Geological Institute
Slovak Academy of Sciences
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THE 4TH INTERNATIONAL WORKSHOP ON THE NEOGENE FROM THE CENTRAL AND SOUTH-EASTERN EUROPE

Abstracts and Guide of Excursion

September, 12 – 16, 2011
Banská Bystrica, Slovak Republic

Edited by
Radovan Kyška Pipík, Dušan Starek, Sidónia Staňová

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ABSTRACTS

GROUND WATER INVESTIGATIONS USING OPTICAL AND MICROWAVE REMOTE SENSING DATA IN SOLANI WATERSHED, UTTARAKHAND, INDIA

Bennia Ahmed[1], S.K. Srivastav[2], R.S. Chatterjee[3], Akhmedshina Madina[4]

[1] redabennia@gmail.fr, Centre for spatial techniques, Algeria
[2] sksrivastav@iirs.gov.in,
[3] Indian Institute of Remote Sensing (National Remote Sensing Agency), 4, Kalidas Road, Dehra Dun 248 001, India. rschatterjee@iirs.gov.in
[4] Centre of Remote Sensing and GIS, Uzbekistan madina.ahmedshina@gmail.com
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This report describes general hdrogeological set for the Solani watershed. Satellie imagery obtained from Landsat-7ETM+ has been analysed to prepare the groudwater prospects map.
It is observed that from the previuos studies optical remote sensing data is not sufficient to map all groundwater parameters at a great level of accuracy. By using SAR interferometry techniques, paleochannels, geomrphic units, lineaments, could be identified and delineated at a reasonable level of accuracy.
In this study following aspects have been covered drainage map, geology, geomorphology, depth to water table map, water table contour map, EC distribution map etc.
From these thematic maps ground water prospects map, has been prepared. As seen in these maps, the depth to water table in this area ranges from 2m from ground level to more than 100m; the EC of ground water varies from 284µS/cm to 2000µS/cm.
Five different prospect zones: excellent, good, moderate, low and runoff zone are identified according to the integration of thematic maps.
It is seen also that northern part of Solani is having low ground water potential than southern part; land is more suitable in southern part of Solani.

TRAGULIDAE AND PECORAN RUMINANTS FROM THE LATEST MIDDLE MIOCENE (SARMATIAN) OF THE STYRIAN BASIN (AUSTRIA)

Manuela Aiglstorfer[1,2], Madelaine Böhme[1,2], Martin Gross[3], Jan van der Made[4], Jérôme Prieto[1,5,7], Gertrud E. Rössner[5,6,7]

[1] Institute for Geoscience, Sigwartstraße 10, 72076 Tübingen, Germany, manuela.aiglstorfer@uni-tuebingen.de
[2] Senckenberg Center for Human Evolution and Palaeoecology (HEP), Sigwartstraße 10, 72076 Tübingen, Germany
[3] Universalmuseum Joanneum, Department of Geology & Palaeontology, Weinzöttlstraße 16, 8045 Graz, Austria
[4] Museo Nacional de Ciencias Naturales, C/ José Gutiérrez Abascal 2, Madrid 28006, Spain
[5] Department für Geo- und Umweltwissenschaften, Paläontologie & Geobiologie, Richard-Wagner-Str. 10, 80333 München, Germany
[6] GeoBio-Center der Ludwig-Maximilians-Universität München, Richard-Wagner-Str. 10, 80333 München, Germany

[7] Bayerische Staatssammlung für Paläontologie und Geologie, Richard-Wagner-Str. 10, 80333 München, Germany

One of the very few localities from the Sarmatian *sensu stricto* in the Paratethys realm with a qualitatively and quantitatively rich vertebrate fauna is located near the town Gratkorn, at the northeastern realm of the Styrian Basin (Austria), near the Alpine escarpment. During a regression at the early to late Sarmatian intersection (Volhynian-Bessarabian-Intervall), continental gravels and soils have been deposited over marine sediments. Up to now, 62 vertebrate taxa are recorded from the paleosol of Gratkorn, which consequently hosts one of the richest and most complete terrestrial vertebrate faunas of that time period (12.2–12.0 Ma; Gross et al., in press). Besides many smaller mammals, reptiles, amphibians, fishes and some remains of birds, an interesting range of larger mammals including *Euprox furcatus*, *Micromeryx flourensianus*, and *Dorcatherium naui* was excavated. This is one of the rare records of *Dorcatherium naui* older than Pannonian and the oldest finding of *Dorcatherium naui* from the Paratethys realm so far. Up to now *Dorcatherium naui* of pre-Pannonian ages have only been described from Przeworno (Poland; Glazek et al., 1971), and Abocador de Can Mata (Vallès-Penedès Basin, Spain; Alba et al., 2011), which are of similar age as Gratkorn. Therefore, the latter does not only represent one of the oldest records of *Dorcatherium naui* but also supports the wide distribution of the taxon already at the latest Middle Miocene. Comparing Gratkorn (late Sarmatian) with localities nearby providing a comparable large mammal faunal richness, interesting aspects can be observed. At Gratkorn and St. Stefan/Lavanttal (Carinthia; early Sarmatian), *Dorcatherium* but no bovids were found so far (Gross et al., in press), whereas in contemporaneous sediments in the eastern Styrian Basin and in the Vienna Basin bovids are present, and in the Sarmatian sediments of the Vienna Basin even quite divers (Gross et al., in press). Both, the eastern Styrian Basin and the Vienna Basin are missing any *Dorcatherium* species (Gross et al., in press), though. By contrast, the early Pannonian locality of Atzelsdorf (Vienna Basin) provided abundant material of both groups (Hillenbrand et al., 2009). The segregative distribution of *Dorcatherium* and bovids during the Sarmatian, and the following coexistence in Atzelsdorf, has most probably ecological and climatological reasons. Thus, with the material of Gratkorn previous ideas on ecological adaptations in *Dorcatherium* (Rössner, 2004) are supported and the understanding of the ecological niche of the "forest-dweller" *Dorcatherium* is specified. Besides new observations on the dispersal, evolution and ecology of *Dorcatherium*, the locality of Gratkorn enables a more detailed view on its species separation, which was in discussion in the past. By comparing the specimens from Gratkorn with material from Austria and the North Alpine Foreland Basin a clear distinction between *Dorcatherium crassum* and *Dorcatherium naui* can be drawn and enforces the taxonomic separation of the two species as accepted by several authors recently (e.g. Hillenbrand et al., 2009; Alba et al., 2011).

References:

Alba, D.M. et al. (2011). Middle Miocene tragulid remains from Abocador de Can Mata: the earliest record of *Dorcatherium naui* from Western Europe. Geobios, 44, 135-150.

Glazek, J. et al. (1971). Miocene vertebrate faunas from Przeworno (Lower Silesia) and their geological setting. Acta Geologica Polonica, 21, 3, 473-516.

Gross, M. et al. (in press). Gratkorn – A benchmark locality for the continental Sarmatian s. str. of the Central Paratethys. International Journal of Earth Sciences, doi: 10.1007/s00531-010-0615-1.

Hillenbrand, V. et al. (2009). The early Vallesian vertebrates of Atzelsdorf (late Miocene, Austria). 7. Ruminantia. Annalen des Naturhistorischen Museums Wien, 111A, 519–556.

Rössner, G.E. (2004). Community structure and regional patterns in late Early to Middle Miocene Ruminantia of Central Europe. Courier Forschungs-Institut Senckenberg, 249, 91-100.

MARINE CONNECTIONS OF THE CENTRAL PARATETHYS AND THE MEDITERRANEAN IN THE UPPER BADENIAN

Miloš Bartol[1], Aleksander Horvat[1,2], Vasja Mikuž[1,2]

[1] Ivan Rakovec Institute of Paleontology ZRC SAZU, Novi trg 2, SI-1000 Ljubljana, Slovenija
[2] University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, Privoz 11, SI-1000 Ljubljana, Slovenija

The Slovenian Corridor, a marine connection between the Central Paratethys and the Mediterranean, opened during a syn-rift phase of the Pannonian Basin formation in the Karpatian. It is widely assumed that this seaway closed by the end of the Middle Badenian at the NN5/NN6 boundary so in the Upper Badenian the Central Paratethys communicated only with the Indopacific bioprovince and the Eastern Paratethys (Harzhauser & Piller, 2007; Steininger & Wessely, 2000; Rögl, 1998). New paleontological evidence from two independent studies: Miocene siliceous phytoplankton of the Krško basin (Horvat, 2004) and calcareous nannoplankton of the Mura depression/Mura-Zala Basin (Bartol, 2009) suggests that the connection between the Central Paratethys and the Mediterranean remained active untill the end of the Badenian.

The Badenian nannoplankton assemblages from the Mura depression closely resemble contemporary Mediterranean assemblages. The succession of biostratigraphic events above the NN5/NN6 boundary: LO of *Sphenolithus heteromorphus*, LCO and LO of *Cyclicargolithus floridanus*, FCO of *Reticulofenestra pseudoumbilicus* (>7 μm), the appearance of the first scattered specimens of *Calcidiscus macintyrei*, observed in the Lenart section (Central Paratethys) and several Mediterranean sites (Fornaciari et al., 1996) is identical. A comparison of ODP and DSDP reports from the world ocean reveals that only the LO of *Sphenolithus heteromorphus* is a globally well correlated event, while the others are diachronous or missing in various regions. The parallelism observed is therefore not a reflection of a universal global trend but rather suggests the existence of a connection between the neighbouring realms during the lower part of NN6.

Diatom assemblages from the oldest marine facies in the Krško basin are of Upper Badenian age - the Krško basin was not flooded before the beginning of the TB 2.5 cycle (Horvat, 2004). The mollusc assemblages of the Krško basin contain the gastropod species *Pereiraea gervaisi* (Vézian). This species can only be found in the Mediterranean, the Western Paratethys and at the Central Paratethys, where it occurs in Upper Badenian or younger sediments (Mikuž, 2000). The paleogeographic distribution of *P. gervaisi* in the Central Paratethys is restricted to its nort-western part. This clearly indicates that the colonisation of the Central Paratethys must have led across the Slovenian Corridor and not through some south-eastern marine connection.

References:

Bartol, M. (2009). Middle Miocene calcareous nannoplankton of NE Slovenia (western Central Paratethys). – ZRC SAZU Publishing, Ljubljana, 136 pp.

Harzhauser, M. & Piller, W. E. (2007): Benchmark data of a changing sea – Paleogeography, Pleobiogeography and events in the Central Paratethys during the Miocene. – Palaeogeography, Palaeoclimatology, Palaeoecology, 253, 8-31, Amsterdam.

Horvat, A. (2004). Middle Miocene siliceous algae of Slovenia: paleontology, stratigraphy, paleoecology, paleobiogeography. – ZRC SAZU Publishing, Ljubljana, 255 pp.

Fornaciari, E., Di Stefano, A., Rio, D. & Negri, A. (1996): Middle Miocene calcareous nannofossil biostratigraphy in the Mediterranean region. – Micropaleontology, 42/1, 37-62, New York.

Mikuž, V. (2000). Pereiraea gervaisi (Vézian) from Miocene beds south of Šentjernej in Lower Carniola. – Geologija, 42 (1999), 123-140, Ljubljana.
Rögl, F. (1998). Palaeogeographic considerations for Mediterranean and Paratethys Seaways (Oligocene to Miocene). – Ann. Naturhist. Mus. Wien, 99A (1997), 279-310, Wien.
Steininger, F. F. & Wessely, G. (2000). From the Tethyan Ocean to the Paratethys Sea: Oligocene to Neogene stratigraphy, paleogeography and paleobiogeography to the circum-Mediterranean region and the Oligocene to Neogene basin evolution in Austria. – Mitt. Österr. Geol. Ges., 92, 95-116, Wien.

PALAEOPRECIPITATION IN THE EASTERN PARATETHYS REGION BEFORE, DURING AND AFTER MESSINIAN SALINITY CRISIS (LATE MEOTIAN, PONTIAN, KIMMERIAN)

Madelaine Böhme[1], Davit Vasilyan[1], Michael Winklhofer[2]

[1] Senckenberg Center for Human Evolution and Paleoecology (HEP), Institute for Geosciences, University Tuebingen, Tuebingen, Germany, m.boehme@ifg.uni-tuebingen.de, davit.vasilyan@ifg.uni-tuebingen.de.
[2] Department of Earth- and Environmental Science, University Munich (LMU), Munich, Germany, michael.winklhofer@geophysik.uni-muenchen.de.

Age control on Eastern Paratethys regional stages during the Miocene-Pliocene transition is improved recently (Krijgsman et al. 2010). Based on this stratigraphic framework, as well as well-resolved regional small mammal biostratigraphy (e.g. Nesin & Nadachovski 2001, Hordijk & De Bruijn 2009) it is now possible to estimate palaeoprecipitation in the Eastern Paratethys at a temporary higher resolution.
Precipitation estimates are based on the bioclimatic analysis of rich and well dated fossil herpetofaunal assemblages (Böhme et al. 2006), coming from the western and northern part of the Eastern Paratethys (Hungary, Greece, Ukraine, Russia).
Data from the late Meotian to the middle/late Kimmerian (~6.2 to ~3.8 Ma) indicate an overall warm and humid to very humid climate (60% to over 200% more precipitation than today), with two remarkable dry (and cool?) intervals with 30 to 40% less precipitation than today. The first dry period correspond to the Pontian regional stage (6.04 – 5.6 Ma), whereas the second dry period is dated to 3.95 Ma and correlates to the middle/late Kimmerian.
These results support a postulated (Krijgsman et al. 2010) change in the Euxinian Basin from a negative hydrologic budged of the during the Pontian to a positive hydrologic budged in the early Kimmerian (~5.4 Ma), with possible implication to the proposed overspilling of Paratethys waters into the Mediterranean Basin during the Lago Mare phase of the Messinan Salinity Crisis (Cita et al. 1978).

References:

Böhme, M. , Ilg, A., Ossig, A., Küchenhoff, H. (2006). A new method to estimate paleoprecipitation using fossil amphibians and reptiles and the Middle and Late Miocene precipitation gradients in Europe. Geology 34, 6, 425-428.
Cita, M.B., Wright, R.C., Ryan, W.B.F., Longinelli, A. (1978). Messinian paleoenvironments. In: Hsü, K.J. (Ed.), Initial Reports of the Deep Sea Drilling Project, pp. 1003–1035.
Hordijk, K., De Bruijn, H. (2009). The succession of rodent faunas from the Mio/Pliocene lacustrine deposits of the Florina-Ptolemais-Servia Basin (Greece). Hellenic Journal of Geosciences 44, 21-103.
Krijgsman, W., Stoica, M., Vasiliev, I., Popov, V.V. (2010). Rise and fall of the Paratethys Sea during the Messinian Salinity Crisis. Earth and Planetary Science Letters 290, 183–191.
Nesin, V.A., Nadachovski, A. (2001). Late Miocene and Pliocene small mammal faunas (Insectivora, Lagomorpha, Rodentia) of Southeastern Europe. Acto Zooligca cracoviensia 44, 2, 197-135.

LOWER/MIDDLE MIOCENE DEPOSITS FROM THE SLOVENJ GRADEC BASIN (NW SLOVENIA)

Stjepan Ćorić[1], Mirka Trajanova[2], Andrej Lapanje[2]

[1] Geological Survey of Austria, Neulinggasse 38, A- 1030 Vienna, Austria, stjepan.coric@geologie.ac.at
[2] Geological Survey of Slovenia, Dimičeva ulica 14, 10000 Ljubljana, Slovenia

Several basins were formed along the Lavantal fault system in the Miocene to Pliocene. One of them, surrounded by thick succession of Miocene clastic sedimentary rocks, occurs in the area of Slovenj Gradec. There, borehole MD-1/05 penetrated at least 852 m thick Miocene marine succession.

Stratigraphic subdivision of the sedimentary rocks in the borehole MD-1/05 is based on the investigation of calcareous nannoplankton assemblages from samples of drilling cuttings. Upper part (38m - 852m) of the section penetrates lower to middle Miocene sediments. The lowermost part of the section (868m – 1260m), containing blocks of Mesozoic carbonate rocks (olistolites?), probably belongs to the lower Miocene basal clastic sedimentary rock sequence. No fossils were found in it, consequently its' strict stratigraphic ranking was not possible.

The Miocene part of the section can be subdivided to the following units based on nannoplankton biostratigraphy:

1. NN5 from 38m – 270m (lower to the middle Badenian; upper Langhian to the lowermost Serravallian) rich nannoflora dominated by: *Coccolithus pelagicus*, *Cyclicargolithus floridanus*, *Helicosphaera carteri*, reticulofenestrids (*Reticulofenestra gelida*, *R. haqii*, *R. minuta*, *R. pseudoumbilica*), *Sphenolithus heteromorphus*, *S. moriformis* etc. In the lowermost part occurs *Helicosphaera waltrans* (228m – 240m).
2. NN4 from 288m – 592m (middle/upper Ottnangian to the lower Badenian; the upper Burdigalian to the lower Langhian) rich nannoplankton assemblages contain similar assemblages with *Helicosphaera ampliaperta* and *Sphenolithus heteromorphus*.
3. NN4 from 600m – 652m (middle/upper Ottnangian to the lower Badenian?; the upper Burdigalian to the lower Langhian), rare assemblages with very scare *S. heteromorphus*.
4. NN4 from 658m to 830m (the upper Ottnangian – Karpatian; upper Burdigalian) very rare lower Miocene forms with zonal marker: *H. ampliaperta* and *S. heteromorphus*.
5. Lower Miocene from 840m – 852m with scarce species which have first occurrences in the uppermost Oligocene and lower Miocene: Helicosphaera carteri and Reticulofenestra pseudoumbilica.
6. The sequence from 852 – 1260 m: probably lower Miocene basal conglomerates containing olistolites (?) of Triassic carbonate rocks.

Early Badenian transgression, which reached the Lavantal Basin (Reischenbacher et al., 2007) can be compared with the short period with *Helicosphaera waltrans* in the lowermost part of the unit 1 of the succession in the Slovenj Gradec basin.

MIOCENE SNAKE FAUNA FROM VRAČEVIĆ (SERBIA): MORPHOMETRIC ANALYSIS

D. Djurić[1], D. Cvetković[2], V. Vujić[2], L. Rubinjoni[2]

[1] Natural History Museum, Belgrade, Serbia
[2] Faculty of Biology University of Belgrade, Belgrade, Serbia, dragana.djuric@nhmbeo.rs

Neogene snake fauna in Eurasia has been subject to much research interest recently (e.g. Rage & Danilov, 2008; Szyndlar, 2009; Venczel, 2011), but the data from the central Balkans is still scarce; specifically, Miocene snakes from this region are poorly known. The aim of this study was to analyse the fossil snake assemblage from Vračević locality (Kolubara district), 80 km southwest of Belgrade (Serbia). In the layer of sandy clays on the banks of Grabovac stream, a rich fossil association was found, including the representatives of all major vertebrate groups, as well as terrestrial and freshwater malacoufauna (Marković, 2003). The age of the locality was estimated as Middle Miocene (European Land Mammal Zone MN 7/8), based on analyses of micromammalian (Marković, 2003) and malacofauna (Kovalenko, 2004). The available ophidian material from this site consists of about 107 trunk vertebrae or vertebral fragments. The remains are referred to following taxa: *Elaphe* sp., *Coluber* sp., *Natrix* sp., *Telescopus* sp. (family Colubridae) and *Vipera* sp. (family Viperidae); also present were indeterminable Scolecophidia. Out of the total sample, we used the subset of most preserved vertebrae (belonging to four taxa: *Elaphe* sp., *Coluber* sp., *Natrix* sp. and *Vipera* sp.) for morphometric analysis. Standard measurements were taken according to Szyndlar (1984). We also used the smaller subset of 23 most complete vertebrae in order to explore its potential for geometric morphometry analyses and report the first results here.

References:

Kovalenko V. (2004). Lymnaeidae iz mestonahoždeni Trijebine i Vračević, Serbia. Bulletin de l'Academie serbe des sciences et des arts 42, 327-339.

Marković Z. (2003). The Miocene small mammals of Serbia, a review. In: Reumer J.W.F. & Wessels W. (eds.) Distribution and migration of Tertiary mammals in Eurasia. Deinsea 10:393-398.

Rage J.C., Danilov I. (2008). A new Miocene fauna of snakes from eastern Siberia, Russia. Was the snake fauna largely homogenous in Eurasia during the Miocene? C. R. Palevol 7, 383–390.

Szyndlar Z. (1984). Fossil snakes from Poland. Acta zool. cracov. 28, 1, 1-156.

Szyndlar Z. (2009). Snake fauna (Reptilia: Serpentes) from the Early/Middle Miocene of Sandelzhausen and Rothenstein 13 (Germany) Palaontol Z 83, 55–66.

Venczel M. (2011). Middle-late Miocene snakes from the Pannonian basin. Acta Palaeontologica Romaniae 7, 343-349.

CONSTRAINTS FOR THE STRUCTURAL EVOLUTION IN THE PANNONIAN BASIN SYSTEM: A STATE OF THE ART

László Fodor[1,2], Frank Horváth[3], Emő Márton[4], Kamil Ustaszewski[5], Endre Dombrádi[3]

[1] Geological Institute of Hungary, 1143 Budapest Stefánia 14, Hungary, fodor@mafi.hu
[2] Eötvös University, Dept. of Regional Geology Budapest, Hungary
[3] Eötvös University, Dept. of Geophysics, Budapest, Hungary
[4] Eötvös Lóránd Geophysical Institute, Budapest, Hungary
[5] Lithosphere Dynamics, GFZ German Research Centre for Geosciences, Potsdam, Germany

Recent advances in various fields of geosciences led to a better understanding the structural evolution of the Pannonian Basin and surrounding orogenic belt. In the presentation we review constraints which are important for the timing and kinematics of the two distinct crustal wedges (Alcapa and Tisza-Dacia units) which were emplaced into the Carpathian embayment.

1) Dextral slip along the Periadriatic line (PL) and its eastern continuation, the Mid-Hungarian Shear Zone (MHZ) at the southern margin of the Alcapa unit started in the late Early Oligocene. Basin stratigraphy indicates subsidence in the middle Oligocene (ca. 30-28 Ma) and widespread magmatism along the PL-MHZ and also in the Sava zone of the Dinarides. Paleogeographic connection between the Hungarian and Slovenian Paleogene basins do not allow major separation before ca. 30Ma. Thus ~30 Ma can be considered as the onset of strike-slip deformation. Structural data suggest transpressional deformation with compression perpendicular or slightly oblique to basin axis (WNW–ESE in present, while N-S in original position).

2) Major extension (~22-16 Ma) in the Eastern Alps resulted in the exhumation of mid-crustal rocks units in the Tauern window. Along the western and southern boundary of the Pannonian basin a similar process led to the formation of the Rechnitz window, the Pohorje massif and several metamorphic complexes in the Sava zone. As an expression of extension, dextral slip continued along the PL-MHZ up to the onset of late Early Miocene sedimentation (19 Ma). Extensional collapse of the Pannonian basin proper (syn-rift sedimentation) took place in the 19 to 11.5 Ma time interval.

3) The most essential element of this extensional collapse were the coeval opposed rotations of the Alcapa (counterclockwise) and Tisza-Dacia (clockwise) units of up to 80-90°. This rotation is extremely well-constrained in the Alcapa unit, where it occurred between 18.5 and 14.5 Ma. Restoration of Alcapa and Tisza-Dacia units and reconstruction of the paleostress fields suggest a quite homogeneous, originally E-W oriented extensional features, which developed further during rotation. This suggests that rotational deformation was driven by the same mechanism of extension.

4) Rotations were not homogenous in amount within the two major blocks, but seem to increase eastward. The locations of the largest rotations seem to migrate eastward; a young rotation of 14(?)-12 Ma occurred only in the eastern part of the blocks, while the western and central parts did not show rotation. These differential rotations were accommodated by opening of deep grabens, also pointing to connection of extension and rotations.

5) The rotational deformation modified the geometry of the extruded blocks and juxtaposed Alcapa, and the Tisza-Dacia units. Their further history during the 11.5 and 5 Ma time interval (post-rift phase) was characterised by minor extension and major subsidence and sedimentary upfill.

6) The earliest phase of extension was associated with magmatism. Voluminous rhyolites and andesites of the central Pannonian basin are partly pre-, partly syn-rotational (~20-18.5 and ~17.5-14Ma, respectively). All volcanic rocks suffered brittle extensional deformation. The granodiorite of the Pohorje (18,6 Ma) suffered ductile to brittle extensional deformation corresponding to larger extrusion depth. This timing and the geochemical data indicate that magma generation was connected with crustal extension and melting. Subsequent calc-alkaline magmatism has continued after major rotations (after 14 Ma) until recent times in the south-eastern region of the Tisza-Dacia unit.

7) The 5-0 Ma time interval of the Pannonian basin is characterised by a transition from extensional to compressional stress field, evidenced in the compressional or transpressional inversion of numerous normal faults. Counterclockwise rotations could associate with this deformation.

NEW PALAEOECOLOGICAL DATA OF SELECTED HORIZONS OF THE STUDIENKA FORMATION BASED ON THE PRELIMINARY RESEARCH OF MICRO - AND MACROFAUNAL ASSEMBLAGES AT ROHOŽNÍK (VIENNA BASIN, WESTERN CARPATHIANS)

Tomáš Fuksi, Matúš Hyžný, Natália Hudáčková

Department of Geology and Paleontology, Faculty of Natural Sciences, Mlynská dolina G1, 842 15, Bratislava, Slovakia

At the Rohožník locality, situated near the foothill of the Malé Karpaty Mts. in the Záhorská Lowland (the Vienna Basin), marine sediments of the Middle Badenian to the Sarmatian age were exposed for the clay mining in the last century. Here we present a combination of the new statistical approach of old datasets, new determinations of mollusks from core–samples collection stored in the Slovak National Museum and collection of decapod crustaceans as well. Studied material comes either from wells or directly from the former clay pit. Concerning the Foraminifera, 70 species have been recorded, representing the time span from the Late Badenian to Sarmatian. Examined mollusk association is composed of gastropods, bivalves, scaphopods and chitons; 26 mollusk genera have been determined. Decapod crustacean association present at Rohožník locality is composed of several taxa; detailed description is currently in progress. Association is dominated by two brachyuran crab species, *Tasadia carniolica* and *Branchiolambrus* sp.; mud shrimps, hermit crabs, box crabs and swimming crabs are also present. The carapace material comes from carbonatic nodules, however, many fragmentary specimens (usually isolated fingers) are known from surrounding clayey sediment.

Most likely, fauna observed here represents community of deeper marine conditions with intervals of the shallow littoral sea influx. Oscillations of marine depth and salinity are observed. Layers of the brackish sediments are wider and more frequent towards to the top of studied profiles. Detailed palaeoecological interpretation was performed to help interpret the ecological preferences for the decapod crustacean species present in the studied locality, as ecological preferences of *Tasadia* and *Branchiolambrus* are unknown as both have no extant congeners.

MIDDLE MIOCENE (KONKIAN) CALCAREOUS NANNOPLANKTON AND FORAMINIFERAL ASSEMBLAGES (TAMAN PENINSULA AND CIS-CAUCASIA, RUSSIA)

L.A. Golovina[1], Y.V. Vernigorova[2]

[1] Geological Inst. RAS, Moscow, Pyzhevskiy 7, golovinal@mail.ru, golovina@ginras.ru
[2] Inst. of Geological Sciences NAS of Ukraine, Kiev, O. Gonchar 55, vernigorof@yandex.ru

Calcareous nannofossils and foraminifers from sections of the Taman Peninsula (Zelensky Hill) and the Western Cis-Caucasia (Fars, Belaya, Pshekha rivers) have been investigated to stratigraphic data and palaeoenvironmental changes during the Konkian time (Vernigorova J., Golovina L., Goncharova I. 2006; Golovina, Vernigorova, Beluzhenko E., 2009). Based on

distribution of these groups the sections Pshekha and anticline Zelensky have been subdivided on three parts. Rich and poor associations are alternated in the sections. The richest calcareous nannoplankton assemblages were found in the middle part of these sections. They consist *Braarudosphaera bigelowi*, *Coccolithus pelagicus*, *Cricolithus jonesi*, *Reticulofenestra pseudoumbilica*, *Rhabdosphaera sicca*, *Helicosphaera carteri*, *Lithostromation perdurum*, *Sphenolithus moriformis*, *Discoaster* sp., *Helicosphaera* sp., *Sphenolithus* sp., *Thoracosphaera* sp. and, according to Martini's zonation (1971), it corresponds to NN6/NN7.
occurrence of *Rhabdosphaera poculi* and *Rhabdosphaera pannonica* in these assemblages may determine to NN7 Zone **(**Branzilal, Chira, 2005).
Species diversity of foraminifera varies and depends on various factors. Some of the very thin layers within the middle part of the anticline Zelensky section contain rich and diverse foraminiferal assemblages with plankton species: *Paragloborotalia mayeri*, *Globigerina* sp. (juv.), *Globigerina* sp. 1, *Guembelina* sp, *Pseudohastigerina* sp., and benthic forms: *Discorbis kartvelicus*, *D. supinus*, *Asterigerina* sp., *Cassidulina bulbiformis*, *Cassidulina* sp., *Angulogerina angulosa*, *Uvigerina gracilissima*, *Bolivina dilatata*, *Bulimina* ex gr. *elongata*, *Buliminella elegantissima*, *Globulina gibba*, *Virgulina schreibersiana*, *Quinqueloculina gracilis*, *Q. badenensis*, *Q.* ex gr. *consobrina*, *Q. konkeksis*, *Q. minakovae ukrainica*, *Quinqueloculina* sp. 1, *Sigmoilina mediterranensis*, *Melonis soldanii*, *Nonion granosus*, *Florilus boueanus*, *Elphidium antonina*.
Based on the study of foraminifers and calcareous nannofossils in the sections are distinguished several regional levels in the upper part of the Konkian, that characterized by distortions in the basin hydrological regime, when the salinity strongly decreased. These palaeoenvironmental conditions are reflected by the deposition of coccolithic limestones, containing bloom of cosmopolitan nannofloral species *Reticulofenestra pseudoumbilica.*

References:

Branzilal M., Chira C. (2005). Microfossils assemblages from the Badenian/Sarmatian boundary. Acta Paleontologica Romaniae. V.5.P/17-26.

Golovina L., Vernigorova J., Beluzhenko E. (2009). A new micropaleontologic study of the Konkian sediments of the Western Ciscaucasia. Proceedings Inst. of Geological Sciences NAS of Ukraine, Kiev. P. 311-321.(In Russian).

Martini, E. (1971). Standard Tertiary and Quaternary Calcareous Nannoplankton Zonation. Proceedings of the II Planktonic Conference, Roma, 1970, A. Farinacci, ed., Ed. Tecnoscienza, p. 739 – 785.

Vernigorova J., Golovina L., Goncharova I. (2006). On the characterization of Konkian deposits of the Taman Vernigorova J., Golovina L., Goncharova I. 2006. Peninsula."Problems of Paleontology and biostratigraphy of the Proterozoic and Phanerozoic. Proceedings Inst. of Geological Sciences NAS of Ukraine, Kiev. P. 231-242. (In Russian).

CORRELATION OF THE ILLITE-SMECTITE DIAGENESIS IN THE SAVA DEPRESSION WITH OTHER SUB-BASINS OF THE PANNONIAN BASIN SYSTEM

Anita Grizelj[1], Darko Tibljaš[2], Marijan Kovačić[2]

[1] Croatian Geological Survey, Zagreb, 10000, Croatia, anita.grizelj@hgi-cgs.hr
[2] Faculty of Science, University of Zagreb, Zagreb, 10000, Croatia, dtibljas@geol.pmf.hr, mkovacic@geol.pmf.hr

The aim of the present study is correlation of changes of mineral composition with increasing burial depths in pelitic sediments from the Sava Depression, sub-basin in the south-western part of the Pannonian Basin System (PBS), with those from the neighbouring sub-basins in the PBS.

Transition from R0 to R1 type of illite-smectite (I-S), as well as from R1 to R>1 type I-S can be used for determining thermal maturity of source rocks and oil generation potential. Investigations of the illitization process of smectite have been recently performed in the Croatian part of the PBS (Grizelj et al., 2011). In the neighbouring sub-basins the process was well documented earlier by Franců et al. (1990), Hámor-Vidó & Viczián (1993), Hillier et al. (1995), Tanács & Viczián (1995) and Sachsenhofer et al. (1998).

Based on XRD data the transition from R0 to R1 type I-S in the Sava Depression started at depths <1.8 km and temperature above 80°C. Slightly higher temperatures (around 100°C) and greater depths of R0 to R1 transformation have been determined in neighbouring sub-basins (110°C at 3.2-3.5 km in the Vienna Basin, 115°C at 2.0 km in the Transcarpathian Depression, and 135°C at 2.0 km in the Maribor area, at 2.5-3.0 km in the Great Hungarian Plain. Only in the Zala Basin and Drava Basins transition started at lower depths (1.0 km). A possible reason for the difference in temperature in the Sava Depression and the neighbouring sub-basins are influence of longer exposition to elevated temperatures and potassium availability on the process of illitization in the Miocene pelitic rocks in the Sava Depression.

Transition from R1 to R>1 type I-S in the Sava Depression started at depths >3.0 km and temperature >170°C. This transition begins in the Great Hungarian Plain at >4.0 km, in the Zala Basin and Drava Basin at 3.0 km, in the Transcarpathian Depression at 3.0 km and temperature 160-170°C, and in the Maribor area at 135-175°C.

Significant differences in the rate and degree of progression of the illitization process of smectite are observed in sub-basins of the PBS. These differences are caused by different thermal histories of the sub-basins, as indicated by the differences in thermal gradients between comparable areas. The thermal gradient for the Sava Depression is 40°C/km, for the Great Hungarian Plain 35°C/km, for the Vienna Basin 25°C/km, and for the Transcarpathian Depression 55°C/km.

References:

Franců, J., Müller, P., Šucha, V. & Zatkalíková, V. (1990). Organic matter and clay minerals as indicators of thermal history in the Transcarpathian Depression (East Slovakian Neogene Basin) and Vienna Basin. Geologiský Zborník, Geologica Carpathica, 41/5, 535–546.

Grizelj, A., Tibljaš, D., Kovačić, M. & Španić, D. (2011). Diagenesis of Miocene pelitic sedimentary rocks in the Sava Depression (Croatia). Clay Minerals, 46, 59–72.

Hámor-Vidó, M. & Viczián, I. (1993). Vitrinite reflectance and smectite content of mixed-layer illite/smectites in Neogene sequences of the Pannonian Basin, Hungary. Acta Geologica Hungarica, 36/2, 197–209.

Hillier, S., Matyas, J., Matter, A. & Vasseur, G. (1995). Illite/smectite diagenesis and its variable correlation with vitrinite reflectance in the Pannonian Basin. Clays and Clay Minerals, 43, 174–183.

Sachsenhofer, R.F., Rantitsch, G., Hasenhüttl, C., Russegger, B. & Jelen, B. (1998). Smectite to illite diagenesis in early Miocene sediments from the hyperthermal western Pannonian Basin. Clay Minerals, 33, 523-537.

Tanács, J. & Viczián, I. (1995). Mixed-layer illite/smectites and clay sedimentation in the Neogene of the Pannonian Basin, Hungary. Geologica Carpatica, Ser. Clays, 4, 3–22.

MICROFOSSILS FROM EARLY MIOCENE LACUSTRINE DEPOSITS OF PAG ISLAND (SW CROATIA)

Valentina Hajek-Tadesse, Mirjana Miknić

Croatian Geological Survey, Sachsova 2, 10000 Zagreb, Croatia, valentina.tadesse@hgi-cgs.hr; miknic@hgi-cgs.hr

The present study represents the extension of previous researches at the location of Crnika section on the Pag Island. All analysised samples are part of the materials collected and published (Bulić¸& Polšak, 2009) and have been donated by the Croatian Natural History Museum with the objectives to carry out detail analysis of microfossil associations.The Miocene lake deposits of section Crnika is exposed along the south western coast of the Gulf of Pag. The total thickness of Miocene lake outcrops and deposits in the covered parts of the profile along the Crnika coastline is 265 m (Bulić¸& Polšak, 2009). According to Jiménez-Moreno et.al (2009) the lacustrine deposits of Lake Pag had been probably deposited during the time interval between 17.2 and 16.7 Ma.

Twenty nine analysed samples of the Crnika section have been found rich in microfossil remains of ostracods, calcified gyrogonites, otolits, forams, rizoids, seeds of land and water plants and molluscs. Out of the all analysed samples special attention has been given to the ostracodes assemblage.

The typical ostracod assemblage for all samples of Crnika section is the *Moenocypris* assemblage. *Moenocypris* is the dominant genus, and only a few remains of *Pseudocandona*, *Paralimnocythere*, *Cypria*, *Potamocypris?* and *Herpetocypris* occurred in several samples. The finding of the genus *Moenocypris* is the first finding of this genus in freshwater Early Miocene deposits of Croatia. *Moenocypris* assemblage is specific and according to Keen (1977) have characterized water depth from 2-15 m, zone of submerged water plants or bare muddy bottoms, with poor circulation alkaline pH and the bottom sediments probably had a negative Eh.

Jiménez-Moreno et.al (2009) and Bulić & Polšak (2009) concluded that Pag Lake belonged in a palaeogeographic sense to a unique Paratethys system of freshwater lakes –Dinaride Lake System, that during the Lower Miocene covered large parts of the Pannonian basin and the neighbouring Dinaric area to the south.

According to our research, specially due to the founding of genus *Moenocypris* investigation of fresh water deposits of Lake Pag can be linked with the wider region. A non-isolated realm for the studied samples is further suggested based on similarities with the freshwater microfossils specially the ostracods of Early Miocene (Becker et.al, 2002; Carbonel & Cahuzac,2005; Schäfer, 2005; Weidmann, 2008) and freshwater Middle Miocene (Krstić, 1987) of a wider geographical area.

References:

Becker, D., Picot, L., Berger, J. P. (2002). Stable isotopes (δ13C and δ18O) of charophyte gyrogonites: example from the Brochene Fluh section (Late Oligocene–Early Miocene, Switzerland).Geobios, 35, 89–97.

Bulić, J. & Jurišić –Polšak, Z. (2009). Macropalaeontology and stratigraphy of lacustrine Miocene deposits at Crnika beach on the Island of Pag (Croatia). Geol. Croat., 62/3, 135-155.

Carbonel, P.& Cahuzac, B. (2005). The continental Ostracoda from the Neogene of the Aquitaine Basin (southwestern France): a geographical and stratigraphical review. Revue de micropaléontologie, 48, 3–13.

Jiménez-Moreno, G., Leeuw de, A., Mandić, O., Harzhauser, M., Pavelić, D., Krijgsman, W. & Vranjković, A. (2009). Intergrated stratigraphy of the Early Miocene lacustrine deposits of Pag Island (SW Croatia): Palaeovegetation and environmental changes in the Dinaride Lake System. Palaeog. Palaeoclim.Palaeoecol., 280, 193−206.

Keen, M.C. (1977). Ostracod assemblages and the depositional environments of the Headon, Osbone,and Benbridge beds (Upper Eocene) of the Hampshire Basin. Palaeontology. Vol. 20 / 2, 405-4

Krstić, N.(1987). Ostracodes from Rabitlje and Otilovići (Pljevlja) Neogene / Montenegro. Zbornika radova. 75-94.Nat.91. 1:69-101.

Schäfer , P., Kälin, D. Reichenbacher, B. (2005). Beiträge zur Ostracoden- und Foraminiferen-Fauna der Unteren Süßwassermolasse in der Schweiz und in Savoyen (Frankreich). Senckenbergiana lethaea 85 (1), 95–117.

Weidmann, M. (2008). La Molasse de la Vallée de Joux (Jura, Suisse et France). Bull. Soc. vaud. Sc.

BEGINNING AND DIVISION OF THE BADENIAN STAGE (MIDDLE MICOCENE, PARATETHYS)

Johann Hohenegger[1], Stjepan Ćorić[2], Michael Wagreich[3]

[1] Department of Palaeontology, University of Vienna, A-1090 Wien, Austria; johann.hohenegger@univie.ac.at

[3] Geological Survey of Austria, A-1030 Wien, Austria

[4] Department of Geodynamics and Sedimentology, University of Vienna, A-1090 Wien, Austria

The beginning of the Paratethyan Badenian stage is yet regarded to coincide with the beginning of the Mediterranean Langhian stage. The subdivision of the Badenian into the Moravian (lower Badenian), Wielician (middle Badenian) and Kosovian (upper Badenian) reflects the subdivision in the Vienna Basin based on benthic foraminifera with the "Lagenidae Zone", the "*Spiroplectammina* Zone" and the "*Bulimina/Bolivina* Zone". Most characteristic are the widespread evaporates of the Wielician in the Carpathian Foredeep and the Transylvanian Basin. According to this subdivision, the beginning of the Kosovian coincides with the Mediterranean Seravallian stage.

Investigations of the Karpatian and Badenian in the Austrian Molasse Basin and the Styrian Basin resulted in the detection of a large interval between the uppermost Karpatian and the base of the Lower Lagenidae zone, the latter is correlated with the NN4/NN5 boundary at -14.91 Ma. Since the boundary between the Early and Middle Miocene will be placed at the beginning of polarity chron C5B at -15.974 Ma, biostratigraphically approximated by the LCO of *Helicosphaera ampliaperta* and the Paracme Zone of *Sphenolithus heteromorphus*, the lowermost Badenian should be placed between -15.974 and -14.91 Ma assuming the coincident beginnings of the Langhian and the Badenian. Detailed integrated stratigraphical investigations in the Styrian Basin (Austria) resulted in a clear paleoenvironmental change documented by shallow benthic foraminifera and the occurrence of the planktonic foraminifer *Praeorbulina sicana* together with the marked change in nannofossil composition at polarity chron C5Cn.1n (-16.268 Ma). This change was caused by the major alpine tectonic event called the "Styrian Tectonic Phase". Therefore, the beginning of the lowermost Badenian must be placed at -16.268 Ma and does not coincide with the Burdigalian/Langhian boundary at -15.974 Ma!

The "Lower Lagenidae Zone" belonging to the NN5 Zone starts at -14.91 Ma and is terminated at -14.357 Ma due to the LCO of *Helicosphaera waltrans*, which is well documented in both the Styrian and Vienna Basin. The stratotype of the Badenian stage belonging to the "Upper Lagenidae Zone" could recently be calibrated by cross-correlating geophysical and geochemical variables with the mid-summer insolation curve. This resulted for the stratotype section in an age between -13.982 and -13.964 Ma, still belonging to the Moravian substage. Taking the NN5/NN6 boundary at -13.654 Ma as the Wielician/Kosovian boundary, then the significant $\delta^{18}O$ increase at -13.82 Ma determined as the Langhian/Seravallian boundary must be equalized with the beginning of the Wielician; then this substage covers only 166 kyr. Therefore the question arises, if the Wielician substage is necessary or it reflects only the beginning of the Kosovian substage or the end of the Moravian stage.

The division of the Badenian into the three substages “Early Badenian”, “Middle Badenian = Moravian” and “Late Badenian = Kosovian” can be remained, but spanning different time intervals compared to the former subdivision. This new division correlates well with 3rd order sequences (Fig. 1).

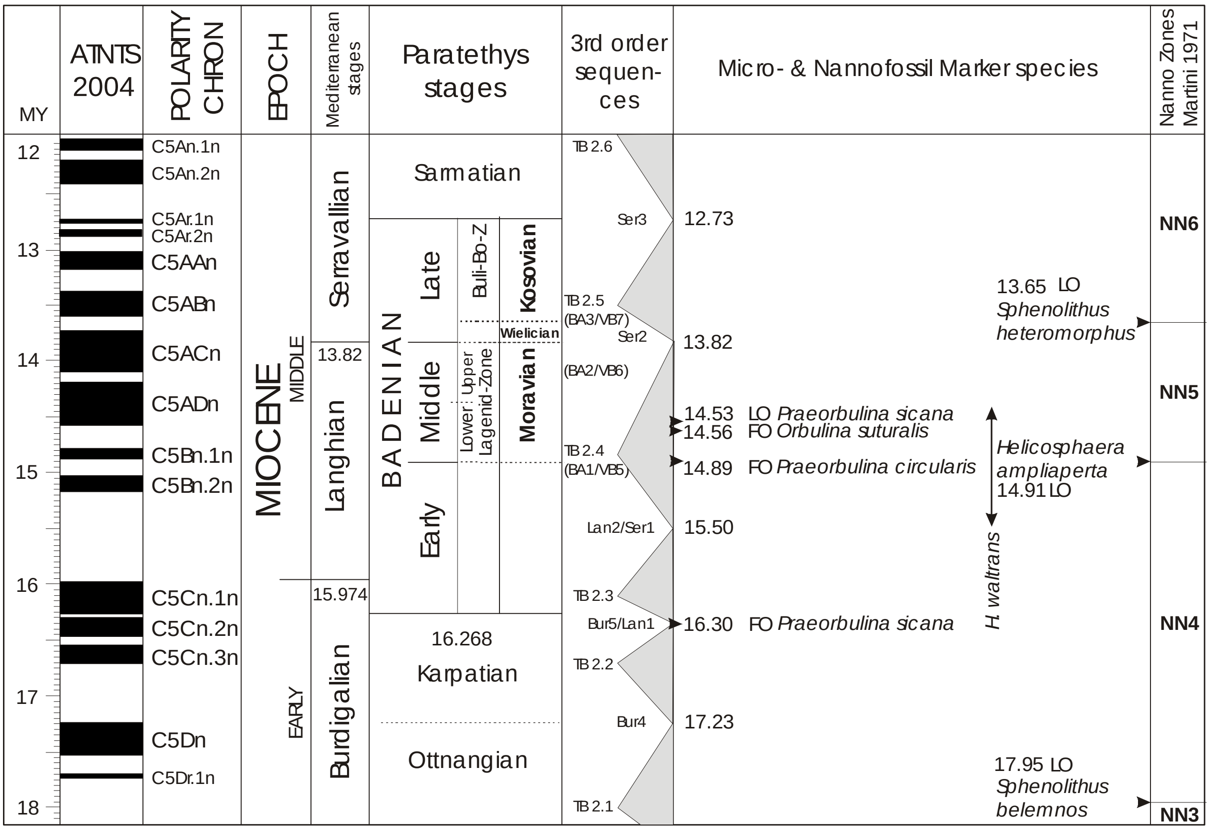

Figure 1. Integrated stratigraphy of the Early/Middle Miocene in the Central Paratethys.

ACID VOLCANISM IN THE SOUTHERN PART OF THE PANNONIAN BASIN (DILJ MT., CROATIA)

Marija Horvat[1], Damir Slovenec[1], Dragutin Slovenec[2]

[1] Croatian Geological Survey, Sachsova 2., 10 000 Zagreb, Croatia, mhorvat@hgi-cgs.hr; dslovenec@hgi-cgs.hr
[2] Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Perottijeva 6., 10 000 Zagreb, Croatia, dragutin.slovenec@rgn.hr

Dilj Mt. is situated in the southern most part of the Pannonian Basin, in Croatia close to the border with Bosnia and Herzegovina. Through the 20th century several researchers worked in this area. However, Pamić & Šparica (1988) gave most detailed petrological study of volcanic rocks associated with Tertiary sediments of Dilj Mt. assuming their Badenian age. According to the geological mapping in 1:50000 scale volcanic rocks were studied in detailed. This work presents preliminary results.

Felsic volcanic rocks and associated pyroclastites occur as an elongated partially disintegrated body, northeast-southwest direction, in predominantly tectonic contact with sedimentary rocks of Middle and Upper Miocene and Early Pliocene. These rocks can also be found as centimetre-decimetre pebbles within the Badenian and Sarmatian deposits. The investigated rocks are light green to green-gray colour, leucocratic, microcrystalline with aphiric to porphyritic texture. Perlitic texture is also present. The texture is homogeneous or amygdaloidal. Volcanic rocks are followed with yellow-gray colour litho-crystallo-vitrofiric tuffs, lapilli-tuffs and rarely pyroclastic breccias.

Mineral composition is uniform: quartz + albite and/or peristerite + K-feldspar ± secondary minerals. Feldspars occur as phenocrysts size to 2.5 mm and as 0.1 to 0.4 mm groundmass microlites. Phenocrysts commonly comprise up to 15% of the rock. They are affected by sericitization and chloritization. The groundmass is cryptocrystalline, holocrystalline or hypocristalline with quartz, K-feldspar and plagioclase microlites. In groundmass acidic volcanic glass relics could be found and they mainly devitrificated to chlorite and/or hydromica (vermiculite/illite). Vesicles are filled with some of the polymorphic modifications of SiO_2. Accessory minerals are apatite, magnetite and leucoxene (probably emerged ilmenite alteration). Cracks are filled up with quartz.

Investigated rocks have high SiO_2 content (72.58-76.62 wt. %) and classified as acid volcanic rocks: middle- to high-Si rhyolites to rhyodacites according to Peacock (1931) and Winchester & Floyd (1977). They are leucocratic rocks (C.I. = 2.55-9.60) with low ferromagnesian components. Rhyolites are characterized by high K_2O content (1.84-8.71 wt. %), high N_2O (1.05-5.60 wt. %) and low CaO (wt. % $<$ 0.73) content. With increasing of SiO_2 content the mass fraction of TiO_2, Al_2O_3, Fe_2O_{3tot}, MnO, MgO, and P_2O_5 decreases opposite to K_2O which increases. Rhyolites show moderate enrichment of LREE to MREE and nearly flat HREE profile at 7-23 times relative to chondrite. Strong Sr and Eu negative anomaly (Eu/Eu*=0.20-0.55) indicate the low pressure fractionation of feldspar. Spider diagram normalized to primitive mantle values show a negative anomaly of HFS elements (Nb-Ta, P and Ti) relative to La, which is typical of subduction zone magmas, which together with elevated Pb contents may suggest weak influence of fluids derived from an earlier subducted plate. However, investigated rhyolitic rocks of Dilj Mt. are derived from partial melting of heterogeneous source material composed of continental crust mixed with magmas derived in upper mantle which have been contaminated with fluids and sediments from an earlier detached subducted plate. Therefore, the origin of acid volcanic rocks of Dilj Mt. should be linked to the post-orogenic geotectonic setting, in the post-collision continental marginal basin. That is consistent with interpretation of some authors (example Horvath et al., 1989) that the Pannonian Basin is a post-subduction continental back-arc basin.

References:

Horvath, F., Rumpler, J., Tari, G. & Dövény, P. (1989). Structural evolution of the Pannonian basin. Terra Abstracts, 1, p.51.

Pamić, J. & Šparica, M. (1988). Badenian volcanics from Mt. Dilj in Slavonija (northern Croatia, Yugoslavia). Bull. Acad. Serbe Scie. Arts. 28, 47-56, Beograd.

Peacock, M.A. (1931). Classification of igneous rock series. J. Geol., 39, 54-67.

Winchester, J.A. & Floyd, P.A. (1977). Geochemical discrimination of different magma series and their differentiation products using immobile elements. Chem. Geology, 20, 325-343.

PECULIAR FORAMINIFERAL ASSOCIATION IN TERRESTRIAL SEDIMENTS OF CENTRAL ANATOLIA (CANKIRI BASIN, TUGLU FM.)

Natália Hudačková[1], Ilaria Mazzini[2], Eva Halasová[1], Marianna Kováčová[1]

[1] Comenius University, Faculty of Sciences, Dept. of Geology and Palaeontology, Mlynska dolina, 842 15 Bratislava, Slovak Republic, natalia@presporok.sk
[2] IGAG-CNR, Via Salaria Km 29,3; C.P. 10, 00016 Monterotondo Staz., Rome, Italy.

Within the framework of the EU VAMP (Vertical Anatolian Movements Project) Topo-Europe 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 Çankırı Basin. Ostracods, benthic foraminifera, nannoplankton, charophytes, molluscs, fish remains, palynomorphs and micro mammals have been recovered from the 21 m thick Tuğlu section. Most likely, the Tuğlu formation deposited in a continental setting characterised by permanent water bodies affected by strong salinity and depth oscillations. Since detailed dating of the section 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, which results are presented here. 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 characterized 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. The three main morphotypes of the porcellaneous foraminifers were identified in the *Quinqueloculina* genus from the section, mainly base on size and coiling, similar situation is observed in variability of the *Miliolina* and *Varidetell* a genus. Morphotype 1 has normal coiling and minimal size, morphotype 2 is bigger than normal size, still normal coiling and morphotype 3 reach extreme size with aberrant coiling. The 3 main invasions of foraminifers are detected, in case those normal types originate in home circumstances and were transported into very special conditions of the water body. The normal forms here evolve to the big and bizarre forms. In the lower part of the profile, the Cretaceous planktonic foraminifera (*Globotruncana*) occur. In the lowermost part of the profile, abundant exemplars of *Perfocalcinella fusiformis* and Palaeogene and Cretaceous reworked calcareous nannofossils were recovered. The palynological record documents subtropical climate (*Cathaya*, *Engelhardia*) and low sporomorphs concentration (Pinaceae) opposite to higher percentages of halophytes (Chenopodiaceae) and dinoflagellates.

THE BADENIAN/SARMATIAN (MIDDLE MIOCENE) TRANSITION IN THE MEDOBORY HILLS (PARATETHYS, UKRAINE) AND ITS SEDIMENTOLOGICAL, BIOTIC, AND GEOCHEMICAL CHARACTERISTICS

Marek Jasionowski[1], Marcin Górka[2], Barbara Studencka[3], Przemysław Gedl[4], Urszula Hara[1], Danuta Peryt[5], Anna Wysocka[3]

[1] Polish Geological Institute – National Research Institute, ul. Rakowiecka 4, 00-975 Warsaw, Poland, marek.jasionowski@pgi.gov.pl
[2] Faculty of Geology, University of Warsaw, ul. Żwirki i Wigury 93, 02-089 Warszawa
[3] Polish Academy of Sciences Museum of the Earth in Warsaw, Al. Na Skarpie 20/26, 00-488 Warsaw

The Medobory Hills located at the northeastern margin of the Carpathian foreland basin (Central Paratethys) in the western Ukraine are constructed mainly by the Upper Badenian and Lower Sarmatian reefs that differ from each other in terms of growth mechanisms as well as biotic and geochemical characteristics. The Upper Badenian coralline algal-vermetid reefs composed mainly of coralline algae with subordinate hermatypic coral colonies (Porites and Tarbellastraea) were populated by taxonomically very rich normal-marine biota comprising bivalves and gastropods, echinoids, crustaceans, bryozoans and foraminifers. The uppermost parts of many reefs are dominated by oysters. Virtually no marine cements occur within the reefs. On the contrary, the framework of the Lower Sarmatian reefs is composed mainly of calcitic precipitates (microbialites and inorganic synsedimentary cements) with a very subordinate contribution of skeletal organisms such as serpulids (and/or bryozoans in places), so they are known as serpulid-microbialite reefs. The reefs were inhabited by taxonomically extremely poor biotic assemblages consisting of a few species of bivalves (dominated by cockles), gastropods, bryozoans and foraminifers. The Upper Badenian deposits associated with the reefs comprise a variety of bioclastic, marly and rhodoid facies whereas the Lower Sarmatian ones involve bivalve coquinas, bioclastic or oolitic grainstones, marls or clays, breccias and conglomerates. The Badenian/Sarmatian boundary within the Medobory Hills is erosional due to a sea level fall. The uppermost portions of the Badenian reefs are usually abraded and additionally cut by deep fissures with walls incrusted with microbialites and filled up with deposits rich in Sarmatian fossils.

The Upper Badenian coralline algal-vermetid reefs originated in normal-marine environment in water of relatively high temperature as proved by occurrence of hermatypic corals and some other warm-water organisms. At the onset of Early Sarmatian the Paratethys experienced a significant decrease in salinity due to isolation of the basin from the world ocean what resulted in demise of normal-marine biota. Paradoxically, however, the predominance of calcitic precipitates in the Sarmatian reefs clearly indicates water highly supersaturated with respect to calcium carbonate. Based on oxygen isotope signatures the supersaturation was caused by a strong evaporation of the mixo-polyhaline water in the marginal, shallow parts of the Sarmatian Sea.cate distinctly that salinity level decreased eastwards.

BADENIAN FAUNA OF CORALS IN VICINITY OF NEGOTIN (NE SERBIA)

Gordana Jovanović

Natural History Museum, Njegoševa 51, Belgrade, gordana.j@nhmbeo.rs

The marine Badenian in vicinity of Negotin is widely distributed and represented mostly by sands, sandstones and clays, while the lithothamnian limestones are scarcer. The sediments richest in fossils include sands and clayey sands of Trnjane near Negotin. There are over 100 recorded species of mollusks at Trnjane alone, while corals and brachiopods are represented in much smaller numbers (Radovanović & Pavlović 1891, Pavlović 1903, Stevanović 1977). Stevanović (1977) believes that the sandy sediments match the Lower Badenian, while the lithothamnian limestones belong to Upper Badenian.

The coral fauna was studied at several sites in vicinity of Negotin: Trnjane, Čokonjar and Sikule (Šarkamen). This material was collected and published in late 19th and early 20th century (Radovanović & Pavlović 1891, Pavlović 1908). It was not studied later. The collection of Natural History Museum in Belgrade includes more than thirty well-preserved specimens.

The studies have shown presence of eight families: Acroporidae VERRILL, Pocilloporidae GRAY, Mussidae ORTMANN, Siderastraeidae VAUGHAN & WELSS, Poritidae GRAY, Dendrophylliidae GRAY, Caryophylliidae VAUGHAN & WELSS and Turbinoliide MILNE-EDWARDS AND HAIME. The most abundant group includes hermatypic genera *Astreopora* BLAINVILLE, *Stylophora* SCHWEIGGER, *Favites* LINK, *Tarbellastraea* ALLOITEAU, *Montastrea* BLAINVILLE, *Syzygophyllia* REUSS, *Caryophyllia* (*Acanthocyathus*) MILNE-EDWARDS AND HAIME, *Porites* LINK, *Siderastrea* BLAINVILLE. Ahermatipic corals is represented by three genera: *Dendrophyllia*, *Ceratotrochus*, and *Caryophyllia***.** One coral specimen was very similar to *Truncatocyathus* STOLARSKI 1992, which was later identified as belonging to genus *Peponocyathus* GRAVIJER 1915 (Cairns 1997). That specimen has a rather rounded base, which is one of the generic characteristics of *Deltocyathoides*, family *Turbinoliidae* MILNE-EDWARDS AND HAIME (Cairns 1997, Tachikawa 2005).

The Middle Miocene (Badenian) corals of Negotin are represented by a relatively rich and high diversity of hermatypic corals and a somewhat smaller number of solitary - ahermatipic corals. The most abundant group belongs to family Pocilloporidae GRAY. The branched colonies of *Montastrea* BLAINVILLE may reach about 9 cm in height and those of *Siderastraea froechlichiana* (REUSS) up to 12 cm. Family Poritidae GRAY is represented with a single thin-branched colony of *Porites* with several boring holes made by *Lithophaga*.

According to the present studies it may be concluded that, according to the number of fossil corals, the Badenian sediments of vicinity of Negotin are the richest sediments of Neogene in Serbia, and that coral fauna from Negotin is most similar to fauna from site Lăpugiu Sus (Romania) (Rus & Popa 2008).

References:

Cairns, S., D. (1997). A generic revision and phylogenetic analysis of the Turbinoliidae (Cnidaria: Scleractinia). Smithsonian Contributions to Zoology, 591, 1-55 . Washington.

Pavlović, S., P. (1903). New collection at the Geological Institute of Velika Škola. Mediterranean fossils from Duboki Potok near village Trnjane (Negotin) Geološki anali Balkanskog poluostrva, 6, 1, 293-326.

Pavlović, S., P. (1908). Corals from the second Mediterranean layers in Serbia. Rad JAZU, 175, Zagreb. 81-86.

Radovanović, S., Pavlović, P. (1891). On Tertiary of Timočka Krajina. Glas Srpske Kraljevske Akademije 29, 1-111, Beograd.

Rus, M. , Popa, M., V. (2008). Taxonomic notes on the Badenian corals from Lăpugiu de Sus (Făget basin, Romania). Acta Paleontologica Romaniae, 5, 6, 325-337.
Stevanović, P. (1977). Carpathian foothills from Kladovo to Negotin and Štubik Istočna Srbija. Neogen. In: Petković, K. (ed.): Geologija Srbije (Stratigrafija, Kenozoik) 2(3). Zavod Regionalnu geologiju i paleontologiju Rudarsko-geološkog fakulteta Univerziteta u Beogradu, Beograd. 25-47.
Stolarski, J. (1992). Transverse division in a Miocene scleractinian coral. Acta Palaeontologica Polonica 36, 4, 3-426.
Tachikawa, H. (2005). Azooxanthellate Scleractinia (Hexacorallia, Anthozoa, Cnidaria). Colected from Otsuki, Kochi prefecture, Japan. Kuroshio Biosfere, Bull. Biol. Inst. Kuroshio, 2, 2-27.

SEDIMENTOLOGICAL AND PALEONTOLOGICAL ANALYSES OF PANNONIAN S. L. (UPPER MIOCENE - PLIOCENE) DEPOSITS NEAR KOZÁRMISLENY (SOUTHWEST HUNGARY)

Lajos Katona[1], János Kovács[2], Mária Sütő-Szentai[3], Imre Magyar[4], Tibor Berta[5]

[1] Natural History Museum of Bakony Mountains, H-8420 Zirc, Rákóczi tér 3-5. Hungary, finci99@freemail.hu
[2] Department of Geology, University of Pécs, H-7624 Pécs, Ifjúság u. 6, Hungary, jones@gamma.ttk.pte.hu
[3] H-7300 Komló, Május 1. út 7, Hungary, sutozoltanne12@t-online.hu
[4] MOL Hungarian Oil & Gas Plc, H-1117 Budapest, Október 23. u. 18, Hungary, immagyar@mol.hu
[5] H-8200 Veszprém, Sólyi u. 2, Hungary

Life and depositional environments in the sublittoral zone of Lake Pannon from the Late Miocene, were reconstructed from fossils and facies of an exposure near Kozármisleny. Lake Pannon had a highly endemic fauna and flora, resembling in many ways the modern Caspian or Ponto-Caspian biota (Cziczer et al., 2008). The excavation site (46°05'N and 18°27'E) is between the villages of Kozármisleny and Árpád (Nagyárpád, today part of Pécs), in the south-western part of Hungary. The site is at 160 m above sea level. We collected fossils and carried out paleoecological observations in the 8–10 m high exposure with the objective of better understanding the sublittoral environment and its life in Lake Pannon.
The grain-size distribution of all sediment samples was measured by laser diffraction (Fritsch Analysette 22) methods (Kovács, 2008). Although the primary focus of our study was benthic life in the sublittoral zone, we also investigated the phytoplankton in three samples. Three palynological and nannoplankton preparations have been investigated for dinoflagellates and coccoliths, using a light microscope (1000× magnification) at normal and crossed nicols.
The Kozármisleny section is composed primarily of yellowish-gray medium to coarse-grained silt, with 20–30 cm thick intercalations of fine-grained silt. The mollusc fossils in the Kozármisleny exposure are concentrated in the fine-grained silt layer. The fossils are mainly bivalves: *Congeria rhomboidea rhomboidea*, *Dreissenomya unionides*, *Lymnocardium arpadense, Lymnocardium haueri*, *Lymnocardium hungaricum*, *Lymnocardium majeri, Lymnocardium rogenhoferi, Lymnocardium schmidti, Caladacna steindachneri, Pteradacna pterophora* and a few gastropods: *Radix kobelti*, *Radix grammica*, *Zagrabica cyclostomopsis*. Based on this fauna and sedimentary facies, the Kozármisleny sequence was deposited in the sublittoral zone of Lake Pannon. The mollusc assemblage is strikingly similar to that of the nearby classic Árpád locality (Szónoky et al., 1999). Biochronologically this is part of the *Congeria rhomboidea* Biochron (c. 8–5 Ma). Palyonological samples contained the following dinoflagellates: *cf. Batiacasphaera* sp., *Gonyaulacaceae*. The green alga *Botryococcus braunii* was found in the samples, which can be found in both brackish and freshwater

ecosystems worldwide. The *Mougeotia laetevirens* and *Spirogyra* sp. microfossils are typical freshwater organisms that also occur in the samples.

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References:

Cziczer I, Magyar I, Pipík R, Böhme M, Ćorić S, Bakrač K, Sütő-Szentai M, Lantos M, Babinszki E, Müller P (2008). Life in the sublittoral zone of long-lived Lake Pannon: paleontological analysis of the Upper Miocene Szák Formation, Hungary. Int J Earth Sci 98, 1741–1766.

Kovács J. (2008). Grain-size analysis of the Neogene red clay formation in the Pannonian Basin. Int J Earth Sci 97, 171–178.

Szónoky M, Dobos-Hortobágyi E, Gulyás S, Müller P, Szuromi-Korecz A, Geary DH, Magyar I (1999). Árpád, a classic locality of Lake Pannon bivalves. Acta Geol Hung 42, 89–108.

LATE MIOCENE AND PLIOCENE TECTONO-SEDIMENTARY CYCLES OF THE NORTHERN DANUBE BASIN

Michal Kováč[1], Rastislav Synak[1], Klement Fordinál[2], Peter Joniak[1], Csaba Toth[4], Rastislav Vojtko[1], Jozef Minár[3]

[1]Department of Geology and Palaeontology, Faculty of Natural Sciences, Comenius University, Mlynská dolina G, 842 15 Bratislava, Slovakia
[2]State Geological Institute of Dionýz Štúr, Mlynská dolina 1, 817 04 Bratislava, Slovakia
[3]Department of Physical Geography and Geoecology, Faculty of Natural Sciences, Comenius University, Mlynská dolina B1, 842 15 Bratislava, Slovakia
[4]Central Slovakia Museum, Department of Natural History, Radvanská 27, 974 05 Banská Bystrica

The development of the northern Danube Basin was closely related to the Late Miocene geodynamic evolution of the Pannonian Basin System. It started with a wide rifting which led to subsidence of several basin depocentres which were gradually filled during the Late Miocene and Early Pliocene. In the Late Pliocene the subsidence continued only in the basin's central part, while the northern marginal zone suffered inversion and uplifted sedimentary fill began to be eroded. Individual stages of the basin development are well recorded in its sedimentary succession, where at least three great tectono-sedimentary cycles were documented.

Firstly, a lacustrine cycle deposited in the time span 11.6–8.9 Ma and this is represented by the Ivanka and Beladice formations. In the Danube Basin southern part in Hungary, where the formations are defined by the appearance of sedimentary facies in time and space, the equivalents are: (1) the deepwater setting marls, clays and sandy turbidites of the Endrőd and Szolnok formations leading to the overlying strata deposits of the basin paleoslope or delta-slope represented by the Algyő Formation, and (2) the final shallow water setting deposits of marshes, lagoons and a coastal and delta plain composed of by clays, sands and coal seams, represented by the Újfalu Formation.

The second tectono-sedimentary cycle was deposited in an alluvial environment and it comprises the Upper Miocene and Lower Pliocene sediments dated at 8.9–4.1? Ma. The cycle

is represented in the nDB, by the Volkovce Formation and in the southern, Hungarian part of the basin by the Zagyva Formation in Hungary. The sedimentary environment is characterized by a wide range of facies from fluvial, deltaic and ephemeral lake to marshes.
The third tectono-sedimentary cycle comprises the Upper Pliocene sediments represented by the Kolárovo Formation and dated 4.1–2.6 Ma. The formation contains material of weathering crust preserved in fissures of Mesozoic carbonates, diluvial deposits and sediments of the alluvial environment.
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LACUSTRINE MIOCENE BETWEEN THE PARATETHYS AND THE MEDITERRANEAN

Nadežda Krstić[1], G. Jovanović, M. Mladenović, S. Pavić

[1]Nature History Museum in Beograd, Njegoševa 51, Beograd, Serbia, n_krstic@PTT.RS

This paper has a very similar topic to the IGCP Project 329 (1992-1997). It was initiated by E. Kojumdžijeva (then already seriously ill), with a wish that the project should be led from Serbia as the central area in Balkan Peninsula.
The area best studied from the paleontological-paleoecological standpoint was the region of Dinaric Mountains, characterized by the developed Dinaric Lake System of lakes. The peneplain of Dinaric Mountains was broken during the Lower Miocene, while compressed between the Adriatic Plates and the Pannonian area. This was recognized already by Cvijić. For example, the southwestern side of Mesozoic cone Sv. Rok (near Gospić) and other elevations was cut off almost vertically on SE side. Such processes led to separation of Neogene areas which were previously more or less united. The proof of their previous connection in this karst area is the wide distribution of genus *Fossarulus* and different congerian species (*Mytilopsis* etc.). Fauna of *Unionacea* is the least known part of fauna of this region.
The paleontological data on the area that used to be covered by Serbian Lake, before the Middle Badenian marine transgression, are poorly known. The Serbian Lake originated by spreading after the collision of the western and the eastern island of Balkan Land[1]. Its large parts were then consumed by deep faults and nappes in Eastern Serbia and the neighboring parts of Romania(?) and Bulgaria, with eastwards vergences. The strong earthquakes used to break the leading edges of the nappe and create unusual formations. One of these is visible in the Nature Park Jelašnica (near the town of Niš). Products of overtrusting and breaking were very pronounced along the contact of crystalline nappe over Lužnica zone. The wide Morava trough that stretched directly southward from Paratethys along Velika Morava brought the waters of Paratethys to the vicinity of present-day town of Kruševac. Otherwise the Serbian

[1] The term Balkan Land was introduced by N. Pantić

Lake formed a diversified coastline, flooding both the lowland along Morava valley and the transversal depressions. Within the Lake sediments, the remains of proboscidean teeth and tusks were almost uniformly strewn at sites close to ancient deltas: *Tetralophodon longirostris, Gomphotherium angustidens, Zygolophodon turicensis, „Mammuthust“ borsoni, Deinotherium giganteum*. Several sites have contained a diverse mollusk fauna as well: *Prososthenia, Mytilopsis, Kosovia, Planorbis, Melanopsis etc.* The fossil material has been collected and identified for a whole century by various authors, so species revision is planned as a necessary task.
The lacustrine Upper Miocene of the eastern part of Balkan Peninsula (Bulgaria) was well studied by Zagorčev and Vacev, and particularly the diatom-specialist Ognjanova (In Bulgaria there is also some marine Eocene, which partially merges with the lacustrine Oligocene along the lineament Lužnica-Struma.) Further south, in Macedonia and all the way to Athens, the Upper Miocene is mostly fluvial in origin, for example at Veles, Kalimanci and Pikermi, containing Turolian mammal fauna. The fine-grained sediments of the towns of Skopje (with fossilized large underwater landslide) and Bureli are identified as slightly younger. In addition to *Theodoxus doricicus*, these sediments also yielded remains of diverse *Prososthenia* and abundant *Unionidae*, as well as the unusual fauna of candonid ostracodes with reverse valves of the whole ‘species flock’. There is even a record of the Pannonian species *Melanopsis affinis* in Bureli and other Albanian sites. This fine-grained upper part of Upper Miocene is well developed in Pelagonian-Eordeian trench, housing mostly diatomite.
In this tectonic graben, the Miocene transits into the Pliocene smoothly. This is also the location of Ohrid Lake with its endemic biota known worldwide. The creation of the Pliocene paleolake was caused by the obduction of Asia Minor over the SE part of Balkan Land. The visually most appeasing example of “thin skin” (being ca. 5,000 m thick) is present on the geological map of the Skopje sheet, where two perfect arcs are connected. The Lake portions formed in the depressions between the older mostly Mesozoic rock arches were connected to each other. Common mollusks appeared in Metohija and Megara near Athens, although the Megara sediments also include many intercalated marine layers with cardiids, due to the impact of nearby Mediterranean. Recent remnants of the Pliocene lakes still contain *Leptocytheridae* and the ostracodes common to Metohija indicating its evolution in an ancient larger aquatorium.

PETROGRAPHY AND PROVENANCE OF EARLY MIOCENE CONGLOMERATES FROM MEDVEDNICA MT. (PANNONIAN BASIN, CROATIA)

Tomislav Kurečić[1], Marijan Kovačić[1], Dražen Balen[2]

[1]Croatian Geological Survey, P.O. Box 268, HR-10000 Zagreb, tomislav.kurecic@hgi-cgs.hr
[2]University of Zagreb, Department of Geology, Faculty of Science, Horvatovac 95, HR-10000 Zagreb, mkovacic@geol.pmf.hr; drbalen@geol.pmf.hr

The Early Miocene conglomerates represent the oldest sediments deposited in the southwestern part of the Pannonian Basin (PB). One of the most representative outcrops of these conglomerates is located on the southeastern flanks of Medvednica Mt. where they are deposited in alluvial environment transgressively on Paleozoic-Mesozoic basement (Šikić,

1995). The aim of this research is to determine composition and provenance of these conglomerates.
The conglomerates have been determined as weakly lithified clast-supported petromict conglomerate. The pebbles average size is 3 to 7 cm reaching 30 cm. Size of pebbles diminishes, while pebble sorting increases with distance from the contact with basement.
Microscopic analyses of pebbles show that sandstones prevail, while limestones (packstone, grainstone, rudstone and mudstone), siltites, metamorphic rocks (marble, quartzite, metasiltite, metasandstone) and several types of granites are subordinate. Within sandstone pebbles carbonate sandstone (calclitites, calcarenites and calcarenaceous sandstones) prevails over arcose, subarcose and lithic arenites.
The composition of pebbles and their size suggest that the source area was very heterogeneous and located in near hinterland. Great resemblance of pebble composition with surface exposure of Paleozoic-Mesozoic of Mt. Medvednica core rocks points to conclusion that these rock were the best candidate for the source rocks. Nevertheless, granite from the conglomerate pebbles differs from the granites from the only known Medvednica Mt. locality (Majer & Majer, 1974) implying that the granite pebbles originate from rocks which are no longer represented on the surface of the Mt. Medvednica. Also, the orientation of imbricated pebbles in similar conglomerates from a outcrop 3 km to the southwest, deposited at the same time, suggests transport of material from the southwest (Pavelić, 1998). Transport of material from the south has also been confirmed for the oldest Miocene conglomerates in the East Croatia i.e. the southern part of PB (Kovačić et al., 2011). This opens possibility that the original source rocks of the investigated conglomerates were not the rocks from today's core of Mt. Medvednica, but the rocks from the source area were located more southerly.

References:
Kovačić, M., Horvat, M., Pikija, M. & Slovenec, D. (2011). Composition and provenance of Neogene sedimentary rocks of Dilj gora Mt.(south Pannonian Basin, Croatia). – Geologia Croatica: journal of the Croatian Geological Survey and the Croatian Geological Society (in press).

Majer, E., Majer, V. (1974). Kiseli do neutralni magmatiti u sjeveroistočnom dijelu Medvednice. – In: Šikić, K. (ed.): Geološki vodič Medvednice. Institut za geološka istraživanja, INA – Industrija nafte d.d., Zagreb. 168-169. (in Croatian)

Pavelić, D. (1998). Taložna evolucija slatkovodnog donjeg miocena sjeverne Hrvatske na temelju analize facijesa. – Unpubl PhD Thesys, University of Zagreb, 149 p. (in Croatian with English summary)

Šikić, K. (1995). Prikaz geološke građe Medvednice. – In: Šikić, K. (ed.): Geološki vodič Medvednice. Institut za geološka istraživanja, INA – Industrija nafte d.d., Zagreb. 7-30. (in Croatian)

AN EARLY (?) MIOCENE BRACKISH-WATER BASIN IN EASTERN HUNGARY

Imre Magyar[1], Andrea Szuromi-Korecz[1], András Nusszer[1], Mária Sütő-Szentai[2], Elvira Nagy-Bodor[3], Koraljka Bakrać[4], Madelaine Böhme[5], András Nagymarosy[6]

[1] MOL Hungarian Oil and Gas Plc, Október 23. u. 18., H-1117 Budapest, Hungary, immagyar@mol.hu, kaszuro@mol.hu, anusszer@mol.hu
[2] Május 1. u. 7., H-7300 Komló, Hungary, sutozoltanne12@t-online.hu
[3] ILEX Bt., Nyerges u. 21., H-1181 Budapest, Hungary, bodor.elvira@t-online.hu
[4] Croatian Geological Survey, Sachsova 2, P.O. box 268, HR-10001 Zagreb, Croatia, kbakrac@hgi-cgs.hr
[5] Senckenberg Center for Human Evolution and Palaeoecology, Eberhard Karls University Tuebingen, Institute for Geoscience, Palaeontological Museum and Collection, Sigwartstrasse 10, 72076 Tübingen, Germany, m.boehme@ifg.uni-tuebingen.de

[6] Department of Physical and Applied Geology, Eötvös Loránd University, Institute of Earth Sciences, Pázmány Péter sétány 1/c, H-1117 Budapest, Hungary, nagymarosy@gmail.com

The Derecske basin, located in Eastern Hungary, is one of the deepest subbasins of the larger Neogene Pannonian Basin System. It is bounded by pronounced NE-SW oriented strike-slip faults and opened as a pull-apart basin. At the base Neogene level, the Derecske basin consists of two subbasins. The deeper, northern subbasin is filled dominantly by Late Miocene Lake Pannon deposits. The shallower, southern subbasin, however, was considered to have been filled with Middle Miocene (Badenian) marine sediments below the Upper Miocene lacustrine sequence.

The southern subbasin has recently been tested by several drillings exploring for gas in the Middle Miocene sequence. Below fossiliferous marine Badenian biogenic limestone (Leitha limestone), these drillings penetrated a thick tuffaceous, sandy, silty, clayey sequence. Micropaleontological investigations of the core samples yielded strongly degraded phytoclasts, some identified as dinoflagellates, and poorly preserved ostracod valves, being dominated by candoniid species. In both groups, the recognized taxa are very similar to, or identical with Late Miocene Lake Pannon endemic forms, namely various species of *Spiniferites*, *Pontiadinium*, *Amplocypris*, *Hungarocypris* (?*Herpetocyprella*), and *Bakunella*. Foraminiferal test linings also occur. The samples were poor in nannoplankton, only sporadic occurrence of *Helicopontosphaera kamptneri*, *Coccolithus pelagicus*, and *Sphenolithus moriformis* was recognized. Other fossils include fish vertebrae (maybe belonging to a perch), fish teeth (a large pharyngeal tooth of a ?carp), percoid fish scales, red algae, and as yet unidentified nannofossils.

The overall fossil content suggests brackish water depositional environment, but its age is still uncertain. The Badenian limestone cover of the formation indicates that it cannot be younger than Badenian, but most of the Badenian occurrences in the vicinity are marine deposits. Therefore, an Early Miocene age (Ottnangian? Karpatian?) seems most probable, although the paleogeographic context (isolation of the basin) and the striking resemblance of some fossils to Lake Pannon endemic taxa are poorly understood and leaves the stratigraphic position and age issue open to discussion.

LATE MIOCENE CLAY-RICH SEDIMENTS FROM THE CROATIAN AND SLOVENIAN PARTS OF THE PANNONIAN BASIN – PALEOMAGNETISM, MAGNETIC MINERALS AND MAGNETIC FABRIC

Emő Márton[1], Bruno Tomljenović[2], Davor Pavelić[3], Mihály Pethe[4], Radovan Avanić[5], Bogomir Jelen[6]

[1] Eötvös Loránd Geophysical Institute of Hungary, Palaeomagnetic Laboratory, Columbus 17-23, H-1145 Budapest, Hungary. paleo@elgi.hu
[2] Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Pierottijeva 6, HR-10000 Zagreb, Croatia. bruntom@rgn.hr
[3] Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Pierottijeva 6, HR-10000 Zagreb, Croatia. davor.pavelic@rgn.hr
[4] Geophysics Department, Eötvös Loránd University, Pázmány Péter sétány 1/c, H-1117 Budapest, Hungary. mifimester@gmail.com
[5] Croatian Geological Survey, Sachsova 2, HR-10000 Zagreb, Croatia. radovan.avanic@hgi-cgs.hr

[6] Geološki Zavod Slovenije, Dimičeva14, SI-1109 Ljubljana, Slovenia. bogomir.jelen@geo-zs.si

During the last 15 years a number of outcrops were sampled from the late Miocene clay-rich sediments of the Southern Pannonian basin (Mura–Zala, Hrvatsko Zagorje and Karlovac sub-basins) for paleomagnetic and magnetic anisotropy studies. Attempts were also made to identify the magnetic minerals in the same material with magnetic and other methods. Despite of the very low concentration of the magnetic minerals, which were identified most frequently as greigite, followed by magnetite, and only in rare cases hematite or pyrrhotite, the paleomagnetic signal was generally good. Both normal and reversed polarity magnetizations were found and in both cases the paleomagnetic declinations deviated from the present north in the CCW sense, except two localities sampled from the Ormos–Selnica anticline. The low concentration of the magnetic minerals was also reflected in the low values of the magnetic susceptibility (generally in the lower range of 10-4 SI) which suggest that the magnetic fabric of the clay-rich sediments is residing in paramagnetic minerals (probably iron-containing illite). The magnetic anisotropy measurements show that the late-Miocene sediments of the Southern Pannonian basin are weakly deformed and microtectonic features are not observable on them. Nevertheless, the maximum axes of the magnetic susceptibility are well-clustered within each locality, i.e. the clays-rich sediments show signs of tectonic deformation. The deformation is mostly compressional in character and the magnetic lineation directions correlate well with the orientations of map-scale folds or NW-SE trending dextral faults, when such features are known. Consequently, in the absence of field observations of deformational features (like in the Karlovac basin), the magnetic lineations alone can be used as reliable indicators of the orientation (and of the character) of the ancient stress field.
Both, the paleomagnetic rotations and the dominantly compressional stress responsible for the observed magnetic lineations are interpreted as due to northward moving and CCW rotating Adria, after 6Ma.

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PALEOMAGNETISM OF THE LATEST OLIGOCENE – MIOCENE EXTRUSIVE IGNEOUS ROCKS FROM THE VARDAR ZONE AND FROM THE SERBIAN PART OF THE PANNONIAN BASIN

Vesna Lesić[1], Emő Márton[2], Vesna Cvetkov[3], Dragana Tomić[4]

[1]Department for Geomagnetism and Aeronomy, Belgrade, Republic of Serbia. vlesic@drenik.net, dragana.tomic@ymail.com
[2]Eötvös Loránd Geophysical Institute of Hungary, Paleomagnetic Laboratory, Budapest, Hungary. paleo@elgi.hu
[3]University of Belgrade, Faculty of Mining and Geology, Belgrade, Republic of Serbia. cvetkov@rgf.bg.ac.rs
[4]Republic Geodetic Authority, Department for Geomagnetism and Aeronomy, Belgrade, Republic of Serbia. vlesic@drenik.net

We have studied the paleomagnetism of quarz-latites, ignimbrites, dacites and basalts from the area West of Kopaonik, the Rudnik area and the southernmost part of the Pannonian basin in Serbia. All the above igneous rocks were emplaced after the docking of the different

tectonostratigraphic units which compose the basement. Nevertheless, the Vardar zone is known as a right lateral shear zone which has been active in the Miocene.
The stratigraphic position of the sampled volcanics is poorly controlled. Most of the basalts were dated with K/Ar method, which yielded ages between 25.0-9.1 Ma. However, we have reason to be cautions to rely absolutely on K/Ar ages, since at one locality (Druzetici) a „lower” and a „higher” basalt was dated as 23 and 15.8 Ma, respectively, while their paleomagnetic directions and polarities are the same. Moreover, the polarity is normal while, according to the standard polarity time scale, reversed polarity is expected for both times.
The main body of the paleomagnetic data are grouped around a mean direction which is practically the same as the expected paleomagnetic direction in a stable European framework (both normal and reversed polarity site mean directions are present). They imply the lack of displacement of the study area. Nevertheless, there are „outliers” partly suggestive of CCW, partly of CW rotation. For lack of good age control, it is hard to interpret the outliers in terms of tectonics. They may indicate local tectonic disturbances or two rotations phases in the opposite senses of a larger area. In order to arrive to a correct interpretation, we are planning to study the paleomagnetism of stratigraphically better controlled sediments from the same areas.

CALIBRATION OF SEVERAL FORAMINIFERA BIOZONES IN THE MARINE MIOCENE FROM ROMANIA

Sorin Filipescu [1], Arjan DeLeeuw [2]

[1]Babeş -Bolyai University, Department of Geology. Str. Kogălniceanu no. 1, 400084 Cluj-Napoca, Romania, sorin.filipescu@ubbcluj.ro
[2]Paleomagnetic Laboratory ’Fort Hoofddijk’, Utrecht University, Budapestlaan 4, 3584 CD, Utrecht, the Netherlands, adeleeuw@geo.uu.nl.

Recent investigations on several key-sections from the marine Miocene in Romania reveal several possibilities to correlate the existing foraminifera biozones to the magnetostratigraphic scale and radio-isotopic ages (De Leeuw et al., submit).
The Early-Middle Miocene transition is well exposed by several sections in the Transylvanian Basin. The age of the volcanic ash (Dej Tuff) sampled at Ciceu-Giurge□ti in the *Orbulina suturalis* Biozone is dated at 14.38 Ma (40Ar/39Ar). The equivalent interval sampled at Pâgli□a is exclusively of normal polarity and was deposited during chron C5ADn.
The middle/late Badenian boundary corresponds to the end of the salinity crisis and was dated at 13.36 Ma (De Leeuw et al., in prep).
The Badenian / Sarmatian boundary has been dated at 12.8 Ma by using the position of the *Anomalinoides dividens* Biozone in relation to the age estimations based on the rate of sedimentation between of the evaporites and the 'middle Sarmatian tuff complex' (MSTC). In our opinion, the top of *Anomalinoides dividens* Biozone should be traced at the level of Hădăreni Tuff (part of the MSTC, dated at 12.38-12.35 Ma), where the paleoecological conditions changed.
Differentiation between biozones in the investigated deep water sections of the Transylvanian Basin becomes more problematic above the MSTC and we thus refrain from age estimates for the *Articulina sarmatica*, *Dogielina sarmatica* and the base of the *Porosononion aragviensis* biozones. The upper part of *Porosononion aragviensis* Biozone can be estimated by the age of

the Oarba Tuff (11.62 Ma) and the Sarmatian-Pannonian boundary (11.3 Ma – Vasiliev et al., 2010).
The potential value of the biozones as regional markers in Paratethys should be carefully analized due to gradual paleogeographic changes across the Alpine-Carpathian orogen. Further correlations with radio-isotopic and magnetostratigtraphic data would probably offer better callibrations to the formal stages of the Miocene.

References:
De Leeuw A, Stoica M, Krijgsman W, Kuiper K.F. in prep. New $^{39}Ar/^{40}Ar$ constraints on the termination and duration of the Badenian Salinity Crisis.
De Leeuw A, Filipescu S, Matenco L, Krijgsman W, Kuiper K, Stoica M, submit. Paleomagnetic and chronostratigraphic constraints on the evolution of the middle Miocene Transylvanian Basin (Romania) and their implications for Central Paratethys Stratigraphy and the emplacement of the Tisza-Dacia plate. Global and Planetary Change.
Vasiliev I, De Leeuw A, Filipescu S, Krijgsman W, Kuiper C, Stoica M, Briceag A. (2010). The age of the Sarmatian–Pannonian transition in the Transylvanian Basin (Central Paratethys). Palaeogeography, Palaeoclimatology, Palaeoecology 297, 54–69.

DIATOM BIOSTRATIGRAPHY WITHIN PELAGONIA BASIN (FYR MACEDONIA AND GREECE)

Nadja Ognjanova-Rumenova[1], Nikola Dumurdjanov[2]

[1] Department of palaentology, stratigraphy and sedimentology, Geological Institute at Bulgarian Academy of Sciences, Acad. Georgi Bonchev Str. Bl. 24, 1113 Sofia, Bulgaria, *nognjan@geology.bas.bg*
[2] Faculty of Mining and Geology Stip, G.Delchev str. 89, 2000 Stip, Macedonia, nika@unet.com.mk

The Pelagonia Basin, measuring 1500 km^2 is a part of the tectonic basins created after the Savian orogeny and the Early Miocene intense peneplenization in the Balkan Peninsula (Dumurdzanov et al. 1997). This led to the formation of a set of sub-grabens within the Pelagonia Basin and the faults running from NW to SE. Several major sub-basins can be distinguished: the Bitola and Prilep areas (FYR of Macedonia) and the areas of Florina, Ptolemais and Servia parts (Greece).This study sums up all data from investigations of Upper Miocene and Pliocene diatomaceous deposits within Pelagonian Basin. Several investigations have focused on taxonomic aspects of the fossil diatom floras in the region. There are descriptions of a few new fossil diatom forms, as well as – Gersonde, Velitzelos (1997), Ognjanova-Rumenova (2005) and Owen et al. (2010) have given more detailed diatom biostratigraphy and paleoecological reconstructions for different sub-basins.
A detailed stratigraphy was developed for Mio-Pliocene deposits in the Bitola sub-basin in southern FYR of Macedonia. This investigation is based on diatomaceous sediments collected from quarrie “Suvodol” and borehole V-466 in the village of Vranjevci – on the farthest eastern margin of Pelagonia depression. The major aims are: (1) determining the diatom floras; (2) establishing a high-resolution diatom stratigraphy; and (3) to reconstruct the paleolimnological conditions that prevailed in the area during the Late Miocene and Pliocene.
The taxonomical composition is very diverse, but the representatives of genera *Cyclotella* Kütz. and *Actinocyclus* Ehr. are the most dominant. The lower part of the Pliocene is marked by the extinction of typical Miocene *Actinocyclus* species – as *A. makarovae* (Temn. & Ognjan.)Temn. & Ognjan., *A. fungiformis* Temn., Khurs. & Valeva and *Actinocyclus sp.*, and the first appearance of *Cyclotella castracanei* Eulenst. Ecological data for the diatom taxa and

the proportion between frustules and chrysophycean stomatocysts are used in the attempts to reconstruct in detail the successive stages in the paleoenviromnental development of the basin, at the end of the Miocene and the beginning of Pliocene.

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References:

Dumurdzanov N., Petrov G., Tuneva V. (1997). Evolution of lacustrine Neogene Pleistocene in the Vardar zone in Republic of Macedonia. In: Proceedings: Magmatism, Metamorphism and Metalogeny of the Vardar zone and Serbo-Macedonian massif; Stip-Dojran, 83–88.

Gersonde R., Velitzelos E. (1977). Diatomeenpaleookologie im Neogen-Becken von Vegora N-W Mazedonien. Ann Ge´ol Pays Helle´n 29, 373–382.

Ognjanova-Rumenova N. (2005). Upper Neogene siliceous microfossils from Pelagonia Basin (Balkan Peninsula). Geologica Carpathica 56, 4, 347–358.

Owen, R., Renaut, R., Stamatakis, M. (2010). Diatomaceous sedimentation in late Neogene lacustrine basins of western Macedonia, Greece. J. Paleolimn, 44, 343-359.

STAGES OF THE POLISH CARPATHIAN FOREDEEP DEVELOPMENT - A NEW APPROACH

Nestor Oszczypko, Marta Oszczypko-Clowes

Jagiellonian University, Institute of Geological Sciences , Oleandry 2a, 30-063 Kraków, Poland, nestor.oszczypko@uj.edu.pl; m.oszczypko-clowes@uj.edu.pl

In southern Poland the Miocene deposits have been recognized both in the Outer Carpathians as well as in the Carpathian Foredeep. In the Outer Carpathians the Early Miocene deposits were incorporated into the accretionary wedge and represent the youngest part of the flysch sequence. The Polish Carpathian Foredeep can be subdivided into outer and inner parts. The inner part is located beneath the Carpathian nappes, while the outer part occur north of the Carpathian front. The inner fore-deep is composed of Early to Middle Miocene deposits, while the outer foredeep is filled with Middle Miocene (Badenian and Sarmatian) deposits up to 3500 m in thickness. The Early Miocene strata are mainly terrestrial in origin, whereas the Badenian and Sarmatian ones are marine. The Carpathian foredeep in Poland developed as a peripheral foreland basin related to the moving Carpathian front. The subsidence of the basin was controlled both by the sediment and thrust-induced load. The main episodes of intensive subsidence in the PCF correspond to the period of progressive emplacement of the Western Carpathians onto the foreland plate. The important driving force of the tectonic subsidence was the emplacement of the nappe load related to the subduction roll-back. During that time the loading effect of the thickening of the Carpathian accretionary wedge on the foreland plate increased and was followed by a progressive acceleration of total subsidence. The mean rate of the Carpathian overthrusting, and north to north-east migration of axis of depocentres reached 12 mm /a at that time. During the Late Badenian-Sarmatian time the rate of advancement of the Carpathian accretionary wedge was lower than that of the pinch-out migration and, as a result, the basin widened. The Miocene convergence of the Carpathian wedge resulted in the migration of depocenters and the onlap of successively younger deposits onto the foreland plate.

ICHNOLOGICAL EVIDENCE OF THE EARLY MIOCENE MARINE TRANSGRESSION IN THE EGGENBURG BAY

Peter Pervesler[1], Reinhard Roetzel[2], Alfred Uchman[3]

[1] University of Vienna, Department of Palaeontology, Althanstrasse 14, A-1090 Wien, Austria,
[2] Geological Survey of Austria, Neulinggasse 38, A-1030 Wien, Austria
[3] Jagiellonian University, Institute of Geological Sciences, ul. Oleandry 2a, Pl-30-063 Kraków, Poland

The Lower Miocene (Eggenburgian – Ottnangian, Lower Burdigalian) sediments in the surrounding of Eggenburg in northeastern Austria stand for a unique, complex palaeogeographic situation (Roštínský & Roetzel, 2005). The transgressing sea covered a morphologically highly structured crystalline area of the Bohemian Massif, forming several small islands and bays (Roetzel et al., 1999). The widespread Burgschleinitz Formation (Steininger & Roetzel, 1991; Roetzel et al., 1999) is characterized by an alternation of immature, moderately to poorly sorted, coarse to fine sands with gravelly intercalations. The sediments are mainly deposited in a wave- and storm-dominated littoral to shallow sublittoral environment in shallow bays sheltered by crystalline barrier islands (Roetzel, 1990). It typically transgressed directly on the crystalline basement of the Bohemian Massif. At the base, poorly sorted silts, sands and gravel of the Kühnring Member are developed locally.

Trace fossils are not rare in the Burgschleinitz Formation of the Eggenburg Bay. The most common ichnogenus in these nearshore deposits is *Ophiomorpha*, which can be observed in several outcrops of the region (Hohenegger & Pervesler, 1985; Pervesler et al., 2011). *Thalassinoides* Ehrenberg was described from the sandpit Sieber (now Hammerschmid). The highest diversity of trace fossils in the nearshore sediments of the Eggenburg Bay with at least 11 ichnotaxa was found in the Burschleinitz Formation of the Kirchenbruch quarry. The sandy sediments of this outcrop were deposited in a small marine subbay open to the west and close to nearby crystalline elevations.

Massive, coarse to medium sands in the lowermost part of the section with typical minerals and components from the surrounding granites were deposited in the nearshore area and lack trace fossils.

The following coarse sandy to gravelly shell layer contains thick-shelled mollusks of the littoral and shows typical characteristics of tempestites.

In the middle part of the section the vertical trace fossil assemblage with *Ophiomorpha*, *Skolithos*, and *Arenicolites* suggests a colonization window; here, after a short regressive phase or stillstand, a stabilization of the sea floor related to new flooding can be assumed. This assemblage is indicative of the *Skolithos* ichnofacies, located in the upper shoreface. Upsection, the transition to the proximal *Cruziana* ichnofacies, which is typically positioned in the middle-lower shoreface, is indicated by *Thalassinoides*. In the muddy sands of the topmost Gauderndorf Formation, the lack of vertical trace fossils indicates the deepening during the proceeding Early Miocene (Eggenburgian) transgression (Pervesler et al., 2011).

References:

Hohenegger, J. and Pervesler, P. (1985). Orientation of crustacean burrows. Lethaia, 18, 323-339.

Pervesler, P., Roetzel, R. & Uchman, A. (2011). Ichnology of shallow sublittoral siliciclastics of the Burgschleinitz Formation (Lower Miocene, Eggenburgian) in the Alpine-Carpathian Foredeep (NE Austria). Austrian Journal of Earth Sciences, 104/1, in press.

Roetzel, R., Mandic, O. & Steininger, F.F. (1999). Lithostratigraphie und Chronostratigraphie der tertiären Sedimente im westlichen Weinviertel und angrenzenden Waldviertel. In: R. Roetzel, (Hrsg.), Arbeitstagung der Geologischen Bundesanstalt 1999, Retz, 3.-7.Mai 1999, pp. 38-54.

Roštínský, P. & Roetzel, R. (2005). Exhumed Cenozoic landforms on the SE flank of the Bohemian Massif in the Czech Republic and Austria. Zeitschrift für Geomorphologie, Neue Folge, 49/1, 23-45.
Steininger, F.F. & Roetzel, R. (1991). Geologische Grundlagen, Lithostratigraphie, Biostratigraphie und chronostratigraphische Korrelation der Molassesedimente am Ostrand der Böhmischen Masse. In: R. Roetzel, (Hrsg.), Geologie am Ostrand der Böhmischen Masse in Niederösterreich. Schwerpunkt Blatt 21 Horn, Arbeitstagung der Geologischen Bundesanstalt 1991, Eggenburg, 16.-20.9.1991, pp.102-108.

FORAMINIFERAL RECORD OF ENVIRONMENTAL CHANGES IN THE WSCHODNIA RIVER AREA (NORTHERN CARPATHIAN FOREDEEP BASIN, SOUTHERN POLAND) PRIOR TO THE LATE BADENIAN SALINITY CRISIS

Danuta Peryt

Institute of Paleobiology Polish Academy of Sciences, Twarda 51/55, 00-818 Warszawa, Poland; d.peryt@twarda.pan.pl

The Middle Miocene salinity crisis in the Paratethys resulted in deposition of evaporites in the Red Sea, Middle East and the Carpathian region that was initiated 13.8 Ma ago. In the Carpathian Foredeep Basin, the evaporites are Late Badenian (Serravallian) in age and are underlain by deep-water deposits in more central basin locations. Foraminifers occurring in forty-one samples coming from a twelve-metres-thick profile of calcareous claystones directly underlying gypsum deposits in the Młyny PIG1 borehole (northern Carpathian Foredeep Basin, southern Poland) have been studied quantitatively aiming to reconstruct environmental changes at the transition from marine to evaporitic conditions. 16 species of planktonic foraminifers and 65 benthic species have been recorded. The lowermost (3 m thick) part of the studied section yields abundant warm water planktonic foraminiferal assemblage composed mainly by orbulinoforms and *Globigerinoides* spp. The P/B ratios vary between 70 to 80%. This warm water planktonic fauna suddenly disappears 8 m below the evaporites and the P/B ratio significantly decreases, to 40–50% in the next 2 m interval and to less than 10% in the uppermost part of the section, i.e. below the evaporites. The followed planktonic assemblage is dominated by *Globigerina bulloides* that is cool water index. Subordinate are cool-temperate species, e.g. *Globorotalia bykovae*. Benthic foraminiferal assemblages from the lowermost 3-m-thick interval of the studied section are well diversified and composed of large-size specimens representing both epi- and infaunal dwellers. Common are Nodosariidae, *Spiroplectinella*, *Martinotiella*, *Cibicidoides*, *Melonis*, *Pullenia*, *Gyroidina*, *Heterolepa*, *Hanzawaia*. An important change in composition of benthic foraminiferal assemblages coincided with changes in planktonic assemblages. In the 8 m thick strata from below the evaporites infaunal forms – *Bulimina* spp. and *Uvigerina* spp. – dominate among benthic foraminiferal assemblages. These taxa are recognized as indicators of high surface water productivity and poor bottom water oxygenation. The upsection decrease of share of planktonic foraminifers reflects the shallowing of the basin accompanied by a decrease in the temperature gradient between the upper (warmer) and lower (colder) water beds. Coeval domination of benthic foraminiferal assemblages by infaunal species suggests an increased surface water productivity and an increased organic flux to the sea bottom prior to the evaporite deposition; a deficit of oxygen in bottom waters favorized infaunal dwellers.

FINDING OF THE PURBECKIAN LIMNIC OSTRACODA IN THE EARLY MIOCENE MARINE DEPOSITS OF THE VIENNA BASIN, SLOVAKIA – PALEOGEOGRAPHIC IMPLICATIONS

Radovan Pipík[1], Ján Schlögl[2], Jean-Paul Colin[3, 4]

[1] Geological Institute, Slovak Academy of Sciences, Severná 5, SK-974 01, Banská Bystrica, Slovakia, pipik@savbb.sk
[2] Department of Geology and Paleontology, Faculty of Sciences, Comenius University, SK-842 15, Bratislava, Slovakia
[3] Impasse des Biroulayres, 33610 Cestas, France
[4] Universidade de Lisboa, Faculdade de Ciencias, Centro de Geologia, Campo Grande, C-6, 3° 1749-046, Lisbon, Portugal

Among the Early Miocene marine neritic ostracoda, well-preserved limnic Mesozoic ostracods *Cetacella armata* Martin, 1958, *Cypridea* ex gr. *tumescens* (Anderson, 1939), *Cypridea* cf. *altissima* Martin 1940, *Mantelliana perlata* Wienholz, 1968, *Theriosynoecum forbesii* (Jones, 1885), *Darwinula* sp. have been found at the locality Cerová. These taxa were a part of the limnic Mesozoic ostracod fauna wide-spread over the world, which disappeared in the Europe with marine Aptian transgression and were replaced in the Late Cretaceous by new and modern ostracod taxa (Babinot et al., 1996).

A presence of *Theriosynoecum forbesii* dates the source deposits with limnic ostracods to the Theriosynoecum forbesii Zone of Late Jurassic/Early Cretaceous, equal to the Tithonian/Berriasian age. In the lithostratigraphical division, this zone corresponds to Purbeck and lower Hastings Groups known from the southern England and north-western France (Horne, 1995).

With a respect to this biostratigraphical attribution, this discovery induces a paleogeographical problem on a source geological unit because no limnic Late Jurassic/Early Cretaceous deposits have been found in the Central Europe till now. The eastern edge of the Bohemian Massif can be regarded as the most possible source, which was at this time emerged land. Preserved Late Jurassic/Early Cretaceous deposits are of marine origin and a lack of the Purbeckian limnic deposits is underlined by Lower Cretaceous regression and karstification of the older deposits. The valves of reworked Purbeckian ostracods lack any marks of transport-related holes and smoothening of the ornamentation and a relatively large distance of the deposition area from the Bohemian Massif make this “source” questionable, even impossible. Perfect preservation requires a transport on a short distance from the neighboring geological units. Central Western Carpathian geotectonic units can be hardly accepted as a possible source, due their continual and fully marine Late Jurassic – Early Cretaceous sedimentary sequence. The only source of the Purbeckian deposits, which could be partially emerged in that time, can be situated in the Outer Western Carpathians, however this limnic deposits were completely eroded.

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References:

Babinot, J.F., Colin, J.P., Tambareau, Y. (1996). Late Cretaceous non-marine ostracods from Europe: biostratigraphy, palaeobiogeography and taxonomy. Cretaceous Research 17, 151–167.

Horne, D.J. (1995). A revised ostracod biostratigraphy for the Purbeck-Wealden of England. Cretaceous Research 16, 639-663.
Voigt, S., Wagreich, M., Surlyk, F., Walaszczyk, I, Uličný, D., Čech, S., Voigt, Th., Wiese, F., Wilmsen, M., Niebuhr, B., Reich, M., Funk, H., Michalík, J., Jagt, J.W.M., Felder, P.J., Schulp, A.S. (2008). Cretaceous. In: McCann, T. (ed.) The Geology of Central Europe, Vol. 2: Mesozoic and Cenozoic, Geological Society of London, 923-997.

EVENTS IN THE MIOCENE EASTERN PARATETHYS, BASED ON DEEPWATER TAMAN SECTIONS

S.V. Popov[1], I.A. Goncharova[1], E.P. Radionova[2], N.Y. Filippova[2], L.A. Golovina[2], Y.V. Rostovtseva[3], T.N. Pinchuk[4], Y.V. Vernigorova[5], N.I. Dykan[5]

[1] Paleontological Inst. RAS, Moscow, Profsoyuznaya 123, serg.pop@mail.ru
[2] Geological Inst. RAS, Moscow, Pyzhevskiy 7, radionova@ginras.ru
[3] Moscow Univ., Geological Dep., rostovtseva@list.ru
[4] Kuban Univ., Krasnodar, pinchukt@mail.ru
[5] Inst. Geology NAS, Kiev, O. Gonchar 55, vernigorof@yandex.ru

The Middle Miocene (Chokrakian and Karaganian) sediments from the Taman Peninsula of the Black seaside were deposited in the environments of outer shelf with depth 150-200 m. Extremely poor zoo-benthic associations containing mollusks, foraminifers, ostracods and specific organic-walled phytoplankton with *Lejeunecysta*, ?*Impagidinium* testify on meso-eutrophic basin with water column stratification and unfavorable gas regime.

During the Konkian time richer foraminiferal association with *Globigerina bulloides*, *Globorotalia* sp., *Quiqueloculina gracilis, Varidentella reussi sartaganica* and mollusks with *Timoclea (Parvivenus) konkensis*, and coccolithophorids with *Reticulofenestra pseudoumbilica* as well as more divers dinocist assemblage point on marine water filling. Change of water circulation and salinity led to more favor gas regime during the Konkian - early Early Sarmatian time. At that time the western Taman Depression shallowed (~100 m).

More abundant benthic fauna of the mid-Middle Sarmatian (s. lato) and lithological evidences indicate shallowing up to photic zone (~50 m), according to Rostovtseva (2009). Deepwater deposition was restored during the Early Maeotian (more 100 m). The western part of Taman Depression became shallow shelf basin from the end of the Early Maeotian (30-50 m). Eastern part have demonstrated deepwater environments (150-200 m) up to the Pontian time.

On the basis of phytoplankton three marine water invasions to Euxinian part of the Eastern Paratethys has been recorded in the Middle Sarmatian, when oceanic diatom species *Azpeitia apiculata* (LO-10.1Ma), later *Lyrella, Grammatophora, Cocconeis* came. *Thalassiosira burckliana* (FO-8.9, LO-7.9Ma) and later - *Thalassiosira grunowii* (LO 7.8Ma), *Selenopemphix nephroides* were founded in the base and in the roof of the Upper Sarmatian deposits. *Braarudosphaera bigelowii, Reticulofenestra pseudoumbilica, Thalassiosira* were recorded in the Lower Maeotian. From the second part of Late Maeotian to the beginning of Pontian time marine invasions took place constantly (Radionova, Golovina, 2011).

Thick diatomite (up to 1.2 m), marl sublayers with nannofossils and episodic abundant freshwater phytoplankton specify on hydrological front environments with flowering of plankton diatoms (mainly *Thalassiosira* and *Chaetoceros)* and *Braarudosphaera bigelowii* during the Maeotian and beginning of the Pontian.

Shallow environments (30-50 m) with abundant brackish mollusks prevailed in the whole studying area from the Pontian. Weathering of the roof of Lower Pontian deposits, presence of land gastropod *Helicopsis* and pebbles in the base of the Upper Pontian (Portaferian) testify on abrupt water level fall and continental break. Waters of river off reached Taman region, so dinocist association consist of freshwater green algae *Pediastrum* spp. (up to 40%). High endemic benthos and phytoplankton composition point on closed brackish basin and episodic influence of river freshwater flow, with depth 30-50 m.

New unconformity and continental break are observed near the Pontian / Kimmerian boundary. The Azov Beds of the lower Kimmerian include diverse mollusks with *Paradacna deformis, P. stratonis, Pontalmyra occidentalis, Arcicardium subacardo* and phytoplankton association with *Pediastrum* and *Botryococcus*, which testify continuation of freshening.

The Kamishburun Beds (Middle Kimmerian) with abundant large endemic shells of *Pteradacna edentula, Arcicardium acardo, A. kubanicum, Tauricardium squamullosum* et al., have also abrupt regional unconformity in the base.

References:

Radionova E.P., Golovina L.A. Upper Maeotian—Lower Pontian “Transitional Strata” in the Taman Peninsula: stratigraphic position and paleogeographic interpretation. Geologica Carpatica, 62, 1, 14p.

Rostovtseva Y.V. (2009). Facies of Taman Peninsula Middle Sarmatian. Lithology and mineral resources,5. pp. 493-507. (in Russian).

FIRST TERRESTRIAL SMALL MAMMAL FAUNA FROM THE MIOCENE OF BULGARIA

Prieto Jérôme[1,2,3], Böhme Madelaine[1,2], Spassov Nikolaï[4]

[1] Institute for Geoscience, Sigwartstraße 10, 72076 Tübingen, Germany (corresponding author: j.prieto@lrz.uni-muenchen.de)

[2] Senckenberg Center for Human Evolution and Palaeoecology, Tübingen (HEP)

[3] Department für Geo- und Umweltwissenschaften, Paläontologie & Geobiologie, & Bayerische Staatssammlung für Paläontologie und Geologie Richard-Wagner-Str. 10, 80333 München

[4] National Museum of Natural History, Bulgarian Academy of Sciences, 1 Blvd Tzar Osvoboditel, BG-1000 Sofia (Bulgaria)

Bulgaria is a dream for vertebrate Palaeontologists. Particularly during the last decade, extremely rich and well preserved large mammal faunas have been excavated and described from Miocene deposits (e.g. Spassov et al. 2006), demonstrating in this way the high potential of the country. In contrast, terrestrial small vertebrate assemblages are almost unknown, the studies being concentrated on the Plio-Pleistocene material (e.g. Popov 2004).

Since 2009 intensive Bulgaro-german fieldwork focuses on the discovery of terrestrial small vertebrate-enriched deposits. This effort was successful, and, as a first step, we present here the faunas found in the city of Blagoevgrad (South-West Bulgaria, Struma River Valley). The fossils come from two superposed paleosoils exposed during the construction of a house. The remains are fragmentary, and isolated bones fragment and teeth occur most frequently.

The small mammals dominate the sample. All reported genera are new in the Bulgarian fossil record: the rodents *Byzantinia* sp. and *Progonomys cathalai*; the insectivores *Crusafontina endemica*, *Desmanella* sp. and *Schizogalerix* sp.; the lagomorph are also present with a form morphologically closed to the Moldavian species *Bellatoides kalfense*.

In a biostratigraphical view, the fauna correlates most probably to the Late Vallesian (Late Miocene), but, because of the lack of precise faunal succession in the region, a more in deep analyze is not possible for the moment. This makes the ongoing discoveries and studies in Bulgaria so fascinating.

References:

Popov, V. V. (2004). Pliocene small mammals (Mammalia, Lipotyphla, Chiroptera, Lagomorpha, Rodentia) from Muselievo (North Bulgaria). Geodiversitas, 26(3), 403-491.

Spassov, N., Tzankov, T., Geraads, D. (2006). Late neogene stratigraphy, biochronology, faunal diversity and environments of the South-west Bulgaria (Struma River Valley). Geodiversitas, 28 (3), 477-498.

MIDDLE MIOCENE INSECTIVORE SUCCESSION FROM HUNGARY: PRELIMINARY RESULTS AND ONGOING STUDIES

Jérôme Prieto [1,2,3], Ostende Hoek[4], W. van den Lars[4], János Hír[5]

[1] Institute for Geoscience, Sigwartstraße 10, 72076 Tübingen, Germany (corresponding author: j.prieto@lrz.uni-muenchen.de)

[2] Senckenberg Center for Human Evolution and Palaeoecology, Tübingen (HEP)

[3] Department für Geo- und Umweltwissenschaften, Paläontologie & Geobiologie, & Bayerische Staatssammlung für Paläontologie und Geologie Richard-Wagner-Str. 10, 80333 München

[4] Netherlands Centre for Biodiversity, Naturalis, P.O. Box 9517, NL-2300 RA Leiden, The Netherlands

[5] Nógrád Megyei Múzeumi Szervezet, Pásztói Múzeum, 3060, Pásztó, Múzeum tér 5, Hungary

During the last decade, intensive field work in the Miocene deposits from Hungary has lead in the discovery of large and well preserved micro-mammal faunas (e.g. Hír 2010). As a result much progress had been made in the understanding of the rodent biostratigraphy and faunal relationships in Eastern Europe. Paradoxically, few studies were undertaken on the Middle Miocene insectivore samples, most of the efforts being focused on younger records. This lack is a shame as this group is traditionally considered a good palaeoenvironmental indicator (particularly for humidity), and recently also proved its importance for palaeogeographical purposes (Furió et al. 2011).

As a first step in the elaboration of the Middle Miocene insectivore faunas from Hungary, we review the Badenian material from Sámsonháza 3 (Nógrád County**)**, and we add new results from the geographically and biostratigraphically close localities Hasznos and Mátrazölös. Clear different genera are recorded in the Sarmatian *s. str.* localities from the Felsötárkany Basin (Heves County), indicating drastic changes in the insectivore faunas during the late Middle Miocene.

The evaluation of these changes in Hungary by comparison with the evolution of the Middle Miocene environments in Europe is the challenge of this work.

References:

Furió, M., Casanovas-Vilar, I. & Hoek Ostende, L.W. van den (2011). Predictable structure of Miocene insectivore (Lipothyphla) faunas in western Europe along a longitudinal gradient. Palaeogeography, Palaeoclimatologie, Palaeoecology, 304, 262-275.

Hír, J. (2010). A short sketch on the studies of middle Miocene fossil rodent faunas in the Pannonian Basin. Zitteliana, B 29, 50.

DETAIL STRATIGRAPHY OF TAMAN PENINSULA (MIDDLE – UPPER MIOCENE)

Eleonora P. Radionova[1], Larissa A. Golovina[1], N.Y. Filippova[1], Sergey V. Popov[2], I.A. Goncharova[2], T.N. Pinchuk[3]

[1] Geological Instute RAS, Moscow, Pyzhevskiy 7, radionova@ginras.ru
[2] Paleontological Institute RAS, Moscow, Profsoyuznaya 123, serg.pop@mail.ru
[3] Kuban University, Krasnodar, pinchukt@mail.ru

Stratigraphy of the Taman Peninsula key-sections (Zelenskiy Mount, Popov Kamen, Taman, Zhelezniy Rog) was studied based on fossil mollusks, foraminifers, and phytoplankton distribution.

Upper Chokrakian deposits contain mollusk *Lutetia (Davidaschvilia) intermedia*, benthic agglutinated foraminifers with *Hyperammina* and *Trochammina*, and poor organic-walled phytoplankton with *Lejeunecysta*, and *?Impagidinium / "Gonyaulax"*.

Base of the Karaganian is fixed by appearence of *Lutetia (Spaniodontella)* and *Discorbis urupensis*. Local beds with *?Hystrichosphaeropsis sp.A.* is arranged based on organic-walled phytoplankton.

Konkian deposits are distinguished by more diverse foraminiferal and dinocist associations, appearance of coccolithophorids and mollusk assamblage with *Timoclea (Parvivenus) konkensis*. They are subdivided in three parts according to foraminifers and calcareous nannoplankton. The richest assemblages were found in the middle part of the Konkian deposits, that contain planktic foraminifers - *Globigerina bulloides*, *Globorotalia* sp., polyhaline benthic forms - *Quiqueloculina gracilis, Varidentella reussi sartaganica* et al.. Nannoplankton association doesn't contain zonal species, but corresponds NN6/7 zones. The occurrence of *Rhabdosphaera poculi* and *Rh. pannonica* in these assemblages may determines to NN7 Zone and correlates with Upper Badenian (Kosovian) deposits.

Lower Sarmatian deposits are characterized by abundant mollusks *Abra alba scythica* and appearance of *Mactra eichwaldi*, *Ervilia dissita*, *Obsoletiformes* sp.. Regional layers with *Miliolinella reusu*, are allocated, based on foraminifers. *Cleistosphaeridium placacanthum* is characteristic form for the Upper Konkian – Lower Sarmatian in dinocist association. The nannofossil assemblages are represented by a few cosmopolitan species.

Middle Sarmatian (s. l.). Thick **"***Cryptomactra* Beds" with *C. pesanseris* are represented by the lower part of the Middle Sarmatian deposits, which belong to *Dogielina sarmatica* regional zone on base the benthic foraminifers. Polydominant association of organic-walled phytoplankton with open-marine species (*Impagidinium aculeatum, I. patulum, Achomosphaera sagena type*) was changed later by poor brackish assemblage of the Pannonic type (with *Spiniferites* spp.), and freshwater algae *Pediastrum* spp . Regional diatom zone *Actinostephanus podolicus* (Temnishkova-Topalova, Kozyrenko,1990) corresponds to Middle Sarmatian, in which oceanic species *Azpeitia apiculata* (LO-10.1Ma) and benthic *Lyrella, Grammatophora, Cocconeis* are appeared.

Upper Sarmatian deposits contain rare *Mactra caspia* and abundant brackish diatoms, belonging to the *Achnantes brevipes* Zone. At the base of the Upper Sarmatian a few oceanic species were found, among which are *Thalassiosira burckliana* (FO-8.9, LO-7.9Ma) and *Nitzschia fossilis* (FO 8,9 Ma).

The **Sarmatian / Maeotian** boundary are determined by appearance of marine mollusks *Skenea tenuis* and *Sphenia anatina* in the base of bioherms and within riff body. In phytoplankton composition freshwater dinocyst association with *Pediastrum* and

Zygnemataceae change in hemi-marine ones with *Spiniferites* spp. and diatoms of *Thalassiosira maeotica* Zone with oceanic forms *Thalassiosira grunowii* (LO 7.8 Ma) and *Th. antiqua* (FO 7.7 Ma) below bioherm.

Upper Maeotian deposits contain brackish mollusks, foramenifers, ostracodes, and diatoms of *Cymatosira savtchenkoi* Zone (Kozyrenko, Radionova, 2003). Diatom assemblage contains the open-marine species of *Nitzschia miocenica* and *Thalassiosira convexa* Zones, correlateable with the early Messinian pre-evaporate deposits and the base of lower evaporate deposits (6.4-6.1 Ma).

Early Pontian deposits were determined by the appearance of endemic brackish mollusks, ostracodes and *Galeacysta etrusca*, *Caspidinium rugosum* among dinocysts (Filippova, 2008). Despite of brackish benthos composition, diatom and calcareous nannoplankton assemblages testify on constant marine invasions during the second part of Late Maeotian and the beginning of Pontian (Radionova, Golovina, 2011).

Upper Pontian – Lower Kimmerian. Marine phytoplankton groups disappeared and endemic brackish association with *Achomosphaera andalousiense*, *Spiniferites cruciformis*,? *Komewuia*-group et al. appeared among dinocysts. The Pontian-Kimmerian boundary determined mainly by appearance of specific Bivalvia in the Azov and Kamishburun Beds.

THE PLIOCENE SEDIMENTS FROM THE NORHERN FLANK OF FRUŠKA GORA (NORTHERN SERBIA) – A NEW APPROACH BASED ON AN INTEGRATED STUDY

Rundić Ljupko[1], Vasić Nebojša[2], Knežević Slobodan[1], Cvetkov Vesna[3]

[1] University of Belgrade, Faculty of Mining and Geology, Department of Geology and Paleontology, Kamenička 6, 11000 Belgrade, Serbia, rundic@rgf.bg.ac.rs; slobodan.knezevic@gmail.com
[2] University of Belgrade, Faculty of Mining and Geology, Department of Petrology and Geochemistry, Studentski trg 16, 11000 Belgrade, Serbia, sedimentologija@yahoo.com
[3] University of Belgrade, Faculty of Mining and Geology, Department of Geophysics, Djušina 7 16, 11000 Belgrade, Serbia, cvetkov@rgf.bg.ac.rs

According to a new version of the International Stratigraphic Chart (2009) based on the ratified proposal of International Commission on Stratigraphy (ICS), the Pliocene marine series involves the Zanclean and Piazenzian Stages (5.3 Ma – 2.59 Ma). It means that previous the youngest Pliocene Gelasian Stage was transferred to the base of Pleistocene. According to this, an attempt was made to correlate the Pliocene lacustrine series and the corresponding regional stages of the Pannonian domain to the general ones.

The Pliocene epoch is represented at Fruška Gora by lacustrine and lacustrine-fluvial sediments, known under the name »Paludina beds« (Petković et al., 1976; Rundić et al., 2010). The paleontological, sedimentologic as well as paleomagnetic analysis show presence of Lower Paludina beds (Dacian Stage) and Middle Paludina beds (older level of Romanian Stage). The Paludina beds are composed of multicolored (gray, bluish, tawny-rusty, brown) sandy clays, clays, small-grained to large-grained sands and pebbles, as well as layers of soft brown coal (lignite). In the Lower Paludina beds, the fossil fauna of mollusks is dominated by following forms: *Viviparus neumayri* BRUSINA, *V. suessi* NEUMAYR, *Hydrobia longaeva* NEUMAYR, *Lithoglyphus acutus* COB., *Melanopsis recurens* NEUMAYR, etc. The Middle Paludina beds, composed out of yellowish sands and sandy alevrites, contain the following mollusks: *Unio sibinensis* Pen., *U. subthalasinus* PEN., *U. zelebori* M. HOERNES, *Viviparus* cf. *bifarcinatus* BIELTZ., *Valvata piscinalis* MULLER. Certain ostracodes such as *Candona* cf.*angulata* MULLER, *Candonopsis* sp., *Darwinula stevensoni* (BR. et ROB.), *Ilyocypris gibba* (Ramd), *I. bradyi* SARS were identified from the Paludina beds in the "NEXE" brick factory near Sremski Karlovci. According to Krstić (2006), they belong to transitional parts of Lower-Middle Paludina beds. Occurrence of irregular tooth of Bovidae (Leptobos) from the Paludina beds confirms that these beds correspond to the Villafranchian deposits of Europe (Dimitrijević & Knežević, 1996).

For paleomagnetic studies, samples are taken from dark blue and black clay from the eastern part of the open pit "NEXE" brick factory near Sremski Karlovci. The value of magnetic susceptibility of samples ranges from $92.29\text{-}309.36 \cdot 10^{-6}$ SI, with the maximum degree of Anisotropy of Magnetic Susceptibility (AMS) of 2.7%. The shape of the AMS ellipsoids is oblate. Thermal demagnetization revealed that the carrier of the remanence greigite. The polarity of primary RM is negative (I=-55) with declination wich coincides with the direction of "stable Europe" from the same time.

References:

Dimitrijević, V. and Knežević, S. (1996) Leptobos (Bovidae, Mammalia) form "Paludina beds" at Cortanovci, Srem – Unusual Occurrence of Irregular Tooth Wearing. *Ann. Geol. Penins. Balk*., 60, 2, 219-228.

Krstić, N. (2006) Pliocene ostracodes of the Paludinian Beds in Pannonian Plain, Serbian Part. Herald of the Natural History Museum, Spec. public. 409 pgs, Belgrade.

Petković, K., Čičulić-Trifunović, M., Pašić, M., and Rakić, M. (1976) Fruška Gora - a monography of geological sturcture and tectonical setting. Matica Srpska, 134 pgs, Novi Sad (in Serbian)

Rundić, Lj., Toljić, M., Knežević, S. (2010) Annual Report on Geological Mapping on the scale 1: 50 000, sheet Novi Sad 3. Ministry of Envronmental Protection and Spatial Planning, 76 pgs, Belgrade (in Serbian)

LOWER BADENIAN NERITIC OSTRACOD ASSEMBLAGE OF THE STRATOTYPE ŽIDLOCHOVICE (CARPATHIAN FOREDEEP, CZECH REPUBLIC)

Michal Seko[1], Radovan Pipík[2], Nela Doláková[3]

[1] Okružná 1420/28, Púchov, Slovakia, michal.seko47@gmail.com
[2] Geological Institute, Slovak Academy of Sciences, Ďumbierska 1, 974 01 Banská Bystrica, Slovakia
[3] Department of Geological Sciences, Faculty of Science, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic

The ostracod assemblages of the stratotype Židlochovice in the Carpathian Foredeep have been examinated from two boreholes. The stratotype is stratigraphically dated to the NN5 zone and a foraminiferal zone Orbulina suturalis of the Lower Badenian (Moravian). An analysis was focused on taxonomy and paleoecology of the species, distribution of the taxa and individuals along the cores, quantification of the ratio valves/carapaces and a species richness by Simpson index (D) of diversity.

A change in lithology from clay to sandy clay, sand and limestone towards the up is accompanied by increase in ratio valves/carapaces from 4/151 to 68/165 signalizing a higher sedimentation rate. Circalittoral to epibathyal *Bosquetina carinella*, *Cytherella pestiensis postdenticulata*, *Henryhowella asperrima* and *Parakrithe dactylomorpha* became less frequent or disappeared towards the up and they were replaced by shallow infralittoral taxa tolerating a decrease in salinity - *Aurila cicatricosa*, *A. opaca*, *A. punctata*, *A. angulata*, *Cnestocythere lamellicosta*, *Loxocorniculum hastatum*, *Pokornyella deformis*, *Senesia philippi* and *Tenedocythere sulcatopunctata*.

A circalittoral/ epibathyal association was composed from 27 to 36 species and D attends its maximum (16.44). A number of the taxa decreased towards the up to 14 species in limestone and D was in its minimum (5.79). A total number of the species (between 18 to 27) and D (between 6.49 to 11.68) increased in a clayey shallow infralittoral environment but they are still lower than in a circalittoral/ epibathyal environment.

We suppose a change in bathymetry from circalittoral/ epibathyal to shallow infralittoral and carbonating sedimentation were the main stress factors controlling a species composition and richness.

Infralittoral to circalittoral (*Henryhowella*), possibly to epibathyal (*Parakrithe*) taxa regularly occurred in the Badenian ostracod assemblages of Austria and Poland (Groos 2006; Szczechura 1998, 2000, 2006; Szczechura & Aiello 2003; Zorn 2004), but the ostracod assemblages from the Židlochovice miss some epineritic, phytal, shallow and freshwater species observed in those countries. We suppose a water depth was a main factor causing the taxonomical differences between the localities what is supported by a finding of psychrospheric *Agrenocythere* in the Czech part of the Carpathian Foredeep.

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References:

Gross M. (2006). Mittelmiozäne Ostracoden aus dem Wiener Becken (Badenium/Sarmatium, Österreich). Österreichische Akademie der Wissenschaften, Schriftenreihe der Erdwissen-schaftlichen Kommissionen, spec. vol. 1: 1-224, Wien.

Szczechura J. (1998). The distribution of *Triebelina raripila* and *Carinocythereis carinata* (Ostracoda) from the Middle Miocene of the Central Paratethys and their palaeogeographic implications. Journal of Micropaleontology 17, 125-130.

Szczechura J. (2000). Palaeoenvironments of the Middle Miocene evaporite-bearing deposits from the Działoszyce Trough, Carpathian Foredeep, Poland, based on microfaunal studie. Geological Quarterly 44, 2, 119-135.

Szczechura J. (2006). Middle Miocene (Badenian) ostracods and green Alane (Chlorophyta) from Kamienica Nawojowska, Nowy Sacy Basin (Western Carpathians, Poland). Geologica Carpathica 57, 2, 103-122.

Szczechura J., Aiello G. (2003). The ostracod genus Nipponocythere Ishizaki, 1971 from the Middle Miocene of the Fore-Carpathian depression, Cenral Paratethys; its origin and paleoenvironment. Geologica Carpathica 54, 1, 9-20.

Zorn I. (2004). Ostracoda from teh Lower Badenian (Middle Miocene) Grund Formation (Molasse Basin, Lower Austria). Geologica Carpathica 55, 2, 179-189.

EXCEPTIONALLY PRESERVED UPPER BATHYAL ASSEMBLAGES FROM THE EARLY MIOCENE OF THE VIENNA BASIN AND THEIR SIGNIFICANCE FOR THE NAUTILOID HABITAT AND LIFE-STYLE

Ján Schlögl[1], Régis Chirat[2], Natália Hudáčková[1], Vincent Balter[3], Michael Joachimski[4], Frédéric Quillévéré[2], Andrzej Pisera[5]

[1] Department of Geology and Paleontology, Faculty of Natural Sciences, Comenius University in Bratislava, Mlynská dolina, 842 15 Bratislava, Slovakia
[2] Laboratoire de Géologie de Lyon: Terre, Planètes, Environnement, UMR CNRS 5276, Université Lyon 1, 27-43 Boulevard du 11 Novembre 1918, 69622 Villeurbanne Cedex, France
[3] Laboratoire de Géologie de Lyon: Terre, Planètes, Environnement, UMR CNRS 5276, Ecole Normale Supérieure de Lyon, 46 Allée d'Italie, 69364 Lyon Cedex 07, France
[4] North Bavarian Center of Earth Sciences, University of Erlangen-Nuremberg, Schlossgarten 5, 91054 Erlangen, Germany
[5] Institute of Paleobiology, Polish Academy of Sciences, ul. Twarda 51/55, 00-818 Warszawa, Poland

Exceptionally preserved upper bathyal assemblages (< 200 m) collected at Cerová-Lieskové locality in the Western Slovakia (eastern margin of the central Vienna Basin) represent one of the most exceptional nautilid deposits reported so far. The deposits are massive, locally laminated calcareous clay and clayey silt with thin tempestites (up to 5 mm thick) and several thin sandstone layers. The age of the deposits is late Karpatian according to the regional stratigraphic scheme (latest Burdigalian). Microfossil assemblages consist of planktonic and benthic foraminifers, radiolarians, sponge spicules, ostracods, coleoid statoliths, fish otoliths, bathyal shark teeth and diatoms. Macrofossils are represented by fishes and multiple invertebrate groups, including small siliceous sponges, bivalves, gastropods, scaphopods, nautilids, coleoids, regular and irregular echinoids, star fishes, brittle stars, and crustaceans (decapods, isopods and barnacles). Plant debris, wood fragments, well preserved leafs and even spikes are locally present. At least 2 demosponge species are preserved intact but flattened. Other exceptionally preserved fossils are nautilid jaws with chitinous lamellae still present, similarly preserved coleoid jaws, organic black bands around the nautilid shell edge, articulated skeletons of several *Callianopsis* species, and articulated isopod moults with both parts of the exoskeleton preserved in situ. Secondary electron microscopy (SEM) reveals that individual shells are exceptionally well-preserved. Raman spectroscopy (Jobin Yvon, HR800) shows that maxima at 702 cm^{-1} and 706 cm^{-1} characteristic of aragonite occur in all bivalve, gastropod, scaphopod and *Aturia* specimens. Planktonic foraminifers exhibit a maximum at 713 cm^{-1} characteristic of calcite.
Palaeoenvironmental analyses are based on benthic foraminiferal associations and stable isotopes from gastropods, bivalves, scaphopods, nautilids and planktonic foraminifers. Two step equations estimating paleodepth on the basis of present-day distribution of foraminifers (Hohenegger 2005) indicate bathymetric range between 240 – 330 m, with extreme values ranging from 149 m to 498 m. Benthic Foraminiferal Oxygen Index shows that the sediments were deposited under dysoxic to low oxic conditions.
In addition to general rarity of the fossiliferous Miocene bathyal deposits and numerous new species described from the locality (mainly gastropods, decapods, sharks), this site is unique because it yielded abundant (about 500 specimens) and very well-preserved newly hatched as well as adult shells of the Tertiary nautilid genus *Aturia*, associated with upper and lower jaws (Schlögl et al., 2011). These assemblages represent the first unequivocal case of autochthonous nautilid deposits reported so far. Oxygen isotope ratios show that *Aturia* was nektobenthic during the whole ontogeny, similarly as *Nautilus*. However, in contrast to *Nautilus*, both newly hatched and adult *Aturia* lived at the same water depth (about 240-330m) and temperature (13-16.2°C or 14.3-17.6°C depending on the value of $\delta^{18}Os_w$) in which the eggs were laid. The dysoxic paleoenvironmental setting in which *Aturia* occurs in abundance may be interpreted in light of both the capacity of *Nautilus* to exploit/tolerate oxygen-depleted waters, and the molecular phylogenetic tree of cephalopods, suggesting plesiomorphic physiological traits associated with hypoxia tolerance. Since the last common ancestor of *Aturia* and *Nautilus* may be traced back at least into the Jurassic, this sheds new

light onto the relative scarcity of Mesozoic and Cenozoic nautilids in well-oxygenated, epicontinental shelf deposits.

References:

Hohenegger, J. (2005). Estimation of environmental paleogradient values based on presence/absence data: a case study using benthic foraminifera for paleodepth estimation. Palaeogeography, Palaeoclimatology, Palaeoecology, 217, 115-130.

Schlögl, J., Chirat, R., Balter, V., Joachimski, M., Hudáčková, N. and Quillévéré, F. (2011). *Aturia* from the Miocene Paratethys: An exceptional window on nautilid habitat and lifestyle. Palaeogeography, Palaeoclimatology, Palaeoecology, doi:10.1016/j.palaeo.2011.05.037

TRACING MORPHOLOGICAL VARIATIONS IN GONYAULACOID AND PERIDINIOID DINOCYSTS IN RESPONSE TO THE LAKE PANNON ECOSYSTEM CHANGES

Ali Soliman[1], Andrea K. Kern[2], Mathias Harzhauser[2], Werner E. Piller[1]

[1] Institute of Earth Sciences, Graz University, Heinrichstrasse 26, 8010 Graz, Austria, ali.soliman@uni-graz-at

[2] Natural History Museum Vienna, Geological-Paleontological Department, Burgring 7, 1010 Vienna, Austria

After a regression phase of the Paratethys Sea at the Serravallian/Tortonian boundary, a brackish lake – Lake Pannon - formed within the Pannonian Basin. Based on this change of physiochemical conditions a remarkable adaptation of dinoflagellates occurred. In an ongoing study we illustrate how a well established and moderately diverse marine community almost disappeared, leaving only a few numbers of well-adapted dinoflagellate species. For this study, species composition and dynamics of dinoflagellate communities in the western part of Lake Pannon were considered at two locations (Mataschen, Styrian Basin; Hennersdorf, Vienna Basin). All the studied samples are rich in dinoflagellates, however, a low number of species was encountered. In contrast, to the high diversity of the Early and Middle Miocene of the Central Paratethys, the main representatives of the lake ecosystem are few gonyaulacoid and peridinioid taxa.

In this study, several species of *Spiniferites* and *Selenopemphix* were selected to trace their morphological variations in response to changes of the lake's physicochemical conditions (e.g. salinity, nutrients). In *Spiniferites bentorii* especially cyst ambitus, size, processes' morphology and the development of the apical boss are changing in reaction to environmental changes, while in *Selenopemphix* sp. cyst size and the density and type of surface ornamentation show distinct variations. Altogether a correlation of morphological characters and ecological parameters of highly abundant gonyaulacoid and peridinioid taxa of the Pannonian Basin System can be demonstrated.

This study is supported by the FWF-project P21414-B16.

A SET OF QUANTITATIVE METHODS AS A PROTOCOL FOR PALAEOECOLOGICAL ANALYSIS OF FORAMINIFERA ASSEMBLAGES

Sóron András Szabolcs

Eötvös Loránd University Department of Physical and Applied Geology, H-1117 Budapest, Pázmány Péter sétány 1/C

Mathematical methods are increasingly important in the palaeontological studies. This is especially true in those fields of palaeontology which deal with large amounts of data, as in micropalaeontology. In foraminifera studies the use of the quantitative methods is becoming widespread. In this work I present a set of quantitative methods which perform well in standard foraminifera studies and are recommended as a protocol for efficient palaeoecological analysis. Most of these methods are implemented in the free PAST software package.

The first step, after the sample preparation, is counting the benthic foraminifera number (BFN), i.e. the number of benthic foraminifers per one gram of sediment. The BFN is a simple indicator of the suitability of the environment as habitat for the foraminfers.

Next, the statistical validity of the sample size is tested by individual rarefaction. This method produces a so-called “banana plot”, on the basis of the taxon abundance distribution in the sample. The number of specimens on the x axis are plotted against the number of taxa on the y axis. Adequate sample size is revealed if the curve flattens out. However, if the increase in taxon number continues along the curve, the number of specimens studied from that sample should be further augmented. Previously studied material can also be tested by this method, allowing a judgement on its fidelity for further incorporation in the analyses.

An approximate estimate of the palaeoenvironment can be made by the “subordo diagram”, a ternary diagram that shows the distribution of the foraminifera fauna of the sample on the basis of the wall composition. Nearly all of the marine environments are represented on the available reference diagrams.

Diversity indices reflect the level of the environmental stress. Each index characterizes the sample from a slightly different perspective. The Fisher’s α and Shannon-Weaver indices are particularly useful in foraminifera studies and may allow to distinguish the marine environments. The Simpson index of diversity provides a measure of whether any randomly selected two specimens belong to the same species. Evenness shows the distribution of the specimens among the species.

The BFOI (benthic foraminiferal oxygen index) is proportional to the oxygen level of the bottom water, and indicates the amount of the organic carbon flux and the primary productivity. The foraminifers are divided into three main groups (oxic, suboxic, disoxic) on the basis their environmental preference and their morphology. After the classification of the foraminifers, the BFOI can be calculated by a few simple equations. The distribution of the foraminifers among the three groups determines which equation should be used.

The genus-species ratio (GSR) is useful in the case of shelf faunas, as it allows to distinguish the different environments along the shelf.

The plankton-benthos ratio (PBR) is the basis of various depth estimation methods. The ratio of planktonic forms is lower near the coast and higher in the pelagic region. The van Marle, the Wright and the van der Zwaan methods differ only in the details of the calculation, but all of them is based on the PBR. Additional information can also be inferred by the changes in

PBR. In some cases, e.g. for epicontinental seas, it is not only controlled by the change in the water depth, but also reflects the degree of connection with the open marine regions.
The relative surface temperature can be estimated by planktonic foraminifers on the basis of modern analogues. The species can be divided into four groups for temperature preference: warm, moderate-warm, moderate-cool and cool. The ratio of these groups indicates the temperature.
The combined usage of these methods permit a detailed quantitative palaeoenviromental interpretation of foraminifera assemblages.

NEW DATA ON THE PARATETHYAN ENDEMIC BIVALVE GENUS *OBSOLETIFORMA* FROM THE MIDDLE MIOCENE MEDOBORY REEFS (UKRAINE)

Barbara Studencka[1], Marek Jasionowski[2]

[1] Polish Academy of Sciences Museum of the Earth in Warsaw, Al. Na Skarpie 20/26, 00-488 Warsaw, Poland, bstudencka@go2.pl
[2] Polish Geological Institute – National Research Institute, ul. Rakowiecka 4, 00-975 Warsaw, Poland, marek.jasionowski@pgi.gov.pl

The Paratethyan endemic bivalve genus *Obsoletiforma* Paramonova, according to Nevesskaja *et al.* (2001), is inferred to spring from the genus *Cerastoderma* Poli. Thus, it is highly likely that similarly to modern representatives of *Cerastoderma* it predominantly colonized near shore muddy gravel, muddy sand and sand substrates, burrowing to a depth of no more than 5 cm.
Excellent bivalve record from the Early Sarmatian (Middle Miocene) reefs of the Medobory Hills provides new information about the environmental tolerance of the genus *Obsoletiforma*. Reefs distributed widely in the eastern borders of the Carpathian Foredeep Basin are composed of an unusual assemblage of skeletal organisms (serpulids and bryozoans) and calcite precipitates. These serpulid-microbialite reefs hosted 12 bivalve species belonging to 4 families. The most noticeable is the absence of marine stenohaline taxa and an abundance and ubiquity of representatives of the genus *Obsoletiforma*. The species *O. gatuevi* (Kolesnikov), *O. lithopodolica* (du Bois), and *O. sarmatica* (Kolesnikov) commonly occur in serpulid (or bryozoan) microbialite boundstone, the dominant facies of reefs (Studencka and Jasionowski 2011). Locally these cockles are ubiquitous and formed oligotypic accumulations, whereas the occurrence of *O. volhynica* (Grischkevitsch) is largely restricted to the serpulid-microbialite frame consisting of superimposed bunches of semi-parallel serpulid tubes covered with microbialitic crusts. The species *O. volhynica* has not been reported from the Early Sarmatian calcareous buildups; its thin, delicate, subquadrate in outline shells were earlier reported from the sandy facies (Grischkevitsch 1967). In contrast, the forms intimately associated with serpulid colonies are distinctly rhomboidal in shape and much longer (up to 30 mm in length). It is highly likely that serpulid colonies provided very favourable environment for the settlement and growth of *O. volhynica*. Although volumetrically subordinate in the Sarmatian reefs, the serpulids played a key role in the reef frame construction. Serpulids are enormously opportunistic organisms, able to survive in environmental conditions characterized by a wide range of physicochemical parameters. They thrive on shallow sea bottoms, in waters with high, low or fluctuating salinities, and variable

temperatures. Massive accumulations of serpulid tubes are typical of environments of high ecological stress that are inhospitable to other biota. Hence, the abundance and ubiquity of *O. volhynica* together with densely clotted serpulid colonies clearly illustrate that the species was fully adapted to extremely stressed environment. It could show similar behavior to *Musculus sarmaticus* (Kolesnikov) observed together with it wherever the environmental conditions were sufficient to allow the growth of densely clotted serpulid colonies providing shelter for byssally attached bivalves. The bivalve-serpulid association observed in the Sarmatian Medobory reefs proves that *Obsoletiforma* was apparently characterized by very high fertility typical of opportunists that rapidly colonize new habitats. It was able to thrive not only in near shore muddy gravel, muddy sand and sand substrates like modern representatives of *Cerastoderma* but also in reefal habitat.

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References:

Grischkevitsch, G.N. (1967). New species of the genus *Cardium* from the lower part of the Volhynian (Early Sarmatian) from the Volhynian-Podolia. Proceedings of Paleontology, 4, 113–116. [In Russian]

Nevesskaja, L.A., Paramonova, N.P., Popov, S.V. (2001). History of Lymnocardiinae (Bivalvia, Cardiidae). Paleontological Journal, 35, supplement 3, S147–S217.

Studencka, B. and Jasionowski, M. (2011). Bivalves from the Middle Miocene reefs of Poland and Ukraine: A new approach to Badenian/Sarmatian boundary in the Paratethys. Acta Geologica Polonica, 61 (1), 79-113.

NEW RECORDS OF THE PECTINOIDEAN GENERA *DELECTOPECTEN* STEWART AND *PARVAMUSSIUM* SACCO IN THE UPPER BADENIAN OF THE CENTRAL PARATETHYS

Barbara Studencka

Polish Academy of Sciences Museum of the Earth in Warsaw, 02-904 Warszawa, Al. Na Skarpie 20/26, Poland, bstudencka@go2.pl

Knowledge on Badenian bivalves from deeper environments of the Carpathian Foredeep Basin bordering the Carpathians arch along its distal periphery is patchy and full of gaps in taxonomic details. A limited number of bivalve assemblages from far-shore clastic facies (mainly clayey) of the Late Badenian age were described and illustrated which results from great thickness of the Sarmatian deposits overlaying the Upper Badenian: 100–300 m in the northern margin and up to 3500 m in the axial part of the Carpathian Foredeep Basin (in its Polish part).

Two boreholes have recently been drilled in the northern margin of the Carpathian Foredeep Basin in Poland to study in detail the upper part of the Neogene complex overlying the evaporitic series of the Krzyżanowice Formation. This Upper Badenian-Lower Sarmatian complex, distinguished as the Machów Formation, is very homogenous and developed mainly as monotonous grey-green fine siliciclastic deposits.

The bivalve study performed on samples from these boreholes revealed the occurrence of minute hyaline shells of *Delectopecten vitreus* (Gmelin, 1791). In the Busko Zdrój (Młyny) IG-1 borehole this scallop occurs in the interval between 127.00 and 150.80 m while in the Kazimierza Wielka (Donosy) IG-1 borehole its was only found in the depth of 162.60 m.

The present record is the first one of this species within the Machów Formation marly clays. All the scallops studied come from its lowermost part, informal unit named as the scallops clays and marls member. The late Badenian age of this unit was determined by means of nannoplankton as the basal part of the NN6 Zone, older than 13.2 Ma on the magnetostratigraphic data.
The species *Delectopecten vitreus* is very rare in the fossil record: until now only one valve was reported from the Upper Badenian sands at Rybnica in Poland and one specimen was found in the Pliocene Kattendijk Formation in the North Sea Basin. Its occurrence in the Mediterranean was documented in the Early Pleistocene of Sicily and Calabria whereas in the Early Miocene of Italy it was only presumed. Recently, *Delectopecten vitreus* has a very wide geographic distribution across the Atlanic and Indo-Pacific. It also occurs in the western and central Mediterranean, mostly inhabiting deep water, occasionally to 3000 m.
Another bivalve study performed on samples from the drill-site acquired some decades ago in the vicinity of Kamanets Podilsky in the Ukrainian part of the Carpathian Foredeep Basin, provides the first fossil record of *Parvamussium fenestratum* (Forbes, 1844) in the Central Paratethys. This scallop found in the depth of 90.60–90.80 m comes from the dark grey clay that intercalated bioclastic limestones distinguished as the Kovalivka Beds of the Kosiv Formation. The Late Badenian age of this unit was determined by means of benthic foraminifera and calcareous nannoplankton.
Specimens referred to this species are scarcely noted in the Mediterranean Neogene: its occurrence was documented in the Early Miocene (Burdigalian) of Italy and in the Early Pliocene of Italy and Spain.
Until now two more species of the genus *Parvamussium* Sacco were reported from the Oligocene–Miocene Paratethys viz., *Parvamussium duodecimlamellatum* (Bronn, 1831) and *Parvamussium felsineum* (Forbes, 1844). The genus *Parvamussium* has a cosmopolitan distribution at present, mostly inhabiting abyssal and bathyal depths, with the highest species diversity in the tropical Indo-West Pacific Ocean.
The bivalve fauna detected in cores represents only a very small and random part of the former community. But as information on bivalves from the Upper Badenian is scarce, even few specimens add important information on the distribution and paleogeographic occurrence of particular species.

DEEP-WATER DEPOSITIONAL ARCHITECTURE, RELATED TURBIDITES AND DEBRITES IN THE CENTRAL PART OF LATE MIOCENE LAKE PANNON, MAKÓ TROUGH, HUNGARY

Orsolya Sztanó[1,2], Horányi A.[1,2], Hughes[3], D.W, Bada, G.[2]

[1] Department of Geology, Eötvös University, Pázmány Péter s. 1/c, Budapest, Hungary 1117, sztano@ludens.elte.hu, horanyianna@gmail.com
[2] TXM Oil and Gas Ltd., Közraktár u. 32, Budapest, Hungary 1093, gabor.bada@txm.hu
[3] Falcon Oil and Gas Ltd., 1875 Lawrence St., Suite 1400, Denver, Colorado USA 80202, Dhughesgeo@aol.com

In Lake Pannon various types of turbidite systems (locally fed, slope-related and slope-detached) were studied on an extensive, high resolution 3D volume acquired in the Makó Trough, SE Hungary. Bottom-floor geomorphology was visualized by seismic attribute maps. Corresponding lithology was monitored by well-logs and about 260 m core material.

At the birth of Lake Pannon highly differentiated basin floor topography was inherited from Mid-Miocene rifting of the Pannonian Basin. Between 11.6-8 Ma islands and peninsulas got gradually flooded and with the increase of water depth deep underfilled depressions and sublacustrine highs with condensed sedimentation commenced all over the area, producing marly deposits known as Endrőd, Csákvár or Szák Formations. At this period coarse clastics occasionally found in these deep depressions are related to local sediment sources, such as the Algyő and Battonya Highs near the Makó Trough, unless they got completely flooded. Although small volume turbidites are also present, deposits of sandy debris flows, gravelly debris flows and grain flows are abundant.

Between 10-4 Ma enormous amount of sediment derived from the uplifting Alps – Carpathians was shed into Lake Pannon, causing the ultimate regression of the lake shore. Two major rivers - the Palaeo-Danube and the Palaeo-Tisza – with their tributaries entered the basin and through deltas gradually built a wide morphological shelf. This shelf was rimmed by a continuously prograding slope, transmitting sand into the depressions filled up consecutively from north to south. The depressions, however behaved as confined basins, their filling up was strongly controlled by length, distance of feeding slopes, volume of turbidity currents as well as orientation and height of bordering sublacustrine highs. Turbidity currents could not pass over to the next depression, until the topographic differences were decreased by significant deposition. This ponding effect is reflected by the up to 1000 m thick accumulation of Szolnok Sandstone, a complex turbidite system fed by several large meandering leveed channels, and which is built by amalgamated sandy lobes and sheets. Their areal extent is a few 100 km^2.

The youngest turbidites in each depression and commonly above basement highs as well, were related to the shale-prone slope, i.e. the Algyő Formation. It passed the area of the MakóTrough ca. between 5.7 and 5 ma ago. The slope itself is commonly dissected by narrow, deep and straight canyons, and wide slump scars. When clay-poor, sand-rich, non-effective turbidity currents arrived from the shelf-break deposition occurred directly at the slope-toe region as simple lobes, within a distance of 10 km. Extended slope-detached turbidite lobes up to a distance of 20 km from the slope toe were fed by clayey-sandy effective turbidity currents arriving through meandering leveed channels. Their alternations were controlled by climatically induced relative base level changes. However, deposition of large volumes of mass gravity transport deposits took place almost continuously, regardless of high or lowstand of lake level due to the extremely high sediment input rates. Recurring floodings of the morphological shelf resulted in the formation of regionally extended, but only few meters thick shales within the small lobes of the Algyő slope-toe, as well as the large lobes of the Szolnok in basin center.

PRODUCERS OF THE UPPER MIOCENE TRACE FOSSIL ASSOCIATION FROM THE SUBLITTORAL DEPOSITS OF LAKE PANNON INTERPRETED AS DECAPOD CRUSTACEANS

Vladimír Šimo[1], Matúš Hyžný[2], Dušan Starek[1]

[1] Geological Institute, Slovak Academy of Sciences, Dúbravská cesta 9, 840 05 Bratislava; vladimir.simo@savba.sk, dusan.starek@savba.sk.
[2] Department of Geology and Paleontology, Faculty of Natural Sciences, Comenius University, Mlynská dolina G1, 842 15 Bratislava; hyzny.matus@gmail.com.

The studied sedimentary sequence with fine grained deposits is situated at the Gbely locality in the Slovak part of the Vienna Basin in the Late Miocene palaeogeographic area of Lake Pannon. The sequence has previously been interpreted as a protected bay to prodelta and distal bars in brackish sublittoral lacustrine-deltaic palaeoenvironment below the fair-weather wave base (Starek et al. 2010).

Investigated trace fossils are preserved either as lithified yellowish casts of burrows in dark clayey sediment or non lithified trace fossils in silty/sandy sediments. Associations of both preservation types are composed of similar trace fossil assemblage. Walls or lining of the studied trace fossils have not been recognized. They can be divided in several types which are preserved in direct association with each other.

First type represents massive subvertical generally not-branching burrows attaining diameter of 5–7 cm and depth locally more than 1.5 m. Rare longitudinal tiny knobs could be interpreted as bioglyphs. The basic morphology corresponds to burrows of brachyuran crabs exemplified by members of the families Gecarcinidae, Ocypodidae and Sesarmidae (e.g. Seike & Nara 2008).

Second type represents remains of complex burrow system composed of subhorizontal tunnels, sometimes with characteristic Y shaped branching, and subvertical shafts with diameter varying from 0.5 to 3 cm. The burrow diameter, however, is always constant within the same tunnel suggesting that each burrow was inhabited by one (or only a few) animal(s). Irregular waving is processed in both vertical and horizontal directions. In some cases spherical chambers are preserved in full relief with thin shafts radiating in all directions. This form could be compared with the ichnogenus *Maiakarichnus* (Verde & Martinez 2004). Subhorizontal tunnels are typically inclined not more than 45° and form either longer tunnels without branching or an irregular spiral directed downward. All these features are typical for decapod crustaceans of the family Callianassidae. Studied burrow systems show rather low morphological diversity suggesting producer to be a member of a single species. Callianassids are known to live in a variety of habitats generally from sublittoral to intertidal marine environments, many, however, are able to tolerate lower salinity conditions and inhabit river estuaries (Dworschak 2000).

Third type represents a maze of tiny tubes with diameter of <0.5 cm running through both above described burrow types. These tiny trace fossils often arise perpendicularly or obliquely from larger burrows. Their producers can be interpreted as commensal organisms, such as worms, living in direct proximity or within decapod crustacean burrows. Such association has been commonly observed both in extant habitats and trace fossil assemblages.

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References:

Dworschak, P. (2000) Global diversity in the Thalassinidea (Decapoda). Journal of Crustacean Biology, 20, special number 2, 238-245.

Seike, K. & Nara, M. (2008) Burrow morphologies of the ghost crabs *Ocypode ceratophthalma* and *O. sinensis* in foreshore, backshore, and dune subenvironments of a sandy beach in Japan. Journal of the Geological Society of Japan, 114, 591-596.

Starek, D., Pipík, R. & Hagarová, I. (2010) Meiofauna, trace metals, TOC, sedimentology, and oxygen availability in the Late Miocene sublittoral deposits of Lake Pannon. Facies, 56: 369-384.

Verde, M. & Martínez, S. (2004) A new ichnogenus for crustacean trace fossils from the Upper Miocene Camacho Formation of Uruguay. Palaeontology, 47, 39-49.

SEDIMENTOLOGICAL AND STRATIGRAPHICAL SIGNIFICANCE OF THE SANDY FACIES FROM THE NORTHERN PART OF THE FORE-CARPATHIAN DEPRESSION (BADENIAN; WESTERN UKRAINE)

Anna Wysocka, Marcin Górka, Andrzej Radwański

Faculty of Geology, University of Warsaw, Żwirki i Wigury 93, 02-089 Warszawa, Poland,
anna.wysocka@uw.edu.pl

The northern margin of the Fore-Carpathian Depression, widely spread from Slovakia, through Poland and Ukraine as far as Moldova, yields a wide range of diverse lithofacies. In western Ukraine, the lithofacies pattern reflects both the morphology of, and the terrestrial supplies from, the Tertiary hinterland of Podolia and Volhynia. Moreover, sedimentological features record a change in the hydrodynamic and diastrophic factors that are connected with the evolution of the Fore-Carpathian Depression, and the Paratethys Basin as well. The Miocene deposits of the Podolia area consist of normal marine Badenian and restricted semi-marine Sarmatian deposits that are characterized by diversified sets of sedimentological and biogenic structures ascribed mainly to the shallow-water environment. The Badenian deposits form a more or less continuous cover and reach a maximum thickness of up to 80 metres in the area of the Roztocze Hills near Lviv. They represent a set of lithologically diversified rocks with a predominance of sandy, quartz and quartz-glauconite deposits, more rarely accompanied by calcarenites and *Lithothamnium* limestones (Wysocka 2002; Wysocka & Jasionowski 2006). These deposits may laterally pass into each other, as well as occur several times within the sections; moreover, they are directly overlain by the Ratyń Limestones belonging to the Evaporitic-Chemical Beds. The widespread lithological type of the Lower Badenian deposits is called the Sandy Facies, or the so-called Mikolaiv Bed in lithostratigraphic schemes (Petryczenko & al. 1994).

The Sandy Facies, built mainly of quartz material, is confined to the western and westernmost regions of the Ukraine, reaching and straddling the boundary to Poland. It continues, through the localities Potelych and Jasnyska, the city of Lviv and beyond (Gleboviti) all of the Roztocze Hills, farther southwardly, through Khorosno and Stratyn as far as the River Dnister Valley. Within this area, the Sandy Facies attains a greater thickness up to, or slightly over, a hundred metres, but locally it may also drop to naught. The faunistic content of all fossil-bearing sections of the Sandy Facies is indicative of open-marine conditions, with oceanic influx from the Indo-Pacific bioprovince (Radwański & al. 2006). The formation of the Sandy Facies is thus located generally in the Badenian (Harzhauser & al. 2003) having been coeval with the classical Korytnica sequence in Poland (Radwański & al. 2006), as well as with a part at least of the Badenian stratotype at the Baden-Sooss section in the Vienna Basin (Rögl & al. 2008).

References:

Harzhauser, M., Mandic, O. & Zuschin, M. (2003) Changes in Paratethyan marine molluscs at the Early/Middle Miocene transition: diversity, palaeogeography and palaeoclimate. Acta Geologica Polonica, 53,4, 323-339.

Petryczenko, O.I., Panow, G.M., Peryt, T. M., Srebroidolski, B.I., Pobereżski, A.W. & Kowalewicz, W.M. (1994) Zarys geologii mioceńskich formacji ewporatowych ukraińskiej części zapadliska przedkarpackiego. Przegląd Geologiczny, 42, 9, 734-747.

Radwański, A, Górka, M. & Wysocka, A. (2006). Middle Miocene coralgal facies at Maksimivka near Tarnopil (Ukraine): A preliminary account. Acta Geologica Polonica, 56, 89-103.

Rögl, F., Ćorić, S., Harzhauser, M., Jimenez-Moreno, G., Kroh, A., Schultz, O., Wessely, G. & Zorn, I. (2008). The Middle Miocene Badenian stratotype at Baden-Sooss (Lower Austria). Geologica Carpathica, 59, 5, 367-374.
Wysocka, A. (2002). Clastic Badenian deposits and sedimentary environments of the Roztocze Hills across the Polish–Ukrainian border. Acta Geologica Polonica, 52**,** 4**,** 535–563.
Wysocka, A. & Jasionowski, M. (2006). Przebieg i zmienność sedymentacji w basenach przedgórskich. Materiały Konferencyjne II Polskiej Konferencji Sedymentologicznej. pp. 178.

2D RESISTIVITY SURVEY FOR DELINEATION OF DIATOMITE BODIES: A CASE STUDY OF GOTSE DELCHEV BASIN, SW BULGARIA

Marlena Yaneva[1], Nadja Ognjanova-Rumenova[2], Asen Mitev[3]

[1] Laboratory on Seismotectonics ,Geological Institute at Bulgarian Academy of Sciences, Acad. Georgi Bonchev Str. Bl. 24, 1113 Sofia, Bulgaria, marlena@geology.bas.bg
[2] Department of palaentology, stratigraphy and sedimentology, Geological Institute at Bulgarian Academy of Sciences, Acad. Georgi Bonchev Str. Bl. 24, 1113 Sofia, Bulgaria, nognjan@geology.bas.bg, [3]as_pl@abv.bg

The present study aims to demonstrate the possibilities of 2D resistivity profiling (ERP) in recognizing and determining the sediment successions in areas with lack of outcrops. A 2D electrical resistivity survey has been carried out in Gotse Delchev basin, SW Bulgaria, in order to obtain data about lateral distribution of diatomite beds in alluvial-lacustrine sedimentary succession. Application of this method is a first attempt for purposes of sedimentology and stratigraphy of the diatomite deposits in Bulgaria.
Gotse Delchev Basin is located in south-western Bulgaria and occupies the central and southern parts of Mesta Graben. It is filled in with predominantly alluvial deposits and partly lacustrine-marshal deposits of Neogene age, referred to the following formal lithostratigraphic units: Valevitsa Formation, Baldevo Formation, Nevrokop Formation, and Sredna Formation. The sediments from Baldevo and Nevrokop Formations are the subjects of the present study. Baldevo Fm (Pontian-Dacian) is composed of typical lacustrine-marshal sedimentary succession – sandstones, siltstones, clays, diatomites and coal. They crop out in the northern and north-eastern part of the basin and are surrounded and covered by sediments of Nevrokop Fm. Nevrokop Formation comprises conglomerates, fine- to coarse-grained sands, sandstones, siltstones and clays of alluvial origin in irregular alternation. Previous sedimentological studies showed that sand is composed of quartz and equal amounts of plagioclase and potassium feldspar, less mica; clays are dominantly composed kaolinite and smectite, with subordinate quantity of illite, chlorite, quartz and feldspar. Diatomite covers the uppermost coal beds in Baldevo Formation. The diatom flora is represented chiefly by recent species – 91,5% and fossil ones – 8,5%. The dominant complex of the investigated diatom flora is monotaxonic and consists of variable roughly silicified *Aulacoseira* species. The flora comprises some typical species for the Late Miocene lakes, i.e. *Aulacoseira distans* var. *scala* (Ehr.)Ognjan., *Fragilaria leptostauron* var., *fossilis* (Pant.)Reh., *Eunotia polyglyphoides* Moiss., *Cymbella obtusa* Pant., and it is dated to the Late Miocene.
2D resistivity profiling was applied to 3 sites, located in northern half of the Gotse Delchev Basin. Two profiles were placed to characterize diatomite presence or absence in Baldevo Fm near coal mine Kanina, the village of Ognyanovo, and the third site is located at the northeastern part near the village of Kornitsa.

The multi-electrode system consisting of Terrameter – SAS 1000, electrode selector ES 10-64 C, multicabels (4 cables x 21 electrodes), electrodes and connecting cables was used. The survey was carried out by Wenner array with 3 or 5 m electrode spacing.

Aiming to determine the certain criteria for recognition of diatomites by their resistivity, the measurements were carried out at the certain outcrop where diatomites cover the upper northern part of the profile, and at the other one, where there was no data about diatomite presence in the cross-section. Their resistivity ranges from 40 to 60 Ω.m. Other layers, recognized by ERP were sandy clays and siltstones (15 – 40 Ω.m), clays (1-13Ω.m), conglomerate and sand (95-120 Ω.m). This interpretation corresponds to the outcrop in the coal mine Kanina, described by the authors in their previous works.

GUIDE OF EXCURSION

Authors

Radovan Pipík
Michal Kováč
Jaroslav Lexa
Tomáš Mikuš
Sidónia Staňová

Fig.1 Geographical position of the visited localities in the frame of the 4th International Workshop on the Neogene from the Central and South-Eastern Europe

Introduction

The Turiec Basin (TB) is located in the interior of the Central Western Carpathians extending in the NNE–SSW direction for about 40 km long and 10 km wide. A westward dipping halfgraben with Neogene sedimentary fill attaining thicknesses up to 1200 m has two main depocentres located in the northern and in the southern part. The pre-Neogene basement of this basin consists of the Central Western Carpathian palaeo-Alpine tectonic units which are mainly built by Mesozoic complexes, and also from Palaeogene post-nappe sedimentary cover in its northern part.

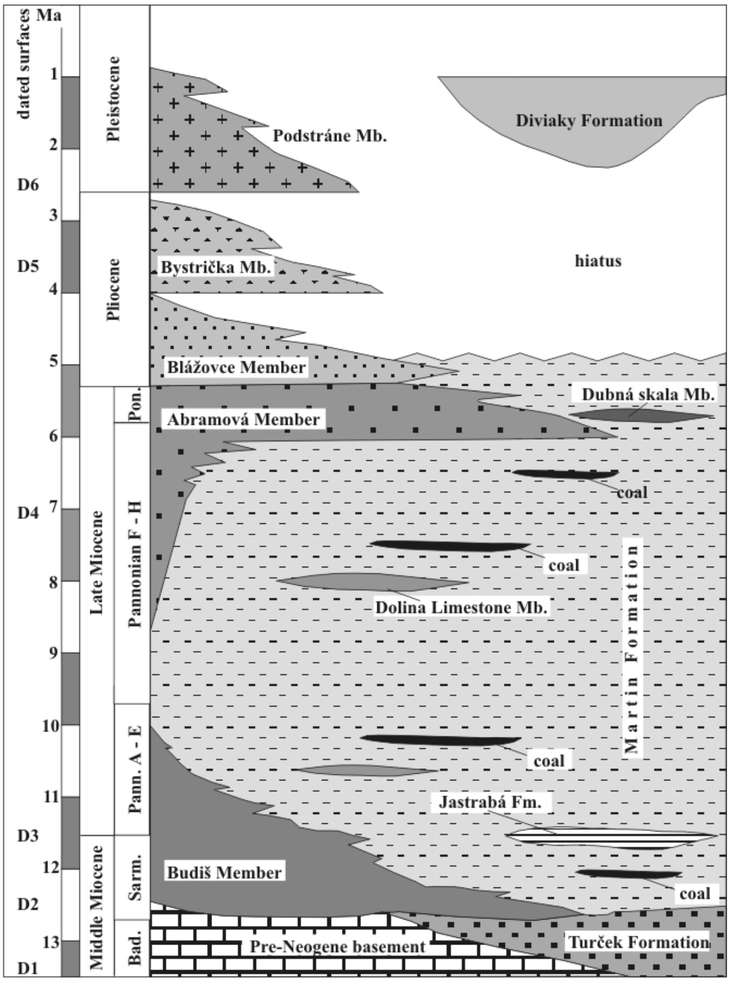

Fig. 2 Lithostratigraphy of the Turiec Basin infill – The Turiec Group and important dated surfaces: (D1) boundary, restricted to the southern part of basin, represents the base of the Middle Miocene sedimentary record, which started with volcano-sedimentary Turček Fm. Base of formation can be correlated with the base of the Late Badenian regional stage (13.65 Ma) or the Serravalian stage (13.82 Ma); (D2) boundary represented by the Budiš Mb. base dated to 12.7 Ma coeval with the base of the Sarmatian regional stage; (D3) level represented by the rhyolite tuff of the Jastrabá Fm., dated to the Sarmatian/Pannonian boundary. The base of the Pannonian regional stage is dated to 11.6 Ma; (D4) approximate base of coarse alluvial fans of the Abramová and Blážovce members (Late Miocene–Late Pliocene) documenting the rapid uplift of the entire area between 6–4 Ma; (D5) upper boundary of the Late Miocene basin fill marked by the Dubná skala Mb. dated to the latest Pannonian–Pontian; (D6) surface dated above 2.6 Ma level covered by the Diviaky Fm. and Podstráne Mb.

The TB fill is predominantly composed of the Late Miocene limnic sediments with an occurrence of the Middle Miocene deposits mainly in the south. The main subsidence of the basin first appeared during the Late Miocene and this was followed by terminal sedimentation during the Pliocene.

A taxonomical comparison between the TB and the freshwater and brackish Neogene basins of Europe demonstrates the endemic character of the TB ostracod and mollusc faunae. The biological (convergent characters, intralacustrin evolution, importance of the sexual reproduction, presence of the ostracod species to the limited biotopes) and physical (bathymetrical and ecological segregation of the species) properties together with the tectonic position of the basin inside the collision orogene zone and the active volcanic arc allow attribution of the Turiec Basin to the category of the fossil long-lived lakes.

Stop 1: Ďanová – Paleogene basement

Co-ordinations: N 48° 58´ 23.1´´, E 18° 55´ 09.6´´

Fig. 3 Locality Ďanová.

The deposits at Ďanová outcrop represent marly claystone to marl, with layer thickness from 10 to 20 cm which alternate with sandy carbonatic shales. Foraminieral association of *Globigerina pseudovenezuelana, G. linaperta, G. eocaena, G. boweri, G. frontosa* document the Eocene, Upper Lutetian to Bartonian in age.

The Paleogene deposits are exclusively exposed on the eastern and northeastern margin. The deformation of the Paleogene rocks probably originated during the desintegrationof the Paleogene depositional area after the Oligocene. The succession is tectonically compressed with a fold axis ENE-WSW and vergency to SE.

The Oligocene tectonics in the Western Carpathians can be characterized by a strike-slip tectonic regime with W–E oriented compression (Pešková et al. 2009; Vojtko et al. 2010). The Early Miocene palaeostress field with WNW–ESE to NW–SE oriented compressional axis (σ_1) generated tectonic structures which had no effect on the opening and formation of the present TB. Although the Middle Miocene structural pattern seems similar to the Early Miocene, the principal palaeostress axes rotated approximately 30–40° clockwise and the dominant tensional axis σ_3 originated in the ENE–WSW direction.

Fig. 4 Basement of the limnic Neogene fill outcropped in the village Ďanová.

Stop 2: Dubná skala – limnic terminal deposits

Co-ordinations: N 49° 07´ 56.2´´, E 18° 53´ 26.2´´

Fig. 5 Locality Dubná skala.

The Dubná skala Member represents the largest body of the freshwater limestone with thickness up to 150 m composed of limestone, sandy limestone, travertine, clay, and clayey sand marked upper boundary of the Late Miocene basin fill dated to the latest Pannonian–Pontian (D5). Several thin and small carbonate conglomerate lenses and layers with a maximum thickness of 2 m are present in the clays and these consist exclusively of dolomite and limestone pebbles with a matrix of clay and freshwater limestone.

The limestone is rich in *Charophyta* thallus, the remains of *Typha sp.* (water plants) and also *Glyptostrobus* sp. typical of marshy biotopes. Terrestrial gastropods *Helicidae, Pomatisidae, Strobilopsidae* indicate proximity of the terrestrial environment to freshwater lake (aquatic

gastropods *Lymnaeidae*). An insectivore fragment attributed to the genus *Paenelimnoecus* (Soricidae) has been found in a clay in a foot of the quarry. The morphological and metrical characteristics of the found tooth (m2 sin.) do not allowed its attribution to a rank of the Middle Miocene till Pliocene European species.

Fig. 6 Limnic limestone and sandy limestone at Dubná skala.

Stop 3: Martin - littoral deposits

Co-ordinations: N 49° 03´ 52.4´´, E 18° 53´ 42´´

Fig. 7 Locality Martin.

Littoral lacustrin deposits of the Martin member dated to the epoch of subsidence, burial of the pre-Neogene basement and development of planation surfaces in the Late Miocene. Gray clay and siltstone alternating with lignite beds, sand and organodetritic limestone are rich on a preserved ostracod, mollusks, fish otoliths and plant leaves with specific taxonomic characters but a modern taxonomical approach is urgently needed.

Paleoenvironmental interpretation: The terrestrial Late Miocene environment around the TB corresponded to lowland with fluvial topography (*Vestalenula*), oxbows (*Nelumbium, Scottia browniana*) and marshy biotope (*Myrica*). A coastal forest (*Glyptostrobus, Platanus, Alnus, Populus,*) with moist habitats (terrestrial gastropods *Helix, Carychium, Succinea, Strobilops, Vertigo*) have changed inland to a low mountainous area covered by forest (*Fagus, Carpinus, Carya, Pterocarya*).

Temporary ponds and small coastal lakes (*Candona neglecta, Cyclocypris laevis, Pseudocandona compressa, Fabaeformiscandona balatonica*) formed on coast and inland. In these ponds salt content could increase by evaporation in the warm periods as *Cypria, Ilyocypris,* and *Eucypris* are encountered in the sediments.
A paralic sedimentation with rhisolits and fossil trees in growing position documents a shallow and dynamically changing environment. This littoral environment implies unstable ecological conditions mainly from a thermal point of view (thermoeuryplastic *D. stevensoni*). The mesothermophil *F. balatonica, P. compressa* and *Cavernocypris subterranea* may indicate a lower water temperature.

Fig. 8 Martin clay pit with littoral limnic fauna.

The lake benthic area was divided into a littoral zone developed in the north and a deep zone in the centre and south of the TB. On the basis of all the paleoecological data, a littoral sedimentary environment in the north was composed of:
- a supralittoral zone – indicated by the presence of *F. balatonica,* living frequently in a very shallow zone that dries up in summer;
- a infralittoral zone with macrophyte belt (*Typha*) growing up to 1 m in depth passed to a zone of floating and submerged vegetation (*Potamogeton, Nelumbium*). A deeper infralittoral was covered by Charophyta which also grew in shallower water. A presence of macrophyte belt is indicated by *C. laevis, Dolerocypris* and *Eucypris. P. compressa, D. stevensoni*, and *F. balatonica* can also occupy this part.

The northern part was inhabited by gastropods (*Viviparus, Theodoxus, Melanopsis, Planorbis*), bivalves (*Congeria, Unio, Anodonta*) and fish (?*Cyprinidarum* sp., ?*Percoideorum* sp.) that remains build significant shell accumulations.
The rheotolerant *Ilyocypris* and *D. stevensoni* provide data about slowly flowing waters in the northern part. Such conditions are also suggested by the degree of preservation of the macroflora.

Stop 4: Socovce – Stráža – deepwater fauna

Co-ordinations: N 49° 56´ 59.1´´, E 18° 51´ 33.9´´

Fig. 9 Locality Socovce-Stráža.

The locality exhibits a coarse-grained conglomerate/gravel of the Abramová Mb. and sublittoral clay of the Martin Mb. at a foot and top of the conglomerate body. Twelve ostracod species of the *Candona aculeata-armata-stagnosa-nubila-simplaria* assemblage have been found in the clays and determined the Middle to Upper Pannonian age.

Candona aculeata-armata-stagnosa-nubila-simplaria assemblage is known only the central and southern part of Turiec Basin mainly in the boreholes. The shapes of Candoninae from these parts of the Turiec Basin are characteristic of triangular, trapezoidal and elongated shapes with pointed posterior, which correspond to a stable environment, without significant ecological variations, which starts 40 m below the water table in the actual lakes. In contrast to the littoral zone of the Turiec Basin, the molluscs and the fish otoliths were rarely found in the supposed deepwater deposits. When they exist, mollusks shells show a similar distribution pattern as in Lake Ohrid. We thus suppose that the Turiec Basin lake was bathymetrically and thermally stratified.

The origin of the bathymetrical differentiation can be related with a tectonic evolution of this area in the Middle and Late Miocene. The basin subsided along the active listric faults on the west margin and antithetic faults near the eastern margin that originated from an extensional E-W regime. At the beginning of the subsidence, in pre-rifting and initial rifting stage, this environment was occupied by

Fig. 10 Socovce – Stráža. Carbonatic conglomerates are bounded by pelitic layers with profundal ostracod assemblage.

species known in littoral community. As a bathymetrical differentiation continued, the Candoninae evolved and changed their shape. Pelitic sedimentation in basin synrift stage was then influenced by input of the waters from the northern part and occasionally perturbated by gravel and coarse-grained sands coming from the uplifted mountains.

Stop 5: Abramová Kolísky – alluvial fans

Co-ordinations: N 48° 55´ 47.3´´, E 18° 47´ 9.3´´

Fig. 11 Locality Abramová – Kolísky.

The Middle to Upper Pannonian Abramová Member represents deposits of alluvial fans at the south-western margins of the basin. The age of this member is determined by a presence of the Upper Pannonian *Candona eminens-laterisimilis* assemblage and its contemporaneous occurrence with *Candona aculeata-armata-stagnosa-nubila-simplaria* assemblage found at the Socovce and boreholes.

Coarse-grained conglomerates/gravels and pebble sandstones/pebble sands at the Abramová-Kolísky site are mainly products of sub-aerial, sporadically subaquatic transport by gravitational flows over a short distance. The conglomerates and pebble sandstones are poorly bedded, with both normal and opposite graded beds observable. Layering is not always visible and the bedding planes are documented only on the contact of the various sandstone and conglomerate grain sizes. Here, the pebbles are poorly rounded and they are composed exclusively of Triassic dolomite and limestone of the Hronic Unit, with the grain size decreasing from the foothills towards the basin. This poorly lithified member attains a maximum thickness of about 400 m. The Abramová Mb. alluvial fans cover the pre-Neogene basement or overlie the pelitic basin fill, but in some places they partly intercalate with clays of the Martin Fm. The coarse alluvial fans of the Abramová and Blážovce members (Late Miocene–Late Pliocene) document a rapid uplift of the entire area between 6–4 Ma.

Fig. 12 Abramová-Kolísky. White carbonatic silt with rhyolite tuff admixture rich on the fossil fauna and flora

The locality is remarkable by a presence of 13 ostracod species of *Candona eminens-laterisimilis* assemblage known only from south-western margin of the Turiec Basin, monoaxonne spicules of the freshwater Spongilidae, freshwater bivalve *Lymnea* sp., gastropod *Viviparus* and swampy and wetland plant association with numerous termophyl species – *Daphnogene, Ficus, Sequoia, Equisetum*.

Stop 6: Kremnica – gold, mining and mint

Fig. 13 Kremnica. View on the historic square and gothic St. Katarina's Church.
http://www.slovakia.travel/imagegallery.aspx?l=1&io=47697&igo=53296

Kremnica belongs to the medieval towns, which, in times of their glory, were attended by monarchs, and other men of note, who had tried to capture the town and possess the rich deposits of gold.
It is assumed that gold and silver were exploited in Kremnica from the 10th century. The real boom came up in the 14th century what is connected with many technical monuments in the city and its surrounding, as example Turček's water pipe.
On November 17th 1328, the Hungarian King Charles Robert of Anjou granted the settlement of Cremnychbana with privileges of a free royal minting and mining town. Kremnica had due to its gold production. At the same time he established the royal mint, which produced large amounts of valuable golden and silver coins which brought fame, glory and leading position in the union of seven Middle-Slovak mining towns. Kremnica mint continues to operate till now which makes it a rarity within the European mints.
The town's historical centre together with the castle creates a very unique and individual example of gothic urban planning.

Stop 7: Jelšový potok – silica hot spring deposits

Co-ordinations: N 48° 37´ 32.5´´, E 18° 53´ 17.7´´

Fig. 14 Locality Jelšový potok

A lithology of the silica sinter sequence in the bentonite quarry Jelšový potok documents its transgressive character over products of earlier volcanic activity (bentonized glassy rhyolite breccias). Silica sinter deposition was interrupted by deposition of tuffitic siltstones and reworked rhyollite tuffs. The silica and tuff bodies change their lateral thickness. A horizon of the thin purple to red bentonized tuff and/or tuffite occurs below the silica sinter bodies. RTG analysis indicates a presence of smectite and CT-opal as a result of the early SiO_2 precipitation. A proper silica sinter is light, without organic matter, generally laminated, indicating a deposition in flowing water under oxidizing conditions. Oriented fossilized remnants of the water plant Typha support this interpretation. The presence of textures characteristic of cyanobacteria genera *Calothrix* and *Phormidium* in laminated sinters imply depositional temperatures < 35 ºC, respectively 35 – 59 ºC (Lynne and Campbell, 20063). Thus laminated sinters represent a distal facies of hot springs that were related to the lateral outflow of fluids from the Kremnica epithermal system.

Alternatively the silica deposition took place in temporary small lakes and marshes with reducing environment at normal temperature. In such the case silica deposits are rather massive, contain organic matter and associate with carbonaceous claystones and thin lignite seams. Silicites associate spatially with extensive bentonitization of rhyolite tuffs and glassy breccias (replacement of glass by smectite). This process frees excess silica found in silicite deposits. O and H isotopic data on silicite deposits and smectites imply increasing temperature northward, closer to the Kremnica epithermal system that was a primary source of fluids for alteration and silica deposition (Koděra et al., 2010).

Fig. 15 Quarry Jelšový potok. Bentonite (light), object of exploitation, is covered by silica sinter sequence (dark).

References:

Gašparik J., Halouzka R., Miko O., Rakús M., Bujnovský A., Lexa J., Panáček. A., Samuel. O., Gašpariková A., Planderová E., Snopková P., Fendek M., Hanáček J., Motlidba I., Klukanová A., Žáková E., Horniš J., Ondrejičková A. 1995. Explanation to geological map of the Turčianska kotlina Basin (1:50 000). GÚDŠ, Bratislava, 1–196 (in Slovak with English Summary).

Hók J., Kováč M., Rakús M., Kováč P., Nagy A., Kováčová-Slamková M., Sitár V., Šujan M., 1998. Geologic and tectonic evolution of the Turiec depression in the Neogene. Slovak Geological Magazine 4, 3. 165-176.

Koděra P., Lexa J., Fallick A.E., Biroň A., Gregor M., Uhlík P., Kraus I., 2010. Tracing low sulfidation systems from their roots down to foothills-example from the Kremnica ore and industrial minerals fields (Slovakia). Acta Mineralogica-Petrographica : Abstract Series 6, p. 289.

Kováč M., Hók J., Minár J., Vojtko R., Bielik M., Pipík R., Rakús M., Kráľ J., Šujan M., Králiková S., 2011. Neogene and Quaternary development of the Turiec Basin and landscape in its catchment: a tentative mass balance model. Geologica Carpathica 62, 4. doi: 10.2478/v10096-011-0027-6.

Lynne, B.Y. and Campbell, K. A., 2003: Diagenetic transformations (opal A to quartz) of low- and mid-temperature microbial textures in siliceous hot-spring deposits, Taupo Volcanic Zone, New Zealand. Can. J. Earth Sci., 40, 1679-1696.

Pešková I., Vojtko R., Starek D., Sliva Ľ. 2009. Late Eocene to Quaternary deformation and stress field evolution of the Orava region (Western Carpathians). Acta Geologica Polonica 59, 1, 73–91.

Pipík R., Bodergat A.M., Briot D., Kováč M., Kráľ J., Zielinski G. Physical and biological properties of the Late Miocene long-lived Turiec Basin and reconstruction of its paleobiotopes (Western Carpathians, Slovakia). Journal of Paleolimnology, (accepted)

Pipík R., Sabol M., 2006. *Paenelimnoecus* sp. (Lipotyphla, Mammalia) from the Late Miocene deposits of the Turiec Basin (Slovakia) and its Paleoenvironment. Beiträge zur Paläontologie 29: 15-21.

Vojtko R., Tokárová E., Sliva Ľ., Pešková I., 2010. Reconstruction of Cenozoic paleostress fields and revised tectonic history in the northern part of the Central Western Carpathians (the Spišská Magura and Východné Tatry Mountains). Geologica Carpathica 61, 3, 211–225.

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