0.5 and 100 % beneath 3 micrometres) and brightness (above 90 %) are predestined as a high-quality filling into plastics, rubber, paper, paints and ceramics. The selectively exploited high-quality talc interbeds are used in cosmetics and pharmacy without necessity of flotation elaboration.

On the relationship between the Paleogene Magura Basin and Pieniny Klippen Belt sedimentary area –the Leluchów sections, a new approaches (Polish Outer Carpathians)

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The relationships between the Central Carpathian Paleogene Basin, Pieniny Klippen Belt and the Magura Nappe are still one of the most important questions, which should be answered.

It is essential for better understanding of the Paleogene paleogeography and evolution of basin located along collision zone of the Central and Outer Carpathian domains.

Our studies were focused on the contact zone between the Magura Nappe and Pieniny Klippen Belt, close to the Polish-Slovakian border. Between the Udol village in the west and Ruska Vola in the east, the Late Eocene-Oligocene, deposits overlap both the Pieniny Klippen Belt as well as the Magura Nappe. These deposits are known as the Ujak facies. According to traditional opinion the Ujak facies overlapped the Pieniny Klippen Belt, and are overthrust by the Magura Nappe. The best recognized Leluchów section of the Ujak facies are situated on the left bank of the Poprad River, in the contact zone of the Krynica Subunit of the Magura Nappe and the Pieniny Klippen Belt. Unfortunately in this section contact of the Magura

succession with lower part of the Ujak succession is covered by thick slope deposits, up to 27 m. Recently, in this area three boreholes have been drilled, by the Polish Geological Institute.

Combining the field observation with core material, following sequence of deposits of the Magura and Ujak transitional zone can be revealed:

1) thick-bedded sandstones of the Piwniczna Member (Early/Middle Eocene) of Magura Formation,

2) thin-bedded flysch and red shales with *Reticulophragmium amplexans* (Mniszek Shale Member, Middle Eocene) of the Magura Formation,

3) few meters thick packet of grey-greenish and red marstone of the Sub-Menilite Globigerina Marls (Late Eocene-Early Oligocene),

4) at least, a 19 m thick dark brown and black Menilite Shales with horstone and tuffite intercalations (Oligocene),

5) a 25 m packet of thick-bedded muscovitic sandstones, an equivalent of the Poprad Member (oligocene) of Magura Formation,

6) dark-grey marly shales with intercalations of thin bedded calcareous sandstones of the Malcov Formation (Oligocene).

The studies conducted by us have shown that during the Late Eocene through the Oligocene the Klippen Pieniny Belt was a transitional zone between the Magura and the Central Carpathian basins.

Jurassic and Cretaceous tectonic evolution of the Sakar and Srednogorie zones, Bulgaria: $^{40}\text{Ar}/^{39}\text{Ar}$ mineral ages and structures

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We present new $^{40}\text{Ar}/^{39}\text{Ar}$ mineral ages from metamorphic, plutonic and volcanic rocks of the principally E-W striking the Sakar and Srednogorie zones, Bulgaria and use these ages together with structural observations to constrain the Jurassic and Cretaceous tectonic history of these zones along northern margins of the Rhodope massif. The Srednogorie zone seems to be particularly important because of its richness of magmatic rocks and associated ore deposits.

The Sakar zone SW of Topolovgrad exposes the Palaeozoic Sakar granite mantled by the metamorphic Laslovo Formation. Along the contacts between granite and their volcanosedimentary metamorphic cover, often shear zones developed with a mylonitic fabrics formed within upper greenschist to amphibolite facies-grade metamorphic conditions giving the structure an appearance similar to a mantled gneiss dome. $^{40}\text{Ar}/^{39}\text{Ar}$ amphibole and white mica dating yield ages ranging between 144 and 136 Ma constraining the age of the main tectonic event of ductile deformation within a deep crustal level at ca. the Jurassic/Cretaceous boundary. Further to the southeast, towards the Rhodope massive, younger white mica ages gradually decreasing to ca. 124 Ma were found in metamorphic rocks. A further, secondary thermal overprint was found in staircase Ar release patterns with a maximum age of a secondary thermal overprint younger than 69 Ma. Together, these ages indicate the principal age of the Sakar zone at the Jurassic/Cretaceous boundary, which predates the formation of the Srednogorie basin, and two stages of thermal overprint.

The Srednogorie zone comprises an Upper Cretaceous siliclastic marine infill of a volcanosedimentary basin and abundant volcanics, subvolcanics and shallow plutons. In the eastern Srednogorie zone, alkalic rocks are abundant. A new $^{40}\text{Ar}/^{39}\text{Ar}$ amphibole age of 82 Ma from a hornblende andesite from the Fakjijska river S of Sredec indicate an important stage of effusive volcanic activity. In contrast, the following ages from plutonic rocks are interpreted to date cooling through the Ar retention temperature, ca. 500–550°C for

amphibole and ca. 300°C for biotite after magma crystallization. They represent, therefore, the minimum ages in respect to their crystallization. These ages include: biotite ages of 83, 79 and 79 Ma from the Granitovo granodiorite, Izgrev diorite and Rosen syenite (at Černomorez), respectively; and amphibole ages of ca. 86, 85 and 76 Ma from microgabbro within the Granitovo granodiorite, the Oman-Fakia gabbro (near Danica) and a gabbrodiorite of ENE Samokov. Together, these ages proof the wide range of magmatism between 86 and 76 Ma and a particularly important cooling event in the Srednogorie zone at ca. 80 Ma. In the case of the Izgrev diorite in the eastern Srednogorie zone, cooling at ca. 79 Ma is associated with chalcopyrite mineralization along conjugate shear-extension veins. Their structural assessment proofs NW–SE extension, and this event is in agreement with many similar but poorly dated observations in the eastern Srednogorie zone. This indicates that regional extension was of transtensive type at ca. 80 Ma in respect to the strike of the Srednogorie zone. Inversion of the Srednogorie basin comprises regional N-S shortening and a subsequent stage of NE-SW transpressive motion as abundant sets of conjugate strike-slip faults indicate.

Monitoring the thermal anomalies around Milos Island with satellite thermal data

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Although remote sensing is recognized as a powerful tool in the collection, analysis and modelling of environmental data, less attention has been given to the use of Thermal Infrared (TIR) remote sensing. Thermal property of a material is representative of upper several centimetres of the surface. As in thermal remote sensing we measure the emitted radiations, it proves to be complementary to other remote sensing data and even unique in helping to identify surface materials and features such as rock types, soil moisture, underwater springs, geothermal anomalies etc. During the last two decades a series of satellite and airborne sensors have been developed to collect TIR data from the earth surface, such as HCMM, Landsat TM/ETM+, AVHRR, MODIS, ASTER, and TIMS. In addition to Land Surface Temperature (LST) measurements, these TIR sensors may also be utilized to obtain emissivity data of different surfaces with varied resolutions and accuracies.

The islands of Nisyros, Yali, Kos, Santorini, Milos, Poros, Aegina and the peninsula of Methana constitute the Hellenic Volcanic Island Arc. This arc seems to be geodynamically very active since it comprises the largest volumes of volcanic materials and is at present a region of high tectonic activity. This activity is very often expressed with earthquakes, gas explosions and hydrothermal eruptions, volcanic eruptions, landslides, etc.

TIR data were used in order to detect undersea hydrothermal activities along the Hellenic Volcanic Island Arc. In this study there is an effort to monitor the thermal anomalies into the sea around Milos Island for the last 25 years using TIR data. More especially thermal data from the LANDSAT-TM the LANDSAT-ETM and ASTER sensors were used. The resolution of the thermal infrared bands ranges between 60 and 120 m. The sensitivity of these sensors is about 0.5°C in the region of 10.4-12.5µm (thermal infrared zone) of the Electromagnetic Spectrum. Thus the sensors can contribute to the detection of thermal anomalies (water outflows into the sea environment), which are useful to hydrothermal studies.

All the satellite data were orthorectified. Then using the appropriate algorithms the radiation was converted into Celsius Degrees in order to calculate the surface temperature of the area. Then in order to better distinguish thermal deviations the temperatures have been classified using the density slicing method. The results are presented in this study.

The morpho-tectonic structure of Kos-Nisyros-Tilos volcanic area based on onshore and offshore data

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The tectonic structure of the volcanic area among the islands of Kos, Nisyros and Tilos is analyzed using as topographic base a digital map covering both onshore and offshore areas. The classification of faults in major and secondary structures separating blocks with Alpine basement outcrops, post-Alpine sedimentary sequences, present-day marine basins and volcanic structures permitted the distinction of neotectonic units. Thus, several tectonic horsts are described with considerable relative uplift of 1-2 km manifested by the outcrops of Alpine basement rocks at high altitudes (Dikeos, Kefalos, Kondellioussa, Tilos). Several tectonic grabens are distinguished by the subsidence of neotectonic blocks at about 600 m depth and the deposition of several hundreds of meters of Quaternary sediments (the basins of Eastern Kos, Western Kos, Western Nisyros, Southern Nisyros and Northern Tilos). Some intermediate transitional tectonic blocks show step-like structures with tilted post-Alpine strata in between the tectonic horsts and grabens (Antimachia plateau, Zipari and Kos – Knidos channel). The Quaternary volcanic structures occur at the central subsided area of the regional tectonic graben between Kos and Tilos forming a positive volcanic relief of more than 1.4 km around Nisyros. The maximum tectonic throw observed between the neotectonic blocks of the area is about 2.5 – 3.0 km based on the displacement of the top of the Alpine rocks.

Detailed chronological and high resolution grain size, geochemical and palaeomagnetic study of the Sutto loess-palaeosol sequence, Hungary

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The loess-palaeosol record in Sutto, Hungary provides an excellent high-resolution archive for palaeoenvironmental changes of the Carpathian Basin. Loess deposits up to 20 m thick cover the Sutto travertine complex, located next to the right bank of the Danube River. The loess is intercalated by two greyish stratified horizons, three brownish steppe-like soils and a pedocomplex, including a reddish-brown palaeosol covered by a chernozem-like palaeosol.

Detailed infrared stimulated luminescence (IRSL) dating was carried out, revealing more or less continuous sedimentation from MIS 6 to MIS 2. Independent age control is provided by radiocarbon dating for the upper part of the profile, by amino acid racemisation (AAR) from the main loess units and by uranium-series (²³⁰Th/²³⁴U) ages correlating the travertine with MIS 7-8 from below the loess.

In order to reconstruct the palaeoclimatic and environmental changes during the penultimate and last glacial cycles, high resolution grain size, malacological, geochemical (bulk carbonate stable isotope composition and n-alkanes) as well as palaeomagnetic analyses have been performed, which provides a high-resolution record of the Sutto loess-palaeosol sequence.

Non-equilibrated and cryptic metasomatized lithospheric mantle beneath Balaton, Pannonian Basin

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Pliocene alkali basalt from the western Pannonian Basin carry mantle xenoliths comprising hydrous and anhydrous spinel peridotites, orthopyroxenites, clinopyroxenites and websterites. We studied 25 anhydrous spinel-peridotites from Szentbékálla, Balaton, in detail, using XRF, EPMA and LA-ICP-MS techniques.

Three major types of textures are widespread in the investigated xenoliths: fine-grained equigranular, coarse-grained protogranular and transitional between equigranular and protogranular textures.

The whole rock Al₂O₃ and CaO concentrations vary from 0.75 to 4.1 and from 0.9 to 3.6 wt% respectively, indicating that the mantle lithosphere in the area experienced variable degrees of partial melting. The degree of partial melting, according to our calculations using the batch melting model, range from 1 to 25 %. Microprobe mineral analyses confirm this trend and provide evidence for equilibrium conditions in the spinel-peridotite field. Thus the Al₂O₃ content of clinopyroxene under equilibrium conditions in coexisting orthopyroxene-clinopyroxene pairs is systematically higher than in orthopyroxene. However, in a number of xenoliths, coexisting orthopyroxene-clinopyroxene have similar Al₂O₃ compositions or orthopyroxene has even higher Al₂O₃ contents than clinopyroxene, indicating that no equilibrium has been achieved between those two phases.

The clinopyroxene trace element compositions of the non-equilibrated samples show strong evidence for metasomatic enrichments. They are strongly enriched in Th, U and LREE and have strong to moderate depletions of Nb, Ta, Zr and Hf concentrations. Their low Ti/Nb (100-200) and their high Zr/Hf (40-60) ratios suggest a carbonatitic nature of the metasomatic agent.

Another group of spinel-peridotites has clinopyroxenes with convex-upward REE patterns that strongly resemble REE patterns of clinopyroxenes from the garnet peridotite field. Orthopyroxenes, without clinopyroxene exsolution lamelle, from this group have unusually high CaO contents, ranging from 1.1 to 1.5 wt% and provide additional similarities to the minerals equilibrated to the garnet peridotite field. While the calculated equilibrium temperatures for all analyzed samples range from 950 to 1100° C, this group yield higher temperatures, varying between 1210 and 1250° C. In addition, the whole rock cr# (Cr/Cr+Al) is higher than 0.2 (it ranges from 0.25 to 0.35) implying that the stability field of the spinel-peridotite will be increased towards higher pressures at the spinel-garnet peridotite transition field. Considering that the lithospheric mantle beneath the Pannonian Basin is the thinnest in Europe and the fact that beneath Balaton, the studied area, the lithosphere has a thickness of around 80 km, this group of xenoliths appears to represent the lithosphere-asthenosphere border.

Clinopyroxenes are the main repositories for trace elements in the spinel-peridotite field and their primitive mantle normalized REE abundances in the non-metasomatized samples should have patterns that are similar and parallel to each other. However, in almost all studied xenoliths we observed a change in the shape of the whole-rock LREE patterns, which suggests an introduction of metasomatic agent(s) that have not affected the constituent minerals and exist as intergranular thin films of fluids/melts. The introduction of such fluids/melts should be related to the host basalts that entrained the xenoliths.

The studied xenoliths do not provide evidence for subduction related metasomatism. Besides the spinel-peridotites that show evidence for carbonatitic metasomatism, an enrichment of LILE has not been observed. As the degree of the Zr and Hf depletions in the clinopyroxenes are consistent with the degree of partial melting that these rocks have experienced any interaction with silica-rich melts could be excluded.

Holocene palaeoenvironmental changes in the Romanian Black Sea shelf

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During Late Holocene times, the Black Sea experienced a shift from a brackish to a marine environment. The purpose of our investigations was to point out these changes, based on lithological and sedimentological modifications, as well as palaeobiological fluctuations, in a very shallow marine setting such as the Romanian Black Sea inner shelf. The study of several cores indicates that the youngest Holocene deposits formed a 'Shallow Unit', made by alternating sequences of mud, silt, clay and coquina layers, containing marine mollusc faunas. The Shallow Unit overlies a 'shell hash layer', mainly made by coquinas with mixing marine and brackish mollusc faunas. The oldest Holocene unit Lacustrine Lutite intercepted by the studied cores is characterized by the deposition of green-yellowish clay, containing freshwater molluscs.

The semiquantitative calcareous nannoplankton analysis of the Holocene deposits led to the identification of several ecozones (youngest first): (i) Ecozone 1, which is dominated by *Emiliana huxleyi* that yielded blooms of over 1400 specimens/mm², and covers the upper part of the Shallow Unit; *Braarudosphaera bigelowii* is present with a very low frequency or even absent; (ii) Ecozone 2, which is also dominated by *E. huxleyi*, that continuously decreases with the depth, from around 1,000 specimens/mm² down to less than 100 specimens/mm²; *B. bigelowii* continuously increased from younger to older intervals of this ecozone, always yielding a negative correlation with *E. huxleyi*; this ecozone extends within the lower part of the Shallow Unit; (iii) Ecozone 3, which is characterized by *B. bigelowii* monospecific assemblages; *E. huxleyi* is absent; this ecozone covers the base of the Shallow Unit and the upper part of the 'shell hash layer'; (iv) Ecozone 4 that does not contain any nannofloras *in situ* or reworked; it was observed in the lower part of the 'shell hash layer' and in the Lacustrine Lutite. These fluctuations could be indicative of a progressive increase in salinity during the deposition of the Shallow Unit, from a brackish setting to a marine one. The upper part of the Shallow Unit was deposited under more stable marine conditions, with salinity close to the modern times. The ostracod and foraminiferal communities follow the fluctuation pattern of the calcareous nannoplankton assemblages, indicating that a marine environment settled, in the Romanian Black Sea inner shelf, only in the latest Holocene. Notably, close to the coastline, in front of the Danube Mouth and Razelm-Sinoe lagoon system, no nannofloras *in situ* were observed in the cored sediments. This fact indicates that the salinity was, probably, extremely low in these areas during Holocene times, as consequence of the regional palaeogeographical setting.

High acidic sulphate salt production on the Cave Wall in the Yoshimi Hyaku-Ana Historic Site, Central Japan

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Acidic sulfates such as aluminum sulfates and ferric sulfates are often observed on the wall of tuff or volcanic rocks in Japan. We investigated wall surfaces of an artificial cave dug from 1941 to 1945 in the Miocene tuff. The cave locates in the historic site of Yoshimi

Hyaku-Ana which is ancient graves of 6-7 centuries. The cave was suffering from severe salt efflorescence and deterioration of its cause. Salts are much in dry winter but less in humid summer. We set up twelve investigation points for monthly monitoring of temperature and humidity. Fallen salts and debris at each point were also collected monthly from November 2008 to December 2009. Main salt minerals, detected by XRD, are hard and granularly effloresced alunogen ($\text{Al}_2(\text{SO}_4)_3 \cdot 17\text{H}_2\text{O}$) on the walls near the entrances, and gypsum was found on the inside walls in the humid summer. On the contrary, powdery effloresced halotrichite ($\text{FeAl}_2(\text{SO}_4)_4 \cdot 22\text{H}_2\text{O}$), sodialum ($\text{NaAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$) and epsomite ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$) were detected in the dry winter. Jarosite ($\text{KFe}_3(\text{SO}_4)_4 \cdot (\text{OH})_8$) minerals were observed on iron hydroxide stains on the walls in every season. Halotrichite, sodialum and epsomite damaged the walls most severely especially in the dry winter. The amount of salts and debris from the inner wall were greater than those from near entrances.

New data on the position of so called „klippes” in succession of the marginal units of the Outer Carpathians

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The large olistoliths of the Upper Jurassic rocks (the “klippes”) occur at the northern and the southern margin of the Outer Carpathians. Controversies concerned not only origin of “the klippes” but also the age and sedimentary character of the surrounding rocks. Earlier interpretations of position of the northern “klippes” located them within folded and tectonised Cretaceous-Paleogene sediments of migrating Carpathian accretionary wedge. Our investigations lead to amendment of the view. The research was carried on the following marginal units along the Outer Carpathians: the Ždanice unit (Czech Republic: Mikulov, Klentince, Štramberk), the Skole unit (Poland: Inwałd, Roczyny, Targaniczanka, Kruhel), the Boryslav-Pokuttya unit (Ukraine: Utoropy, Akroshory), the Marginal Folds unit (Romania, Slon, Draina). The results of research are as follows:

1. In the region of Mikulov (Czech Republic) the Upper Tithonian “klippes” are embedded in the Lower Miocene Ždanice-Houstopeče Formation. 2- The Upper Jurassic “klippes” that occur in the marginal part of the Skole unit in Poland, on the base of the foraminifera and the calcareous nannoplankton, are surrounded by the Lower Miocene sediments. Different is, however, the origin of “the klippes”. In the western part of the Skole unit “the klippes” represent the marginal part of the European Plate, while in the eastern part the Kruhel “klippes” derived from the Bilche-Volytsa zone of the Ukrainian part of the Foredeep. 3- Samples of matrix collected from the gravelstone containing a Štramberk-type (peri-reefal, Tithonian-Berriasian) limestones at Utoropy and Akreshory (Ukraine) revealed the presence of the Early Miocene foraminifera and calcareous nannoplankton. Sediments surrounding the Ukrainian “klippes” at Utoropy are the same as in case of the Kruhel “klippes” and represent the Lower Miocene Vorotyshcha Formation. 4 – Romanian samples collected from the Slon olistostrome (Slon and gypsum formations) confirmed the Early Miocene age of sediments. Peri-reefal limestone olistoliths from the Slon locality are of the Late Tithonian-Berriasian age.

The above presented results of studies suggests that, at least northern “klippes” (predominantly of the Tithonian-Berriasian age) are embedded in sediments that have character of chaotic complexes and are of the Early Miocene age.

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Tectonics of the Klippen Belt and Magura Nappe in the eastern part of the Pieniny Mts. (western Carpathians, Poland and Slovakia) – new approaches and results

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The Pieniny Klippen Belt (PKB) is a suture zone, which separates the Central Carpathians from the Outer Carpathians. The PKB successions are built up of the Lower/Middle Jurassic to Upper Cretaceous, dominantly pelagic and flysch deposits. The traditional multi-stage tectonic model of the PKB assumes that during the Palaeocene, retro-thrusting followed by subsidence and deposition of the “Magura Autochthonous Palaeogene” took place. Recently, we have studied the structural relationship of these deposits in the PKB, and we came to the conclusion that they belong to two formations with different tectonic positions. The Kremná Formation (?Oligocene – Lower Burdigalian) belongs to the Magura succession and appears in a tectonic window, beneath the Grajcarek thrust-sheet and the Czorsztyn (Sub-Pieniny) Nappe, while position of the Złatne Beds, which occur inside the Pieniny Nappe, is not clear. In the Slovak part the calcareous flysch sediments of the Jarmuta-Proč Formation described earlier as a “klippen mantle” form the youngest sedimentary member of the lowermost tectonic unit of the PKB, named here as the Fakľovka Unit. These youngest deposits are involved in tectonics of the PKB and document that final folding and thrusting of the PKB took place in the late Early Miocene (after Eggenburgian), corresponding to folding and thrusting of the Magura Nappe.

Calcareous nannoplankton biostratigraphy of the terminal sediments of the Magura basin – a case study of the polish sector (outer western Carpathians)

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The Oligocene to Early Miocene closing of the northern sector of the Outer Carpathian sedimentary area is manifested by deposition of the Krosno synorogenic lithofacies in the Grybów-Dukla-Silesian/Sub-Silesian/Skole and Boryslav-Pokuttya basin system. The analogous Malcov synorogenic lithofacies is typical for the Pieniny Klippen Belt and Magura Basin. These lithofacies comprise the fining and thinning upwards sequences. Towards the top, the sedimentary sequences are dominated by marly pelites. In the Pieniny Klippen Belt, as well as in the Krynica and Rača zones of the Magura Basin, the deposition of the Malcov lithofacies was initiated during the NP24 and persisted to NP25 Zone. In the northern part of the Magura Basin (Siary Zone) the youngest deposits (so called Supra-Magura beds) belong to the NP24 Zone. The most important species to determine the NP24 zone in the region is *Cyclicargolithus abisectus*, and for NP25 – *Sphenolithus conicus*. During the Late Oligocene (NP25/NN1) the frontal part of Magura Nappe were thrust northwards onto the terminal Krosno flysch basin. The clastic material derived from eroded front of the Magura Nappe has been found in the Krosno shaly facies of the Silesian Basin. The northwards thrusting of the Magura Nappe was also accompanied by formation of the piggy-back basin on the Magura Nappe, filled with synorogenic turbidites of the Zawada and Kremná formations – NN1 and NN2 zones. These nannofossil associations are characterised by the presence of *Sphenolithus*

delphix (NN1) and *Sphenolithus disbelemnus* (NN2) while the species of *Dictyococcites bisectus* is absent. At the same time the level of reworked species is high.

Stratigraphy and Larger Foraminifera of the Eocene Shallow-Marine and Olistostromal Units of the Southern part of Thrace Basin, NW Turkey

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The Eocene marine sequence in the southern part of the Thrace Basin (NW Turkey) involves a variety of platform and deep-marine olistostromal units, the stratigraphies of which have been highly debated in the past. A detailed analysis of larger foraminifera in these either foraminifera or foraminifera-coral-coraline algae-dominated platform and associated comparatively deeper-marine units permits us to establish a high-resolution biostratigraphy in the context of shallow benthic zonation (with SBZ Zones) of Tethyan Paleogene. The oldest Zone (SBZ 5 corresponding to the basal Ypresian) was observed only in olistoliths. An old erosional remnant of a transgressive shallow marine to basinal sequence (Dişbudak sequence; late Ypresian-? middle Eocene) was recognised below the the regionally most widespread carbonate platform unit, Soğucak Formation. The Dişbudak sequence, previously considered to belong to the Soğucak Formation and formally introduced recently, contains the foraminifera, such as orthophragmines, nummulitids and alveolinids in its shallow-marine package referred to SBZ 10 (late Ypresian). The Soğucak Formation, which oftenly exhibits patchy reef developments, contains a rich and diverse assemblages of orthophragmines (*Discocyclina*, *Orbitoclypeus* and *Asterocyclina*), nummulitids (reticulate and other *Nummulites*, *Assilina*, *Operculina*, *Heterostegina* and *Spiroclypeus*), and other benthic taxa (*Silvestriella*, *Pellatispira*, *Chapmanina*, *Orbitolina*, *Linderina*, *Gyroidinella*, *Fabiania*, *Halkyardia*, *Eoannularia*, *Sphaerogypsina*, *Asterigerina*, *Planorbulina* and *Peneroplis*). Their assemblages, referred to SBZ 15/16, 17, 18, 19 and 20 Zones, provide a precise tool for recording the history for marine events having resulted in the deposition of Soğucak Formation during mainly four periods. The spatial distribution of them, recorded as Late Lutetian, Early Bartonian, Late Bartonian and Priabonian, within the present paleogeography, suggest a marine inundation from W-SW to E-NE. The Çengelli flysch sequence overlying the Soğucak Formation in a limited area to the east of Gelibolu peninsula, contains the benthic foraminifera mainly in the limestone olistoliths, mostly derived from the Soğucak Formation, and also in the turbiditic levels. The assemblages in the olistoliths reveal the existence of various shallow-marine limestone sequences ranging in age between (late) Bartonian and early Priabonian.

An Investigation of Biogeochemical Anomalies for Li and Sr in the Kırka (Eskişehir -Turkey) Borate Mining Area

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Biogeochemistry was founded by V.I. Vernadsky in the 1926. But a few journals were able to report all of the important developments in biogeochemistry in the 1950's. Recently,

biogeochemical prospecting methods are successfully used for detection of the new mineral deposits in the underlying substrate. This method involves the chemical analysis of some plants and determination of indicator plants for some elements. The aim of this study is to determine plant-soil relationships for the native plant species that grow directly on the Kırka (Eskişehir-Turkey) borate mining area. The information obtained from this study could be used to establish guidelines in order to determine of indicator plant species for Li and Sr. *Genista aucheri* Boiss, *Euphorbia hirsuta* L., *Juniperus oxicedrus* L. subsp. and *Pinus nigra* Arn. plant samples and soil samples of them were collected in and around the Kırka (Eskişehir-Turkey) borate mining area, at 46 stations. Plant and soil samples were analysed for Sr, Li, Cu, Zn, Mn, Co and Ni, with the flame atomic absorption spectrophotometer (FAAS). In the same way the B concentrations in plants and soil samples were measured the absorbance at 420 nm by spectrophotometer. The Li and Sr contents of plant and soil samples were determined. Then, biogeochemical anomalies of them were investigated. Element contents of the plant samples were compared with the element level of the soil samples, and then indicator plants were founded. Statistical relations were established between Li, Sr values of soil samples and plant species (twigs of *G. aucheri* (n=18, r=0.6214), *J. oxicedrus* (n=24 r=0.7267 and leaves of *J. oxicedrus* (n=20, r=0.8293), *P. nigra* (n=19, r=0.6655) for Li, twigs of *P. nigra* (n=16, r=0.8567) and leaves of *J. oxicedrus* (n=16, r=0.6824), *E. hirsuta* (n=14, r=0.7511) for Sr. Furthermore, correlation analyses were made for determining the inter-elemental relationships between soil (for B, Sr, Li, Cu, Zn, Mn, Co and Ni) and indicator plants. Therefore *G. aucheri* *E. hirsuta*, *J. oxicedrus* and *P. nigra* are good indicators of the Li and Sr concentrations in the soil and these species could be successfully used in biogeochemical prospecting, patfinder plants for borat mining and environmental monitoring.

Geological features of Kışla dome structure in South of Isparta and its tectonic evolution, SW Turkey

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Geographic structure named as Isparta Angle in SW Turkey is generated by the folding of carbonate axis in terms of opposite “v” forming Western Taurides in the northern part of the Antalya Gulf. The Mesozoic rocks in the western part of the Isparta Angle form the Beydağları Platform. Besides, the Akseki-Anamas Carbonate Platform forms the eastern side of the Isparta Angle. The rocks in the southern part of the Isparta Angle and in environment of Antalya are composed of allochthonous ophiolitic components and can be considered as Antalya Nappe. On the other side, the allochthonous rocks as Lycian Nappes with ophiolitic components overlie the western part of the Isparta Angle. Moreover, the allochthonous rocks known as Beyşehir-Hoyran and Bozkır Nappes overthrust the eastern part of the Isparta Angle and form the most important nappe system in the area.

Satellite imageries of the area located 20 km south of Isparta indicate a circular dome structure around Kışla. This dome structure has been generated within the Isparta Çayı Formation and the overlying marine clastic series in Antalya Nappes. The radius of this circular dome structure reaches up to 10 km approximately. Two and three dimensional satellite imageries of the study area, the map of tectonic lineaments and the map of surface temperatures prepared using thermal band of satellite imageries (Landsat ETM+) support the existence of a dome structure in the study area.

The rocks in the investigated area can be divided into two groups within a geological map of scale in 1:25000: (i) autochthonous-parautochthonous and (ii) allochthonous rocks. The autochthonous-parautochthonous rocks in the area consist of Davraz Formation (Early-Late Jurassic carbonate rocks), Beydağları Formation (Early-Late Cretaceous carbonate rocks), Yazır Limestone (Aquitania reef limestone) and Ağlasun Formation (Burdigalian flysch). The allochthonous rocks in the region are composed of rock components forming

Antalya and Yavuz nappes. Antalya Nappes are represented by Isparta Çay Formation (Early-Middle Triassic stratified chert and plaquette limestone) and rocks in ophiolite melange. In the region, the rock units in Antalya Nappes overlie the carbonate rocks of Beydağları Formation in the southern part of the investigated area tectonically. Besides, the Eocene turbidites known as Yavuz Nappes, form the other important allochthonous unit in the region. The Eocene units belonging to Yavuz Nappes and overlie the Miocene (Aquitanian to Burdigalian) units tectonically.

On the other side, the dikes and subvolcanic domes of trachytic ($5,45 \pm 0,21 - 5,77 \pm 0,22$ Ma) and lamproitic ($6,75 \pm 0,25$) composition are located in various points of the study area. These volcanic formations are located in Antalya-Isparta volcanic belt of N-S strike mostly. By a tectonical interpretation of the investigated area, the area was affected by two various compressional tectonic forces, namely N-S and E-W. The time interval from Late Cretaceous to Early Pliocene contains compressional tectonic features in N-S direction dominantly. After Early Pliocene time, the area was affected by compressional tectonic features in E-W direction. These compressional tectonic features affecting the study area and developing after each other and in various directions are the tectonical reasons which led to the formation of the Kışla Dome. On the other side, subvolcanic dikes and domes in the Kışla Dome area reflect a magmatic activity in the same age with the Kışla Dome which is supported by age determinations of volcanic rocks and their equivalent plutonic rocks such as syenite xenolithes (trachyte: $5,77 \pm 0,22$ Ma and 24.000 ± 2.000 a; Syenite: $4,92 \pm 0,9$ Ma).

Radiolarian biostratigraphic dating on Middle Triassic basalts in western part of Neotethyan oceanic basins

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Early rifting-related submarine volcanics and related deep-sea sedimentary units, including radiolarites of the Western Tethyan orogenic belt, provide important clues to the geodynamic evolution of the Mesozoic Neotethys. Stratigraphic dating of these rocks is especially difficult due to the absence of stratigraphically useful macrofauna. However, radiolarian micropaleontologic investigation has proven that this group is particularly useful for biostratigraphic dating in such sequences where the deep-sea sedimentary units (i. e. radiolarian cherts, cherty limestones, etc.) are connected with volcanics. Radiolarian-rich sedimentary units are widespread in Neotethyan units ranging in age from Triassic to Cretaceous and geographically from the Iberian to southern Tibet and western Thailand despite the restricted outcrops and limited available biostratigraphical evidence of radiolarites associated with volcanic rocks in Neotethyan oceanic basins. The aim of this study is to present new radiolarian biostratigraphical data from several localities in the northern Pindos and Othrys Mountains, Greece, where radiolarites directly overlie basalts, and from several localities from Bükk-Darnó area in NE Hungary. The radiolarian biostratigraphic dating suggests that the westward propagating Neotethyan rifting started earlier in the Hellenic domain than in the Circum-Pannonian region. In the former area pelagic sedimentation began in the Late Scythian and oceanic crust was already formed in the Late Scythian?–Anisian time, whereas in the latter region (which was located in the northwest end of the later Neotethys Ocean) pelagic sedimentation began only in the Middle–Late Anisian, but formation of new oceanic crust is not documented before the Ladinian.

Archaeological topographical survey and marine geophysical investigation at ancient and medieval harbour of Kyllini/Glarentza (NW Peloponnese, Greece)

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The present study presents the preliminary results of the interdisciplinary topographical, underwater archaeological and marine geophysical survey conducted in NW Peloponnese, Greece, in order to shed light on the ancient harbour site and Crusader's port of Kyllini/Glarentza. Built by the Franks in the 13th century, it developed as one of the major ports during the Crusaders' period in NW Greece. The medieval harbour installations were built on the ancient port of Kyllini of the Classical period. It was an important naval base and harbour serving the sanctuary of Olympia.

The Kyllene Harbour Project is a joint project of the Finnish Archaeological Institute at Athens and the Department of Underwater Antiquities (Ministry of Culture). It is conducted in collaboration with the Department of History, Archaeology and Cultural Resources Management, University of the Peloponnese, and the Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras.

The remains of harbour installations of the medieval port are very extensive, including an inner and an outer harbour, demonstrating that the flourishing Crusaders' port consisted of different sections. One of the principal purposes of the interdisciplinary study is a detailed survey of the submerged remains in order to comprehend the layout of the harbour and to reconstruct the coastline for the different construction phases of the port (Classical and Medieval).

The coastal area under study is located at the northern end of the promontory of the Chlemoutsi headland, at the northwestern coast of the Peloponnese. Geologically, the area is a segment of a large coastal sandy plain with barrier lagoons, the Elis coastal plain, extending along the western coast of the Peloponnese. The coastal formations consist of Holocene alluvial deposits made up of colluvium, fluvio-torrential sediments, coastal dunes and beach material. At present, the shoreline of the Elis coastal plain is controlled by transgression and erosion, but in the past the coastal evolution had been controlled by the eustatic sea-level signal, local tectonic instability and diapirism.

The archaeological survey concentrated on the precise 3D topographical investigation using total stations to measure details of the harbour remains and shallow-water features. The marine geophysical study has, so far, employed a 3.5 kHz sub-bottom profiler system in order to examine the seafloor bathymetry and the recent sub-bottom stratigraphy of the coastal area. A side-scan sonar system was employed in order to examine the seafloor surface composition and the existence of potential targets on the seafloor. Furthermore, an Overhauser magnetometer survey was conducted in order to investigate the magnetic signature of the seafloor, especially in the area where the harbour remains are concentrated.

In the field campaigns of 2007-2009, the marine geophysical instrumentation carried out a dense grid of parallel and vertical lines to the shoreline, whilst the topographic survey of the underwater remains recorded more than 30 000 points which give detailed picture of the archaeological remains and their current setting. The water depths recorded by the echosounder and the shallow-water topographical survey were combined to present the total bathymetry of the area. All the collected data were georeferenced and displayed in a G.I.S. environment.

The synthesis of the collected data revealed the aerial distribution of the submerged harbour remains and the seafloor morphology related to the different ancient port

installations. Furthermore, it revealed targets of potential archaeological interest. Finally, the study demonstrated that the use of remote sensing techniques in conjunction with detailed archaeological and topographical survey in shallow-water coastal sites could be an effective methodological approach for the study of submerged ancient ports and coastal installations in the eastern Mediterranean.

Regional conceptual model of Upper Pliocene - Pleistocene aquifer formations from Dacian Basin in southern part of Romania

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The conceptual models of main aquifer structures from Southern Romania were carried out by spatial bounding of porous media, recharge and discharge area contouring, ground water flow description and by taking in consideration geomorphologic, climatologic and hydrologic factors.

The conceptual model represents the base of groundwater flow numerical simulation. Accurate groundwater flow conditions assessment underlies by clarifying the models such as geomorphological, climatological, hydrological, geophysical, geological and structural – tectonic, hydro-geological, hydro-geochemical, etc.

In accordance with spatial bounding, three major aquifer structures have been set out. The first one with largest extension from Dacian Basin corresponds of Dacian granular deposits. The second aquifer structure occurs in Lower Romanian permeable deposits and Upper Romanian - Lower Pleistocene aquifer formation is in the upper part of Neogene sequence. The porous formations from Dacian and Romanian are at shallow depths on the border regions of Dacian Basin. The aquifer formation of Lower Pleistocene with small depths has large extension, so that is of great interest for drinking water.

Vastly, the aquifer structures follow the Dacic Basin tectonic profile. In the Getic Depression, Carpathian Foredeep and in the connection zone between cratonic areas of the Moesian Platform with depression zone, both the depths and thickness of permeable deposits substantially increase. On these lines, in the eastern part from Olt River, in the Getic Depression area, the permeable deposits of Dacian and Romanian are deeper than 1500 – 1700 m, respectively 800 – 1400 m. In these conditions, the groundwater mineralization is very high.

The conceptual models development involve aquifer structures, spatial bounding and also identification of recharges and discharge area. The recharge zones cover large surfaces in the northern part of Dacic Basin. The natural groundwater discharge by line of springs, in surface waters, or other aquifer transfer zone exists in the southern part of the Moesian Platform. In the aquifer deposit outcrops, the recharge is by direct percolation of rain water, water losses from surface water network, shallow aquifers, etc. The recharge elevations have large variation from 70 - 80 m in plain area up to 800 - 850 m in northern regions. An important quantity of water recharge from granular deposits of the Lower Pleistocene formation provides by leakage of water from Dambovita - Arges, Prahova - Teleajen, Buzau and Putna alluvial cones.

In case of mathematical simulation of groundwater flow and groundwater resources assessment, of great importance is to understand all the factors which influence the groundwater movement. For quantitative assessment of groundwater resources on the regional scale, from a multitude of factors only some elements have representation. By consequence, excepted recharge and discharge elevations, rainfall, evapotranspiration, surface and underground water flow, the great importance have porous knowledge, aquifers storage, conductivities, leakage factors and parameters distribution.

Triassic rift-type basalts and related deep-water sediments in the western ophiolite belt of the Hellenides–Dinarides (from Othrys Mts., Greece to Darnó Hill, NE Hungary)

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The lecture provides characteristic phenomena, selected among others, which gives a way to recognition of the extension, intensity, and time span of the advanced rifting, one of the longest time periods in the Alpine Wilson cycle.

Triassic rift-related magmatism was dominantly intermediate in character. It produced basalts, andesites and dacite at the extrusive level, and gabbro, diorite, granosyenite and granite in the intrusive levels and lasted at least 40 to 50 Myrs. It is spatially and genetically related to the volcano-sedimentary formation as the foundation of the Gondwana passive continental margin and later on totally covered by the Mesozoic carbonate platform sediments. The spatial extension can be traced along the whole Alpine-Himalayan orogenic belt. Its equivalents in time, on the Euroasian diverging margin, are not easily recognized. They were subjected to long-term destructive, subduction related processes, during convergence, since the Jurassic to the Early Cretaceous. The intensity of the magmatism ceased with the opening of the Tethys, and accompanied ophiolite formation, a result of sea-floor spreading. Study of Triassic magmatism and its products, including ore deposits, is a key to palinspastic interpretation and geological evolution of the Tethys.

Triassic rift-type basalts associated with deep-water sediments of usually red colour are common constituents in the melanges of the western ophiolite zone of the Hellenides–Dinarides, extending from Othrys Mts. and Northern Pindos Mts. (Northern Greece) to the Medvednica and Kalnik Mts. (NW Croatia), then displaced along the Mid-Hungarian Zone up to the Darnó Hill and western Bükk Mts. (NE Hungary). They form meter to kilometer-sized blocks in the mélanges. Pillow basalts are reddish or greenish in colour, usually amygdaloidal, with a characteristic “peperite facies”, in which basalts are mixed with red, normally limy sediments. They are geochemically of various types: WP, MOR or even IA. Associated sediments are red Hallstatt-type limestones, red radiolarites and red Bódvalenke-type cherty limestones representing transitional facies between them. Biostratigraphic data (conodonts, radiolarians) show Late Anisian to Lower-Middle Norian age of this volcanism, but in the Northern Pindos Mts. even Late Scythian data were found. These blocks occur in a

Jurassic-Cretaceous accretionary mélangé zone and bear witness of the advanced rifting in the NW-part of Neotethys.

The complex lithostratigraphy of the Triassic formations, including sediments and magmatic rocks, supports existence of advanced rifting processes, at the former passive continental margin of Gondwana, but deny creation of the oceanic crust in the Lower and Middle Triassic time, in the Neotethyan evolution.

Triassic pillow lavas on the head of the obduction front of the Zlatibor Mt. ophiolite, SW Serbia

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The Tethyan evolution in Dinarides includes rifting, sea-floor spreading, ophiolite genesis and emplacement, mélangé accretion, ocean basin closure and collision. Advanced rifting of Adria (Gondwana) in Triassic time opened a deep rift basin but still not floored by oceanic crust. The basin was intensively filled up by volcano-sedimentary successions; deep water carbonates, clastics, cherts, and extensive basaltic magmatism, with spilites and keratophyres, preferentially as lava flows and pillow lavas. The intra-oceanic subduction and consequent obduction of the two colliding oceanic crusts, after reversal from extension to compression regime, created bulldozing effect on the head of the obducting ophiolite front. The incorporated deep-water formations, underwent different degree of metamorphism and turned into the diabase-chert formation. This feature along the obduction ophiolite front from the Zagorje-Mid-Transdanubian megaunit, to Dinarides, Albanides and Helenides, and up to the Zagros ophiolites, with due delay in time, is a common large-scale phenomenon. Recognition of peperite facies within pillow lava complexes, with its paleontological records in the sedimentary part, gives an efficient tool for distinction of the sea-floor pillow lavas (ophiolites) from those rift-originated, which usually stacked together in the mélangé.

The abstract deals with peperite in pillow lavas sampled at the Bistrica locality, on the road Prijepolje-Priboj, near to the dam where Bistrica rivulet flows into the Lim river, at the southern slopes of Zlatibor Mt. At the locality, the diabase-chert formation consists of sliding and gravity mass flows of unconsolidated, chaotically distributed rocks, m-sized blocks of sandstones, siltstones, claystones, m-km sized olistolith/olistoplates of Jurassic and Triassic limestones. Magmatic rocks are represented by diabases and spilites (olistoliths, flows, "pillow" lavas etc.), gabbros, ultramafics (harzburgites, serpentinites). The ultramafics of Zlatibor Mt. lie over Ophiolite mélangé. North of Bistrica rivulet, at confluence into the Lim River, the terrain is built of ultramafics, lherzolite, amphibolites, epidot-amphibolites, eclogites, gabbro-amphibolites and metamorphosed diabases, shists, metasandstones, etc. On the road between Bistrica and Pribojska Banja, the mélangé contains massive amphibolites and amphibolite schists with corundum and garnet. The amphibolites are a product of Jurassic subduction and exhumation during the collision and tectonic emplacement. The pile of pillow lavas stacked together with ultramafics and amphibolites, has been interpreted as a dismembered ophiolitic unit. It consists of m-sized lobes, closely spaced pillows, with accommodation emplacement and younging upward. The chilled, dark green, chloritized rims separate the green, gray and reddish, densely spaced lobes. The peperites, made of pink micritic limestone within highly contorted lobes, contain small but diagnostic conodont fauna: *Paragondolella tadpole* (Hayashi), CAI, medium light gray, 61/2, Triassic in age from the Cordevolian to the Lower Tuvalian. The peperite facies, within a huge pile of pillow lavas corroborates rifting magmatic activity in Triassic time, and supports obduction of oceanic crust on the elements of the passive continental margin, including volcano-sedimentary formations with basalt extrusives.

Preliminary geochemical data of Variscan granitoids from Somes pre-Alpine terrane from W Romania (Apuseni Mts.)

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The Tisia Composite Terrane (TCT) is built up from Variscan high-grade metamorphic series and granitoids. The TCT forms the basement of South Hungary, NE Croatia, N Serbia and W Romania and it is surrounded by mobile zones and fault lines. The present study focuses on different, presumably Variscan granitoid occurrences in W Romania. Outcrops of these granitoid suits are located in the Apuseni Mts. (Romania). In order to obtain correlation studies between granitoid suits from the TCT, an extended field survey is being carried out in the Apuseni Mountains. The Apuseni Mountains consist of four Alpine tectonic units: the Bihor Unit, the Codru Nappe System, the Biharia Nappe System and the Mures zone. Its basement is built up from three pre-Alpine metamorphic Godwanan terranes: Somes, Biharia and Baia de Aries which contains Variscan granitoid intrusions. This paper presents preliminary geochemical data of granitoid occurrences in the Somes terrane: Siria granitoid (SG) (presumably the same age as CG), Codru granitoid (CG) (372 Ma), Codru migmatite (CM) (516 Ma), Muntele Mare granitoid (MMG) (both main pluton and satellite branches) (297-291 Ma). The composition of the suits is more or less heterogenic, many structural and compositional variations are represented within a group. The MMG suite contains: equigranular two-mica granitoids, biotite granitoids, K-feldspar megacryst bearing granitoids, leucogranites, leucogranites with gneissic texture. The CM suite is mostly metatexite, where both paleosome (~70%) and neosome are present (~30%). The SG and CG are two-mica granites either containing or lacking feldspar megacrysts. The studied samples have calc-alkaline and moderately peraluminous character, the only exceptions are framed by the CM which are calcic. Modal and geochemical classifications show granodiorite to monzogranite compositions for MMG, granitic (monzo- and syeno-) for CG and SG, and granodiorite to tonalite for CM. The MMG samples contain both K-feldspar (orthoclase and microcline) and plagioclase. MMG main pluton plagioclase content varies from albite to andesine being present in almost equal proportions. Samples from the MMG satellite are more abundant in albite and andesine while oligoclase is almost missing. K-feldspar is nearly absent from CM, and the plagioclase feldspars are mostly andesine and oligoclase. The mg# values in the MMG main rocks are ranging from 0.34 to 0.38 which is slightly lower than the Mg content in MMG satellites where mg# falls between 0.38-0.42. The mg# values for the CM biotites are between 0.37-0.42. The Al^{VI} content is relatively high for CM and MMG satellite samples, mean values are 2.81 for CM and 2.76 for MMG satellite. In the case of the main MMG pluton samples the Al^{VI} content is much lower, the mean value is 0.35. All values for bioties are calculated for 22 O. Petrogenetic and geotectonic interpretations were elaborated based on whole rock geochemical compositions (major and trace elements). The samples from MMG, CG and SG show a relatively small scatter, they plot to the syn-collision and post orogenic fields on the multicationic diagrams (R₁-R₂), while the CM samples are mantle fractionates.

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Climatic and environmental history of southwestern Balkans during the last glacial cycle; first results of Lake Prespa sediment core

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The Collaborative Research Center (CRC) 806: “Our Way to Europe; Culture-Environment Interaction and Human Mobility in the Late Quaternary” (www.sfb806.uni-koeln.de), focuses on the dispersal of Modern Man from Africa and his permanent establishment in Central Europe. In this framework, project cluster B deals with the eastern corridor of dispersal into Europe, namely the Near East, Anatolia and the Balkans. The integrated project B2 focuses on the Balkan region where *Homo sapiens sapiens* first arrived about 30-32 ka BP (uncalibrated) ago. Southwestern Balkans constitute an ideal setting for evaluating hypotheses concerning glacial vegetation refuges, paleoclimatic and human impact aspects.

The study area of project B2 consists of two transboundary lakes: Lake Prespa (AL/FYROM/GR) and Lake Dojran (FYROM/GR). Both lakes are relatively old - early Pliocene (5Ma) and late Miocene (8Ma), respectively, and are located in the main **three** refugial areas of important central European forest species during the last glacial. Building on the promising outcome of neighboring Lake Ohrid sediment record multi-proxy analysis, this project aims to reconstruct the environmental history of the region during the last glacial-interglacial cycle on a sub-millennial time scale. Hence, plant microfossil analysis and sedimentological and other micropalaeontological investigations in sediment sequences from these lakes will offer the opportunity to reconstruct even short time climate changes.

For this purpose, a long (15,75m) sediment record from Lake Prespa was recovered in 2009. The coring site was selected after the completion of shallow seismic surveys carried out between 2007 and 2009. The Prespa core was retrieved using a short gravity corer for undisturbed surface sediments and a 3m long piston corer (UWITEC Co.) and is already being investigated using geophysical, geochemical, ostracod, and pollen analysis. One of the core halves was used to measure magnetic susceptibility and then kept as archive for future analysis. The other half was sub-sampled with a 2-cm interval and then the samples were freeze-dried. In this first phase of the project, samples for pollen analysis were taken every 32 cm, processed with standard palynological methods and pollen, spores, and palynomorphs were determined under a light microscope at 400 x magnification and identified with keys and pollen atlases.

The 50 samples used for pollen analysis are characterized by relatively high pollen concentration throughout the entire 15.75 m-core. There are several tephra layers identified within the sequence, including the well-known Campanian/Ignimbrite Y5' layer which serves as precise dating markers. The Pleistocene sequence is dominated by open-steppe vegetation along with the presence of forest pollen taxa, which suggest relatively cold conditions. On the other hand, the Holocene sequence is characterized by the surge of *Quercus* and *Pinus* which indicates the transition to forest-dominated vegetation. Human impact can be traced by an increase in pollen of taxa such as *Plantago* sp., as well as the appearance of typical agricultural plants such as *Cerealia*, *Olea* and *Juglans*.

The genesis of the base-metal mineralization from Scind-Rachitele-Poiana Horea, Vladeasa Mountains, Romania

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Geological research carried out on the structural and lithostratigraphic relation between base-metal mineralization and medium-grade metamorphic rocks led to elucidation of their genesis. The massive and disseminated sulfide ores are localized in rhyolitic metaepiclastics and in overlying biotite-muscovite-micaschists of leptino-amphibolitic formation (SM₂) of Somes series (Upper Precambrian-Lower Cambrian), highly retrograded and crossed by laramide microgranites. The Somes metamorphites are developed as a horst between Vladeasa graben and Transilvania basin. Syngenetic, concordant, metamorphosed mineralization was formed by sulfide precipitation, fed by submarine hydrothermal activity. It is genetically associated to rhyolitic volcanism of island-arc stage evolution and belongs to metamorphosed hydrothermal volcano-sedimentary type. The following subtypes were identified taking into account the mineral assemblage and the lithostratigraphic and tectonic control:

1. syngenetic, stratiform, concordant, massive/disseminated Zn-Pb +/-Cu, Au, Ag ore, consisting of pyrite (25-30%), arsenopyrite (7-10%), sphalerite (3.8-4.6%), galena (0.6-3.7%) pyrrhotite (0.6%), chalcopyrite (0.4-0.8%), tetraedrite, siderite, quartz, sericite, situated in the upper part of quartz-feldspar schists, at the boundary with the biotite-muscovite-micaschists. In the Alunis valley there are 2 bends which unify on the strike. The boundary is sharp at the bottom and clear or gradual at the top, by euhedral arsenopyrite dissemination. On the strike, the massive ore passes to pyrite-arsenopyrite disseminated ore. The banded massive ore, sometimes brecciated at the bottom, consists of broken porphyroblasts of pyrite and arsenopyrite, sometimes of 0.3-0.9 mm in size, associated with quartz, "cemented" by soft sulfides, included in siderite. The sphalerite contains coherent and incoherent exsolutions of pyrrhotite and chalcopyrite. The gold is included in the crystal lattice of sulphides. Galena, with tetraedrite exsolutions, has high contents of Ag. The Au:Ag ratio is about 1:10.

2. syngenetic, lenticular of Fe (siderite, magnetite) and Cu-Au ores (pyrite, arsenopyrite, chalcopyrite, pyrrhotite, quartz, sericite), in quartzose sequences of biotite-muscovite micaschists, overlying the quartz-feldspar schists. In Negru brook area, there are 3 lenses of massive pyritic ore which unify into one in the depth. In Gingineasa area, there are 2 orebodies, one of siderite and magnetite assemblage, at the lower part of the sequence, and another one of banded massive sulfide, mainly pyrite, arsenopyrite and chalcopyrite, at the top. Both are localized in highly retrograded biotite-muscovite-micaschists, with interbedded amphibolite of ten meters in thickness, crossed by crenulation cleavage and transposed on a cross fault plane. In banded iron ore, the magnetite grains have a core of siderite and they were probably formed during increasing O₂/CO₂ ratio. On a fault plane which cut the banded sulfide lenses, secondary pyrrhotite was formed as nests by conversion of pyrite during tectonic deformation.

3. metamorphosed hydrothermal sulfide ore, hosted by cross faults, consisting of siderite, as large porphyroblasts, pyrite, arsenopyrite, pyrrhotite, chalcopyrite and quartz, developed nearby the syngenetic, stratiform massive ore, or cross cutting them.

4. hydrothermal sulfide ore, formed by remobilizations and recrystallizations during synmetamorphic deformations and Laramide tectonic phase of Alpine cycle, in shape of discordant veinlets of galena in iron ore; of arsenopyrite on "ac" fissures; of arsenopyrite, pyrite, chalcopyrite, siderite, and quartz (Agastau valley); as small lenses of arsenopyrite, pyrite and sphalerite (Cetatuia valley); as nests of steely galena, including large crystals of arsenopyrite (Alunis brook); as parallel vein, with the massive pyritic ore, consisting mainly of sphalerite and subordinate amount of pyrite, chalcopyrite, galena and fragments of iron ore and breccia column (Leurdis brook, mining works) made of sphalerite, pyrrhotite, galena, arsenopyrite, pyrite, siderite, quartz and fragments of micaschist, strongly affected by

chloritization. The breccia body was produced by a Laramide igneous body intrusion, highly affected by argillic alteration. The massive and disseminated sulfide ore has the same genesis as the sulphide ore deposits of the Tulghes Group, Eastern Carpathians.

Late Holocene vegetation history and human impact in Beles (Belasitza) mountain

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The palynological information from three peat-bogs in Beles (Belasitza) mountain located on the Greek-Bulgarian border allowed the reconstruction of the vegetation history and human impact during the late Holocene. One of the two peat-bogs, situated on the northern slope, has started its development ca. 2200-2000 years ago. By that time above the *Fagus* belt were growing groups of *Pinus* (most probably *Pinus sylvestris*). At lower altitudes the vegetation cover was composed of *Quercus* forests with *Carpinus orientalis*, *Ostrya carpinifolia*, partly *Tilia* and *Ulmus*. The distribution of *Castanea sativa* (sweet-chestnut) was still limited. The herb vegetation occupied open areas and among the great variety of species the presence of *Rumex*, *Plantago lanceolata*, *Scleranthus*, Cichoriaceae, Brassicaceae indicates human activity deserved attention. The most substantial change in the forest cover took place before 1760 cal. yrs. BP (III cent. AD). The sharp decrease in the total quantity of tree pollen testified to a short-term profound interference of Man which resulted in the destruction of *Fagus* communities thus causing lowering of the upper tree-line. Conifers were replaced by shrub lands of *Juniperus* and diverse herbs, mostly grasses. The increase in the presence of *Castanea* pollen appeared synchronous with that of *Platanus* and *Juglans*. Most likely, since historical time the formation of the recent belt of *Castanea sativa* has started on the northern foothills of the mountain. The relatively young age of the peat-bogs does not provide a definite answer about the natural or anthropogenic origin of sweet-chestnut forests. The find of cereal pollen from *Triticum*-type and *Secale* confirmed the cultivation of wheat and rye. The palynological information for the last centuries indicated a reduction of the areas formerly occupied by *Fagus*, an enlargement in the presence of *Juniperus*, at lower altitudes of *Carpinus orientalis*/*Ostrya carpinifolia* and partly *Quercus*. The core Beles from the southern slope of the mountain covers a relatively short period starting roughly at ca. 1350 AD. *Pinus* forests dominated up to the mid-XVI cent. AD but then were gradually restricted to their present-day limited occurrence. On the contrary, *Fagus* forests began their expansion by the end of phase B-a. Two sharp peaks in the expansion of beech, a large one by the end of XVII cent. AD, followed by a smaller one around the mid-XIX cent. AD, can be observed in the pollen diagram. These events reflected the existence of favorable climatic conditions, prevailing during these periods, and were also recorded in other mountainous areas of central and northern Greece (Pertouli, Voras, Paiko, Lailias, Rhodopes). Throughout the diagram, the impact of Man on the vegetation is clearly manifested. It started as stock-breeding (low *Cerealia* pollen values compared to *Plantago lanceolata*-type) at mid-altitudes and expanded to agriculture around the beginning of the Turkish occupation as shown by the pollen curves of *Cerealia*, *Rumex*, Chenopodiaceae, *Artemisia*, *Juglans*, *Castanea* and *Vitis*. After a recession which lasted from the end of XVII cent. AD up to the mid-XIX cent. AD, human impact was manifested as deforestation that took place in all vegetation zones of the mountain and the free areas were colonized mainly by grasses.

Deep-seated gravitational slope deformations in the highest parts of the Czech Flysch Carpathians: evolutionary model based on kinematic analysis, electrical imaging and trenching

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The Czech part of the Outer Western Carpathians (OWC) is mainly formed by variously bedded flysch that is susceptible to an occurrence of deep-seated gravitational slope deformations (DSGSDs). On contrary to majority of other mountainous regions where the DSGSDs have recently been studied, the OWC are generally aseismic, they didn't experience a postglacial deglaciation debulking and reach only low to moderate local relief. This study deals with four structurally preconditioned mountain ridges in the Moravskoslezské Beskydy Mts. whose ridgetop parts are spectacularly disrupted by the mass movements. Each study area has been put through a detailed analysis including mapping, speleological research, structural and kinematic analyses, paleoseismological trenching, 2D electrical resistivity tomography and radiocarbon dating. All studied DSGSDs are predisposed by mutual interactions between bedding planes, joint sets, and both normal and strike-slip faults within strongly lithologically and tectonically anisotropic flysch massifs. The orientation of gravitational morphostructures well correlates with a structural fabric of the studied region. The extensive geophysical profiling and trenching on the selected sites revealed significantly higher occurrence of the crevice-type caves and other air-filled voids within the anisotropic rock massifs than it was previously stated. Distinctive subsurface zones with extremely high resistivities (>4000 ohm.m - indicating caves) often continue outside the morphological expressions of the DSGSDs. This finding indicates that the failures initiate inside the ridges at depths mostly 10-40 m. The paleoseismological trenches applied to three sackung-like features revealed complicated inner structures involving faulted and bended strata, cataclastic bands and opened (partly infilled) crevices. These structures are an evidence of gravitationally activated tectonic elements whereas dislocations evolved by both gravitationally-induced movements (e.g. sackung, lateral spreading etc.) and collapse of rock mass above opened crevices. Bedrock structures are overlain by both coarse-grained colluvial wedges and fine-grained colluvia. Radiocarbon dating of organic deposits infilling the gravitational trenches indicates Holocene age of the studied landforms; some of them evolved even during the Late Holocene. Our studied DSGSD are spatially connected with other consequent slope failures like landslides which is valuable contribution for discussion about DSGSD-related catastrophic failures of slopes. Kinematic analysis performed in our study area furthermore indicate that existence of structurally-preconditioned landslides within the area of DSGSD can be only hardly explained applying normal values of angle of internal friction of claystone intercalations, which likely dropped to residual values by long-term creep activity related to DSGSD evolution. This finding suggests the important role of DSGSD for evolution of consequent catastrophic mass movements. Our results indicate that (i) the extensive manifestations of the typical DSGSDs can evolve even in low to medium high mountains - especially, if rock massifs are formed by strongly anisotropic rocks, (ii) beside the known processes such as the lateral spreading, toppling and sackung, the important evolution mechanism of the disrupted ridges involves the collapse and the subsidence of the ridgetop zones due to the deep-seated creep-related opening of the crevices, (iii) the process of the DSGSDs formation continues within studied region up to recent times by the formation of new gravitational structures and activation of older (Pleistocene-Early Holocene) landforms.

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The Granite Market in Greece

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The extraction, exploitation and trade of marble are among of the most important comparative advantages of Greek economy. However, despite the presence of many granitic bodies of various sizes in Greece, no granites are extracted systematically. As a result, the domestic demand of granites is almost totally covered by imports of either raw or processed granite. This has a serious impact to the trade gap of granites, which increases over the last fifteen years. Data on the Greek granite market are presented and evaluated, in order to elucidate the current trends. According to these, the demand for granites and the penetration of granites in the marble-granite market appear to increase over the period 1992-2008. The main factors that affect the demand for granites are the number of hotels built and the net per capita disposable income of the consumers and to a less extent the number of new and renovated dwellings.

Natural radioactivity of granites from Aegean islands (Atticocycladic Zone)

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Twenty three granite and granodiorite samples from the Atticocycladic Zone have been measured for their natural radioactivity in order to assess the radiological impact in case they are used as building materials. More specifically, the activities of ⁴⁰K, ²²⁶Ra and ²³²Th in Bq kg⁻¹ were measured. The investigated samples have been taken from Tinos, Mykonos, Paros, Delos, Serifos, Lavrio, Naxos and Ikaria, including any possible rock type found in these regions. The activity concentrations of ⁴⁰K, ²²⁶Ra and ²³²Th of the investigated samples exceeded the average level of these radionuclides in soil and other kinds of building materials. However, this is typical for granitic rocks, because they contain U- and Th-rich minerals in higher amounts than other building materials. In order to assess the health risk of using the above samples as building materials, the following indices proposed by the EC and UNSCEAR were calculated: absorbed gamma dose rate (D_a), annual effective dose (H_E), activity index (AI) and gamma-ray index (I_γ). The calculation of the above indices is based on the standard room model, proposed by UNSCEAR which implies a room with dimensions of 3X3X3m, having infinitely thin walls, without doors or windows and being fully constructed of granite. The absorbed gamma dose rate (D_a) of all the investigated samples lies above the limit proposed by the EC which is 80 nGy h⁻¹. However, two samples from Ikaria and one sample from Naxos exceed the acceptable limit for the absorbed gamma dose rate which is 160 nGy h⁻¹ (199, 172 and 176 nGy h⁻¹, respectively). As far as the annual effective dose (H_E) is concerned, no sample exceeds the limit of 1 mSv y⁻¹. The activity index (AI) of the samples is below or equal to the limit of 1 Bq kg⁻¹, except one sample from Ikaria (1.2 Bq kg⁻¹). Finally, no sample exhibits gamma-ray index (I_γ) higher than 6 which means that the use of all the samples investigated could be recommended. More specifically, all the investigated samples from Tinos, Paros, Serifos, Lavrio and Delos should be exempted from all restrictions concerning their radioactivity, together with one sample from Mykonos, one from Naxos and two from Ikaria. On the other hand, the use of the rest of the samples taken from Mykonos, Naxos and Ikaria is recommended in local level, in exceptional cases. The average values of the above indices of the samples investigated is below the world average as it was taken from the literature, in the case of all indices. Moreover, the indices of the samples of

this study are by far lower than those of the imported granitic rocks in Greece. Therefore, at least from radiological point of view and for the investigated rocks, the granites from the Atticocycladic Zone can be used as building materials rather than the majority of the imported granites.

Tectonostratigraphic models of the Alpine tectonostratigraphic terranes of the Hellenides

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The tectonostratigraphic terrane analysis of the Hellenides has resulted in the distinction of nine terranes, representing five continental crustal blocks with pre-Alpine basement overlain by Alpine carbonate platforms and four Tethyan oceanic terranes with ophiolites and pelagic sediments. The tectonostratigraphy of the above terranes is related to their paleogeodynamic and paleogeographic evolution, which can be distinguished in three major stages: (i) A first stage of continental rifting in the northern margin of Gondwana, which is characterised by volcanosedimentary successions of Late Palaeozoic – Triassic. (ii) A second stage of continental drifting and of oceanic opening of Tethyan basins in between the continental terranes. This stage is characterised by the development of shallow-water carbonate platforms on the continental terranes and by ophiolite suites interlayered with pelagic sediments within the tethyan basins. The duration of this stage is Triassic – Paleogene. (iii) A third stage of docking of the tectonostratigraphic terranes along the active European margin, which is characterised by flysch sedimentation along the trenches developed in front of the evolving arc and trench systems. The duration of this stage is from late Triassic to Neogene. The timing of the transition from one period to the other for each terrane is shown by the different tectonostratigraphic formations observed in each case with distinction of two models: one for the continental terranes and carbonate platforms and another for the oceanic basins. In both cases the duration of each geodynamic stage for each terrane is obtained from the chronology of the tectonostratigraphic facies change. Thus, the rifting stage comprises the ages of the successive volcanosedimentary formations, the drifting and oceanic opening stage comprises the ages of the carbonate platforms and of the ophiolites and associated pelagic sequences respectively and the docking stage comprises the ages of the flysch formations. The general trend is younger ages observed in the southern terranes and older ages towards the northern terranes. The two alternative tectonostratigraphic models are applied in the two groups of terranes with indication of the different timing of each formation, corresponding to the different geodynamic-paleogeographic stages. The period of drifting of each terrane can be used as a dimensional indicator of the Tethyan width that was covered by the terrane motion across the ocean (e.g. 190 Ma for the Tripolis platform but only 110 Ma for the Pelagonian platform).

Tectonostratigraphic observations in the western Thrace Basin in Greece and correlations with the eastern part in Turkey

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New observations on the Tertiary tectonostratigraphy of the western part of the Thrace Basin in Greece enabled the distinction of several tectonostratigraphic formations ranging between Middle Eocene and Late Oligocene. The first major conclusion was that two NE-SW trending dextral strike-slip fault zones – the Soufli FZ in the south and the Ardas FZ in the

north- dissect the western part of Thrace Basin into three sub-basins: the Alexandroupolis SB in the south, the Orestias SB in the middle and the Petrota SB in the north.

The Alexandroupolis SB consists of two stratigraphic sequences separated by an angular unconformity. The lower sequence comprises the Kirki Formation, made of sandstones, shales and conglomerates of reddish colour, overlain by a 30 m thick sandstone member and by the Chorafaki Formation made of alternations of sandstones and pelites. The age has been determined as Middle Eocene (nannofossil biozone NP17, 39.8-36.8 Ma). The upper sequence comprises the Avas Formation, made of neritic limestones followed by the Pylaea Formation, made of marls, sandstones and some limestone interbeds. The age has been determined as Late Eocene-Early Oligocene (NP19/20-NP23, 36.2-30.0 Ma). At the area around Feres the Pylaea Formation contains thick volcanic rocks and pyroclastics.

The Orestias SB is featured only by the upper sequence, comprising the Metaxades Formation which is equivalent to the Avas Formation of Alexandroupolis SB and the Pythion Formation, which is equivalent to the Pylaea Formation of Alexandroupolis SB. A characteristic stratigraphic member is the *Congeria*-bearing limestone of Early Oligocene age. Volcanic rocks are practically absent from Orestias SB.

The Petrota SB has a basal clastic formation of sandstones and conglomerates of Late Eocene age, overlain by marls of Oligocene age.

The pre-Tertiary basement is different in the three sub-basins of western Thrace. The low-grade metamorphic Makri unit (part of the Circum Rhodope Unit) is observed below the western margin of Alexandroupolis SB, whereas the Melia not metamorphosed diabases and flysch are observed below the central part of the sub-basin. On the contrary, medium-high grade metamorphic rocks are observed below the southern margin of Orestias SB and also below the western margin of Petrota SB.

The above tectonostratigraphy can be correlated to that of the southern part of Eastern Thrace in Turkey around Tekirdag- Keşan - Kallipolis. Thus, Kirki Fm is equivalent to Fiçitepe Formation, Chorafaki Formation is equivalent to Keşan Formation, Avas Formation is equivalent to Soğucak Fm, Pylaea Formation is equivalent to Ceylan and Mezardere Formations. The *Congeria*-bearing sediments are indicating the northern margin of the Thrace basin both in the western part (e.g. Didimoticho, Pythion Fm) and the eastern part (e.g. Pinarhisar).

Fault geometry, surface ruptures, damage pattern and deformation field of the 2009 L'Aquila earthquake in Italy. Findings and implications

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The 6th of April 2009 Mw=6.3 earthquake in L'Aquila, central Italy, provides a broad range of useful outcomes and points for consideration in relation to all disciplines involved in seismic hazard assessment. Despite its moderate magnitude, the L'Aquila event resulted in the highest earthquake death toll in the EU since the 1980 Irpinia (Italy) quake. This event provides an important case-study, most notably because moderate magnitude earthquakes in areas of high population density, such as this, present a high risk in extensional settings due both to their high rate of occurrence and proximity to human habitation, forming a typical case study scenario. This event ruptured a small fault segment of the fault system and not one of the major postglacial fault scarps that outcrop in the area. This explains the minor primary surface ruptures that have been reported so that the 2009 L'Aquila event can be characterized

as belonging to the lower end member concerning the capacity of the existing seismic sources of the area. These faults have not been activated during the 2009 event, but have the capacity to generate significantly stronger events. The deformation pattern of the 6th and 7th of April 2009 Mw=6.3 and Mw=5.6 earthquakes in L'Aquila is revealed by DInSAR analysis and compared with earthquake environmental effects. The DInSAR predicted fault surface ruptures coincide with localities where surface ruptures have been observed in the field, confirming that the ruptures observed near Paganica village are indeed primary. These ruptures are almost one order of magnitude lower than the ruptures that have been produced by other major surrounding faults from historical earthquakes. DInSAR analysis shows that 66% (or 305 km²) of the area deformed has been subsided whereas the remaining 34% (or 155 km²) has been uplifted. A footwall uplift versus hangingwall subsidence ratio of about 1/3 is extracted from the mainshock. The maximum subsidence (25cm) was recorded about 4.5 km away from the primary surface ruptures and about 9 km away from the epicentre. In the immediate hangingwall, subsidence did not exceed 15 cm, showing that the maximum subsidence is not recorded near the ruptured fault trace, but closer to the hangingwall centre. The deformation pattern is asymmetrical expanding significantly towards the southeast. A part of this asymmetry can be attributed to contribution of the 7th of April event in the deformation field.

Fault geometry influenced significantly the damage pattern. Villages located on the hangingwall experienced higher intensity values, compared to villages located on the footwall. This is also verified by the DInSAR which shows that the hangingwall area was subjected to higher deformation values. On average, subsidence values were two and a half times up to three times larger than the uplift values, leading to more violent shaking. The large number and extensive spatial distribution of secondary surface ruptures that occurred not only within the recent sediments of the Aterno basin, but also on pre-existing fault planes was another characteristic of this earthquake. These ruptures are usually disregarded in seismic hazard assessment planning and design studies, but can produce significant damage. Finally, basin effects and the bedrock geology played once more a decisive role to the damage pattern, even at short distances. It is interesting to note that villages that were only 1.5km apart, but founded on different bedrock geology recorded up to three intensity values difference.

Environmental assessment of potentially toxic trace elements in sediments of Filippos B port, northern Aegean Sea – a comparison with other national and international coastal regions

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Nine sediment samples from Filippos B port, Kavala, northern Greece, were collected, sieved under 200 µm and analyzed for their content in 14 potentially toxic trace elements (Ag, As, Ba, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, U, V and Zn). The results indicate that the majority of the elements are found in concentrations similar to other national and international coastal regions. However, Cd seems to be highly enriched in the sediments of the present study. The samples with the highest concentrations of Cd, as well as for the rest of the elements, are found in front of the local, anthropogenic activities. According to their distribution, the elements of the present study can be divided into two groups; group A includes the elements Ag, As, Cd, Hg, Pb and U, group B the elements Ba, Co, Cr, Cu, Mn, Ni, V and Zn. The former are influenced mainly by the activities of a fertiliser plant, while the latter by all the local anthropogenic activities.

Rockfall Susceptibility Zoning and Evaluation of Rockfall Hazard at the Foot Hill of Mountain Orliagas, Greece

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Rockfalls are frequently generated in mountainous areas and threatened manmade environment. Therefore, the detachment of large size boulders and their fall track are issues that should be evaluated for urban planning and the construction of lifelines and road networks. In order to achieve this, several methodologies had been proposed and applied, regarding the evaluation of the landslide hazard. The most known methods concern the application of GIS software for the evaluation of the run-out distances of boulders and the simulation of the fall tracks. In this article, a delineation of areas susceptible to rockfalling at the foothills of mountain Orliagas, Greece, is provided using the minimum shadow angle method and, in addition, selected case studies of rockfalls were studied. These cases were simulated and analyzed using the Rockfall software while the employed parameters were tested and calibrated using silent witnesses. The outcome provided by this study, is that the simulated fall track and the rockfall run-out distance were in agreement with the spatial distribution of the reported boulders while the total kinetic energy and the bounce height during the fall track have been evaluated, thus can be used for the construction of remedial measures. In addition, as it is shown in the resulting by this study maps, the area between the villages of Ziakas and Spileo can be separated into two zones, A and B, regarding the landslide hazard for the road network which is evaluated as low and very high, respectively.

A Newly Discovered Fossil Stratatound Hydrothermal Manganese Deposit at Aspro Gialoudi, N.W. Milos, Greece

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The white smoker Mn-Ba-Pb deposit at Aspro Gialoudi in NW Milos is shown to be a fossil stratiform exhalative hydrothermal deposit analogous to the Vani manganese deposit which is located about 1.3 km to the NE. Both deposits are located proximal to fault systems. However, the Vani manganese deposit is adjacent to the NW-SE-trending Vromolimni-Kondaros Fault which marks the western margin of the Gulf of Milos and is one of the major faults on Milos, whereas the Aspro Gialoudi deposit is adjacent to the relatively minor dimensions NE-SW fault on the west coast of Milos. Both the Aspro Gialoudi and Vani manganese deposits formed in a similar manner, namely by transport of hydrothermal fluids through the adjacent fault systems into a reservoir of volcanoclastic sandstone to produce a deposit initially consisting of pyrolusite and occasionally ramsdellite, which were later replaced by cryptomelane, hollandite, coronadite and hydrohaeterolite. Because the NE-SW fault on the west coast of Milos is minor compared to the Vromolimni-Kondaros Fault, the Aspro Gialoudi manganese deposit consisted mainly by cryptomelane, hollandite, coronadite and hydrohaeterolite, is very much smaller than the Vani deposit. The Aspro Gialoudi deposit has not been described before because of its remoteness and small size.

The hydrothermal manganese deposit at Aspro Gialoudi was formed little earlier to roughly contemporaneously with the Vani manganese deposit at about 1.8 Ma. by similar processes and are considered to be integral parts of the same hydrothermal system.

Movement along the NE-SW fault located on the western margin of Milos triggered the hydrothermal activity which resulted in the formation of this deposit which seems to be controlled by alternating cycles of deposition of sulfides and hydrothermal manganese oxides within the fault which were probably the result of alternating periods of waxing and waning of seismic activity along that fault. The hydrothermal fluids penetrated the volcanoclastic sandstone which hosts the Aspro Gialoudi deposit along fractures and fissures, which led to the formation of this deposit in two stages as at Vani. The intense low-temperature, hydrothermal activity would have been relatively short lived. Furthermore, based on the REE geochemical data the hydrothermal fluids that formed the Cape Vani Mn oxides and hydroxides formations were mainly seawater. Although the Cape Vani formations were in contact with oxidising seawater for a sufficient period of time, our geochemical data (depletion of Mg, Ca in relation to the continental crust) suggest that there was no significant alteration of these formations by seawater after their deposition.

In general, the compositional data show that the elements most enriched in the Aspro Gialoudi, Vani and Vani Dome deposits relative to the average continental crust (Wedepohl 1995), lie in the sequence As>Pb>Sb>Cd >Mn>Tl>Mo>Zn>Cu>Ba>Be>Sr>Co>Bi. All the other elements analyzed are depleted in these deposits relative to the continental crust. The chalcophilic elements, the siderophilic elements Mo and Co plus barium and strontium are therefore the most strongly enriched in the hydrothermal Mn deposits relative to the average continental crust.

Preliminary carbon and oxygen isotope data on carbonate sequences from the Pădurea Craiului Mountains, Romania. Paleoenvironmental significance

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Isotope stratigraphy is a useful tool for stratigraphic correlation, especially for strata deposited during major perturbations of the carbon and oxygen cycles that affected the marine, terrestrial and atmospheric reservoirs. The Pădurea Craiului Massif (north-western extremity of the Apuseni Mountains, Romania) had a long-lasting evolution with a pre-Hercynian start, being mainly shaped during alpine orogenesis. Most of its formations belong to the Bihor tectonic unit. The basement is made up of crystalline schists of the meso-metamorphic Somes Series. Sedimentation started during Permian with detritic deposits interbedded with rhyolites. The overlying Triassic deposits are unconformable and include detritic formations (Lower Triassic) and massive layers of carbonate rocks (Middle Triassic). The almost complete lack of the Upper Triassic is due to the uplift of the region during the Cimmerian tectonic phase. The Lower Jurassic deposits include the detritic formation (Hettangian–Lower Sinemurian), the limestone formation (Upper Sinemurian–Pliensbachian) and the marl formation with ammonites and belemnites (Toarcian). The Middle Jurassic consists mainly of marls. The Upper Jurassic formations are massive (over 100 m thick) and are made up exclusively of limestones. During the Upper Tithonian and Lower Cretaceous the limestone deposits have been uplifted which resulted in a paleo-karst surface that hosts discontinuous bauxite deposits. Lower Cretaceous sedimentation started with the deposition of fresh-water limestones (Hauterivian) followed by successive layers of marine limestones (Barremian), marls (Aptian), marine limestones (Aptian), glauconitic sandstone (Aptian-Albian) and ended with a package of red detritic deposits (Albian-Cenomanian?). After the intra-Turonian thrust movements, the Senonian sediments have a post-tectonic character and outcrop in several isolated area. Subsequent positive epirogenetic movements and two main phases of magmatic activity (Upper Cretaceous–Paleocene and Badenian–Pliocene) completed the morphogenesis of the Piatra Craiului Mountains.

The $\delta^{13}\text{C}_{\text{PDB}}$ and $\delta^{18}\text{O}_{\text{PDB}}$ values of bulk carbonate samples from the Mesozoic formations of the Pădurea Craiului Mountains vary from -2.27‰ to +2.97‰ and from -8.07‰ to -2.91‰, respectively. All isotope compositions correspond to seawater carbonates. An increasing trend of the $\delta^{18}\text{O}$ values with the age of the formations is to be noted. The highest values $\delta^{18}\text{O}$ (-4.44‰ to -2.91‰) correspond to the Cretaceous formations. The Triassic limestones display the lowest $\delta^{18}\text{O}$ value (-8.07‰) and this could be a consequence of the global oxygen isotope excursion recorded at the Permian/Triassic boundary. Such light $\delta^{18}\text{O}$ values are consistent with an Early Triassic warm, depleted of oxygen and stagnant ocean. The lowest $\delta^{13}\text{C}$ value (-2.27‰) was obtained for the Upper Jurassic limestone formation. As these limestones have been uplifted and karstified under lateritic conditions during the late Jurassic and early Cretaceous, the ^{13}C -depleted value probably resulted from an admixture of primary and diagenetic carbonate. The lower value could also be a remnant of the carbon isotope negative shift documented worldwide and caused by the Early Jurassic (Toarcian) oceanic anoxic event. All Cretaceous limestone formations display positive $\delta^{18}\text{C}$ values (1.78‰ to 2.97‰). Positive carbon-isotope excursions are generally compatible with times of low atmospheric carbon dioxide content. The Barremian marine limestones (Blid formation) display slightly lower $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values relative to the Albian-Aptian limestones. Paired carbon and oxygen isotope determinations provide a possibility of interpreting not only changes in the global carbon and oxygen cycle through time, but as a discrimination criterion in problems of stratigraphic correlations as well. Paleotemperature estimations based on calcium bicarbonate and seawater isotopic fractionations give temperatures as high as 26°C for the Triassic limestones and between 22–23°C for the Jurassic – Lower Cretaceous formations. These results are similar to the isotope temperature records of other carbonatic sequences of equivalent age. A larger number of data and high-resolution carbon and oxygen-isotope stratigraphy are required to develop a better understanding of changes in paleoenvironmental conditions.

The present isotope study is part of an ongoing project funded by the Romanian National University Research Council (PN II, Programme: IDEAS, contract ID-95).

Time-Dependent probability distribution on faults associated to strong earthquakes ($M \geq 6.5$) in the broader Greece area

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Greece and the surrounding area are characterized by high seismicity. Strong earthquakes ($M \geq 6.5$) have repeatedly occurred in this area, as historical information and instrumental recording reveal. Using as input data 67 strong earthquakes that occurred since the beginning of the 20th century, the coseismic stress changes are calculated, in order to make a probabilistic earthquake forecast in the study area under the influence of past events. For this purpose, the calculated coseismic stress changes are translated into earthquake probability using an earthquake nucleation constitutive relation, which includes permanent and transient effect of the sudden stress changes. According to this method, a sudden change in stress seems to modify earthquake rate, moving other faults toward or away from failure, changing the probability of potential earthquake on these faults. Earthquake probability on a fault is lowest after the last event but as tectonic stress grows the odds of another earthquake increase. For all needed calculations a pdf (probability density function) for the time of failure for an earthquake of defined magnitude on the fault of interest must be taken into account along with the calculated stress changes on the fault. Specifically, the estimated probability values concern the probability in each part of a given fault or fault segment, and the probability distribution is illustrated across the specific fault. All calculations were performed at 10 km depth but it was necessary to check whether the estimated probability values vary with depth. Therefore, all estimations were performed for each fault or fault segment at the

depth of 8, 12 and 15 km. The probability calculations were carried out and given for the whole study area during the next 30 years in the form of tables and maps.

Pre-Alpine history of the Ukrainian Carpathian Foreland and its combustible minerals

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Pre-Alpine history of the Ukrainian Carpathian Foreland is connected with the ancient continental marginal areas of the East European Platform, and succession of the formation – with a long and varied interaction between surrounding regions at different stages of their development: active geosyncline, orogenic and young platform during several tectonic stages – Baikalian (R3), Caledonian (V-D1) and Hercynian (D2-P). At each of these stages on the territory of the western region of the Ukraine the structures, characteristic of that stage only and unlike others, were formed. By genetic principle one can distinguish here: 1. Volyn-Orsha Baikalian transverse foredeep (as it was understood before). However, if this structure is considered on a scale of the whole East European Platform and its distribution is taken into account, then it should be called through foredeep (avlakogene), although its formation undoubtedly is connected with the events occurred near the platform edges. 2. Caledonian fore-system included in Volyn-Podillya area of the Baltic-Black Sea pericraton (s.s) deep (V-D11) and Boyanets foredeep (foothills) (D12-3). 3. Lviv-Lublin Hercynian posthumous foredeep (D2-C2). 4. Hercynian fore-platform uplift composed of dislocated deposits from Riphean to the Lochkovian stage of the Lower Devonian. 5. Hercynian foothill deep (Silesia-Pokuttya) (C2-P) which is now overlapped by formations of next Alpine stage, but lets us know about itself by fragments of its rocks (black coal and conglomerate of verrucano) in flysch and molasses along the whole northern slope of the Carpathian. It is known that main belts of oil and gas accumulations are often confined to similar structures of the ancient platforms. Pericraton deeps, the constituent parts of the edge systems of continental borderlands, are especially rich in combustible minerals. Similar structures are located in the eastern part of the Arabian Peninsula, Volga-Ural region, in Alberta and Saskatchewan deeps in North America and on Sahara plate. Within the Ukrainian Carpathian Foreland the deposits of natural gas and black coal have been discovered. Gas deposits are mostly found in terrigenous deposits of the Middle and Lower Devonian, black coals – in deposits of Carboniferous. Moreover, analysis of the known criteria of oil and gas potential has allowed us to distinguish perspective complexes: Silurian and Cambrian. In the first of them, the discovery of new hydrocarbon fields is connected with a lithofacies of organogenic limestones that compose a submeridian reef system consisting of organogenic buildups at three levels: Bahovytsk, Malynovetsk and Skalsk, and extends from the Volodymyr-Volyn fracture through Lokachy-Olesko-Buchach to the Ukrainian-Romanian frontier. In the Cambrian complex, promising for oil and gas are both anticlinal traps and traps of non-anticlinal type – lithological zones of thinning out of sand layers, stratigraphic, disjunctively screened and so on. Results of studies devoted to generalization of material on the Late Precambrian sedimentary formations give reasons to classify Wendian and Riphean complexes as promising objects, too.

Coal deposits are connected with the Carboniferous of the Lviv-Volyn Basin where one can count about 90 coal seams. Of commercial value are six of them in the Buh suite of the Serpukhovian stage, and they are worked by 14 mines. Further prospects are connected with the northern part of the basin as well as with the Polish frontier areas.

Neotectonic activization of the Crimean-Black Sea region

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Seismic activity of the region, abnormally high formation pressures at local structures, activity of fractures and abnormally high concentrations of the elements of deep genesis are counted as one of the main geological factors determining modern tectonic regimes. The Crimean-Black Sea region for a long time is known by its seismic activity. The location of the earthquake epicenters in the Black Sea region points to that they are controlled by the Southern Berezhnyi and Southern Pravdynsk breaks, which separate the Crimean Peninsula from the deep-water Black Sea depression, as well as by the South Azov break. The direction of seismofocal plane, that has a northern dipping, testifies to modern compressing strain and confirms the supposition that the Mountain Crimea was formed in consequence of underthrust (subduction) of the deep-seated zones of the lithosphere and mantle of the Black Sea plate under the Scythian Tectonic Belt, located farther north, with uplifting of its edge area. Analysis of the seismic activity of the Black Sea region shows that the greatest seismic activity is confined to the southern coast of the Black Sea, to Northern Anatolia, that is to say, to the zone included into the Alpine-Himalayas belt of active Alpine dislocations. In the northern Black Sea area, the earthquakes are of rather less activity, and they are concentrated in three areas only: near the Crimean Peninsula, in the Caucasus and in the region of Vrancea in the outlying part of the southern arc of the Carpathians in Romania. The epicenters of the most earthquakes in the region are concentrated in the earth crust at depths from 10 to 50 km. But in the region of Vrancha, except crustal earthquakes, a great number of substructural seismic disturbances were fixed at depths from 100 to 250 km. This fact already long time ago has allowed a number of investigators to identify the Vrancea zone with typical seismofocal Benioff zones. It is obvious that of the same nature are the crustal earthquakes of the southern coast of the Crimea and Caucasus. The epicenters of the Crimean earthquakes form a wide seismofocal plane (about 40 km wide) which is steeply inclined to the north underneath the Crimean Mountain. Just in this zone occurs the transition, the transformation of a "thin" suboceanic Black Sea lithosphere plate (thickness about 30 km) into the "thick" continental plate of the region of the Crimea and the slope of the Ukrainian Crystalline Shield. The thickness of the latter under the Mountain Crimea is 50 km. The activity breaks in the Crimea-Black Sea region is manifested either in restoration activity or is accompanied by the fields of neotectonic stresses only. Abnormally high concentrations of the elements deep genesis such as radon, helium, mercury vapours, etc., are the evidence of tectonic activities of fracture zones. Modern tectonic movements of the earth crust of the Northern Black Sea in the Quarternary time and during the present epoch are characterized by the predominance of uneven uplifting. Moreover, in the neotectonic maps isobases are of sublatitude extending. That may be just one more evidence of underthrusting of the suboceanic crust of the Crimea and Black Sea hollow under the continental crust of the Crimea and northern Black Sea area, the underthrust stimulated the uplifting of the Crimea and Black Sea region. Thus, neotectonic activization of the Crimea-Black Sea region fixed one of the stages of the Alpine tectogenesis connected with the collision of lithosphere plates of Arabian-African and Eurasian. This is in conformity with the northern direction of seismofocal zones of earthquakes of the region, especially in near-Crimean area. Judging from the centres of seismic activity of the region, the main direction of this activity are confined to the Crimean Peninsula, the Caucasus, the Southern Carpathians and Dobrogea (zone of Vrancea). According to our data, just in these areas are butt-ends (protrusions) of the lithosphere plates that are joined.

Genetic algorithm as a tool for paleoclimate records correlation

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Palaeoclimate records which came from different profiles are usually reconstructed on the basis of different geochronology methods. From this reason it is hard to place these profiles on one time scale. Even more problems occur when the correlation of records is based on the non-isotopic time scales (depth, biostratigraphy, etc.). As a solution we propose nonparametric methods and computer software based on genetic algorithms as a tool for correlation palaeoclimatic records regardless of the time scale. Described algorithms we show using stable isotope records from several stalagmites from Demianova Caves System (Low Tatra Mts., Slovakia) dated by radiocarbon and U-series methods.

Radiometric dating of rhyolites by conventional K/Ar method: methodology

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Rhyolite magmatism represents a substantial part of calc-alkaline volcanic rocks in continental margin and/or back-arc setting and frequently associates with epithermal mineralization. Their precise and reliable dating is important for understanding the magmatic evolution, as well as the related metallogenetic processes. Nowadays, the higher precision is reached especially by applying $^{40}\text{Ar}/^{39}\text{Ar}$ and/or single grain U/Pb dating. However, using a proper methodology, even with the conventional K/Ar age determination, we can reach highly reliable results with precision of 3 % relative for single datings (at 1σ resp. 68 % confidence level). Improved methodology has been applied to rhyolites of the Jastrabá Fm. and related epithermal mineralization in the Kremnické vrchy mountain range in central Slovakia. Obviously, dated samples were carefully selected, knowing their geological setting and processes affecting the rocks. Generally, dating of whole-rock samples can not provide reliable results. Selection of target phases based on careful petrographic investigation, including a use of BSE images and electron microprobe analyses of K-bearing phases, represents an important step. Phases affected by epigenetic alteration should not be dated. Target phases in rhyolites of the Jastrabá Fm. in order of decreasing K-content are: hydrothermal K-feldspar (adularia, 12,6–13,7% K), magmatic K-feldspar (sanidine, 8,4–10,7% K), subsolidus K-feldspar (7,9–9,6% K), biotite (7,1–8,1% K), spherulitic groundmass (3,9–7,0% K), kfs-groundmass (3,6–6,1% K), glass (3,3–4,6% K), amphibole (0,53–0,72% K), plagioclase (0,3–1,2% K). Separation of selected target phases is carried out using heavy liquid, electromagnetic separator, shaking and handpicking (for final cleaning) on grain-size fractions 0.63–0.4 mm, 0.4–0.25 mm and 0.25–0.125 mm, 300–500 g each. As a rule, all datable phases are collected. Potassium is determined by flame photometry with a Na buffer and Li internal standard with relative analytical error 2%. Argon is extracted from the samples by RF fusion in Mo crucibles, in previously baked stainless steel vacuum system. Pure ^{38}Ar spike is added from gas pipette system and the evolved gases are cleaned using Ti and SAES getters and liquid nitrogen traps, respectively. The purified Ar is transported directly into the mass spectrometer and Ar isotope ratio is measured in the static mode, using a 15cm radius magnetic sector type mass spectrometer built in Debrecen. The relative analytical error of ^{38}Ar spike is 2%, the relative analytical errors of $^{40}\text{Ar}/^{38}\text{Ar}$ and $^{36}\text{Ar}/^{38}\text{Ar}$ isotope ratios determination are 1%. Age of the sample is calculated using the decay constants suggested by Steiger and Jäger (1977) and isotopic composition of natural potassium ^{39}K - 93.2581%, ^{40}K - 0.01167%, ^{41}K - 6.7302%, assuming that the rock or mineral has been a closed system for K and ^{40}Ar concentrations. Analytical error is given at 68% confidence

level (1σ). Usually it varies around 3 % relative. Despite the perfect sample preparation and analytical work some results are dubious owing to natural reasons and should be eliminated from further consideration. There are several ways to check reliability of results: (1) K-concentration should correspond to the dated phase; (2) percentage of $^{40}\text{Ar}_{\text{rad}}$ should be high enough; (3) consistent results on different fractions/phases; (4) consistent results on samples of the same unit (statistical testing); (5) testing by the isochrone method – identification of phases with excess $^{40}\text{Ar}_{\text{rad}}$ (xenocrysts and/or plagioclase and amphibole phenocrysts) and $^{40}\text{Ar}_{\text{rad}}$ loss (glass). One has to be always aware of statistical aspects, especially confidence interval of a single datum. Appropriate statistical methods should be used in evaluation of multiple data. With multiple data for geological units differences in age smaller than error of a single datum can be recognized – one of the possibilities is a graph of normal distribution densities. If results do not fit with geological relationships something must be wrong – either radiometric dating or more likely our geological assumptions. Our results on rhyolites and related mineralizations of Kremnické vrchy are in other presentation of Lexa and Pécskay.

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Mineralogical–Geochemical Study of Uranium Bearing Granite Phases in Paranesti Area, N. Greece

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This study concerns the petrological-geochemical characters of the “granite type” rocks from Paranesti area, in which I.G.M.E. has localized the most important uranium ores in Greece. Their mineralogical phases are examined and they are correlated with the geochemical data of the major elements, as well as with some of the trace elements from mineralized samples of the area.

Raman spectroscopy as a tool to distinguish grossular/hydrogrossular from vesuvianite in rodingites from the Othrys ophiolite (central Greece)

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Raman Spectroscopy was employed to confirm the presence of hydrogrossular, rather than vesuvianite, in rodingites of the Othrys ophiolite suite, central Greece. The Raman spectra obtained from the fine-grained, weakly birefringent minerals, with anomalous bluish-grey interference colours documented the presence of hydrogrossular by its characteristic bands at ~360-362, 534-537, 817-819, 870-872 and 3600 cm^{-1} . No Raman spectra indicative of vesuvianite were obtained precluding the existence of this phase. The absence of vesuvianite implies that the metasomatising fluid phase was rather rich in CO_2 , an observation which is also verified by the abundance of calcite and assists in further studying the evolution of these rocks.

The akrotopege “Barbarabad”, Carinthia, Austria

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The history of a mineral spring, with historical data, chemical analyses and references to literature is the topic of this article. The history of this spring with a water temperature below mean yearly surface temperature but with a pronounced mineralization goes back to the late 15th century. Already in the year 1506 the spring was called mineral spring (Heilquelle) and dedicated to holy Barbara. In the following centuries a lot of legends were told in combination with the therapeutic power of the water.

The first chemical analysis of the water was performed by Crantz and semi quantitative values for the content of calcium- and magnesium- sulphates were published by this author. The range of therapeutic applications varies from dermatologic diseases up to rheumatism in this time.

Accurate chemical analyses were given by Mitteregger and explicitly written: “In 10 000 G. T. ist enthalten: Abdampfückstand 2,70 G. T. [Gewichtsteile]. Aus dieser Analyse ist zu ersehen, dass dieses Wasser zu den indifferenten kalten Gebirgsquellen zu rechnen ist.” “In the 19th and in the first five decades of the 20th century the spring and the bath had an excellent reputation, after this time the owner ruined the whole buildings by bad management”. Nowadays no access to the spring and the environmental buildings is possible.

Perhaps by some relevant articles we can wake up this jewel to reality. Especially, while today the “originality” in all spheres of our life is of predominant interest.

On a comparison of olistostromes and olistoliths from the Cilento Flysch in the Southern Apennines (Italy) and the Northern Carpathians (Poland, Slovakia)

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Comparative studies show significant analogies of geodynamic stages between the S Apennines and the N Carpathians as well as analogies of occurrence of similar levels with olistoliths and olistostromes related to these stages. One of the periods with extensive development of olistoliths and olistostromes was related in both orogenes to the final geodynamic stage when internal margin of sedimentary basins as well as adjacent accretionary prism started to be extensively uplifted and overthrust onto their foreland. The redeposited blocks and olistoliths are of shallow water sediments and their adjoined basement of various ages. These have been derived from the internal margin of the basin as well as from older basin sediments transformed already into accretionary prism. In the Cilento Flysch unit (S Apennines) a level of chaotic deposits developed during Paleogene and/or Neogene. It crops out along coastal cliff at Tempa Rossa within the Cannichio Formation (Monte Stella Succession) where debris-flows rich of mudstone and sandstone clasts or olistoliths and sandstone layers folded and mixed together by submarine slumping are visible. They are partly similar to deposits of an olistostrome within the Hieroglyphic Beds (Silesian Nappe, Carpathians), which crops out along a shore of the Rożnów Lake.

In the Monte Sacro Succession (S Apennines) two large olistostromes occur within the Miocene San Mauro Formation. The upper one, about 100 m thick, includes large olistoliths (olistoplaques) of Late Cretaceous red shales. Comparable to it is an olistostrome within the Bystrica Subunit of the Magura Nappe by Rabka village (Polish Carpathians) that is built up of debris-flows, sandstone blocks and olistoliths of Eocene red shales. In both cases very

thick-bedded marly turbidites occur below. In the Carpathians other good example of olistoliths derived from basin margin are Bukowiec olistostromes within the Krosno Formation (Oligocene) which contain blocks of shallow water limestones and basement metamorphic rocks. Within the youngest sediments that terminated Western Carpathian flysch succession there are olistoliths derived from accretionary prism that was build up of older, Cretaceous and Paleogene rocks. Good examples are olistostromes within Menilite Formation in Skrzydlna and Klęczany with large olistoliths of Lower Cretaceous flysch deposits derived from a southern margin of the Silesian Basin. Locally, huge olistoplaques, up to hundreds meters in diameter, are also observed within the Krosno Formation (Late Oligocene - Early Miocene) in Gorlice - Jasło area that are represented by the Magura and Fore-Magura successions. The Monte Sacro Succession is terminated by a thick complex of conglomerates. That can be compared with the early Miocene Sloboda Conglomerates from the Borislav-Pokutya Nappe in marginal part of the E Carpathians

On the other hand, the olistoliths and olistostromes within the Cretaceous sediments of the Pieniny Klippen Belt are believed to be of origin related to the tectonic margin along the active ridge migrating during the Late Cretaceous till Early Eocene. The rising “cordillera” produced a huge amount of clastic material, mostly deposited in flysch facies sporadically intercalated with diastrophic slumped bodies.

Some spectacular outcrops of flysch and conglomerate olistostromes are in Orava river bank (N Slovakia), where thick flysch sequence of Turonian – Coniacian age contains bodies of chaotic slump sediments 15-80 m thick.

Nearby, at the Dolný Kubín town another type of olistostrome outcrops: the Late Cretaceous Globotruncana marls (Púchov Formation) are overfilled with clasts of Early to Late Cretaceous marls and marlstones. Both examples document the proximity of source area, and even the erosion of synchronous sediments involved. Such phenomena support the idea that at least part of the klippen in some areas of the Pieniny Klippen Belt is of sedimentary origin, as stated earlier and recently.

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The impact of a uranium mining site on the stream sediments (Crucea mine, Romania)

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XRF methods were used to evaluate the impact of uranium mine dumps on the stream sediments from Crucea region (Romania). In order to estimate the natural and anthropogenic inputs of radioactive and heavy metals in the sediments, normalization to Al was applied. The pollution degree of the bottom sediments show that U, Th and Pb reach medium and punctual high values, while the rest of the elements appears in concentrations close to the background or lower. The measurements carried out in the surroundings of a local uranium mine show that the impact of Crucea mine on water quality downstream of mining area is insignificant.

The Lower Danube Valley. Geological structure and evolution during the Pliocene-Quaternary

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Stratigraphical and geophysical arguments are put forward, whereby that the beginning of sediment deposition by the Lower Danube and by its tributaries date back to the Late

Pliocene (2.6 Ma) and go up to and into the Early Pleistocene. During the interval of 2.5–0.9 My, the Danube kept branching out gradually towards the east of the Dacian Basin. Concomitant, a number of intensely flooded low plains developed within the actual Romanian Plain as part of the Lower Danube Basin. Subsequently, during the Middle Pleistocene–Holocene, the Danube River cut the actual profile of the Valley. As a result, the higher relief of the Romanian Plain led to repeated down-cuttings of the 7 (8) stepped terraces. In the eastern half of the Lower Danube Valley, against the background of a mainly subsiding behaviour of the Platform, the upfinning sequences of the 7 terraces were progressively overlaid by the Aeolian Formation (up to 55 m thick). On the Black Sea continental shelf, within the Danube roughly 150 km long deep sea fan, there have been identified 8 seismic sequences, the first two with mass flow deposits, and the other six with alluvial channel fills. They have been ascribed, in accordance with their order of deposition, the indices S1 to S8. The S1 sequence may be ascribed to the 800–700 ka interval, and the S2 sequence to the 640–530 ka interval. According to Wong et al. (1997), the approximate intervals of deposition of the last six alluvial sequences are: S3 between 480–400 ka, S4 between 400–320 ka, S5 between 320–190 ka, S6 between 190–75 ka, S7 between 75–25 ka and S8 during the last 25 ka.

Using MODIS atmospheric profile data to monitor regional atmospheric instability in Greece: two case studies

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This study aims at investigating the potential of using atmospheric instability indices, derived by the MODIS/AQUA and TERRA atmospheric profiles, in local weather forecasting. The MODIS Level 2 Atmospheric Profile product consists of several parameters, including temperature and moisture profiles for twenty isobaric level and three atmospheric stability indices: the Total Totals (TT), the Lifted Index (LI), and the K index (K). All of these parameters are produced day and night at 5x5 km pixel resolution at cloud free conditions. The good spatial resolution of the MODIS instrument and of the derived parameters gives a good potential for the identification of pre-convective conditions.

Two cases of thermal induced convection over Greece on 17 and 20/6/2010 were examined. The first date is a typical case of an early afternoon thermal convection development over continental Greece supported by an advancing upper-level trough. The second case is characterized by the evolution of large storms during evening over Thessaloniki and north-eastern Greece associated with very high lightning activity. These storms were the result of a short wave upper-trough passage northern of Greece which triggered convection over the warm ground surface.

First, a comparison between the indices derived by MODIS and temporal matched collocated radiosonde data was performed to assess the quality of the derived parameters. From the above analysis it seems that the three satellite derived instability indices are well correlated with those derived from radiosondes.

Then maps with the spatial distribution of the atmospheric instability based on MODIS satellite data were constructed for the morning satellite passes (9:50 and 8:45 UTC, respectively), a few hours before the convection initiation, and were qualitatively compared to Meteosat Second Generation (MSG) satellite imagery and lightning data to investigate the relation between satellite derived air instability indices and storm occurrence. Among the three instability measures, the Lifted Index and K Index performed best in showing the potential of instability in this region several hours before the initiation of cloud formation.

These results show that MODIS remotely sensed data can be quite helpful in the short term storm prediction. More precisely, it is possible to derive air instability indices of satisfactory quality using MODIS satellite data. This allows us to have this kind of information with unprecedented spatial resolution in areas with no available radiosonde data. In addition, these satellite derived data can be used to visually enhance the areas of high likelihood of strong convection and of cloud growth in Greece at summertime.

From the operational point of view MODIS data are not timely since they are available only twice per day. Morning overpasses in Greece occur sometimes too late. Quite often convection has already started producing cumuliform clouds, which in turn prevent the atmospheric profile retrieval. The Global Instability Index (GII) product derived by the 15min time resolution geostationary MSG imagery could be used in the fast recognition and successful prediction of summer convective cloudiness and precipitation, despite its low spatial resolution (50 km).

Age and source heterogeneities in the rocks of Lutzkan and Ruy plutons, Bulgaria: some thoughts about their relation to the Au-mineralization at “Zlata” deposit

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The Lutzkan magmatic complex (LMM) belongs to the Kraishte tectonic zone of Bulgaria. It crops out as large plutons (Lutzkan and Ruy) and few small bodies S and NW from the town of Trun and about 50 km W of the Bulgarian capital Sofia. The rocks of the magmatic complex intrude amphibolite facies metamorphic rocks with presumed Precambrian age and Lower Paleozoic low-metamorphic carbonaceous metasediments, meta-andesite and metabasalts deposited in a deep marine environment. The intrusive rocks of the Lutzkan complex are covered by Permian sediments and overlain and intruded by Paleogene volcanic rocks and dykes. The rock types of Lutzkan pluton are considered to range from gabbros and diorites to leucocratic aplite-granites whereas the granites and granodiorites being the most widespread variety. The Ruy pluton and its vein rocks are mainly granitic in composition. The age of the plutons is considered Ordovician-Silurian or Lower Carboniferous.

Geochemical studies and U-Pb zircon/titanite conventional (ID-TIMS) and LA-ICP-MS dating of the plutons revealed that the gabbro-diorites of the Lutzkan pluton belong to the basement unit. They are Cambrian in age 537 ± 1.6 Ma (U-Pb zircon dating) with mantle-dominated island-arc geochemical characteristics (Ta-Nb negative anomaly; $\epsilon_{\text{Hf-zircon}}$ values between +8.9 and +12.4). The rocks are calc-alkaline, metaluminous, and A/CNK varies between 0.7 – 0.9. They show low fractionation of the REE with La_N/Lu_N of 4 and a weak Eu anomaly of 0.8. The gabbro-diorites have very low K_2O , Rb, Ba, Cs, Sr, Th, U contents and flat HREE distribution, slight enrichment in LILE and LREE. These features are consistent with a subduction-related geodynamic setting.

The granitoids of Lutzkan and Ruy pluton are dated at 334.1 ± 1.2 Ma by late magmatic titanites and at 332.57 ± 0.60 Ma by zircons, applying the “chemical abrasion” technique and the new double spike solutions of the Earth Time project ET2535. They show distinct geochemical characteristics: negligible or absent Ta-Nb anomaly; $\epsilon_{\text{Hf-zircon}}$ values between +3 and -10. The granitoids of both plutons are mainly high-K calc-alkaline, meta- to peraluminous, with A/CNK between 0.74 - 1.2, fairly enriched in K_2O , Rb, Ba, Cs, Sr, Th, and with important U content up to 21.4 ppm. Granitoids display fractionated trend of REE, La_N/Lu_N varying between 13 and 17, and moderate Eu negative anomaly (0.68-0.69). On spidergrams the granitoids show pronounced LILE enrichment. With the transition toward more compatible elements the trend becomes less fractionated. The geochemical characteristics and zircon inheritance imply melting of lower-middle crustal materials with mixed crust-mantle origin. A possible candidate might be the hosting amphibolite facies metamorphic rocks: the differentiated metagranites with MME there are dated at 588.3 ± 1.6 Ma by U-Pb zircon method and reveal positive (age corrected) $\epsilon_{\text{Hf-zircon}}$ values between +0.4 and +10.

Gold has been mined since ancient times in Trun region and has been traditionally related to the Lutzkan and Ruy plutons. The Lutzkan pluton hosts the first gold deposit in

Bulgaria, “Zlata”. It was mined from the beginning of the 20th century by English companies and in 1939-1974 by Bulgarian companies. The EurOmax Company has been exploring a license in the region of the Lutzkan magmatic complex since 2004. EurOmax classifies these deposits as Intrusion Related Gold (IRG) deposits with gold mineralisation related to the CO₂-rich gold bearing fluids produced by the cooling of the intrusion at depth (www.euromaxresources.com/projects). Although the deposit is not directly dated based on the type and the characteristics of the Au-Ag±W mineralisation we suggest a link with the differentiated Carboniferous granitic intrusion of LMM.

Climatological assessment of atmospheric instability indices for southeastern Europe

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Atmospheric instability indices are routinely used in operational forecasting for identifying the possibility of convective storm activity. This study focuses on the long-term temporal assessment of Showalter Index, SWEAT Index, K- Index and CAPE at three coastal (Athens, Istanbul and Brindisi) and at one inland station (Sofia) of southeastern Europe. The indices are calculated from daily archived radiosonde observations for a 36-year period, from 1973 to 2008. In order to identify meaningful temporal trends, a two-phase methodology is applied. The first step contains the assessment of the monthly, seasonal and yearly averages. The yearly trends of Showalter and SWEAT indices indicate an increase of atmospheric instability mean values for Athens, Brindisi and Sofia after mid 1990s. The second step, which is the primary focus of this study, is the assessment of index extremes. After the selection of index threshold levels, index extremes are studied in terms of threshold exceedences. The analysis reveals long term trends for some combinations of indices and stations.

Fe-Mn Nodular Concretions Associated with Middle Jurassic Oceanic Melange (Argolis, Greece)

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Fe-Mn nodular concretions from Angelokastron and Lykotroupi areas, Northern Argolis Greece, are friable and compact types. They are associated with Middle Jurassic radiolarian red chert and red siliceous shale matrix slivers, originated and detached from a Middle Jurassic oceanic mélangé. Friable Mn concretions consist of poly- or mononucleate nodules lacking primary botryoidal microstructures and possessing a unique composition. They form by the replacement of chalcedonic jasper by cryptomelane and todorokite; these concretionary crystalline manganese-structures are dissected by a birnessite phase oxidized to ntsutite and then crosscut by veinlets of hollandite and manganese carbonated fluoroapatite during late-stage hydrothermal alteration. The resultant composition consists mostly of manganese with a very low content of iron and transition metals. The mineralogical and chemical compositions differ from those of recent or fossil manganese nodules and are related to a hydrothermal field. Compact Fe-Mn concretions consist of jasper and chert dissected by veinlets of hydrothermal todorokite. Sulphides with magnetite characterize these concretions, even when altered and silicified. Some enclose scattered fragments of magnesiochromite with Ni-rich todorokite as veinlets and as concretionary crystalline structures. Some others, such as silicified basaltic fragments, contain remnants of copper mineralization such as sulfides, oxides, and hydroxide copper minerals, generated by an older hydrothermal event with subsequent oxidation. Furthermore, a few compact concretions, which were chemically treated, revealed that they contain equal amounts of iron and manganese similar to the

hydrothermal ferromanganiferous crusts on basalts. The reworked Fe-Mn nodular concretions resulted from submarine hydrothermal and fissural activity. These processes took place during the pre-emplacment period of an oceanic crust unit preserved today as the Subpelagonian ophiolite.

Tectonic evolution of the Argolis Peninsula (Greece)

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The Argolis Peninsula indicated a Tertiary nappe stack of different Pelagonian tectonic units structurally overlying the Subpelagonian series. From the base to top they consist of three major tectonic units, which have been successively emplaced throughout different extensional and compressional tectonic regimes: (a) the Para-autochthonous Subpelagonian Unit, as Lower Unit, which is composed by Middle Triassic - Lower Jurassic limestone sequence of Didyma-Trapezona, an ophiolitic mélange of Late Jurassic age, an ophiolitic nappe bearing pillow lavas with radiolarian red cherts of Triassic and Jurassic age and at the top by Meso-autochthonous series that is consisted of an unconformably cover by the Cretaceous to Eocene meso-autochthonous sedimentary sequences, which are tectonically overlain by Pelagonian-originated units, like a Middle Unit (b) Flyschoidal Mélange of Late Cretaceous - Early Tertiary age, associated with various carbonate and ophiolite tectonosomes trapped and carried within this highly disrupted terrigenous flyschoidal mélange and, (c) an Upper Unit consisting of Cretaceous carbonate slivers bearing serpentinite sole. An intra-Jurassic extensional regime (D0) has affected the limestone sequence of Didyma-Trapezona, which was subjected to an extensional stress-field of NE-SW direction. This extensional regime had an effect on the deposition of condensed pelagic limestone of Toarcian age and upwards to the tectono-sedimentary ophiolitic mélange of Late Jurassic age originated from the destruction of an oceanic internal basin. A Late Jurassic compressional stress-field (phase ϕ_1) with NE-SW direction affected the red cherts, which is responsible for the overthrusting of the pillow lavas ophiolitic nappe over the ophiolitic mélange and shows a movement towards the southwest with structural elements that are characterised by overturned NW-trending folds, shear planes and internal thrusts of similar direction having low angle of dip towards the NE and show a constant vergence towards the southwest. After the compressive tectonic phase of Late Jurassic, the Argolis at that time records a severe intra-Cretaceous extensional regime (D1) with NE-SW stress field direction leading to the successive transgression events and hiatus in sedimentation that have occurred from SE to NW of diachronous Meso-autochthonous Cretaceous limestone deposits, topped by deep-water limestone of Campanian-Maastrichtian and then from Lower Tertiary limestone passes upwards into post-Ypresian flysch of the para-autochthonous Subpelagonian Unit. The post-flysch compressional stress-field (phase ϕ_2) with NW-SE direction of late Eocene age, which may be connected with the Cycladic blueschist formation, during the Eocene continental collision of the Hellenides, has contributed to the formation of the Flyschoidal Melange Unit, overriding by the Upper unit, and finally has caused their thrust over the Para-autochthonous Subpelagonian Unit. This compressional phase activated the old lines of NE-SW direction and consists of fronts of internal shearing and thrusting of the same direction and with planes at low angle of dip towards the SE. The recognized structural data indicate a compressional movement towards the northwest. The Upper Unit, which tectonically overlays the Flyschoidal Melange Unit is also affected by the same post-flysch (ϕ_2) phase and was synchronously affected by a transtensional tectonic regime D2, which is characterized by an oblique slip of the normal faults with NE-SW direction and within the same stress-field direction. The neotectonic faults reveal an extensional regime (D3) with NNW-SSE direction stress-field that has affected the Neogene and Quaternary sediments, with a NE-SW trend (σ_3 , minimum principal axis of stress) and is responsible for the creation of Ligourio-Dhimaina and Drepano-Nafplio-Argos graben-like structures.

Structural interpretation of seismic data in Polish Outer Carpathians southwest and southeast of Krakow

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The deep structure of the Polish Outer Carpathians and its basement, that is southern prolongation of the North European Platform, has been recognized by deep boreholes as well as by deep seismic sounding profiles. The Polish Outer Carpathians are built up from the flysch deposited during Late Jurassic-Neogene times. They form nappes thrust over the southern part of the North European platform covered by the autochthonous Miocene deposits. Relationship between basement and flysch nappes in the Outer Carpathians is based on interpretation of seismic and magnetotelluric survey. The Precambrian basement beneath the Outer West Carpathians is divided into two basement blocks: the Upper Silesia Block on the west and the Małopolska Block on the east. The Krakow-Smilno Fault system marks the boundary between two different tectonic realms within the North European Plate.

In the area southwest of Krakow, the Precambrian basement is covered discordantly by Devonian and Upper Paleozoic formations. The Mesozoic sequences are known only from the eastern part of the investigated area, their thickness significantly increasing eastwards. The Miocene deposits lay discordantly on the various Paleozoic, Mesozoic and Paleogene rocks. The series of mainly normal faults reach top of Paleozoic, sometimes Miocene rocks. The biggest strike-slip faults cuts also allochthonous flysch sequences. In the area southeast of Kraków, the oldest rocks are represented by Precambrian phyllites covered by Paleozoic, Triassic, Jurassic, Upper Cretaceous and Miocene deposits. The investigated top of Jurassic horizon is cut by series of faults, dividing the Mesozoic basement into separate blocks. The large thrust Łąka faults are cutting through Paleozoic, Mesozoic, Miocene and allochthonous flysch sequences. The southwestern fault systems developed under mainly extensional regime with strong strike-slip component, while southeastern systems developed under mainly compressional regime.

Olistostromes and olistoliths: a historical review and modern perspectives

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The terms olistostrome and olistolith have been introduced by G. Flores (4th World Petroleum Congress, Rome, 1955) to indicate either mass-transported bodies with a chaotic block-in-matrix fabric, or single slide blocks, intercalated between layered sequences in the Tertiary succession of Sicily. Both terms soon became extensively used by the international geological community world-wide. With the extended usage, they evolved to generally indicate stratally disrupted to chaotic complexes and “exotic” bed packages, which originated by mass-transport events, mainly recycling extrabasinal rocks. In this extended meaning, the

concept of olistostrome played a significant role in other, important scientific debates, such as the origin of mélanges, being paradigmatically assumed as indicative of sedimentary processes (olistostromal mélanges).

We will briefly discuss what happened to the terms during the 50 years of their history and how this led to the following points:

1) Are the terms olistostrome and olistolith still to be used, and, if yes, with what meaning?

2) Olistostromes have been considered markers of either phases of basin instability and regional-scale tectonic events, or of peculiar geodynamical or tectonic stages. Are these assumptions true, or are olistostromes merely related to a specific condition of slope instability?

3) Olistostromes have been only seldomly studied from sedimentological point of view. Therefore, their translational and depositional mechanics, as well as the internal processes of stratal disruption and dispersion leading to their breccia-like, block-in-matrix fabric, are still poorly known.

4) The two previous points concern the genetical and regional relationships between the bodies defined as olistostromes and the more general category of mass-transport complexes (MTC), with a particular emphasis on the basin-wide ones.

In the sedimentary record of collisional chains, the majority of fossil MTC, including olistostromes, originated during the stages of intracontinental deformation, having been deposited in foreland and wedge-top basins. In some cases, collisional orogeny has allowed MTC related to extensional tectonics and passive margin to become exposed.

This contrasts with the observed abundance of present-day MTC, which prevail in passive and divergent margins and along the flanks of volcanic islands atop the oceanic crust. The present-day submerged contractional margins, however, do not show a significantly high concentration of MTC, apart from the erosional margins off the coasts of Peru. Moreover, basin-wide MTC are only present when catastrophic events occur, as in the case of the subduction of seamounts and volcanoes.

Some, possibly concomitant, solutions to these discrepancies will be discussed in this communication, with a special emphasis on the origin of mélanges in the accretionary wedges and relations between mass-transport processes, slope tectonics, contractional tectonics and mud diapirism.

Deterioration Processes of Travertine Monumental and Contemporary Stonestructures

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Architectural decorative elements as well as monumental stone structures made of travertine are subject to complex deterioration processes, which cause morphoses and strength reduction depending on climatic conditions.

Deterioration susceptibility was compared for travertine from boundaries of Mediterranean area (Hierapolis, Turkey) and from Lowland Polish area (Raciszyn, Poland). The comparison outcome is the observation that wall surface colours turn gradually to grey, become rough, and weather-exposed structure fragments crack irregularly and fall off.

For both travertine varieties, macroscopic analysis, microscopic analysis, scanning (SEM) analysis, and strength and strain tests indicated that younger Hierapolis travertine were more porous and lighter than Raciszyn travertine. Besides, Hierapolis travertine featured a lower strength as a result of a significantly stronger leaching out of organic debris, and of a lower crystallization extent level for the carbonate skeleton structure.

Comparative porosity tests made for new Hierapolis travertine (HO) and for ancient quarry Hierapolis travertine (HA) provided with a conclusion that since the ancient time until presently, the material porosity increased by range of 60%, while the strength decreased by

range 50%. At the same time, accelerated deterioration tests under lab conditions proved that a further deterioration of this weathered and porous material gave reason for an entire decomposition of structure to irregular rubble chips.

As determined in further tests, the reason for travertine deterioration was mainly the structure weakening due to the leaching of carbonate compounds, organic fragments in particular. Located in the voids created that way, the secondary material was removed at a later time by eolian action or by infiltration. This process developed dynamically because travertine featuring a low resistance to varying temperatures in both climatic environments was exposed to temperature impact. The frost action caused a strength reduction by approx. 20% of the fresh materials, and in case of advanced weathering (HA), material is decomposed very soon. Similarly, above-zero temperatures reduced the fresh material strength by range 20% and even more than 60% for advanced weathering (HA). In those case for the weathered material integrity factor $I_{RC} = 0.12\%$ for the weathered material. Laboratory tests of deterioration processes with application of ultrasonic methods and strength tests indicated that thermal changes were the major factor for a slow destabilisation of travertine structure in both climate zones. Sunlight operating at daytime combined with cooling down at night for surfaces of ancient structures over centuries - that was the reason for a significant loosening of inter-grain bonds and the strong eolian erosion, which was made even more serious by biological weathering, and which led to falling apart to irregular pieces due to absence of any maintenance work.

Travertine rocks feature a relatively significant resistance to salt solutions. In highly porous materials, salt can freely crystallize inside voids without any damage to the structure. This positive feature is significant, in particular under moderate climate conditions where travertine used as an elevation material is exposed to adverse winter weather factors.

K/Ar mineral geochronology of the northern part of the Sithonia Plutonic Complex (Chalkidiki, Greece) and implications for its thermal history

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The Sithonia plutonic complex (Chalkidiki, Greece) occupies the greater part of the Sithonia Peninsula intruding the Circum Rhodope Massif to the west and the Serbomacedonian Massif to the east. It comprises an Eocene pluton and so far, its origin and evolution has been studied by many researchers. The subject of the present study is the K/Ar mineral geochronology of the northern part of the pluton which consists of three main bodies, the Two-mica Granite (TMG), the Porphyry Leucogranite (PLG) and the Leucogranite (LG).

The systematic K/Ar study of the pluton along with existing Rb/Sr mica and U/Pb zircon ages are used to investigate the thermal history of the pluton and shed light on the process that affected it and resulted in discordant Rb/Sr and K/Ar mineral ages. Thirty-nine samples of muscovite biotite and K-feldspar samples were selected according to the lithological characteristics and spatial distribution. These samples yielded K/Ar ages ranging from 38 to 49 Ma for muscovites, 32 to 47 Ma for biotites and 37 to 43 Ma for K-feldspars respectively.

The K/Ar geochronological results indicate that the mineral ages of TMG and PLG are in accordance with the principles of the isotopic closure temperatures of the K/Ar isotopic system, but the geochronological results of the LG indicate disturbed behaviour.

The processing of the geochronological data with the K/Ar isochron method, in association with the Rb/Sr data, indicates that a reheating event took place and disturbed the isotopic systems of biotite and K-feldspar but did not manage to disturb the isotopic system of muscovite. Regarding the thermal evolution of the LG, it is considered that the voluminous

pegmatite intrusions in the LG area disturbed the isotopic systems of the two minerals but the simultaneous or imminent reheating mentioned above caused the resetting of the K-feldspar isotopic system and partly the biotite isotopic system.

The reheating event, which is probably associated with a tectonic event, that disturbed the mineral isotopic systems exceeded the closure temperature of biotite for the Rb/Sr isotopic system ($350 \pm 50^\circ\text{C}$), but did not exceed the closure temperature of muscovite for the K/Ar isotopic system ($375 \pm 25^\circ\text{C}$).

The comparison of the K/Ar mineral ages of the present study, the existing Rb/Sr and U/Pb mineral ages and the closure temperatures of the different isotopic systems for the different minerals indicate a high cooling rate for the TMG of the Sithonia pluton which reaches $60 \pm 12^\circ\text{C}$ per million years, received as minimum due to thermal event that caused slightly younger biotite and K-feldspar resultant ages. This is in agreement with the aspect that the extensional collapse of the Hellenides where the Sithonia pluton intrudes started during Eocene.

Upper Triassic platform, slope and basin facies of the Pilis Mountains (Transdanubian Range, Hungary)

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The Pilis Mountains is located in the NE part of the Transdanubian Range. It is a narrow fault-bounded range of NW–SE strike, 30 km NW of Budapest that consists of Triassic platform carbonates and coeval slope and basin facies. Due to the NW general dip of the succession the oldest formations crop out at the southwestern end of the range. Here the Norian Main Dolomite is overlain by bedded Dachstein Limestone of Middle to Late Norian age. Further NW, along the steep northeastern slope of the range Norian slope and basin facies are exposed (Feketehegy Formation). The slope facies are characterised by redeposited platform-derived carbonates and mollusc coquinas. Above the coquina beds of the Feketehegy Formation near-reef facies was encountered in the north-westernmost Triassic blocks of the Pilis Mountains. Based on investigation of the bio- and lithofacies, palaeographic setting and evolution of a Late Triassic intraplatform basin (Feketehegy Basin) could be outlined.

The NE part of the Transdanubian Range was relatively close to the edge of the passive margin of the Neotethys Ocean. The extensional regime due to the continuing ocean opening led to development of smaller or larger intraplatform basins in the outer platform belt during the Late Triassic. The Feketehegy Basin was one of them, which formed in the Middle to Late Norian. Low-angle slopes developed between the platform and the basin, site of deposition of large amount of platform-derived sediments. Patch reefs and ooid shoals came into being along the margin of the newly formed basin. Bivalves *Pseudomyoconcha* and *Pteria* inhabited the platform margin and the upper slope from where large amount of shells redeposited by storm currents and accumulated on the low-angle slope in the form of storm coquinas. Reworked ooids, strongly abraded bioclasts and locally reef-derived bioclasts and lithoclasts of various origins were deposited in the deeper part of the slope, above the storm wave base. Further basinward fine-grained tempestites were deposited below the storm wave base in a restricted, oxygen-depleted basin. The basin evolution came to an end probably in the latest Norian to Rhaetian when the prograding platform reoccupied the former basin.

Structure of the Podhale basin – new insights from seismic data interpretation

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Interpretation of seismic and well data from the Podhale basin was completed within the international TOPO-EUROPE Programme, that addresses the 4-D topographic evolution of the orogenic belts and intra-plate regions of Europe through a multidisciplinary approach linking geology, geophysics and other methods. TOPO-EUROPE consists of 10 projects, with Thermo-Europe as one of them. The Thermo-Europe project aims to test alternative mechanisms for the potential coupling of climate and tectonics at various scales across Europe. This will be achieved through improved documentation of the rates and distribution of erosion during the Neogene and through modelling the tectonic response to this signal of erosion. Within Thermo-Europe project 8 Individual Projects (IP) and 3 Associated Projects (AP) are distinguished.

For the IP 8 Thermo-Europe project “Mechanisms of uplift and erosion in the Carpathian thrust wedge and foreland basin” three main study areas have been identified: Carpathian foredeep basin, High Tatra Mts. (Inner Carpathians) and the Podhale Basin. Within the Podhale basin, main research goal is to explain time and space relationship between the basin inversion, mountain uplift and sedimentation.

The Carpathian thrust belt consists of three main tectonostratigraphic domains: the Inner Carpathians (including the High Tatra Mountains and the Podhale basin), the Pieniny Klippen Belt and the Outer Carpathians (with their outermost unit formed by the compressionaly deformed foredeep deposits) flanked to the north by the mostly undeformed Carpathian foredeep basin.

The Podhale basin is a part of a larger structure called Central Carpathian Paleogene Basin. It is interpreted by some authors as forearc basin. The Paleogene sedimentary infill of the Podhale basin consists of two different complexes. The older one is up to 100 meters thick and consists of Eocene limestones, the so-called Nummulite Eocene. It is almost completely covered by the Upper Eocene-Upper Oligocene flysch series (shales and sandstones), up to 3000 meters thick. The Podhale basin is situated between the Tatra Mountains in the South and the Pieniny Klippen Belt to the North. In the South, the flysch beds dip northward at low angle, in the central part of the basin they are almost horizontal, and only along its northern limb the Paleogene succession is strongly folded, sometimes even vertical. Such basin-scale geometry is a result of Tertiary activity of large strike-slip fault zone that forms boundary between the Podhale basin and the Pieniny Klippen Belt. Numerous transverse faults active in Middle Miocene cut the Podhale Paleogene succession, i.e. the Bialy Dunajec fault zone (located in the central part of Podhale basin) and Bialka fault zone (located in the eastern part of Podhale basin).

Various studies have been carried out within the Podhale basin. Most of them were based on field structural and stratigraphic studies, coupled with analysis of well data. Since late 1970' geophysical methods have also been used to study this area. Recently completed reinterpretation of 2D (acquired in 1970' and 1980') and 3D (acquired in 1990') seismic data, calibrated by several deep boreholes, provided new insight into certain aspects of structure and geological evolution of the northern part of the Podhale basin, adjacent to the Pieniny Klippen Belt. Podhale flysch infill (Zakopianskie and Szaflarskie beds) seems to unconformably rest on deformed Mesozoic substratum, equivalent to the Tatra nappe system. This might suggest early Paleogene initial minor uplift of the Tatra region to the South. To the North, Paleogene flysch series together with their Mesozoic substratum seem to be upturned, and this large-scale geometry might be interpreted as caused by drag folding along steep, possibly strike-slip fault, bordering Pieniny Klippen Belt. It is also possible that lower part of the Paleogene infill (Szaflarskie beds) might have been deformed by south-verging thrust faulting and associated north-verging backthrusting. This might have been related to the Miocene regional strike-slip movements along the Pieniny Klippen Belt.

High-resolution optical and acoustic 3D seafloor reconstructions from robot and diver-based surveys

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Robust simultaneous localization and mapping (SLAM) techniques have become standard techniques for navigation of robotic platforms over the last decade. SLAM allows autonomous robots to use environmental information to improve their navigation and map estimates. A key aspect of SLAM is that it maintains a representation of the uncertainty of the map and vehicle trajectory. This enables a principled (and automatic) approach to enforcing consistency in maps when revisiting an area (such as when ‘closing a loop’ or when using overlapping tracklines). In essence, SLAM allows multiple views of the same feature to be mapped to the same location, reducing map errors such as drift and repeated structures. In the context of underwater surveys, SLAM enables properly instrumented robots to collect data and generate geo-referenced, self-consistent maps. In practice, these algorithms fuse multiple sources of navigation data such as surface GPS, acoustic positioning, Doppler velocity log (DVL), inertial measurement units (IMU) and depth, with environmental observations from cameras and sonar.

This paper presents a brief overview of the capabilities that the marine robotics group at the Australian Centre for Field Robotics (ACFR) has developed in terms of improved high resolution optical and acoustic mapping, automated interpretation and visualization. We then show how some of these technologies have been applied to SCUBA-based surveys that result in high-resolution, geo-referenced 3D mosaics without requiring robotic platforms.

We present results from the autonomous underwater vehicle (AUV) Sirius and a diver-held stereo camera rig. Both natural and man-made structures are reconstructed, with techniques that enable large-scale composite views that preserve 3D structure. Preliminary results for monitoring applications are also presented, discussing the ability to revisit an area and detect changes in time.

The range of capabilities developed at the ACFR can potentially assist underwater archaeology in a broad range of applications including the automatic generation of 3D reconstructions of large underwater sites, effective visualization and interaction of archaeologists and general public with these reconstructions, and potentially automated monitoring for degradation or disturbance of archaeological sites.

Tracing the ancient tectonic processes by coarse-grained, mass-flow deposits: the Western Carpathian Mesozoic – Palaeogene case history

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Tectonically generated mass-flow deposits, such as terrigenous tectonosedimentary breccias and flysch-related conglomerates, form stratiform bodies of coarse-grained, poorly sorted resediments inserted within more fine-grained, usually deep-marine clastic and/or pelagic sediments. They were emplaced by some gravity-driven mechanism and include various block-in-matrix type sediments named as olistostromes, pebbly mudstones, scarp breccias, wildflysch, etc. The mass-flow deposits may occur in a range of environments and

tectonic settings – either extensional, or contractional. The former are designated as the synrift, the latter as the synorogenic conglomerates. Both provide very useful palaeotectonic information, since their composition and stratigraphic position often allow an exact timing of distinct orogen-scale tectonic events. We present a case study of tectonosedimentary conglomerates from the Central Western Carpathians (CWC) and Pieniny Klippen Belt (PKB). They are interpreted as unique tracers of Mesozoic–Palaeogene tectonic history of the Carpathian orogen.

Extensional tectonic regimes are mostly associated with rifting events, when newly formed basins are quickly subsiding and filled with terrigenous clastic material derived from uplifted rift shoulders. The extension-related synrift breccias were exclusively fed by local, normal fault-related sources and their composition reflects ongoing denudation of the source areas. Deposition may cover a considerable time span (tens of Myrs), on condition that rifting occurred in several pulses.

The first Mesozoic synrift breccias in the Western Carpathians are known from the Middle Triassic. They were related to the late Anisian rifting and breakup of the Meliata Ocean. Early–Middle Jurassic extensional phases are recorded by halfgraben formation and comparatively widespread synrift clastics, such as olistolite-bearing scarp breccias in the Tatric, Fatric and Oravic domains. Aprons of proximal breccias are interfingering basinwards with hemipelagic or sandy turbidite-dominated sediments. Their composition reveals stepwise exhumation and erosion of the source areas and they are interpreted as activations of rift shoulders generated by rifting and breakup events of the South Penninic-Vahic Ocean. The lowermost Cretaceous breccias occur in the Tatric and Fatric, but mainly in the Oravic superunit, where they record the North Penninic-Magura oceanic breakup. Still younger, Barremian–Aptian olistostromes occur in the ridge-related Tatric and Fatric units.

Synorogenic sedimentary complexes related to compressional tectonic regimes terminate the sedimentary successions of inverted basins. In the course of ongoing deformation, they are often destroyed shortly after origin and their material can be recycled several times. Synorogenic breccias/conglomerates contain a variable material derived from wide orogenic zones characterized by a complex geological structure. The contraction-related mass-flows exhibit a distinct coarsening and thickening upward trend. Unsorted material eroded from the overriding sheet and well-rounded and sorted material derived from distant subaerial sources and/or recycled from older conglomerates, are often mixed together. Their deposition seldomly exceeded a few Myrs; thus their sedimentary age narrowly constrains the timing of related thrusting events.

Middle–Upper Jurassic olistostromes of the Meliatic and Silicic units represent the synorogenic breccias formed in response to the Meliata Ocean closing. In the paleogeographically more northern areas, the first such sediments appeared in the Aptian–Early Albian of the Fatric domain where they record the incipient inversion of this large intracontinental rift basin. Subsequently, the thick prisms of mid-Cretaceous “exotic” conglomerates of the Tatric-Fatric units (incl. the PKB Klape unit) were deposited. Senonian–Palaeogene synorogenic breccias are particularly frequent in the front of the CWC orogenic wedge where they originated in response to subduction of the Penninic oceanic zones (Váh and Magura Oceans) and collision of their former continental margins. In the PKB, the deep-marine conglomerate bodies with olistoliths were formed in relation to thrusting events of the Oravic units. Their composition directly reflects lithology of the overriding thrust sheets. It has been found that numerous “klippen” are in fact olistoliths – a feature often overlooked until now.

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New structural and geochronological data for the Tertiary evolution of the Rhodopes

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The Rhodope Metamorphic Province was traditionally believed to be a craton consisting of mostly Precambrian basement rock units and separated into numerous blocks along steeply dipping brittle faults (see e.g. the official 1:100000 scale Bulgarian geological map). In the past few decades, the Rhodope Metamorphic Province was recognized as being part of the Alpine-Himalayan chain by a growing number of publications. Recent tectonic studies, including the new 1:50000 scale Bulgarian geological map, generally subdivide the Rhodope Metamorphic Province into lithotectonic units that have been deformed internally while they were transported relative to each other along low-angle faults. Despite some differences, most published tectonic maps agree that the lowest tectonic levels of the Rhodope Metamorphic Province are represented by leucocratic gneisses and thick marble in the Drama Window between the Strimon Valley and the Nestos Shear Zone and by orthogneisses exposed in the Central Rhodope, Kesebir-Kardamos, and Biala Reka-Kechros Domes. They are overlain and framed by intermediate and upper tectonic units containing small proportions of metabasic and metaultrabasic rocks that are commonly interpreted to be ophiolites. Recent studies have shown that the orthogneiss protolith ages of the lower, intermediate, and upper levels are markedly different, reflecting different palaeogeographic origins of the units comprised in these tectonic levels.

The formation of the main gneissic foliation ended before the Tertiary in upper tectonic levels which are locally overlain by Maastrichtian sediments. In the intermediate level, the formation of the main gneissic foliation continued into the Eocene and the oldest overlying sediments are (Middle to?) Late Eocene in age. Very recent radiometric data provide evidence that top-SW thrusting of the intermediate and upper tectonic levels over the lower level along the Nestos Fault continued well into the Eocene.

From the Middle or Late Eocene on, top-SW faulting in the SW Rhodopes was extensional, leading to the formation of large sedimentary basins. Our structural studies, combined with stratigraphic constraints from the basin sediments and radiometric data of pre-, syn-, and posttectonic magmatic rocks point to a two-stage history of extension in the SW Rhodopes that finally led to the formation of the Drama Window. A first Late Eocene stage of extension was accommodated along the Ribново-Mesta-Kerdilion fault system and followed by an Early Oligocene phase of normal faulting along steeply NE-dipping faults. After a phase of relative tectonic quiescence in the Late Oligocene and Early Miocene, a second stage of extension, related to clockwise rotation of the western Aegean domain, started in the Middle Miocene.

In the Central and Eastern Rhodopes, top-N extension took place in the Palaeogene. We found evidence for a top-N low-angle normal fault (Kyuse-Hasanlartepesi Fault) between the Central Rhodopean basement and the sediments of the Eastern Rhodope Basin that was active in the latest Eocene and earliest Oligocene. Our new LA-SF-ICP-MS U-Pb data for zircons from sheared and undeformed pegmatite veins provide evidence that an older top-N(W) extensional Fault (Borovica Fault) inside the Central Rhodopean basement was active in the Lutetian. At the same time, normal faulting went on above the Kesebir-Kardamos Dome further east.

The present-day geometry of the tectonic units exposed in the Rhodopes is largely the result of Eocene to Miocene extensional tectonics which strongly reshaped the pre-extensional geometry of the Rhodopes. Age constraints for the earlier contractional stages have been obtained mostly by dating of zircon or monazite from (ultra-) high-P eclogites and metapelites occurring in the intermediate and upper tectonic levels. These ages show a

considerable scatter between the Middle Jurassic and Middle Eocene which probably reflects complex P-T-t paths. Eocene ages for high-P metamorphism have so far only been reported from two localities in the intermediate tectonic level, i.e. the Sidironero Unit in Greece. We present new results of Lu-Hf garnet geochronology for three eclogites sampled in different localities from a part of the Starcevo Unit in Bulgaria, which belongs to the intermediate tectonic level. These data corroborate a Lutetian age of high-P metamorphism in the intermediate level while a fourth sample from the upper tectonic level (Kardžali Unit) yields a Barremian age. Exhumation of the intermediate tectonic level from a depth corresponding to the Eocene high-P metamorphism was probably accommodated by top-N shearing along the Borovica Fault (coeval with thrusting along the Nestos Fault) and later along the Kyuse-Hasanlartepesi Fault. The Borovica Fault is probably the boundary between the upper and intermediate tectonic levels.

New insights on the occurrence of a Variscan suture in the Upper Danubian Nappe (Romania, Serbia, Bulgaria) evidenced by ^{40}Ar - ^{39}Ar geochronology

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The Alpine Upper Danubian Nappe crops out in the Southern Carpathians in Romania and in the North of the Balkans in Serbia and Bulgaria. The pre-alpine basement of this Nappe displays an important tectonic marker in the form of the Danubian Ophiolite. This Ophiolite (~ 500 km²) has been dismembered by the Oligocene Alpine tectonic in four ophiolitic massifs: Tisovita Iuti in Romania, Deli Jovan and Zaglavak in Serbia and Tcherni Vrah in Bulgaria. Although the Danubian Ophiolite has been considered as Late Proterozoic during the last decades, the Deli Jovan massif has been recently dated to the Lower Devonian (U-Pb zircon age of 405 ± 2.6 Ma). Our study gives a petrostructural analysis investigated on listvenitic gabbros from the Tisovita Iuti ophiolitic massif and their adjacent rocks (Corbu Unit) and provides new geochronological data on the listvenitization processes.

Listvenitic gabbros consist of a metasomatic assemblage composed of zoisite + calcite + Cr-chlorite + Cr-muscovite developed on amphibolitized gabbros under strongly hydrated conditions at temperatures around 280°C. They are located in a thin N-S band at the Eastern part of the Tisovita Iuti ophiolitic massif and generally display a mylonitic texture. Similarly, the Corbu Unit crops out in a 2 km wide N-S band, at the eastern part of the listvenitic gabbros, and consists of a mélange of slices composed of various metamorphic rocks (volcano-sedimentary rocks, margin sediments, acid volcanic rocks and ophiolitic rocks) from low- to high-grade.

Structural data obtained on listvenitic gabbros and on Corbu rocks indicate that these two units have undergone a similar deformation, which is partitioned between highly deformed mylonites and slightly-deformed juxtaposed rocks. These rocks display high-dip North-Southward foliation planes, associated with a strong subhorizontal stretching mineral lineation and isoclinal folds parallel to this lineation. These fabric elements appear to develop during the same event, giving evidence for components of both simple and pure shear, suggesting a deformation which probably occurred in a transpressive context.

New ^{40}Ar - ^{39}Ar ages performed on two Cr-muscovites from slightly and highly listvenitized gabbros give plateau ages of 372.6 ± 1.3 Ma and 360.6 ± 1.2 Ma, respectively. As the listvenitization process involves important chemical remobilisations with the presence of CO₂-rich fluids and according to the similar deformation type encountered both in the Corbu mélange and in the listvenitic gabbros, we propose that these rocks are formed close to

an accretionary wedge and probably correspond to the obduction sole of the Danubian ophiolite during a Variscan oblique collision.

These results imply the occurrence of a Variscan oceanic suture in the Eastern part of the Variscan Belt, classically ending in the Sudetes Area (Poland). Moreover, the Late Devonian closure of the Danubian oceanic domain is very similar to data observed for the evolution of the Rheic Ocean and its associated basins.

Petrology and geodynamics: findings from Dinarides – Hellenides and adjoining regions

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Subduction-related mantle derived melts in the Dinarides and Hellenides commonly display large compositional variations. Focusing on Tertiary granitoid and volcanic mafic products and using major and incompatible trace elements as proxy to get insights on metasomatic events, diagrams show that mafic melts ranging from calc-alkaline to shoshonitic and ultrapotassic are ubiquitous, indicating the coeval occurrence of mantle-derived melts with strongly different enrichments of incompatible elements. These findings suggest that a heterogeneous mantle, able to generate such a rich compositional variability of melts, existed during Tertiary in the area.

Actually, two mantle source compositions are considered just as two extreme end-members occurring in a mantle wedge able to generate melts spanning all intermediate potassium compositions. The first end-member can be interpreted as being derived by partial melting processes of a strongly metasomatized mantle source where K-rich phases, such as phlogopite, played a key role. The low contents of Al, Na, and Ca, and the high concentrations of compatible elements argue in favour of a restitic peridotitic source. The second mantle end-member shows higher Al, Na, and Ca contents, and lower contents of compatible elements, suggesting a derivation from a fertile metasomatized lherzolitic mantle source.

The main question arises as to what processes may generate such an inhomogeneous mantle wedge. Numerical simulations of infiltration of metasomatic fluids into a lithospheric mantle wedge have been performed. We consider a fractured lithospheric mantle wedge in which metasomatic fluids, released by dehydration of the oceanic slab, infiltrate. For simplicity sake we consider that fluids are constituted by only one “metasomatic agent” (e.g. K₂O). The fracturing of the mantle is assumed to be random. We also assume that fractures are always saturated with the metasomatic fluids and that metasomatism is developed by diffusion of such fluids from fractures to the surrounding mantle. Results show that the efficiency of the process is directly proportional to the density of fractures: the higher the density of fractures, the higher the metasomatism in the mantle wedge. This process resulted in coexisting portions of mantle that suffer metasomatism at very variable degrees, leading to a “leopard-skin”-like mantle. Partial melting of such a heterogeneous mantle wedge would produce mafic melts with highly variable degree of enrichment of incompatible elements. On the basis of these considerations we suggest the presence, during the Tertiary, of a metasomatized “leopard-skin” mantle wedge with highly variable chemical compositions, the partial melting of which may explain the wide compositional spectrum of mafic magmas in Dinarides and Hellenides.

Mantle metasomatism and magmatism can be attributed to the complex geodynamic evolution of the area. In particular, we suggest that two subduction events metasomatized the same mantle wedge from Early Jurassic to Tertiary, the partial melting of which led to strongly different mafic magmas.

Characteristics of cyclic Upper Triassic platform carbonates in the Transdanubian Range, Hungary and in the Pelagonian Zone, Greece – a comparison

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For comparative studies of the Upper Triassic cyclic platform carbonates, the Transdanubian Range, Hungary and the Pelagonian zone, Greece were chosen. Palaeogeographically, they represent two distant segments of the passive margin of the Neotethys Ocean. During the Late Triassic, on this wide margin an extremely extensive tropical carbonate platform domain was developed referred to as the Dachstein-type carbonate platform system. The Transdanubian Range (TR) represents a segment of the continent encroaching platform, whereas the Pelagonian-Subpelagonian zone (PG) may have been a large isolated platform surrounded by deep-water basins. The discussed Upper Triassic thick platform carbonates (Földolomit/Hauptdolomit Formation and Dachstein Limestone in TR, and Pantokrator Formation in PG) are made up of cyclically arranged facies deposited under similar environmental conditions in the interior zones of the platforms. Three major characteristic facies types can be distinguished: shallow subtidal–lagoonal (e.g. megalodon-bearing, bioclastic, and/or peloidal, and/or oolitic wackestones, packstones or grainstones), intertidal (e.g. microbial stromatolites, fenestral mudstones) and supratidal-pedogenic (e.g. calcretes-dolocretes, palaeosoils), which correspond to the three typical and macroscopically distinguishable lithofacies (members C, B and A) of Fischer's (1964) Lofer-cycle. The cycles are usually bounded by discontinuity surfaces (d) related to subaerial exposure and subsequent pedogenic alteration. The meter-scale (Lofer) cyclicity is predominant throughout the successions. However, various stacking patterns including symmetric complete (d-A-B-C-B'-A'-d), truncated, incomplete, and condensed cycles or even alternating peritidal and subtidal facies without any unconformity are recognized in both areas studied. Pervasive or partial early diagenetic dolomitization affected some parts of the cyclic successions in both areas. However, age-dependence of the early dolomitization was clearly demonstrated only in TR, where the older part of the carbonate platform succession (latest Carnian to Middle Norian) was subject to pervasive dolomitization, whereas the younger part is non-dolomitized and there is a transitional unit between them. This trend is attributed to changing climate from semiarid to more humid. In the NE part of TR the carbonate platform drowned at the Triassic-Jurassic boundary, whereas the platform conditions prolonged until the end of the Hettangian in the SW part of TR. However, the Hettangian segment is characterized by non-cyclic subtidal oncoidal limestones, implying upward deepening trend. In contrast, in PG the platform conditions continued until the early to middle Early Jurassic, and the Lower Jurassic succession is typified by well developed pedogenic features suggesting long lasting subaerial exposure intervals, i.e. an upward shallowing trend.

Summing up, the Upper Triassic platform carbonates of the TR and PG show strikingly similar features concerning the litho- and biofacies, the stacking pattern and the thickness of the elementary cycles, despite their distant and different palaeogeographic setting within the western Neotethys realm. This suggests eustatic signal, i.e. the cyclic deposition was essentially controlled by orbitally forced eustatic sea-level changes, although the contribution of autocyclic mechanisms cannot be excluded either. Definite signatures of subaerial exposure (karstic features and vadose meteoric diagenesis) at and below the cycle boundaries also support the allocyclic control.

Seismicity in the southern part of the Harghita Mountains and its possible correlation with recent volcanic activity

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The southern part of the Harghita Mountains, in the South-Eastern Carpathians represents the site of the most recent volcanic eruptions from the entire Carpathian-Pannonian region. The products of these eruptions were dated using radiocarbon method ranging 42–10 Ka. The composition of the magmas is high-K calc-alkaline with adakite-like features, characteristic for a post-collisional regime. Ciomadul, the most recent volcano at the southern end of the Harghita Mountains, is situated in the southernmost prolongation of the Călimani-Gurghiu-Harghita range along the inner part of the South-Eastern Carpathians started about 11 Ma ago in the Călimani Mountains and migrated in time and space from NW to SE. Ciomadul volcano is located in the rough proximity of the Vrancea seismic zone (a shift of about 60 km toward NW) and its magma generation is attributed to the geodynamic events closely related to the seismogenic area. Recent investigations show a number of particular geophysical and geochemical features located in the study region including: 1) the abrupt attenuation of the seismic waves coming from the Vrancea intermediate depth foci for paths going towards the southern edge of the Harghita Mountains, 2) the most intense heatflux anomaly in the whole Romania, 3) the most prominent ³He/⁴He anomaly measured in natural gases and thermal mineral waters, are all in favour of the hypothesis of a still existing local hot magma chamber. Until recently, very few earthquakes were recorded in this area. Data acquired during recent seismicity monitoring of the Vrancea zone, also benefited from the stations installed in the interior of the Carpathian bend area suggest a possible enhancement of the local seismicity beneath the southern edge of the Harghita Mountains, both in the crustal and subcrustal levels. At the same time, recent tomography images obtained using local earthquake data correlate well with the presence of a vertical low-velocity material coming from the upper mantle to the assumed magmatic chambers located in the crust.

The purpose of the present paper is to investigate the seismicity patterns in the crust and in the mantle at the inner side of the SE Carpathians, with special focus on the southern Harghita Mountains volcanic area looking for possible correlations with most recent volcanic activity. At the same time, our goal is to integrate the results in a global and coherent geodynamic model and to provide on this basis a first framework for hazard assessment related to possible future activity in Romania.

The stylopodium and zeugopodium of *Mammuthus meridionalis* (Nesti) discovered at Leu, Dolj County (Romania)

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The paleontological deposit from Leu, discovered in 1998, is situated 25 km southeast from Craiova (South-West of Romania). This deposit is located on the right slope of the Frasin Valley, at about 10 m height as against the stream of water, in a sand and gravel quarry.

The paleontological content is the following: *Mammuthus meridionalis*, *Stephanorhinus* group *etruscus/hundsheimensis*, *Equus stenorhinus* Cocchi, *Leptobos etruscus* Falconer, *Leptobos* sp., *Eucladoceros* sp., *Castor plicidens* Major, *Ursus etruscus* Cuvier and a few coproliths belonging to a canid.

The mammalian association from Leu was attributed to Pleistocene, namely to the zone MN 18.

The fauna discovered at Leu is similar to the ones already described, located in several deposits in Oltenia – Irimesti (Mitilan’s Fountain), Tetoiu (Bugiulesti) – horizon 2 – and from the Romanian Plain – Prundu.

In Eastern Europe, the fauna from Leu is equivalent to the fauna from the Odessian Complex, which contains the same large mammals. In Central Europe, an equivalent could be the Kisslingian level in the Netherlands, the correspondent could be represented by the Eburonian level. In France and Italy, the equivalents are the faunas from Senèze and Olivola.

Most of the fossil samples (over 90%) discovered at Leu belong to the species *Mammuthus meridionalis*: three mandibles, two upper M3, 24 vertebrae, numerous ribs, carpians, metacarpians, tarsians, metatarsians, patellas, and phalanx. To these elements, the bones of stylopodium and zeugopodium are added: one humerus, one radius, one cubitus, one femur, six tibiae and two fibulae.

The humerus of *M. meridionalis* discovered at Leu is reconstituted from several fragments and it presents deteriorations at the cranial side of the proximal extremity. It is characterized by massiveness and poor relief. The head is low and broad.

Unfortunately, the ulna is rather deteriorated.

The radius discovered at Leu is reconstituted out of several fragments and it presents deteriorations at the proximal extremity; the distal extremity is missing.

The femur discovered at Leu is characterized by the following peculiarities: relatively short diaphyse, under-developed head and badly emphasized condyles.

The six tibiae of *M. meridionalis* from Leu are massive and rectilinear. The proximal extremity is the greatest portion of the bone. The shaft of the bone has a prismatic shape in the proximal half, while in the distal half is closer to a cylindrical shape. The distal extremity displays a cochlea for the articulation with the astragal.

In Romania, *M. meridionalis* as a species is relatively frequent at the level of Pleistocene, but descriptions of the post-cranial skeleton undertaken so far are scarce and extremely concise.

This research is a contribution to the better knowledge of the post-cranial skeleton of the *M. meridionalis* species.

New data regarding the resources of tellurium and its distribution in the waste dumps and tailing dam from the Certej-Sacaramb ore deposit, Metaliferi Mts., Romania

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The Sacaramb ore deposit is located in the so-called ‘Golden Quadrangle’ area situated in the Metaliferi Mts. and it is the most important Au-Ag tellurides deposit in Romania and in Europe, too. Genetically, it is a hydrothermal vein deposit with Au-Ag tellurides. The ore veins are located in an andesitic stock (pyroxene andesite of Sacaramb) generated by the Neogene calc-alkaline magmatism in the Metaliferi Mts. The vertical extension is about 600 m and the surface of this stock is ca. 1 km². Over 100 mineral species have been identified in the Sacaramb ore deposit, some of them firstly described in the world (nagyagite, petzite, krennerite, stuetzite, muthmannite, museumite). Till recently, tellurium was interesting only from scientific–mineralogical point of view and there was no interest for resource estimation in Romania. Since 2005 this element started to be considered as an important one, when the company ‘First Solar’, USA used it in the construction of solar panels with photovoltaic cells based on Cd-Te technology.

The first estimation regarding tellurium resource of the Sacaramb ore deposit was made by Udubașa & Udubașa (2004), taking into consideration Au/Te ratio, (i.e 1/2) into the most common tellurides - nagyagite and sylvanite (1/2 ratio) and the amount of gold extracted from Sacaramb ore deposit (over 1746-1941), calculated as being ~ 30 t Au. Therefore, the amount of Te mined and unprocessed (i.e. just dumped) would be ~ 60 t.

Our report presents the results of the last two-year research on the tellurium resources hosted into three waste dumps (Sectors I, II and III – at Sacaramb area) and into the “Iazul Avariati/Damaged Tailings Dam” at Certej. The tellurium contents have been determined using ICP-MS on the previously analyzed samples where Au-AA26 method for Au- and Ag-contents was made. Based on the resulting data the Au/Te ratio was obtained and the tellurium resources were estimated. Concerning the Au/Te ratio, it should be mentioned that this is ~ 0.25 in the case of the damaged tailing dam and it is averaging 0.35 in the three waste dumps; these values are different from the above mentioned theoretical values. The explanation of the existence of a higher Au/Te ratio in the damaged tailing dam is that the tailings originate from the processing plant where gold has been recovered, but tellurium has not. Consequently, the Au/Te ratio changes for Te. There is a difference in the content of useful elements in all four investigated zones, meaning that the waste dumps have higher Au and Te contents in comparison with the ore deposit. According to the new data, accepting that the Au/Te ratio is 0.3, it would result in a resource of ~ 85.7 t of tellurium for all the perimeters of Sacaramb.

Regarding the correlation degree, tellurium is directly well correlated with gold and silver respectively, confirming that tellurium is related to gold and silver mineral compounds. Actually, the Au, Ag and Te distribution map into the tailings dam area and waste dumps area indicates an overlap of the enrichment zones for all these elements.

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Biostratigraphic zonation based on foraminifera and algae in the Triassic deposits of the north sector of the Eastern Carpathians

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Triassic carbonate deposits which represent the topic of our research belong to a system of Alpine nappes (Median Dacides) that form the Crystalline Mesozoic Area of the Eastern Carpathians. From bottom to top, these tectonic units are the following: the Infrabucovinian Nappes, the Subbucovinian Nappe, the Bucovinian Nappe and the Transylvanian Nappes. The Bucovinian Nappe has the highest extension among the Central-East-Carpathian Nappes system, supporting the remains of the Transylvanian Nappes that occur only as isolated klippe floating within the Hauterivian-Albian wildflysch Formation of the Bucovinian Nappe. The lower tectonic units of the Bucovinian Nappe, respectively of the Infrabucovinian Nappes and of the Subbucovinian Nappe, occur discontinuously, outcropping in several halfwindows. Triassic sedimentation started by an Induan detrital level, consisting of conglomerates and sandstones. The Induan deposits are overlain by Olenekian-Rhaetian carbonate deposits. The detrital Induan completely lacks microfauna and subsequently, the zones approached in our research are only defined in the overlaying carbonates. The Anisian-Ladinian dolomites and limestones that form almost exclusively the Infrabucovinian and Subbucovinian Nappes offer little micropaleontological information, and with no stratigraphical significance. The limestones of the Bucovinian Nappe and especially those of the Transylvanian Nappes have revealed a paleontological content, rich enough to define Triassic zones. As a result, the biostratigraphic zonation in the studied area especially relies on biofacies data, achieved by microscopic studies of carbonate Triassic deposits of these two last units. Six zones on foraminifera and algae assemblages are defined in the Olenekian-Rhaetian. The *Meandrospira pusilla* Zone characterizes the Olenekian stage. The zone occurs in Bucovinian and Transylvanian facies. It was separated in the stratified limestone level, overlying the detrital Induan in Haghimas Syncline (Bucovinian facies). The massive dolomites of the Bucovinian Nappe provided a poor paleontological content consisting of a few foraminifera of no stratigraphical value, which makes impossible the definition of the zone in the lower Anisian. The *Meandrospira dinarica* Zone corresponds to Pelsonian and Lower Illyrian of the

Bucovinian Nappe. It characterizes the lower half of the algal limestones, overlying Lower Anisian massive dolomites. The *Diplopora annulata* Zone characterizes the Upper Illyrian substage and Ladinian stage of the Middle Triassic. The zone has been identified in both Bucovinian and Transylvanian Nappes. The mentioned zone defines the upper half of the white algal limestones in Bucovinian facies and the white-gray limestones in Transylvanian facies. The *Ophthalmidium exiguum* Zone corresponds to Carnian and was only separated in Transylvanian limestone facies. The *Glomospirella friedli* and *Miliolipora cuvillieri* zone characterizes the Norian. The zone was separated only in the Transylvanian Nappes of the Rarau Syncline, where it occurs in two distinct lithologies: nodular red limestones and white limestones. The *Angulodiscus tenuis* Zone corresponds to Rhaetian Transylvanian facies. It was established in the red and grey limestones of the Rarau Syncline. Comparing the zones established by various authors in the Tethysian domain with the zones separated in this study in the Triassic carbonate deposits of the Eastern Carpathians, one will notice similarities and identities, especially at the Olenekian and Anisian stage. Starting with the Upper Triassic, the index-species here proposed are completely different of those that define the zones of the West Carpathians, Bulgaria, or the entire Carpathian-Balkan region. This proves the existence of some particular conditions, specific to sedimentation, within the north region of the Eastern Carpathians.

Biogeographic connections between Thracean-Aegean region and Eastern Paratethys

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The Thracean-Aegean region was an area with mainly continental deposition during long time from the Late Oligocene to the Early Miocene. Sedimentological evidence from the roughly terrigenous sediments testifies intensive uplift environments in the South Balkanids. Marine connections with the Mediterranean took place via the Pre-Alpine and Slovenian corridors during this time (Rögl, 1998; Popov et al., 2004).

The marine Middle Miocene sedimentation is very restricted in this region: S. Gillet (1957) illustrated Lower Sarmatian (Volhinian?) cardiiids and Rückert-Ülkümen (1993) found foraminiferal assemblage with Sarmatian endemic species (such as *Elphidium hauerianum*) from the area west of İstanbul. The upper Sarmatian (Khersonian) Beds with *Macra caspia*, *M. bulgarica* were described from the same area (Pamir, 1933; Erentoz, et al., 1953; Arıç-Sayar, 1957; Sayar, 1989). Probably, the region was a brackish water gulf of the Eastern Paratethys, extending to the Çanakkale region (Taner, 1997), but without continuation into the Aegean area. Data about the presence of Sarmatian and Maeotian in Macedonia (Stevanovic in Pontien, 1989; Stevanovic, Ilyina, 1982) are erroneous. Lagoonal fauna, of composition very similar to the Maeotian one, is alternated here with the real marine facies bearing *Arca*, big pectens and corals. Similar marine-brackish alternating facies are known in the Alçıtepe Formation outcropping in the northern Aegean, Gelibolu and Çanakkale regions (Sakınç & Yalıtırak, 2005, Çağatay et al., 2006, 2007).

Brackish sediments with the Pontian-like mollusk and ostracod fauna are recognized in the whole Aegean Depression from the Northern Greece to Athens area. These deposits of the Choumnikon Formation are characterized by normal polarity and correspond to C3An.1n Subchron (6.30-6.04 Ma). The Choumnikon fauna includes numerous taxa with Paratethyan affinity: endemic lymnocypridines, *Congerina* and ostracods, but also euryhaline marine genera such as *Cerastoderma* and *Macra* among mollusks, which were absent in the Pontian of Eastern Paratethys as well as in the Pannonian Basin. We believe that the origin of the Choumnikon brackish elements is related to the oldest Pannonian biota. This formation is 40-50 m thick, underlain and overlain by sediments with marine Mediterranean fauna. At the

beginning of the Pontian (~ 6.0 Ma) this fauna populated the Eastern Paratethys. The Pontian brackish mollusks of the Eastern Paratethyan fauna comprised *Congeria*, *Dreissena*, *Abra*, inherited from the Maeotian time, and lymnocypridines (*Pseudocatillus*, *Paradacna*, *Pontalmyra*, *Eupatorina*, *Euxinocardium*), migrated to the Eastern Paratethys (Popov, Nevesskaya, 2000). Two last genera are unknown in the Pannonian Basin, but are present in the Aegean association. The species of the Late Pontian fauna inhabited the Mediterranean at the “Lago-Mare” stage (Esu, 2007).

At the same time, a few brackish basins existed in the Anatolian part with endemic non-Paratethyan fauna: Denizli Basin, in the western Anatolia, with *Theodoxus*, *Micromelania*, sculptural *Valvata*, *Radix*, *Pseudocardita* (Oppenheim, 1918; Taner, 1974a, b; Wesselingh et al. 2008) and Yalova Basin, (Yalakdere formation) in the Eastern Marmara region (Emre et al. 1998).

During the Pliocene continental environments prevailed again in the Thracian–Aegean region. However, earliest Zanclean Mediterranean transgression reached the northern Aegean, Dacic, and Taman basins (Çağatay et al. 2007; Maruntianu, Papaianopol, 1995; Semenenko, 1997).

Later, at the early-middle Quaternary time one-way connection prevailed and the Chaudian *Didacna* of Black sea origin was found in Çanakkale region (Andrussov, 1896; Taner, 1983), and Caspian *Didacna subpyramidata* Pravosl. was described from the middle Pleistocene of the Iznik lake basin (İslamoğlu, 2009). Late Pleistocene connections took place and were described in details based on microphytoplankton (Aksu et al., 1995, Mudie et al., 2002) and mollusks (İslamoğlu et al., 2001; Kazancı et al., 2004). In the latest Pleistocene (Neueuxinian), the Marmara basin was affected by only Paratethys, by interrupting the connection with the Mediterranean (İslamoğlu & Tchepalyga, 1998).

Evolution of drought severity for a 118-year period in the Republic of Moldova

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The Republic of Moldova is among several Balkan countries affected by extreme drought. Some districts in the country suffer from severe droughts approximately once per every 3 years, with serious consequences for the agricultural and food sectors. Any contribution to understanding and predicting drought conditions will be a step toward minimizing drought impacts. Droughts in Moldova were evaluated using meteorological data since 1955 and/or a long time series (1891–2009) recorded at Moldova’s State Hydrometeorological Service. Evolution of drought severity for the 118-year and/or 54-year time series is based on the S_i -m drought index, using temperature and precipitation series for the calculations. In addition to meteorological data, the crop yields for corn (*Zea mays* L.), a crop widely grown in Moldova, were used to demonstrate drought impact. The S_i -m shows an increasing tendency toward more intensive and prolonged severely dry and extremely dry summer months. The analysis shows that 86% of the poor yield years were recorded for corn when drought occurred during April and July–August. Corn yield is also highly sensitive to the occurrence of a short drought spell in August (e.g., 1994, 1999, 2003 and 2007). Finally, the negative regression coefficient for corn yield indicates that corn is most vulnerable to extreme droughts during April. This was the second cause for poor yields, and particularly in southern districts during 1946, 1947, 2000 and 2009. In these dry steppe areas, extremely dry Aprils may explain 38% of the variability in corn yield.

Coastal Instability and Urban Changes - the Case of the Nessebar Peninsula

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The Nessebar Peninsula has a narrow and elongated shape located at the northern part of the Bourgas lowland at the west Black Sea coast. One of the strongest factors forming out its coasts is the destructive activity of the sea waves. During the last two and a half millennia the urbanization and constructive works on the peninsula envisaged a free of flooding strap up to several dozens of meters for protection from the destructive power of the storm waves. In a stagnating sea level and in a protected sea basin, the fortification works are situated along the sea and even enter it. The *diateikhisms* of the classical and late antique fortifications of Mesambria in the northern and southern bay had probably also harbor functions, while the pre-Roman arch-like wall in front of the fifth isobath in the southeastern bay reflects the tradition to closely “follow” the sea. An immediate proximity to the water basin is evident from constructions directly on the rock ground. This is the case with the pre-Roman trapezoid wall in the northeastern zone of the peninsula or with the pilot fortification of the bases and the substructions of the late antique wall in the southeastern bay. A much more disruptive effect upon the coastal zone has the destructive impact of the waves in the periods of transgressive rising of the sea level. In the southeastern coastal zone, the localization of the early Thracian and of the classical Dorian fortification in the zone of the fifth-fourth isobath, presumably sets the lower mark of the variation of the water level in the 12th-5th centuries BC up to a depth of 5-7 m. The rise of the sea level in the 1st millennium AD imposed the displacement of the fortifications onto higher terrain. Walls erected in the 5th c. AD in *opus mixtum* are discovered in the southeastern bay in front of the second isobath. In the middle and the second half of the second millennium the waves scraped niches in the cliff slopes of the peninsula. The overhanging land layers fell down together with the fortification works and public buildings on the head of the peninsula. Next to the late antique fortification wall, dropped in the southeastern bay, the northern part of the church of “The Mother of God Eleousa” fell into the sea before 1341/42, and also the church “St. Protomartyr Stephen” fell during the earthquake in 1855. The same happened up to the beginning of the 18th c. to the Dorian temenos of Zeus and Hera, to the theatre of the antique city and the early Christian basilica that has been topographically inherited by the church “St. George the Old” in 1704. After the transport of the abundant mass by the coastal sea currents a slightly sloped terrace formed out. In the northeastern zone of the peninsula after the submergence of the rock coast up to the end of the 20th c. a strap has been abraded. It is some 15-25 m wide and lies between the trapezoid hellenic wall and the basilica “Mother of God Eleousa”. At the southeastern coast between the church “St. George the Old” and the late antique wall the peninsula lost at least 70 m wide strap. Most intensive is the coastal erosion to the east. There, some 240-250 m from the fortified Dorian settlement submerged. At the end of the 20th c. the peninsula has a specific shape with narrow and elongated bays and outreaching capes. After the construction of the multifunctional structures for coastal protection the three-millennium-old cultural heritage of Nessebar is preserved for the future.

Upper Cretaceous silicites from the Bohemian Cretaceous Basin (Czech Republic) as a versatile building material

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Bohemian Cretaceous Basin extends over 15,000 km² and makes the largest sedimentary unit of the Bohemian Massif (Czech Republic). Its lithology is characterized by

prevalent clastic sedimentary units but more shallow parts of the sedimentary basin were filled by mudstones and carbonate rocks. Fine-grained rocks of aleuropelitic character and variable mineralogical composition in which silica (mostly less crystalline forms like CT-opal, tridymite etc., but also clastic quartz), carbonate (calcite locally enriched in magnesium) and clay minerals (illite, kaolinite and glauconite) prevail can be classified in the range from clayey-calcareous silicites to siliceous-clayey micritic limestones.

Traditionally, these rocks have been used as a common building stone but also as sculptural stone. Along these traditional uses, recent investigations show that some varieties of silicites are also employed as raw material for hydraulic lime binders burning. This paper discusses properties of these traditional stones and possibilities for determining their source locality. Their durability is discussed based on the thorough analysis of physical and mechanical properties and on the experience with their long-term behaviour in outdoor exposures.

Geological Timescale of Tectonostages for Continental Margins

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The lithosphere plate tectonics theory describes the process of oceanic crust opening and closure in geological history of the Earth using the Wilson cycle. Upon the end of the cycle, the oceanic crust being formed at its early stages is almost completely destructed in the process of subduction. As for the continental margin, it is modified during the cycle with formation of volcanic and non-volcanic island arcs, back- and fore-arc sedimentary basins, and orogens. During the next stage of the cycle, the previously formed continental margin is again affected by deep transformation, leaving in the structure of the newborn margin only some relics of the previous ocean crust known as ophiolites. However, as the study proves, complete destruction of the previous continental margin is not reached. Always or quite often a significant part of the newborn continental crust is preserved and laterally accreted to an existing continental plate and is being modified during further transformations passing through consecutive stages that could be called a vertical line of the tectonostages for particular continental margin. Evidence for that conclusion is an age rejuvenation of the continental crystalline crust while moving from the central parts (shield) towards their outskirts (continental margin). It is proposed a geological timescale of tectonostages derived from the Wilson cycle and establishing their time boundaries for the last 2500 million years. Along with the developed model for continental margins evolution, it allows application of the concept of horizontal sequence of tectonostages transition into vertical and vice versa to study structure of continental margins. It is supposed that for the Wilson cycle of 1200 million years every continental margin is subjected to the tectonic process as follows. During the first stage of a divergent epoch (0-200 Ma), a new oceanic basin is forming due to a continental rift. Present-day example of such a rift one can consider the Red Sea Rift and latitude-oriented rift system between North and South America stretched into the Pacific and Atlantic Oceans. Predecessor of the future Red Sea Ocean were the Tethys and the Prototethys paleo-oceans, which originated during the stages of 590, 75-385, 75 Ma and 992,5-793,0 Ma ago. The Tethys is corresponding to present-day Alpine-Himalayan orogenic zone and related sedimentary basins, and the Prototethys – to the Donbass Foldbelt and its eastern prolongation into Karpinskiy Ridge. Rejuvenation of continental margins age towards the periphery of the continents set the problem of studying evolution of those margins applying concept of vertical and horizontal sequences of tectonostages. For this purpose, the model of evolution (tectonic stratification) of continental margins is developed. It includes six stages of tectonic evolution: origination of a new ocean and its opening (divergent epoch of the Wilson cycle), stage of the oceanic basin shortening and thermal subsidence (convergent stage), stage of partial inversion, and the next stage of the complete inversion along with the

compression thrusting (collision stage). Corresponding to the stages are the types of crust being formed (ocean, quasi-ocean, quasi-continental, continental). The stages are divided into geosynclinal and orogenic sub-stages (the Bertran cycle). It is demonstrated that tectonostages and orogenies are matching (Alpine, Hercynian, Caledonian, Baikal and others) for the last 1500 million years. Actually, the features and direction of changes in vertical and horizontal sequences of continental margin tectonostages is a basic tectonic regularity to be studied because it determines existing types of sedimentary petroleum-prone basins, sedimentary complexes and separate prospects considered as hydrocarbon traps.

Evaluation of Sea-Level Rise Impact on Cemented and Uncemented Beach. Case Study from Thassos Island, Greece

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A semi-buried underwater beachrock exposure, in the west coast of Thassos Island (N Greece), has been investigated due to coastal erosion phenomena. The partial removal of the beachrock's outcrop by locals incurred rapid regression of the beach, while the protected by the formation coast, remained stable during the same time interval. The use of the Bruun Rule as a contributor in the quantification of the marine transgression in the study area showed a participation of the sea-level rise to the beach erosion equal to 7% of the total erosion at minimum. Several other factors, which are related to the unique dynamic conditions at the eroded coastline, might have contributed to augmented erosion values.

Evidence of Pre-Apulian (Paxos) isopic Zone in the Filiatra-Pylos area (SW Peloponnese, Greece)

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The studied area, for decades was regarded as belonging to the Gavrovo-Tripolis isopic zone. However, in last years the area has been the subject of extensive geological mapping reinvestigation, which has brought to light the fact that the features of this geographical part could geotectonically be correlated to the Pre-Apulian (Paxos) isopic zone of the external Hellenides.

The observed lithostratigraphic successions of Filiatra-Pylos area, in comparison with those of Ionian and Gavrovo-Tripolis zones, are clearly and highly distinguishable. In the studied area, the whole Cretaceous to Tertiary sedimentary successions are composed of whitish shallow-water limestones, locally bituminous or rich in organic matter, with multiple emersions bearing scarcely bauxitic episodes, with absence of typical darkish platformal lithofacies like Gavrovo-Tripolis carbonate sequences or any deep-water limestone sequences with chert like Ionian carbonates. In addition to that, the entire examined sedimentary sequence is also developed over a Triassic evaporitic substratum, which is entirely absent within the Plattenkalk Series in Peloponnese. The exceptional thick siliciclastic flysch successions are normally developed over the marly limestones and the clastic deposits and cover by Miocene. Moreover, the flysch sequence in Gavrovo-Tripolis zone and the metaflysch sequence with the Plattenkalk Series are presented by highly restricted outcrops in overall Peloponnese.

The whole area is also characterised by the presence of large anticlines, however the easternmost flysch sequence outcrops are deformed as thrust and fold structures, by the SW

advancing propagation of the Hellenides. The dominant mesoscale structures are those of faulted anticlinal folds, which have roughly northwest-southeast-trending fold axes and overturn to the southwest. These structures are due to the overthrust caused by Mesozoic-Tertiary pelagic sequence of Pindos thrust belt and by conglomerate debris-flow mega-slivers. These slivers are originating from the deeply up-faulted, gravity sliding and collapse of the upper levels of the Gavrovo-Tripolis and Pindos thrust belts.

Gavrovo-Tripolis and Apulian platforms formed during Early Mesozoic Tethyan opening and they developed as a part of the Early Cretaceous foreland-thrust belt system, which resulted from the collision of Apulia and Eurasia. During the Tertiary, the Apulian continental margin was affected by compressional tectonics due to the continuing collision. Subduction of Apulia beneath the Hellenic margin of the upper European Plate took place in the Miocene, which is responsible for the tectonic deformation due to the increasing west-to-east lithospheric shortening and gives rise to the intracontinental subduction formation of Plattenkalk and Phyllite-Quartzite Series.

Consequently, the examined sedimentary features, in Filiatra-Pylos area, are well correlated with the lithostratigraphic successions of Paxos, Ithaki, Cephalonia, Lefkas and Zakynthos, but are also connected with those of Megisti Island in Dodecanese, which geotectonically belongs to the Pre-Apulian isopic zone of the External Hellenides.

Preliminary petrographic data on the Early Cretaceous Boeothian flysch (External Hellenides, central Greece); provenance and palaeogeographic implications

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This paper defines the petrographic features of the Boeothian Flysch, an Early Cretaceous turbiditic deposit, which marks the boundary between the External/Internal Hellenides in central-southern Greece (south of the Kopais plain). The results from this study represent a preliminary contribution in reconstructing the Early Cretaceous palaeogeography of a limited segment of the Alpine Tethys (i.e. the Pindos Ocean), mainly supported by provenance changes of the detrital modes of arenites and related tectonic events. The Boeothian Flysch, whose stratigraphic succession is made up of basal conglomerates grading upwards to sandstones and pelites, interlayered with calpionellid micrite limestones, is here supposed to belong to the Early Cretaceous flysch family, cropping out along all the western and central Europe Alpine Chains for more than 7,000 km, from the Gibraltar Arc to the Balkans. This flysch commonly marks the contact between the internal and external areas and usually shows a provenance linked to internal areas, mainly made up of crystalline sources and, locally, by ophiolitic complexes. Representative samples of sandstones were analyzed for petrographic compositions in order to detect the source areas. The data obtained suggest that the provenance of the Boeothian Flysch is closely related to sediment sources belonging to internal domains and formed by a Jurassic carbonate platform and metamorphic basements, connected to the Pelagonian Terranes (Auct.), and by ophiolitic complexes. Thus, it is also possible to hypothesize that Early Cretaceous uplift and rejuvenation processes affected these internal domains with the production of a detrital supply, filling the innermost sector of the Pindos Ocean, whose external margin was bounded by the Parnassos microcontinent. This uplift process may probably represent the beginning of the Late Cretaceous tectogenesis, widely recorded in almost all the central-western Alpine Tethys.

Characteristics and behaviour of the mudstones from the Upper Triassic

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In sites where the mudstone was recently excavated, after exposure to persistent rain, the surface of the ground was transformed from a soft rock to a muddy ground impeding or turning very difficult the traffic of the equipment and the prosecution of the normal construction tasks. The Portuguese mudstones (siltstone and claystone) dated from the end of the Triassic, often show severe geotechnical problems when affected by engineering works, changing very rapidly from a soft rock to soil when uncompressed and in the presence of water. To evaluate their characteristics, field and laboratory tests were executed. The mineralogy is constituted essentially by illite (or muscovite), kaolinite, chlorite and quartz. Calcite and dolomite can also be found. Despite the geotechnical problems they present, they do not contain expansive minerals (smectite). In the intact rock, the porosity is about 15 to 20%, but with very fine pores, presenting a unimodal distribution, with dimensions around 0.03 to 0.05 micra. The total area of pores of the mudstones is from 10 to 14 m²/g. The apparent unit weight of the intact mudstones is ca. 22 kN/m³. The point load strength is under 1.27 MPa when dry, reducing drastically even below 0.1 MPa after a few minutes of submersion, corresponding to water content between 5% and 15%. After the 2nd cycle of the “Slake Durability Test” 60% of the mudstone is lost, being disintegrated until the 6th cycle. The expansibility is more intense in the first minutes of wetting, stabilizing after 10 to 20 minutes, developing an expansion stress between 0.1 MPa in the intact rock, up to 0.35 MPa in the soils derived from the laboratory disintegration of these soft rocks. These soils have a PL=24% and a LL=34%. The methylene blue value (VBS) is between 0.5 and 1.2 g/100g. According to the unified soil classification, the disintegrated soil derived from the mudstone is ML-MI (silt of low to intermediate plasticity) or CL (low plasticity clay). Using the AASHTO classification the soils are A1 (silty soil) or A6 (clay soil). Using the LCLC/SETRA classification the soils are A1 (low plasticity silt). The results from the SPT tests and from the dynamic penetrometers (DPSH) showed very low penetration strength at the surface of the muddy material, increasing very rapidly in depth when reaching the less weathered material. In vertical cuts with moderate heights in the periphery of the work area, the behaviour of the *in situ* and undisturbed mudstone was quite reasonable without significant degradations or instabilizations of the cut face. These abrupt properties transition showed that a reasonable way to prevent the degradation of the mudstone is avoiding both the relief of the vertical stress and the contact with the water. In conclusion, the field observations and the tests executed allowed to clarify the causes of the deleterious geotechnical behaviour of these mudstones, in particular when they are subjected to human intervention, associated with the presence of water during the execution of engineering works. The Triassic mudstones are an unusual soft rock material, with very fine pores, without expansive clays, suffering rapid degradation, losing strength and durability, showing an evolution from a soft rock to a muddy soil, when wetted or saturated, more rapidly than it was anticipated by the field observations, creating very serious geotechnical problems of exposed ground surfaces without any confinement. The more problematic situations are related to foundations and slopes, which suffer degradation after intense rainfalls following the exposure or remobilization of those materials. The extremely fast weatherability of these mudstones after wetting, mainly results from the fine equidimensional network of pores, developing high capillarity stress and driving rapidly the water to the interior of the material. The water absorbed destroys the cohesion forces between the uncemented silt particles, turning the soft rock in a muddy soil.

Complex Investigation of Krupnik–Kresna Region in Southwestern Bulgaria by Geodesy, Gravimetry and Seismology

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In the year of 1904, in the region of Krupnik–Kresna occurred one of the strongest earthquakes on the Balkan Peninsula, felt in almost whole Eastern Europe. The magnitude of this event was about 7.5 and intensity X in Medvedev–Sponheuer–Karnik scale in the epicentric zone. The seismologically active structure which caused this destructive event is the Krupnik Fault – a part of the Struma fault zone.

In the framework of “Young scientists” project between several research institutions in Bulgaria, an attempt to compare and complete the data, results and conclusions from different methods of geodesy, gravimetry and seismology was made. The main goal is to form a whole geodynamic picture in the area of investigation. Part of the present work is to determine double couple focal mechanism solutions from P wave first motion polarities of small earthquakes with magnitude about 3 in the region. On the other hand, several GPS campaigns were carried out re-measuring the points from long-existing investigation network in the area. A new set of benchmarks was established for levelling profiles through the visible rupture remaining after the strike from 1904. Also two gravimetric profiles crossing the main tectonic structures were re-measured. All these studies confirm the recent activity of the Krupnik fault.

Geochemical comparison of felsic Eocene granite intrusions in the Rhodope massif, southern Bulgaria and northern Greece

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We compare whole rocks geochemistry of several felsic granite bodies of similar age (53–42 Ma) that are emplaced into the intermediate and upper plate of the Central Rhodope metamorphic core complex (CRMCC), namely: the Smilyan granite in the southernmost part of the Madan unit; the Pripek granite in the Startsevo unit, the Yugovo granites in the Assenitsa unit and the Paranesti granite from the Barutin–Buynovo–Elatia–Skaloti–Paranesti plutonic complex partially hosted by the Madan and Assenitsa units. The time span of granite intrusions overlaps the period of synmetamorphic partial melting in the CRMCC (~50–36 Ma) and clearly predates the anatectic melts crystallization in the core of the complex (38–36 Ma). The temporal and spatial proximity suggests genetic/feedback relations between intrusive granites and migmatites.

The geochemical features of the compared granites show predominantly felsic compositions ($\text{SiO}_2 > 70\%$) and alkaline-calcium to Ca-alkaline and alkaline characteristics. The Smilyan, Pripek and Paranesti granites are meta- to peraluminous (A/CNK 0.80–1.29), and Yugovo granites are only peraluminous (A/CNK 1.06–1.26). High Ba (≥ 1000 ppm) and Sr (> 600 ppm) content is a common feature of granite LILE (Ba, Sr, Rb) geochemistry. Negligible negative to positive Eu-anomaly (Eu/Eu* 0.8–1.2) and high LREE/HREE ratios (up to 54.1) are typical of the chondrite-normalized REE patterns. Increasing Rb/Sr (0.04→1.53) and Rb/Ba (0.03→0.45) ratios towards the most felsic granites mark a trend of feldspar fractional crystallization. The LILE distribution patterns of Pripek and Paranesti granites indicate more evolved differentiation than the Smilyan granite. Decreasing Zr and Hf contents and Zr/Hf

ratios towards the higher-silica compositions reflect typical magmatic trends with zircon fractionation and enhance the close geochemical resemblance of the granite intrusions. All of them display volcanic-arc and collision-related affinity according to the most popular discriminations based on incompatible trace elements. The isotopic data available support granite magma generation from predominantly igneous precursors of mixed mantle-crust characteristics.

On the other hand the granite intrusions show remarkable geochemical similarities with in situ formed anatectic melts from the CRMCC diatexitic core (felsic peraluminous compositions, low HFSE and REE, high LILE contents and LREE/HREE ratios, and negligible negative to positive Eu anomaly) that infer to a common mechanism of granite magma generation, e.g. crustal melting. The younger age of the anatectic melts (37-38 Ma) precludes direct feedback relations between intrusive granites and migmatites. A low temperature crustal melting involving mainly felsic minerals from orthometamorphic substratum could explain the granite magma origin and its similarities with the younger anatectic melts from the CRMCC core.

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The exhalations of CO₂ in the Poprad River valley (Polish Inner Carpathians)

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The Krynica tectonic-facies zone within the Magura Unit of the Polish Inner Carpathians contains a region rich in carbonated mineral waters and in moffettes, i.e., dry exhalations of carbon dioxide. The lithostratigraphic profile spans the strata from the Upper Cretaceous to Upper Eocene. The region of the moffettes studied is situated in the Poprad River valley between Muszyna and Tylicz. The exhalations have been found in the Złocki stream and Jastrzębik stream valleys near Muszyna, in the Szczawiczny stream valley near Krynica and in Tylicz. The largest and most beautiful exhalation with an area of about 25 m² occurs in the bottom of the Złocki stream valley. Both this exhalation and the smaller, adjacent exhalations and the springs of carbonated waters are associated with the Szczawnik-Złocki-Jastrzębik antiformal structure and with a system of discontinuous dislocations, i.e., a thrust and faults. The emanating gas represents almost pure CO₂ (about 99.3%) with minor admixtures of CH₄, N₂, Ar and other noble gases.

The upper surface of the basement of the Carpathian orogen in the Poprad subregion rests at a depth of about fifteen kilometers. The origin of the gaseous components – particularly of CO₂ – is usually attributed to metamorphism of carbonates rocks under the thick cover of overthrust flysch strata and/or to Tertiary volcanism. The volume of carbon dioxide emanating from the moffette in question is about 15,000 m³ CO₂/day. The maximum content of CO₂ in the soil air close to the moffette reaches 94%. The temperature of the emanating gases is around +10°C, both in the Złockie site and in other moffettes of the region.

The moffette is partly covered by the water of the stream and also by the water flowing out of submerged springs of carbonated mineral waters, thus the emanations are manifested by smaller or larger bubbles of carbon dioxide. They are accompanied by rusty-coloured, gelatinous floccules of colloidal hydrohematite and goethite, the minerals originating by oxidation and hydrolysis of hydrated ferrous carbonate contained in the mineral waters mentioned. The process is a result of metabolism of the green plants populating this habitat (forest bulrush *Scirpus silvaticus* is a dominating species), and also of ferruginous bacteria

Ferribacterium sp., cyanide plants (Cyanophyceae), euglenines (Euglenophyceae), diatomeae (Bacillariophyceae) and green algae (Chlorophyceae).

In the year 1998 the moffette in Złockie was declared a legally protected site as the Professor Henryk Świdziński monument of inanimate nature and later placed on a proposed European list of protected geosites (European List of Geosites).

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Mineral, thermal and therapeutic waters of the Polish Carpathians

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The province of the Polish Carpathians is characterized by a wealth of various mineral, thermal and potentially therapeutic waters, and by a coexistence of normal, mineral and thermal waters as well.

The Inner Carpathians enclose the Podhale Basin and the Tatra Mountains, the latter being the major recharging area of underground waters. The Podhale Basin represents a classic artesian basin, in which the carbonate strata of Eocene and Triassic carry thermal waters recorded at the depths from 680 m (Zazadnia IG-1) to 5261 m (Bańska IG-1) in 14 boreholes. The temperature of the waters ranges from 20 to 86°C at the mineralization (TDS) from about 0.3 to 3 g/dm³. They are utilized in recreation and in heating installations.

The waters in question within the area of the Pieniny Clippen Belt are limited to a few springs of sulphurous water.

The Outer, i.e., Flysch Carpathians, are composed of tectonic units of a lower rank overthrust on each other, strongly dislocated and dismembered into separate blocks. Within their area the following water types have been found: carbonated waters, waters containing carbon dioxide, chloride waters, brines, thermal waters and sulphurous waters. The carbonated waters and waters containing carbon dioxide have currently been rendered accessible in 68 springs and 138 boreholes, and occur only within the areas of the Magura and Silesia units. They represent waters with mineralization (TDS) from 0.4 (acratopegae) to 27 g/dm³, and their hydrochemical types are HCO₃-(Ca)-(Mg)-(Na), (Fe), (I), and HCO₃-Cl-Na, (Fe), (I). In Krynica, waters of the Zuber type, unique in the world, are provided from four boreholes on the slopes of Parkowa Góra Mt. The Zubers are carbonated waters with the TDS content from 21.2 to 29 g/dm³ of the hydrochemical type HCO₃-Na-(Mg), I. The chloride waters and brines occur within all the tectonic units of the Outer Carpathians and their TDS content ranges from 35 to about 146 g/dm³ (the latter in Jaworze Dolne). They have been reported in many boreholes drilled mainly during oil and gas prospecting. The chloride waters (e.g. in Rabka and Poręba Wielka) and brines (Sól, Jaworze, Krosno) are mostly synsedimentary waters of the Cl-Na, I type. They are associated with both the Carpathian flysch strata and the older rocks (Devonian, Carboniferous) of the Carpathian basement (Ustroń Śląski, Kęty, Jaworze). For instance, the uptakes in Ustroń pump thermal brines of the Cl-Na-Ca type, the TDS content 103-126 g/dm³ and the temperature 50°C from the Devonian basement. The sulphurous waters have been recorded in 125 springs within the Carpathians. They contain H₂S in the range 1-160 mg/dm³ at the TDS ranging from 0.3 to 3.6 g/dm³; most of these waters are acratopegae.

Natural radioactivity of uranium (²³⁸U, ²³⁴U), radium (²²⁸Ra, ²²⁶Ra), radon (²²²Rn) and lead (²¹⁰Pb) isotopes as well as the total concentration of the α- and β-radioactive nuclides have been studied in 75 water samples from the area of the Polish Carpathians. The results indicate that in none of them the content of radioactive elements exceeds the values permitted by radiological regulations.

The standard of therapeutic waters in the Polish Carpathians have those found in Andrzejówka, Dębowiec, Głębokie, Leluchów, Lubatówka, Łomnica, Iwonicz-Zdrój, Jastrzębik, Krościenko on the Dunajec, Krynica-Zdrój, Milik, Muszyna, Piwniczna-Zdrój, Polańczyk, Powroźnik, Rabka-Zdrój, Rymanów-Zdrój, Szczawa, Szczawnica, Szczawnik, Tylicz, Ustroń, Wapienne, Wysowa, Złockie, Zubrzyk and Żegiestów. The Carpathian mineral, thermal and therapeutic waters have been utilized in 12 statutory spas in balneotherapy (medicinal and recreation bathing), crenotherapy, production of CO₂, and also are bottled in several plants.

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“Rootless” ophiolites above the Pelagonian core complex of north central Greece

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More than twenty ophiolitic fragments ranging in size from meter-scale to several tens of km² occur strato-tectonically above the Pelagonian continental massif (mid-Neoproterozoic and Permo-Carboniferous crystalline basement plus Triassic-Jurassic platform carbonate cover) in the region between the mid-late Jurassic Mesohellenic ophiolites (rooted within the Mesohellenic Trough in the west) and the Vardar Zone ophiolites (rooted in the Vardar Zone in the east). Formerly presumed to be part of a single, initially continuous mid-upper Jurassic ophiolite nappe, we have begun documentation of these fragments within the context of their role in the exhumation model of Pelagonia.

A “rootless” ophiolite is a piece of oceanic lithosphere that is no longer contiguous with an ophiolitic complex emanating and emplaced from a plate suture zone. The Rodiani complex has long been considered tectonically continuous to the Vourinos massif, but rather appears to be more alike to Aspropotamos-Pindos lithosphere. Extension from Vourinos would require tectonic thinning of about eleven km of ophiolitic lithosphere, and rotation of the Rodiani section that cannot be explained by a simple antiformal structure between Vourinos and Rodiani within the interceding Triassic-Jurassic Pelagonian platform carbonates. Zindani, also apparently tectonically continuous with Vourinos, is severely altered to a massive serpentinite (predominantly antigorite) body, imbricated with Pelagonian schist. The Livadi ophiolite, once included as part of the Paleozoic (Pelagonian), crops out as a nappe above the Pelagonian gneissic core complex. The contact comprises a metamorphic discontinuity with the much lower T-P lithologies of the ophiolite. Primary ophiolitic fabrics and ridge-crest structures are still recognizable in the Livadi complex. The smallest ophiolitic fragment that includes a complete Steinmann Trinity occurs near Lefkovrisi, Kozani (the “IGME” ophiolite): less than three meters of section including serpentinite, pillow lava, and Upper Jurassic oceanic sediments crop out over a pebbly mudstone mélange similar to that of the Vourinos ophiolite, and beneath the Lower Cretaceous lateritic rocks to Upper Cretaceous reefal limestone and flysch.

Most of these “rootless” bodies are overlain by Upper Cretaceous transgressional limestone that allows rotation to their pre-Upper Cretaceous orientations. This aids in delineating older constrictional structures from exhumation structures. The pre-Upper Cretaceous interval includes formation of laterite deposits and extensively striated cobble formations (olistolithic or tectonic in origin). The provenance of supra-ophiolitic sedimentation is consistently “towards the east,” that is, towards the area of the Pelagonian core complex. Structures within the ophiolitic fragments themselves are generally too highly

overprinted by exhumation structures to determine the constrictive or emplacement origins of the nappe. The apparent continuation of a pebbly mudstone from the west to higher metamorphosed equivalent (amphibolite schist) towards the east and above the Pelagonian core suggests derivation from the NE-emplacing Mesohellenic slab.

Compared to the “rooted” Mesohellenic ophiolites that exhibit abundant constrictional structures associated with emplacement, all these small complexes are overprinted by “extensional” or transtensional structures. The thickness of these rootless ophiolites is so small compared to the distance of displacement from either potential root zone that an emplacement as a single, once contiguous, obduction nappe is probably not possible. Their outcrops over a long distance from a root zone can only result from thrusting within the Jurassic subduction followed by later extensional exhumation. Our study questions what these bodies show as representative portions of the roof zone above the exhuming complex. The metasomatic veining and heavy alteration of serpentinite is probably a remnant of exhumation beneath these “rootless” oceanic remnants.

Holocene tsunamis in coastal areas of northern Greece: sedimentological and geoarchaeological evidences

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Shallow drill cores in flat and southerly exposed coastal areas around the Thermaikos Gulf (Thessalonica and Katerini areas, and west coast of Kassandra, the western “finger” of Chalkidiki) and the coast in northern Greece near the cities of Lagos and Alexandroupolis provided evidence for past high-energy sedimentary events, which are interpreted as tsunamites. As a result, several Holocene coarse clastic layers have been found intercalated in sandy beach, clayey or gypsiferous lagoonal deposits. These layers have erosive bases, show fining-up and thinning-up sequences, and include shell debris, foraminifera and rip-up clasts of lagoonal sediments. Widely observed significant feature of these layers involve mud-coated beach clasts and rip-up clasts that rework the high-plasticity clays of lagoons. Such features that indicate highly disturbed sedimentological conditions (hyperpycnal flows) are rarely described elsewhere. Repeated intercalations of these layers with all the mentioned indicative features downhole are interpreted paleotsunami deposits from tsunamis generated by earthquakes or earthquake-triggered submarine landslides resulted by seismic shaking in the Thermaikos Gulf or the North Aegean Basin. However, we have to distinguish individual events (the one layer case) and packages of fining-up deposits, which are deposited during one event, but during several waves (usually 3-4 subsequent fining-up layers). Another important observation is that open beach conditions end immediately with a tsunamigenic event, and later lagoons form. Hence, both the coastal parallel currents, which are currently promoting spit deposits and lagoons, and tsunami events are shaping the coastlines of northern Greece.

A major tsunamigenic source is located along the western tip of the North Anatolian Fault Zone (NAFZ) in the North Aegean Basin, where water depths ranging between 1.200 and 1.650 m are sufficiently deep to generate tsunamis. Historic tsunamis have also been observed, e.g. the 1893 Samothraki event. However, the event layers up to now cannot be assigned to individual seismic or landslide sources, but the potential of a tsunami threat in the Thermaikos Gulf area can now be tested, following both sedimentological and modelling processes. Such potential threat regarding the Thermaikos Gulf has only recently been notified but never tested and studied in depth. Modelling of the tsunami potential of the basin-

bounding fault southwards of the Thermaikos Gulf provides an example for possible tsunami generation at only one segment of NAFZ along an approx. 55 km normal fault at the southern fault-bound margin of the North Aegean Basin.

The Herodotus Histories report on inundations and sea withdrawals occurring during the Greek-Persian war, which occurred near Potidea on Kassandra. In the ancient Greek village Mende we found evidence for a tsunamigenic layer, dated with shells to 2500 BP, which may tentatively be interpreted as the sedimentary remains of the “Herodotus tsunami” in 479 BC. Other tsunamigenic events, e.g. near Sozopoli village, occurred c. 5000 BP.

Triassic and Jurassic radiolarians from the Dinaridic Ophiolite Belt (Zlatibor area, SW Serbia)

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The Dinaridic Ophiolite Belt of western and SW Serbia is made up of ophiolites and widespread mélanges containing different components up to nappe-size, interpreted as radiolaritic-ophiolitic trench fills in front of advancing nappes. Matrix ages of the different mélange complexes are very rare, but play a crucial role in the reconstruction of the emplacement of the ophiolite nappes. From the radiolaritic matrix between different ophiolite, radiolarite and rare carbonate blocks of the ophiolitic mélange in three southern Zlatibor areas (A. south of Trnava in the valley of Katušnica River, B. south of Ljubiš in one double road curve, and C. east of Ljubiš near Visoka village) we isolate radiolarians of Early Callovian to Middle Oxfordian age; therefore the age of this Trnava/Ljubiš mélanges Blocks of ribbon radiolarite in the mélange are of Middle (Ladinian) to Late Triassic (Norian) age indicated by radiolarians. These radiolarites are interpreted to derive from the sedimentary cover of the Neotethys oceanic crust. Therefore the age of the reworked oceanic crust must be slightly older than the youngest radiolarite component. A derivation from the Middle Triassic volcanics, which is widespread in the Dinaridic realm, can be excluded. These volcanics are covered by Late Ladinian and Late Triassic shallow-water carbonates, missing in the clast spectrum of the mélange.

According to this radiolarian data the age of the radiolaritic-ophiolitic mélange corresponds to the age of the Sjenica ophiolitic mélange further south. Also the component spectrum is similar. The whole Trnava/Ljubiš mélange succession is interpreted to be a primary sedimentary synorogenic radiolaritic trench-fill sequence that formed simultaneously with nappe emplacement and ophiolite obduction/accretion, overprinted by contemporaneous and younger tectonics forming a typical mélange. This mélange was deposited during the late Middle to early Late Jurassic period coeval with ophiolite nappe thrusting in the Neotethys realm. The depositional area could be interpreted to have been a deep-water trough in front of advancing nappes.

Of special interest is the overlying mélange sequence which consists of different carbonate blocks of Triassic age, of both deep-water and shallow-water origin deriving from an outer carbonate shelf. The carbonatic mélange in the Sirogojno area is relatively matrix-free, only in some fissures in lagoonal Dachstein Limestone blocks remnants of the matrix are preserved. This resembles the situation in Krš Gradac near Sjenica, where Middle to early Late Jurassic radiolarite matrix with Triassic radiolarite components occur between blocks of lagoonal Dachstein Limestone. The derivation source of the carbonate blocks should be the Drina-Ivanjica Unit high further to the east. We consider therefore westward transport of the ophiolitic mélange and the ophiolite nappes as well as westward transport of the carbonate

mélange on top. Westward directed ophiolite obduction and thrusting in Jurassic time largely occur in the Dinaridic-Albanide realm, but the exact age of the emplacement is still a matter of discussion: Middle to early Late Jurassic or latest Jurassic to earliest Cretaceous. Our new data confirm (a) an allochthonous derivation of the ophiolitic mélange and the overlying ophiolite nappes (obduction), (b) the Middle to early Late Jurassic formation of the radiolaritic-ophiolitic mélange in the Dinaridic Ophiolite Belt and (c) their westward transport in Jurassic time. A younger, second westward thrusting phase, is documented by underlying radiolarite sequences with intercalated shallow-water debris of Kimmeridgian to Tithonian age. These occurrences are tectonic windows below the overthrust ophiolitic and carbonate mélanges. This clearly shows a polyphase thrusting of the ophiolitic mélange in westward direction.

An autochthonous origin of a Triassic Ocean between the Outer Dinarides and the Drina-Ivanjica Unit as northward continuation of Pelagonia/Korabi units, as proposed by another group of authors, can be excluded. This would exist in the lagoonal area of the Triassic carbonate platforms in the Dinarides, separating for example in Late Triassic time the restricted lagoon (Hauptdolomit) from the open lagoon (Dachstein Limestone).

Genetic significance of the Cretaceous black and red shales from the Eastern Carpathians (Romania)

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In the outer nappe systems of the Eastern Carpathians, namely the Moldavids, marine Upper Cretaceous red sediments overlay the Lower Cretaceous organic-rich black shales. The oldest parts of the black shale units are composed of Upper Valanginian-Upper Barremian hemipelagic and pelagic muddy siliciclastic rocks and carbonate muds, commonly intercalated with fine-grained turbidites. These features indicate an abyssal plain setting. During the sedimentation of the middle part of the black shale units, in the Late Barremian-Early Albian interval, the depth of the basin increased. This assumption is based on the occurrence of mainly hemipelagic sediments, with a few thin turbiditic intercalations.

The youngest part (Albian *pro parte*) of the black shale units is characterized by a turbiditic sedimentation, with mainly sandy sequences of middle and lower deep-water fans. A continuous decreasing of the basin depth is to be assumed. The presence of the authigenic glauconite in the Albian sandstones suggests a palaeoenvironmental change, linked to the occurrence of oxygenated turbidity current circulation.

A significant shift in the sedimentation regime of the Eastern Carpathian Moldavids took place in the Late Albian, when Cretaceous Oceanic Red Beds (CORB) occurred. This type of sedimentation lasted up to the Coniacian. The lower part of the CORBs, composed of radiolarites intercalated with variegated shales, pyroclastic tuffs and thin sandstones, is interpreted as a hemipelagic and pelagic sedimentation in an abyssal plain environment, where rarely turbidites occurred. Upwards, there are mainly burrowed variegated red and green shales. The youngest parts of CORBs are characterized by increased thickness and frequency of the turbidites. While the main part of the CORB is carbonate-free or has very low carbonate content, the upper part of these strata becomes rich in marls and mudstones, indicating a decreasing of the basin depth.

The accumulation of the black shales in the Eastern Carpathians during the Late Valanginian-Late Albian interval is linked to the existence of a small, silled basin of the Moldavian Trough, in which restricted circulation led to the density stratification of the water column, resulting in the deposition of anoxic Lower Cretaceous sediments (i.e., the black shales). Because of the tectonic deformation that took place during the Late Albian time, the restricted circulation changed to an open circulation regime in the Moldavian Trough. Hence, the anoxic regime was progressively replaced by an oxic one, across the Albian-Cenomanian

boundary interval. The beginning and the end of the CORBs in the Moldavid units depend thus on various palaeogeographic and palaeoenvironmental settings, and it was controlled by the regional tectonic activity.

An Evaluation of High Resolution Mapping Techniques for Documenting Submerged Archaeological Sites

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The capabilities of robotic vehicles to locate and map submerged cultural sites has drastically improved in recent years. Benefiting from advances in high frequency sonar systems, high dynamic range cameras and the accompanying data processing techniques, the archaeological community now has access to data products approaching centimeter level accuracy over scales of 100's to 1000's of square meters. There are, however, many open issues stemming from the inherent capabilities of acoustic and optical mapping that need to be explored to bridge the gap between what the scientific and archaeological communities expect for quantifying and documenting these often complex sites.

The resolution of the data products is typically spatially varying and affected by sampling density, perspective limitations, surface and sediment characteristics and water clarity. As a result it is often difficult to capture all of the potential errors and distortions in the data products in a clear and repeatable manner.

This paper will present results from several years of field surveys in the Aegean and Black seas working at sites in water depths between 50 and 600 meters. Many of these sites were recently located using side scan sonar searching techniques and then subsequently mapped using the Hercules ROV system. The sensor suite for high resolution mapping has included both 675 kHz and 2250 kHz multibeam sonars, a 675 kHz pencil beam scanning sonar, 12bit stereo paired digital still cameras and a 532 nm structured light laser sheet. The accompanying navigation data have been collected during structured surveys with a Doppler velocity log (DVL), fiber optic gyroscope attitude sensor and a quartz crystal depth sensor. These data can be used to create site photomosaics, bathymetry maps and hybrid optical and acoustic texture mapped representations, each of which can be effective as components in a overall site characterization and documentation process.

Using navigation refinement techniques derived from the Simultaneous Localization and Mapping (SLAM) concept common in the robotics community we have been able to create gridded bathymetry maps to half-centimeter spacing with high frequency multibeam sensors and structured light imaging techniques. This level of detail can now enable the accurate measurement of handle sized features on amphorae and detect subtle variations in the sediments around a wreck. Hybridizing this with stereo vision has also provided insight into the shape and textural characteristics of objects as well as the fundamental characteristics of the visual and acoustic sensing modalities. Our challenge moving forward is connecting and enhancing these capabilities in line with the expectations of the archaeological community, while respecting that the primary funding, expertise, and applications for the technology will continue to be in the more established oceanographic sciences. This begins with an assessment of the effectiveness of different technologies for various archaeological objectives, which we define according to the rubrics of identification, characterization, mitigation, investigation, and excavation. Each approach places progressively more demanding requirements on the technology and laborintensive processing to translate the oceanographic data into comprehensible archaeological results. In order for site recording to be worthwhile, therefore, the capabilities and limitations of the technology must be factored into the research design and the archaeological objectives of the expedition. A survey that sets out with the goal

of finding and investigating ancient shipwrecks in a deep water environment must ensure that the tools and techniques available can deliver results that satisfy that rubric, with the benchmarks being comparable expectations for shallow water and land site investigations. We began developing protocols for these different levels of investigation using an overarching methodological rubric of 'nautopsy,' which at this stage is still an evolving and informal way of characterizing the concerns and objectives of recording deep sea archaeological sites.

The growth of regional archaeological survey in the Mediterranean in the last thirty years has been dramatic, and with this growth has come an increasing sophistication in methods and technologies. Procedures for juxtaposing and synthesizing individual survey datasets, however, have lagged far behind. Until this situation changes, the primary value in regional underwater surveys will be the collection of data that do synthesize readily with established knowledge and conventions for representing that knowledge. In the case of an amphora cargo, then, certain precise measurements and observed features (handle stamps, fabric, etc.) of the individual jars provide the key to unlocking the date and origin of the cargo, with minute stylistic changes sometimes enabling the date of a Classical shipwreck to be narrowed to within a quarter century, exceeding the accuracy of radiocarbon dates from the same period. For this level of recording to take place without physical disturbance of a deep water site presents many challenges, both underwater and in the translation of the raw data into the representational conventions of archaeology. This paper confronts the challenges and reviews the achievements of the new site recording technologies in deep water, and proposes guidelines for ensuring that these techniques generate the maximum amount of archaeologically useful data in line with the scientific objectives of the survey.

K-Ar mineral dating and thermochronometry of the south Sithonia plutonic Complex (Chalkidiki, Greece)

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The Eocene Sithonia Plutonic Complex (Chalkidiki, Greece), which intrudes the Circum Rhodope Belt and the Serbomacedonian Massif, is divided into a northern part comprising two-mica (TMG) granites and leucogranites (LG) and a southern part comprising hornblende-biotite granodiorites (HBGD), grading into tonalities (HBTON), and biotite granodiorites (BGD). Abundant mafic microgranular enclaves are enclosed in the granodiorites and tonalites. A mixing plus fractional crystallisation process (MFC) is considered responsible for the evolution of the Sithonia Plutonic Complex. Two end-members are considered, an acid represented by leucogranites and a basic one represented by a lamprophyric-like magma which underplated a lower crust of amphibolitic/basaltic composition. At the early stages of the evolutionary process fractional crystallisation was more active than mixing giving rise to tonalitic/monzonitic enclaves while later on mixing was the prevailing process giving the wide spectrum of composition of the southern part of the complex (HBTON, HBGD, BGD).

The aim of this study is the K-Ar mineral geochronology and thermochronometry of the southern part of the Sithonia Plutonic Complex.

Based on the variety of rock types and their spatial distribution, twenty seven samples (mineral separates) of hornblende (3), biotite (12) and K-feldspar (12) were selected and dated. The K-Ar ages obtained range between 45 and 50 Ma for hornblende, 40 and 46 Ma for biotite and 36 and 42 Ma for K-feldspars respectively.

The K-Ar ages yielded and the published Rb-Sr mica ages are used to investigate the thermal history of the complex. The intrusion of the LG affected mostly the northern part of the HBGD (~46 Ma) and disturbed more the K-Ar isotopic system of the biotite than the Rb-Sr system. The last intrusion was that of the BGD at about 42 Ma. The larger age difference between Bt and Kf and the smaller Kf age in BGD in comparison to the rest rock types along

with the fact that biotite gives an isochron only in BGD indicate that: 1) The cooling rate of BGD is slower than the rest rock types, and 2) The K-Ar isotopic system for Kf in BGD was open for longer time resulting in a homogenous feeding of biotite with radiogenic Ar. In this way biotite was enriched in ^{40}Ar .

The closure temperatures of hornblende, biotite and K-feldspar, the K-Ar ages obtained and the available Rb-Sr mica ages were used to decipher the thermal history of the southern Sithonia Plutonic Complex. The estimated average cooling rate for HBGD+HBTON was $\Delta^{\circ}\text{C}/\Delta t = 40.2^{\circ}\text{C}/\text{Ma}$, nearly the same as that for the whole south part of the complex (HBGD+HBTON+BGD) estimated to $\Delta^{\circ}\text{C}/\Delta t = 40.1^{\circ}\text{C}/\text{Ma}$. This cooling rate is lower than the cooling rate estimated for the TMG of the northern part of the Sithonia Plutonic Complex ($\Delta^{\circ}\text{C}/\Delta t = 60^{\circ}\text{C}/\text{Ma}$). For the last cooling rate zircon ages have also been used.

Future estimations of precipitation in the Balkan Peninsula with the use of a Regional Climate Model

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During the last decades there were a lot of discussions regarding climate changes. Many climatological studies have focused on precipitation and drought due to their important role for many human activities. South Europe and especially the Balkan Peninsula is a prominent and vulnerable area, mainly due to its complex topography. This study aims to estimate the changes in the precipitation regime at the Balkan Peninsula through the end of the 21st century using a Regional Climate Model (RCM).

The daily precipitation data used are derived from an updated Regional Climate Model, the RACMO2, developed by the Royal Netherlands Meteorological Institute (KNMI) with the GCM ECHAM5 as a «parent» model. For the future climate projections the SRES A1B scenario is used. The spatial resolution of the model is 25x25 km and the data cover the whole European area. Of the 14136 grid points of the domain, those corresponding to the Balkan Peninsula have been chosen and their precipitation daily time series were analyzed. Also, three extreme indices were calculated and their trends were analysed over the entire time period (1960-2100). The selected indices were: the heavy rainfall threshold (the 95th percentile of rainday amounts (mm/day)), the greatest 5-day rainfall (greatest 5-day total rainfall (mm)), and the longest dry days (maximum number of consecutive dry days (days)). It is to be noted that the first index is based on thresholds defined using percentile values rather than fixed values. This makes the pq95 index transferable in different regions with different climatic regimes. The greatest 5-day rainfall amount is an important measure of extreme from the point of view of flooding in a region.

The first results of the study showed that heavy rainfall conditions will become more intense in the future mainly in the western part of the Balkan Peninsula. On the other had, the model “predicted” a general shift to drier conditions. In the case of the summer period a persisting absence of rainfall is expected in the future, since the length of dry spells approaches 90 days. Finally, extreme precipitation tends to decrease during the warm part of the year by the end of the 21st century, while intense precipitation episodes should be more often expected in autumn.

In the last part of the study, the relationship between extreme indices of precipitation and the atmospheric circulation was analysed. More specifically, the North Sea-Caspian teleconnection index is identified as an upper level (500hPa) atmospheric teleconnection between grid points 0° to 55°N; 10°E to 55°N (North Sea) and 50°E to 45°N; 60°E to 45°N (northern Caspian). During the negative phase of the NCP index there is an increased southwesterly anomaly circulation towards the study area, while during its positive phase there is an increased northeasterly circulation towards the Balkans. After calculating the daily calendar of the index, until the end of the 21st century, the statistical relationship between the

teleconnection index and the extreme rainfall was estimated for both the present time and future period.

The impact of landslides to the landscape evolution in the island of Andros

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This paper presents the impact of landslide phenomena to the landscape evolution of Andros Island. The morphology of Andros Island, was highly affected by tectonism (extensional deformation) in combination with the highly weathered metamorphic rocks of the Cycladic metamorphic massif. These are the two main reasons for the landslide phenomena in the island. The landslides on the island have a specific distribution following the slopes with high angles. These are located on high altitude areas very close to the major tectonic structures, or on the side slopes of highly eroded valleys due to the running water action. The results of the fieldwork and the terrain analysis showed that the landslides are divided into three distinctive groups, corresponding to their scale and their formation conditions. The oldest (1st) group of landslides affects very large parts of mountain slopes that have been moved downwards due to driving forces connected with the tectonic evolution of the area and the deformation faults, but also with the action of weathering and erosion processes. The geological formation of the slope parts is responsible for the generation of the intermediate (2nd) group of landslides. All landslides included in this group of mass movements are manifested in sites which consist of schists with marble intercalations and marble bodies. These formations are intensively fractured. The youngest (3rd) group includes all the synchronous landslide phenomena. These landslide phenomena, which affect linear technical works and urban areas, are connected with the geomorphologic conditions, climatic regime as well as human activities, and are presented in many places over the island, mainly during of high precipitation periods.

Application of geological mapping and teledetection techniques for identification of olistostromes and olistoliths in the Outer Carpathians

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Olistostromes formed in the Outer North Carpathians during different stages of the development of flysch basins are quite frequent. They are known from the Cretaceous, Paleogene and Miocene flysch deposits of the main tectonic units (the Pieniny Klippen Belt, the Magura, Dukla, Fore-Magura, Silesian, Subsilesian and Skole nappes and from the Miocene molasse of the Carpathian Foredeep). Detailed field mapping enabled the identification of new localities with olistostromes and large olistoliths. In the inner zones of the Silesian Nappe they were found within the Lower Cretaceous deposits of the Hradište Formation in Żywiec, the Upper Cretaceous Godula Formation in the Silesian Beskid Mts., Late Cretaceous and Middle Eocene in Rożnów Lake surroundings. Olistostromes with large olistoliths, or occasionally olistoplaques, within and above the Oligocene-Early Miocene Krosno Beds occur near Gorlice and Skrzydlina. The Paleogene and Early Miocene olistostromes have been found in the Subsilesian Nappe and olistostromes composed of

Upper Cretaceous, Palaeocene, as well as Oligocene and Miocene strata, were identified in the Skole Nappe. In the Bystrica Subunit of the Magura Nappe olistostromes of Middle Eocene and probably Late Oligocene–Early Miocene age were mapped. In the course of a recently conducted detailed field mapping it was found that large portions of the Pieniny Klippen Belt consist of huge olistostrome bodies.

In some cases, studies of the geological maps also helped to identify olistoliths and olistostromes. The presence of single olistoliths is manifested by single “spots” that remain in lithological and/or stratigraphical contrast with the surrounding strata. Olistostromes create a random (spotty) texture remaining in contrast with ordered linear texture of the surrounding flysch strata. Revision of geological maps revealed that, e.g. the so-called Fore-Magura thrust-sheet between Koniaków and Żywiec is not a separate tectonic unit but a sequence of the Krosno Beds of the Silesian Nappe containing two or three levels of olistostromes as well as solitary olistoliths. East of this area, between Andrychów and Myślenice, numerous individual olistoliths have been recorded within the Krosno Beds. Field observations reveal that these olistoliths are usually associated with debris-flows.

The teledetection techniques (geological interpretation of aerial photographs, satellite images, radar images, condensed contour maps and DEM - Digital Elevation Models) were used by the present authors to identify olistostromes and olistoliths. At first, images of known olistostromes and olistoliths were studied to find the remotely-sensed geomorphological features that would be helpful in the identification of olistostromes at other localities. Subsequently, on the basis of these experiences and relations between morphology of the terrain and the geological structure the authors attempted to identify previously unknown occurrences of olistostromes and olistoliths. The results are satisfactory if olistoliths consisting of rocks more resistant to weathering than the matrix of the surrounding olistostrome body. Such features are clearly observed on DEM and satellite images as random morphological patterns (mound-like texture). On the condensed contour maps olistoliths often appear as small closed ovals of contour lines, marking separate klippen which form hills or mounds. Especially pronounced appear megablocks of the Pieniny Klippen Belt in Poland and Slovakia which are huge olistoliths of the Middle Triassic-Lower Cretaceous carbonate and siliceous rocks embedded within the Cretaceous-Palaeogene flysch of the Zlatne Successions in the vicinity of Haligovce village (eastern Slovakia) and the Middle Jurassic-Early Cretaceous limestone olistoliths in the vicinity of Maruszyna (Poland). Spectacular are large olistoliths of the Upper Jurassic limestones of Štramberg and Pavlovské Kopce (Czech Republic) clearly seen on DEM and satellite images. E.g. an irregular mound-like structure marks the occurrence of the Middle Eocene olistostrome in the Bystrica Subunit of the Magura Nappe in north-east part of the Orava region.

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Territorial differentiation of natural recreation potential of Ukraine

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Natural recreation potential of Ukraine includes natural recreation lands, mineral waters, medicinal mud and medicinal raw materials for pharmaceutical industry. The value of country's natural recreation potential was estimated through money cost of free time spent outdoors for recreation; mineral waters and medicinal mud – through value of its exploited stock and on the basis of regional market prices. Average indices of natural recreation potential valuation per unit of territory and per inhabitant (the so-called territorial and economic potential productivity) were taken for 100 points.

With regard to geographical allocation of Ukrainian natural recreation potential (as based on materials of its map modeling), two tendencies are clearly observed: the first is the evidence that two major natural regions – Ukrainian Carpathians and Azovo-Chornomorske Uzberzhzhia (Azov-Black Sea Coast) – accumulate over the half of the initial natural

recreation potential of the country, while the second witnesses that Ukrainian natural recreation potential is concentrated around cities-millionaires and big cities. In other words, it is only in Kyiv, Khatkiv, Dnipropetrovsk, Donetsk and Lugansk Regions that over 1/3 of its (potential) totality is accumulated. To substantiate perspectives of recreation in Ukraine, it is important to analyze territorial differences in intro-components structure of natural recreation potential of this country. Thus, it is worth mentioning that the role of sanitary-resort treatment resources increases from the Eastern Economic Macro- (District) where their total is 18%, to the Western (23%) and Southern (33%) Macro-Rayons. Sanitary-resort resources are of special importance in the Odessa (59%) and Zakarpattya Oblasts (43%), Autonomic Republic of Crimea (40%), Vinnytsya (39%) and Lviv (30%) Oblasts. It is obvious that the perspectives of sanitary-resort branch in Ukraine belong to these regions. At the same time, the share of sanitary-resort treatment in natural recreation wealth of the Kyiv, Kharkiv, Dnipropetrovsk, Donetsk and Lugansk Oblasts successively decreases from 1/3 to 1/6. It is in the first turn explained by the increase of the role of natural resources for rest and tourism, efficiently used by the recreants from cities-millionaires and big cities in the form of week-end outdoor holidays. It is also important to mention those Ukrainian administrative Rayons where natural recreation potential is the first (basic) component in the integral natural resources potential (NRP). These are the Chornomorskiy (Black Sea) Rayon of the Autonomic Republic of Crimea, city of Chernivtsi, Kosiv Rayon in Ivano-Frankivsk Oblast, Mukachevo, Svalyava, Khust Rayons in Zakarpattya Oblast, and Kharkiv Rayon in Kharkiv Oblast. 54 more Administrative Rayons of Ukraine possess natural recreation resources as their second-important natural wealth. It is also important to analyze indices of Ukrainian people's provision with natural recreation potential (average index – 100 points). Thus, as regards to Ukrainian natural regions, the East-European Plain is provided at average level of 86 points, Ukrainian Carpathians – 187, and the Crimean Mountains – 331 points. In East-European Plain, the Steppe is provided with natural recreation resources at a level of 91 points, Forest-Steppe – 83, and Mixed Forests – 80 points. Uneven provision in Rayons is evidenced by the following: absolute indices in Mixed Forests amount to 727 points (Slovechansko-Ovrutskiy Rayon, Zhytomyrske Polissya) and 395 points (Dovbaczansko-Chervonoarmiyskiy Rayon). The Forest-Steppe does not manifest too much difference. West-Ukrainian Forest-Steppe Province is provided at a level of 59 points per inhabitant (absolute value – 562 points), Dnistrovsko-Dniprovsk Forest-Steppe Province – 77 points (amplitude – 205-231 points) Livoberezhno-Dniprovsk Forest-Steppe Province – 91, and Serednorosiyska Forest-Steppe Province – 111 points. The Crimean Mountains manifest high and relatively homogeneous level of people's provision with natural recreation, and, except for two rayon – Western (Girsko-Krymska Oblast, 34 points) and Chornorickiy (Peredgirn-Krymska Oblast, 35 points) – ranges within the limits of 260 – 462 points. People's provision with natural recreation resources in Ukrainian Carpathians is rather high and homogeneous. The Oblast of Peredkarpattya is estimated to have 125 points, the same of Zovnishni (External) Carpathians – 156, Vododilno-Verkhovynska – 341, Polonynsko-Chornogirska – 340, Rakhivsko-Chyvchynska – 375, Volcanic Carpathians and Mizhgirni Kotlovyny – 253, and Zakarpatska Plain – 214 points. As regards Rayons, people's provision is not considerably different. Thus, the geographical analysis proves that territorial differentiation of Ukrainian natural-recreation potential significantly influences upon substantiation of the ways for its balanced development.

Quarternary evolution of “Ancient Lake Ohrid”, FYROM/Albania

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The cross-boundary Lake Ohrid (40°54' – 41°10'N, 20°38' – 20°48'E) located at the border of FYR of Macedonia and Albania is situated within a karstic environment in an active tectonic region in the Balkanides and stretches over a length of c. 30 km and a width of c. 15 km. The regional basin and range setting in an extensional back-arc system, that is controlled

by the roll-back of the subducted plate of the Northern Hellenic Trench, produces an elongated N-S trending basin with relatively straight shorelines along the lake. These in particular are linked mostly to N-S trending active faults that are formed by extension and point to active subsidence. The evolution of the shorelines during the Holocene was investigated by studying extensive parts of the present-day coastline, including locations in the northern and southern plains as well as deltas of inflowing rivers and mass movement bodies on the eastern shore where a steep relief is exposed. Ground Penetrating Radar and electric resistivity have been applied as non-invasive shallow subsurface mapping methods to image sedimentary and tectonic structures and unconsolidated sediment cores were taken to support the geophysical data. The southern plain is dominated by alluvial plain deposits and deltaic foresets, generated by the meandering Cerava River. This could be validated by the geophysical data. The northern plain shows fluvial-dominated sequences including channel structures which are underlain by deltaic sediments and foresets. The Velestovo site to the east of the basin provides evidence for a shallow lagoon or marsh environment by peat deposits with periodical clastic input of the Velestovo creek. A change in the drilled sediments from peat to clayey marls at a depth of 8 m suggests a change in the depositional environment, which can be related to a sudden lake-level drop or to tectonic activities. No evidence for a higher lake-level during the Holocene was found in the plains north and south of the lake, except rare temporal floodings, which are also documented historically and lacustrine faunal elements (ostracods, Chara) encountered within the sediments. The abrupt change in sediment composition in the core of the east coast can be related to a sudden lake-level drop, enhanced discharge of the karstic springs or to tectonic activities. Considering the tectonic activity of the region and the landscape architecture a tectonic event is likely the cause of this effect. In conclusion, the plains north and south of the lake are dominated by clastic input related to climate variations and uplift/erosion, whereas the steep western and eastern margins are controlled tectonically by normal faulting. Mapping of the limestone cliffs around Lake Ohrid yielded no evidence for abrasional platforms or notches as indicators for past higher lake-levels. Hydroacoustic survey exhibited several drowned platform like terraces at depth ca. of 30 and 60 m below present-day lake level.

Cosmogenic ^{10}Be dating of Danube terraces in Hungary

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Quaternary development of the Danube valley in the Pannonian Basin is of crucial importance for the understanding of the landscape evolution and neotectonics of the region. The Danube River is the only river crossing the uplifting Transdanubian Range (TR), therefore providing a unique opportunity for the quantification of the Quaternary river incision/uplift rate of the TR. The TR is a low altitude (up to 750 m) mountain range composed to Palaeozoic to Mesozoic basement between the two major sub-basins of the Pannonian Basin System. Accordingly, for a better understanding of the structural evolution of the area, it is necessary to calculate the vertical movements and to distinguish between tectonic and climatic forces in landscape evolution. The existing terrace chronology – the so called “traditional terrace system” – in the Danube valley was based on geomorphological, sedimentological and palaeontological data. These data, however, allow only a relative chronology, which is valid at certain river sections and does not provide numerical ages of the terrace horizons. Exposure age dating of the Danube terraces has started in the axial zone of the TR, where cosmogenic ^3He was used to determine the age of andesite strath terraces. These data showed that Danube terraces, and connected uplift of the TR are significantly younger than it was suggested before. Instead of the late Pliocene – early Pleistocene onset of the uplift suggested by the traditional terrace system, a middle Miocene beginning was

proposed with an uplift rate above 1 mm/y. This result is indicative of ongoing tectonic deformation of the interior of the Pannonian Basin and rises the need for absolute age determination of river terraces at other valley sections, too. Accordingly, as a continuation, our study now focuses on gravel terraces upstream of the Danube Bend. Here earlier studies, using relative chronological data of the terrace-gravel suggest early Pleistocene age of the highest terrace horizons. We apply cosmogenic ^{10}Be for age determination, aiming at finding evidences on the young vertical movements at several sections of the Danube valley. Sampling occurred along depth profiles using all particles involved in the cosmogenic nuclide production and allowed determining the exposure time denudation rate pairs for each locality. Sample preparation occurred at CEREGE-CNRS, Aix en Provence and AMS measurements occur at ASTER, the French National Facility, CEREGE. Measurements and calculations are on their way, our first results show that the formation of the highest horizons occurred in middle Pleistocene times (ca. 600ka) in contradiction to the formerly suggested earliest Pleistocene age. The lower horizons also appear to be younger than their age based on previous relative chronologies. The first denudation rates calculated by the depth profile data suggest slow denudation of the flat terraces surfaces, the average values ranging around 4-6 m/My. Exposure ages are in accordance with the previous ^3He study, that is to say, the dated gravel terraces also appear to be younger than it was suggested by previous works. These results suggest that considerable vertical movements occur in the lithosphere of the Pannonian Basin and ongoing deformation contradicts the theoretical tectonic stability of the basin interior.

Petrogenesis and tectono-magmatic significance of volcanic and mantle rocks from the Albanian-Greek ophiolites: Implications for the Triassic-Jurassic evolution of the Dinaride Tethyan branch

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The Albanian-Greek ophiolites crop out in two major ophiolitic zones: 1) the External Ophiolites (EO) which can be subdivided into: a) a westernmost belt (EOa): W Mirdita, Pindos, Koziakas, Othrys; and b) an easternmost belt (EOb): E Mirdita, Vourinos, Argolis. 2) the Internal Ophiolites (IO) which can be subdivided into: a) Almopias ophiolites (IOa) and b) Guevgueli ophiolites (IOb). Many stratigraphic and petrological similarities can be observed between ophiolites from the IO and EO.

The Albanian-Greek ophiolites and sub-ophiolitic mélanges include eight different types of volcanic rocks: 1) Triassic, within-plate alkaline rocks (WPB) which are included in both EO and IO mélanges; 2) Triassic high-Ti mid-ocean ridge basalts showing enriched compositions (E-MORB) (EO and IO mélanges); 3) Triassic (EO and IO mélanges) and Jurassic (EOa) high-Ti mid-ocean ridge basalts showing normal compositions (N-MORB); 4) Jurassic medium-Ti basalts (MTB) (EOa); 5) Jurassic low-Ti, island arc tholeiitic (IAT) rocks (EOb and IOa); 6) Jurassic very low-Ti (boninitic) rocks (EO and IO ophiolitic and mélange sequences); 7) Jurassic back-arc basin basalts (BABB) (IOb); 8) Triassic (EO and IO mélanges) and Jurassic (IOb) calc-alkaline rocks (CAB). They also include two types of mantle peridotites: 1) depleted lherzolites (EOa) and 2) harzburgites showing various degrees of depletion (EOa, EOb, IOa). The main aim of this work is to identify the possible petrogenetic mechanisms, in terms of mantle sources, primary melt generation, and mantle residua, for the distinct lava groups and their related tectonic settings of formation, in order to propose a reconstruction of the tectonic evolution of the Mesozoic Dinaride Tethys as follows:

1) From the Late Palaeozoic-Early Triassic, extensional tectonics affecting the Gondwana triggered the rifting of the continental lithosphere. The magmatic activity included: (a) CAB rocks generated from a sub-continental mantle formerly modified by SSZ geochemical components; (b) alkaline WPBs deriving from an OIB-type mantle source.

2) During the Middle-Late Triassic, the uprising of primitive asthenosphere led to the generation of the Tethyan oceanic lithosphere. This stage is associated with the formation of: (a) N-MORBs derived from ~10-20% partial melting of primitive asthenosphere; (b) alkaline WPBs most likely erupted in seamounts or off-axis areas; (c) E-MORBs generated from ~12% partial melting of primitive asthenosphere influenced by the OIB-type component. The residual MORB mantle is represented by the depleted lherzolites cropping out in the EOa.

3) From the Early-Middle Jurassic, the tectonic regime was dominated by intra-oceanic convergence associated with the development of MTBs and IATs which derived respectively from ~10% and 10-20% partial melting of the MORB residual mantle with variable addition of subduction components. Afterwards, the progressive slab roll-back led to mantle diapirism and incipient intra-arc spreading associated either with 10-20% partial melting of the MTB and IAT residual mantle (harzburgite) or with ~30% partial melting of the MORB residual mantle (depleted lherzolite), both enriched in LREE by subduction-derived fluids. These partial-melting events produced the boninitic magmas in both fore-arc and inner arc and left, as residual mantle, the depleted harzburgites which are commonly found in the EOa, EOb and IOa.

4) During the Late Jurassic, a magmatic arc developed onto the Eurasia continental realm, leading to the formation of CAB rocks by ~15-20% partial melting of depleted peridotite mantle significantly enriched in Th and LREE by subduction-derived fluids. Soon after, extension in the back-arc region led to the uprising of primitive (MORB-type) asthenosphere, which was enriched in Th and LREE by the nearby subduction. 10-20% partial melting of this mantle source produced the BABBs cropping out, with CAB intercalations, in the IOb.

Reconstructing prehistoric landscapes in tectonically active regions: the Corinth and North Evia prehistoric lakes during LGM

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The Aegean and Ionian regions are known as tectonically and seismically very active areas and are characterized by frequent earthquakes and fault rupturing. In Central Greece particularly, the active neotectonic basins of the Gulf of Corinth and the North Evia Gulf undergo strong crust deformation under high strain rates during Pleistocene – Holocene, as indicated by vertical (uplift or subsidence) movements along their margins. The superposition of long-term vertical tectonics on the effect of the successive sea-level changes has produced a remarkable relief composed of uplifted marine terraces and submerged terrestrial landscapes.

Both the Gulf of Corinth and the North Evia Gulf are connected to the Ionian and Aegean Sea respectively through narrow and shallow straits. Maximum depth in the straits does not exceed 65-70m. Systematic high resolution seismic profiling, swath bathymetry and gravity piston coring have shown that both marine basins were isolated lakes when the sea-level was about 120-125m lower than the present one during the last glacial maximum(LGM). AMS radiochronology data have shown that sea water entered the lakes about 13-14kyrs before present, when sea-level rise drowned the shallow straits. The prehistoric landscapes which surrounded the LGM lakes became submerged and subject to tectonic movements and marine sedimentation.

The coastline of the LGM Corinth lake has been detected in seismic profiles from the northern margin of the Gulf at -90 m below present sea level. Geological data show that the northern margin of the Gulf subsides at 0.7-1.0 m/kyr while the southern margin emerges at 1.0-1.3 m/kyr. Consequently, the coastline of the LGM Corinth lake should have been initially at 77-80 m below present sea level. On the uplifting southern margin of the Gulf the coastline of the lake has not been detected yet but is expected to have emerged at about 65-70 m below present sea level since the incursion of sea water.

The water level of the LGM North Evia lake has been found in seismic profiles at about 90 m below present sea level. Vertical tectonic movements are evident around the Gulf but have not been quantified yet, so the initial lake level can not be determined precisely. Holocene sedimentation in the Gulf is mainly depended on the fertile clastic material supplied by rivers which drain the surrounding mountains. The submerged prehistoric landscape is covered by marine sediments, their thickness being up to 40 m off the outflow of rivers along the southern margin. Limited sedimentation areas or even relict landscapes have been mapped away from river mouths.

Thorough evaluation of the seismic data and sedimentological and laboratory analyses of the sediment cores are essential for the precise reconstruction of the submerged prehistoric landscapes around the Corinth and North Evia lakes during the last glacial maximum and early Holocene. Vertical tectonic movements and sedimentation rates need to be quantified and considered for the final paleo-morphological reconstruction.

Preliminary results of provenance analyses of exotic magmatic and metamorphic rock pebbles from the Eocene flysch deposits of the Magura nappe (Krynica facies zone, Polish Outer Carpathians)

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During the Late Cretaceous to Palaeogene, the Magura Basin was supplied by clastic material from source areas situated at the northern and southern margins of the basin, which are presently not outcropped at the surface. The northern source area is traditionally connected with the Silesian Ridge, whereas position of the southern one is still under discussion. The south-Magura source area supplied the Eocene pebbly paraconglomerates containing partly exotic material. The studied clastic material contains fragments of igneous and metamorphic rocks, derived from a continental type of crust, and frequent clasts of Mesozoic to Palaeogene deep and shallow-water limestones. Volcanites, rarely granitoids as well as schists, gneisses, quartzites and cataclasites were found in the group of crystalline exotic pebbles. Monazite ages of “exotic” pebbles from the Tylicz and Piwniczna-Mniszek sections document the Variscan age of metamorphic rocks. The provenance of these exotic rocks could be connected with the Eocene exhumation of the SE sector the Magura Basin basement or by supply of crystalline material from remote SE source area (Dacia and Tisza mega units).

The seasonal variations of ultraviolet radiation result in changes of human serum bone turnover markers

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Vitamin D is recognized as the sunshine vitamin playing a vital role in maintenance of skeletal health. Vitamin D status depends on latitude, as vitamin D₃ is synthesized in the skin under the influence of UV irradiation from the sun mainly during spring and summer. Biochemical markers of bone turnover can be classified according to the process that underlie in markers of bone formation, [bone ALP, osteocalcin] and markers of bone resorption, [pyridinuum crosslinks, collagen I C- and N-terminal telopeptides (CTX-I and NTX-I)].

The aim of the present study was 1) to investigate in a sunny Mediterranean country like Greece whether bone turnover, as determined by biochemical markers, varies by season 2) to correlate these changes with the quantity of the Ultraviolet radiation (UV) and 3) to determine the degree and the qualitative characters of this variability.

The study was conducted for one year. The study group was composed of two separate groups; each group included 30 healthy adults (15 male and 15 female). In the first group, were studied in a prospective longitudinal manner and remained the same throughout the year. In the second group of healthy subjects were studied in a cross sectional manner and recruited randomly in the same last week of each season from healthy individuals coming to donate blood at the Hospital Blood Centre. Serum and urine calcium, phosphate, albumin, bone alkaline phosphatase were determined. Urinary calcium was measured on a 24h urine sample, delivered on the day of the blood sampling. Electrochemiluminescence immunoassay "ECLIA" (Roche) was used for quantitative determination of serum bone markers Osteocalcin, TP1NP, PTH, β -CrossLaps, Vitamin D3 (25-OH). The UV-B irradiation was measured at a ground-based station located in Patras (38.29° N, 21.29° E) of the Greek UV Network by a NILU-UV multi-channel radiometer. NILU-UV multi-channel radiometers provide UV irradiance measurements at five wavelength bands centered at 302, 312, 320, 340 and 380 nm, with full width at half maximum (FWHM) of approximately 10 nm.

Annually changes of serum bone turnover markers appears early in spring. These changes resulted from expected changes of serum Vit D due to seasonal variation of UV radiation: 1) Seasonal Variation of Bone markers turnover in 30 healthy individuals: UV-B (MJ/m²) Winter 1.459, Spring 4.426, Summer 7.475, Autumn 3.438, (n.s.) TP1NP (ng/mL): 43.31±16.34, 52.19±22.33, 45.76±18.20, 44.75±12.95, Vitamin D3(25-OH) (ng/mL): 28.77±4.77, 31.77±6.80, 42.02±14.75, 30.63±7.29, p<0.001, Osteocalcin (ng/mL): 17.70±7.26, 19.95±6.64, 17.46±5.49, 16.86±4.43, p=0.06, B-Crosslaps (ng/mL): 0.275±0.167, 0.339±0.186, 0.299±0.138, 0.259±0.129, n.s., PTH (pg/ml): 36.80±13.32, 34.46±12.27, 32.92±13.47, 35.64±13.49, n.s., Serum Calcium (mg/dl): 9.55±0.38, 9.39±0.66, 9.47±0.70, 9.58±0.61, n.s. Bone Alkaline phosphatase (IU/L): 51.84±13.66, 51.68±14.71, 42.80±12.48, 51.20±15.14, p<0.001, respectively. 2) Seasonal Variation of Bone markers turnover in 120 healthy individuals (30 every season selected randomly UV-B (MJ/m²): Winter 1.459, Spring 4.426, Summer 7.475, Autumn 3.438, TP1NP (ng/mL): 36.87±10.88, 44.53±21.00, 36.75±12.93, 38.25±16.76, n.s. Vitamin D3(25-OH) (ng/mL): 21.17±6.27, 29.30±8.20, 31.24±10.47, 25.39±5.42, p<0.001, Osteocalcin (ng/mL): 15.25±4.95, 19.35±6.88, 13.81±3.94, 12.42±5.45, p<0.001, Crosslaps (ng/mL): 0.230±0.130, 0.296±0.201, 0.234±0.141, 0.196±0.088, n.s. PTH (pg/ml): 27.62±11.07, 29.12±12.59, 22.62±6.94, 28.91±10.11, n.s. Serum Calcium (mg/dl): 9.39±0.39, 9.79±0.24, 9.78±0.49, 9.80±0.75, p<0.001, Bone Alkaline phosphatase (IU/L): 44.71±12.11, 46.08±14.16, 33.47±11.88, Autumn(-), p<0.001, respectively.

Based on bone turnover markers, we conclude that bone formation precedes bone resorption.

The current state of conservation of Romanian stone monuments

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The paper deals with aspects concerning the conservation degree of Romanian stone monuments of different periods affected by natural and anthropogenic causes, with consequences on the historical development of the region. There are discussed main phenomena related to their present state, the stone from monuments restored/preserved, respectively, the recently discovered ones, on which no interventions have been performed. The analysis of these stones was achieved, through a correlation between the destruction and alteration factors, specific to the Romanian region and their casuistics and consequences of

the degradation and deterioration phenomena. Also, for their analysis the nature and characteristics of the stone have been considered, along with the procedures of manufacturing, restauration, identifying some anomalies and inadequate interventions, already notorious.

Jurassic calc-alkaline granitoids associated with the East Vardar Ophiolites

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There are two major styles of Jurassic granitic magmatism associated with the Vardar Zone ophiolites: (1) strictly intra-ophiolitic intrusions dominating in the northern part and (2) magmatic bodies intruding both ophiolites and the basement in the southern part.

The intra-ophiolitic granitoids occur near Ždraljica and Kuršumljica (Serbia) and form dykes and small irregular bodies cutting gabbro-diorite ophiolite complexes. Geochemically, three subgroups are distinguished: (i) intermediate rocks, (ii) low- Sr_i granites and (iii) high- Sr_i granites. Intermediate rocks are represented by diorites, quartz diorites and quartz monzodiorites with $Sr_i=0.70557 - 0.70746$ and $\epsilon_{Nd}(T) -4.5 - -0.8$. The low- and high- Sr_i granites are petrographically similar, but differ in isotope composition, i.e., $Sr_i=0.70330 - 0.70767$ and $\epsilon_{Nd}(T) -5.1 - 1.5$ and $Sr_i=0.70956 - 0.71602$, $\epsilon_{Nd}(T) -6 - -5.1$, respectively. Furthermore, the high- Sr_i granites have higher HREE and Y contents.

The southern granitoids in F.Y.R. of Macedonia and Greece (Fanos) form large bodies that intrude both the Vardar Zone ophiolites and metamorphic rocks of the Serbo-Macedonian Massif. The rock suite of F.Y.R. of Macedonia includes intermediate to acid members (diorite, quartz monzodiorite, granite) and shows a trend of decreasing radiogenic $\epsilon_{Nd}(T) - (3.3 - -8.9)$ and increasing $Sr_i (0.70740 - 0.71588)$ with increasing silica content. In contrast, the Fanos granite is isotopically relatively uniform with $Sr_i=0.70516 - 0.70559$ and $\epsilon_{Nd}(T) - -1.6 - -0.7$.

Geochemical modeling suggests that the high- Sr_i granites derived from peraluminous magmas that were generated by obduction-induced melting of (meta) sedimentary rocks. The low- Sr_i granites and the intermediate rocks of Serbia formed separate, possibly small, magma chambers, partly related to obduction-induced melting of a low- Sr_i source, formed in part by subduction related volcanic arc magmatism.

Granitic magmatism in the southern part of the Vardar Zone is characterized by melting of slightly enriched mantle- and lower crustal magmas that were modified by AFC processes in F.Y.R. of Macedonia and FC processes in Fanos. Their emplacement was favored by collisional processes resulting in great crustal thickness and the post-collisional emplacement of mantle-derived magmas that provided the heat for partial crustal melting.

Paleoenvironmental setting of rudists in the Upper Cretaceous (Santonian-Campanian) deposits from Valea Neagră de Criș (Borod Basin)-Northern Apuseni Mts, Romania

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The Upper Cretaceous deposits located in the eastern extremity of Borod Depression represent, for the Northern Apuseni Mountains, a well-known cropping out area for Gosau-type facies with rudists which is similar to the typical Eastern Alps section. The investigated

stratigraphic succession includes both carbonate and siliciclastic deposits. The carbonate deposits with rudists (hippuritids) bioconstructions crop out in the base of the succession. The upper part is dominated by siliciclastic sequences that contain, at various levels, bioaccumulations mainly consisting of radiolitids. The rudist assemblages identified from these deposits include species typical for the Gosau facies, as well as distinctive species (*Miseia*, *Gorjanovicia*, *Mitrocaprina*) characterising south-European, Mediterranean areas. These latter species are now first mentioned for the Upper Cretaceous deposits in the area under study.

Influence of air temperature and CO₂ concentration on C3 plants

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Adaptation ability of C3 plants was verified with regard to the expected climate changes. The measurement of carbon dioxide exchange was carried out and net photosynthesis (PN) was calculated in C3 species of white goosefoot (*Chenopodium album* L., Chenopodiaceae). The tested plants were grown in plant growth chambers (Sanyo MLR 350) with controlled temperature (20°C), light length (14 hours day) and illuminance (20000 lx). While testing, the air temperature was increased stepwise from 5 to 40°C. Similarly, CO₂ concentration was changed in leaf cuvette from 200 – 1500 ppm by built-in removable CO₂ regulator. Considering the assumed climatic changes relating a raise of the air temperature and CO₂ concentration, the values of carbon dioxide concentration based on the climate scenarios ECHAM4 (Germany) and HadCM3 (G. Britain) were classified as well. Optimistic carbon dioxide emissions scenario B1 assumed the CO₂ concentration to be 467 ppm and pessimistic one A2 to 535 ppm.

The exchange of carbon dioxide was measured after the plant adaptation on certain temperature and CO₂ concentration in the light as well as under dark conditions. The adaptation to the given temperature and CO₂ concentration took approximately 45 minutes. Except for the carbon dioxide concentration and air temperature setting, in the clamp-on chamber the photosynthetically active radiation (PAR) value was programmed to automatically control light intensity at the level of 500 $\mu\text{mol m}^{-2} \text{s}^{-1}$ being the optimum for C3 plants. Measurements were taken with the CIRAS2 (PPSystems, UK) supplied with universal leaf cuvette type U RICE having the measured leaf area of 1.7 cm².

The C3 plants examined are best adapted to temperature ranging from 20 to 25°C in light. Nevertheless, at high concentration of CO₂ the C3 plants have proven to cope better with higher temperatures than with low ones. At 5°C the calculated values of PN achieved approximately 4 $\mu\text{mol m}^{-2} \text{s}^{-1}$ regardless the carbon dioxide concentration. Conversely, at 40°C the influence of CO₂ concentration was more significant. Therefore, we suppose that with increasing CO₂ concentration C3 plants are able to tolerate rise in temperature. Net photosynthesis rate at 1000 ppm CO₂ reached at least the value of 10 $\mu\text{mol m}^{-2} \text{s}^{-1}$. When dark adapted, there is a better ability to cope with a higher CO₂ concentration at lower temperatures. In the dark the PN values were often negative, because the energy required for plant survival exceeds the energy amount obtained by photosynthesis.

Considering these facts, the climate changes will have significant influence on C3 plants. As a response to the rising CO₂ levels and air temperature, the rate of photosynthesis will increase and plants will accumulate more aboveground biomass. It can be assumed that climate changes will influence the competition ability of crops as well as weeds. Additionally, climate changes could influence the ecosystems composition and plant morphology.

Estimate of influence of U, Th and K radiogenic heat on the Marmara Region and lithospheric structure

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The natural radioactive nucleids with long half life in the earth are Uranium, Thorium and Potassium and they contribute to the heat produced in the crust. During decay process of the radioactive nuclides in rocks, emission of α , β , γ particles transform into radiogenic heat. The amount of radiogenic heat per time generated from rocks can be determined by concentration of the radioactive nucleides in the rocks and it is independent of forms, temperature and pressure of the rocks. Concentrations of radionuclides in the samples can be determined by gamma ray spectrometer or some concentrations were obtained from chemical analysis.

The radioactivity concentrations of U, and Th, K in the soils of the Kestanbol granite area are relatively high, but these values are regarded as typical for the region. The high concentrations are determined from Kozak in the Çanakkale Region. The contributions of radiogenic heat production to lithospheric temperature were discussed.

In this study radiogenic heat production values were estimated from U_{238} , Th_{232} and K_{40} concentrations from a variety of granitoid rocks in Marmara region and radiogenic heat rate contributed to lithospheric thermal structure was obtained for Çatalca, Kestanbol and Çanakkale.

Cenozoic granitoids in the Dinarides of southern Serbia: age of intrusion, isotope geochemistry, exhumation history and significance for the geodynamic evolution of the Balkan Peninsula

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The Dinarides represent a complex orogen consisting of thrust sheets that contain ophiolitic as well as Adria-derived continental material. These thrust sheets are situated in a lower plate position with respect to an upper plate formed by the Tisza and Dacia Mega-Units with European affinities. The area around the Kopaonik massif in southern Serbia exposes the two innermost Dinaridic composite nappes, namely the Drina–Ivanjica and the Jadar–Kopaonik–Studenica composite thrust sheets. In the latest Cretaceous to Early Paleogene these innermost Dinaridic thrust sheets collided with the already existing (pre-Turonian) Carpatho–Balkan orogen that is a part of the Dacia Mega-Unit and constitutes the upper plate of the complex collision zone. A separating suture zone (Sava Zone) runs along the eastern rim of the innermost Dinarides that is along the internal limit of the Jadar–Kopaonik–Studenica composite thrust sheet and separates the Dinarides from the Carpatho–Balkan orogen. The metasediments of the Kopaonik and Studenica Metamorphic Series and the overlying Western Vardar Ophiolitic Unit were intruded by Cenozoic granitoids. Available structural data indicate that the intrusion of these plutons post-dates three phases of compressive deformation (D1–D3), the latest associated with thrusting in the internal Dinarides and suturing with the adjacent Carpatho-Balkan orogen.

Two age groups for the Cenozoic granitoids in the Dinarides of southern Serbia were determined by high precision single grain U–Pb dating of thermally annealed and chemically abraded zircons: (i) Oligocene ages (Kopaonik, Drenje, Željina) ranging from 31.7 to 30.6 Ma and (ii) Miocene ages (Golija and Polumir) at 20.58–20.17 and 18.06–17.74 Ma, respectively.

Apatite fission-track central ages and modelling combined with zircon central ages, together with local structural observations, constrain the subsequent exhumation history of the magmatic rocks. They indicate rapid cooling from above 300 to ca. 80 °C between 16 and 10 Ma for both age groups, caused by extensional exhumation of the plutons that are located in the footwall of core-complexes (D4). Miocene magmatism and core-complex formation thus affected not only the Pannonian basin but also a part of the mountainous areas of the internal Dinarides.

For the geodynamical setting of the Balkan Peninsula we propose, based on new Hf isotope analyses and the discussion of an extensive set of age data from the literature, that Late Eocene to Oligocene magmatism, which affects the Adria-derived lower plate units of the internal Dinarides, was caused by delamination of the Adriatic mantle from the overlying crust, associated with post-collisional convergence that propagated outward into the external Dinarides. Miocene magmatism, on the other hand, is associated with core-complex formation along the southern margin of the Pannonian basin, probably associated with the W-directed subduction of the European lithosphere beneath the Carpathians and interfering with ongoing Dinaridic–Hellenic back-arc extension.

P-T-time paths associated with extensional doming: constraints from thermomechanical numerical models

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Extensional doming in continental environment has been studied numerically using 2D visco-plastic codes yielding good results on prediction of large-scale structures such as symmetric or asymmetric domes, fault tectonics and deformation of domes and surrounding rocks. However, the thermal evolution of extensional domes remains difficult to compute because of the coupled interaction between mechanical forces and temperature. This coupling is fundamental, because it provides a link between modelling on one side and thermobarometry and thermochronology on the other side. In effect, P-T-time evolution of exhumed rocks of an extensional dome can constrain time, size, and patterns of metamorphic overprints simulated in thermo-mechanical models. We treat mechanical and thermal aspects together (including modelling of metamorphic P-T-time paths of crustal rocks), using a visco-elasto-plastic rheology in a four layer setup (upper crust, lower crust, lithospheric mantle and asthenospheric mantle). We employed I2ELVIS, a numerical 2D computer code designed for conservative finite differences method. The model domain is 300 km wide and 160 km deep.

Two modes of dome development and geometry were obtained depending on first order parameters such as initial temperature at the Moho and initial thickness of the continental crust: (i) Lower crustal doming: with a hot Moho ($T_{\text{MOHO}} > 700$ °C) or a thick crust, strain is localized in the upper crust and distributed in the mantle. At these conditions, partial melting in the lower crust forms the core of the dome and maintains a flat Moho. The migmatites are exhumed in the footwall of a high-angle detachment that progressively rotates with ongoing extension to form a low-angle detachment bounding a migmatitic “core complex”. The P-T-time path of these migmatites is characterized by a one-stage decompressional cooling. (ii) Asthenospheric-triggered doming: with a cold Moho ($T_{\text{MOHO}} < 700$ °C), strain is distributed in the crust and localized in the lithospheric mantle, which allows upwelling of the asthenosphere. The low angle detachment migmatite “core complex” develops after the asthenosphere upwelling. The migmatites show a two-stage P-T-time path with isobaric heating followed by decompressional cooling. Thus, different thermal regimes produce similar structural patterns that have quite different geodynamic evolutions. Topography of the Moho and P-T-time paths of the footwall rocks are therefore key tools to discriminate at which initial thermal condition the migmatite “core complexes” developed.

Correlation of major tectonic units from the Alps to Western Turkey

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This contribution presents an extension of a previously published tectonic overview (http://pages.unibas.ch/earth/tecto/homepage/Schmid_etal_2008.pdf) into Greece and Western Turkey and discusses along strike similarities and differences. The Dinarides, linked to the Alps along the present-day Mid-Hungarian fault zone (a former transform fault), represent an orogen of opposite subduction polarity in respect to the Alps. The Dinarides and Hellenides consist of thrust sheets containing ophiolitic as well as Adria-derived continental material. These thrust sheets are located in a lower plate position in respect to an upper plate that is composed of the Tisza and Dacia Mega-Units (Dinarides) and Rhodopes (Hellenides), which have European affinities. These tectonic plates are separated by a Late Cretaceous-Early Paleogene suture zone (named Sava Zone), which represents that part of the Vardar Zone that stayed open until end-Cretaceous times and separates upper from lower plate in the Dinarides-Hellenides. This suture can be followed along strike all the way to the Izmir-Ankara suture zone. In the Dinarides and Hellenides parts of the ophiolites of the Vardar branch of the Neotethys Ocean (Western Vardar ophiolites) were obducted already during the latest Jurassic onto the Adriatic margin and were subsequently involved in Late Cretaceous to early Paleogene thrusting. This led to the formation of a series of composite nappes that consist of continent-derived material in their lower part and ophiolites in their upper part. During the latest Jurassic parts of the Vardar Ocean (Eastern Vardar ophiolites) were also obducted and thrust onto the European margin (i.e. the Dacia Mega-Unit), later to become part of an orogen with Europe-vergent structures. Our one-ocean concept does not require the presence of “terrane” separating various oceanic branches along the Neotethys margin, such as the Drina-Ivanjica block or the Pelagonian “massif”. Such continental units simply represent tectonic windows of the distal Adriatic margin, outcropping from below the obducted ophiolitic sheets referred to as Western Vardar Ophiolitic Unit. Moreover, there is no need for a separate ocean linked with Meliata-Maliac ophiolites, because these remnants simply represent the Triassic-age parts of the Vardar Ocean, preserved as imbricates below, or relics within, ophiolitic mélanges accreted in front of the obducted Western Vardar ophiolites. This one-ocean logic can be followed all the way from the Western Carpathians and Dinarides to the Peloponnesus and possibly into the Cycladic Islands. We find no evidence for a Pindos oceanic lithosphere either (i.e. for the so-called “Pindos Ocean”); the Pindos basin simply represents a pelagic seaway located in between carbonate platforms. Furthermore, the derivation of the protoliths of the Cycladic Blueschists, generally also attributed to the Pindos “Ocean”, from oceanic crust is questionable.

By contrast, in Turkey ophiolite obduction clearly occurred during the Late Cretaceous rather than in Late Jurassic times which suggests a major change along strike located somewhere between the Cycladic Islands and the Anatolian peninsula. Moreover, the Menderes massif, tectonically underlying the Cycladic Blueschists, does represent the eastern continuation of the Gavrovo-Tripolitza Zone rather than that of the Pelagonian zone. Another major along-strike change concerns the southeastern continuation of the Carpatho-Balkan orogen, which is considered a part of the Dacia Mega-Unit: the Rhodopes represent a part of the European margin that was northerly adjacent to the Vardar branch of Neotethys and that was subducted northward below Moesia and subsequently partly exhumed as a huge core complex surrounded by normal faults. Hence, it is not clear yet if the Rhodopes, or alternatively the lower part of them (Drama block), were formerly bordered by another branch

of Neotethys, originally located to the north of Vardar branch, or alternatively, by the Paleotethys. In other words, the Rhodopes may have been formerly separated from Moesia by oceanic lithosphere located north of the Vardar branch of Neotethys.

Natural stone, an environmentally highly competitive building product

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Civil engineering construction is the largest industry in the world and represents approximately 10% of world GDP. Somewhere around 40 % of the life cycle energy use in residential buildings emanates from embodied energy, i.e. the energy used in the manufacture of building materials and products. The energy consumption of this industry is thus of the utmost importance for a sustainable environment.

The low energy usage during extraction and processing of natural stone building products is a strong marketing potential factor but is very seldom used by stone suppliers. The presentation will focus on why and how to overcome this problem.

The stone industry is a very fragmented industry with little international collaboration. Most stone producing companies are SMEs (Small and Medium scale Enterprises) and have therefore not the financial means to influence international regulations or develop relevant methods for proper calculation of the energy consumption in all steps from the quarry to the final kerb, façade cladding or floor tile.

ECO-labelling could have been an important driver for this process to start. The main problem with the present ECO-labelling system is that it pays too much attention to waste production and the visibility of the quarry and very little to the energy consumption. In addition, it is not a flexible system that takes into the account different needs in different countries or local regions. The present system has been done without the presence of the stone producer and is therefore not supported by the same.

Recent, impartial, comparative investigations show that the production of concrete may use four times more energy than stone (depending on the actual product type) and timber almost forty times, just to mention two examples. In addition, properly chosen stone types will outlast these materials several times over.

In order to effectively make use of this strength, stone producers need to collaborate throughout Europe and agree on common methods that are accepted also by other construction industries. There are several acceptable methods available but also far too common with non serious ones, used to show the advantage of a specific product by merely taking a few of all relevant factors into account.

EUROROCK, the European & International Federation of Natural Stone Industries, has recently initiated a project focusing on collecting the energy use for a large number of specified stone products. In each member country, producers are encouraged to provide information about the energy use for extraction, processing (sawing, grinding, polishing or flaming etc), packaging and transportation for a selection of stone products. Waste production is also taken into account. This is the first major collaboration attempt of European stone producers in this field and has the potential of leading to a change of the ECO-labelling system and will provide stone producers with the very much needed marketing advantage compared to competing products.

Compilation of energy consumption is the first important step towards the demonstration of low environmental impact and enhancement of public acceptance. However, the mapping of all actions and associated energy use is only the starting point for structured improvements of a sustainable stone industry.

Seafloor massive sulfides in arcs: implications for the Aegean

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Seafloor massive sulphide (SMS) deposits of copper, zinc, lead, silver and gold are found worldwide as products of hot spring activity on both sedimented and sediment-starved spreading ridges of ocean basins and back arcs, on abyssal seamounts, on arc volcanoes and in immature arc/back arc rifts as well as continental margin rifts. Many are modern analogs of volcanic-hosted massive sulphide (VMS) ores in the ancient geological record. Initial discoveries were made in continental margin rifts of the Red Sea (the metalliferous mud of the Atlantis II Deep) followed by low temperature springs in the Galapagos spreading and high temperature springs at 21°N on the East Pacific Rise. The early exploration focussed on oceanic spreading ridges and several large, rich discoveries were made, most notably along the slow spreading Mid-Atlantic Ridge. All of the early work on SMS was conducted by research scientists. In the 1990s, Nautilus Minerals and Neptune Minerals, two companies both based in Australia, began staking huge tracts of seabed that were known or were thought to contain SMS. Nautilus is on track to commence mining, probably in 2012, their Solwara 1 SMS deposit in eastern Manus Basin (EMB) off the east coast of Papua New Guinea that had been discovered by Ray Binns of the Australian CSIRO and the author in 1996. We were initially drawn to the EMB through the realization that decades of geological study, including our own, of VMS deposits had shown the most important ores formed during the rifting phase of island arcs. Furthermore, although not the case for the EMB, the largest VMS deposits were developed on continental rather than oceanic crust. Examples include the Iberian Pyrite Belt of Spain and Portugal, the Bathurst district of eastern Canada and the Hokuroku district of Japan. In view of the above, the submarine portions of the Aegean arc and especially its back arc hold great potential for SMS. Both subaerial and submarine hydrothermalism are known in the arc volcanoes. Of particular interest is the Anatolian Trough, an extensive, heavily sedimented back-arc rift in continental crust of the northern Aegean Sea. Nearby Lemnos and Samothrace islands are hydrothermally active. Marine geophysical data are sparse but coincident gravity and magnetic highs with high heat flow can be interpreted as indicating that igneous intrusions into the thickly sedimented crust have created hot springs on the seafloor.

Recent micro-tectonic movement from three karst caves, Slovenia

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Monitoring of micro-tectonic movement in Postojna cave started in 2004 and in Polog and Kostanjevica caves in 2008. In Postojna cave two TM 71 extensometers, 260 m apart, are installed at the same fault zone, which extends about 1 km north from the Dinaric oriented (NW-SE) Predjama Fault. Since 2004 to the present small tectonic movements are detected, dextral horizontal movement of -0.05 mm for Postojna 1 and extension of -0.03 mm for Postojna 2. But the highest peaks can be of 0.08 mm. Preliminary results in Polog cave, where TM 71 is placed in the vicinity of 1998 (Mw=5.6) and 2004 (Mw=5.2) earthquakes on the Ravne Fault, show -0.08 mm of extension between two limestone beds (from October 2008 to March 2009). From March to May 2009 the movement on *x*-axis returned back to -0.02 mm. The highest trend in Kostanjevica cave was detected as vertical movement along *z*-axis for +0.035 mm from June 2008 to May 2009, representing subsidence of the NW block and uplift of SE block. In all three studied caves the data obtained by TM 71 monitoring are related to

active tectonic movements of wider fault zones of Predjama (Postojna cave), Ravne (Polog cave) and Brežice Faults (Kostanjevica cave).

Note on the evolution of a Miocene composite volcano in an extensional setting, Zărand Basin (Apuseni Mts., Romania)

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Bontău is a major eroded composite volcano filling the Miocene Zărand extensional basin, near the junction between the Codru-Moma and Highiş-Drocea Mts., at the tectonic boundary between the South and North Apuseni Mts. It is a quasi-symmetric structure (16-18 km in diameter) centered on an eroded vent area (9x4 km), being buttressed to the south by Late Jurassic to Late Cretaceous ophiolites and sedimentary deposits of the South Apuseni Mts. The volcano was built up in two sub-aerial phases (14-12.5 Ma and 11-10 Ma) from successive eruptions of andesite lavas and pyroclastic rocks with a time-increasing volatile budget. The initial phase was dominated by emplacement of pyroxene andesites and resulted in scattered individual volcanic lava domes associated marginally with lava flows and/or pyroclastic block-and-ash flows. The second phase was petrographically characterized by amphibole-pyroxene andesites and was a result of a succession of pyroclastic eruptions (varying from strombolian to subplinian type) and extrusion of volcanic domes that resulted in the formation of a central vent area. Numerous debris flow deposits have been emplaced at the periphery of primary pyroclastic deposits. The end of the magmatic activity was most probably intrusive as recorded by several andesitic-dioritic bodies and associated hydrothermal and mineralization processes in the volcano core complex area. Distal epiclastic deposits are associated with terrestrial detritic material and coal, filling the basin around the volcano in its western and eastern part. Chemical analyses show that the lavas are of calc-alkaline type and are all andesites ($\text{SiO}_2=56\text{--}61\%$) in composition. The petrographical differences between the volcano evolution stages, showing an increase in amphibole content at the expense of two pyroxenes (augite and hypersthene), are slightly mirrored in the major element compositions of the rocks; only CaO and MgO contents decrease with increasing SiO_2 . In spite of a ~ 4 Ma long evolution, the compositions of calc-alkaline lavas suggest insignificant fractionation processes, resulting from the extensional setting in which they occur that did not favor prolonged magma chamber processes.

Geochemistry and U-Pb zircon age of low-grade metavolcanic rocks from the Biga Peninsula, Northwestern Turkey

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Northwest Anatolia and especially the Biga Peninsula is the area having special importance in the case of understanding of geology of Turkey and its surrounding. The Biga Peninsula has a Variscan basement affected by Alpine tectonics which is mainly composed of metavolcanic rocks. NE-SW-directed metavolcanic rocks occur in the basement of Çamlıca

metamorphic association and made up of brown, green, yellowish green metalava, metatuff and small amount of metasedimentary rocks. The common mineral assemblages of the metavolcanic rocks are mainly composed of quartz + chlorite + epidote + albite + actinolite + calcite ± sphe ± zircon. This mineral assemblage indicates that these metavolcanic rocks underwent greenschist-facies metamorphism.

Major, trace and rare earth element (REE) geochemistry for metavolcanic rocks from the Biga Peninsula has been determined to reveal their origin and tectonic setting. The metavolcanic rocks have compositions of andesites with calc-alkaline character. Calc-alkaline chemistry is represented by intermediate SiO₂ content, low MgO and low Cr. Chondrite-normalized REE patterns are moderately fractionated (La_N/Yb_N ~ 2.2 to 8.9). Europium anomalies are variable (Eu/Eu* 0.6 to 1.9) and generally negative (average Eu/Eu* 0.83). The plagioclase fractionation is confirmed by a slight development of negative Eu anomaly. The metavolcanic rocks have a distinct negative Nb anomaly with negative Sr, Ba, Hf anomalies in extended element diagrams. The large negative Nb, Sr, Ba and Hf anomalies in the metavolcanic rocks exhibit a crustal involvement in their derivation. The crustal influence may be related to either partial melting at the base of continental crust or contamination of mafic magma with crustal material. On tectonic discrimination diagrams, all metavolcanic rocks cluster within the volcanic arc field away from either the within plate or ocean ridge fields. Those within the volcanic arc field indicate calc-alkaline magma type. Such a magma type is a characteristic of volcanic arc setting for the metavolcanic rocks. Moreover, negative Nb anomalies are also characteristic of the volcanic arc.

Zircon grains from these metavolcanic rocks, which are euhedral with typical magmatic morphologies, were dated by LA-ICPMS. Zircon ages of two samples yielded 328.6 ± 3.5 Ma and 343.2 ± 2.6 Ma, respectively. These are interpreted as the time of protolith crystallization of metavolcanic rocks. This volcanic episode of the Biga Peninsula can be attributed the Variscan magmatic activity and also collisional event leading to the amalgamation of tectonic units took place during Variscan orogenic event.

Relationship between Cenozoic structures and polymetallic mineralizations in the central part of the Serbo-Macedonian massif

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The geodynamic evolution of the Serbo-Macedonian massif can be reviewed in few geological and geotectonic epochs, but very specific is the Cenozoic evolution from geodynamic, geotectonic, structural, magmatic and metallogenetic point of view. Cenozoic activation at the territory of the FYR of Macedonia enclosed the most complex geotectonic units such as Vardar zone and SMM. Its occurrence is mainly along fissures of general NW-SE direction and activated meridian cracking zones and faulting systems of general NE-SW direction. In such conditions came to complete redistribution of the lineament structures network when on the main direction of Mesozoic structures NW-SE (340°) occurred fault system of the same direction but slightly different angle (320°). Striking transcurrent faults can be recognized from air and satellite pictures, striking in the same direction as the zone of activation, as well as systems of smaller parallel faults, systems of diagonal jagged faults and systems of straight, tension faults. A special characteristic of the zone of autonomous activation are their numerous ringlike structures. This activation significantly contributed to the localization of the Cenozoic mineralizations within the Eastern FYR of Macedonia. The disruption structures of of NW-SE direction control three major Cenozoic metallogenetic zones (two of them characterized by the Oligocene-Miocene magmatism and mineralization in the Kratovo-Zletovo and Bucim-Damjan-Borov Dol ore regions and third characterized by Miocene volcanics and related mineralization at the Osogovo ore region). Logical metallogenic analysis have confirmed that megastructures in the Tertiary autonomous activation zone correspond to the ore districts and coincide with the centres of magmatic

activity, while the distribution of mineral deposits in them is found to be distinctly laterally zoned. The lesser ringlike structures correspond to the structure of the ore fields or mineral deposits, as it is a case with the Bukovik-Kadiica polymetallic ore system. Especial feature within these structural elements are the faulting structures with general direction NE-SW which relicts are saved up to date. They have controlled seismic zones and have shown influence to the localization of magmatic bodies and ore mineralization on places where structures of NW-SE cross cut. These types of structures are common in so called wide zones of relaxation. After the activation of Cenozoic faults followed stage of formation of pericline structures and systems of concentric structures of volcanic type (numerous volcanic calderas in the Kratovo-Zletovo volcanic area). The Bukovik-Kadiica ore district, characterized by complex polymetallic mineralization, is located in the most eastern parts of the Besna Kobila-Osogovo-Tassos metallogenic zone. Determination of tectonic elements was done by different methodologies: generalization of horizontals, river networks, interpretation of satellite imagery etc. From north to the east, the lower part of the area, has been surrounded by the raised arc (1600-1700 m). Radial and radial-centrifugal forms allowed determination of two crossed oval structures: southern and northern. Higher points, erosion study and alluvial accumulation are pointing out to a slope-like development with characteristic valleys and slopes on the southern oval structure and raise of the northern oval structure. Intersection of the oval forms has been complicated by the ring structure 3.5 km in diameter. Its central part overlaps with the independently raised Bukovik (1700 m). Around the raised area there is a depression belt, which has been articulated with the highest parts of the adjacent river valleys. To the east, outer side of the structure has been limited by raised arc. The Bukovik ring structure has been located within the intersection of orthogonal system of fissures determined on the linear tectonic elements of the recent relief. Field observations, desk studies, satellite imagery, metallogenic features, confirmed that morphostructural parameters of the Bukovik-Kadiica area are characterized by structures of two general directions (NW-SE and NE-SW). Also, this study has shown that mineralization was closely associated to the intersection knots of major structures.

Strain geometry and kinematics along the central Pindos Thrust Belt in Northern Greece: implications for the structural evolution of the External Hellenides

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The Pindos Thrust Belt (PTB) represents the intensively folded and thrustsedimentary sequence deposited in the Pindos basin along the western margin of the Pelagonian microcontinent. Pindos Thrust Belt expands, from northern Greece to the southern Greece on the Peloponnesus, exhibiting a NW-SE strike, thereafter it turns in an E-W striking direction. Its north continuation in Albania is represented by the Crasta –Cukali Zone. PTB is enveloped between the Gavrovo Zone, to the West and the Pelagonian nappe system to the East. The zone accommodates a succession of continuous Mesozoic deep sea sediments, comprising cherts, clay- silt- stones and pelagic limestones. An Upper Cretaceous to Eocene flysch terminates the sequence. Orogenic processes (Neohellenic Stage) associated with plate convergence during Tertiary caused compression and crustal thickening, generating folding and thrusting (PTB) followed by normal faulting and extension.

Based on a quantitative analysis along the N-S striking segment of PTB in Northern - Central Greece we present structural data concerning the Tertiary deformation regime of PTB. Strain and paleostress tensor analysis of deformation were also performed on selected outcrops.

Data analysis point to the following deformation styles to have affected the PTB:

An early D1 deformation style of Paleocene to Eocene age, represented by asymmetrical, angular, tight folds with axes bearing a N-S to NW-SE present day orientation. D1 is associated with the progressive westward to south-westward propagation of thrusting of

the external Hellenic orogenic wedge over the Adriatic platform. Back-thrust structure geometry with NE -ward vergency is also recorded. Striation lineation on the thrust planes exhibits a ENE-WSW to NNE-SSW strike. Paleostress analysis shows a subhorizontal, E-W to NE-SW trending maximum main axis σ_1 and a subvertical minimum main σ_3 -axis.

A late D2 deformation style of Oligocene –Miocene age, overprints the former D1 structures, producing WNW-ESE to E-W trending compressional structures, such as asymmetrical steep folds and thrust faults.

Sense of movement is evaluated mainly towards SSW to S. Striation lineation along thrust planes exhibits progressively a NNE-SSW to N-S trend. NW-SE dextral and NE-SW sinistral trending strike slip faults, associated with the D2 compressional structures, induced a SE- or NW-ward orogen parallel motion. Furthermore, some of the D1 thrust faults were reactivated during the D2 as strike slip faults. Paleostress analysis shows a subhorizontal maximum main axis σ_1 in a N-S to NNE-SSW direction during D2 event.

Both in map and outcrop scale curvature of D1 structure trace, as well as the orientation geometry of the D1 and D2 structures, imply a continuous deformation regime during Tertiary time under oblique plate convergence and a transpression related strain field.

Seismotectonic model on geological data for 1892 Dulovo earthquake, lower Danube valley

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The potentially active faults in the area of Lower Danube Valley between the arcs of Carpathian and Balkan mountain chains are not properly recognized. The epicentre of the only historically known “strange” earthquake on the territory of Bulgaria with a magnitude evaluated at $M_s = 7$, known as the “1892 Dulovo Earthquake” is situated in this area. The first step for creating a seismotectonic model for this earthquake is the identification of the nearby active fault. The analysis has shown that it is realistic to accept that the earthquake occurred in the frames of the Tutrakan Graben. A fault segment of the Dulovo Fault, the most probably activated during the 1892 Dulovo Earthquake, is recognised. Its length is 42 ± 5 km, and the width is 15 ± 2 km. The offset of the normal faulting from the last seismic events is evaluated at 2 m. Three approaches are used for determination of the maximum magnitude of the earthquake that can be generated. They give M_s in the range between 6.8 and 7.5. The most probable value is 7.0.

Migrations caused by catastrophic flooding of the Black Sea during the Holocene

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Geological data suggest an exceptionally large natural catastrophe in the Black Sea region 7500-7600 yrs. BP. Before it Black Sea was a fresh water lake with coasts 90–120 m below the recent sea level. This catastrophic rapid flooding of the Black Sea by the Mediterranean Sea waters was dated in numerous samples by ¹⁴C at 7560 ± 50 cal. yrs BP. It flooded 160000 km² and destroyed settlements of the early civilizations around the Black Sea coast. At that time here were settled Indo-Europeans.

We mapped the migration of some of the Vedic tribes all the way from the Black Sea region to India by precise positioning of the established 4399 toponyms and hydronames formed on the base of their ethnic names derived from processing and linguistic analysis of 6 900 000 toponyms and hydronames on the maps of India, Pakistan, Bangladesh, Afghanistan, Uzbekistan and Iran.

We make critical analysis of the available geological and archeological data related to the Black Sea Flood in order to establish its reliability and to refine its dating and extend. We demonstrate that timing of the start of formation of sapropel sediments; the formation of hydrogen sulfide zone in the Black Sea as result of decomposition of the sapropel deposits; the appearance of the first marine organisms and the abrupt replacement of the Black Sea freshwater dinocysts by a Mediterranean population coincide in the frames of the experimental error of the dating, with the best age estimate of $7\ 160 \pm 50$ radiocarbon years BP = $7\ 560 \pm 50$ cal. yrs BP. It allows us to relate it with the major human migrations at 7500 yrs. BP as traced and dated by paleolinguistic analysis and archeology. We present a number of climatic, oceanographic, linguistic, calendar, geographic and archaeological evidences suggesting that these events are related. Catastrophic flooding of the region appear to initiate migration of Indo-Europeans and their separation and differentiation in groups like German, Thracian, Illyrian, Greek, Arian, etc. tribes. Thus it strongly affected the development and history of all Indo-European people. The scale of this natural catastrophe suggests that this was perhaps the largest human migration produced by a natural disaster. This work examines the evidence for the flooding triggering this migration and also examines the extent of that migration.

The timing of the Black Sea Flood as determined by marine evidences and the timing of the start of the massive migration out of the Black Sea region coincides in the frames of the experimental error and is the same as the beginning of the Bible chronology (Creation of the World), i. e. 5500 years B.C. and also as the beginning of the Byzantine and ancient Bulgarian calendars (5505 years B.C.). This suggests that this catastrophic event was so dramatic and had so great consequences for great number of people, to be used as the beginning of the time counting by the people leaving in approximate vicinity to the affected region. At that time all Indo- Europeans (including the ancestors of the ancient Greeks and Bulgarians) were settled at the Black Sea coast, so it is quite reasonable to presume that their chronology starts from the Black Sea Flood as far as this was the most dramatic natural phenomena they faced in their history. It is reasonable to suggest that the migration out of the Black Sea region was initiated by the Black Sea Flood as far as it flooded a significant part of this densely populated region. This submerging of 160 000 square kilometers was caused by a rapid rise of the Black Sea level with about 100 meters. It left homeless and without food supply great part of the Indo Europeans settled around the former sea coast. Therefore this most dramatic disaster in the human history forced them to migrate out of this dangerous region. This way the Black Sea Flood played major role in the Indo Europeans history.

We provide vast range of data demonstrating that Black Sea Flood triggered an out-migration from the Black Sea area into India with major repercussions for present population characteristics as established by comparative genetic studies.

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Is it possible to use natural resources in a sustainable manner after intensive exploitation?

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Due to the long isolation period and the development of various industry sectors, the contamination of land and additional negative environmental impacts have been continuous and severe in the period 1950-1990 for Albania. Based on data published in literature, this review is a first attempt to put together the natural resources and the sites where the ore

minerals have been treated in Albania in order to address issues related to the sustainable development. However, the intervention of the government to minimize the adversity left behind from the former industry in the form of resource conservation subsidies or depletion taxes for new investors, might improve the present environmental situation. The use of cost benefit analysis to evaluate the development in conjunction with sustainable use of natural resources might minimize the adversary effects of the past. Since other factors, such as the financial constrains, play an important role in the equation, the aid of the foreign investors or international institutions shall also be supported and assisted by the Albanian authorities.

A characterization of human erythemat and vitamin D exposure from UV radiation measurements at Rome station

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Solar ultraviolet (UV) radiation covers the wavelength range 200-400 nm and is responsible for many physical, chemical and radiative processes in the atmosphere. The spectral atmospheric attenuation of solar ultraviolet radiation depends mainly on stratospheric ozone absorption, Rayleigh scattering by air gases and Mie scattering by aerosols. Surface albedo, altitude, solar zenith angle (depending on latitude and time of day) and local atmospheric composition (tropospheric gas, cloud cover and particulate) are responsible of large seasonal and geographical surface UV variability.

Despite the fact that the amount of solar ultraviolet radiation reaching the Earth's surface comprises only a small fraction of the global radiation, approximately 6-7% in the UVA (320-400 nm) region and less than 1% in the UVB band (280-320 nm), current evidence suggests that it is the major causative factor in several short and long term skin and eye diseases. Nothwithstanding the adverse effects, solar UV radiation is responsible of vitamin D₃ synthesis required for skeletal health and appropriate vitamin D levels have been suggested as beneficial factor against breast, prostate and colon cancers. Exposure to solar UV radiation during occupational and leisure activities is therefore a significant public health issue. A scientific debate is still ongoing regarding the health duality of solar ultraviolet radiation and seeking for the optimal UV exposure.

In the present study surface high-quality UV irradiance measurements recorded in the period 1996-2009 at Rome station by means of Brewer spectrophotometry are taken into account. The Solar Radiometry Observatory of Sapienza University of Rome (41.9° N, 12.5° E, 75 m a.s.l) is operational with the Brewer spectrophotometer #067 since 1992 and the YES broadband UV radiometer since 2000. The spectral UV data are used to retrieve the ambient (i.e on horizontal surface), biologically effective UV quantities. The action spectrum for the synthesis of pre-vitamin D (CIE 2006) and of erythema (CIE 1998) were employed to determine the vitamin D and erythemat dose rates. The seasonal and diurnal variability of both biologically effective UV irradiances at this mid-latitude urban site under clear and all sky conditions are provided in order to identify the periods of UV overexposure as well as the periods in which the minimum effective dose rate is needed for pro-vitamin D₃ photoconversion. An investigation on both biological quantities as a function of total ozone and solar zenith angle is also performed. In addition, climatological erythemat and vitamin D doses are determined and compared to standard vitamin D and erythemat doses for different skin types.

Finally, a methodology to convert CIE erythemat dose rates values in vitamin D dose rates is proposed and the polysulphone dosimetry, usually employed in order to quantify the erythemat dose, is discussed as a potential approach to pre-vitamin D₃ dosimetry. The results will be tested using data obtained by in vivo field campaigns.

Isotopic and paleomagnetic studies of the Middle and Upper Jurassic carbonates in the Pieniny Klippen Belt: environmental and paleogeographic implications for the Northern Tethys

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The Pieniny Klippen Belt was formed during the Late Cretaceous-Cenozoic tectonic movements due to the closure of the Pieniny Klippen Basin (PKB), a former part of northern sector of the Tethys Ocean. Geophysical and geological data show PKB trusted onto the southern margin of Paleozoic formations of the Eurasia craton. However, paleomagnetic results from the Middle and Upper Jurassic rocks from the Veliky Kamenets section, Western Ukraine to the Western Slovakia speak in favor of significant paleogeographic dispersion of the units, currently incorporated into PKB. Most of the late Jurassic basins, according to data in hand, developed at much lower latitudes than those inferred for the south/southwestern margin of Eurasia continent. Paleomagnetically evidenced shallowing of paleolatitude, amounting 10° between the Lower Callovian and the Middle Oxfordian (ca. 10 Ma), could be caused by a fast and a long-range drift of PKB basement, rifted off the northern European Craton toward the South. Sedimentary record for this time is lacking, a hiatus having different range but generally embracing the Middle Callovian/Late Jurassic time span.

Apart from the paleomagnetic data, we have attempted to collect independent evidence for paleogeographic changes in PKB during mid-to-late Jurassic time. In our study, we have sampled carbonate rocks underlying and overlying the hiatus, following the same outcrops that were sampled for paleomagnetic studies. Some samples from the manganese crusts were also collected. We performed geochemical studies including REE analysis using ICP-OES and ICP-MS techniques, which demonstrated higher concentrations of REE and U, Th, K, Nb, Zr and Hf in samples collected from limestones underlying the hiatus, as well as a significantly different concentrations of La/Yb-Sc/Ni and Zr/Th between the Callovian and the Oxfordian limestones. We tentatively interpreted this record as an effect of change in a source of elemental alimentation for the PKB that took place between Batonian and Oxfordian time, the latter including more mafic components.

We were also able to demonstrate change of the oceanic environment of PKB using Nd and Sr isotopic composition of the carbonate and silicate fractions. Analyses were performed using Finnigan MAT 261 MC-MS at the Isotope Lab., UAM, Poznań (Poland).

Neodymium isotopic composition of the carbonate fraction analyzed from the strata bracketing the hiatus is regarded as a direct record of the contemporaneous composition of the seawater. It shows no evidence for localized input of old continental Nd from the adjacent land areas. Our analyses revealed that both the early Callovian and the late Oxfordian seawaters of eastern part of the Pieniny Klippen Basin were isotopically homogeneous in each case. The main result is, however, that a significant exchange of the seawater happened between Early Callovian and Middle Oxfordian time. Samples collected from strata below the hiatus yielded ϵ_{Nd} values ranging from -6.6 to -7.0. These isotopic signatures are identical to those known from the Alpine part of the Tethys. Above the hiatus, however, the ϵ_{Nd} values are constantly higher, between -5.3 and -5.8, marking opposite trend in ϵ_{Nd} evolution than postulated for the Western Tethys in the same time span. Our data, therefore, record enter of more radiogenic oceanic waters into the basin. Because the seawater in the western segment (Alpine-Penninic) of the Tethys was predominantly less radiogenic during the Middle Oxfordian, we speculate that oceanic waters could be introduced into the Pieniny Basin from the Pacific Ocean. This event could be causally linked to a rapid rifting process and dramatic widening of the Pieniny Basin, in line with the scenario of the substantial paleogeographic change indicated by paleomagnetic results.

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Contribution of gravity data interpretation to the seismotectonic model compilation – an example from Bulgarian EC8 implementation

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Capability of gravity anomalous field data for revealing of deep structures in the earth's crust is well known and often applied to delineate various geological structures such as faults, flexures, thrusts, borders of dislocated blocks and vast intrusions, horsts and grabens, and others, which create significant rock density contrast in horizontal planes. Calculation of Directional derivatives of the Bouguer gravity anomalous field of Bulgaria was used to constrain the geological information for compilation of seismotectonic model which has been implemented in the recently released seismic zoning of the country according to EC8 standards.

For the present research a grid of 1.5x1.5 km from the Bouguer gravity database was prepared. The density of this grid is less than the density of observation points but sufficient for the regional scale of investigation and helps the filtration of existing noise. Using these data and the Fourier techniques, the total horizontal gradient and vertical gravity gradient have been calculated and analyzed.

The gravity anomalies of transition type are well distinguished after a data transformation to the magnitude (modulus) of the Total Horizontal Gradient (THG). The horizontal derivatives along two orthogonal axes have been calculated and geometrically summed. When applied to two dimensional surveys, the THG tends to place narrow ridges over abrupt changes in density and locating maxima can be done by simple inspection or automated procedure.

The calculated Vertical Gravity Gradient (VGG) reflects in other pattern the mentioned above transition anomalies. The vertical derivative of gravity field is similar in its space distribution to the vertical component Z of magnetic anomalies caused by the same structures in case of their vertical magnetization, according to Poisson's theorem. Thus, the vertical gradient of a transition anomaly is a dipolar anomaly with its negative part to the horizontal direction of density decreasing of a vertical or inclined dislocation.

Delineated gravity anomalies with their amplitude, width, length and coordinates have been compared with the spatial distribution of seismicity, epicentre density function and map of the active faults of the Bulgarian territory. In most of the cases, outlined gravity transitions are characterised with increased seismicity and accompanied by faults drawn according to geological evidences.

Natural aggregate resources in Serbia – an overview

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Aggregate rock industry in Serbia had a turbulent history in the past 20 years, as it had to survive severe political and economical changes in the country and the whole SEE area. The economic crisis resulted in dramatic decrease of aggregate rock production during the beginning of the last decade of the 20 century, to the level of approximately 20-30 % compared to the year of 1990 (all data are from the USGS Minerals Yearbooks, based on Serbian Statistical Reports). Production level remained low but relatively stable until 2004. Since 2005, production of aggregate rocks is steadily increasing, with sand and gravel, and

cement output reaching the level of the 1990. Unfortunately, statistics for crushed rock are unreliable from 2005, as production volume is in fact much larger than officially presented. Lime is the only commodity with the current production at the level of ~45 % compared to the year 1990, due to the old equipment, old technology and low standards of limestone quality which are not accepted for the production of high quality industrial lime.

In the last ten years geological exploration was rather intensive, with more than 30 new aggregate rock deposits explored and prepared for exploitation. Currently, there are 141 aggregate rock deposits in Serbia, out of which 113 have exploitation license, and 28 are still under exploration. These statistics exclude deposits of sand and gravel for construction industry, which are still not completely under jurisdiction of the Ministry of Energy and Mining (MEM), which is in charge for exploitation and exploration licenses for all other mineral commodities.

There are several petrological varieties of rocks used in aggregate industry in Serbia. The majority of deposits are limestone and dolostone (77 in total), 30 deposits consists of magmatic rocks, and 34 deposits of metamorphic rocks, mostly marble (usually calcitic and, subordinately, dolomitic).

The basic factor influencing promotion of aggregate rock industry in the last ten years was road construction, resulting in exploration of all 7 diabase deposits; similar situation is with basalt, andesite, and dacite. Two deposits, one of basalt and one of diabase are used for mineral wool production. Quite contrary, almost all of granite deposits are used as ornamental stone, and several in ceramic industry.

Sedimentary rocks are almost exclusively used in aggregate rock industry (73 out of 77 deposits), predominantly in construction industry (54 deposits). Five deposits are used by cement factories, 7 by lime producers, but all of those 7 quarries also produce aggregate rock. There are several deposits which supply by some specific end-users, like Bor copper smelter, filler industry, or production of metal magnesium from dolostone.

Metamorphic rocks are mainly used as filler (calcite varieties, 15 deposits), or as construction aggregate (dolomitic marbles, 8 deposits). Lime is produced from one calcite marble (which is most probably recrystallized limestone). Marble is also used as ornamental stone (10 deposits), although some recrystallized limestone deposits are also included.

Spatial distribution reflects the geology of Serbia, leaving Vojvodina almost without aggregate rock resources except sand and gravel along the main rivers, which will require sustainable supply mix to maintain long-term construction activities.

The lack of sustainable aggregate resources management in the past caused some problems, like unprecise definitions of exploitation of quarries within National parks and other protected areas (which are much younger than quarries), absence of mineral resources maps on the national and regional levels which should and must be base documents for land use planning. Complicated legal procedures during exploration and exploitation periods also imposes an unnecessary burden on the investor (license holder), which shall require simpler procedure in the near future. Some analytical standards should be revised.

In the recent years a WEB-GIS was established by the MEM, which enables all interested investors to check the available areas for exploration. Some improvements of the Mining Law were also performed, but the new law concerning geological exploration and mining is necessary. Environmental laws and regulations are modeled according to the EU standards. Nevertheless, it is still impossible to get borders of protected areas online.

Permanent education at all levels is also important for future expansion of all sectors of aggregate rocks industry.

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Upper Cretaceous radiolaria from the Manín unit: paleoecological and sea-level implications

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The investigated section is formed by red-bed sediments, which cropping out near Praznov village (Middle Váh Valley). Radiolarian microfauna from this locality has been discovered for the first time in the Santonian-Campanian formations of the Western Carpathians.

Radiolarians assemblage from the middle part of the Praznov section corresponds to stratigraphic interval from the Coniacian? to the Upper Santonian. Spumellaria predominate in the number of species as well as in quantity.

Association from higher parts is characteristic for the stratigraphic interval from the Santonian to the Upper Campanian. According to zonation by Hollis & Kimura (2001) both associations belong to the *Dictyomitra kozlovae* Zone.

Quantitative ratio reveals the predominance of spumellaria over nassellaria, their quantitative ratio changes. Diversification of both groups is almost the same. On the basis of O'Dogherty & Guex (2002), which studied the rate and model of radiolarian evolution during the Cretaceous, these authors specified several successive phases during this period, which could correspond to the sea-level lowstand phases.

The samples from the Praznov locality were relatively rich in the representatives of the family *Pseudoaulophacidae*, which according to Vishnevskaya & Basov (2007) disappeared at the Santonian/Campanian boundary. Therefore, the samples studied are surely represent assemblages from below the boundary of the Santonian/Campanian, representing only lower part of the zone *Dictyomitra kozlovae* (Dk1), which correspond to the Santonian. The S/N ratio provides evidence for deterioration of environmental conditions, which reflected the previous significant biotic event during Santonian – Campanian.

On the basis of foraminiferal associations, stratigraphic interval of the Praznov section has been established from the Cenomanian to the Upper Campanian. The Middle Turonian part is determined by the species *Praeglobotruncana oraviensis trigona* (Scheibnerová). The species of *Falsomarginotruncana renzi* (Gandolfi), *Marginotruncana terfayaensis* (Lehman), *Marginotruncana pseudolinneiana* Pessagno, *Marginotruncana coronata* (Bolli) and *Contusotruncana cornicata* Salaj represents the Coniacian to the Santonian association the Praznov section. The youngest part of this section belongs to the Upper Campanian, as is evidenced by the index taxon of *Globotruncana arca* (Cushman) and *Globotruncana ventricosa* (White).

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Experimental and theoretical studies of the relaxation of electrically induced (with direct current) polarization signals in porous media

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Polarization properties of porous solids (rocks) depend on both the nature of the rocks and of the filler (pore fluid). Therefore, the polarization parameters can give valuable information about the nature of the rocks. One possible approach to study these parameters is

to study transient's formation or elimination of the electric field in the medium. We discuss some experimental results on the relaxation polarization (of the electric field) in a sample porous body due to an external electrical field, as well as its adequate mathematical modeling. As a sample porous medium we consider purified sand in a viniduril (polyvinyl chloride) box which was filled with the aqueous solution of a salt or a mixture of water and oil. Experiments were conducted for solutions of different concentrations and different proportions of water and oil. A constant potential difference was applied to a sample which caused a constant electric current in the sample. The carbon and the high-quality stainless steel were used for the electrodes. The values of the potential difference and current were carefully controlled. We have measured the dynamics of the potential difference between some internal sample points using the multimeter with the RS-232 interface. These measurements have been automatically transferred to the computer for processing. The experiments were conducted for different initial values of the external voltage from 20 V to 400 V, with the voltage increased by 10 V steps. The voltage was stabilized. The time of application of the low constant voltage causing no noticeable heating is 15 min. For larger voltages the heating can become significant, and the time of application of the voltage was reduced to 2-3 min.

Experimental studies have shown that the filler significantly influences the nature and the speed of the relaxation of the electric field. The smallest relaxation times and initial polarizations and the largest speeds were observed for the distilled water, while the largest initial values of the polarization were observed for samples filled with the electrolyte solution. Our results also show that the largest times for the voltage drop are obtained for a mixture of water and oil used as filler with the relaxation curves highly depending on the concentration of oil.

We emphasize that such complex structures are characterized by very different polarization mechanisms, from electronic to electroosmotic with very different characteristic relaxation times (from 10^{-13} s to minutes). By using macroscopic experimental technique we actually measure the average value of the electric potential. Therefore, in order to properly describe the polarization relaxation one needs to know the relationship between the macroscopic electrical characteristics of the medium and its components (phases). In view of this, we consider the relaxation time spectrum characteristic for the materials in question. We calculated the effective electrophysical characteristics of a porous medium and emulsion by using well known equations. Our calculations show that for the solution of salt one can achieve a good agreement between the experiment and theoretical predictions even only two relaxation times are taken into account. The influence of the interrelationships between the electrical and mechanical fields on the polarization relaxation processes is also discussed.

Sustainable aggregates resource management: approach within South East Europe

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Earth scientists, geologists, are involved not only in fundamental research projects, but also in applied projects. Most applied projects are multidisciplinary and have as their goal the solution of different open and ongoing challenges that society faces. An important set of these projects deals with the provision of an adequate and secure supply of raw materials. Within such projects many questions are addressed by geologists, who are able to utilize their geological knowledge to collect relevant data, analyze those data and to compile it into comprehensive information that provides a solid base for sound decision making. Geologists can best perform these tasks when they are aware of the need for information, the potential contribution of geology and other disciplines, and prevailing societal paradigm of sustainable development.

Consider, for example, the case of aggregates (crushed stone, sand and gravel), which are crucial for infrastructure and construction. Their importance and role in the societies has evolved over time, and last few decades have seen dynamic changes. In parallel to these changes, the role of aggregates resource geologists has also changed, due to the requirements for data and information related to resources. In the increasingly complex world that we face more and more diverse geological information is required, not only information on deposit quantity and quality, but also other geo-oriented information that supports the economic, environmental and social aspects of deposit, quarry development, and the whole mine life cycle.

Many countries are rich in aggregates, but supply is not coordinated, which is the case within South East Europe. Among many challenges are illegal and damaging quarries, unreclaimed sites, limited recycling, and community opposition. Primary aggregates can only be extracted where they occur, but quarrying has had environmental and social impacts, including inefficient usage of water and energy, air pollution, and community disruption. These have given the industry a negative image, intensified by illegal quarrying, limited recycling of construction and demolition (C&D) wastes, and minimal use of quarry and industrial by-products.

Geologists form a major part of the project team of the South East Europe project entitled “Sustainable Aggregates Resource Management”. Main objectives of the project are to develop a common approach to sustainable aggregate resource management (SARM) and sustainable supply mix (SSM) planning, at three scales, to ensure efficient and secure supply in South East Europe. Efficient, low socio-environmental impact, quarrying and waste management is SARM. SSM promotes the use of multiple sources of aggregates, including recycled wastes and industrial by-products (slag) that together maximize net benefits of aggregate supply across generations. At the site level, the issues are high environmental impacts, limited recycling, the need for stakeholder consultation and capacity building, and lack of social license to operate. At the regional/national level, the issues are policies and regulations affecting aggregates that: do not address resource and energy efficiency or EU guidelines, preclude the use of recycled materials and industrial by-products, and fail to address aggregate consumption in long-term sustainable development and spatial planning. The transnational issues are lack of capacity and lack of coordination on aggregates production and transport among nations.

The project partnership has the requisite expertise for implementing the project, achieving the objectives and producing the planned outputs. These include: Recommendations on environmentally and socially acceptable quarrying, prevention of illegal quarrying, quarry waste management and opportunities for increasing the rate of recycling of quarry waste and construction and demolition waste, implementation of relevant EU legislation, and aggregates policy and management; manuals on SARM and SSM at the regional, national and transnational spatial scales, and methodology of life cycle assessments in the primary and secondary aggregates sectors.

The impact of fault zone and fractures on the discharge rate of Sasan Spring, Kazerun, Southern Iran

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Carbonate aquifers typically exhibit complex groundwater flow patterns, mainly due to depositional heterogeneities, faulting, fracturing and karstification. Sasan spring is a significant karst groundwater discharge point in the Kazerun area, one the most important karstic region of the southern Zagros in southern Iran. The annual precipitation, recharge coefficient and apparent catchment area of the Sasan spring are 524 mm, 37%, and 36.2 km², respectively. On this basis, the annual discharge of the spring is expected to be 7 MCM. However, the actual measured annual discharge of the spring is 91.4 MCM, some thirteen times larger than 7 MCM. It therefore seems that a major part of the recharge source to the spring is supplied from the adjoining watershed through a fault zone and the associated

fractures. To find the source of this extra water, the geometrical properties and the permeability of the associated fault zone of the local Amui fault have been analyzed. The results show that the overall setting of this fault is a conduit-barrier fluid flow system with a uniform structure. The mentioned extra recharge occurs through the carbonate rocks in the eastern part of local Salbiz and Ghandil anticlines along the Kazerun fault zone. It then reaches the Sasan spring by the Amui fault and associated fractures.

A climatic investigation of precipitation amount associated with 500-hpa cyclones which are affecting the Greek territory during warm period of the year

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An objective analysis of 500-hPa cyclones (500-hPa lows) is performed during the warm period (15 Apr-15 Oct) of the year for central and east Mediterranean regions. A 40-year (1958-1997) data basis of geopotential height values with a detailed (2.5°X2.5°) spatial and temporal (00, 06, 12, 18 UTC) resolution is used in the study. Lows are determined as local minima in each 3X3 matrix of geopotential height values for every grid point in the area of study. A gradient criterion between the central point and the surroundings is additionally applied to exclude weak lows, which probably originate from the assimilation procedure. A sub-area which consists of 36 grid points and includes the Greek peninsula is selected for the investigation of relationship between cyclone occurrence and precipitation amount. Cyclone occurrence is classified in nine groups consisting of four (4) grid points each. During the domination of these cyclones, daily precipitation amounts were determined from precipitation data collected at a 20-station network, which was operational during the same time period. In cases of multiple cyclone occurrences per day, the location of the deepest cyclone was selected. The spatial distribution of average precipitation amount in each of the nine cyclone groups is plotted and discussed. The comparison of these nine distributions revealed three major factors affecting the location of frequency maxima and minima. The first is low-level instability, the second is orography and the third is positive vorticity advection associated with 500-hPa cyclones.

Cretaceous alkali basalts from the Pieniny Klippen Belt

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Occurrences of mafic alkaline volcanics are scattered all around Europe, being mostly related to anorogenic, extensional tectonic environments. While the widespread Cenozoic alkaline basalts have been intensively studied and are rather well known, their Cretaceous precursors are often involved in the Alpine-Carpathian orogenic zones, therefore their genesis and geodynamic setting are partially obscured by superimposed deformation and alteration. We describe a newly discovered body of alkaline basalts in the central part of the Pieniny Klippen Belt – Vršatec, then, farther to the east, dike bodies of Hanigovce and in the Ukrainian part of the klippen belt, alkaline basalts of Velikij Kamenec. The basalt at Vršatec is lying within the mid-Cretaceous deep-marine pelagic sediments of the Pieniny Klippen Belt in western Slovakia. The body consists of hyaloclastic lavas of basanitic composition. There is not revealed any direct contact of the Hanigovce bodies with the surrounding sediments; however, due to missing signs of contact metamorphism in their close environment –

sediments of the Proč, and/or Proč-Jarmuta layers, we consider them olistoliths. Macroscopically they are homogenous very fine-grained rocks with visible phenocrysts of olivine, clinopyroxene and rarely amphibole. The matrix is made from devitrified glass, tiny albites, clinopyroxene and amphibole microliths and zeolites. Olivine is wholly altered and superimposed by a mixture of chlorite and serpentinite minerals. The basalts from Velikij Kamenec have similar mineral and chemical composition. The mineral composition (Cpx – high contents of Ti, Na, K; amphibole – kaersutite etc.) points to alkaline character of the rocks, which is also evidenced by the presence of partly resorbed leucite/analcime.

The chemical composition of volcanics is rather specific. Generally, these rocks are characterized by low SiO₂ contents (ca 41.0 weight %), enhanced contents of TiO₂ and P₂O₅ (3.3, and/or 1.5 weight %) and elevated contents of incompatible elements such as Ba (1300 ppm), Sr (1100 ppm) and LREE, as well as those of Nb (217 ppm), V (161 ppm) and Zr (1050 ppm). For various discrimination diagrams these volcanics correspond to OIA (oceanic island alkali basalts) or WPA (within-plate alkali basalts) fields. Similarly, the course of the normalized REE curve is clearly declined in the direction of low HREE contents without a considerable Eu-anomaly. Such a course of normalized curve is typical for ocean island (OIB), Cretaceous basalt from the Jarmuta Formation or continental alkaline volcanic suites of central and Western Europe, as well as for Mesozoic alkaline rocks from various parts of Europe.

Reconstruction of the geodynamic setting of the Cretaceous mafic alkaline volcanism in the Alpine-Carpathian-Pannonian realm infers the general extensional/rifting tectonic regime that ultimately led to the opening of Penninic oceanic rift arms. However, this rifting started as basically passive and non-volcanic. Only during the later, post-breakup extension phases the slow-spreading oceanic ridges developed, which are characterized by the MORB-type basaltic volcanism. Alkaline volcanic provinces have linear character and appear to follow passive continental margins of Penninic oceanic arms opened during the Jurassic and Early Cretaceous. We infer that alkaline volcanism resulted from heating and partial melting of the subcontinental mantle lithosphere on peripheries of asthenospheric upwellings confined to slow-spreading ridges of the Alpine Tethys. Consequently, regarding the debate about the plume vs. non-plume origin of the Cretaceous alkaline volcanism, the geological data from this area rather support the latter opportunity.

Could geophysical modeling solve some of the Transylvanian Basin (Romania) structural problems?

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The Transylvanian Basin is composed of crystalline basement assigned either to the Internal Dacides/Median Dacides or to the Tisia/Dacia terrain, of Mesozoic deposits (belonging to the Vardar Ocean ?), sporadically of Paleogene deposits, of Upper Miocene deposits (7000-9000 m) formed in a fast subsidence regime and structurally of two pre-Miocene depressions (Puini Basin at west and Tarnave Basin at east) separated by a crystalline basement crest (Pogaceaua) with a maximum apex at 3500m. The Miocene subsidence depocenter with major development in the two basins preserving Jurassic (locally), Cretaceous and Paleogene deposits coincides with the presence of a supposed ophiolitic layer in the basement (seismic data), although the drillings revealed island-arc volcanics exclusively, similar to those outcropping in the Apuseni Mts. The thermal flux data (partially registered on the geothermal map of the Geological Institute of Romania, 1986) suggest a negative regime on areas with maximum Miocene subsidence. Maximum magnetic anomalies of (+250nT) and minimum gravimetric anomalies of (-64mgal) overlap the areas with increased subsidence. The interpretative variants which explain the starting of the Miocene subsidence summarize the generation of a back-arc basin (similar to the Tisian Basin of Pannonia) as a consequence of the Peninic slab subduction, as back-arc extension associated with an upwelling asthenospheric mantle. The major contradictory element of this

hypothesis remains the deciphering of the Badenian-Pannonian continuous convergence which invalidates the back-arc extension hypothesis. Another element of the structural analyses on the Transylvanian Basin outlines the Moho and Conrad surfaces, both exhibiting important concave shape, overlapping the maximal subsidence zones (convex shape) of Puini and Tarnave depressions. The seismic and drilling investigation supplied the detailed geometry of the Mesozoic, Paleogene and Miocene sedimentary deposits, of the island-arc and presumed ophiolitic volcanics and of the contact surfaces with the crystalline basement respectively. A geophysical data modeling based on the tridimensional geometry of all stratigraphic compounds of the Transylvanian Basin, on the registered magnetic and gravimetric data and on the statistically processed petro-physical data, was also performed. The starting point concerns two types of structures, corresponding to two possible hypothetical models on the basement: 1. the development of a complex continental crust known as Tisia/Dacia with convex configuration at the Moho and Conrad surfaces level, beneath a concave basin filling (less explained); 2. the development of two trapped fragments of oceanic crust (Puini Basin and Tarnavelor Basin) designed after the collision of the Apuseni Mts. and the East Carpathians continental crusts, under which the mantle lies, rapidly cooled at their contact. The cooling mantle triggered the subsidence during Badenian. The modeling demonstrates that the second variant is the unique solution for the presence of several oceanic crust fragments trapped between collision continental crusts, rapidly cooled during post collision – a process that allowed the mantle compression and the basin subsidence.

Metamorphic sole in the northernmost part of the Vardar Zone Western Branch (Village Tejići, Mt. Povlen, Western Serbia)

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The geodynamic evolution of the Mesozoic ophiolites within Dinarides and Vardar zone is of special scientific interest. According to the available data these two ophiolites show both similarities and differences especially in their age, mineralogy and composition, including weakly- or well-developed metamorphic sole at their base. Ophiolites in the Tejići village consist a minor part of the Tethyan (Mediterranean) ophiolites situated in the northernmost part of the Vardar Zone Western Branch - a relic of the marginal basin but since Middle Jurassic a large oceanic realm which existed from the Upper Triassic to the Upper Cretaceous (Maastrichtian), i.e. the most important oceanic area of the Alpine-Mediterranean region after the closing of the main Vardar Ocean. It comprises ultramafic rocks (harzburgites and subordinated lherzolites) with typical tectonite fabric, gabbros, diabases, pillow lavas together with volcanic breccias and subordinated tuffaceous sediments that were tectonically emplaced to their present position during the late Upper Jurassic. The ophiolites itself are tectonically overlain by the Upper Cretaceous limestones. High-grade metamorphic rocks (amphibolite ± garnet and epidote-bearing amphibolite) occur at the base of the ophiolite sequence and are followed by medium- to low-grade metamorphic rocks represented either with blocks of augen gneisses or outcrops of garnet micaschist, chlorite micaschists and biotite (±chlorite)-epidote (±calcite) schists and subordinate calcshists and phyllites. Average P–T conditions of 630-680 °C and ca. 6±1.5 kbar were obtained for amphibolites and about 435-550 °C and 4.5 ±0.5 kbar for micaschist. In general, these rocks are characterized by greenschist to amphibolite facies mineral assemblages. Their protolith are basic igneous rocks, their volcanoclastic and rarely sedimentary (clastic) rocks. All mafic metamorphic rocks display moderate enrichment in light REE that could be ascribed to pre-metamorphic basalt-seawater interaction. The presence of metaclastic rocks probably indicates the site of emplacement close to a major landmass, which is in agreement with amygdales in pillow basalts and the absence of deep water sediments. Bulk-rock chemistry of the amphibolites and other primary basic rocks show two different geochemical affinities: tholeiitic (Nb/Y=0.07–0.18), and alkaline (Nb/Y=1.77–3.48). REE patterns and trace element discrimination

diagrams suggest that possible protoliths for the first were tholeiitic island arc basalts and for the second group within-plate alkali basalts. The metamorphic rocks were formed between 160-150 Ma ago when their protoliths were overthrust by hot ultramafic slab reflecting the time of the beginning of compression i.e. closing stages of the ocean basin. The age of these metamorphic sole rocks is very close to the age obtained for the sole rocks in Zlatibor (Dinaride Ophiolite belt), the amphibolites at the Rogozna Mt. (Western Vardar ophiolite belt), as well as with the Ar/Ar ages obtained for the Albanian amphibolite soles (165-175 Ma) and slightly younger than the sole rocks in Brezovica (over 170 Ma).

Quaternary glacial features on the Tzumerka Massif (Pindos chain, Greece) Preliminary data

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Many glacial traces as cirques and moraine deposits have been found and studied on the Athamanion Massif, Pindos chain (Hellas). The Athamanion Massif, is situated at a latitude between 39°22'N - 39°35'N and a longitude of 21°05'E – 21°15'E, includes some of the highest peaks of Hellas like, from North to South, Kakarditsa (2,429m), Chila Exida (2,254m), Katafidi (2,098m), Strogoula (2,112m), Gerakovouni (2,364m), Sxismeno Lithari (2,306m), Megalolivado (2,199m) and Sklava (2,088m). All this mountains show to have been interested affected by also impressive glacial features. The studies carried out allow determining, probably, that great glacial tongues were located in particular, along the eastern slopes from Tsouma Plastari to Kakarditsa, as well as in the valleys inside the Massif, like that of the Melissourghitikos and of the Xistras rivers.

An impressive difference in moraines preservation has been observed between the eastern general slope of the Massif and the western one. It is due to the fragile and strongly eroded geological bodies outcropping along the last.

Glacial cirque, laterals and frontals moraines deposits have been recognised and mapped in the study area. Here and there also well preserved, seems to be referable to the last great glacial expansion, so called Wurm of alpine glacial, and to three periods of stasis during and after the glacial retreat. In particular the last and more recent moraine seems to be referable to the late glacial, but more data must be searched.

The ELA of the maximum glacial expansion has been calculated by mean of the “average elevation” method, results lowered at about 1600m of elevation.

The quaternary lithostratigraphy aspects of the Wallachian Depression (Romania)

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The Pliocene and Quaternary continental lithostratigraphy from the Wallachian Depression (situated between the South Carpathians and the Balkans) in Romania, named the Bucharest Group can be subdivided into (progressively subsiding west to east from north-eastward of the Romanian Plain): 1-Dacian Subgroup, characterized by the Dacian Area (Environment), predominantly alluvial plain, unconsolidated marshland, drained by the Dacian River Network (terrace free); 2-Wallachian Subgroup, characterized by the

Wallachian Area (Environment), consolidated dry ground, drained by the Wallachian River Network (straight and terraced water courses); 3-Cândești Subgroup, characterized by the Cândești Area (alluvial fan-Environment); 4-Danube Delta Subgroup, characterized by the Danube Delta Area (delta environment). The Dacian Subgroup can be divided into two formations: Danube-Siret Formation, Wallachian-Lower Pleistocene in the west of the Romanian Plain (Bălăcița – Olt Member: detritic dominance) and the Wallachian – Lower Holocene in the east of the Romanian Plain (Titu – Măicănești Member: pelitic dominance.). The Wallachian Subgroup can be divided into four formations: 1-Drincea-Olt Formation (red ferruginous clays, weathering crust), at the limit between the Lower Pleistocene and Middle Pleistocene; 2-Craiova-Galați Formation (predominant aeolian loess deposits), Middle Pleistocene-Upper Pleistocene; 3-Romanian Plain Formation (Complex), terrace and floodplain deposits of the Wallachian River Network valleys, Middle Pleistocene-Holocene; 4-Calafat Formation, Holocene, aeolian sandy dunes. The evolution of the Danube itself marked two periods: 1-Paleofluvial Period (Lower Pleistocene, presumably beginning in the Upper Pontian), when the Dacian Danube did already exist (a modest river, flowing in the Dacian River Network at its entrance into the Romanian Plain) and the Pannonian Danube (Danubes) also a rather modest rivers which flowed into the Dacian River Network at its entrance into the Pannonian Plain; 2-Neofluvial Period, Middle Pleistocene-Actual, when the Pannonian-Dacian (Actual) Danube already exist and was part of the Wallachian River Network formed in the lower part of the Middle Pleistocene, right after being caught in the Defile which had facilitated the formation of very important lively river. The Danube reached Galați (and the Black Sea) after the Siret and the Prut River dit it, during the upper part of the Upper Pleistocene. The Danube Channel, the Danube Canyon, yhe Danube Deep-Sea Fan, the Paleo-Danube presumably represent the Siret (including the Prut) Channel, the Siret Canyon.

Geochronological, geochemical and metamorphic framework of the Moslavačka Gora Massif (Croatia)

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The Moslavačka Gora Massif (MGM) in Croatia, located about 50 km east-south-east of Zagreb, is a major exposure of crystalline basement within the Tertiary sediments of the Pannonian Basin. The central part of the massif is built up of a finegrained, two-mica S-type granite. The peripheral parts are formed by a metamorphic complex which includes mainly felsic anatexites and orthogneisses of granitic composition, some metapelites (paragneisses and micaschists) and rare amphibolites.

In terms of the Alpine plate tectonic framework, the MGM has been considered as a part of the Tisia block. Recently, the MGM has been related to the so-called “Sava Zone”, which is believed to host the suture between Tisia and the Dinarides. Reliable information concerning the geological evolution of the massif was as yet hardly available, so that any correlation with neighboring basement units remained largely speculative.

For a long time it was a common belief that the MGM represents Variscan crystalline basement. However, our new geochronological data indicate that this massif is a Cretaceous high-temperature/low-pressure metamorphic dome that was intruded in its center by a Cretaceous granite pluton. The age of the LP/HT metamorphism is estimated at ca. 90–100 Ma using the method of electron microprobe based Th-U-Pb dating on monazites. U-Pb dating of zircons by means of LA-SF-ICP-MS method for the Central Granite gave a concordant age of 82 ± 1 Ma. Zircons from three different samples of metagranites were dated at 486 ± 6 Ma, 483 ± 6 Ma and 491 ± 1 Ma, suggesting that most of the metamorphic complex of the MGM represents an Early Ordovician granitic series.

In order to better characterize the different metagranites of the MGM, a geochemical study was carried out. The volumetrically dominant Jelen grad type defines a coarse grained, K-feldspar phyric, S-type granite suite. Fine grained metagranites (Garić-grad type) show the characteristics of A-type magma.

The metamorphic evolution of the MGM was studied on metapelites. From the observed peak paragenesis (Crd-Grt-Kfs) and electron microprobe data it can be concluded that the Cretaceous metamorphism was of the low-pressure type reaching granulite facies conditions of ca. 750 °C and 3–4 kbar. A retrograde metamorphic event, mainly caused by heat and fluid input from the Central Granite, occurred at lower amphibolites facies conditions (500–600 °C, 1–2 kbar).

As yet there are no clear evidences for a Variscan tectonothermal event in the MGM. However, Permian magmatism or anatexis in the lower crust is indicated by inherited Permian zircons in the Central Granite. Relics of Permian monazite found in one sample of metapelite document a Permian phase of metamorphism in the metamorphic series of the MGM.

The high heat flow regime of Cretaceous age is unique in the basement of the Pannonian Basin and may be a local feature triggered by a mafic intrusion in the lower crust.

Petrographic, geochemical and physical methods used for determination of provenance of Czech marbles

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A large number of provenance studies have been published since the 1980s dealing with marbles of the Mediterranean area, in which the methodologies and characteristics were examined in detail. However, available data and comparative studies from other areas are still absent. The major aim of this extensive study, which has been started in late 1990s, consisted of distinguishing the different marble types of the Czech Republic by means of petrographic, geochemical and physical criteria. It includes quantitative approaches, comparing the data from the studied quarries with the properties of artefacts, and evaluating the examined methodology for the study of marble provenance. The work is part of an interdisciplinary research project entitled 'Lithotheque of Czech historical dimension stones'.

The geological situation of the Bohemian Massif (Czech Republic) is very complicated in terms of the various tectonometamorphic and magmatic events that have affected these rocks. The various sedimentary limestones were metamorphosed to form crystalline limestone lenses within metasedimentary rocks, at ages ranging from the Proterozoic to the Lower Palaeozoic. These metamorphosed carbonates were, and still are, of special interest in the production of milled, crushed, and dimension stones worked in the Czech Republic, as well as in some bordering countries.

As the result of the continuing research, the new data were gathered from the southern and western part of the Bohemian Massif. The studied marbles were distinguished with the aid of combinations of following petrographic, geochemical, and physical techniques: optical microscopy, petrographic image analysis, cathodoluminescence, stable isotopic analysis and magnetic susceptibility. Data interpretation has allowed to characterize the marble types on the basis of the mineral assemblage, fabric parameters (carbonate grain size and carbonate grain shapes, index of grain size homogeneity, shape preferred orientation), the fabric of cathodoluminescence, values of C and O isotope ratios ($\delta^{13}\text{C}$, $\delta^{18}\text{O}$) and values of the mass specific magnetic susceptibility. This approach has been found to be useful for fingerprinting calcitic, dolomitic and impure marbles, including rocks involved with various degrees of deformation.

Protection of marble surfaces by using nano-particles

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Stone has been used as one of the main building material in a significant part of our cultural heritage. The beauty, the abundance and the durability of stones were the reasons of their long lasting application to construction. In the case of stones, special skills were needed during all stages of stone elaboration. From the extraction from the quarry, the transportation, the curving and application, each stage had to be carefully designed and detailed executed. In classical Greece, marble and limestone were used for the construction of temples, theatres, Odeon's and forums. Blocks of stones with or without binding layers in between were used for erecting masterpieces some of which were rendered and some were left with their original surface exposed to the atmosphere.

During time these materials were exposed to different natural or anthropogenic deteriorating agents. Usually decay is occurring on the material's surface as this layer is directly exposed to the environment. Gradually, the decay could proceed to the internal structure through cracks and pores, resulting in a diminutive building material in terms of mechanical and physical properties. The type and extent of decay significantly depends on the material's nature.

Ancient masons were trying to protect the materials since very early against the sun and the rain. Traces of wax, oil or natural resins proves this effort. Since then, there was a continuous effort by using the available in each period technological means to protect stone surfaces. During the last decades it has been understood that each monument is unique and a multi disciplinary scientific approach is needed for stone treatment. The study of the reasons of decay, laboratory analysis, documented application of the method and monitoring of the results are necessary steps for a durable and compatible intervention.

Based on the principles of the minimum intervention, of reversibility of each application and the compatibility of the new material with the original one, the present paper negotiates the application of known materials such as silanes and silicones in admixtures with siliceous pyrogenic silicon nanoparticles on the surface of stones.

The addition of these nanoparticles increases the BET specific surface area because of the small diameters of the particles. This large surface area-to-mass ratio causes intense inter-particle interactions, which are the result of attractive dispersion and dipolar forces. And that is precisely the reason for the outstanding water repellency effect of these nano-particles admixtures to silane and siloxanes.

The aim is to increase water repellency of the stone surface, protecting the material against all deteriorating effects dealing with water absorption.

The tests were applied to white marbles from Dionisos, Thasos and Naxos and they concern the application of three different solutions containing nanoparticles. The application was performed by immersing the samples into the solutions for 5 minutes and after drying the properties measured were: water absorption and open porosity according to RILEM CPC11.3 before and after the application, capillary absorption according to EN1015-18:2002 and water drop tests. Also their exposition to open air was tested for a period of three months. Additionally the samples were examined under SEM.

The tests proved the adequate protection achieved the application of the solutions enriched with nano-particles to marble surfaces. The durability of the layers to environment is left to be studied.

Palaeoenvironmental reconstruction and climate change in South Eastern Europe (Neogene Karlovo lignites, central Bulgaria)

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Neogene Karlovo Basin, Central Bulgaria was comparatively studied with other Bulgarian lignites for palaeoenvironment assessment. Petrographic and chemical methods were used. The data allowed floral reconstruction at the region and assumption for the climate during the corresponding geological time. The data of geochemical and petrographic studies gave proves for the long-term evolution of the Late Neogene on the South Eastern Europe connected with the decrease in palaeotropical elements and increase in arctotertiary taxa. Conifers remained main coal-forming vegetation predominantly represented by *Pinaceae*. Biomarker assemblage assumed insignificant *Cupressaceae/Taxodiaceae* contribution. Monoaromatic angiosperm-derived triterpenoids with ursane/oleanane skeleton proved the presence of dicotyledonous angiosperm-derived organic matter in the palaeoplant taxa as well. Palaeoenvironmental conditions within the forest swamp should be determined as limnic, with varying water table and seasonal drying.

New evidence for impacts of the AD365 tsunami along the North African Coast

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Inspired by a fascinating report of the 4th c. AD writer Ammianus Marcellinus, a destructive, earthquake-generated tsunami is inferred to have seriously affect Alexandria in Egypt in 21 July AD365. This earthquake is traditionally associated with tectonic processes along the Aegean Arc, and more recently with the up to 9.5m uplift of West Crete and with seismic destruction in coastal Libya, in Cyprus and Sicily among other areas. In addition, models of the causative fault and of the tsunami propagation have been proposed, while it has been presented evidence that the overall process involved at least three major seismic events near Cyprus, SW of Crete (M>8.5) and possibly between Libya and Sicily.

A recent systematic interdisciplinary study permitted to refine the fault-model at Crete and to re-evaluate the tsunami effects along the North African Coast.

No clear evidence for destruction of the main city of Alexandria by a tsunami exists, at least as far as the history of its famous Library suggests, while a report for a miracle of St Athanasius who saved the city from the tsunami was identified. Tsunami denudation must have been important in the Nile Delta east of Alexandria, but on the contrary, there is no evidence for tsunami damage in Cyprus and the major coastal towns of Libya, the first to have been affected by a Cretan event; some reports for tsunami deposits in southern Greece mainland or of tsunami propagation as far as Croatia seem also at least questionable.

The most likely explanation is that the report of Ammianus is not genuine and precise, as several authors have noticed on the grounds of history and tsunami propagation modeling, and inundation of the coast east of Alexandria was probably associated with an earthquake south of Cyprus, not an unusual event, indeed, or of its secondary effects. The possibility of a second tsunami which affected southern Italy and possibly the western Greek coast cannot be discarded, since there is evidence for coastal uplift in this last area during the critical period, consistent with the hypothesis that the historical reports for a "universal" earthquake in AD365 reflect an amalgamation of several major seismic events which occurred in a rather short time interval.

Sensitivity study of a local numerical fog prediction system

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Accurate and reliable information on expected visibility conditions at the airport of Thessaloniki-Greece, is of high importance, concerning safety and operational expenses for the airport and the airway companies. On the other hand, the life cycle of fog involves complex interactions among dynamical, turbulent, microphysical and radiative processes that are still not fully understood. Therefore, the implementation of a numerical fog simulation-prediction model could be a very helpful tool, for understanding in depth the physical processes involved in the different stages of fog formation and consequently to accurately forecast fog conditions.

The main objective of this effort is to investigate and address the sensitivity of the one dimensional COBEL-ISBA (COuche Brouillard Eau Liquide - Interactions Soil Biosphere Atmosphere) local model to different microphysics, planetary boundary layer and surface schemes of the WRF-ARW regional non-hydrostatic atmospheric model at the “Macedonia” airport of Thessaloniki. High-resolution numerical experiments regarding the fog event that was formed on the 6th January 2010 at the airport were performed with the latest version 3.2 of the WRF-ARW regional atmospheric model. The fog was quite thick, with estimated minimum visibility reaching 100 m and it was extended to an area covering the whole airport and the surroundings, that is up to a radius of 5 km. This fog event persisted for about 8 hours. Different combinations of the Mellor-Yamada Nakanishi-Niino (2.5 level) TKE and the Bougeault and Lacarrere TKE boundary layer schemes with microphysics schemes and the Monin-Obukhov (Jannjic Eta) and Mellor-Yamada Nakanishi-Niino surface-layer schemes, have been investigated in order to assess the predictability and the overall performance of the COBEL-ISBA model. The numerical results, regarding meteorological parameters, such as, air temperature, relative humidity and horizontal visibility, have been compared with actual measurements and the findings, have been evaluated and discussed.

This work describes and evaluates an ensemble approach, which is designed to quantify the sensitivity of COBEL-ISBA model to different physical parameterizations of the WRF-ARW model at the airport of Thessaloniki.

Geochemical characteristics of the amphibolites (ophiolitic metabasites) from the Serifos metamorphic core complex, Attic-cycladic metamorphic belt, Cyclades, Greece

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Half of the surface outcrop of the Serifos island (NW Cyclades, Attic-Cycladic Metamorphic Belt) is composed of a volcano-sedimentary sequence regionally metamorphosed to greenschists facies. This unit consists of, mainly carbonate-rich metasediments, alternating with silicate-rich layers with chlorite and mica-rich layers and enclose a wide variety of metabasites: amphibolite blocks and mafic schists (with minor relict blueschists facies assemblages, now retrogressed to greenschists). The origin of the amphibolites (ophiolitic metabasites) within the Attic-Cycladic Metamorphic Complex (ACMC) remains enigmatic due to the disrupted occurrence of these rocks that makes difficult to constrain the structural relationship of these rocks with their host rocks and their tectonic significance. This study documents preliminary geochemical data (major and trace elements) of the amphibolites interlayered within the Serifos Greenschist Unit. A comparative geochemical study of these rocks with other meta-ophiolite rocks from similar structural occurrences in other Cycladic islands, is attempted. On the basis of petrographic and major - trace element

bulk chemical data, these rocks can be distinguished in different rock types (basalts/andesites and minor gabbros) with different chemical affinities: a) The relatively LILE-enriched amphibolites resemble typical low- to medium – K calc-alkaline basalts (CAB), comparable to the recent Aegean back-arc volcanics. b) Other amphibolites display chemical affinities similar to island arc tholeiites (IAT). c) The retrogressed blueschist – to –greenschists facies metabasites are coarse-grained gabbroic rocks with mixed IAT/MORB chemical affinities. Further geochemical work need to be carried out in order to improve our knowledge on the tectonic setting and emplacement of the Serifos amphibolites.

Gemmological examination of 3 jewellery objects from the Veliki Preslav treasure in Bulgaria

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In August 2009, by a special permission from the director of the Veliki Preslav Museum it was possible to examine 11 jewellery objects of the Preslav treasure. Between the late 9th and the early 10th century, Preslav was the capital of the great Bulgarian empire, in 971 it was devastated by the wars between Sviatoslav from Kiev and the Byzantine emperor John I Tzimiskes. In spring 1978, a treasure was discovered near the former Preslav royal palace, after farmers had been ploughing into a depth of 0.60-0.70m the winter before. The treasure box had probably been hidden since 971 in an old dwelling. The jewellery objects shows a distinct Byzantine influence but may have been produced in local workshops under Byzantine masters.

Standard gemmological equipment was used for the testing procedures. Results relating to three gold medaillons, two round ones (5cm in diameter) and one rhomb-shaped (6.5x6cm) will be described. A total of 30 drilled emeralds of hexagonal prismatic shapes with polished surfaces was examined, measuring between 0.20 to 0.60mm in length and 0.40 – to 0.72cm in width and showing a pale to intense green colour. 13 of otherwise non-transparent emeralds have translucent to small transparent areas that allow to observe mica platelets, tremolite needles and small negative crystals (two-phase inclusions) under the microscope (30x-120x). The inclusion pictures observed would correspond with what could be expected of emeralds that were formed by pneumatolytic contact metamorphism.

The European emerald deposits in Upper Egypt and the Austrian Habachtal do both belong to this basic type of formation and are discussed as possible sources of origin. Examples of comparable emerald crystals in –Roman and early medieval jewellery, observed by the authors in museums in Sofia, Cairo, Alexandria and Aachen, are discussed as are other possible worldwide sources of origin. As they were discovered at a later date (Colombia in 1514, Ural in 1830 and all others in the 20th century), the question remains if the deposit in the Hindukusch area of Afghanistan, mentioned by Theophrastus in 314BC, might be a possible source although there are no further written sources and there is no evidence of mining between the 4th century BC and the 1970s when the deposit was rediscovered by the Soviet occupation. Pliny's reference to Scythian emeralds is discussed and compared with Scythian jewellery objects.

24 pearls in barrel and button shapes, measuring between 0.35 and 48cm, were examined; their light to dark grey colour is interpreted as the result of environmental influence. Pearl surfaces show moderate to distinct signs of dissolution. They are most certainly of marine origin and do probably come from classical finding places like the Persian Gulf, the Red Sea or the Strait of Manaar between India and Sri Lanka.

11 drilled purple gemstones or irregular polished shapes, in a size range of 0.55-0.68 cm, were identified as 10 purple sapphires and 1 garnet. They had before been described as amethysts. The possible origin in Sri Lanka is discussed.

Thermal processes in Triassic SEDEX ore deposit Vareš and adjacent pile of pillow lavas, Central Bosnia and Herzegovina

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The abstract deals with the two prominent representatives of Triassic advanced rifting magmatism, SEDEX ore deposit Vareš and its principal driving mechanism for fluid convection, a huge pile of pillow lavas. Their position, at the head of the obducted ophiolite front, accomplishes a general pattern which can be followed from the Zagorje-Mid-Transdanubian megaunit, Dinarides, Albanides and Hellenides. The products of Triassic advanced rifting magmatism, are situated within the basement of the growing carbonate platform in Mesozoic time, invaded by bulldozing, obducting slab of the oceanic crust, during collision and closure of the Neotethyan ocean in Jurassic-Lower Cretaceous time. Their present position is in the mélangé, chaotic mixture of complex lithology, developed during ophiolite emplacement, or as para-autochthonous, at the base of or even within the carbonate platform itself. The both objects are situated at the head of the obducted ophiolite Krivaja-Konjuh massif.

The Vareš Fe-Pb-Zn-Ba SEDEX deposit is located 40 km northern from Sarajevo, Bosnia and Herzegovina. Mineralization is derived from hydrothermal sea floor exhalations within a Triassic rift depression of the Tethys.

The Vareš basalt quarry, situated in the vicinity of the deposit, exposes Middle Triassic pillow lavas, peperites and hyaloclastite breccias formed by extrusions of basaltic lava into unconsolidated seawater sediments. Interactions of basaltic lava with the seawater produced mostly chloritic alteration of basalt and precipitation of hydrothermal calcite in feeding channels of lava lobes and hyaloclastite breccia matrix. Calcite is associated with siderite, chlorite, zeolites and minor epidote.

Primary fluid inclusions (FIs) hosted by hydrothermal calcite reflect conditions of fluid/rock interaction. The coexistence of liquid-rich and vapour-rich FIs points to precipitation from boiling fluid and allows the estimation of trapping conditions. Assuming recent seawater salinity, homogenization temperatures in an interval between 275 and 290°C correspond to the formation depth between 650 and 900 m. Secondary two-phase (L+V) aqueous FIs display salinity close to the salinity of recent seawater (3.5-5.7 wt.% NaCl equ.) and their homogenization temperatures (TH) are in the range of 60–110°C.

The Vareš Fe-Pb-Zn-Ba SEDEX deposit comprises stratiform siderite-hematite-chert beds formed by exhalation of hydrotherms onto the bottom of rifting basin. The mineralization displays a distinct vertical zoning, reflecting a gradual change of redox conditions in the depositional environment. The sequence starts with bituminous, thinly bedded shales with pyrite and base metal sulfides, overlain by barite and siderite, deposited under reducing conditions. Overlying clastics and oolitic limestone are succeeded by hematite shale, hematite ± chert beds, deposited in oxidizing environment. The principal minerals are siderite, manganese-rich hematite, barite, pyrite, marcasite, chalcocopyrite, galena, sphalerite, tetrahedrite and Pb-sulphosalts.

Microthermometric investigations on siderite and barite samples distinguished several FI types including: 1) Two-phase (L+V) NaCl-CaCl₂-H₂O FIs (2-6 wt.% NaCl equ.; TH ≈ +110°C), 2) H₂O-CO₂-NaCl FIs (~4.5 wt.% NaCl equ.; TH ≈ +100°C), 3) Aqueous FIs with liquid hydrocarbons, 4) Pure hydrocarbon FIs, and 5) Mono-phase aqueous FIs.

The FIs data indicate that modified seawater represents the major constituent of the mineralizing fluids and that magmatic activity in the region had served as principal driving mechanism for fluid convection. The presence of hydrocarbons reflects interaction of mineralizing fluids with organic rich sediments.

The total surface of the exposed pillow lava on both banks of the Stavnja rivulet exceeds several square km. The pillow lava pile is made of m-dm sized pillows rounded, semirounded, squeezed, contorted, green, red and gray in colour.

The foundation of the pile are lobes, partly disintegrated, turning into hyaloclastite breccias and pink peperites, within the inter-pillow space. The carbonate part of peperite contains Triassic index conodont fauna *Paragondolella excelsa*, *Paragondolella foliata foliata*, *Paragondolella foliata inclinata*, *Nurella* sp., CAI 6½, what appropriates to the Langobardian. The basalt was extruded into soft, unconsolidated sediments, of the Triassic rifting basin, and there are still no evidences of the oceanic crust which developed afterwards in Jurassic time.

Passive seismic experiment at the contact of the Dinarides and Pannonian Basin (ALPASS-DIPS) – deployment and characteristic receiver functions

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A group of active source seismic surveys have been performed in central Europe (CELEBRATION 2000, SUDETES 2003 and ALP 2002), covering wide area between Baltic and Adriatic sea. The main aim of these surveys was to determine more precisely the structure of the Earth's crust and upper mantle. Due to great problems related to shot-points, active seismic surveys have been more and more replaced by passive seismic experiments. The ALPASS-DIPS (Alpine Lithosphere and Upper Mantel PASSive Seismic Monitoring-Dinarides-Pannonian Segment) is a continuation of the active ALP 2002 project, which covers a wide area of NW Dinarides, transition zone towards the Pannonian basin, and SW part of the Pannonian basin. Most of the temporary seismic stations, which are denominated Cro_01 to Cro_12, were deployed along the profile Alp07 permitting comparison and amendment of the active and passive seismic methods. Profile Alp07 stretches from Istra to the Drava river at Hungarian–Croatian border in a WSW–ENE direction. It is oriented approximately perpendicular to the Dinarides and the main faults in the Adriatic region. It stretches from the edge of the Adriatic microplate through the northern part of the Dinarides. The profile also crosses a wide ophiolite zone, which is divided into the narrow Dinaridic ophiolite zone and much wider Sava-Vardar zone, and terminates at eastern part of the Tisia block in the Pannonian basin.

Seismic modelling, both inverse and forward, was performed on the data gathered along Alp07 profile. The velocity model shows that the Moho depth is the greatest in the area of the Dinarides, reaching about 40 km and is shallowest (20–30 km) in the Pannonian basin. On the basis of seismic modelling, as well as gravity modelling, three types of crust were defined along the profile: the Dinaridic and the Pannonian crusts that are separated by a wide Transition zone. The Dinaridic crust is two-layered, while the Pannonian crust can be seen as a unique layer characterized by low seismic velocities and densities.

The data recorded within passive seismic project ALPASS-DIPS were processed using P-receiver function method, based on converted P-to-S phase. Analysis of receiver functions shows three types of seismograms: Dinaridic, Transitional and Pannonian. Pannonian type can be represented with data analysed at station CBP4M which belongs to the Pannonian crust. Transitional type can be seen at station Cro_07 because it is located in a Transition zone, while Dinaridic type can be observed at station Cro_03, and belongs to Dinaridic crust. Three major lithospheric discontinuities can be defined at the Dinaridic type and the Transitional type, while the Pannonian type reveals only two discontinuities. To validate these results, receiver function modelling was performed. The main velocity contrast under the station Cro_03 is at the 42 km depth, which can be interpreted as Mohorovičić discontinuity. The upper crust is characterised by rather low velocities, but good agreement of the calculated and observed receiver functions could be obtained only with high-velocity layer at a depth between 3 and 5 km. The existence of high-velocity layer in the upper crust at the south-

western end of Alp07 profile was already indicated in the P-wave velocity model obtained within active seismic experiment. The modelling revealed that under the station Cro_07 upper crust is characterised with low velocities and a strong velocity contrast at the mid-crustal boundary, resulting in high amplitude of the second peak. In the Pannonian part of the profile, modelling confirmed that crust can be considered as single layered. Pannonian type model with sedimentary layer and one-layered crust can fit very well the observed data, and based on active seismic data analysis, it corresponds very well with the unique-layer interpretation of Pannonian crust.

Geophysical models at the contact of the Dinarides and Pannonian basin

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Available gravity data, along with the new seismic data gathered from 2002, enabled developing of geophysical models of crust and upper mantle at the contact of the Dinarides and south-western part of the Pannonian basin. The study area is located in the boundary zone of the Adriatic microplate as part of the African plate and Pannonian segment as part of the European plate. Seismic data are available from two large international projects: wide-angle refraction and reflection experiment ALP 2002 – Seismic Exploration of the Alpine Lithosphere, and passive seismic experiment ALPASS-DIPS (Alpine Lithosphere and Upper Mantel PASSive Seismic Monitoring-DInarides-Pannonian Segment). Basic exploration was carried out on the profile Alp07 stretching from the edge of Adriatic microplate (Istra) through the northern part of the Dinarides, crossing wide ophiolite zone (Dinaridic ophiolite zone and Sava-Vardar zone) and terminating in the Pannonian basin at the eastern part of the Tisia block. Direction of this 300 km long profile is almost perpendicular to the Dinarides.

Velocity model was obtained from the active-source seismic data by inversion tomography and forward modelling using ray tracing method. Based on the velocity model, 2-D gravity modelling was performed on the profile, in order to determine lithosphere densities. The data gathered during passive seismic experiment were analysed by receiver function method and used to define velocity discontinuities in the crust and upper mantle. Since the profile Alp07 is located in the marginal part of the Dinarides, gravity modelling enabled extension of the study area to the central part of the Dinarides. Five gravity profiles were set up southeast from the Alp07 profile, covering the area of Croatia, Bosnia and Herzegovina and southern parts of Hungary. Structural units defined on the Alp07 profile on the basis of both models, velocity and density, can be followed in wider area. Calibrated densities, defined on the Alp07, enabled more precise gravity modelling on the other profiles. Density models show the greatest thickness of crust under the Dinarides, and thinning of the crust towards the Pannonian basin. Two-layered crust is observed under the Dinarides, as well as in the marginal part of the SW Pannonian basin, but under the Pannonian basin, crust can be considered as single-layered. Whereas the structure covered by the profiles is two-dimensional, the obtained results enabled the construction of structural map of the Moho and its three-dimensional image. It shows the greatest depth of the Mohorovičić discontinuity in the Dinarides root. In the NW part of the study area the depth is about 40 km, and increases to the SE where it reaches about 46 km. The subsidence of the Moho is particularly marked on the north side of the Dinarides at the contact with the Pannonian basin, where, based on structure geometry, subduction is assumed. The shallowest Mohorovičić discontinuity is located in the NE part of the study area (the Pannonian basin) at depth less than 20 km.

Structural Moho map of the area can be very helpful in planning future seismic experiments in the area. Density calibration was carried out on the profile Alp07, which is located at the edge of the contact, and structural map has been made assuming there are no lateral changes in densities. However, if stronger lateral changes are present, it can lead to significant changes in gravity model. The depth of interfaces, especially Mohorovičić discontinuity, as well as position of structural units can be modified. Therefore it is necessary

to set at least one profile across the central part of the contact of the Adriatic microplate and Pannonian segment. The future step will be setting a profile with dense deployment of broadband seismic stations, especially in the area of expected subduction. The data will be interpreted by high-resolution migration techniques to map interfaces and to obtain a physical evidence of the subduction. High-resolution migration techniques use scattered teleseismic waves. Waves are represented by a diffracted wavefield, backprojected to depth. Because the diffracted wavefield is caused by small scale-length perturbations, the position and depth of these smaller subsurface units can be easily estimated.

Structural data from Skupniów Uplaz Mountain (Tatra Mts., Poland)

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The study area was situated along Skupniów Uplaz Mountain in the larger Tatra Mts, southern Poland. An investigation was carried out in Inter Carpathians, in Križna Unit. The limestone and dolomites of anisian and ladinian built this mountain. Beds of limestone and dolomite form a homocline in study area. A dominant orientation of strike and dip has value 110/42N. There are found many small-scale tectonics structures in this area. There were distinguished two groups of stylolitic seams, the en echelon fractures, five sets of fractures and three sets of normal faults. These structures served to reconstruct structural evolution of this small region. Firstly, when beds were in horizontal position, there was a vertical stress, which caused a lithostatic stylolitic seam. Afterwards, the tectonics stylolitic seams, the en echelon fractures and the hybrid fractures were formed before folding, when beds were in horizontal position. The tectonics stylolitic seams are formed after lithostatic stylolitic seams were created, when a horizontal stress was oriented N-S. The en echelon fractures were formed after tectonics stylolitic seams. The right-slip en echelon fractures and the sinistral en echelon fractures were found in study area. A stress orientation was impossible to define, because the en echelon fractures were irregular orientation after rotation to horizontal position. A system of hybrid fractures was formed, when a stress was oriented W-E. This system is composed of a set of fractures number IV and a set of fractures of number V. These sets are complementary. A dominant orientation of set of fractures number IV has value 77/55S. A dominant orientation of set of fractures number V has value 118/51S. Thirdly, there were took place a folding and Križna Unit was made. The reverse faults were found in study area. Unfortunately, they have a varied orientation and they couldn't create a set, so there is no information about a stress orientation during this stage. A rotation uplift of Tatra Mts. took place after folding. After this event a set of normal fault and a set of fractures number III was formed together, when a stress was oriented ENE-WSW. An orientation of set of normal faults has values 162-173/80-90N. A dominant orientation of set of fractures number III has value 166/80N. In the end, a system of normal faults and a system of fractures was formed, when a stress was oriented WNW-ESE. An orientation of system of normal faults has values 9-45/70-80N and S. A system of fractures is composed of a set of fractures number I and a set of number II. A dominant orientation of set of fractures number I has value 20/88N. A dominant orientation of set of fractures number II has value 37/80S.

Holocene raised shorelines along Athos Peninsula, Northern Aegean Sea, Greece – first data

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Athos or Agion Oros peninsula is the eastern of the three smaller peninsulas of Khalkidhiki in northern Aegean Sea. It is an elongated highly mountainous peninsula exceeding up to 2,030 m asl at Mt. Athos, surrounded by steep and high rocky coasts eroded by the sea. The peninsula consists of granite and metamorphic rocks mainly schist and gneiss in northern and central part, while the south part is dominated by marble. In this paper are presented the first data concerning the discovery of fossil raised shorelines that were located along the west and south coast of the peninsula. Due to steep coastal morphology that restricts any access from the land, geological reconnaissance was completed with a boat that shipped along the coastline from Ouranoupolis (at NW) up to Scala Kafsokalyvion pier (at SE). More than 40km of coastline were visually inspected and photographed in detail with a digital camera. Detail observations and the photographic record were used to document the fossil shorelines and to estimate their rising. On land reconnaissance of the coast line was realized at the Monastery of Agiou Dionysiou and along the footpath from Agiou Dionysiou towards Agiou Pavlou monasteries.

Results: The raised shorelines comprise marine notches, benches and micro-platforms that were cut on the hard rocks along the coast. Marble preserves the best traces especially the solution notches. On the contrary granite, schist and gneiss did not favour notches formation but in some places some relics of fossil raised wave-cut abrasion platforms were located, still surviving the coastal erosion. Very well preserved raised notches on the marble exceeding up to ~2m height from present sea-level were traced along a distance of ~4 km from Cape Diaporti to Cape Fonias and Skala Kafsokalyvion. They reveal at least 3 raised notches along the vertical marble coast from Cape Diaporti & “Simonos rock” up to Karoulia and Katounakia pier. While eastwards to Kafsokalyvia pier, where the coast reveals less inclination, one to two raised benches and micro-platforms were observed accompanied also with one or two notches. At Agiou Dionysiou monastery, where green-schist exposes, relics of a fossil wave-cut abrasion platform were found along the coast. At the top surface of this platform, raised at ~1m asl, some remnants of hard cemented coarse sands with gravel, pebbles and cobbles were found. These sediments, suffering present wave erosion, correspond to older coastal clastic sediments; they also contain many shell fragments of marine molluscs. Dating of a shell sample with the C¹⁴ AMS technique gave an age 3263 ± 45 BP.

Conclusions: It is the first time that raised coastlines are recognized in Northern Aegean Sea. The south part of Athos Peninsula reveals characteristic visible marks of neotectonic uplift, *i.e.* raised notches. Height of raised shorelines above present sea level indicates that rate of neotectonic movements exceeds the rate of Holocene sea level rise. Although one C¹⁴ AMS age is not enough to monitor the neotectonic uplift, it allows an estimation of the timing of this neotectonic event. If this age is representative, then a mean rate of active uplift is estimated at 1.3 – 1.5 mm/yr based on the Holocene sea level rise curves for northern Aegean (isostatic model for Aegean and curve of Thermaikos Gulf). There is an indication that relative sea level rise is strongly influenced by local conditions. Research is still in progress, in order to investigate the coastline along south and east side of the peninsula, especially in the area that marble is exposed along the coast, including more visits for sampling and topographic measurements. Geological reconnaissance was realized on November 2009, along the route followed by “Agia Anna”, the only boat allowed to carry visitors to Agion Oros monasteries.

Examination of the groundwater quality in a settlement of Eastern Hungary

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The water quality from groundwater wells in a small town, called Mikepércs, situated on the SW edge of the Nyírség, eastern part of Hungary, is investigated. By the time of the

research, the sewage network had not been yet constructed in Mikepércs, thus the inhabitants collected the sewage in septic tanks. In Mikepércs the tanks usually had not adequate insulation and therefore the majority of the sewage (more than 90% according to our estimations) was emitted into the soil. As there are sandy soils around the settlement the sewage can filter into the soil and reach easily the groundwater level at depth of about 1.5-3 m below ground surface. According to our preliminary expectation, we have detected significant pollution in most of the groundwater wells in Mikepércs, especially concerning orthophosphate, nitrate and ammonium pollutants, which concentrations were much over the hygienic limit value. Besides the watering of animals, sometimes people drink groundwater so we can say that consuming of groundwater can cause both human and animal health risk.

Measure of heavy metal load in the floodplain of the river Tisza

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The quality of the River Tisza is significantly influenced by the industrial activity of Ukraine and Romania. The main problem is the heavy metal pollution which can be in dissolved form in the water or attached to colloidal particles in the sediments. In this paper an investigation of soil samples taken from the floodplain of the river was carried out. Surface samples were collected and profiles were created. As, Cd, Co, Cu, Ni, Pb and Zn concentrations were determined. The results show significant and continuous heavy metal load. ANOVA test was carried out and the metal concentration in the upper layer of the active floodplain is proved to be considerably higher than in the reclaimed side. Regarding copper and zinc, in addition to the total metal content, their percentage available for plants (Cu and Zn percentages measured in the Lakanen-Erviö solution) is also more in the active floodplain than in the reclaimed side (copper: 27%, zinc: 47%). Discriminance analysis can identify the location of the soil samples (correlate to the levee) with 92% accuracy. Soil profile shows increased heavy metal loads in the top layer of the soil and proved that the accident in 2000 was not the only pollution occurrence. Based on the results we came to the conclusion that the pollution comes constantly with the sediments from the over arm of the River Tisza and its tributaries.

The role of the time factor in the hydrothermal metallogenesis related to the Neogene volcanism in the Carpathian-Pannonian Region

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Sudbuction-related terrestrial igneous/volcanic environments provide one of the most favorable conditions for hydrothermal ore genesis as recorded by world-class volcanic-hosted

deposits along active and collided continental margins. A number of key factors related to magmatic/volcanic activity contribute to the effectiveness of those environments in concentrating metals present at low contents in large volumes of magma and/or country rocks within smaller volumes of high-concentration ore bodies. Such factors invariably include the presence of persistent and focalized heat-sources fueling the “hydrothermal engine” by hydrous fluid circulation in the shallow crust leading to metal extraction, transport and concentration through time. Here we focus on the role of the time factor in controlling both heat-source persistency and metal availability in the Neogene volcanic areas of the Carpathian-Pannonian Region (CPR). Based on K-Ar geochronology (> 1400 data), patterns of time-space evolution of Neogene volcanism and ore mineralization in CPR have been identified in both the back-arc part of the orogenic system and the fold-and-thrust arc, as follows.

1. In the back-arc intra-Carpathian region petrochemistry of volcanism has evolved in the order: felsic calc-alkaline, intermediate-acidic and then alkaline. The total duration of volcanic activity is about 20 Ma (from 21 to < 1 Ma), however, ore fertile stages are clearly related to the intermediate-acidic volcanism which has more restricted time span starting at around 17-14 Ma and lasting to about 5-7 Ma in different areas. The most striking observation is that the major stage of ore deposition occurred in a relatively narrow time interval between 11 and 14 Ma. Localization of major ore deposits are controlled by regional fault systems interacting with evolved volcanic structures. These ore deposits mostly represent differentially eroded parts of deep-seated intrusion-related low-sulfidation type epithermal systems in their exposures. The exception is the Apuseni Mts. where an additional younger ore stage with Cu (-Au) porphyry ores occurred at 9 Ma in relation to emplacement of shallow andesitic intrusions.

2. In the Carpathian arc portion of CPR two evolution patterns can be distinguished:

2a. a slowly migrating (from west to east) persistent ca. 700 km long intermediate/felsic calc-alkaline magmatic arc from Eastern Moravia to Bârgău Mts., in the 15-7 Ma time range. Ore deposition occurred in the southeastern part of the arc, again in a relatively narrow time interval between 8 and 11 Ma. Localization of these ore deposits are mostly controlled by shallow andesitic intrusions.

2b. a transient, fast-migrating (from north-west to south-east) volcanism along the ca. 160 km long Călimani-Gurghiu-Harghita (CGH) range in the East Carpathians (11- < 0.05 Ma) without important ore mineralization.

In general, duration of magmatic activity in individual areas is particularly significant if taking into account a “magmatic focusing factor” (i.e. duration of magmatism weighted by occurrence area of its products): longer-lasting magmatism in a smaller area both in the groups of 1 and 2a results in higher ore productivity as compared to shorter-lasting and/or larger occurrence area magmatism in the 2b group. On the other hand, regional scale fault systems related to the back-arc tectonism as long-living controlling factors (group 1), as well as occurrences of shallow intrusions as short-living local factors appear to be also important in defining ore mineralization (group 2). Post-mineralization uplift/subsidence related to the Carpathian collision and basin inversions defines erosion levels in different areas and thus ore types (from shallow epithermal to porphyry levels) observed in exposures.

Fissure caves and other gravitationally-induced discontinuities detected by 2D electrical resistivity tomography - case studies from flysch Carpathians (CZ, PL, SK)

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Fissure caves as one of the types of the subsurface dislocations can represent initial forms of the gravitational disintegration of rock massif ranging from shallow to deep-seated (>40 m) gravitational slope deformations. Occurrence of pseudokarst forms, such as crevice-type caves, trenches, escarpments, tension cracks or sinkhole-type depressions is frequent in

the massifs of the Outer Western Carpathians which are formed by anisotropic flysch rock. Detailed research of these landforms can significantly contribute to understanding to the processes transforming a relief of the medium-high mountains in the Carpathian flysch belt. Method of electrical resistivity tomography (ERT) based on various resistivity values of particular subsurface structures offers a non-invasive way to display the situation beneath the surface. Each of the commonly used electrode arrays (Wenner Alpha, Wenner-Schlumberger and Dipole-Dipole) is suitable for different type of subsurface structures. Verification of the known fissure cave systems is one of the advantages of this method. However, final 2D resistivity model often reveals new information on the subsurface structures, namely undiscovered cave chambers or spreading crevices. Using the ERT-evidence of the known cave system in the similar lithological situation, we are able to detect supposed non-revealed cave parts or individual new cave. Research focused on application of ERT on the fissure-induced structures on several sites located to the area of Czech, Slovak and Polish Carpathians during the years 2009-2010 brings a new knowledge in their detection. Method of the Wenner-Schlumberger array offers similar results as the Wenner Alpha electrode array. Both of the methods are suitable mainly for the (sub) horizontal subsurface structures and as such seemed to be less suitable for detection of rather vertical fissure-structures. According to our experience, Dipole-Dipole electrode array appears to be the best method for fissure cave detection (likely due to high total resolution). The results of Dipole-Dipole array are also the best in accuracy of location of particular cave segments in final 2D resistivity model. Nevertheless, too high sensitivity to high near-surface resistivity may sometimes be the limiting factor of the use of the Dipole-Dipole array. Understanding the genesis of gravitationally-induced discontinuities may considerably help to fully recognize their role in context of massif disintegration and overall landscape evolution. Presented study deals with detection and verification of known fissure caves and their possible prolongation with use of different electrode array, resolution and depth range. Set of the ERT results confirms an assumption that deep-seated disintegration is closely connected with development and extension of the fissure and fault systems. These forms of the massif disintegration also represent initial phase of the slope processes such as rock-slides, catastrophic rock avalanches or forms of terrain subsidence (sagging, toppling). Experimental 2D resistivity modelling has been also applied to the dealt issue. Geophysical technique of the ground penetrating radar (GPR) has been used on the one of the sites in order to confirm and specify the ERT results.

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Preliminary data on the crystal-chemical characteristics of beryl from Cer Mt. (Serbia)

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A beryl crystal from Cer Mt. (Serbia) studied in this paper was characterized by means of XRPD and wet-chemical analyses. It has following unit cell dimensions: $a = 9.2166(8) \text{ \AA}$, $c = 9.192(1) \text{ \AA}$, $V = 676.2(1) \text{ \AA}^3$ and ratio $c/a = 0.9973$. According to the calculated c/a ratio and structural formula of $(\text{Be}_{2.86}\text{Li}_{0.11})_{2.97}(\text{Al}_{1.96}\text{Fe}^{2+}_{0.05})_{2.01}\text{Si}_{5.96}\text{O}_{18}(\text{Na}_{0.09}\text{Ca}_{0.03}\text{Mg}_{0.03}\text{K}_{0.01})_{0.16} \times 0.14\text{H}_2\text{O}$ composition, this sample belongs to the “normal beryl group”. The obtained characteristics prove that the host pegmatite is of Li-bearing type.

EPMA and TEM study of monazite hydrothermal alteration in Igralishte granite pluton, Southwestern Bulgaria

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The Igralishte pluton (Ograzhden block, Serbo-Macedonian massif) is built-up of two-mica S-type granite with age of 243.28 ± 0.84 Ma, embedded among high-metamorphic rocks (gneisses, gneiss-schists and amphibolites). The most significant alterations of the plutonic rocks are caused by postmagmatic high-temperature alkaline (K and Na) metasomatism. Besides, a tectonic and hydrothermal overprint at 36.36 ± 0.56 Ma is recently recognized using Rb-Sr analysis of whole rock and biotite. Monazite brings clear signs of hydrothermal alteration being presented by randomly shaped relics of the mineral surrounded by pseudomorphic dispersed aggregates of secondary products. In backscattered electron (BSE) images these aggregates appear as much darker areas than those of the monazite relics and contain very small lighter spots with increased content of Th, REE, Si and Y. According to EPMA data, the major part of the aggregates corresponds to apatite containing variable quantity of britholite molecule. Beside the pseudomorphic replacement of monazite, in the internal parts of the monazite relics in fissures there are a lot of inclusions of thorite and xenotime. The performed EPMA dating of the thorite and xenotime, although giving wide variation in the age (180-250 Ma), evidences their formation due to the postmagmatic high-temperature hydrothermal process and alteration of monazite. Pseudomorphic replacement of monazite + inclusions of thorite and xenotime is proposed to be realized at lower temperatures due to the later hydrothermal overprint.

Two types of monazite particles were found during transmission electron microscopy (TEM) examination: the first one represents intact mineral grains related to the relic forms of monazite and giving selected area electron diffraction (SAED) patterns typical for monocrystal material; the second one is altered monazite presented by polycrystalline aggregates whose SAED patterns show spot reflections grouped in rings. The performed EPMA in TEM evidences that the altered monazite contains much more Si, slightly more Y, Th and Ca than that in the intact monazite, while the ratio between (P+Si) and other elements (REE+Th+Ca+etc) in both varieties of monazite is almost the same. These data indicate that at least on the early stage of the monazite breakdown, mainly the PO_4 sublattice of the mineral is affected by hydrothermal alteration - through the substitution of P by Si. This process can be considered as britholitization of monazite. The inspection of series of particles of the polycrystalline monazite allows establishing that they are not composed of randomly oriented domains. This fact is illustrated by a case particle whose polycrystalline SAED pattern is superposition and derivative of series of slightly rotated and inclined SAED patterns originated from one and the same [211] zone. The domains (with prevailing size 10-20 nm) of this particle demonstrate characteristic Moiré fringes with spacings of ~ 2.0 and 4.5 nm originated from (120) and (011) atomic planes of monazite. The obtained results allow one to suggest that the observed microstructure of the polycrystalline monazite is a manifestation of original mosaic microstructure of the mineral but influenced by the later alteration processes. Most probably the established altered monazite represents an intermediate state of the monazite microstructure before their collapse into the pseudomorphic aggregates.

New insights into the lithosphere beneath the Romanian seismic network from Rayleigh wave dispersion and receiver function analysis

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We present new models of shear wave velocity structure of the crust and upper mantle beneath Romanian broad band stations. The data set consist in more than 300 teleseismic earthquake with epicentral distance between 30° and 95°, magnitude greater than 6 and a signal-to-noise ratio greater than 3 for the P-wave pulse. Most epicenters are situated along the northern Pacific Rim and arrive with backazimuths (BAZs) between 0° and 135° at the Romanian seismic network. We combine the receiver functions with fundamental-mode of the Rayleigh wave group velocities to further constrain the shear-wave velocity structure. To extract the group velocities we applied the Multiple Filter Technique analysis to the vertical components of the earthquakes recordings. This technique allowed us to identify the Rayleigh wave fundamental mode and to compute the dispersion curves of the group velocities at periods between 10 and 150 s allowing us to resolve shear wave velocities to a depth of 100 km. The time-domain iterative deconvolution procedure of Ligorria and Ammon was employed to deconvolve the vertical component of the teleseismic P waveforms from the corresponding horizontal components and obtain radial and transverse receiver functions at each broadband station. The data are inverted using a joint, linearized inversion scheme which accounts for the relative influence of each set of observations, and allows a trade-off between fitting the observations, constructing a smooth model, and matching a priori constraints. All models fit well their individual data sets. This highlights the point that the inversions are not unique. The upper mantle velocities for the receiver function inversion are too large, while the surface-wave inversion lacks any detail about the Moho. These particularities are corrected in the joint model proving the reliability of the results. The results show a thin crust for stations located inside the Pannonian basin (28-30 km) and a thicker crust for those in the East European Platform (36-40 km). The stations within the Southern and Central Carpathian Orogen are characterized by crustal depths of ~35 km. For stations located in the Northern part of the Eastern Carpathians we found a crustal depth of 32 km. For stations located in the Apuseni Mountains the Moho discontinuity is replace by a transition zone extended between 36 and 40 km depth. For a station located in the Carpathians bent area we identify a double Moho (32 respectively 44 km depth) possible due to the Vrancea subduction process. For the crust of Moesian Platform we get higher values (~35 km) compare to those obtained from seismic refraction profile (VRANCEA'2001). The North Dobrogea crust reaches a thickness of about 44-46 km. For most of the stations the crust-mantle transition zone has a significant gradient, with velocity values varying from 3.8 to 4.7 km/s. Our results are compatible with those obtained from previous studies.

An olistolith with continuous latest Bajocian to late Cenomanian pelagic deposition within the Bornova Flysch Zone in western Turkey: Radiolarian Assemblages

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Bornova Flysch Zone (BFZ) comprises several olistoliths or tectonic slivers, representing the lithosphere of the Izmir-Ankara Ocean and accretionary melange complexes formed during its closure. Radiolarian assemblages in one of the olistoliths in BFZ, to the NE

Manisa city, between Akhisar and Sındirgi towns, is studied along Sogutlu stratigraphic section in detail. Sogutlu section is 73,5 m thick and composed of green to red, mainly thin to medium-bedded chert and mudstone alternation. Ten samples out of eighteen yielded relatively diverse radiolarian assemblages.

Basalmost part of the section contains characteristic latest Bajocian – early Callovian radiolarian taxa (*Acanthocircus suboblangus suboblangus* (Yao), *Higumastra* sp., *Tritrabs ewingi* s. l. (Pessagno), *Acaeniotyle diaphorogona* s. l. Foreman, *Hsuum* sp., *Crubus* sp., *Ristola altissima major* Baumgartner & De Wever, *Mirifusus fragilis* s. l. Baumgartner, *Spongocapsula* sp., *Parvicingula* sp., *Podobursa helvetica* (Rüst), *Podobursa* sp., *Sethocapsa* sp. A sensu Baumgartner, *Stichocapsa* spp. and *Eucyrtidiellum unumaense* s. l. (Yao)). Successively, radiolarian assemblages indicating Late Jurassic, early Early Cretaceous and late Early Cretaceous and early Late Cretaceous time intervals have been obtained from the section. Youngest radiolarian assemblage yielded from the section includes diverse radiolarian taxa (*Dactyliosphaera silviae* Squinabol, *Pseudoaulophacus* sp., *Godia* sp., *Rhopalosyringium* sp., *Dictyomitra* spp., *Dictyomitra crassispina* (Squinabol), *Pseudodictyomitra pentacolensis* Pessagno, *Pseudodictyomitra pseudomacrocephala* (Squinabol), *Xitus* spp., *Novixitus mclaughlini* Pessagno and *Stichomitra communis* Squinabol) and these taxa clearly reveals the late Cenomanian age.

Previous studies reveal that the Izmir-Ankara oceanic basin was initially opened during late Ladinian – early Carnian. The new radiolarian data obtained from this olistolith reveals that relatively condensed, continuous pelagic sedimentation took place in this basin during the latest Bajocian to late Cenomanian time span.

Secular variation of the Earth's magnetic field in the Balkan region during the last 5 millennia

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Archaeomagnetic data available for a certain region have been traditionally used to construct reference secular variation curves for single countries. Nevertheless, even though the Earth's magnetic field varies from a geographic region to another, there is no reason to limit its study into national borders. We present here the first archaeomagnetic secular variation curve for the South Balkan region, based on all data that are included in a 700 km circle centered at Thessaloniki. This dataset consists of 226 directional and 416 intensity data, mainly originating from Greece, Bulgaria and former Yugoslavia. Some data from Southern Italy that fall within this circle are also included. The data cover almost continuously the last 5 millennia with a small gap around 2000 BC. The directional data are well consistent to each other while the intensity data show considerable dispersion. All data have been reduced at the latitude of Thessaloniki (40.60° N, 23.00° E) and plotted versus time. The moving window technique with windows of 100 years shifted by 50 years has been used to calculate a continuous secular variation curve for both direction and intensity. The obtained curves clearly show some characteristic features of the geomagnetic field variation during the last 5 millennia. Low inclination values are well documented around 1200 AD, 300-400 AD and 1800 BC, even though only few data are available for the latter period. Eastward declination is observed around 1200 AD and 800 BC while for the period between 200 BC and 500 AD only small variations in declination are noticed. The intensity curve is highly influenced by the important dispersion of the reference data points. Comparison with the predictions of the SCHA.DIF.3K regional and the CALS7K and ARCH3K global geomagnetic field models shows good agreement with the regional modelling curve while the global models show much smoother variations. The bulk number of reference data used to calculate the proposed Balkan curves makes them better constrained and thus more reliable compared to the curves constructed using limited data of individual countries.

The vitamin D synthetic capacity of sunlight: *In situ* monitoring and model calculation

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In appropriate dose solar UV radiation is beneficial for people, specifically due to production of vitamin D₃ in skin from its precursor 7-dehydrocholesterol. Vitamin D₃, traditionally perceived as the main regulator of calcium homeostasis, is now acknowledged as one of the body's many control systems.

But the UV overdose may result in detrimental health effects (sunburn, accelerated ageing of the skin, skin cancer), and because of that, when calculating biologically effective solar UV irradiance, in most cases the CIE erythema action spectrum is widely used as biologic weighting function for estimation of biological activity of solar UV radiation.

However, in view of significant difference between the action spectra of CIE erythema and vitamin D synthesis the beneficial vitamin D synthetic capacity of sunlight cannot be correctly estimated from these data. At the same time to weigh the risks and benefits of sun exposure it is necessary to determine moderate exposures that provide adequate vitamin D nutrition for people but prevent skin cancer.

With due regard to the essential role of vitamin D₃ for human health we examined the possibility of use an *in vitro* model of vitamin D synthesis for simplified estimation *in situ* of provitamin D₃ photoconversion into previtamin D₃ from the UV absorption spectra similar to a number of chemical UV dosimeters as, for instance, polysulphone film, that measured an accepted UV dose by the absorbance decrease at the fixed wavelength. The large-scale linear correlation ($R=0.99$) was found on a clear summer day in Nea Michaniona (40.47N, 22.85E) between concentration of accumulated previtamin D₃ and maximum absorbance decline in the initial provitamin D₃ absorption spectrum at 282 nm. However, long-term observations in Kiev (50.38 N, 30.53 E) carried out over three years during April-September showed worse ($R = 0.77$) correlation, and a source of ambiguity of such indirect estimation of previtamin D₃ concentration is discussed in detail.

In our opinion, the difference in the latitude of Kiev (50.38 N) and Nea Michaniona (40.47 N) together with variable ozone and weather conditions has essential effect on the short wavelength edge of solar UV spectrum that is closely linked to the rate of irreversible photodegradation of previtamin D₃ causing rather large scatter in the Kiev data compared with those ones from Greece.

In addition, taking into account the widespread of natural synthesis of vitamin D in biosphere under solar UV irradiation that induces synthesis of vitamin D from its precursor, we have introduced new algorithm for direct calculation of the vitamin D effective irradiance. Based on the First Law of Photochemistry: "Light must be absorbed for photochemistry to occur" and keeping in mind that photobiological effects are initiated by photochemistry, a straightforward procedure for calculation the vitamin D synthetic capacity of sunlight has been developed using solar UV spectra as input data to the reaction model of previtamin D photosynthesis. Performed calculations demonstrate critical dependence of previtamin D₃ accumulation on stratospheric ozone, season, latitude, and cloudiness.

There are good grounds to believe that direct calculation of the vitamin D synthetic capacity of sunlight using solar spectra together with the photoreaction model is favoured over commonly used calculations based on the *in vivo* vitamin D action spectrum, especially in view of the fact that the vitamin D₃ action spectrum is based only on the work of a single laboratory unlike the erythemic response which was developed and validated in ~20 laboratories.

Comparison of experimental and simulation data conforms to recent findings on Europe's darker atmosphere in the UV-B and implicates practical certainty of presented algorithm for global mapping of biologically active (antirachitic) solar UV radiation. In our opinion, this algorithm is useful for direct estimation of the vitamin D synthetic capacity of

sunlight and provides a means for introduction of new UV 'D-index' on daily UV forecasts in addition to commonly used erythemal UV index.

Geochemistry and hydrology of a small catchment: fogs as an important part of the wet deposition

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The present paper deals with an importance of wind driven low clouds and fogs on the geochemistry and water balance of small forested watersheds situated in the mountainous headwater regions of the Czech Republic. The importance of the fog and cloud water droplet deposition in seacoast and mountaintop areas has been recognized for a long time. This portion of the wet deposition is rather ephemeral and terrible difficult to measure, but clouds and fogs was proved as an important delivery mechanism for atmospheric particles, gases, and liquid water from the near surface atmosphere onto the forest canopy. This contribution is concerned especially with advected fogs, that are wind-borne such orographic and other clouds that envelop mountain-tops. This type of fog wets vegetation (in harmony with radiation fogs) and unlike radiation fogs, because of the associated winds, can bring large amount of water and dissolved ions to the earth's surface. The main goals of the present paper are to: (i) introduce the small experimental watersheds established in the headwater regions of the Czech Republic in order to evaluate their water balance and geochemistry; (ii) evaluate the time and space variation of the fog characteristics (especially the duration and frequency of occurrence; liquid water content and horizontal visibility); (iii) assess the water and mass balance of the selected experimental catchments taking into account the input of water and matter delivered to the basin via low clouds and fogs; and (iv) describe new techniques for fog water collection, i.e. ground-level cloud water sampler designs will be introduced. Mountainous ecosystems of the headwater region in the Czech Republic are frequently immersed in wind-driven clouds and this condition is believed to lead to significant deposition of water beyond that measured by incident rain gauges. In order to study the input of water and matter from wind driven low clouds and fogs on the water balance and chemistry of mountainous forested catchments, three experimental watersheds were established: (1) the Liz basin (Sumava Mts. – southern Bohemia; 0,99 km², 828 – 1073 m a.s.l., brown podzolic soil, moldanubic crystallinum, paragneiss, prevailing type of tree: spruce aged up to 120 years); (2) the Uhlirská basin (the Jizerske hory Mts. – northern Bohemia; 1,87 km², 774 – 870 m a.s.l., brown podzolic soil, podzol, peat, Variscan igneous rocks of granite massif of the Krkonose-Jizerske hory crystalline complex, biotitic gneiss, prevailing type of tree: spruce aged up to 80 years); (3) the Modry potok basin (the Giant Mts. – north-eastern Bohemia; 2,62 km², 1010 – 1554 m a.s.l., ferrous humic podsole, brown podzolic soil, rocks of metamorphic aureole of Variscan granite pluton, mica schist, prevailing type of tree: spruce and dwarf pine 62 % and meadow 38 % of the area). These experimental catchments are situated in the main massifs of the Bohemian border mountains. They differ especially in the level of anthropogenic impacts on vegetation cover. While the Liz catchment represents a relatively healthy productive forest in a clear landscape, the Uhlirská basin is situated in a formerly heavily polluted region of the so-called "Black Triangle". The Modry potok basin in the Giant Mts. represents the original spruce forest in the lower part of the basin and the artic-alpine tundra with dwarf pine covers the upper part above the timberline. Based on the model predictions and on the water balance of the forest canopy the annual occult (deposited from low clouds and fogs) precipitation totals were estimated by the 10 % of the annual falling (rain and snow) precipitation total in the Sumava Mts., by 10 – 15 % in the Jizerske hory Mts., and even more than 20 – 25 % in the Giant Mts. An analysis of a statistical study of fog characteristics since 1960 till the time being was worked out. A fog water chemistry study carried out over the 16-years period proved high acidity of fog water and high values of

enrichment factors (that means the ratios between concentrations of chemical compounds in falling and occult precipitation). The compounds NH_4^+ , SO_4^{2-} and NO_3^- are the dominant species both in fog water and in precipitation. In order to collect cloud water samples, the active and passive sample-taking devices were constructed. Besides the collectors, as described in literature, both passive and active fog water collectors of the new design were developed and installed at the selected localities.

Characterization of natural dimension stones used in Hungarian historic constructions; a case study of the Ruin Garden in Székesfehérvár

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The example of the Ruin Garden of Székesfehérvár in Hungary was selected as a case study for this current research. That assemblage of monuments in Székesfehérvár is of a great historic importance since it served as the coronation and burial church for most of the Hungarian kings in the Middle Ages. Moreover, its several reconstructions and expansions throughout history and the presence of several lithotypes found among the remained building and decorative stones makes the research related to the materials crucial not only for the conservation of that specific monument but also for a series of other historic structures in the Hungarian territory.

A total of 65 samples were collected both from left over pieces and the existing walls and went under investigation. In order to help the study, a series of maps was created based on in-situ investigations. Several wall selections were selected and three different kinds of maps were designed for each one. The first series of maps depicts the different construction periods of the selected section of the walls. The second series of maps shows the distribution of the different lithotypes over the wall which helps both to better evaluate the use of different stone types over the different construction periods and to correlate the different stone types to the various identified weathering forms. The last series of maps represent the visible weathering forms on the building materials. As it is well represented by the selected wall sections, several types of limestones such as oolitic, travertine, bioclastic and red biomicritic ones are the most widely used lithotypes in the different construction periods of the monument. Rhyolite and granite were also widely used in some construction periods.

Several weathering forms were observed on the various lithotypes with the oolitic limestone presenting the most severe ones such as individual fissures visible by naked eye, detachment of grains, multiple scaling, black and white crusts and detachment of black crust. The red limestone appears to be the most durable one among the different types of limestones. Only minor alterations were observed on these blocks such as decolourization of the surface and a few cracks.

The new maps have proven to be very useful also for the further identification of the site such as the documentation of the in-situ measured results (e.g. moisture content, rebound values measured by Schmidt hammer, drilling resistance) and their ensuing interpretation in relation with the existing climatic conditions.

As a further step for understanding the behaviour of the three most relevant materials, additional samples were taken from local quarries with similar physical and mineralogical characteristics: a medium-grained and a coarse-grained oolitic limestone from Sósút and a red compact limestone from Tardos, Hungary. Both historic and freshly quarried stones were submitted to a series of physical and mechanical tests in order to identify the materials properties and behaviour such as their pores volume and structure, ultrasonic velocity, uniaxial compressive strength, dynamic modulus of elasticity and resistance to frost damage.

The interdisciplinary study of the results confirms that stones in the monument show deterioration in terms of mineralogy, fabric and physical properties in comparison with quarried stones. Moreover stone-testing proves compatibility between quarried and historic stones. Good correlation is observed between the non-destructive-techniques and laboratory tests results which allow us to minimize sampling and assessing the condition of the materials. Concluding, this research can contribute to the diagnostic knowledge for further studies that are needed in order to evaluate the effect of recent and future protective measures.

Mammalian remains from a new site near the classical locality of Pikermi (Attica, Greece)

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We present the first results on the fossil mammalian fauna recovered during the first excavation season at the new site Pikermi Valley-1 (PV1). The fauna comprises two hipparionine species (*C. cf. mediterraneum*, *H. cf. brachypus*), a giraffid (*Bohlinia cf. attica*), five bovids (*Palaeoreas lindermayeri*, *Protragelaphus skouzesi*, *Tragoportax cf. amalthea*, *Gazella* sp., Bovidae indet.) and two carnivores (? *Adcrocuta eximia*, Felidae indet.). The composition of the fauna suggests a Turolian age.

Thermal behavior of freshwater cultured pearls

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The 95% of the pearls present in the gem market are freshwater cultured pearls in *Hyriopsis* ssp. Heating is frequently applied to off-colored pearls for their color enhancement. The understanding of the thermal behavior of pearls, would be useful to separate the natural colored from the treat-colored (after heating) pearls. This study presents analysis of the mineral structure and the organic matrix as well as the thermal behavior of *Hyriopsis* ssp. cultured pearls.

The studied samples were white freshwater cultured pearls in *Hyriopsis* ssp. which were analyzed with the X-ray powder diffraction (XRPD) and the Fourier transform infrared spectroscopy (FTIR) methods. In the XRPD patterns of all samples only calcium carbonate was identified with the structure of aragonite. The FTIR transmittance spectra of the powdered samples, using the KBr technique, show the characteristic absorption peaks of aragonite. However, some additional shoulders, at about 1662, 1270 and 1172 cm⁻¹, were observed probably due to the organic matter of the pearls. Furthermore, the broad bands in the region between 3600 and 3200 cm⁻¹ are probably attributed to the water content of the pearls. After heating at “low” temperatures (up to 250 °C), changes were observed only in the FTIR peaks related to the organic matter and the water. No changes on XRPD patterns were observed.

This preliminary study indicates that heat-treatment of the pearls up to 250 °C, changes only the bands of organic matter and water in the FTIR spectra. With a followed heat treatment, especially of the whole pearls, the critical temperature of their color changes can be

found and linked with the decomposition of the organic matter and/or pearls dehydration. Additional studies with non-destructive methods, by which the above changes could be observed (e.g. Raman spectroscopy), will be performed in order a method applicable in gemological laboratories to be found.

The latest paleogeographical realities of the Pannonian Basin in the late Quaternary: the relict Pannonian Lake, its successor and the finalization of the Danube way in the Upper Holocene

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The new studies on the southeastern part of the Pannonian Depression confirm our idea concerning the existence in this basin of a lake with its shores around +100 m in the Uppermost Pleistocene (the Relict Pannonian Lake, Belgrade – 2006). A morphologic peculiarity placed in the Cazanele Mici area seems to have been permitted the maintaining of the shores for some time at this elevation. The Relict Pannonian Lake could be the direct successor of the Middle Pleistocene Lake made evident as a paleogeographical reality by the Serbian scientists in the southeastern part of the Pannonian Basin. The severe restriction of the surface of this lake has taken place at the beginning of the Holocene, as a result of the mega-floods, which mark the boundary between the Pleistocene and the Holocene. Therefore, a successor of the Relict Pannonian Lake seems to have maintained for some time in the Lower Holocene with its shore around the +85 m elevation. This perspective confirms the idea of some geomorphology researchers, which accepted a gradual retirement of the Pannonian Lake in Quaternary, associated with a succession of shorelines. In this case, the finalization of the stream system of the Danube, as a unitary river, has very recently happened (in Upper Holocene). In addition a possible connection between a stream system tributary to the Black Sea and another one tributary to the Pannonian area along the actual Danube Gorge could be realized only in the Greben zone (most probably during the Pasadenian phase). The existence of the Relict Pannonian Lake at the end of the Upper Pleistocene seems to be confirmed by the altitude of the all pre-historical sites in the Pannonian area. In addition, important data of mythical paleogeography are consistent with all these possible paleogeographical realities of the Pannonian area.

Zircon typology and preliminary mineral chemical and isotopic investigations on basaltic gem stone zircons from eastern Saxony, Germany

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Basaltic zircons are known in eastern Saxony (Germany) from the Elbsandsteingebirge for a long time. Furthermore, there are some new localities described from the Upper Lusatia (Hofeberg quarry) and the Zittauer Gebirge (Lausche hill). The zircons derived from alkaline basalts. The Hofeberg locality in the south of the Görlitz town could provide evidence for *in situ* discoveries. Both of the other occurrences exist as placers.

The zircon crystals have a mean size from 0.5 up to 4 mm (min. 0.2 to max. 9 mm) and show a gem stone quality. Many crystals are broken and/or intensive rounded. The rounding is the result of a magmatic corrosion in the basaltic transporter rock. This is an argument against the genesis of these zircon megacrystals in the basaltic melt. The broken crystals (splinters) are probably the result of the fast cooling during the basaltic eruption.

The origin and the genesis of these zircon megacrystals in alkaline basalts are currently unknown and controversial. Recent research favour one of the following two models: a cogenetic and a non cogenetic origin. Therefore, investigations about the mineral chemistry and isotopy from these basaltic zircons may supply important information about melt processes in the Earth mantle and about processes of magma differentiation and mixing.

In a first step we have investigated the zircon typology from the above-named three localities in eastern Saxony. We can observe two respectively three subpopulations: the first are S- and J types with predominant 100-prisma and blunt-angled 101-dypiramid in crystal form. The same crystal types were observed by phonolite zircons from the Zittauer Gebirge what indicates a petrogenetic relationship between this basaltic zircon subpopulation and the phonolitic melt and therefore a cogenetic origin. The second subpopulation only observed at the Lausche locality is composed by D- and P5-types with exclusive 110-prisma and blunt-angled 101-dipyramid. The prism is very small and is missing sometimes, so that only double-pyramids exist. The third subpopulation is with 1% to 5% rare, but at the Hofeberg locality very common with 43% from all zircon-typological investigated crystals. Only these crystals are mostly non-transparent. They are G1-, P1- and P2-types with 110-prism and blunt-angled 101-dypiramid.

The last crystal type represents typical granitic zircons, but there is evidence for an alkaline origin e.g. from syenitic, phonolitic or trachytic rocks by mineral chemistry and mineral inclusions. Following zircon typology and mineral chemistry zircons from the first subpopulation indicate also an alkaline origin, but the melt was some different to the first one. Preliminary *in situ* Hf-isotopic analyses of zircons from the first subpopulation show an origin from the lithospheric mantle.

Tectono- sedimentary evolution of the Eocene transgressive deposits in the SW Turkey: an overview

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Western Anatolia is characterized by N-S and NE-SW oriented extensional neotectonic regime and with E-W, NE and NW-trending depression fields. The Aegean region has been subjected to active N-S extensional tectonics, under the control of the westward movement of the Anatolia plate bounded by the North Anatolian and East Anatolian faults. Tectonic evolution stages of SW Turkey can be divided into four main periods (from latest Cretaceous to the late Miocene). These are in ascending order; (1) Closure of the Pamphylian basin and emplacement of Antalya nappes (during the latest Cretaceous and the Paleocene), (2) Emplacement of Lycian nappes (end of Eocene-Early Oligocene), (3) Forming of the Oligocene molasse basins, (4) Opening of the Baklan and Acıgöl grabens (late Miocene) under the NW-SE and N-S extensional regimes of which has developed simultaneously. The Middle-Upper Eocene sedimentary sequence in Acıgöl (Başçeşme formation), Burdur (Varsakyayla formation) and Isparta (Kayıköy formation) basins (SW Turkey) have commenced with conglomerates and coarse grained sandstones and change to the shale dominated turbidites and limestone interbeds in the upper most part. Generally, the amount of fauna fossils and calcium carbonate content increase upward from the conglomerate to the limestone. The main sedimentary structures of the coarse conglomerate and sandstone constituents in the lower most part of the Eocene sequence indicate the terrestrial (alluvial fan) and transitional (tidal flat) environments. Further more thin bedded sandstone- mudstone alternations point out marine facies (flysch facies) through the eastern part of study area (Isparta region). As a result of this study, it can be mention that palaeoenvironmental changes associated with sea level fluctuation depend on the transgression and tectonic activity.

Using of GPR method for examination of post-glacial deposits in the alp of Ornak (the Tatra Mountains)

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The aim of the study presented in the paper was the assessment of Quaternary glacial sediments thickness in the Western Tatra using the Ground Penetrating Radar (GPR). The experimental measurements were carried out on the alp of Ornak. The incentive for undertaking GPR measurements in this region were the results of practically first laboratory investigation of glacial sediments in this area, obtained from three boreholes executed on the alp of Ornak, described by Kenig and Lindner. The results of Kenig and Lindner indicate that the depth of the investigated deposits is highly variable. The depth of the glacial sediments in three different boreholes varied from 2 to almost 8 m. They reported that in the upper part of Koscieliska Valley three separate layers of moraine deposits, separated by sediments of various fractions appeared. The bottom part consists mainly of coarse and middle-grained gravel fraction, containing crystalline rocks, a small proportion of sand fraction, and a few percent of loamy fraction. We expected that our preliminary GPR studies to the depth of 20 m would permit to assess whether with this method the results obtained in few points in boreholes could be extended on the whole alp of Ornak, and possibly on the whole Tatra mountains.

GPR surveys were conducted along three profiles, which were designed in the central part of the alp of Ornak. Measurements, in the mode of constant-offset reflection profiling, were carried out using RAMAC/GPR georadar system from MALA Geoscience. Results of measurements with GPR method depend mainly on contrasts between dielectric constants ϵ_r [-] of different geological media. A qualitative measure of the ability of boundary between layers of rocks to be registered by GPR is the reflection coefficient. It tells us what fraction of GPR electromagnetic signal is reflected from boundary between two layers with different complex dielectric constant. When the contrast is sufficient, the reflexes from boundary can be recorded in radargrams. Crystal basement (Tatra granite) has a small porosity and therefore should have a lower dielectric constant. Different electrical properties of crystal basement and sediments should make the boundary between them a good reflector and should form a well visible boundary. It seemed that the GPR method could be useful for investigation the boundary between crystal basement and Quaternary deposits.

Quite different problem is the depth penetration of GPR waves. When the electrical conductivity and frequency increase, the attenuation coefficient increases too, and the vertical range of penetration decreases. Therefore, the GPR measurements were conducted in this site after long time without precipitation, which allowed to record reflexes from considerable depths, even though geological medium in this site was build of till. Taking into account information mentioned above the GPR measurements were made with relatively low frequency (50 MHz) which permits for deep penetration.

A point that should be mentioned is, however, that Kenig and Lindner report the depths of the boreholes, but do not state that they completely penetrated the Quaternary sediments and reached the rocky bottom. In this situation our preliminary GPR measurements were carried out to confirm hypothesis presented by Kenig and Linder. Preliminary results of borehole measurements and 2D GPR surveys seem to be promising. However, for quantative interpretation 3D GPR measurements and additional boreholes are needed.

Late glacial vegetation and palaeoenvironment in the northwestern Rila Mountains, Bulgaria: the pollen record of Lake Ribno

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Pollen analysis was conducted on the lateglacial section (200 cm) of a core retrieved from the glacial Lake Ribno (2184 m a.s.l.) situated in the cirque of the Seven Lakes in the northwestern Rila Mountains. The palynological data supported by a series of AMS radiocarbon dates from bulk sediment allowed reconstruction of the vegetation dynamics and palaeoenvironmental conditions at high altitudes during the Lateglacial period. The vegetation and climate changes established were bound to a detailed chronological framework for the time interval 16500–11500 cal. yrs. BP. Around 17000-16000 years ago the landscape in the study area was dominated by mountain steppe vegetation composed of *Artemisia*, *Chenopodiaceae*, *Poaceae* species and other cold-resistant herbs. Scattered stands of *Pinus* and *Juniperus-Ephedra* sbrubland were also found. This vegetation pattern was determined by the harsh climatic conditions. An important result was the delimitation of an interstadial/stadial cycle, analogous with the Bølling/Allerød–Younger Dryas from Western Europe, which correlated well with the global data from Greenland ice cores. From a biostratigraphical point of view the improvement of the climate after 15000 cal. yrs. BP in the Rila Mountains during the Bølling/Allerød interstadial (15000-12800 cal. yrs. BP) was characterized by a rise in the quantity of tree pollen from *Pinus*, *Pinus peuce*, *Betula*, *Alnus* and *Juniperus*. Meanwhile the herb vegetation partly retreated confirmed by the decline of *Artemisia* and *Chenopodiaceae* pollen values. At lower altitudes deciduous trees such as *Quercus*, *Corylus*, *Carpinus betulus*, *Tilia* started to spread from their refugial places. The first appearance of *Picea*, *Abies* and *Fagus* was also recorded. During the Younger Dryas stadial (12800-11500 cal. yrs. BP) a final revert of the glacial conditions in the mountain has occurred clearly documented by the re-advance of the mountain-steppe herb vegetation and the retreat of trees downslope. The local radiocarbon chronology indicated precisely the termination of the Lateglacial and the onset of the Holocene period. The new palynological and radiocarbon data obtained from the lateglacial sediments of Lake Ribno were also compared with the information from two other glacial lakes Trilistnika and Sedmo Rilsko located in the same cirque above and below the study site, respectively, and a good conformity of the results was established. In addition, the correlation of the palynological data with the available geomorphological evidence, the reconstruction of the respective snowline and precipitation anomalies during the Last Glacial Maximum and the Lateglacial in the Rila Mountains confirmed that the three lakes studied have become free of ice before 16500 cal. yrs. BP when accumulation of grey silt, poor in organic content, and not suitable for radiocarbon dating has started.

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Composition of dust and the formation of black weathering crusts in Hungary and Germany

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Dust has a significant contribution to the formation of black weathering crusts. Various limestone buildings showing black soiling were studied in Germany and in Hungary. Dust, crust and limestone samples were collected and analysed to understand the contribution of dust to black crust formation. Test methods included microscopic and SEM analyses and detection of mineralogical composition by using XRD. Since some elements and organic carbon act as catalyst for crust formation trace element distribution (LA-ICPMS) and organic carbon content were also detected.

According to analyses gypsum is the main secondary mineral of limestone weathering crusts both in rural and urban areas, although there are different concentrations detected in Germany and Hungary. Siliceous and carbonaceous fly-ash particles were found in both countries with the prevalence of the former one. Lead mostly accumulates in dust, but also common in the black crust. Surprising high concentrations were found at the crust/limestone boundary in the samples of Budapest and Cologne city centre. The dust composition reflects the setting but does not necessarily a good indicator of the environmental conditions.

Constructional problems at interventions into slaty sedimentary rocks in Slovenia in terms of fabric and composition

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In Slovenia, several open excavations and tunnels have been constructed in tectonically weakly metamorphosed shaly, silty to sandy sedimentary rock formations of Carboniferous age. During a typical process of excavation rocks are subjected to changes in stress direction, which can result in different types of failure. To a large extent, these failures depend on the direction of loading in relation to the most pronounced types of discontinuities. During design stage of road structures in Slovenia, however, incomparably greater attention is paid to the relevant laboratory geomechanical factors than to the effect of the textural-structural and mineralogical properties of the rocks. It is only in recent years that some attention has been paid to the research into the connection between the textural-structural and mineralogical properties of slates and clay-containing rocks and their weak geomechanical behaviour. Nevertheless, these researches are not taken into serious consideration yet. In order to determine more accurately the type of relationship between the petrographic characteristics of these rocks and their resistance to the point load, a series of petrographical analyses and corresponding point load strength index tests were performed. Samples were taken from trial boreholes and at excavation sites of the rock mass for the tunnels of the Ljubljana area as well as from the wider area of earthworks for the Ljubljana - Celje motorway in central Slovenia. The investigated rocks have mud to sand grain size. From the structural point of view, they exhibit clear dynamo-metamorphic changes. They are manifested with the occurrence of folds, crenulations, strong secondary foliation s_1 , differential cleavage and fracture porosity. In contrast to primary foliation s_0 , where the grains are intergrown, secondary foliation s_1 is smooth, and only insignificant intergrowing of the grains can be observed. At the micro level these deformations are expressed as recrystallization (mainly degradational), new growth,

pressure shadows, kinking of the phyllosilicates, and mechanical reorientation of the mineral components along s_1 . Preferred orientation of the phyllosilicates and slaty cleavage (s_1) have developed, and represent one of the most pronounced structures along which the rock prefers to split. It was shown that in all cases a good correlation exists between the average point load strength index of the rock samples, the direction of loading, and the petrographic/fabric type in the samples without pre-failed surfaces. Failures in the slate and metasiltstone follow concentrations of preferred oriented phyllosilicates of the s_1 slaty cleavage in the first place. Other parameters (e.g. average grain size, granoblastic texture, quantity of quartz etc.) are of secondary importance and find principal expression in homogeneous rocks and in cases when they were loaded transversely to the main discontinuity. In the pre-failed rocks, the direction of loading played the major role. The relevance of the above stated facts is clearly manifested in the field of geotechnical works where their disregard led to landslides on the surface and to several mass collapses in tunnel works. The predominant direction of failure in-situ additionally depends on the geological macrostructure, and on the direction of intervention into the rock. Determination of the fabric and compositional properties of such rocks is a key factor for the identification of the weakest directions and for the appropriate and timely adaption of method and direction of excavation.

Mineralogical and microstructure characterization of a Neogene natural building limestone from Western Crete, Greece

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Natural building stones are being used in Crete for ages to build masonry structures because of being abundant, relatively easy to cut and shape and good performance in many applications. In Crete the largest comprehensive occurrences of Neogene sediments are found along the north-western coast (provinces of Chania and Rethymon), in the Heraklion depression and in the Sitia district, Eastern Crete. Several quarries for the extraction of Neogene limestone, being used as building and decorative natural stone, are located in Western Crete country. Despite their great variety, relatively few types of stone are suitable for construction materials. In addition to accessibility and ease of quarrying, the stone must satisfy requirements of strength, hardness, porosity, durability and appearance. Mineralogy and microstructure greatly influences engineering properties like permeability, strength and durability. The present study summarizes the results of a primary investigation of a Neogene fossiliferous fluvio - lacustrine - brackish - shallow marine marly limestone, cropping out thirty km east of Chania, Crete. The combination of macroscopic rock description, mineralogical, chemical and microstructure analyses were used, in order to characterize the natural stones regarding their colour, lithology, microfacies, sedimentary structure and fabric.

The natural stone is macroscopically described as an unweathered white-yellow to white-grey homogenous compact limestone rock. The mineral composition was investigated by using X-ray diffraction (XRD) analysis. The main minerals present are calcite and quartz, whereas clays, micas and feldspars are present in minor amounts. The chemical composition was determined by wet chemical analyses. The results, illustrate that the composition of the major elements is in general monotonous with typical high contents of CaO (40 % wt.) and SiO₂ (17% wt.), followed by Al₂O₃ (5% wt.). In order to enhance the microscopic analysis of the rock fabric and to observe weathering phenomena, special treatment of the raw samples has been used before the preparation of thin sections. This consists of pore and microcrack staining by a mixture of epoxy resin and fluorescent dye. The prepared thin sections were then observed through a conventional optical microscope (Leica DMLP type), equipped also with a source of UV light. Microscopic investigations showed that, the Neogene formation consists of fossiliferous micrite marly limestones, which appear as moderately-sorted, fine

grained packstones, rich in foraminifera, echinoderms, calcareous as well as siliceous sponge spicules and other bioclasts. Some quartz crystals are well observed. Cavities and chambers in some fossils are filled with relatively coarse-grained mosaics of authigenic sparry calcite. Fabric-selective porosity is controlled by primary depositional fabrics that include interparticle and intraparticle pores. A system of secondary pores, developed independently of texture or fabric (channel porosity) is also observed.

Detailed porosimetric analysis has been conducted using mercury intrusion technique. Through this measurement, pore radii, pore size distribution, pore volume and pore surface area can be evaluated. Porosity in all studied samples is high (29-30 vol. %), the specific surface area of meso-macro-and coarse pores (range of measured pore radii where from 3 nm to 58 μm) varies between 14.04-14.17 m^2/g and the volume of all pore size categories ranges from 160.71-163.43 mm^3/g . Also values of specific surface area and volume of mesopores (2-50 nm), macropores (50-7.500 nm) and coarse pores (over 7.500 nm) were measured respectively. Mineralogy, chemistry, thin section criteria, together with porosity and microstructure characterization, allow these natural building limestones to be used as compatible replacement materials in reconstruction works of certain buildings (monumental and other), that have been previously built with similar natural stones.

Early Pliocene deposits in Kephallonia (Ionian Islands): Biostratigraphy and paleoenvironmental-paleoclimatic implications

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The island of Kephallonia is located in the eastern part of the Ionian Sea, off the shores of Western continental Greece. The Paxos geotectonic unit comprises the largest part of the island, while in the eastern part outcrop the Ionian unit sediments. The studied marly limestones and marls in Livadi (approx. 30 m thick) are located on the northeastern part of Paliki peninsula, north of the city of Lixouri. Katelios section (approx. 70 m thick) located at the southeastern coast of the island, consists of marls alternating with sandy layers and marly limestones. The exposed sediments at Livadi represent part of the latest synorogenic deposits of Paxos unit, corresponding to the Trubi limestones above the Messinian evaporites. Katelios sequence is located immediately below the Ionian thrust on Kephallonia Island and could comprise the continuation of the Livadi sequence. Micropaleontological analyses (calcareous nannofossils, dinoflagellates and foraminifera) have been performed on both studied outcrops in order to determine their age and investigate the paleoenvironmental and paleoclimatic depositional conditions.

Calcareous nannofossil biostratigraphy revealed a number of bioevents establishing the chronostratigraphic correlations of the studied deposits. In the sediments of Livadi section, the presence of *Sphenolithus* spp. (abundance >5%), several discoasterid species (*Discoaster brouweri*, *D. pentaradiatus*, *D. surculus*, *D. intercalaris*, *D. variabilis*) and abundant planktonic foraminiferal species *Sphaeroidinellopsis* spp. along with the moderate presence of *Amaurolithus* spp. and *Reticulofenestra pseudoumbilicus* (abundance 1-2%) documents the biostratigraphic correlation with the nannofossil biozone NN12. Livadi outcrops are more precisely assigned within the *Sphaeroidinellopsis* Acme Zone, just below the Paracme Zone of *R. pseudoumbilicus*. Therefore they are of Early Zanclean age, ranging between 5.30-5.21 Ma. The sequence of Katelios section is featured by the dominance of *R. pseudoumbilicus* (abundance >20%), the presence of *Pseudoemiliana lacunosa* and *Discoaster asymmetricus*, *D. pentaradiatus*, *D. surculus*, that enable the biostratigraphic assignment within the NN14-15 nannofossil biozone (4.12-3.839 Ma) during the Late Zanclean.

The dynamics of calcareous planktonic and benthic communities are of paramount significance in estimating the palaeoenvironmental conditions because they quickly respond to oceanographic changes (primary production, water stratification, temperature, salinity, etc.).

Warm surface water conditions in a pelagic environment are assumed for the interval just above the Miocene-Pliocene boundary (uppermost synorogenic sediments of Paxos unit,

Livadi section), as documented by the nannofossil assemblages and the well developed planktonic microfauna. In particular the presence of discoasterids, *Rhabdosphaera* spp., *Sphenolithus* spp., *Scyphosphaera* spp., *Amaurolithus* spp., *R. pseudoumbilicus*, *Sphaeroidinellopsis* spp. and the calcareous dinoflagellate *Thoracosphaera heimi* is indicative of warm subtropical conditions. Relatively increased productivity is implied by the presence of *Helicosphaera* spp., which is known to preferentially high productivity waters in the middle photic zone. In this study, the genus *Helicosphaera* is represented mainly by *H. carteri*, a species with preference in warm waters and moderately elevated nutrient levels.

The Late Zanclean deposits of Katelios section are associated with a shallow depositional environment marked by the presence of abundant benthic foraminifera. The nannofossil assemblages indicate warm-temperate and high-productivity conditions due to the abundance of *R. pseudoumbilicus*. Additionally the dominating discoasterid species (abundance >5%) *D. pentaradiatus*, *D. asymmetricus*, *D. brouweri* favour warm and more productive intervals, in contrast to rare *D. variabilis* and *D. surculus* which are mostly associated with colder conditions.

Vrancea and Hindu Kush areas of mantle earthquakes: Comparative tectonic analysis

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The Late Cenozoic tectonics in the Eastern Carpathians and the Pamir-Hindu Kush region are compared to ascertain structural position and origin of strong mantle earthquakes in the Vrancea and Hindu Kush megasources. Intensive Oligocene–Quaternary deformation took place in the Pamir-Hindu Kush region. Under compressive regime, large upper crust blocks were detached and displaced up to several hundred kilometers. Relics of the oceanic crust of the Precambrian, Hercynian Paleo-Tethys and Early Meso-Tethys were overthrust by the upper crust blocks and subsided to the depth of 40–70 km, where they were metamorphosed into higher density metabasites of the granulite-eclogite type. In the Pliocene–Quaternary, the region was quickly elevated, mainly because of decrease of density of the upper mantle. As a result, the detached dense metabasite slab began to move down to the depths of 270–300 km. The same processes took place in the Vrancea area. The basic rocks of the Inner Carpathian zones were moved and underthrust the Moesian Platform with simultaneous overthrusting by the Outer Carpathian zone. Under the load of the Outer zone nappes and the Focsani basin sediments, the basic rocks were metamorphosed into the dense metabasite slab. After decrease of the upper mantle density because of asthenospheric convection beneath the Carpathians, the slab began to move downwards. Destruction of the moving slabs produced the mantle earthquakes.

Brittle tectonic events in the western boundary of the East Serbian Carpatho-Balkanides: preliminary results based on structural and paleostress analyses in the Gornjak area

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The Carpatho-Balkanides in the East Serbia are composed of multiple longitudinal tectonic zones characterised by various stratigraphic/lithofacial differences and very complex structural or tectonic compositions. In this paper we analyse and discuss a relatively small amount of collected data and present determination of paleostress tensors in the Gornjak area.

These are preliminary results that are going to be further documented and reinterpreted by data collected in three more cross-sections in the areas of Ravanica, Kučevo and Despotovac.

The Gornjak area represents Serbian part of the larger Saska-Gornjak unit that is considered a part of the Getic nappe. It is mostly composed of Triassic and Jurassic limestone which provide abundant evidence of Alpine ductile and brittle deformation stages. Kilometer-scale folds have uniform geometry trending from north to south, which provide general trends of tectonics shortening during the oldest deformation stage. Ductile tectonic event in the Gornjak unit predominantly produced gentle to mostly open cylindrical and planar folds. Upright linear folds have almost gently plunged axis towards the N and NW.

Well developed fault planes, often with multiple striations were observed and later statistically analysed by direct inversion method, and to a lesser extent by NDA method (where applicable). The paleostress analysis is based on high quality data of 175 faults and striation datasets and they were processed in specialized software - Tectronics FP. Relative ages of these events were mainly indicated by superimposing fault surface kinematics indicators.

According to preliminary analysis, four main brittle deformation phases, composed of six unique kinematics events were determined. The oldest kinematic event (D_1) indicates predominant NW-SE compression. The shape of stress ellipsoid, orientation of σ_1 , σ_2 , σ_3 axes (sub-vertical σ_3 axes) and stress ratio $R=0.9$ suggest a stress regime close to radial compression. This stress regime resulted with formation of ductile structures with axes dipping gently to N-NE. The continuation of this tectonic phase in brittle deformation conditions caused mostly reverse movements along NE-SW to ENE-WSW fault systems. During the same tectonic phase, this compressional kinematics was followed by strike-slip kinematic events. The stress ellipsoid ratio indicates increasing intensity difference acting along maximal and medium stress directions. This change caused a transition from almost radial compression to strike-slip tension. During this tectonic phase NNW-SSE to NNE-SSW sinistral faults were activated. During D_2 phase an E-W compression was exerted. A stress ratio of $R=0.3$ implies a pure strike-slip regime. It probably resulted in activation of dextral movements along ENE-WSW to ESE-WNW striking fault systems. The D_3 tectonic phase started with pure strike-slip events having a NE-SW oriented maximal compression axis. This kinematic act gave rise to a NE-SW striking fault system. Initially sinistral-normal oblique-slip movements were slightly changed resulting in pure sinistral strike-slip movements along the same fault system. Changes of magnitude in minimal (σ_3) and medium (σ_2) main stress directions while retaining the maximal (σ_1) compression direction caused a change in stress regime to pure compression. The D_4 tectonic phase comprises of single kinematic event with maximal compression in N-S direction. Stress ratio and main stress axes orientations indicate a pure strike-slip regime resulting with activation of predominantly dextral movement along NNW-SSE to ENE-WSW striking fault systems.

Probabilities of earthquake occurrence in the Corinth Gulf and its vicinity inferred from combined information

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Earthquakes hazard probabilities were performed for the broader area of the gulf of Corinth. Related parameters, characteristic of the seismic history of the examined area, were obtained. The probabilities of strong and catastrophic earthquakes with magnitudes $M_w \geq 5.5$ and $M_w \geq 6.0$, within 20- and 50- year period were also determined. For this purpose the whole area is divided in cells $0.2^\circ \times 0.1^\circ$. The obtained results show that there is a very dangerous zone (high probabilities), which starts from the city of Patras and ends to the gulf of Itea, where the estimated probabilities are either very high or high. The highest values observed in cell 39, where for 20-years period and for $M_w \geq 5.5$ the probability is 77%, while for the same

time period and for $M_w \geq 6.0$ the probability is 42%. Moreover for the time period of 50-years and for the corresponding magnitudes the probabilities are 97% and 74%, respectively.

Earthquakes - Volcanoes (Causes and Forecast)

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The earthquakes are caused by large quantities of liquids (e.g. H_2O , H_2S , SO_2 , ect.) moving through lithosphere and pyrosphere (MOHO discontinuity) till they meet ledges (mountain roots or sinking lithospheric plate fronts). West of the ledges the pressure is great due to the differential movement of the crust and the pyrosphere, while east of the ledges sub-pressure prevails. The liquids are moved from West Eastward carried away by the pyrosphere because of differential speed of rotation of the pyrosphere by the lithosphere. With the concentration of liquids on the western side of a ledge, the pyrosphere is displaced and the liquids occupy this space up to its full capacity and then they reach the lowest part of the ledge. That is when their escape to the east begins. Because of the sub-pressure on the eastern side of the ledge, the movement of these liquids is accelerated, they vaporize and in the form of an explosion their whole mass passes through to the east of the ledge (BERNOULLI Principle). Several phenomena are caused at the moment of their escape such as powerful sound wave, the gasses are overheated because of the internal frictions and they are ionized, resulting to the creation of a powerful electric field that causes flashes in the atmosphere (discharges) over the specific area, sub-pressure in the area west of the ledge. The area where the aforementioned components were before is now occupied by a violent liquid mass of pyrosphere, which tends to follow the flow of the gasses. However, because it has a highest viscosity than them, it hits the ledge and causes the earthquake, cracks in the lithosphere and damages to the surface, mostly to the east of the epicenter. The power of an earthquake depends on the quantity of fluids, the capacity and the angle of the ledge. In case the earthquake takes place underneath the oceanic crust, the energy from the collision of the pyrosphere on the crust is conveyed to the sea water, causing the displacement of large bodies of water (TSUNAMI). In several cases, when a large quantity of fluids is concentrated west of a ledge, a few hours before the big earthquake small quantities of fluids escape causing small tremors (Foreshocks). When a powerful earthquake takes place west of a negative ledge (mountain root or lithospheric sinking front), this ledge partially breaks and many other small ledges are created, with angles that allow any quantity of fluid components that pass underneath them to cause a number of smaller earthquakes, due to their smaller capacity than the previous ledge (Aftershocks). With starting point an earthquake which was noticed at an area and from statistical studies, we know when, where and what rate an earthquake may be, which earthquake is caused by the same quantity of liquids, at the next east region. The forecast of an earthquake ceases to be valid if these components meet a crack in the lithosphere (e.g. limits of lithosphere plates) or a volcano crater. In this case the liquids come out into the atmosphere by the form of gasses carrying small quantities of lava with them (volcano explosion). In order to determine the epicenter, we use the most reliable preceding phenomenon, which is the rise of the crust's temperature that is spotted with a cone, its top being the hypocenter and its base center being the epicenter of the expected earthquake. Using a network of thermometers, we monitor the rise of temperature, which is easily detectable in the underground waters, especially a few days before the manifestation of an earthquake. Therefore we know precisely where a large quantity of fluids is trapped, the escape of which to the east will cause an earthquake. The combination of these two methods allows us to foresee an earthquake accurately. When a big earthquake takes place in an area, a part of the ledge breaks off and its angle is dulled, thus within a short period of time no other equal or bigger earthquake takes place in this area. The time necessary to restore this ledge (either by coagulation or by tectonic plate sinking, is statistically estimated. In certain places the oceanic crust is particularly thin and has many cavities. This is due mainly to the constant ruptures of the lithosphere, e.g. in the area of the "Bermuda triangle". When a big quantity of fluids is found under such a cavity, the phenomena described above take place. In this case however

no earthquake takes place, because the fluids and gasses escape to the east and a sub-pressure is created in this space, and at the same time the crust is thin and the pressure the overlying oceanic water exerts on it is big, so the crust breaks and the space the pyrosphere would occupy causing an earthquake, is now occupied by water. Over this area, we notice a momentary drop of the water level, a sub-pressure in the atmosphere and descending air currents. Also, the contact of water with the exposed pyrosphere causes some of it to vaporize and a thick fog is formed locally. The time span of these phenomena is small, because the contact of the water with the pyrosphere causes the crack of the crust to reconnect quickly and calmness is restored.

Spatial and temporal variations in the geochemistry of suspended particulate matter in the shallow deltaic embayment of Northern Thermaikos Gulf, Greece

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The chemical composition of Suspended Particulate Matter (SPM) in the northern Thermaikos Gulf was studied during a six month experiment, carried out from June 2004 to November 2004. Water samples were collected from three different depths (1 m below sea-surface, 10 m depth, 2 m above sea-bottom) and filtered to obtain SPM elemental and Particulate Organic Carbon (POC) concentrations. The geochemical properties of SPM were determined by thin-film X-ray Fluorescence spectrometry.

SPM and POC concentrations exhibited strong spatial and temporal variations, related to the different environmental characteristics such as river discharge, wind/wave-induced resuspension of bottom sediment, biological productivity and anthropogenic interference.

Correlation analysis showed that the elements Al, Si, Fe, Ti, K, Mg, V and Ba, have terrigenous origin, i.e. detrital aluminosilicates minerals. Chromium, Ni and Co are of natural origin; they are derived from Axios and Aliakmon watersheds as mafic and ultramafic detrital material. Sulphur, Zn and Cu are derived from partly treated domestic and industrial effluents. The vertical distribution of POC implies higher biological activity at the upper layer of the water column. A part of Ca represents the autochthonous biogenic fraction i.e. biogenic carbonates. Phosphorus is mainly in the form of organic phosphate.

Synthesizing carbonates with added value for industrial use from the former industrial waste applying methodology of CO₂ mineral sequestration

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The sequestration (liquidation) of CO₂ is defined as catching, deposition and storing of CO₂. Industrial CO₂ can be deposited in the exhausted oil and gas deposits, in unexploitable coal seams or in the aquifers. Different methodology is represented by the binding of CO₂ in minerals (rocks) by the methodology of mineral sequestration (carbonatization). The first group of methods is accompanied with the risks of CO₂ deliberation during transport and deposition of CO₂. Moreover, the storage sites must be located away of the seismo-active zones and expensive monitoring is necessary during hundreds of years.

Some industrial wastes (e.g. fly ashes, slags) contain modified minerals or substances able to react with CO₂ with resulting its solid bonds in the lattice of newly formed carbon minerals - carbonates.

The main advantage of mineral sequestration of CO₂ by the carbonatization is the safe and fast (lasting only several hours) liquidation of gaseous CO₂, resulting in the origin of synthetic carbonates. They have no negative impact on the living environment, and, moreover, they can be used in industrial production.

Our pilot laboratory tests of CO₂ sequestration using laboratory high-pressure reactor were done on the samples of the fly ash and slags after the brown coal combustion and the crushed ultramafics (serpentine) after the exploitation of chrysotile asbestos.

The X-ray analyses revealed in the primary samples of the fly ash and slags 92-100 % of the amorphous phase without the presence of carbonates. The serpentine samples contained nearly 90 % of serpentine minerals, only with subsidiary content of calcite. During the reaction of mechanically (fly ash, slags), resp. thermally (crushed ultramafics) activated compounds of the waste with gaseous CO₂ at precisely determined P-T conditions (0.1-0.9 MPa, 20-200 °C), the new mineral phases – acid carbonates and carbonates have precipitated in the relatively short time (2-22 hours) after carbonatization, filtration and following drying with crystallization.

The X-ray analyses confirmed the high quality of newly formed mineral phases – precipitated calcium carbonate (ca 100 % CaCO₃) with the calcite and aragonite minerals in the ratio 9:1, originating from the sample of fly ash, resp. 3:2 in the case of the sample of slags. The CO₂ sequestration using serpentine has produced the high purity nesquehonite (97 %), resp. hydromagnesite (96 %). The new products have fine-grained to powdery composition of white to white-yellowish colours, which supports their application as inorganic fillings in industrial production of plastics, rubber, cements, paints, paper, etc.

According to the journal *Industrial Minerals*, in February 2010 the price of the ground calcium carbonate (GCC) reached 80-103 GBP/t, the price of precipitated calcium carbonate (PCC) 320-480 GBP/t, resp. elaborated precipitated calcium carbonate up to 550 GBP/t.

The application of the CO₂ sequestration by carbonatization in the industrial scale would result in the lowering of the amount of industrial CO₂ emitted into the air and deceleration of the global warming. It will simultaneously lead to minimization of the amount of stored waste material and to production of the economically interesting carbonates usable in manifold industrial branches. By this way the methodology directly as well as indirectly contributes to the protection of living environment. Presented research corresponds with the documents of the European Commission concerning the catching and liquidation of CO₂ with the need to lower CO₂ emissions by 20 % until 2020.

An approach to Sicilian underwater prehistory

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It is wise and necessary to say in advance that beside the well framed potential picture expressed by others, we don't have till now any real datum concerning any kind of prehistoric archaeological evidence so far found in the sea in central Mediterranean and, particularly, in Sicily if we exclude the famous cave of Cosquer not far from Marseille, some traces of Neolithic settlements in Roussillon and Grotta Verde in northern Sardinia. The evidences from Palinuro and Malta cannot be interpreted as real evidence of underwater prehistoric sites because they need further investigations.

Such consideration becomes more evident if we examine not the entire central Mediterranean region, but only the area around Sicily, between southern Italy and Aeolian islands, in the North, and Pantelleria, Lampedusa and Malta, in the South. Actually this topic of underwater prehistoric evidence of submerged settlements was widely faced in a mythological perspective. But this will be not my perspective because I will avoid to deal with the fascinating, but vague, question of the identification and position of Plato's Atlantis,

widely and deeply discussed by many authors either on the mythological/literary point of view, and on the morphological and geographical side.

Even if we go into a detailed picture of this well defined central Mediterranean area, till now, beside some stone anchors, whose chronology could range between unidentified prehistoric and historical periods, and few isolated evidences of prehistoric and protohistoric objects so far found, we don't have any real archaeological context of that period. The only consistent "prehistoric discovery" so far done in this area of Mediterranean was the controversial "wreck" of Pignataro, found nearby the eastern coast of Lipari.

Taking into consideration this insufficient archaeological situation I'll try to give some indications on the methodologies to be used, as well as on the most potential areas to be investigated with the aim to discover real traces of underwater prehistoric sites around Sicily. But it will be necessary, in order to fulfil a correct methodological and logical approach to this fascinating scientific domain, to proceed firstly with a comprehensive picture of the sporadic prehistoric and protohistoric evidences so far collected from the sea, secondly with the knowledge of palaeo-geographic background of the area under exam and finally with the indication of a research's strategy and perspective.

In this frame the recent discovery of two fossilized molars of *Elephas mnaidrensis*, in the sea not far from the south-western Sicilian shore will open new research horizons.

The main types of gold deposits in Romania

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Romania is (was) known as a country rich in gold, richer as the most European countries. One area (the Gold Triangle or Quadrangle in Metaliferi Mts.) and several deposits/mines (Roşia Montană, Gurabarza/Brad, Bucium, Săcărâmb etc.) are worldwide known, due to the gold richness of the ores and in some cases as being type localities of some minerals, especially Au-Ag tellurides (e.g. Săcărâmb/Nagyag), respectively.

The above mentioned deposit type is of hydrothermal origin and have been formed in relation to the Neogene, mostly subduction-related, volcanism. In addition, there are also gold deposits located in metamorphic rocks, mostly in the South Carpathians, which are shear-zone related. The third type is of alluvial origin; for some of them the source was identified but there are numerous deposits or occurrences with diffuse or dispersed sources. The latter are also distributed mainly in the South Carpathians.

In addition to the above mentioned major gold deposit types, the gold production of Romania was based also on gold derived as by-product from polymetallic ores, mostly hydrothermal, situated in the northern part of Romania, related to the Neogene volcanism too. There are either gold-dominated deposits, e.g. Săsar, Valea Roşie, Dealul Crucii or polymetallic deposits with disseminated gold. In the Metaliferi Mts. (western part of Romania) porphyry type ores with a typical association Cu-Au, e.g. Bolcana-Troiţa, Voia, Bucium-Tarniţa etc., are also known.

The gold production of Romania was however basically related to the hydrothermal ores belonging mainly to the Gold Quadrangle in the Metaliferi Mts. The famous deposits of the area, named "the New Eldorado" by McLaren (1918) are (were) not very large. Nevertheless, the veins are concentrated on small areas, with a high to very high frequency of ore veins per area. For example, the celebrated Au-Ag telluride deposit at Săcărâmb producing 300 kg Au per year, with an average Au content of about 9 g/t and Ag of 17 g/t (the period involved is before World War II), is developed on an area of only 1 km², on a depth of about 500 m. From the same deposit about 60 t of Te have been extracted. Locally, some gold vein were extremely rich, e.g. Musariu (13-19 g/t), Valea Morii (15-30 g/t).

Roşia Montană is by far the largest gold deposit in Romania with a total of about 500 t of gold. Estimates by Roşia Montană Gold Corporation for the remaining gold to eventually be mined in open pit, range between 250 and 300 t.

All the gold mines in Romania are now closed. Attempts are made to recover the nanogold from the waste dump material by different methods, e.g. by using suitable plants (an ongoing research project by the authors).

A future gold resource could be also the gold presumably associated with BIF-like iron deposits, such as Palazu Mare in Dobrogea, a Krivoi Rog type deposit covered by a relatively thick, partly karstified, carbonate sequence.

The gold production of Romania is best known from the period before the World War II; it varied from 4 t to 8 t of gold. Afterwards the gold production became secret and no public data were available until 1990. A figure of about 1-2 t/year is estimated for the last years. The gold fineness greatly varied from deposit to deposit. Older data give 500 ‰ for the gold from Roşia Montană and about 975 ‰ for the gold from alluvial deposits at Pianu (North Sebeş Mts.).

Upper Cretaceous marine sites of the Haţeg Country Dinosaur Geopark

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The Haţeg Country Dinosaur Geopark is located in the central part of Romania, being famous for its continental macrofaunas in general, and for its Upper Cretaceous (Maastrichtian) dinosaur fossils in special. However, in this geopark there are also significant sites of Upper Cretaceous deposits that contain abundant and various marine fossils. Among them, there are two palaeontologically-important sites, namely the Snail Hill from Ohaba-Ponor and the Rudists from the Strei Valley, both of them being located in the SE part of Haţeg Country Dinosaur Geopark. The Snail Hill exposes a sequence spanning the Early Cenomanian-Early Turonian interval. This age was assigned based on the identified calcareous nannoplankton assemblages, containing, among other taxa, *Quadrum gartneri*, *Q. intermedium*, *Eprolithus floralis*, *Lithastrinus septenarius* and *Helenea chiastia*. The oldest Cenomanian deposits are sandstones and calcarenites with numerous taxa of *Actaeonella*, mostly belonging to *A. lamarki*, *A. conica* and *A. goldfussi* species. Other rudist taxa of the Cenomanian deposits exposed in the Snail Hill from Ohaba-Ponor are *Durania connectens* LUPU 1966, *Eoradiolites* sp., *Eoradiolites triangularis* ORBIGNY 1842, *Fossulites* sp., *Medeella* sp., *Neocaprina gigantea* GEMMELLARO 1865, *Praeradiolites fleuriau* ORBIGNY 1842, *Sauvagesia praesharpei* TOUCAS 1909, *Sauvagesia* sp., *Sphaerucaprina* sp., *Sphaerulites astrei* LUPU 1966, *Sphaerulites foliaceus* LAMARCK 1815. In the marlstones that overly the *Actaeonella* coquina, specimens of the ammonite *Mantelliceras mantelli* (indicative for the upper part of the Early Cenomanian), as well as other macrofaunal taxa, such as *Nerinea parva*, *Pecten acuminatus*, *Exogyra columba*, *E. conica*, *Modiola polygona*, *Lopha carinata* and *Puzosia* sp. are present. Mollusc genera, such as *Aporrhais*, *Protocardium* and *Panopea*, could be also found. Upwards, the marlstones and claystones of the Snail Hill from the Ohaba-Ponor contains the ammonite species *Acanthoceras rhotomagense*, *Acanthoceras jukes-brownei* and *Eucalycoceras pentagonum* indicating a Middle-Late Cenomanian age, together with abundant other macrofaunas, especially molluscs. Another marine Upper Cretaceous palaeontologically-important site is represented by the Rudists exposure from Strei. There, a sequence of marine Upper Cretaceous sedimentation, consisting of *Actaeonella*- and *Hippurites*-bearing conglomerates and sandstones of the Strei Formation, is exposed. These are the youngest Cretaceous marine sediments of the SE part of the Haţeg Country. The rudist fauna, comprising mostly *Hippurites lapeirousei* (GOLDFUSS), *Hippurites nabresinensis* FUTTERER and *Hippurites* cf. *colliciatus* WOODWARD, dates these deposits as Santonian–Campanian, but the sandstones contain Campanian nannofloras. Therefore, probably the age of the exposed sequence is Campanian. Both above-described sites add a significant palaeontological value to the geological heritage of the Haţeg Country

Dinosaur Geopark. These sites are important geological patrimonial resources that are able to generate tourist, cultural and scientific activities.

Geochemical characteristics of natural waters contaminated by hexavalent chromium, in Eastern Sterea Hellas, Greece

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The chemistry of the groundwater in Eastern Sterea Hellas (central Euboea and Asopos valley), central Greece, has revealed high concentrations of hexavalent chromium in groundwater systems exceeding, sometimes, the Greek and the EU drinking water maximum acceptable level for total chromium. The environmental impact of hexavalent chromium is a controversial issue critical to the protection of groundwater resources. By using the GFAAS for total chromium, diphenylcarbazide-Cr(VI) complex colorimetric method for hexavalent chromium, and flame-AAS and ICP-MS for other toxic elements, their concentrations were investigated in several groundwater samples. According to the results of this analytical work, the geochemical differences of those waters and the origin of the hexavalent chromium are discussed. The contamination of water by hexavalent chromium in central Euboea is mainly linked to natural processes, but there are cases that it is associated with anthropogenic activities. In Asopos valley the hexavalent chromium pollution is associated with the industrial wastes.

Morphogenetic types of ore bodies, ore textures and crystallization mechanisms in the hydrothermal madan deposits, central Rhodopes

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In the Madan Pb-Zn deposits three morphogenetic types of ore bodies are recognized: (i) steep simple veins; (ii) complex disseminated stockworks and (iii) gently sloping marble-hosted skarn-ore bodies. Their formation is structurally controlled by the fault systems, and lithological variety of the host Rhodope metamorphic complex. The replacement ore bodies reveal complex morphology according to the number, thickness and position of the host marble layers, shifts along the fault structures and local physicochemical parameters. Among the well presented morphological types – bed-like, mushroom-like, columnar or irregular, single or multilayered replacement bodies occur. The varied sulphide textures are formed by crystallization in open space or metasomatic growth in solid state. Infill ore textures like cutting veinlets, layered textures, druses, crustifications and breccias are indicative for crystallization in open space. Typical for the vein and stockwork mineralization, they are observed as well in the dissolution cavities formed by “hydrothermal karst” in the replacement ore bodies. In the latter, characteristic are the textural varieties inherited by the primary skarns in the processes of alteration and overprinting. Radiate and spherulitic, concentric, conical, massive, porous, rhythmic-banded textures typically occur. Ore impregnations and nests, pseudomorphs and interstitial formations complete the textural diversity. Certain zonal distribution in the mineral and textural characteristics is determined. The main mechanisms of ore deposition include boiling, intensive fluid/rock interaction, retrograde alteration of skarns, performed generally by convection and diffusion.

Monitoring mineral extraction and processing sites in the West and Southwest Romania by remote sensing-derived information and laboratory analyses

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Samples collected from eight mineral extracting and processing sites, representing commodities of different origin and in different environments (lignite, bituminous coal, porphyry copper and gold extraction mines, copper flotation, metallurgic waste dump), were analyzed in the laboratory for: mineralogy on thin sections, X ray diffraction (XRD), gamma spectrometry, density and spectral reflectance measurements. In sample locations, estimated ground reflectance spectra were extracted from Landsat-TM images, in order to verify the OH-FeOx anomalies, obtained by processing the satellite images with a methodology previously developed for mapping mining wastes at regional scale. The processed satellite images highlighted, by means of the extent and type of OH-FeOx anomalies, the area coverage of the deposited mined material and pointed out the modifications in time. Diagnostic spectral features given by iron ferric/ferrous ions, OH-metal and/or molecular water stay at the basis of the remote sensing OH-FeOx anomalies and the minerals which they indicated, were confirmed either by the microscopic observations on thin sections, or XRD, or both. A differentiation of the sites was performed by statistically analyzing the remote sensing anomalies and comparing with the results of the microscopic analyses and XRD.

Observations and modeling of moisture and decay patterns in stone monoliths in Southern England

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Stone deteriorates as a result of a range of natural and human-induced processes, and such deterioration can be unsightly and costly, especially where it affects important stone monuments such as gravestones. Moisture is a fundamental influence on stone deterioration as it provides a medium for transport and reactions (chemical weathering), as an essential factor for micro-organism growth (biological weathering) and as cyclical changes of state (liquid/solid/gas) exert a key control on many physical weathering processes. Despite this importance, little is known about the patterns of moisture distribution and movement within stone, how they vary over time and how they may be correlated with the nature and severity of deterioration.

Commonwealth War Grave (CWG) stones are found widely across the UK and Europe, dating largely from the early to mid 20th century and provide a natural test of the variation of stone deterioration under different climatic and environmental conditions involving single blocks (monoliths) which are more amenable to modeling. We report here on results from a linked field experiment, modeling, and field survey-based study to investigate the nature and causes of moisture and decay patterns in relation to microclimatic and environmental conditions at two areas in southern England (Dorset and Oxfordshire). At each field experimental site 8 gravestones and similar sized Portland stone monoliths have been erected, and climatic and environmental monitoring equipment emplaced (automatic met stations, evaporation gauges, soil moisture probes, piezometers). A suite of novel non-invasive and non-destructive methods to investigate moisture regimes and the early stages of deterioration has been developed, including 2D resistivity surveys, hand-held moisture meters, Equotip

hardness testing and time-lapse photography. Such a field experiment approach provides an ideal way of testing links between climatic and environmental variables and stone deterioration and validating output from numerical modelling approaches (such as Hydrus, which has been used in this project). Further observations of moisture regimes and decay features have been made from CWG stones within cemeteries near our experimental sites.

Hand held resistivity and capacitance probe surveys, in conjunction with electrical resistance tomography, provide detailed, spatially-resolved data on moisture distributions which can be compared with mapping of the nature and severity of decay and monitoring of surface water patterns from time-lapse photography. Here we show direct evidence of damp conditions (both surficial and deep-seated) at the base and top of gravestones, associated with two types of deterioration, with a drier central area characterised by less weathered stone. Decay surveys indicate extensive surface damage within the upper parts of the gravestones, and considerably less damage below this.

The structural-metallogenic maps of ore districts of F.Y.R.O. Macedonia

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The metallogenic characteristics, tectonic setting, and structure of F.Y.R.O. Macedonian territory, Kozuf-Aridea and Kadica-Bucovic ore districts and its specific formation features are discussed in this paper on the basis of new results and data obtained by previous investigations. The interpretation of satellite images and morphostructural analyses were employed successfully for revealing the ore-concentrating structural features. The tectonic elements of the present-day topography were marked out and compared with the structural features that existed during the period of ore formation. The use of the present-day structural landforms of F.Y.R.O. Macedonia for reconstruction of the tectonic elements of ore-bearing periods became possible after substantiating their inherited evolution. The ring structure occupies a special position in southern F.Y.R.O. Macedonia and ore districts are controlled. Geological, geochemical, and morphostructural attributes allow interpretation of this structure as a center of long-term endogenous activity that evolved since the Jurassic-Cretaceous time.

Cretaceous magmatic evolution of the Srednogie Zone (Bulgaria) and the continuous evolution into the Rhodope Massif (Bulgaria, Greece)

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The Apuseni–Banat–Timok–Srednogie (ABTS) belt of extensive calc-alkaline magmatism and Cu–Au mineralization is related to the subduction of the Tethys ocean beneath the European continental margin during the late Cretaceous time. Major economic porphyry-style and high-sulphidation ore deposits are restricted to certain segments along the belt and are aligned on the Panagyurishte corridor (Central Srednogie) in Bulgaria and the Timok region in Serbia. The present study reviews the geology, geochemistry and geochronology of igneous events in the Srednogie/Timok Zone, some features of the related Cu-Au mineralization and the continuous magmatic evolution to the South (Rhodope Masif).

The Srednogorie Zone (central and eastern part) revealed U–Pb zircon dates from subvolcanic intrusions and major plutons, supplemented by published Ar–Ar and Re–Os age data for the hydrothermal ore deposits, a general younging of magmatism from 92.1 ± 0.25 Ma in the north (Elatsite deposit) to 78.53 ± 0.15 Ma in the south (Capitan Dimitrievio pluton). The Timok region shows the starting point of the magmatism at 90–86.6 Ma and to end with the intrusion of plutons about 82–78 Ma (see Moll et al., 2010, this volume). Economic Cu–Au mineralizations in both sections are related to subvolcanic/ volcanic suites and are dated in the range of 92 to 86 Ma in Bulgaria and mainly about 86–84 Ma in the Timok zone. The age progression correlates in two profiles (Central-Eastern Srednogorie) with an isotope-geochemical trend (Sr–Nd, Hf–zircon data) of decreasing crustal input into mantle-derived magmas. The age and geochemical trends are explained as a consequence of slab retreat during oblique subduction.

The Cretaceous magmatism continues into the Rhodope Massif. The western Rila batholith gives a zircon age of 69.26 ± 0.26 Ma and a granite at the western border of the Rila batholiths an age of 61 ± 1.5 Ma (LA-ICPMS) which are interpreted as the time of emplacement; NW of Dospat an U/Pb zircon age of 77 ± 1.3 Ma and further to south at Elatia-Barutin the zircon dating show magmatic age of 55.93 ± 0.28 Ma. The ϵ -Hf characteristics change from the border Srednogorie Zone/Rhodope Massif of +10 (T-80 Ma) to +2–6 in the central part of the RM and to +1–3 (T-56Ma) at Elatia-Barutin. The crustal input of the Cretaceous/Tertiary magmatism increases to south which is documented by Sr–Nd isotope tracing data and the model of the slab retreatment (Srednogorie Zone) has to be change for the geodynamic interpretation.

Pilot study for artificial recharge of the South-Eastern Mesaoria Aquifer (Cyprus), using tertiary treated wastewater

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In many arid or semi-arid countries, like Cyprus, groundwater is the main source for domestic and irrigation use. The degradation of groundwater resource can be quantitative and qualitative, if the abstraction exceeds the natural recharge rate. For this reason treated water at these areas is a valuable water resource and should be taken into account in designing a rational water policy. Furthermore, the interest in artificial recharge of groundwater using pretreated waste water continues to increase, especially in the semi-arid countries. In this paper, the possibility of artificial recharge in the South-Eastern Mesaoria (Kokkinochoria) aquifer, close to Liopetri village, is examined. This study area is characterised by low precipitation (330 mm) and it is covered by deposits of Nicosia formation, Pliocene aged, which consists of marls and fined to coarse grained calcitic sandstone. The aquifer is developed between the sandstones horizons and sands. The average thickness of the aquifer is up to 80 m and the maximum 120 m. Overpumping during the last decades, through a large number of boreholes, has caused a decline of groundwater level and the occurrence of negative piezometry up to 30 m below mean sea level. As a result, sea intrusion phenomena are recorded for distance up to 1–2 km inland. Therefore, the use of tertiary treated wastewater, which is produced at Agia Nappa-Paralimni treatment plant, is proposed for the application of artificial recharge through boreholes. Adequate pretreatment of the reclaimed water is also considered prior to the recharge, taking into account the final use of the aquifer's water.

Molybdenite occurrences in Greece: mineralogy, geochemistry and depositional environment

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Molybdenite occurs mainly in three mineralization types in Greece: (a) porphyry Mo-Cu-(±Te-Ag-Au), (b) reduced intrusion-related Mo-W systems (skarn, intrusion-hosted) and (c) shear zone-related Cu-Au-Bi-Mo. In porphyry-Mo-Cu prospects the molybdenite is the main ore constituent together with pyrite in quartz stockworks crosscutting sericite±carbonate altered porphyry stocks (dacite at Pagoni Rachi/Kirki, Myli/Esymi, Konos/Sapes, Melitena/Rhodopi and Stypsi/Lesvos; microgranite at Ktismata/Maronia; monzonite at Sardes/Limnos, Fakos/Limnos and Skouries/Chalkidiki). Reduced intrusion-related systems are characterized by the presence of molybdenite, pyrite and wolframite-scheelite in intrusion-hosted sheeted quartz veins and/or dissemination (granodiorite at Kimmeria/Xanthi, Plaka/Lavrion and leucogranite at Pigi/Kilkis and Seriphos) and skarn-hosted ores (Kimmeria/Xanthi). Finally in the shear-zone Stanos prospect molybdenite accompanies chalcopyrite, native Bi, Bi-tellurides and sulfosalts. The studied molybdenites display a wide spectrum of their rhenium content ranging from almost Re-free molybdenites at Stanos, to very low-Re molybdenite in the intrusion-related systems (Lavrion, Serifos, Pigia and Kimmeria), and high to ultrahigh-Re molybdenites in the northern Greek porphyries. The rare mineral rheniite (ReS₂), occurs along with Fe-Cu sulfides, Pb oxides, and native Sn in Pagoni Rachi and Konos prospects. Rheniite and high-Re molybdenite precipitated under oxidizing conditions and from relatively acid hydrothermal solutions, whereas Re-poor molybdenites are indicative of reduced conditions mostly dominant in the intrusion-related systems. At the northern Greek porphyry-Mo prospects, magmas previously enriched from their mantle source rocks were responsible for extreme contents of rhenium in molybdenite.

Sulfate redistribution in the convective clouds

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Clouds and precipitation play an important role in cycles of various tropospheric chemical species, especially sulfur and nitrogen. This is very complex problem that has to include many processes, such as cloud dynamics, microphysics and tropospheric chemistry.

In this paper, an aqueous chemistry module was incorporated into complex 3D cloud-resolving mesoscale ARPS (Advanced Regional Prediction System) model developed in the Center for analysis and prediction of storms (CAPS) at the University of Oklahoma. The goal of this paper was to examine the sensitivities of vertical redistribution of sulfate to the physical processes that take place in cloud. Six water categories were considered: water vapor, cloud water, rainwater, cloud ice, hail and snow, and five chemical species: gases H₂O₂, SO₂, O₃, and aerosols SO₄²⁻ and NH₄⁺. Each chemical constituent in each microphysical category was represented by differential equation for mass continuity, so there are 30 new prognostic equations. The absorption of a gas phase chemical species in the cloud water and rainwater is calculated either by the equilibrium according to Henry's law and by real kinetic

calculation of gas uptake. The source and sink terms in equations of continuity represent either transfer of a chemical species from one microphysical category to another (e. g. transfer of cloud ice sulfate to cloud water sulfate by melting, transfer of cloud water sulfate to rainwater sulfate by autoconversion etc.) or a chemical reaction (e. g. oxidation of cloud water SO₂ by H₂O₂ and O₃ to cloud water sulfate). Comprised microphysical processes in source/sink terms are: autoconversion, accretion, Bergeron processes, freezing, depositional growth, melting, sublimation and evaporation. It is assumed that initial concentrations of chemical fields fall off exponentially, from the given values of mixing ratios at the lowest model level. Two environments were simulated: continental background and moderately polluted. The cloud model is initiated by a single sounding giving the values of temperature, humidity, pressure, wind direction and velocity. The initial meteorological fields are horizontally homogeneous. The experiments were made with the real orography.

The resulting cloud model coupled with chemistry module provides a powerful diagnostic and prognostic tool for studying the relative importance of physical and chemical processes in determining the distributions of sulfate and nitrate species in convective clouds and precipitation, as well as the transport of trace chemical species within convective systems. A special emphasis was dedicated on sulfate redistribution in different water categories during the convective cloud life. Vertical profiles of sulfate following the cumulonimbus trajectory can give us a lot of information about sulfate redistribution also. The maximum values of SO₄²⁻ in the cloud water is located in the lower part of the cloud, at the place of maximum vertical wind or just a slightly behind. The same situation is with maximum values of SO₄²⁻ in cloud ice: maximum of SO₄²⁻ correspond to maximum of vertical wind.

Cretaceous lithostratigraphy in the CBGA region and some remarks to the correlation of syntectonic sedimentary successions

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The lithostratigraphy of the Cretaceous of the CBGA region is characterized by a large variety of lithostratigraphic units within individual member countries. This fact is due to the large variety of facies, especially as a consequence of Alpine orogeny, and the high number of different tectonic zones and thrust units. However, some facies types and units can be correlated over several countries, i.e. grey to whitish pelagic limestones of the Lower Cretaceous, which constitute a widespread facies within the Tethys realm, largely controlled by the paleoceanographic setting and evolutionary events.

Within pelagic limestones of the Lower Cretaceous ("Neocomian"), clastic admixtures may be present, that indicate syndepositional tectonism related to early phases of Alpine orogeny ("eo-Alpine" phases). Clastic rocks such as huge breccia bodies and sandstones were found in a belt from Austria (Rossfeld Formation, Northern Calcareous Alps) to Slovakia (Nozdovice Breccia, Manin Unit; Strážovce Formation, Križna Nappe) and Hungary (Lábatlan Sandstone Formation, Transdanubian Range). Most of these formations also contain chrome spinels as heavy minerals, which point to a common geotectonic position and source area type.

Mid-Cretaceous formations from the Eastern Alps and the Carpathians may be also correlated due to a common plate tectonic evolution. The Losenstein Formation (Albian-Lower Cenomanian) of the Eastern Alps marks a distinct phase of compression and thrust wedge basin evolution in the Eastern Alps. Similar deep-water conglomerates and sandstones can be found in the Western Carpathians of Slovakia, the Poruba Formation (Tatricum and Križna Nappe). Again, also the petrography of conglomerates and sandstones point to a common source area and a common geotectonic position at the northern margin of the Austroalpine microplate. Similarities to the Pieniny Klippen Belt may be discussed in the future.

A special case is formed by the Gosau Group and equivalent Gosau-type sediments within the Alps-Carpathians-Balkanides area. The term "Gosauschichten" or Gosau-type

sediments was used for a number of (transgressive) Upper Cretaceous successions within an area from the Eastern Alps of Austria up to the Carpathians of Romania. At its type locality in the Northern Calcareous Alps of Austria, the Gosau Group is defined by a basal angular unconformity above Permian to Lower Cretaceous rocks, thus marking a new sedimentary cycle starting in Late Turonian times. The Lower Gosau Subgroup (Upper Turonian - Campanian) consists of terrestrial deposits at the base, including bauxites, and passes gradationally into shallow-marine successions with abundant fossils like rudists. The Upper Gosau Subgroup comprises deep-water deposits such as marls and a broad variety of deep-water clastics up to the Eocene. Similar deposits are known from Slovakia (Brezová Group) and Hungary (Transdanubian Range). Largely similar transgressive successions with slightly different stratigraphic ages are also reported from Romania (Apuseni Mountains) and Serbia (e.g., Mokra Gora, Western Serbia). Although geotectonic positions and basins may have been different, this points to a common evolution of the area after a mid-Cretaceous tectonism followed by renewed marine transgressions and a deepening of the depositional areas.

Syn-rift and synorogenic olistostromes and their role in interpretation of tectonic evolution of the Neoproterozoic Lufilian orogen as background for comparative studies

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The Lufilian belt is a part of the Neoproterozoic-Lower Palaeozoic Pan-African orogenic system of southern and central Africa. Its sedimentary sequence of the Katanga Supergroup (880-500 Ma) is composed of five groups: Roan and Nguba that represent rifting stages and Kundelungu, Fungurume, and Bianco, which reflect evolution of the synorogenic foreland region. The occurrences of olistostromes, traditionally called the Katangan “megabreccias”, are a prominent feature of the Lufilian belt architecture. Some olistostrome bodies reach thickness of 2000 m and contain huge blocks of Katangan rocks, some of which host the famous copper-cobalt orebodies of the Dem. Rep. of Congo sector of the Central African Copperbelt. They were previously considered as tectonic mélanges (“friction breccias”) marking regional decollement zones related to thrusting during the Pan-African orogenesis. However, these fragmental rocks were recently shown to be of sedimentary origin and to form two extensive olistostrome bodies, which shed new light on the stratigraphy and tectonic evolution of the Lufilian belt. Borehole cores available in this copper mining region reveal fine details of their stratigraphic, sedimentological and structural relations.

The main lines of evidence for the olistostrome genesis are following: (1) lack of pervasive shearing that would point to tectonic fragmentation; (2) textures and structures diagnostic for subaqueous sediment gravity flows ranging from debris flows to turbidites; (3) roundness and provenance of clasts, and lateral facies gradients implying erosion, abrasion and unroofing of the Katangan source rocks elevated in the source areas; (4) lower boundaries of fragmental bodies are not tectonic but stratigraphic; (5) injections of unconsolidated conglomeratic matrix filling open joints in megablocks and fragmented slide sheets, which represent olistoliths and olistoplaques.

The older olistostrome unit is a disorganised to locally organised syn rift complex with olistoliths reaching five metres across. The clasts were derived from the uplifted rift margin and redeposition resulted from mass-wasting (rockfalls producing sedimentary breccias), sliding of solitary blocks, and pebbly to cobbly debris flows, some of which evolve to turbidites. The underlying strata are deformed by slump folds, and the succeeding lowest part of the olistostrome contains slump-generated debris flows with fragments of the dismembered slump beds. This olistostrome succession consists of three complexes typified by matrix-supported debris-flow conglomerates with Roan clasts. Some of the conglomerate beds pass upwards to normally graded turbidite layers and are accompanied by solitary slump beds. The three conglomeratic assemblages are separated by two intervals of sedimentary breccia

composed of allochthonous angular Roan blocks interpreted as mass-wasting debris redeposited into the basin by high-volume sediment-gravity flows. The breccia bodies document unroofing of the source area in that the older one contains dolomite clasts derived from the upper Roan strata, and the younger breccia consists of quartzite fragments sourced from the lower Roan.

Synorogenic olistostromes in the Fungurume Group deposited in the foreland basin of the Lufilian Belt and derived from the Katangan nappes thrust northwards are composed of nappe-derived olistoliths and olistoplaques up to several kilometres in size embedded in debris-flow conglomerates. They represent all units older than the Fungurume Group. Olistostrome at Kambove overlies a turbidite sequence, distally grades to a conglomerate complex and includes olistoliths of red-bed strata, which in the Katanga Supergroup occur in the foreland region. This is interpreted as recycling of the foreland sediments involved in a successive orogenic phase due to advancement of the orogenic front from the south and migration of the foreland depocentre during a punctuated orogenesis.

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The early Miocene rodents from Turija (Banovići), Bosnia and Herzegovina

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The coal bearing deposits in the Turija opencast mine near Banovići yielded a small-mammal assemblage. The general composition of the assemblage is very similar to the ones from the Early Miocene of Anatolia. This similarity is more marked on the subfamily and genus level than on the species level. The Muridae are dominating the assemblage in diversity (with five species of four genera) as well as in number of specimens (80%). The Gliridae are with three species of two genera the second group (18%) and the Sciuridae with two genera and two species are rare (2%).

The Muridae are represented by species of *Deperetomys*, *Mirrabella* and *Eumyarion*, and a new genus and species of a spalacid, the Gliridae by two species of *Bransatoglis* and a species of *Microdyromys* and the Sciuridae by *Palaeosciurus* and “*Ratufa*” *obtusidens*.

The biostratigraphical correlation of the rodent assemblage from Turija depends necessarily on comparison with faunas from central Europe and Anatolia, because our knowledge of the local succession is very limited. Moreover, the Oligo/Miocene rodent fauna from the east coast of the Paratethys appears to be very different from that on the west coast. The absence of Eomyidae hampers a straightforward correlation with the European sequence, but six out of the ten species recognized in Turija are known from Europe and/or Anatolia also. The stratigraphical ranges of the species relative to the European MP/MN scheme and the preliminary Anatolian zonation shows convincingly that the best fit of the assemblage from Turija is with MN1 in Europe and zone B in Anatolia. In combination with magnetostratigraphical measurements the age estimate of this rodent assemblage is between 23.8 and 23.5 Ma.

Relationship between the Cretaceous? “black shales” and Cretaceous oceanic red beds of the Grajcarek Succession-a geochemical approach (Pieniny Klippen Belt, west Carpathians, Poland)

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In the Polish Outer Carpathians, the contact zone of the Magura Nappe and the Pieniny Klippen Belt is known as the Grajcarek Succession (Unit). This succession contains the “black flysch” deposits, with controversial age, overlain by the Cenomanian radiolarian shales (CRS), followed by the Turonian through Campanian variegated shales (CORB). All these deposits have been sampled. The major and trace elements were analyzed, as well as relation of trace metals with organic matter content (TOC) was recognized. The studies performed by authors reveal that deposition of the CRS took place under oxygen deficiency condition. The trace-element distribution characterizes the hemipelagic regime of sedimentation of both the upper portion of the “black flysch” (spotty shales) as well as the CRS, which were deposited during increasing sea-level. Enrichment in redox-sensitive elements match was probably due to scavenging by H₂S-rich pore fluids. It suggests that spotty shales and the CRS were deposited under very similar sedimentary conditions. During the Late Cretaceous, crucial change in oceanic sedimentation occurred in the Tethys. The Mid-Cretaceous “black shale” facies were passed into Upper Cretaceous oceanic red beds (CORBs).

Bolkardağı bauxite deposits at Ayrancı, Karaman, Central Turkey. Part I. Geological setting

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The region investigated is located 15 km southeast of the Ayrancı district (Central Turkey), covering an area of about 300 km². The aim of this study is to investigate the stratigraphical setting and erosional surface of bauxite deposits and examine their age in relation to host rocks. Thus, the geological evolution of the area and formation of bauxite deposits are discussed on the basis of geologic, tectonic and stratigraphic data. Permian–Cretaceous rocks of the Bolkardağı unit, which is one of the main tectonic associations comprising the Central Taurides, are found at the basement, and overlain by Miocene units. Sequence starts with the Upper Permian Dedeköy formation, which is composed of dolostone at the bottom and limestone to the top. It is conformably overlain by schist, phyllite, metasandstone and marble of the Lower Triassic Saraycık formation. Middle Triassic vein rocks of diabase composition (Kasır diabase), with a maximum diameter of 100 m, divide the Saraycık formation units. The Saraycık formation and all other old units are unconformably overlain by the Jurassic–Cretaceous Berendi formation. Karamanoğlu Ophiolite is pushed over the Berendi formation, seen as a thick carbonate sequence. This ophiolite was probably emplaced during the Late Cretaceous period. Karamanoğlu Ophiolite is unconformably overlain by Miocene Mazı and Divlek formations, which are represented by conglomerate-sandstone and clayey limestones, respectively. The bauxite deposits are found within the Upper Permian Dedeköy formation, and between the Gerdekesyayla Dolostone and Bulgardede Limestone member, and also in the limestone. Geological setting and degree of metamorphism of these bauxites indicate that they were formed during the Late Triassic–Early Jurassic (?) period on Upper Permian carbonate rocks and Lower Triassic shale–sandstone–limestone units and before being transported into the dolines and caves of carbonate rocks. The fact that bauxites are formed on top of dolostone and on the top, base and within limestone may indicate that these two carbonate units response differently to karstification.

Mineralogy of the Pliocene Trachyte and its Carbonatitic Minette Inclusions in Ostrvica, F.Y.R. Macedonia

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The trachyte at Ostrvica hill (age 3.21 ± 0.10 Ma) in Vardar zone is the most evolved volcanics of the ultrapotassic Pliocene-Quaternary series in F.Y.R. Macedonia. It is aphyric, with clinopyroxene and phlogopite microphenocrysts within a sanidine-anorthoclase groundmass. It contains inclusions of carbonatitic minette ranging in size from several mm to 6–7 cm. They are light coloured porphyric rocks, rich in vacuoles, composed of phlogopite and completely altered olivine(?) phenocrysts amongst acicular clinopyroxenes within a feldspar–calcite groundmass with abundant Fe-oxides and acicular apatite microlites. The inclusions are rimmed by a mm thick mixing zone composed of the same minerals but with intermediate composition between that of minette and trachyte. The clinopyroxenes are mainly diopside-augite with low Ti and Al content (with 6Al only in the minette). Positive correlations are observed between Na and Fe³⁺, Al and Ti, and negative one – between Al and Si. In the inclusions phlogopites the negative correlation between Mg# and 4Al is found. The feldspars in the trachyte and minette inclusions are Ca-sanidine to Ca-anorthoclase, in the mixing zone – sanidine only. In the inclusions two plagioclase generations (An₄₁ and An₂₅) exist. The estimated crystallization temperature of the minette clinopyroxenes is 1280–1180°C, of plagioclase (An₄₁) – 1130°C and in the hosting trachyte – 1080°C, at the pressures 6.9 and 7.7 kbar, respectively. The temperature of the feldspars crystallization (K-Na-feldspars and Pl₂₄) in the minette groundmass is 809–878°C. By analogy with other ultrapotassic volcanics from F.Y.R. Macedonia it is suggested, that the discussed volcanics originated from phlogopite-bearing metasomatised mantle.

Lom coal basin (NW Bulgaria) – preliminary data on palaeoecology and sedimentology

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Lom coal basin is located in NW Bulgaria in the west subsided part of the Lom depression. Lom basin is filled in with thick sedimentary succession of Neogene age, comprising alluvial sand, silt and clay, interbedded with coal seams, and covered by loess deposits of Quaternary age. Neogene deposits have been divided into two formal lithostratigraphic units – Archar Formation (pure sand of alluvial origin, Pontian age) and Brusartsi Formation (clay, silt and sand with coal beams in the lower part, Dacian-Early Romanian age). The previous studies of Lom basin sediments were focussed on coal characteristics and no detailed sedimentological studies were published. The diatom presence in clays from Brusartsi Fm is established for the first time during our study. The present study aims to characterize sediments of Brusartsi Formation and palaeoecology in the Lom basin based on data from sedimentological studies (include grain-size analysis, petrographic study of thin-sections under the polarizing microscope), and mineralogical studies of the fine sand fraction in immersion eugenol, and X-ray diffraction analysis, and diatom studies. Taxonomic structure studies were made using scanning electron microscope (SEM) Philips 515 at Freie

Universität Berlin. Thus preliminary studies of sediments from 5 boreholes drilled during 2007-2008 and kindly provided by ENEMONA, were carried out.

Neogene sedimentary succession in the boreholes studied is represented by deposits of Brusartsi and Archar Formations. The full thickness of Brusartsi Fm. has been drilled and only the upper parts of the Archar Fm. Sediments drilled from Archar Formation are thick up to 10 m - light gray and almost white sand, very well sorted (mainly quartz and less feldspars, some epidote, garnet and sphene; rare ore minerals are present). Sediments from Brusartsi Formation are varying from 70 to 105 m in thickness. They are represented by thick 2-5 up to 22 m clays and silty clays, gray and gray-greenish in color, and with massive or laminated structure. Some of clays contain significant amount of diatoms up to 50% of the rock volume and in some samples 1 mm thick layers are extremely composed of diatoms. Main rock forming minerals are chlorite (clinochlore), smectite (montmorillonite), illite, quartz and feldspar according to data from X-Ray diffraction analysis. Clay particles are oriented parallel to sedimentation surface and their composition evidenced for chiefly detrite origin. Sand is medium to very well sorted, medium to coarse grained, light grey in colour. These sands show lower mineralogical and structural maturity compared to those from Archar Fm. Well sorted sand from Brusartsi Formation is composed of relatively equal amounts of quartz, plagioclase and potassium feldspar, and very few grains of garnet, amphibole, sphene and epidote. Pyrite represents opaque minerals.

The diatom flora is freshwater one. The planktonic representatives of genus *Aulacoseira* Thw. have the highest abundance – and they compose the rockforming complex. On some levels there are periphytic (epiphytic) forms, belonged to genera *Fragilaria* Lyngbye *sensu lato*, *Tetracyclus* Ralfs, *Navicula* Bory *sensu lato*, *Cymbella* Ag. *sensu lato*, *Eunotia* Ehr., *Amphora* Ehr. The most abundant species is *Pinnularia nobilis* var. *neogena* (Grun.) Cl. It can be considered as biostratigraphic marker for Late Miocene-Pliocene age. Based on our SEM investigation on the frustules of *P. nobilis* var. *neogena* high stages of dissolution of the frustules were determined. Dissolution occurred progressively and centripetally, and the final stage was the corroded silica matrix of the central area.

The grain-size composition and mineralogy of clay minerals led to the conclusion that sedimentation occur in a relatively shallow broad basin with low hydrodynamics. Results from diatom analysis confirm this conclusion and indicate that the basin was eutrophic freshwater lake. The temperature regime was similar to the lakes of the moderate latitudes.

Geochemical characteristics of Upper Cretaceous volcanics in the north of Istanbul, Turkey: implication for the subduction zone magmatism

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The volcanic rocks Upper Cretaceous in age are exposed along the Black Sea coasts east-west trending in the northwest Turkey and Srednegorie zone through Bulgaria. The geological and geochemical data, petrographic and mineralogical findings have been presented respectively. The basement rocks in the north of Istanbul are represented by sedimentary rock groups Paleozoic and Triassic in age. The volcanic rocks Upper Cretaceous in age overlay the basement rocks disconformably. The basement rocks and volcanic sequence are covered by Neogene sediments disconformably. Volcanic rocks are dominated by andesite, basaltic andesite and associated with lesser proportion of basalt, dacite, rhyodacite, less olivine basalt and their volcanoclastic equivalents. The volcanic rocks in the region have been differentiated volcanic breccias, poorly sorted volcanoclastic deposits, massive lavas and volcanic originated sandstone considering their lithological facial features and field characteristics. In some locations hyaloclastite type of rocks are common. Some of them are reworked in the marine environment. This is the evidence that the volcanism was formed as submarine volcanic activities. The volcanic units are cut by some basaltic and/or

basaltic andesite dykes. Lavas show microlitic porphyritic, hyaloplitic, spherulitic and hyaloporphyritic textures. When petrographically examined, the samples give evidence of hydrothermal alteration or devitrification. Corroded quartz, oscillatory zoning of plagioclase phenocrysts and reverse zoning are the evidences showing thermal and compositional disequilibrium produced by magma mixing. In this paper the geochemical characteristics of volcanic rocks have been discussed. Subduction of the Neotethys under the Istanbul zone (Pontides) created a new active continental margin arc. The volcanic rocks outcropped in the north of İstanbul are included in High-alumina basalt (>17 % Al_2O_3) group firstly with this study. The petrochemical characteristics of volcanism have been defined on the analyses of 24 representative lava samples covering the whole stratigraphic sequence, the major-oxide, trace and rare earth element data. In order to better understand the genesis of subduction-related volcanism, we also performed an electron microprobe study on phenocryst phases of two hydrous lava samples and one unhydrous olivine basalt sample (e.g., pyroxenes, amphiboles and olivine). All lava suits are calc-alkaline with arc-like signatures and characterized by LILE and LREE enrichment and N-MORB-like patterns of HFSE and HREE. Such signatures are consistent with melts being derived from a mantle that was metasomatized by slab-derived aqueous fluids and silicic melts. With these features İstanbul volcanics have been attributed to crystal fractionation and interaction with the subduction zone and modified mantle wedge and to be enriched mantle origin. Geochemically volcanics show negative anomalies in Nb, Ta, P and Ti typical of arc magmas. Nb-Ta-Ti depletions are evidences of aqueous fluid metasomatism since fluids were depleted in these elements due to residual rutile in the dehydrating slab. Mantle-derived rocks have The Zr/Nb, Nb/Y, Ba/Nb and Y/Nb ratios are akin to continental margin volcanics and also Zr/Y-Zr binary diagram show that there is similarity between continental margin volcanics and İstanbul volcanics. We assume that basaltic andesite and andesite dykes to be the source of volcanic products.

Ground penetrating radar investigation of Gönen Tumulus in Isparta/Turkey

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Prior to 1940s, excavation was the only method for locating buried archaeological studies. By the middle 1950s, along with archaeological searches, geophysical methods are used very often. Geophysical methods have proven to be very useful to archaeologists in order to detect, map and study the characteristics of different types of objects and structure in the subsurface. Among these methods, ground-penetrating radar (GPR) is particularly useful, because this active electromagnetic technique is able to detect the presence of buried objects having different dielectric properties with respect to the surrounding material.

Ground-penetrating radar (GPR) is a method that is able to provide very high resolution, three-dimension information. It is a fast and effective electromagnetic (EM) method. It is based on the propagation and reflection of EM waves, it is sensitive to variations of the EM parameters in the subsoil, specially the dielectric constant and the electric conductivity. Despite its relatively low penetration depth (specially with high-frequency antennae and in moderately conductivity environments), the GPR resolution capability (also depending on frequency and soil properties) is far greater than obtained by other geophysical methods. This makes the technique suitable for high-resolution shallow studies such as archaeological applications and shallow stratigraphy mapping.

The study primarily aims at providing adequate imaging resolution of large and prominent targets of archaeological interest, such as tumuli, at all depth levels. We implemented an integrated ground-penetrating radar (GPR) technique to perform high-resolution imaging and characterization of tumuli (burial mounds).

The ancient city of Konane (Roman Conana) is located in the area around the modern village of Gönen, which lies 24 km north of Isparta in southwest Turkey. In antiquity this area was known as Pisidia. The high peaks of the Barla and Tınaz Mountains frame the valley to the north and gently descend through alluvial fans into the plain of Gönen. While many travelers have visited this area in search of ancient material, none has ever undertaken a systematic survey using the most advanced methods.

In this study in particular aims to combine an archaeological survey and the study of inscriptions with modern methods such as geophysical measurements and topographical mapping. The aim of the geophysical research at the site in Gönen (Isparta/Turkey) was to recognize the shallow soil layers and to determine and outline the existence of possible archaeological objects.

Preliminary finds suggest that the city center of Konane in the Hellenistic period may have actually been located at Kale Tepe, and only in the later Roman phase did the city move southeast, which is now under the modern town of Gonen. The preliminary archaeological data also present distinct signs of expansion in Konane's settlement during Late Antiquity. The occupation and possibly later fortification of the Akyokuş Tepe, in conjunction with the growth of rural settlement in the western sector of the valley, invite hypotheses over the new economic outlook and demographic expansion in the region.

A landslide research at Northeastern Turkey using 2D electrical resistivity method

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Landslides are an earthflow that may occur in areas with heavy rainfall, on the banks of rivers and on mountain slopes. They may be defined as a sudden or gradual rupture of rocks or soils and their following movements down slope by power of gravity. Landslides endanger engineering structures, properties and human lives. The most important causes of landslides in northeastern Turkey are generally morphology of slopes, heavy rainfall, excavation, decomposed rocks and existence of underground water in soil material. In the study area, structurally complex volcanic and sedimentary sequences, occurred limestone, marl, claystone and tuffite, were observed. The geological units are weathered due to heavy rainfall, surface and underground waters. The weathered units as a result of increase in water movements in landslide area caused the reduction in slope stability, and hence the earthflow by power of gravity occurred. The landslide located in 7 km south from the province of Trabzon in northeastern Turkey is investigated using the two dimensional dipole dipole electrical resistivity method. The resistivity imaging produces significant results to characterize the landslides. The resistivity survey is the definition lateral extension and thickness of landslide body, the determination of a potential sliding surface, and the detection of the movement of groundwater flow and its distribution within the slip mass. The landslide having about 17° slope is approximately 120 m long, about 100 m wide, and in an environment with an altitude ranging from 150 m to 200 m. The highway and buildings in the landslide area have been largely damaged due to the landslide. The resistivity pseudosections with a dipole spacing varying from 5 to 30 m over eight profiles with the length of 100 m, five of which were oriented transversely to the landslide body, carried out during the field study. The field apparent resistivity pseudosections were inverted to obtain a true resistivity structure using an algorithm based on the finite element forward and the least-squares inversion methods. The subsurface is divided in to rectangular blocks, the number of which is less than the number of resistivity data. The inversion method adjusts the resistivity model trying to iteratively reduce the difference between the calculated and observed apparent resistivity values. A parameter mesh for the case of 21 electrodes and n-separation of 6 for the used array is used. The number of parameter layers is set equal to the maximum n-separation of the measured data set and the thickness of each layer is set as 0.5 of the inter electrode spacing for array used. The number of parameters in every layer is eleven. Note also that the

side and bottom parameters were set to be large to simulate infinite boundaries. The inverted resistivity sections show that the landslide body has different degrees of an altered material and a high degree of saturation. The sliding surface is at a depth of about 10 m, with 2.5 m of soil material overlying 7.5 m of landslide material. The landslide body has different degrees of an altered material and a high degree of saturation, and the sliding surface is at a depth of about 10 m. The relatively high resistivity values at the bottom of the sliding surface correspond to the marl layer.

Petrogenesis and SHRIMP zircon U-Pb dating of some granitoids within the Western Pontides, Southeastern Balkans, NW Turkey

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The Pontides is one of the main tectonic units of Turkey which have been defined western, central and eastern Pontides. The Western part of the Pontides is separated tectonic subunits such as the İstanbul and Strandja zones. The Strandja zone reveals part of the large crystalline terrane in the southern Balkans, which also includes Rhodope and Serbo-Macedonian massifs. The İstanbul Zone is a continental terrane and includes sedimentary succession ranging from Ordovician-Carboniferous deposited metamorphic basement and it is settled at the east of the Strandja Zone.

According to the our new zircon U-Pb age data, the basement rocks of Strandja zone form Late Proterozoic and Early Paleozoic metagranitic rocks. At these zones granitoids are determined with different age, geotectonic setting and magma genesis. In the Çatalca region, tip of the southeastern part of the Strandja Zone, two units are determined as the Precambrian Çatalca metagranite and Permian Tepecik cataclastic granite. In the eastern part of the studied area, within the İstanbul Zone, the Permian Sancaktepe granite (Gebze) and the Upper Cretaceous Çavuşbaşı granodiorite intruded into the Paleozoic sedimentary rocks. According to the mineralogical-petrographical-geochemical and geochronological properties of granitoids, the Çatalca region granitoids are similar to the Sancaktepe granite.

In terms of the geochemical features, the granitoids in the Çatalca region and the Sancaktepe granite have subalkaline, high-K calcalkaline and peraluminous characters, while the Çavuşbaşı granodiorite display subalkaline, middle-K calcalkaline and metaluminous characters. All three units display I-type magma character and arc-type geotectonic events, but some samples are between I-type and S-type according to the geochemical results. According to isotope geochemistry the Çatalca granitoids have low values of initial $^{87}\text{Sr}/^{86}\text{Sr}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ isotopes (0.6941 and 0.5120), while Sancaktepe granite has similar values (0.6989 and 0.5122). The Çavuşbaşı granodiorite display the highest values of isotopic ratios (0.7035 and 0.5127).

Çatalca metagranite gives the Latest Precambrian-Early Cambrian (534.5±4.7 MY) SHRIMP zircon U-Pb crystallization ages. Tepecik cataclastic granite and Sancaktepe granite crystallized during the Permian with age determinations of 249.4±1.5 MY and 253.7±1.75 MY, respectively. The youngest unit of this region is the Çavuşbaşı granodiorite which yields an Upper Cretaceous age (67.75±0.59 MY). The presence of the Late Precambrian-Early Cambrian granitoids in the Strandja Zone is newly data for the region. Gondwana or Pan-African origin similar ages basement rocks there are in some localities such as Menderes and Bitlis Massives and İstanbul zone in Turkey. Thus, these rocks may be correlated with the same ages rocks in the other localities along the Rhodope-Pontide belt that related to the evolution of Tethyan ocean.

New findings from surfacing Permian-Triassic transmission in Eastern Taurus (Yahyali, Kayseri, Turkey)

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Turkey consists of several continental fragments which were joined together into a single landmass in the late Tertiary. During most of the Phanerozoic these continental fragments, called terranes, were separated by oceans, whose relicts - ophiolites and accretionary prisms - are widely distributed throughout the Anatolia. The Anatolide-Tauride terrane south of the Pontides shows Gondwana affinities but was separated from Gondwana in the Triassic and formed an extensive carbonate platform during the Mesozoic. Our investigation area, Küçükusu region (Yahyali, Kayseri, Turkey), is located in the eastern part of the Anatolide-Tauride terrane.

There are late Permian-early Cretaceous old units in and around Küçükusu Region (Yahyali/Kayseri). There are old Scythian-Anisian carbonate rocks on Permian. These units are overlain tectonically by middle Jurassic (Dogger) – early Cretaceous old carbonate rocks. In this study, both the characteristics of Permian – Triassic transmission and the expression of relationship between Divrikdağı and Küçükusu Formations are aimed. In this scope, five stratigraphic sections are taken from the region and microtextural features and foraminifera content of approximately 200 samples compiled from these sections are observed and biozones of Triassic foraminifera obtained are expressed. As a result of these researches; it is detected that there are *Pachyphloia schwageri*, *Mizzia velebitana* and *Sichotenella* sp. fossils in the late Permian level and they compose the highest level of Permian and there is a fossil-free zone in one meter thickness in the border of Permian-Triassic. From the samples taken from this fossil-free level a new foraminiferal specimen is formed with *Cyclogyra* ? sp. cf. *mahajeri*, *Rectocornuspira kalhori*, *Ammodiscus parapriscus*, *Mendrospira pusilla*, *Hoyenella sinensis* and *Glomospira sinensis*. Based on these fossils; Scythian age is given to this unit. The new foraminifera specimen that is obtained exists together with *Cyclogyra* ? sp. cf. *mahajeri* and *Rectocornuspira kalhori* fossils and represents the Induan stage of Triassic. Although the shell structure and coiling of this fossil resemble to *Cyclogyra* ? sp. cf. *mahajeri* and *Rectocornuspira kalhori* fossils it has important differences as well. The field that is studied starts with oolitic limestone formed of small and regular structured ooid grains on Triassic-Permian border. It is seen that ooids are processed again through the top and uses ooids at the lower level as core and due to this it is concluded that low environment energy increase towards the upper levels of Scythian. In the upper levels alteration is observed in the ooid covers and microfaultings are observed on the unit. The formation of these deformations is thought to occur as a result of settlement of middle Jurassic – early Cretaceous carbonates on the region.

Observations on the Palaeogene of Samothraki Island: implications for the geology of Rhodope and Thrace

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The geological setting of Samothraki Island is characterized by Jurassic ophiolites (mostly basaltic pillow lavas, and an igneous suite that ranges from gabbro to plagiogranite) of the Circum-Rhodope belt, and younger sedimentary rocks locally subjected to low-grade to greenschist-facies metamorphism. They are covered by volcanics (ranging from basalts to rhyolites) and intruded by granitoids of Oligocene to Miocene age.

The oldest sedimentary rocks are coarse breccias and conglomerates interbedded with polymictic sandstones and siltstones, and locally, thin limestones. All these rocks underwent

strong deformations and low-grade to greenschist facies metamorphism. The petrography of the pebbles indicates a dual provenance. (A) Almost all ophiolitic petrographies are present: basalts and dolerites (pillow-lavas included), gabbros, diorites, plagiogranites. (B) Pebbles (dominant in the upper parts of the section) from low-grade metamorphics of the Circum-Rhodope flysch or of shallow marine origin (coral-bearing limestone included). Coral remains from a conglomerate pebble found at Aghios Georgios have been determined in the past as Late Jurassic to Early Cretaceous. The age of the conglomeratic formation itself is uncertain – it may be Late Cretaceous or Palaeogene.

The Palaeogene terrigenous formation of Samothraki is referred to the Upper Eocene. However, the lowermost parts of the profile may be of pre-Priabonian, and the uppermost ones, of Early Oligocene age. The formation covers unconformably and transgressively the ophiolites or follows over the conglomeratic formation. Sandstones and siltstones with shaly and limestone interbeds are dominant, in the middle parts of the section being interbedded with thick limestones (packstone and wackestone) rich in foraminifers, corals, corallines, bryozoans, echinoderms, gastropods and bivalves. Locally (Kastro at Hora), the section begins directly with the limestone beds hinting at possible reef facies wedging out inside the sandy molasses facies, and passing into olistostrome. The sedimentary microfacies of the limestones correspond to a proximal middle carbonate platform, and may be correlated with similar facies in Thrace. The limestone beds are usually strongly tectonized, and in the basal parts and along contacts with the basement have been subjected to low-grade metamorphism. Near the Kastro at Hora, thin Palaeogene limestone beds are observed as tectonic insertions within the ophiolites of the basement. Strongly fractured limestone interbeds are often boudinaged, and parts of the section pass into *mélange* of mixed sedimentary and tectonic origin.

Comparisons with the Palaeogene rock sequences and environments of nearby Rhodope and Thrace basins enable reconstructions of the palaeogeography and palaeogeodynamics. Cretaceous crustal thickening during the collisional orogeny was followed by extensional collapse of the orogen, and formation and closure of several Palaeogene troughs. The formation of the Thracian trough began in Palaeocene times, and continued throughout the Eocene. Locally in Thrace (east of Xanthi) and Samothraki, intense south-vergent thrusting is recorded. During Late Eocene time, lacustrine basins developed in the Rhodope area, and were followed by early Oligocene transgression accompanied by volcanic activity. The evolution of this Oligocene intracontinental volcanic island arc (probably formed by extensional collapse of a “plateau” overriding a detached subducting slab) ended with Late Oligocene regression, transtension along major fault belts, and Early Miocene transpression.

Climatology of Erythemally and Vitamin D Weighted Irradiance at Thessaloniki, Greece, from a NILU-UV Multi-filter Radiometer and a YES UVB-1 Radiometer

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A UV monitoring network in Greece was established in 2004, equipped with NILU-UV multi-filter radiometers. It was designed to cover geographically Greece and Cyprus, with nine stations distributed at locations representing different environments. The NILU-UV instrument provides irradiance measurements at five wavelength bands centered at 305, 312, 320, 340 and 380 nm, with full width at half maximum (FWHM) of approximately 10 nm. The irradiance measurements at the five wavelengths are used to derive various products, among them the CIE and the Vitamin D weighted irradiances (dose rates). The measurements are recorded in 1-minute intervals and can provide sufficient details about the daily variation of irradiance.

One of the UVNET stations is located at Thessaloniki, Greece (40.5° N, 23° E) where a YES UVB-1 radiometer operates regularly. Following appropriate methodologies which depend on the type of the instrument and the available spectral information, the erythemal irradiance and the vitamin D weighted irradiance are calculated from these two instruments.

One of the aims of this study is to assess the differences of the CIE-weighted irradiance derived from the available instruments. A five-year (2004-2009) dataset of common measurements with NILU-UV and YES UVB-1 radiometer for the station of Thessaloniki is used to calculate the CIE-weighted irradiance and the uncertainties introduced by the different methods are assessed. In addition, the vitamin D weighted irradiances derived from the YES UVB-1 radiometer with two different methodologies are compared with those retrieved from NILU-UV.

Based on our findings, the risks versus the benefits of the solar UV radiation are discussed for the station of Thessaloniki in Greece.

The Late Miocene floras from Crete; vegetational and palaeoclimatic trends

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On the island of Crete, three Late Miocene outcrops have been discovered so far consisting of significant terrestrial plant macro-remains that have provided a considerable amount of floristic data and constituted the material for a series of palaeobotanical studies in the recent past. The oldest outcrop is located at the southern part of central Crete, near Pitsidia village in the Messara basin, where radiometric data from superjacent layers yielded an age of around 10.5 million years ago, into Early Tortonian. The recovered plant assemblage is still under investigation by the authors and to date its taxonomic composition includes more than 25 different taxa. The second outcrop is located near Makrilia village in the eastern part of the Island in Ierapetra basin. The palaeoflora consists of 62 identified taxa and the age of the sediments is defined by integrated biostratigraphy of dinocysts and nannoplankton as Late Tortonian, approximately 7.7 to 8.6 million years. The youngest plant assemblage originates from different small outcrops exposed near Vrysses village in the homonymous sedimentary basin in the western part of the Island. It includes 19 identified taxa and is assumed to be of Latest Tortonian – Early Messinian age, based on biostratigraphic considerations (ca. 6.0 to 7.5 million years). For the Makrilia outcrop, pollen and spores data exist as well, while a few more palynological reports are available from other contemporaneous sediments from the Island.

As these palaeofloras cover a time span of about 5 million years of the Cretan vegetation history, comparing the floristic data, valuable information about the possible changes in floristic composition, the vegetation succession and the evolution of climatic conditions during this period of the ancient Cretan region can be revealed. However, the interpretation of the plant assemblages and the extraction of definite conclusions are rather risky due to the inadequate number of floras, their particularly different depositional environment and undoubtedly the taphonomical bias.

The discovered plant macro-remains comprise mainly of foliage (impressions, seldom carbonized compressions) and less frequently of fruits, seeds, shoots, flowers and inflorescences. The preservation quality varies significantly from bad to almost excellent but generally is characterized as fairly fine.

Floristically, the three palaeofloras share only a few common species, like *Quercus mediterranea* Unger, *Acer pseudomessulanum* Unger, *Buxus pliocenica* Saporta et Marion and *Daphnogene polymorpha* (A. Braun) Ettingshausen. However, the assemblages from Makrilia and Pitsidia are obviously closer, as they share many taxa like the wetland plants *Myrica lignitum* (Unger) Saporta, *Taxodium* Rich., *Equisetum* L., *Populus* L., *Salix* L. and some, more or less, mesic arboreal elements including *Fagus* type *attenuata*, *Quercus*

kubinyii (Kovats ex Ettingshausen) Czezcott, *Podocarpium podocarpum* (A. Braun) Herendeen. Contrary to Pitsidia, the Makrilia flora illustrates a remarkable higher diversity. Especially, the mixed mesophytic forests comprise a great number of various deciduous accessory elements like *Zelkova zelkovaefolia* (Unger) Kotlaba, *Ulmus* L., *Carpinus* L., *Fraxinus* L. and *Tilia* L. Likewise, the families Lauraceae and Magnoliaceae are well diversified in Makrilia flora, accompanied by other thermophilic taxa like *Engelhardieae*, *Tetraclinis salicornioides* (Unger) Kvacek and *Asterocalyx styriacus* Ettingshausen. At the same time, in Makrilia the sclerophyllous woody plants are more frequent and diverse.

Conversely, the flora of Vrysses demonstrates a more sub-humid character with many xeromorphic elements that indicate the occurrence of well-developed sclerophyllous plant associations. The mesophytic woodland palaeocoenoses are clearly less diverse and probably poorly developed. Tall deciduous trees like beech and oaks are apparently lacking. Instead, only a few deciduous shrubs like “*Parrotia*” *pristina* (Ettingshausen) Stur and *Ziziphus ziziphoides* (Unger) Weyland seldomly occur. Typical swampy plants are completely absent here.

Climatically, the examined plant assemblages demonstrate a warm temperate character for the Late Miocene of Crete. Without any doubt, all of them include a prominent proportion of sclerophyllous woody plants which increases gradually from the Early Tortonian to the Messinian and these elements eventually established a very strong representation at the Messinian stage. This fact probably indicates a gradual transition to drier conditions and an increased seasonality of precipitation during the Late Miocene in the Cretan area. This conclusion is strongly supported as well by all the related palynological records from the island.

European Geopark Network and Geotourism

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Established in 2000, the European Geoparks Network (EGN) aims to protect geodiversity, to promote geological heritage to the general public, as well as to support sustainable economic development of geopark territories, primarily through the development of geological tourism.

The network has drawn together territories from across Europe that share these aims and now work together in an active and dynamic way in order to achieve them. Originally consisting of four territories, the network has been expanded to include, as of May 2010, 37 territories across 15 European countries.

In 2001 the European Geoparks Network signed a formal agreement with the UNESCO Division of Earth Sciences, whereby UNESCO gave the network its endorsement.

A further agreement was signed with UNESCO in 2004 whereby the EGN was given the responsibility for regulating membership of European Geoparks in the UNESCO Global Geoparks Network. As a result the EGN acts as the European sector of GGN.

The structure of the European Geoparks Network is relatively simple and comprises an Advisory Committee (11 members including representatives of UNESCO, IUGS and IUCN) and a Coordination Committee (comprising of two representatives from each member). Decisions concerning the network are only taken by the Coordination Committee. As part of the Coordination Committee, there is an elected EGN Coordinator and Vice Coordinator to represent the whole Network. They coordinate contacts with other international bodies (E.U., UNESCO, IUGS, IUCN, Council of Europe etc.) and prepare the agenda of the meetings in cooperation with the meeting hosts.

The European Geoparks Network adopted a common logo which is registered in all European countries. An EGN member has the right to use the European Geopark logo in its communications thereby contributing over time to creating a common image of quality, linking the enhancement of European Earth heritage with sustainable development.

Membership of the EGN, entitles a Geopark to use the logo of the EGN in its promotional material and is entitled to call itself a European Geopark. According to the Madonie Declaration, it is also entitled to use the appropriate logo of the Global Network of Geoparks. These logos must only be used on products produced directly by the Geopark management.

In order to achieve high quality standards in Geoparks, the EGN decided to establish an evaluation procedure for all new applications. Evaluation missions are undertaken by two Geopark experts who are sent to the applicant territory to evaluate the application and to discuss the application with the relevant national and local authorities as well as stakeholders and local communities.

Vulnerable geosite protection and management in Geoparks – a case study of tafone in Lesvos petrified forest Geopark

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Geoparks consists of a number of adjacent geosites which have different attributes in terms of value (scientific, educational, aesthetics) and vulnerability. In the Lesvos Petrified Forest Geopark area, beyond the fossilized plants which constitute a natural monument of international value, there are many other sites of interest in terms of geology, geomorphology, ecology and local traditions. Coastal geosites of the Lesvos Petrified Forest are of significant geomorphological, aesthetic, educational and touristic value including cliffs, collapsed boulders, tafoni structures and cavernous weathering forms. Tafoni are widespread on the Miocene volcanic formations on Sigri coast. Miocene volcanics are hosting the silicified plants of the Petrified Forest; a protected natural monument of international value and beauty. Due to their importance and fragility the Natural History Museum of the Lesvos Petrified Forest adopted special measures for the protection and conservation of the tafoni structures of the territory. The research activity in the costal area of western Lesvos island led to the inventory of tafoni. As a consequence of the research some endangered tafoni were brought to the museum for protection, conservation and exhibition. This tafoni exhibition introduces the museum visitors to the processes forming the external surface of our planet.

Quaternary tectonics of the Western Carpathians in Poland: Evidence from deformed fluvial terraces

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Neotectonics of the Carpathians used to be studied extensively, particular attention being paid to the effects of large-scale domal uplifts and open folding above marginal zones of thrust and imbricated map-scale folds, and rarely to the characteristics of young faulting. Neotectonic faults tend to be associated with the margins of the Orava-Nowy Targ Basin, superposed on the boundary between the Inner and Outer Western Carpathians, as well as with some regions within the Outer Carpathians. The size of Quaternary tilting of the Tatra Mts. on the sub-Tatric fault were estimated at 100 to 300 m, and recent vertical crustal movements of this area detected by repeated precise levelling are in the range of 0.4-1.0 mm/a in rate. Minor vertical block movements of oscillatory character (0.5-1 mm/yr) were detected along faults cutting the Pieniny Klippen Belt owing to repeated geodetic measurements performed on the Pieniny geodynamic test area. In the western part of the Western Outer Carpathians, middle and late Pleistocene reactivation of early Neogene thrust surfaces was suggested. Differentiated mobility of reactivated as normal Miocene faults (oriented N-S to

NNW-SSE and NNE-SSW) in the medial portion of the Dunajec River drainage basin appears to be indicated by the results of long-profile analyses of deformed straths, usually of early and middle Pleistocene age. Quaternary uplift of the marginal part of the Beskid Niski (Lower Beskidy) Mts. (W-E to WNW-ESE) in the mid-eastern part of the Outer Western Carpathians of Poland was estimated at 100-150 m, including no more than 40 m of uplift after the Elsterian stage. In the Pliocene and Quaternary the Polish Carpathians witnessed differential vertical and some remnant horizontal movements, resulting in the formation of elevated and subsided areas. Morphological examples of Quaternary tectonic activity include, i. a., disturbed longitudinal profiles of strath terraces. Valleys of the Outer Carpathians bear 5 to 9 terrace steps of Quaternary age. Most of Pleistocene terraces are strath or complex-response terraces; the Weichselian and Holocene steps are usually cut-and-fill landforms, except those located in the neotectonically elevated structures, characterised by the presence of young straths. Longitudinal profiles of individual strath terraces frequently show divergence, convergence, upwarping, downwarping, or tilting that can be indicative of young tectonic control. Moreover, the size and rate of dissection of straths of comparable age are different in different morphotectonic units; a feature pointing to variable pattern of Quaternary uplift. Rates of river downcutting result mainly from climatic changes throughout the glacial-interglacial cycles, but their spatial differentiation appears to be influenced by tectonic factors as well. Examples based on detailed examination of deformed straths and fluvial covers in selected segments of the Soła, Skawa, Dunajec, Wisłoka, Jasiołka and Wisłok rivers in the Polish Outer Carpathians appear to indicate Quaternary reactivation of both normal and thrust faults in the bedrock. The latter are mostly confined to the eastern portion of the Outer Carpathians.

Search for Mesolithic Landscapes in Lithuanian territorial waters

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Over last decade members of Underwater Research Centre (URC) from The Institute of Baltic Region History and Archaeology (IBRHA) of Klaipeda University in several locations on the seabed of Lithuanian territorial waters discovered relicts of prehistoric coastlines and traces of submerged forests.

Ancient coastline is marked by stones of washed moraine on the seabed and relicts of coastal cliffs in the depth of 8-22 metres. These are washed separate moraine ridges and their groups, staying higher about 4 metres from actual bottom.

Particular attention of geologists and archaeologists is focused on findings of relict forests on the seabed. Submerged stumps are traced in three sites; two of them are in the neighbourhood of Klaipeda and the third one is south of it. They are separated by 5 km and 22 km (from north to south).

Most advance to the south is site RF-I (Relict forest-I), which is close to Juodkrante, on a sandy bottom in the depth of 26-29 metres. Three stumps with roots in moraine clay loam with about 15 cm of sandy layer had been discovered there. Stumps are rising to the height of 0,5 – 1,5 metres and they remain to be good condition (from 0,4 m to almost 1 m in diameter). The stumps were traced in a range of 6-8 m from each other. Close to them is a terrace with moraine issues of about 1 m in height. By means of ¹⁴C method two stumps were dated. Calibrated date of one of the stumps is 8090 BC. That of the other one is 8948±155 BC. These are relicts of pines (Pinus). These pines belong to pre-boreal period, when level of the Baltic (Joldia) sea dropped to more than 30 metres.

On a stony bottom of the other site (RF-II), in the depth of 14,5 m, a wooden stump, rising 30 cm above the seabed, was traced. There is a sandy layer of 5 cm and clay loam slush around it. Two huge branches are deep in the clay loam. This sample is dated by 5831±120 BC and the date is calibrated.

RF-III appears to be on a sandy bottom, in the dept of 11 metres. Yet one single stump of a relict tree, 33-35 cm in diameter, is discovered there. It is rising up to 50 cm above sand.

Supposedly, the pine broke when falling eastwards from the west, in the direction of coast. Roots are covered with sand, the layer of which is about 40 cm. Under lies gravel. A section of the stump is dated by 7612 ± 66 BC and the date is calibrated. Most probably, this submerged „forest“ is stretching towards the coast. In 19th century close to this site, in Koggalis, waves washed ashore stumps of once growing there trees.

In the neighbourhood of to Svetoji, which is close to Latvian border, bathymetric measurements were made in 2009. Seabed images in the area of 52 km² were also received by side scan sonar. Research in the depth of 8 - 20 m disclosed interesting elements of destroyed relict coasts. Remains of trees were not traced.

All stumps of relict woods were traced incidentally. Attempts were made to find a supposed wreck in RF-I site (a quasi-wreck). A side scan sonar traced a dim object and after diving a trail-net, caught on a stump alongside other stumps, was discovered. At RF-III the sonar traced a dim contour. A few days later a stump was discovered there. Most probably, the sonar sensed remains of net, caught on a stump. Due to storm they were later taken away to another place. A stump for RF-II-1 site was traced, visually exploring the surroundings of huge underwater stones.

When analysing records of the sonar in RF-I site, in about 20-25 m from discovered stumps some small dim spots were traced on a sandy bottom. Perhaps, more stumps are resting there. The side scan sonar sensed similar trails in other site too, sometimes even in an area of a few hundred sq. metres. Yet relict forests had not been looked for systematically. In the summer of 2010 search for ancient coasts and relict forests in a territory of 20 km² is planned, which also includes RF-I area. Water area of about 45 m in depth will be explored, employing Multibeam Echosounder Sea Beam 1185. It will be followed by a diver inspection, and the sites will be filmed with underwater video. Samples of soil will be taken and analysed. Development of methodology for search of relict stumps on a sandy bottom is one of research aims. Search for submerged stumps is aggravated by the fact that most of them are rising above bottom for less than 1 m. Besides, according to available data, their density on the seabed is small. Yet no trunks are discovered. Only those broken close to the soil had survived. Another aim of the research is development of detailed picture of seabed relief. Hopefully, interpretation of data will enable to restore palaeo-geographical environment of this site in 9th – 8th millennium BC and discover probable inhabited locations of Mesolithic period.

The role of paleoseismology in studying an emerging or blind Fault: the case of Nisi fault, NW – Peloponnese, Greece

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Geologic data at epicentral areas regarding surface slip following large earthquakes are occasionally contradicting in the exact locations of fault traces. In addition, this task is more difficult when a blind fault or previously unknown fault ruptures as is the case for the M_w : 6.4 June 8th 2008 Movri Mountain earthquake that struck NW – Peloponnese, Greece is involved. This earthquake caused widespread deformation and damages in buildings, as well as extensive hazards especially in terms of ground surface ruptures. Three surface ruptures were triggered by the Movri Mountain earthquake showing the following geological characteristics. Vertical displacements, up to 30 cm have been identified along a major high angle NNW-striking, 6 km long segment of the co-seismic rupture around the Nisi village area (8 km SE of Varda). Along this rupture zone we also observed several secondary on fault coseismic features, such as landslides and liquefaction phenomena. NNE-trending ruptures in the Petrochori area (18 km ENE of Varda) were mainly observed along a ~500 m wide zone of diffused deformation, accompanied by many landslide phenomena. This rupture zone has a length of ~4km and aligns with the up to now aftershock distribution. The third set of WNW-

striking surface ruptures has been identified throughout the broader epicentral area. However, a major 3 km long WNW-trending zone was mapped west of Michoi village. This orientation displays significant left-lateral component of horizontal motion. The most promising rupture, lying near the epicenter of the event, attains a maximum offset of 30 cm. In this surface rupture a paleoseismological trench was excavated in order to investigate if it was of tectonic origin or just a gravitational effect. Based on seven ^{14}C samples, we identify two surface – rupturing earthquakes in the last 1Ka prior the recent event. Thus, observations from paleoseismology suggest that the Nisi fault earthquake appear not to be random over the last centuries. Our ^{14}C data support the view that this fault resembles other known faults lying along the south coast of the Gulf of Corinth, in terms of slip rate and recurrence interval such as Helike and Schinos faults. Therefore, we infer that the Nisi fault displays a slip rate on the order of 1.5 mm/yr.

Author Index

- Abolmasov B., 17
Acillona P., 374
Adamaki A., 17
Adamcová R., 18
Adamia Sh., 19
Adamson C.S., 19
Agiadi K., 20
Aidona E., 197
Akiska S., 21, 91
Akyildiz M., 280
Albanakis K., 327, 402
Alderton D., 22
Aleksandrowski P., 222
Alekseev V.Yu., 408
Alexandri G., 23
Alexandridis T.K., 70
Alexe V., 103
Alexopoulos A., 182
Alexouli-Livaditi A., 340
Alfieris D., 296
Ali Sh., 23
Aliani F., 234
Aljinović D., 24
Al-Mukhtar M., 36
Alonso F.J., 138
Alp H., 136
Anagnostopoulou Ch., 339
Anagnostou Ch., 402
Anason A., 104
András E., 287
Andrasanu A., 25
Andreeva P., 26
Anselmetti F., 218
Antal B., 402
Antić M., 399
Antonarakou A., 27
Arai S., 242
Argiriou A., 346
Argyriadis I., 27
Arkadaskiy S., 235
Arvanitidis N.D., 28
Asan K., 29
Asatiani G., 184
Asatryan G., 29, 88
Asch K., 41
Asvesta A., 30
Atanasova E., 206
Atanasova-Vladimirova S., 31
Atanassova R., 406
Athanassiou A., 32, 391
Atzemoglou A., 33
Aubrecht R., 33
Aufgebauer A., 288
Avagyan A., 29, 88
Avdev S., 206
Aysal N., 419
Babák K., 34
Bachmanov D.M., 399
Baciu C., 35
Bačo P., 199
Bada G., 83
Badosa S., 36
Baika K., 283
Bais A.F., 346, 421
Bajc J., 180
Bajnoczi B., 275
Bağ E., 104
Bala M., 37
Baldi-Beke M., 280
Balen D., 371
Balinov V., 37
Balintoni I., 157
Balis D., 23
Ballard R., 337
Balogh K., 38, 369
Baranov A., 39
Barati M., 39
Barbera G., 328
Barbu O., 77
Barta G., 275
Barth A., 193
Bassi D., 420
Batistatu V.M., 240
Batki A., 40
Batsi A., 333
Batuk F., 136
Bauer Ch., 218
Baumgartner P.O., 40
Baumgartner P.O., 72
Bavec M., 41
Bayram A.F., 42
Baziotis I., 265
Beck K., 36
Beidinger A., 43
Beljić Č., 362
Bełka Z., 361
Benetatos C., 180
Beqiraj A., 44
Beridze T., 148
Bernoulli D., 72, 352
Bessenyei É., 381
Besutiu L., 44
Betts N., 247
Bezák V., 45
Bilal E., 304
Bilas G., 70
Bilge H., 417
Bilyarski S., 273
Bindea G., 46, 407
Birkenmajer K., 135
Biszczyk-Jakubowska J., 47
Blazev K., 356
Bliznakov A., 206
Blumenstein O., 48
Boaz N.T., 267
Bobrowska A., 310
Boengiu S., 370
Boev B., 415
Boev I., 415
Bogičević K., 48
Bolsée D., 133
Boncheva I., 26
Bonev I.K., 406
Bonev N., 49, 262
Booth J., 50
Bortolotti M., 72
Bortolotti V., 50, 72
Bosse V., 51, 122, 132
Botev E., 93
Botoucharov N., 52
BouDagher-Fadel M.K., 249
Bourlés D., 83
Bourliva A., 53, 54
Bouzas D., 32
Bozilova E., 290, 395
Bozsó G., 54
Bragin N.Yu., 55, 56
Bragina L.G., 55, 56
Brănoiu G., 161
Brânzilă M., 347
Braucher R., 83, 343
Briceag A., 277, 405
Briole P., 109
Broman C., 169
Bronguleev V., 57
Bruntaud X., 36
Brusca L., 86
Brustur T., 103
Büchner J., 57, 392
Bučová J., 58, 367
Bucur I., 59, 348
Buda G., 287
Budai T., 312
Bukowski K., 222
Burg J.-P., 263, 351
Burton P.W., 400
Buxton B., 337
Buyukutku A., 60
Cadicheanu N., 60
Čadjenović D., 188
Cagatay N., 218
Călin N., 104
Çalışkan T.A., 281
Camerlenghi A., 309
Camilli L., 314
Camilli R., 314
Caputo R., 68
Caracciolo L., 61
Caraivan G., 62
Carras N., 182
Carrizo L., 138
Carter E.S., 139
Casale G.R., 360
Casapu I., 62
Cavazza W., 63, 87
Čechovská K., 402
Cehlarof A., 64

Çelik Y., 65, 66
 Ćeliković R., 66
 Cenameri M., 44
 Cetean V., 67
 Chabukiani A., 19
 Chatziangelou M., 68
 Chatzikirkou A., 250
 Chatzipetros A., 68, 69, 296
 Chamberski H., 52
 Chepil P., 220
 Chera C., 62
 Cherif I., 70
 Cherneva Z., 51, 70, 122, 131, 132, 330
 Chiari M., 40, 50, 72
 Chichinadze G., 120
 Chikhelidze K., 120
 Chkhaidze Z., 123
 Chkhotua T., 19
 Chodyń R., 340
 Cholakova Z., 206, 260
 Chowanec J., 73
 Chrissafis K., 391
 Chararas B., 68
 Christodoulou D., 283
 Christofides G., 74, 85, 204, 292, 311, 318, 338, 348
 Christophoridis C., 134
 Chubarova N., 74
 Cieszkowski M., 75, 76, 137, 303, 340
 Çina A., 77
 Cioacă M., 269, 321
 Cioacă M.E., 269
 Ciornei N., 67
 Cociuba I., 59, 297, 392
 Codrea V., 77
 Ćolak A., 242
 Coleman D., 337
 Colosimo A., 360
 Coltoi O., 407
 Colțoi O., 78
 Comanescu L., 142
 Connolly J., 263
 Console R., 79
 Constantinou C.A., 409
 Copuroglu I., 177, 414
 Cosca M., 262
 Costin D., 35
 Cowan D.S., 309
 Crawford T., 248
 Critelli S., 61
 Croff Bell K.L., 337
 Cronan D.S., 79
 Császár G., 59
 Császár G., 81
 Császár G., 82
 Csiki Z., 77
 Csillag G., 83, 185, 343
 Cukur D., 218
 Cuna S., 297
 Ćurić M., 83, 84, 410
 Curran J.M., 248
 Cvetković V., 85, 204, 318, 348, 350, 399
 Czop M., 122
 D'Alessandro W., 86
 D'Atri A., 87
 Danelian T., 29, 88
 Daróczy L., 38
 De Bruijn H., 413
 Decker K., 43
 Deligiorgi D., 307
 Dellaporta K.P., 89
 Delogkos E., 89
 Demaiffe D., 317
 Demer S., 90
 Demirela G., 21, 91
 Depiesse C., 133
 Derco J., 402
 Dervišević R., 66
 Detsi K., 169
 Di Vincenzo G., 87
 Dimitriadis S., 30, 189, 198
 Dimitrijević R., 384
 Dimitriu R., 92, 103
 Dimitrov D., 93, 129, 358
 Dimitrov I., 243
 Dimitrov P., 93, 358
 Dimitrova D., 206, 260
 Dimiza M.D., 398
 Diot H., 317
 Dirik K., 94
 Djerić N., 95, 285
 Dmytrowski P., 96
 Dobos A., 149
 Dobos A., 96
 Dobre L., 96
 Dobrescu A., 62, 97, 99, 368
 Doktor M., 98
 Dolmaz M.N., 183
 Dombay Şt., 98
 Domonik A., 98
 Doncheva M., 37
 Dordea D., 62, 97, 99, 368
 Đorđević-Milutinović D., 220
 Dosztály L., 285
 Downes H., 100, 242
 Drăguţ L., 101
 Drinia H., 27, 102
 Ducea M., 245
 Dudaori O., 120
 Dudjak D., 378, 379
 Dudkin F., 202
 Dufka D., 192
 Duliu O., 103
 Dumańska-Słowik M., 104
 Dumitraş D., 104, 269
 Dumitrica C., 110, 407
 Dunai T.J., 83
 Dunkl I., 152
 Durmeková T., 105
 Dušanić S., 106
 Dyulgerov M., 106, 306
 Dziedzic A., 98
 Dzięgiel M., 107
 Dziubińska B., 107
 Ebner F., 159, 215
 Economou-Eliopoulos M., 7, 108, 109, 406
 Edel J.B., 197
 Edelstein O., 214
 Eisank C., 101
 Eklund J., 407
 Elias P., 109
 Eliopoulos D.G., 109
 El-Mehaghag A.A., 267
 Emil R., 392
 Enciu P., 110
 Eric V., 85
 Esu D., 212
 Etiopie G., 35
 Evaggelatos F., 409
 Evangelistis D., 283
 Fakiris E., 283
 Falalakis G., 187
 Falcone G., 79
 Falus Gy., 213
 Fassoulas C., 111, 164, 422, 423
 Fatka O., 227
 Feidas H., 305
 Fernandez-Steeger T., 146
 Fernandez-Turiel J.-L., 295
 Festa A., 309
 Filipescu D., 321
 Filipescu S., 165
 Filippidi A., 391
 Filippidis A., 53, 112, 177, 295
 Finger F., 371
 Firlinška M., 340
 Fisak J., 389
 Florea F.F., 370
 Florek R., 245, 309
 Fodor L., 83, 112, 343
 Fonoca Al., 284
 Foris D., 113
 Forry F.L., 262
 Fort R., 138
 Forward P., 151
 Fottova D., 389
 Foumelis M., 294
 Fountoulis I., 114, 294
 Fragoulis D., 183
 Frechen M., 275
 Frei D., 170, 249
 Friedman A., 314
 Fritsch E., 114, 391
 Fritz H., 224
 Froitzheim N., 129, 170, 268, 316
 Frontasyeva M., 103
 Frunzescu D., 115, 161
 Fügenschuh B., 350, 352
 Fulga C., 62
 Fülöp A., 116, 214, 231
 Gağała Ł., 117
 Gagnidze N., 184
 Gál Á., 118

Galanakis D., 308
 Galant Y., 118
 Gale L., 119
 Gali Z., 96
 Galoyan G., 88
 Galrouni Ch., 187
 Gamkrelidze I., 120
 Ganas A., 68, 109, 121, 129
 Garcia-Guinea J., 166
 Garecka M., 278
 Gasiorowski M., 122
 Gautier P., 51, 122, 132
 Gavatadze T., 123
 Gawlick H.-J., 33, 81, 124, 258, 335
 Gedl P., 125
 Geçalioglu Kuşcu G., 126
 Geneli F., 127
 Genser J., 273
 Georgiadis I., 128
 Georgiev I., 93, 129
 Georgiev N., 129, 170, 226, 268, 316
 Georgiev S., 130, 145
 Georgieva G., 131, 330
 Georgieva M., 131
 Georgiou Ch., 308
 Georgopoulos N.A., 346
 Geraga M., 283
 Gerasimidis A., 290
 Gerdes A., 57, 371, 392
 Gerdjikov I., 51, 122, 131, 132, 226
 Gerya T., 351
 Gerzina N., 95
 Gherghina A., 142
 Gheuca I., 392
 Ghikas C., 333
 Ghineț C., 104
 Ghita C., 142
 Gillotay D., 133
 Gimeno D., 295
 Giouri A., 54, 134
 Gkarlaouni Ch., 134
 Gladun V., 220
 Glasby G., 296
 Glasmacher U.A., 158
 Gmeling K., 355
 Gméling K., 135, 191
 Gokasan E., 136
 Gokceoglu C., 136
 Golebiowski T., 394
 Golonka J., 75, 76, 98, 137, 140, 219, 245, 309
 Gomez-Heras M., 138
 Göncüoğlu C., 227
 Göncüoğlu M.C., 127, 148, 386
 Gorbunov A., 103
 Goričan Š., 40
 Goričan Š., 124
 Goričan Š., 139
 Goričan Š., 223
 Gorin S., 255
 Gónna M., 96, 140
 Görög Á., 150
 Gorum T., 136
 Gosztonyi Gy., 382
 Goundas I., 166
 Grachev A., 268
 Gradinaru E., 96, 215
 Gradinaru M., 140
 Gradzinski M., 122
 Grecu B., 141, 386
 Grecu F., 142
 Grelewicz M., 142
 Grieco G., 143, 144
 Gross M., 186
 Grozdev V., 145
 Gruijters S.H.L.L., 147
 Grun M., 231
 Grunert P., 154
 Grütznert C., 146, 334
 Gübelin S., 179
 Guex J., 139
 Gugushvili V., 148
 Gulácsi Z., 285
 Gumus E., 424
 Güngör Y., 419
 Gurk M., 238
 Gürsu S., 148
 Gyori A., 149
 Haas J., 150, 215, 285, 312, 319
 Hadži-Niković G., 17
 Hahn A., 151
 Halamić J., 285
 Halásová E., 212
 Hall C., 407
 Hallot E., 122
 Hamilton A., 407
 Hamouzová K., 349
 Harangi Sz., 152
 Harff J., 153
 Hartvich F., 154
 Harzhauser M., 154, 186
 Hatipoglu-Bagci Z., 155
 Hatta T., 277
 Hatzipanagiotou K., 302
 Heath S., 283
 Hecht L., 235
 Hegedüs E., 213, 378
 Heinrich C., 261, 408
 Hercman H., 122, 156, 301
 Hetényi M., 54
 Hidas K., 213
 Hodireva V., 156
 Hoeck V., 157, 165
 Hoffmann N., 157, 158, 342
 Hoinkes G., 218
 Hoprich M., 43
 Horkel K., 159
 Horvath E., 275
 Hosgör I., 227
 Hovorka D., 159
 Hradecký J., 160, 291, 383
 Hraško L., 45
 Hristova V., 161
 Hrvatović H., 24, 285, 377
 Hudáčkova N., 212
 Huertgen J., 342
 Hunger K., 179
 Hyodo H., 38
 Iamandei E., 161, 162
 Iamandei S., 161, 162
 Iancu A., 104
 Iancu O.-G., 347
 Iatan L.E., 304
 Iatrou M., 283
 Ilić M., 163, 253
 Iliiev Tz., 415
 Ilieva E., 256
 Ilieva M., 330
 Iliopoulos G., 164, 240, 422
 Illášová L., 164
 Illášová E., 159
 Inglis G., 337
 Ion A., 392
 Ionescu C., 157, 165
 Jordanidis A., 166, 167
 Iovea M., 103
 Irakleous Th., 409
 Ishida Y., 242
 Islamoglu Y., 323
 Itaya T., 38
 Ivanov D., 161, 168
 Ivanov M., 168
 Ivanov Z., 273
 Ivanova D., 26, 168, 420
 Ivanova I., 260
 Ivanova T.P., 399
 Ivarsson M., 169
 Jackson I., 41
 Jáger V., 185
 Jahn-Awe S., 129, 170, 268, 316
 Jakob J., 171, 238
 Janák M., 268
 Janc D., 83, 84
 Janega A., 105
 Jankowski L., 173
 Jaoshvili G., 172
 Jarmołowicz-Szulc K., 173, 174
 Jarząbkiewicz A., 98
 Jarzyna J., 175
 Jelev V., 206
 Jipa-Murzea C., 77
 Johansson K., 353
 Johnson-Roberson M., 314
 Joniak P., 175, 212
 Jovanović D., 203, 258, 285, 286, 335
 Jovanovski M., 255
 Józsa S., 150, 285
 Jozwiak W., 211
 Jurewicz E., 279
 Jurje M., 214
 Jurkovšek B., 24, 197
 Kaczmarczyk J., 142

Kadosa B., 185
 Kafousia N., 208
 Kafritsa E., 183
 Kagiorgi M., 111
 Kahraman B., 94
 Kaklis T., 409
 Kalaitzidis S., 167
 Kalisperi D., 238
 Kalyoncuoglu U.Y., 176
 Kamaci Z., 281
 Kansun G., 177, 414
 Kantiranis N., 54, 177
 Karacostas Th., 375
 Karadenizli L., 178
 Karadjov M., 415
 Karageorgiou E. D., 302
 Karakitsios V., 208, 328
 Karakostas V., 17, 79, 134, 229, 298
 Karaman M.E., 178
 Karamata S., 215
 Karampelas S., 179, 391
 Karapetsas N., 70
 Karátson D., 152
 Karayigit A.I., 66
 Karipi S., 302
 Karoutsos G., 375
 Karpenko I., 326
 Kartal T., 410
 Karvela V., 225
 Karvounis G., 307
 Karwowski Ł., 244
 Kashilska Z., 243
 Kastelic V., 180
 Kastrati S., 144
 Kati M., 180, 182
 Katsikis J., 302
 Kaus B., 351
 Kavouri S., 183
 Kayin S., 183
 Kazantzidis A., 346, 421
 Kazmierczuk M., 175
 Keaney A., 248
 Kekelia M., 184
 Kekelia S., 184
 Kereszturi G., 185
 Kern A., 186
 Khawaja S., 186
 Khundadze N., 225
 Khutsishvili S., 148
 Kiliyas A., 134, 187, 357
 Kiliyas S., 151, 169
 Kilibarda Z., 188
 Kipfer R., 218
 Kipouros N., 128, 188, 189
 Kirakosyan V., 225
 Kiratzi A., 180
 Kirchenbaur M., 316
 Kiss B., 152
 Kiss G., 190, 285
 Kiss P., 191
 Kitchka A.A., 233
 Klain L., 49, 235
 Kłapyta P., 192
 Klimeš J., 192, 291
 Knobloch A., 193
 Koch R., 59
 Kociu A., 194
 Kohút M., 195
 Kokinou E., 196
 Kokkalas S., 426
 Köksal S., 148
 Kołaczek P., 192
 Kolar Jurkovšek T., 286
 Kolar S., 378, 379
 Kolar-Jurkovšek T., 24, 197, 377
 Koleva-Rekalova E., 168
 Kollanyi K., 280
 Kollias S., 121
 Koltun Y., 221, 300
 Komárková V., 291
 Kondopoulou D., 197, 198, 387
 Kondrat V., 364
 Konečný P., 199, 200
 Konečný V., 135
 Konečný V., 199, 200, 231
 Konidaris G.E., 208
 Koniger P., 275
 Kontakiotis G., 27
 Kopp M., 201
 Koralay O.E., 355
 Koravos G., 400
 Korepanov V., 202
 Korn D., 203
 Koroneos A., 74, 85, 204, 292, 311, 318, 338, 348
 Kortenski J., 374
 Kosakowski P., 205
 Košir A., 223
 Koskeridou E., 20
 Kosler J., 276
 Košťák B., 154, 354
 Kostopoulos D., 249, 263, 333
 Kostopoulos D.S., 32
 Kostopoulou E., 339
 Kostopoulou V., 319
 Kostov I.R., 376
 Kostov R., 205
 Kostyanov S., 206
 Kotsev T., 260
 Kotsev Ts., 206
 Koufos G., 207, 208
 Koukoulis A., 302
 Koukouvelas I., 426
 Kouli K., 208
 Kounov A., 209, 350
 Koutavas A., 210
 Koutsovitis P., 211
 Kovačević N., 84
 Kovacicova S., 211
 Kováčová M., 175, 212
 Kovács A.C., 378
 Kovács I., 213
 Kovács J., 213
 Kovacs M., 116, 214, 231, 382
 Kovács S., 190, 215, 285
 Kövér S., 285
 Kövér Sz., 150
 Kozhoukharova E., 216
 Kozłowska A., 174
 Kozłowska A., 217
 Kranis H., 114
 Krasakopoulou E., 402
 Krastel S., 218, 231
 Krenn K., 218
 Kristály F., 118
 Krkač M., 17
 Krobicki M., 137, 219
 Krohe A., 265
 Krolopp E., 275
 Kronome B., 33
 Kronome K., 33
 Krstić D., 204
 Krstić N., 220
 Krupsky Y., 220, 221
 Krzywiec P., 117, 222, 313
 Kuberska M., 174, 217
 Kucharič L., 402
 Kukoč D., 223
 Kuloshvili S., 184
 Kuparadze D., 225
 Kurt H., 29
 Kurz W., 224
 Kuşcu İ., 21, 91
 Kutluay A., 94
 Kvinikadze M., 225
 Kyriakopoulos K., 86, 328
 Labropoulou E., 346
 Lakova I., 26, 168
 Lalechos S., 225
 Lassiter J., 127
 Lazar I., 140
 Lazarevič Z., 48
 Lazarova A., 226
 Lee E.Y., 43
 Lee I., 39
 Lefebvre B., 227
 Legler C., 193
 Lein R., 124, 258
 Lekkas E., 294
 Lelek D., 228
 Leptokaropoulos K., 229
 Less G., 230
 Less Gy., 280
 Lewandowski M., 361
 Lexa J., 135, 231, 301, 382
 Licha T., 396
 Liermann A., 158
 Lindhorst K., 231
 Linnemann U., 57, 392
 Litt T., 218
 Livaditis G., 340
 Logvinov I., 211
 Loj M., 236
 Lucifora S., 175, 212
 Łukasiak D., 98
 Łukaszewski P., 98
 Lula E., 232

Lula F., 232
 Lüth F., 153
 Lyapunov S., 103
 Lykousis V., 345
 Lyras G., 240
 Lysenko V.I., 233
 Maanijou M., 234
 Machev Ph., 235
 Madej J., 236
 Madeja G., 237
 Magaldi D., 237
 Magganas A., 49, 180, 211
 Magyari E., 152
 Magyari-Sáska Zs., 98
 Maheras P., 339
 Mahon I., 314
 Maith I., 238
 Majdrakov M., 206
 Makarenko A., 57
 Malata E., 239
 Malata T., 117
 Malešević N., 168
 Mali H., 159
 Mallios A., 314
 Malureanu I.I., 240
 Mancini F., 66
 Manetti P., 61
 Maniakas I., 240
 Manta T., 284
 Marchev P., 31, 145, 242, 262
 Marcucci M., 72
 Marijanović P., 242
 Marincea Ș., 104
 Marinela P., 243
 Marinov G., 330
 Marinov S.P., 243, 374
 Marinova A., 256
 Marjanović M., 17
 Markopoulos Th., 397
 Markoski B., 255
 Markou K.B., 346
 Markova K., 243
 Marković Z., 48, 413
 Marroni M., 50
 Martelli M., 86
 Márton I., 262, 382
 Maruntiu M., 147, 317
 Marynowski L., 244
 Marzec P., 245, 309
 Matenco L., 245, 352
 Mațenco L., 100
 Matev Kr., 330
 Mathes-Schmidt M., 334
 Matović V., 369
 Matziaris K., 373
 Mavrikas G., 121
 Mavroulis S., 114
 Mavrudchiev B., 31
 Mayda S., 246
 Mayer A., 371
 Mazzini I., 175, 212
 Mazzoleni P., 328
 McAlister J.J., 248
 McAllister D., 19, 247
 McCabe S., 19, 247, 248
 McKinley J., 248
 Medvedev A., 299
 Megremi I., 406
 Meinhold G., 249
 Meleti C., 23, 421
 Melfos V., 134, 180, 250, 410
 Melinte-Dobrinescu M.C., 277, 336, 405
 Melles M.E., 238
 Mello J., 215
 Memiş Ü., 90
 Mentas A., 409
 Merlini A., 143
 Metaxas Ch., 225
 Metodiev L., 168
 Michael C., 28
 Michailidis D., 250
 Michailidis K., 53, 250
 Michalik J., 82
 Michas G., 86
 Micu C., 92
 Migiros G., 251, 252, 285
 Mihalić S., 17
 Mihaylov E., 330
 Mikadze Kh., 123, 252
 Mikes T., 285
 Mikuš V., 58
 Miladinović Z., 163, 253
 Milakovska Z., 243
 Milevski I., 254, 255
 Milivojević J., 48
 Milovanov P., 256
 Milovanović D., 286
 Milu V., 257
 Milutin J., 188
 Mirek J., 298
 Miri M.M., 234
 Missoni S., 33, 124, 258, 335
 Mitru D., 259
 Mitsis I., 296
 Mladenova V., 206, 260
 Mladenović A., 396
 Mocanu M., 92
 Modesti S., 360
 Moissette P., 20
 Mokrousova O., 260
 Moll M., 261
 Molnár F., 38, 118, 190, 191, 285, 382
 Molnár M., 152
 Monnier C., 317
 Moraru V., 260
 Moritz R., 262, 410
 Moroni M., 144
 Mosonyi E., 262
 Motyka J., 122
 Moulas E., 263
 Mpogiatzis P., 264
 Mposkos E., 265
 Mrowczyk P., 237
 Mrozek T., 265
 Muftah A.M., 267
 Mukhamediev Sh., 268
 Müller P., 83
 Murru M., 79
 Muto F., 61
 Mylonas P., 346
 Naden J., 151, 169
 Nagel T.J., 129, 170, 268, 316
 Nagy S., 165
 Nagy-Póra K., 165
 Nance R., 333
 Nardin E., 227
 Natkaniec-Nowak L., 104
 Neacșu A., 269, 321
 Neagoe C., 141
 Neagu D-D M., 240
 Nedialkov R., 270, 306
 Nedyalkov R., 130
 Negulescu E., 97
 Nejbert K., 361
 Németh G., 152
 Németh K., 38, 185, 231, 270
 Németh Z., 271, 402
 Nenadić D., 48
 Nescieruk P., 272
 Neubauer F., 273, 317
 Nicolescu R., 392
 Nigro F., 76
 Nikolakakis M., 111
 Nikolakopoulos K., 274
 Nomikou P., 275
 Novak M., 203
 Novothny A., 275
 Nowak M., 59
 Nowozynski K., 211
 Ntaflos Th., 23, 152, 276
 Nyilas T., 54
 Oaie G., 277
 Oberhänsli R., 352
 O'Dogherty L., 139
 Ogata K., 309
 Ognjanova-Rumenova N., 415
 Oguchi C., 277
 Ohnishi R., 277
 Okay A.I., 63, 87, 112, 230, 280
 Olszewska B., 278
 Örcen S., 218
 Orešković J., 378, 379
 Orlandea E., 321
 Orlecka-Sikora B., 229
 Orlova T., 388
 Ortelli M., 262, 410
 Oszczytko N., 222, 228, 239, 272, 279, 346, 414
 Oszczytko-Clowes M., 228, 272, 279
 Ovtcharova M., 106, 350
 Özcan E., 112, 230, 280
 Özdemir Z., 280
 Özgür N., 90, 281
 Özsayın E., 94
 Ozsvárt P., 150, 282, 285

Pakkanen J., 283
 Palcu M., 284
 Palinkaš L., 190, 215, 285, 286, 377
 Palmentola G., 370
 Pál-Molnár E., 40, 54, 287
 Palyvos N., 121
 Pamukcu C., 310
 Panagiotakis C., 196
 Panagiotopoulos K., 288
 Panagiotou Ch., 409
 Panaiotu C., 96
 Panaiotu E.C., 140
 Panaite I., 289
 Panaite M., 289
 Panajiotidis S., 290
 Pandolfi L., 50
 Pánek T., 160, 291, 383
 Papadakis G., 86
 Papadimitriou E., 17, 79, 134, 187, 229, 298
 Papadopoulos A., 54, 292
 Papadopoulos G., 426
 Papadopoulou L., 54, 74
 Papageorgiou A., 402
 Papageorgiou S., 409
 Papanikolaou D., 275, 285, 293, 334
 Papanikolaou I., 146, 252, 294, 334
 Papanikolaou M.D., 398
 Papastefanou C., 292
 Papastergios G., 177, 295
 Papatthanassiou G., 296
 Papatheodorou G., 283
 Papavasileiou K., 28, 296
 Papazachos C., 264
 Papp D.C., 297
 Paradisopoulou P.M., 298
 Paraskevopoulos K.M., 391
 Parcharidis I., 294
 Parsons T., 79
 Pataridze D., 225
 Paul Z., 278
 Pavlakis P., 267
 Pavlides S., 68, 69, 89
 Pavlyuk M., 299, 300
 Pawlak J., 301
 Pécskay Z., 22, 85, 100, 118, 135, 191, 200, 204, 214, 231, 301, 311, 338, 355, 382, 415
 Pedrotti M., 144
 Pek J., 211
 Pelikán P., 150
 Pene C., 78, 259
 Perantonis G., 28
 Pergamalis F., 302
 Perraki M., 302
 Person A., 29
 Pertlik F., 303
 Perugini D., 318
 Pescatore T., 303
 Petrescu L., 304
 Petrinec R., 18
 Petrov I., 256
 Petrova S., 168
 Petru E., 304
 Pexaras Th., 305
 Peychev V., 93
 Peytcheva I., 31, 145, 256, 261, 273, 306, 408
 Philippopoulos K., 307
 Photiades A., 72, 307, 308, 327, 344
 Pietsch K., 222, 245, 309
 Pikovskiy Y., 118
 Piller W., 154, 186
 Piller W.E., 154
 Pini G.A., 309
 Pinińska J., 98, 310
 Pipera K., 311
 Piroeva I., 31, 385
 Piros O., 312
 Pisaniec K., 222, 313
 Pitra P., 122
 Pizarro O., 314
 Plasienka D., 314
 Plašienka D., 33, 58, 279, 367
 Pleuger J., 129, 170, 316
 Plissart G., 317
 Plötze M., 18
 Poli G., 85, 204, 318
 Pomoni-Papaioannou F.A., 319
 Pomonis P., 302
 Pop C., 35, 103
 Popa M., 320
 Popescu A., 320
 Popescu C.Gh., 321
 Popescu D.A., 322, 370
 Popescu L.G., 322, 370
 Popkhadze L., 172
 Popkhadze N., 148
 Popov S.V., 323
 Popova I., 330
 Popović D., 106, 286
 Porzucek S., 236
 Posgay K., 213
 Possnert G., 395
 Potfaj M., 303
 Potop V., 324, 349
 Poul I., 154
 Poznanović M., 384
 Preshlenov H., 325
 Příkryl R., 325, 372, 397
 Principi G., 50, 72
 Pristavova S., 256
 Prokisch J., 382
 Proyer A., 218
 Prskalo M., 242
 Prykhodchenko O., 326
 Psomiadis D., 327
 Psonis K., 327
 Puglisi D., 328
 Puskarczyk E., 175
 Pytharoulis I., 375
 Querol X., 66
 Quinta-Ferreira M., 329
 Rabrenović D., 168
 Radev I., 330
 Radulian M., 320
 Radulov A., 358
 Radulović N., 188
 Radulović V., 168
 Radvanec M., 402
 Raeva E., 330
 Raileanu V., 386
 Rajchel J., 331, 332
 Rajchel L., 331, 332
 Rankin A., 151
 Rassios A., 171, 197, 333
 Ratopoulou M., 182
 Razmadze A., 184
 Reicherter K., 146, 157, 158, 334, 342
 Reinsch T., 171
 Reischmann T., 249
 Renda P., 76
 Repouskou E., 397
 Rexhaj A., 193
 Rhoades D., 79
 Richard L., 335
 Ricman C., 103
 Rigopoulos I., 302
 Ringenbach J.-C., 117
 Rizun B., 299
 Roban R.D., 277, 336
 Roger J., 334
 Rojay B., 175, 212
 Rolf C., 275
 Roman C., 337
 Romanidis G., 338
 Romer R.L., 348
 Roşu E., 355
 Rotea M., 165
 Rousakis G., 345
 Rousi E., 339
 Roussiakis S., 164, 250, 391
 Rozos D., 340
 Ruciński P., 340
 Rudenko O., 341
 Rudenko V., 341
 Rudersdorf A., 342
 Ruffet G., 122, 132
 Ruskiczay-Rüdiger Zs., 83, 343
 Ružička P., 18
 Rylko W., 278
 Saccani E., 50, 72, 344
 Sadradze N., 19, 184
 Sahakyan L., 29, 88
 Sakellariou D., 89, 345
 Salata D., 346
 Salerno F., 86
 Salihović R., 66
 Saltamavros A.D., 346
 Sandu A.V., 347
 Sandu I., 347
 Šarić K., 85, 348
 Sarov S., 129

Sarov St., 408
 Sarris A., 196
 Säsäran E., 59, 348
 Säsäran L., 348
 Satrapová J., 349
 Saura E., 117
 Savchak O., 300
 Savić Lj., 220
 Sayılı İ.S., 21, 91
 Sayin N., 350
 Schäbitz F., 288
 Schaltegger U., 106, 350
 Schefer S., 350, 352
 Schenker F.L., 351
 Schmid M.S., 95
 Schmid S.M., 209, 350, 352
 Schmidt S., 268
 Schmitt R.-T., 260
 Schouenborg B., 353
 Schwarz L., 194
 Schwenk T., 231
 SCOPEs team, 145
 Scott S.D., 354
 Sebe K., 185
 Šebela S., 354
 Seer M., 98
 Seghedi I., 9, 100, 231, 320,
 355, 382
 Seifert W., 392
 Şen Ş., 178
 Senatore M.R., 303
 Şengün F., 355
 Şentürk M., 281
 Serafimovski T., 145, 356, 408
 Sfeikos A., 187, 357
 Sfendoni T., 108
 Shanov S., 358
 Shengelia D., 120
 Shevchenko T., 125
 Shields D.J., 365
 Shirasaka M., 242
 Shkodrov B., 358
 Shopov Y., 358
 Shtiza A., 359
 Shubitidze L., 120
 Siani A.M., 360
 Sidorcuk M., 361
 Sidraba I., 156
 Siegesmund S., 396
 Sieniawska I., 222
 Sijerčić I., 66
 Sikalidis C., 53, 177
 Šilhán K., 160
 Silleos G.N., 70
 Simeonova S., 362
 Simić V., 163, 253, 362
 Simon K., 396
 Simon V., 165
 Šinigoj J., 41
 Sir M., 389
 Sklavounos S., 391
 Skourtsos E., 114
 Ślączka A., 75, 76, 137, 303
 Słomka T., 98, 219
 Smith B., 19, 247, 248
 Smolková V., 160
 Smosna P., 122
 Smrečková M., 364
 Snee L., 22
 Sobotka J., 364
 Solakov D., 362
 Šolar S.V., 365
 Soldatos T., 74, 311, 338
 Soliman A., 186
 Sorbi M.R., 366
 Sosson M., 29, 88, 184
 Soták J., 364
 Soukup J., 349
 Soulié-Märsche I., 212, 220
 Spanos S., 367
 Spikings R., 262
 Spiliotopoulos M., 367
 Spišiak J., 164, 367
 Spötl C., 159
 Sprinceana V., 62, 368
 Sprinceană V., 99
 Spry P.G., 410
 Spulber L., 35
 Squires C., 177
 Srečković-Batočanin D., 369
 Stamatakis M.G., 183
 Stamatias G., 252, 334
 Stamatopoulos L., 370
 Stampfli G.M., 11
 Stancheva E., 131
 Stănoiu I., 370
 Starijaš B., 371
 Šťastná A., 325, 372
 Stavrev P., 362
 Stecchi F., 66
 Stefanidou M., 373
 Stefanova M., 243, 374
 Stefouli M., 225
 Stembekr J., 192
 Stevens F., 133
 Stewart R., 38
 Stiros S., 374
 Stoica M., 277
 Stolaki S., 375
 Stoulos S., 292
 Stouraiti C., 375
 Stoyanov V., 206
 Stoykova K., 168
 Strack E., 376
 Strauss P., 43
 Strmić Palinkaš S., 286, 377
 Stuewe K., 224
 Sudar M., 203, 215, 258, 285,
 335
 Sujka G., 156
 Šumanovac F., 378, 379
 Suzuki H., 33, 335
 Swadźba R., 380
 Świąder A., 340
 Sykioti O., 109
 Sýkora M., 367
 Syrides G., 381
 Szabó A., 381
 Szabó Cs., 213
 Szabó Gy., 381
 Szabó Sz., 382
 Szakács A., 100, 118, 231, 320,
 355, 382
 Széll L., 67
 Szobotka S., 103
 Tábořík P., 291, 383
 Takaya Y., 277
 Tančić P., 106, 384
 Tarasov V., 211
 Tarassov M., 385
 Tarassova E., 385
 Tasev G., 356, 408
 Tataru D., 141, 386
 Tchoumatchenco P., 168
 Tekin U.K., 386
 Tekkeli A.B., 136
 Tema E., 387
 Temur S., 414
 ter Borgh M., 245
 Terenetskaya I., 388
 Tesar M., 389
 Thanh N.X., 38
 Theodoridou M., 390
 Theodorou G., 250, 391
 Theodosoglou E., 391
 Thidar A., 277
 Thiel C., 275
 Tibljaš D., 371
 Ticleanu M., 392
 Tiepolo M., 97
 Tietz O., 57, 392
 Tilch N., 194
 Titorenkova R., 385
 Toboła T., 104
 Togonidze M., 120
 Toker E., 393
 Toksoy Koksall F., 127
 Tolika K., 339
 Toljic M., 245
 Tolosana-Delgado R., 61
 Tomecka-Suchon S., 394
 Tonkov S., 290, 395
 Török Á., 390, 396
 Tougiannidis N., 171, 238
 Trajanova M., 396
 Treloar P., 151
 Triantafyllou G., 397
 Triantaphyllou M.V., 267, 293,
 398
 Trifonov V.G., 399
 Trifonova P., 362
 Trivić V., 399
 Trubitsyn A., 39
 Trubitsyn V., 39
 Tsaklidis G., 17
 Tsapanos M., 400
 Tsapanos T., 400
 Tschegg C., 276
 Tsekouras A., 346

Tselepidis V., 285
 Tsiapas E., 401
 Tsikouras B., 302
 Tsimi C., 121
 Tsioura-Vlachou M., 328
 Tsirambides A., 402
 Tsombos P., 327
 Tsompanoglou K., 402
 Tsourlos P., 33, 264, 327
 Tsutsunava T., 120
 Tuček L., 271, 402
 Tunusluoglu M.C., 136
 Tur H., 136
 Turanlı T., 337
 Tusa S., 403
 Tvalchrelidze M., 172
 Tzamos E., 128
 Udubasa G., 404
 Udubasa S.S., 404
 Újvári G., 213
 Üner S., 94
 Unterweissacher T., 159
 Urgeles R., 309
 Ustaszewski K., 352
 Uzuncimen S., 386
 Valev G., 206
 Valiakos I., 423
 Valkaniotis S., 89, 296
 Valter M., 18
 Vamvaka A., 187
 van Lagen B., 167
 van Ruymbekke M., 60
 Vangelov D., 226
 Varga G., 213
 Varnavas S.P., 79
 Vărzaru C., 405
 Vasilasche V., 347
 Vasilatos Ch., 406
 Vasković N., 369
 Vassileva R.D., 406
 Vavelidis M., 48, 134
 Vazquez P., 138
 Velitzelos E., 162
 Vergés J., 117
 Verichev K., 74
 Vįjdea A.M., 147, 407
 Viles H.A., 248, 407
 Vinkler A.P., 152
 Vishnevskaya S.V., 95
 Volkov A., 356, 408
 von Eynatten H., 61
 von Quadt A., 31, 145, 256,
 261, 273, 306, 408
 Voudouris K., 409
 Voudouris P., 180, 250, 262,
 296, 410
 Vouvalidis K., 340
 Vozár J., 215
 Vozárová A., 215
 Vujovic D., 410
 Wacha L., 275
 Wagner B., 231, 288
 Wagreich M., 82, 411
 Warke P.A., 19
 Waškowska A., 75, 98, 137
 Weingartner H., 48
 Weiszbürg T.G., 118
 Wendorff M., 412
 Werner P., 117
 Wessels W., 413
 Wiatr T., 146
 Williams S., 314
 Witek Gh., 284
 Witek K., 37
 Woelfler A., 224
 Wójcik A., 272
 Wójcik-Tabol P., 205, 414
 Wörle M., 179
 Wysocka A., 222
 Xypolias P., 426
 Yağmurlu F., 281, 393
 Yalamov T., 358
 Yalcin M.G., 177, 414
 Yamazaki M., 277
 Yanev S., 26
 Yanev Y., 415
 Yaneva M., 415
 Yavuz O., 416
 Yiğit E., 417
 Yiğitbaş E., 355
 Yılmaz İ.Ö., 280
 Yılmaz S., 418
 Yılmaz Şahin S., 419
 Yılmaz Y., 416
 Yordanov B., 130
 Yudin V.V., 233
 Yumun Z.U., 420
 Yunga S., 268
 Žaba J., 142
 Zabuski L., 265
 Zagorchev I., 420
 Zaharia B., 320
 Zakaraia D., 19
 Zakariadze G., 19
 Zamolyi A., 43
 Zananiri I., 187, 198
 Zaneva-Dobranova E., 37
 Zatoń M., 244
 Zattin M., 63
 Zdravkov A., 374
 Zempila M.M., 421
 Zervopoulou A., 69
 Zhdanova E., 74
 Zhidkov M., 57
 Žic J., 220
 Zidianakis G., 422
 Zilahi-Sebess L., 213
 Živanović J., 362
 Živčić M., 180
 Životić D., 362
 Zoran M., 407
 Zorlu S., 280
 Zouros N., 89, 423, 424
 Zuber A., 73
 Zuchiewicz W., 236, 424
 Zuffa G.G., 87
 Žulkus V., 425
 Zygouri V., 426