shallow-water outcrops are mainly on the basin-margin, while the deep-water ones are rather located in the central part of the basin. We found just one fauna containing *Congeria czjzeki* – a characteristic species of sublittoral assemblages – at the locality of Lopadea Veche. We hypothesize that 9.5-9 million years ago the Transylvanian Basin became isolated from the Pannonian Basin, as suggested by the appearance of new endemic taxa, and evolved as an independent lake.

Authigenic $^{10}Be/^{9}Be$ isotopic dating method was applied on 7 samples from 4 localities. The tentative results were combined with the biostratigraphic data, thus in case of the deep-water sediments, 2 biozones and 4 subzones ("*Lymnocardium*" *praeponticum* – *Gyraulus vrapceanus* assemblage zone and *Congeria banatica* assemblage zone with *Radix croatica*, *Velutinopsis velutina*, *Undulotheca nobilis* and *U. rotundata* lineage subzones) were established.

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KRÉZSEK, CS., FILIPESCU, S., SILYE, L., MATENCO, L. & DOUST, H. (2010): Miocene facies associations and sedimentary evolution of the Southern Transylvanian Basin (Romania): Implications for hydrocarbon exploration. Marine and Petroleum Geology, 27, 191–214.

LUBENESCU, V. (1981): Studiul biostratigraphic al Neogenului superior din sud-vestul Transilvaniei [Biostratigraphic Study of the Upper Neogene in the South-West of Transylvania – in Romanian, with English abstract]. Anuarul Institutului de Geologie şi Geofizicâ, 58, 123–202.

MAGYAR, I., GEARY, D.H. & MÜLLER, P. (1999): Paleogeographic evolution of the Late Miocene Lake Pannon in Central Europe. Palaeogeography, Palaeclimatology, Palaeoecology, 147, 151–167.

NEUBAUER, T. A., HARZHAUSER, M., MANDIC, O., KROH, A. & GEORGOPOULOU, E. (2016): Evolution, turnovers and spatial variation of the gastropod fauna of the late Miocene biodiversity hotspot Lake Pannon. Palaeogeography, Palaeoclimatology, Palaeoecology, 442, 84–95.

SZÉLES, M. (1962): Alsópannóniai medenceüledékek puhatestű faunája [Mollusc fauna of the Early Pannonian basin sediments – in Hungarian, with German abstract]. Földtani Közlöny, 92/1, 53–60.

BIOERODED ROCKY SHORES AND CALCAREOUS PLANKTON STRATIGRAPHY OF THE MIDDLE MIOCENE (BADENIAN) TRANSGRESSIVE SUCCESSIONS IN THE NORTH CROATIAN BASIN (CENTRAL PARATETHYS)

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Mesozoic (Upper Cretaceous and Triassic) basement limestone lithoclasts occurring in basal conglomerates (overlain by rhodolith-bearing and *maërl* deposits) of the Middle Miocene transgressive deepening-upward successions of northeast Mt. Medvednica (North Croatian Basin, Central Paratethys; BRLEK et al., 2016) show abundant *Gastrochaenolites* and *Entobia* borings (represented by an *in situ* rocky substrate community of bivalves and sponges, respectively), with *Gastrochaenolites* being the dominant ichnogenus and together with *Entobia* often occurring on all sides of limestone clasts. *Gastrochaenolites torpedo* and *Gastrochaenolites lapidicus* are the two most commonly recorded ichnospecies of bivalve borings (with possible occurrence of *G. dijugus*, *G. cluniformis*, and *G. orbicularis*). *Gastrochaenolites-Entobia* ichnofossil assemblage related to the *Entobia* subichnofacies and in turn assignable to the *Trypanites* Ichnofacies, is very typical of Neogene rocky shores (DE GIBERT et al., 2012). This ichnoassociation characterizes littoral rockground environments indicating wave-cut platforms and marine flooding surfaces (transgressive surfaces) with a low or null rate of sedimentation (BROMLEY & ASGAARD, 1993). Actualistic comparison was made in order to make more accurate palaeoecological and palaeoenvironmental interpretations (based on e.g., ecology of possible tracemakers, as well as recorded trace fossil assemblages, orientation, preservation, and succession of ichnocoenosis with possible cross-cutting relationships) of the basal Middle Miocene conglomerates. Modern Northern Adriatic rocky coast endoliths (*Lithophaga lithophaga*, *Rocellaria/Gastrochaena dubia*, clinoid sponges) and their bioerosion trace fossils (*Gastrochaenolites torpedo*, *Gastrochaenolites dijugus*, ? *G. lapidicus*, *Entobia* sp.) were analysed from breakwater limestone boulders of the west Istrian coast (DEVESCOVI & IVEŠA, 2008).

The Badenian, regarded as Middle Miocene regional stage of the Central Paratethys, has recently been subdivided by HOHENEGGER et al. (2014) based on paleoclimatic events (e.g., MMCO and MMCT), sea-level changes and biostratigraphic data. According to ĆORIĆ et al. (2009), the initial Middle Miocene marine flooding of the North Croatian Basin corresponds to Middle Badenian transgressive pulse (NN5 Zone, TB 2.4) of the Central Paratethys (HOHENEGGER et al., 2014). The co-occurrence of calcareous nannoplankton *Sphenolithus heteromorphus* and *Helicosphaera waltrans* (with absence of *Helicosphaera ampliaperta*) in some marl intervals (which represent the uppermost part of the Middle Miocene trangressive deepening-upward successions on northeast Mt. Medvednica) analysed here, points to the lower part of nannoplankton Zone NN5. HOHENEGGER et al. (2014) correlated this part of NN5 with *Orbulina suturalis* Plankton Zone of the Middle Badenian (TB 2.4 – main Badenian transgressive pulse of the Central Paratethys), which is also supported by the recorded co-occurrence of planktonic foraminifera *Orbulina suturalis* and *Praeorbulina glomerosa circularis*. Somewhat younger age (the upper part of NN5 Zone) of some successions is suggested by the occurence of *Orbulina universa*, supported also by recorded nannoplankton assemblage with *Reticulfenestra minuta*, *Coccolithus pelagicus* and *Helicosphaera carteri*. Besides the Badenian transgressive pulse(s) of the Central Paratethys being the probable cause for the development of Mt. Medvednica transgressive successions, possible local tectonic influence must also be taken in consideration due to possible age difference and stratigraphic position of closely spaced Mt. Medvednica outcrops on the Badenian sea-level curve.

BRLEK, M., ŠPIŠIĆ, M., BRČIĆ, V., MIŠUR, I., KUREČIĆ, T., MIKNIĆ, M., AVANIĆ, R., VRSALJKO, D. & SLOVENEC, D. (2016): Mid-Miocene (Badenian) transgression on Mesozoic basement rocks in the Mt. Medvednica area of Northern Croatia. Facies, 62:18, doi: 10.1007/s10347-016-0470-z.

BROMLEY, R.G. & ASGAARD, U. (1993): Endolithic community replacement on a Pliocene rocky coast. Ichnos, 2, 93–116.

ĆORIĆ, S., PAVELIĆ, D., RÖGL, F., MANDIĆ, O., VRABAC, S., AVANIĆ, R., JERKOVIĆ, L. & VRANJKOVIĆ, A. (2009): Revised Middle Miocene datum for initial marine flooding of North Croatian Basins (Pannonian Basin Systems, Central Paratethys). Geologia Croatica, 62, 31–43.

DE GIBERT, J.M., DOMENÈCH, R. & MARTINELL, J. (2012): Rocky shorelines. In: KNAUST, D. & BROMLEY, R.G. (eds.): Trace fossils as indicators of sedimentary environments. Developm Sediment, 64, 441–462.

DEVESCOVI, M. & IVEŠA, LJ. (2008): Colonization patterns of the date mussel *Lithophaga lithophaga* (L., 1758) on limestone breakwater boulders of a marina. Periodicum Biologorum, 110, 339–345.

HOHENEGGER, J., ĆORIĆ, S. & WAGREICH, M. (2014): Timing of the Middle Miocene Badenian Stage of the Central Paratethys. Geologica Carpathica, 65, 55–66.

LITHOSTRATIGRAPHIC SUBDIVISION OF LONJA FORMATION (APPROXIMATE PLIOCENE, PLEISTOCENE AND HOLOCENE) BASED ON SUBSURFACE AND SURFACE DATA

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Entire subsurface clastic (Neogene and Quaternary) infill volume of the Sava Depression has been divided into lithostratigraphic units in the rank of formations while only some were subdivided into the rank of members (PLETIKAPIĆ, 1969; ŠIMON, 1980). This kind of approach was influenced by the Petroleum geology importance of determined formations, hence member subdivision and detailed analysis were only performed in the hydrocarbon bearing ones (e.g. Ivanić-Grad, Kloštar Ivanić and Široko Polje formation).

Lonja formation presents the youngest most part of the Pannonian Basin infill and roughly relates to sediments of Pliocene, Pleistocene and Holocene age. As a formation of lesser importance, it was not analysed in detail and subdivided. As in more modern hydrocarbon explorations, an importance for gas accumulations arose, it became more interesting. An integrated analysis comprised of available outcrop sampling and analysis regarding lithological composition, heavy mineral fraction, micro and macro-fossil determination along with palynological analysis. Surface to subsurface data correlation was performed based on macrofossil (primarily *Viviparus* molluscs), microfossil (ostracoda) assemblage along with their approximate position to the subsurface model. In the next step, surface data was correlated with the available subsurface data (Well logs, rock cutting description, scarce seismic) resulting in subdivision of the Lonja formation into six members (Figure 1.), primarily on well log analysis.

Paleo-reconstruction of the environments that followed the shallowing of the Pannonian Lake after Miocene (LUČIĆ et al., 2001; MANDIĆ et al., 2015) was performed based on well log and surface data. As the result of the analysis, a difference was noted in the clastic material assemblage in contrast to Uppermost Miocene (*Rhomboidea* beds). Heavy mineral fraction lacked less resistant minerals in the base part of the formation (Hrastilnica, Ravneš and base part of the Vrbak member) suggest either long sediment transport or resedimentation of older clastic strata.