Environmental, Structural and Stratigraphical Evolution of the Western Carpathians

CONFERENCE

Environmentálny, štruktúrny a stratigrafický vývoj Západných Karpát
Bratislava, 4.–5. 12. 2008

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The International conference ESSE WECA, being organized every second year by the Department of Geology and Paleontology, Faculty of Natural Sciences, Comenius University, Bratislava, was held in 4.–5. December 2008. The lectures and poster presentations took place at AMOS lecture room at the Faculty of Natural Sciences, Comenius University in Mlynská dolina, Bratislava. Altogether 50 participants from Poland, Czech Republic and Slovakia were registered to the conference. New knowledge was presented in 22 lectures and 24 poster presentations grouped in three topic sections:

1. New data on geology and tectonic evolution of the Pieniny Klippen Belt

2. New data on geology and tectonic evolution of the Flysch Belt

3. Neotectonics and new data on geology and evolution of the West Carpathian Neogene basins

The participants of the conference very positively evaluated its logistics and high scientific standard. The conference was characterized by a friendly atmosphere, being influenced also by approaching Christmas time.

Medzinárodná konferencia, ktorú každý druhý rok organizuje Katedra geológie a paleontológie Prírodovedeckej fakulty UK v Bratislave, sa konala 4.–5. decembra 2008. Prednášky aj posterová prezentácia prebiehali v miestnosti AMOS na Prírodovedeckej fakulte UK v Mlynskej doline. Na konferencii sa zaregistrovalo 50 účastníkov – vedcov z Poľska, Českej republiky a zo Slovenska.

Na programe boli prednášky a posterová prezentácia z nasledujúcich troch tematických okruhov:

1. Nové poznatky o geologickom a tektonickom vývoji pieninského bradlového pásma

2. Nové poznatky o geológii a tektonike flyšového pásma

3. Neotektonika a nové poznatky o geológii a vývoji karpatských neogénnych bazénov

Prednesených bolo 22 referátov a v posterovej časti sa predstavilo 24 príspevkov. Zahraniční aj domáci účastníci hodnotili konferenciu veľmi kladne, a to aj pokiaľ išlo o organizáciu a o vedeckú úroveň príspevkov. Úspešná akcia prebiehala v priateľskej, sčasti už v príjemnej predvianočnej atmosfére.

Part of participants of ESSE WECA conference during presentation in AMOS lecture room, Faculty of Natural Sciences, Comenius University.

Časť účastníkov konferencie ESSE WECA počas prezentácie v prednáškovej sále AMOS na Prírodovedeckej fakulte Univerzity Komenského.

M. BANASOVÁ[1], M. STRENG[2], D. REHÁKOVÁ[1] and H. WILLEMS[3]: **An exceptional flora of calcareous dinoflagellates from the Middle Miocene of the Vienna Basin, SW Slovakia**

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Novel and diverse associations of calcareous dinoflagellate cysts have been discovered in Late Badenian (late Middle Miocene) coastal marine sediments within the Vienna Basin. Samples derive from a clay pit near Devínska Nová Ves, a borough of Bratislava, Slovakia, in which the Late Badenian lectotype section is exposed. Seventeen different taxa, many of them new and of abnormal morphology, have been distinguished and assigned to ten genera. The following seven taxa are newly introduced from the Devínska Nová Ves clay pit: four genera comprising five new species, i.e., *Calciconus irregularis*, *Juergenella remanei*, *Cylindratus borzae*, *Posoniella pustulata*, *Posoniella campestris*, one new *varietas*, i.e., *Calcicarpinum perfectum* var. *poratum*, and one new *forma*, i.e., *Caracomia arctica* forma *duplicata*. In addition, the following new combinations have been made: *Posoniella tricarinelloides* (Versteegh), *Juergenella ansata* (Hildebrand-Habel and Willems), and *Juergenella granulata* (Kohring). The genus *Melodomuncula* Versteegh is emended based on a new interpretation of its tabulation, and the genus *Pirumella* Bolli is emended because the concept used for the genus is not in accordance with the original description.

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The following geodynamic evolutionary stages, reflecting the Wilson's cycle, can be distinguished in the Northern Carpathians (Golonka et al., 2006):

Stage I – rifting of terranes off the major continent, forming oceanic basins (Triassic – Lower Cretaceous);

Stage II – formation of subduction zones along the active margin, partial closing of oceanic basin, development of deep-water flysch basin associated with this rifting on the platform (passive margin) with the attenuated continental crust (Upper Cretaceous – Paleocene);

Stage III – collision, perhaps terrane – continent, with the accompanying convergence of two large continents, development of accretionary prisms, Eocene – Lower Miocene time in the Carpathian region;

Stage IV – postcollisional (Miocene)

Each of them formed conditions for sedimentation of debris flow deposit with olistoliths and origin of olistostromes.

The term olistostrome is derived from the ancient Greek and means "slide-layer" (Cieszkowski and Golonka, 2006). An olistostrome is a sedimentary deposit consisting of blocks of diverse origin that are immersed in the matrix. In the Northern Carpathians this matrix consists of clay, mud and sand or their mixture forming turbidity package. The blocks in olistostrome are named olistoliths. The size of olistoliths varies, from centimeters to kilometers. Very large blocks could slide independently into the basin with no easily distinguishable matrix. The matrix in this case is the flysch sequence or even entire sedimentary-tectonic unit. The olistostromes formed in Northern Carpathians as debris flows during the different stages of the development of flysch basins, from rift through post-rift to the orogenic stage. They are known from the Cretaceous, Paleocene, Eocene, Oligocene and Miocene flysch deposits of main tectonic units. Those units are the Skole, Subsilesian, Silesian, Dukla and Magura nappes as well as Pieniny Klippen Belt.

The oldest olistolits in the Northern Carpathians are related with the Upper Jurassic-Lower Cretaceous rifting and post-rifting stages of the Northern Carpathians and origin of the proto-Silesian basin. They are known from the Upper Jurassic Vendryne Formation, as well as Upper Jurassic--Lower Cretaceous Cieszyn Limestone Formation and Lower Cretaceous Cieszyn-Grodziszcze Formation.

In the southern part of the Polish Northern Carpathians as well as in the adjacent part of Slovakia the olistoliths are known from the Cretaceous-Paleocene flysch deposits of the Pieniny Klippen Belt Złatne Unit and in Magura nappe representing the second stage of the plate tectonic evolution – an early stage of the development of the accretionary prism. The most spectacular olistostromes have been found in the vicinity of Haligovce village in Pieniny Klippen Belt and in Jaworki village at the border zone between the Magura nappe and Pieniny Klippen Belt. The olistoliths and large clasts are represented by igneous rocks including possible ophiolite basalts as well as a variety of carbonate rocks of Triassic-Paleogene age. This material represents the former PKB basinal and ridge sequences as well as Inner Carpathian terrane sequences. The Haligovce Klippen and Homole block represent largest Pieniny Klippen Belt olistoliths (Golonka et al., 2006). In the basal part of the Godula Formation (Turonian – Campanian) represented by very thick-bedded sandstone turbidites of the Silesian nappe the large flat blocks of the shales derived from the Lgota Formation (Albian – Cenomanian) rest on slumped beds (Ślączka et al., 2006). In the area surrounding artificial Rożnów lake several olistostrome horizons are known from the Istebna Formation (Maastrichtian – Paleocene) as well as from the Hieroglyphic (Roznov) Formation (Middle-Upper Eocene). The large flat or plastically folded blocks of flysch deposits are present here. Blocks of marls and occasional limestones occur in the debris-

-flow sandy-gravel matrix with pebbles. The pebbles represent different sedimentary, metamorphic and magmatic rocks. West of Rabka the Middle Eocene olistostrome is developed in the Bystrica Subunit of the Magura nappe. Within the debris-flow sandy-gravel matrix there occur olistolits of Eocene variegated shales of Łabowa Formation as well as shaly-sandstone flysch and destructed sandstone layers and sandstone balls.

During Upper Paleogene collisional stage inside the accretionary prism of Zdanice, Subsilesian and Silesian nappes numerous olistoliths were deposited within the Oligocene-Lower Miocene Menilite Formation and Krosno Formation. The largest olistoliths (kilometers in size) are known from the Moravia region, where huge bodies of shallow-water rocks of Upper Jurassic-Lower Cretaceous age were deposited within the Upper Paleogene flysch. The largest olistoliths in Poland were found in the vicinity of Andrychów and are known as Andrychów Klippen (Golonka et al., 2006; Ślączka et al., 2006). In Skrzydlna quarry in the basal part of the Cergowa Sandstone in the Menilite beds (Oligocene) the very coarse conglomerates occur having pebbles of Paleozoic, Mesozoic and Paleogene rocks. Some Jurassic and Paleogene blocks measured up to 2.5 m. Just above them in the section the large olistostromes are developed being composed mainly of the Lower Cretaceous flysch deposits which represent Cieszyn-Grodziszcze Formation and Verovice Formation with minor addition of the Eocene grey or red marls and shales. Exotic-bearing shales from Bukowiec are known from the eastern part of the Polish Outer Carpathians. They create lens within the Oligocene Krosno Formation in SE, inner part of the Silesian nappe in front of the Dukla nappe. They contain huge (aproximately 15 meters in length) block of shallow water deposits.

The olistostromes witnessed the processes of the destruction of the Northern Carpathian ridges. The ridge basement rocks, their Mesozoic platform cover, Paleogene deposits of the slope as well as older Cretaceous flysch deposits partly folded and thrust within the prism slided northward toward the basin, forming the olistostrome. The Fore-Magura (Grybów) and Silesian ridges were totally destroyed and colapsed during subduction. Recently they are known only from olistoliths and exotic pebbles in the Outer Carpathian flysch. Their destruction is related to the advance of the accretionary prism. This prism has obliquely overridden the ridges, leading to the origin of the Menilite-Krosno basin. In the final, postcollisional stage of the Northern Carpathian plate tectonic development some olistoliths and even olistostromes were deposited within the Miocene molasse rocks.

In the western part of the Polish Outer Carpathians several boreholes (Ślączka et al., 2006) have penetrated autochthonous Upper Oligocene to Lower Miocene deposits beneath the Carpathian nappes. The basal portion of this sequence is composed of the fan-delta pebbly mudstones and conglomerates of the Zawoja Fm. (Oligocene-Egerian, see Oszczypko, 1998). These conglomerates pass upwards into dark marine mudstones of the Zebrzydowice Fm. (?Egerian-Ottnangian, see Oszczypko-Clowes and Oszczypko, 2003). Marine sedimentation period was followed by an Intra-Burdigalian (Karpatian) uplift, folding and thrusting of the Outer Carpathians onto the foreland platform. This was accompanied by the development of the large-scale flysch olistoplaques and gravitational nappes of the Sucha Fm. along the frontal parts of the Sub-Silesian nappe, which was located about 50 km south of its present-day position.

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M. OSZCZYPKO-CLOWES: **The terminal flysch deposits in the light of calcareous nannoplankton studies: The case study from the Polish and Ukrainian Outer Carpathians**

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During the last few years several authors studied the age of the youngest flysch deposits of the Western and Eastern Carpathians (see Melinte, 1995; Švabenicka et al., 2007; Oszczypko et al., 2005; Oszczypko-Clowes and Oszczypko, 2004; Oszczypko-Clowes, 2003, 2008; Andreyeva-Grigovich et al., 2008).

The Oligocene-Lower Miocene closing of the northern sector of the Outer Carpathian sedimentary area is manifested by deposition of Krosno/Malcov and Magura sandstone types of synorogenic lithofacies.

The Malcov lithofacies is typical for the Pieniny Klippen Belt/Magura Basin, while the Krosno one occupied the Grybów-Dukla-Silesian/Sub-Silesian/Skole and Boryslav-Pokuttya basin systems. The beginning and termination of these deposits was diachronic and migrated across the basins towards the north. These lithofacies reveal the fining and thinning upwards sequences. Towards the top the sedimentary sequences are dominated by marly pelites. In the PKB and Krynica Zone of the Magura Basin the deposition of the Malcov lithofacies was initiated during the NP 24 and persisted to NP25 zone, whereas in the Rača zone in NP24 and NP25 respectively.

In the Grybów-Dukla units the Krosno shally facies belongs to NP25. Towards the north this facies terminates in NN1 to NN3/NN4 zones in the Silesian/Subsilesian and Skole/Skiba nappes respectively. In more external part of the basin (Boryslav-Pokuttya folds) the Krosno (Polyanytsia) lithofacies pass into Vorotyshcha Salt Formation (NN4 zone). In the Magura Basin the Oligocene-Lower Miocene deposits are represented by thick-bedded sandstones with sporadic intercalations of pelitic deposits, derived from south-east trending source area. During the Oligocene in the Krynica, Bystrica and Rača facies zone these deposits interfingered with the Malcov lithofacies. In the northern part of the Magura Basin (Siary zone), supplied from the northern source area at that time the thick-bedded, glauconitic Wątkowa sandstones as well turbiditic mars were deposited. The youngest deposits (so-called Supra-Magura beds) of the Siary zone belong to NP24 zone.

During the Upper Oligocene (NN25/NN1) the frontal part of Magura nappe thrust northwards onto the terminal Krosno flysch basin. The clastic material derived from eroded front of orogene has been found in Krosno beds of Silesian Basin. The northwards thrusting of the Magura nappe was also accompanied by the formation of the piggy-back basin on the Magura nappe, filled with the synorogenic turbidites of the Zawada and Kremna formations (NN 2–3), which are characterized by the abundance of recycled nannofossils deriving from the front of orogenic wedge.

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N. DOLÁKOVÁ[1] and M. KOVÁČOVÁ[2]: **Late Miocene vegetation from the Vienna Basin (Czech and Slovak republics)**

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During Late Miocene, the Western Carpathian paleogeography started to change. The lake Pannon retreated southwards, and the northern coast of the back arc basin was slightly elevated due to progradation of deltaic and alluvial facies, especially in the lowlands.

The studied "Pannonian lake" sediments come from the Czech and Slovak parts of Central Paratethys (Vienna and Danube basins). Changes of the sedimentary environment from the deep to shallow lake and deltaic environments, followed by development of alluvial plains, were noticed. Salinity crisis due to Paratethys isolation led to development of total freshwater environment at the end of this period. Samples from 3 superficial localities and 15 boreholes were palynologically studied. Occasional occurrences of Dinoflagellates indicate a slightly higher salinity, whereas green algae *Pediastrum*, aquatic ferns *Azolla*, and aquatic and coastal plants (*Nelumbo*, *Nymphaea*, *Myriophyllum*, *Sparganium*, *Potamogeton*, Cyperaceae etc.) represent a freshwater environment. Due to paleogeographic changes and climatic oscillations the number of thermophilous taxa decreased and some of them disappeared completely from this area (f. e. Sapotaceae, Palmae). Mostly broad-leaved deciduous elements of mixed mesophytic forests (*Quercus*, *Celtis*, *Carya*, *Tilia*, *Carpinus*, *Betula*, *Juglans*) with some thermophilous elements admixture of *Engelhardia*, *Castanea*, *Trigonobalanopsis*, *Symplocos*, *Cornaceaepollis satzveyensis* generally dominated. Variously high relief of the uplifted mountainy chains created ideal conditions for higher presence of extrazonal vegetation (*Cedrus*, *Tsuga*, *Picea*, *Cathaya*) in the investigated area. Zonal type of vegetation including marshes, riparian forests with *Alnus*, *Salix*, *Pterocarya*, *Liquidambar*, *Betula*, *Fraxinus*, shrubs and lianas on dryer substrates associated riparian forest (*Buxus*, Ericaceae, Vitaceae, *Lonicera*, Rosaceae type *Rubus*), and coastal swamps with Taxodiaceae, *Nyssa*, *Myrica*, *Sciadopitys* were growing in the floodplain lowlands of the Vienna Basin. Accumulations of the Chenopodiaceae in the interfluve areas probably indicate local saline swampy environments during sea level fall. The increasing amounts of herbs indicate the existence of wet prairie areas (*Thalictrum*, *Rumex*, *Valeriana*, Dipsacaceae, Lamiaceae, *Galium*) or steppes (*Artemisia* – up to 17 %, Asteraceae, *Campanula*, Fabaceae, Daucaceae, Caryophyllaceae, *Plantago*).

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The paleogeographic elements of the Western Carpathians during Late Jurassic and Early Cretaceous times are linked to the lithostratigraphy of the various facies zones as well as occurrence of hydrocarbon source rocks. These source rocks were deposited within North European Platform and Severin-Moldavidic (Proto-Silesian) Basin. The uplifted and basinal zones were distinguished within the platform. The Baška-Inwałd Ridge and Pavlov Carbonate Platform belong to the uplifted elements, while Bachowice and Mikulov basins represent the basinal zones.

The Upper Jurassic organic-rich Mikulov marls were deposited within the Mikulov Basin. These 1400 m thick organic-rich rocks with TOC value 0.2–10 %, average 1.9 % with type II and III kerogen sourced oils in the Vienna Basin and Carpathian subthrust. They represent the world-class source rocks. These source rocks were found in the wells in southeastern Czech Republic and northeastern Austria.

Severin-Moldavidic Basin developed as rift and/or back-arc basin. Its basement is represented by the attenuated crust of the North European plate with perhaps incipient oceanic fragments. The sedimentary cover is represented by several sequences of Late Jurassic – Early Miocene age belonging recently to various tectonic units in Poland and Czech Republic. The Upper Jurassic-Lower Cretaceous organic-rich rocks of this basin belong to Vendryně, Hradiště and Veřovice Formations. They originated within the deeper parts of the basin in restricted marine environment.

The samples from the shales of the Vendryně Formation from Skalice, Czech Republic indicate TOC 0.91–1.04 % (max. 2.32 %), from Gumna (Poland), 1.43–1.77 %, from the Katowice-Wisła road 0.48–0.64 % and from Goleszów (Poland) 0.99–1.36 %. The kerogen belongs to type II-III. The samples from the Hradiště Formation from Skalice and Ostravice (Czech Republic) indicate TOC 0.6–1.5 %, from the uppermost part of this formation from Pindula 2 – indicate TOC 2.0–2.5 %. The samples from shales of the Veřovice Formation from Rzyki near Andrychów (Poland) TOC 0.38–3.0 %, from Zasań near Myślenice (Poland) TOC 1.56–3.72 %, and from Veřovice in Moravia (Czech Republic) 0.31–3.66 %.

The Vendryně Formation rocks do not contain significant amount of organic carbon. The increased TOC was encountered within the Veřovice Formation and uppermost part of Hradiště Formation. These rocks represent global anoxic event OAE 1b. Veřovice Formation contains potential source rocks for the Outer Carpathians systems with reservoirs various in age.

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M. GRADZIŃSKI[1], M. DULIŃSKI[2], H. HERCMAN[3], P. HOLÚBEK[4], M. KOVÁČOVÁ[5], E. STWORZEWICZ[6], P. RAJNOGA[1] and W. WRÓBLEWSKI[1]: **Factors controlling growth of travertine mounds in northern Slovakia**

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Travertines as the freshwater carbonates are commonly regarded as one of the best paleoclimatic indicators on land areas. The idea that their growth is particularly vigorous in warm and humid climatic condition is widely accepted. However, they are fed by deep-circulation waters of considerably long residence time, saturated with CO_2 of deep origin. Hence, the question arises if paleoclimate really governs, and to which extent, the deposition of such travertines.

To clarify above problems the complex study of travertines in Slovakia has been undertaken. Numerous extensive travertine mounds, up to several tens of metres high and several hundred metres in lateral extent occur there. They display a wide spectrum of fabric types, from typical of proximal thermogene travertines to characteristic of meteogene ones. The former comprise: crystalline crusts, shrubs, gas bubbles, pisoids, sunken rafts, while the latter include cyanobacterial and/or algal stromatolites and oncoids, as well as numerous imprints of higher plants. They also contain rich assemblage of mollusc fauna. Despite their great variations of fabrics, the travertines were predominantly fed by CO_2 of deep origin, which has been proved by the carbon stable isotope analysis. Moreover, the results of uranium series dating, as well as palynological and microfacies investigation suggest that not all studied travertines were laid down in temperature maximum of interglacials.

Furthermore, Slovak travertines are spatially related to fault zones, which indicates that they were fed by water rising along fault planes. Thus, the tectonic activity seems to be the important factor controlling travertine origin. Such faults may be responsible for providing conduits for deep--circulation, highly mineralized waters since the phase of fault fracture opening would be followed by increased migration of mineralized waters from greater depths toward the surface. The finding of sedimentary breccias incorporated within the studied buildups and widened fissures, filled with phreatic calcite spar cutting the travertines, supports the view above.

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E. HALÁSOVÁ[1], L. JANSA[2], D. REHÁKOVÁ[1], P. SKUPIEN[3] and Z. VAŠÍČEK[4]: **New biostratigraphic data from Ostravice river channel reservation (Outer Western Carpathians)**

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In 1966 the locality Ostravice, well-known between geologists, was declared as natural landmark "Ostravice river channel". It is located along Ostravice river, flowing through the Ostravice village. The frequently visited locality of Outer (Flysch) Western Carpathians is known particularly because the river channel well exposed the thrust plate of the Silesian nappe over the Subsilesian nappe. Tectonically foliated marly-sandy deposits of the Frýdek Formation belong to the Subsilesian nappe. According to Roth (1967) Maastrichtian planktonic foraminifers are present there.

Deposits of the Silesian nappe in this locality belong mainly to Hradiště Formation. Roth (1967) denotes the Hauterivian age of deposition without detailed data. Eliáš et al. (1979), without clarification, referred them to Hauterivian up to Early Aptian age. Silesian nappe formations in this natural landmark could be divided into three passages. The lowermost passage, which starts by the thrust plate and ends by river rapids, is characteristic by very complicated structure, in the consequence of proximity of the thrust plate and the flysch character of deposits, where greywacke sandstones and dark-grey claystones are roughly in equivalent proportion.

The second passage begins by Ostravice river rapids and follows against current in the length of about 70 m. The clayed limestones and grey claystones, periodically intercalated by platy, somewhere up to benched sandstones crop out there. In the uppermost part of the exposed profile limestones disappear, so the uppermost part of the Hradiště Formation is represented mainly by grey to dark-grey calcareous claystones interbedded with platy sandstones. The second section was lithologically documented in detail and sampled. Samples for microfossil study purposes were marked as ODA to ODO.

After the interruption of the profile in the length of 13 m some metres thick third passage follows, being represented by dark-grey non-calcareous shaly claystones with the layer of pelosiderites. These deposits belong to the Veřovice Formation.

In detail studies of the second part of Ostravice–rapids profile, built by Hradiště Formation, brought some new data. From the evaluation of thin sections was evident, that in sequence of rapids and in overlying layers the clayey micritic limestones are mainly present. This factor was not documented during foregoing investigations. The higher erosion resistance of limestones caused formation of the terrain stage, to which is the river rapid tied.

In studied limestone the samples calcareous nannofossil assemblages were detected with *Cruciellipsis cuvillieri* (Manivit) Thierstein, *Speetonia colligata* Black, *Litraphidites bollii* (Thierstein) Thierstein, *Rucinolithus terebrodentarius* Applegate et al. in Covington & Wise, *Rucinolithus windleyae* Rutledge & Bown and *Calcicalathina oblongata* (Worsley) Thierstein, indicating the Late Hauterivian age. The missing of nannoconids and micrantholiths, which are important rock-forming elements in coeval deposits of the Tethyan and Atlantic province (for example Rochovica outcrop in the Klippen Belt, Western Carpathians), could indicate reflection of the cold stream influence, water column depth, or eutrofication of the surface water?

In studied micritic limestones, marly shales and siltstones the poor fossil rests were identified of undetermined benthic foraminifera, calcified radiolaria, spines of sea urchins, detritus of crinoid segments and assemblages of calcareous dinoflagellates with *Cadosina semiradiata semiradiata* Wanner, *Cadosina semiradiata olzae* (Nowak), *Cadosina semiradiata cieszynica* (Nowak), *Stomiosphaera wanneri* Borza, *Stomiosphaera* sp., *Stomiosphaera echinata* Nowak, *Carpistomiosphaera valanginiana* Borza, *Colomisphaera lucida* Borza, *Colomisphaera conferta* Řehánek and *Cadosinopsis nowaki* Borza. The established assemblage is typical for the latest (Uppermost) Valanginian and Hauterivian. The latter mentioned form Cadosinopsis nowaki Borza, identified in the sample ODH, has been yet stated only from Hauterivian (Borza, 1984; Reháková, 2000).

The poorly preserved cysts of non-calcareous dinoflagellates in studied samples appeared quite sporadically, being only generic determined – *Circulodinium, Exochosphaeridium, Oligosphaeridium* and *Spiniferites* and typical for Valanginian to Aptian.

The third passage of Ostravice profile is lithologically different. Non-calcareous dark-grey pelitic deposits with pelosiderites of the Veřovice Formation are exposed. They contain rare pyritized radiolarian skeletons and teeny detritus of coalified plant remains. The correlation of these deposits with their outcrops in other localities of the Silesian unit allowed to fix the Late Aptian age.

Only small part of Hradiště Formation outcrops in studied locality. The whole Barremian and Lower Aptian deposits are missing here. The contact between Hradiště and Veřovice Formations is tectonic.

N. HLAVATÁ-HUDÁČKOVÁ and E. HALÁSOVÁ: **Upper Badenian–Sarmatian paleoenvironment from the Jakubov – Malacky area (Vienna Basin Slovak part)**

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The development of investigated intramountain Vienna Basin (Slovakia) was affected by global environmental changes as well as specific ones due to local factors, being a part of epicontinental sea called Central Paratethys. The most distinctive changes occurred in the Middle Miocene. These processes caused formation of marine and terrestrial phases in the Paratethys area having occasional connections with the Mediterranean and Eastern Paratethys. The closing and reactivating of seaways, especially during the Miocene, produced changes of environmental conditions. The Upper Badenian (13.6–12.7 Ma) is regarded as the last period of marine connection between the Paratethys and Mediterranean Tethys. Sarmatian sediments represent last normal to brackish marine sediments in the Vienna Basin. Analyses of depositional environment of the Upper Badenian and Sarmatian infill of the Vienna Basin in the Malacky and Jakubov area shows distinct facies segmentation from sedimentological, as well as from paleontological aspects. Upper Badenian sediments are represented by grey calcareous siltstones, claystones to sandstones with bioturbation and fragments of macrofossils. They probably represent sediments typical for intertidal or deltaic environment. Distinct shallowing is supposed in marginal area with A/P (*Ammonia*/*Porosononion*), A/E (*Ammonia*/*Elphidium*) A/H (*Ammonia*/*Haynesina*) foraminiferal assemblages accompanied by calcareous nannofossils dominated by small reticulofenestres, *Reticulofenestra haqii* and *R. minuta*, the *Glyptostrobus* marshes are developed also. Mentioned assemblages are typical for high energy environments of shallow, brackish water of the inner shelf, sheltered bays or deltas with depth to 20 m and salinity under 32 %. More likely it could also represent intermediate or hyposaline marshes. Lowermost Sarmatian represents associations with *Ammonia*, which continued from Upper Badenian sediments. This stressed shallow conditions, even freshwater, are changed to deeper dysoxic *Anomalinoides badenensis* associations. Large Elphidia Zone is developed in the northern areas, being probably bordered on central parts of sedimentation area. It is typical for shallow water, to 20 m deep, well aerated marine or brackish environment. In the upper portions of profiles the associations with small miliolids occurred. Assemblages of small miliolids, *Ammonia vienensis* and *Elphidium* are interfingering into marginal parts of studied area depending of the water supply. It is typical for very shallow environments (to 2 m) of intermediate, hyper or hyposaline marshes, grassy, occasionally flooded or exsiccated. In core depths of approximately 625 m the marshes wooded by Glyptostrobus forest are proved, being documented by charred bark, seeds and cones. In these sediments the change of calcareous nannoplankton association was detected. It is represented by acme of *Braarudosphaera bigelowii* and *B. bigelowii parvula* – indicators of very stressed environment. In these horizons *Foraminifera* do not appear at all.

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M. HYŽNÝ: **New Karpatian decapod crustaceans assemblage from Cerová-Lieskové (Vienna Basin)**

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The locality of Cerová-Lieskové is situated on the western slopes of the Malé Karpaty Mts. in the SW part of Vienna Basin.

The studied section is represented by the Lakšárska Nová Ves Formation (Špička and Zapletalová, 1964) being characterized by grey calcareous pelitic "Schlier" development. The biostratigraphic dating is based on nannoplankton flora assemblage and indicates the NN4 Zone of the Lower Karpatian age (Baráth et al., 2003).

Several animal groups were documented at the studied locality including foraminifers, bivalves, gastropods, echinoids, cephalopods and fish otoliths. Recently more attention has been paid to crustaceans which represent two different orders here: Decapoda and Isopoda. 79 specimens have been studied, which yielded totally 7 different taxa (1 belongs to Isopoda order).

The greatest number of specimens was determined as *Callianopsis* sp. nov. (order Decapoda, infraorder Thalassinidea, superfamily Callianassoidea). The material exhibits striking sexual dimorphism through the shape of the major cheliped. Nearly all morphological characters needed for proper systematic identification of fossil callianassid material proposed by Manning and Felder (1991) were observed on the studied specimens, including the morphology of dorsal carapace and all segments of major and minor chelipeds of both sexes. The second almost isochelate thalassinid taxa comprises two specimens and has not been determined yet.

From Anomurans there were collected totally 4 specimens belonging to single family Galatheidae and two different taxa. *Munidopsis* sp. nov. is represented by 3 almost complete carapaces. The second species has not been described properly yet since only one fragmentary specimen was found, but it certainly has to be described as a new species belonging to subfamily Galatheinae.

Infraorder Brachyura is represented by only species *Styrioplax exiguus*, which was first described from Austrian part of Vienna Basin (Glaessner, 1928). Karasawa and Kato (2003) in their re-evaluation of the family Goneplacidae argued that it is not possible to assign this species to any subfamily with certainty because the type material is not very well preserved. This new material from the Cerová-Lieskové locality comprising totally 4 specimens will allow us to classify *S. exiguus* more precisely than ever before after proper examination.

Order Isopoda is represented by 3 specimens probably belonging to family Cirolanidae. Specific assignation is not possible because soft parts needed for determination are not preserved. In one case there are nearly all parts of cephalon, pereon and pleon preserved, documenting the biphasic molting typical for isopods.

The crustacean fauna collected at the Cerová-Lieskové locality brings new data in several respects: *Callianopsis* sp. nov. is the second record of this today exclusively Pacific genus in the Europe, which confirms the decapod crustacean faunal changes not only between the Pacific and Atlantic regions (Feldmann and Schweitzer, 2006; Schweitzer, 2001) but also between Atlantic and Paratethyan realm through Mediterranean. The new material of *S. exiguus* together with the re-examination of the type material sheds new light on the classification of the genus of *Styrioplax*. Finally collected presumable cirolanid specimens represent the first record of fossil marine isopods in Slovakia.

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B. CHALUPOVÁ and J. MICHALÍK: **Chondrichtyes and Osteichtyes remains from the Kardolína locality in the Tatra Mts. (Fatra Fm., Western Carpathians)**

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The shark and fish teeth extracted from bone beds occurring in the Rhetian Fatra Fm. of the Kardolína locality in the Tatra Mts. are briefly described. The fauna comprises well established Rhetian Chondrichtyes and Osteichtyes.

Rhetian fish remains (single shark and actinopterygian teeth and scales) were previously reported from slopes of the Tatra Mts. by Gaździcki (1974) as well as Duffin and Gaździcki (1977). Indeterminated Rhetian fish remains were also mentioned by Michalík (1977, 1979), or by Gaździcki et al. (1979).

The Kardolína section is situated on steep slope of the Mt. Pálenica (NNE of the village Tatranská Kotlina) in eastern part of the Belianske Tatry Mts. It represents the most complete profile of the Fatra Formation (Michalík et al., 2007), rich in fossil molluscs, brachiopods, corals, echinoderms, foraminifers, ostracods and algae. Shark teeth were collected from beds 2.2/2.3. Fish fossils (single teeth and vertebrae) were collected in beds 2.2, 2.3, 3.1, 3.2, 3.3, 3.4, 4, 4.2, 5.1, 5.2, 5.4, 13/14, 14/15 and 15/16 and they are housed in the Geological Institute of SAS in Bratislava.

Many small (a few mm) shark teeth belonged of *Lissodus minimus* (Agassiz, 1839). Agassiz in 1839 described by as *Acrodus minimus* from most Westbury Formation. One tooth belongs to *Hybodus minor* Agassiz, 1833. It is characterized by a relatively larger, sharper central cone and fewer lateral cusps (only one or two per side). The cusp is offset to the labial side of the tooth and bear pronounced striae or ribs. Punctate root of the tooth is prominent but varies from a thin platform to a fat or bulbous knob. This root is generally mildly concave or flat-bottomed and is straight along its labial side but broadly curved lingually (Storrs, 1994).

Teeth of *Sargodon tomicus* Plieninger, 1847 belong to the most often finds. They are of two morphological types. There is an incisiform type, and dome-like crushing tooth type. Before Italian findings, *Sargodon* was known only by its teeth, which are recorded from the Norian-Rhetian of Europe, especially from bone-beds of England, France and Germany. *S. tomicus* is a very deep-bodied fish, its maximum depth being slightly less than the standard length: less than 30 cm to more than one meter (Muscio, 1988).

The conical teeth belong to *Saurichthys longidens* Agassiz, 1834 and *Birgeria acuminata* (Agassiz, 1839), which were predators, while the highest trophic level was occupied by "primitive" basal actinopterygians (Lombardo and Tintori, 2005). *Saurichthys* ("lizard fish") were recognizably pike-like fish, with a characteristic caudal placement of the dorsal and anal fins. Morphological characteristics of these fish are sufficiently similar to that of pikes for their lifestyles to have been most probably very similar. Thus, it is generally hypothesized that the large (up to a meter in length) saurichthyiform fish were ambush predators, using their elongated and narrow mouths to snatch the smaller fish they probably fed on after a rapid burst of swimming. *Saurichthys* was relatively cosmopolitan, found in deposits on all continents except Antarctica. *Birgeria* was a large fish with robust dentition. Basal portion of teeth below enamel cap is relatively shorter. The enamel cap terminated proximally by prominent collar; teeth with fine vertical striations, best developed immediately proximal to collar. *Birgeria* have the body almost naked, scales only present on dorsal half of caudal pedicle, on body axis of caudal fin, and anteriorly to the caudal pedicle in a single row along the main lateral line (Savage and Large, 1966).

The base of the Fatra Fm. in the Kardolína locality contains record of colonization by marine faunas (shark and fish) during the Rhetian transgression, which become dominated by *Sargodon tomicus* Plieninger, 1847.

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M. JAMRICHOVÁ and R. AUBRECHT: **Microfacies analysis of selected profiles of the Czorsztyn Unit of the Klippen Belt**

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The majority of studied profiles is situated in the central Považie area (Hrebeň, Štepnická skala II. and Žiačik) except of "Erdúdsky kostol" locality situated in Orava region. Microfacies studies distinguished following dissimilarities with the classical scheme of Birkenmajer (1977). In the Hrebeň section, red Krupianka Limestone is missing above the Smolegowa Limestone but grey to pink-red crinoidal limestones occur there. Higher up they pass into micritic crinoidal limestones which contain quantity of brachiopods and a "filamentous" microfacies. Deepening of the sedimentation environment is indicated by increasing micritic component and appearing of "filamentous" microfacies. The sedimentary environment of this limestone is subtidal up to deeper neritic. In this formation, condensed sedimentation was registered, being indicated by the Fe-Mn crusts (hardgrounds). After the interruption of sedimentation the Czorsztyn Nodular Limestone with the "filamentous" microfacies sedimented. In Oxfordian, the "filamentous" microfacies was replaced by Globuligerina microfacies in the upper part of the formation. Transitional "filamentous-Globuligerina" microfacies indicates that the transition was gradual and not abrupt, as known earlier. Onset of globuligerinids and radiolarians proves consequent deepening of the sedimentary basin. The Globuligerina microfacies is replaced by Saccocoma microfacies in Kimmeridgian; it appears together with *Bosira buchi* (Roemer). Globuligerinids appear again in the overlying pseudonodular crinoidal limestones with Saccocoma microfacies in the Hrebeň section, which indicates gradual replacement of Globuligerina by Saccocoma microfacies contrasting to sudden onset which was recognized before. The Czorsztyn Limestone Formation of "Erdúdsky kostol" section is formed prevailingly by Saccocoma microfacies. Brown to brown--red crinoidal (Saccocoma) limestones in the Štepnická skala II. locality were distinguished under a new name – Streženice Limestone Formation of the Kimmeridgian to Lower Tithonian age. The studied Dursztyn Formation of Upper Tithonian-Lower Beriassian age is represented by Rogoża Coquina (Hrebeň, Šepnická skala II. and Žiačik), Korówa Member (Hrebeň, "Erdúdsky kostol") and the Sobótka Member (Štepnická skala II. and "Erdúdsky kostol"). The sedimentary environment of the Dursztyn Limestone Formation is deeper neritic, dominated by planktonic organisms. On the basis of association of calcareous dinoflagellate cysts and calpionellids following zones were distinguished: Malmica Zone distinguished from the uppermost part of Streženica Limestone and from the lower part of Red Nodular Limestone of Štepnická skala II. section and from Rogoża Coquina of Hrebeň section. Semiradiata Zone was distinguished from the upper part of Rogoża Coquina of Štepnická skala II. section. Crassicollaria Zone was distinguished from Korówa Member of Hrebeň section, from Korówa Member and from the lower part of Sobótka Member of "Erdúdsky kostol" section and Crassicollaria Zone with Intermedia subzone from the uppermost part of Rogoża Coquina of Štepnická skala II. section. Calpionella Zone with Alpina Subzone was distinguished from Korówa Member of Hrebeň section and from the upper part of Sobótka Member of "Erdúdsky kostol" section. Calpionellid zonations was used by Pop (1994) and calcareous dinoflagellate cyst zonations by Reháková (2000). In the Žiačik locality, the Rogoża Coquina is different from the other occurrences by absence or subordinate amount of Globochetae microfacies. The youngest members observed were grey and red limestones of Aptian up to Albian age with *Hedbergella* sp. ("Erdúdsky kostol") and neptunian dyke with the rare appearance of *Ticinella* sp. (Žiačik).

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Š. JÓZSA, M. GOLEJ and D. PLAŠIENKA: **Peculiar micro and macrofauna of the Albian limestones of the Klape Unit (Varín sector of the Pieniny Klippen Belt)**

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Several bodies of dark grey, massive, marly and siliceous or cherty limestones occur in the area around the Jalovec hill about 2 km NW of the Lysica village. Surrounding rocks are poorly outcropped, they are probably formed by thin-bedded shale/sandstone alteration described as the "spherosiderite beds" (Haško and Polák, 1979), correlative to the Nimnica Formation defined by Salaj (1990). These sediments belong to the basal part of the Klape Unit (or Manín Unit according to Haško and Polák, 1979) overriding Upper Cretaceous formations of the Kysuca Unit. The limestone bodies are nearly isometric, up to 100 m in diameter. These bodies were described as "klippen" by Haško and Polák (1979), but limestones are of the approximately same age as the associated distal flysch sediments (Upper Aptian? – Albian, l. c.). More probably they represent olistoliths or tectonically disrupted slump bodies derived from the basin slopes.

An uncommon assemblage of planktonic foraminifera with other benthic foraminifera, scarce bivalve fauna and wood fragments has been recovered from limestones of this formation. Planktonic foraminiferal assemblage shows nearly monospecific composition and belongs to the family *Favusellidae*. There have been identified *Ascoliella nitida* (Michael) and in lesser amount *Ascoliella* cf. *voloshinae* (Longoria and Gamper), representing the first descriptions of free specimen from the family *Favusellidae* of Albian deposits of Slovak Western Carpathian area. From benthic foraminifera the representatives of genera *Tritaxia*, *Lenticulina*, *Vaginulinopsis*, *Gavelinella* and scattered *Textulariopsidae* gen. et spec. indet were identified. Among other microbioclasts sponge spicules and scarce fish teeth have been found. The planktonic foraminifera occur in spongolitic wackestone nearly packstone microfacies with echinoid fragments and with rare clastic admixture. Gorbachik (1980) observed that the favusellids are commonly found in neritic environments.

In the bivalve association only left valves of the genus *"Ostrea"* are preserved. Oysters were attached to the substrate or bottom by the left valve. The right valves are wholly missing in the studied sediments. In the umbonal areas of the left valves no attachment area was observed, hence the attachment to the sediment particles or larger (e.g. wood) surfaces is supposed (parallel marks on the valve surface). The latter hypothesis is supported by the missing of the right valves that could be lost after the death of the organism and destruction of the organic matter that hold the shells together. The left valves attached to the mobile substrate were then transported longer time and deposited in another part of the basin (in the present sampled sediments).

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J. KOPECKÁ: **Paleoecology of the Lower Badenian Carpathian Foredeep based on foraminiferal fauna in Central Moravia (Czech Republic)**

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The Carpathian Foredeep (CF) in the area of Czech Republic is bordered with the passive margin of the Bohemian Massif in NW and with the overriding nappes of the Western Carpathians in SE. The Lower Badenian Carpathian Foredeep in Moravia represents a final evolutionary stage of the peripheral foreland basin in NW part of the Central Paratethys. Beginning of Lower Badenian sedimentation is characteristic by the presence of clastic deposits (conglomerates and sandstones). Transgression into deeper parts of the basin was followed by calcareous clay sedimentation.

In Central Moravia, calcareous clays from the borehole HV-5 Rybníček (Vyškov area, Central Depression of the CF, 200 m, 63 samples of core section) and two outcrop localities in Olomouc area (Upper Moravia Basin): Olomouc-Neředín (14 m, 7 samples of outcrop section) and Olomouc-Nová Ulice (1 sample) were analysed. All studied sections have a common feature: occurrence of stratigraphically significant *Orbulina suturalis* Brönn. and *Praeorbulina glomerosa circularis* (Blow) in all sections. This corresponds with the planktonic foraminiferal Zone M6 (15.1–14.8 Ma) of the Alpine–Carpathian Foredeep (Coric et al., 2004).

At the individual localities, there was found variation among foraminiferal fauna assemblages. Planktonic foraminiferal assemblages differ in their diversity and in plankton/benthos (p/b) ratio. Planktonic foraminifera with high diversity from the HV-5 Rybníček borehole samples are represented mainly by genera *Globorotalia* (*Obandyella*), *Paragloborotalia* and *Globigerinoides*. The p/b ratio is between 50–90 %. Planktonic foraminiferal fauna with low diversity from the Olomouc area localities samples is represented mainly by genus *Globigerinoides*. The p/b ratio is 25–35 % for assemblages of the Olomouc-Nová Ulice locality and 2 % for assemblages of the Olomouc--Neředín locality. For the HV-5 Rybníček borehole, the p/b ratio indicates outer shelf up to upper bathyal zone environment. In the Olomouc area localities, p/b ratio points to markedly shallow water condition of middle shelf at the Olomouc-Nová Ulice locality up to inner shelf at the Olomouc-Neředín locality (interpretation by Murray, 1991). Benthic foraminiferal assemblages differ in the presence of deep-water foraminifera (e.g. *Neugeborina*, *Cibicidoides*, *Melonis*, *Lenticulina*, *Heterolepa* and *Uvigerina*) in the HV-5 Rybníček borehole samples and in the presence of shallow-water foraminifera (e.g. *Asterigerinata*, *Heterolepa* and *Nonion*) in samples from the Olomouc area localities. Lower diversity of bentic foraminiferal fauna in some samples of the HV-5 Rybníček borehole and the Olomouc-Nová Ulice locality is connected with the occurrence of genera *Bulimina*, *Bolivina*, *Millostomella*, *Siphonodosaria* and *Pullenia*. These foraminifera are typical for bottom environments with low oxygen level (Kaiho, 1994).

Described foraminiferal assemblages indicate different bathymetric conditions at studied localities. Deep water conditions typical for the HV-5 Rybníček borehole correspond with other studies from the Moravian part of the Carpathian Foredeep (e.g. Brzobohatý, 1981; Diviš and Sviták, 1998; Petrová, 2002; Petrová, 2004; Petrová and Hanák, 2004). Shallow water environment described at the Olomouc area localities is also known from several localities of the CF including Olomouc area with occurrence of red algal limestones (e.g. Zapletal et al., 2001; Zapletal, 2004; Doláková et al., 2008). Benthic foraminifera, which in several samples significated low oxygen level at the bottom, can feature environment with seasonal accumulation of biomass at the sea bottom. It is a result of high production of biomass in photic zone in area of convergence of marine currents (Phleger, 1960). It supposes good water mass circulation between the Mediterranean and the Central Paratethys (Brzobohatý, 1987; Báldi, 2006). Decomposition of biomass at the sea bottom causes reduction of oxygen level. These results are consistent with the current paleogeographic interpretation of the Lower Badenian in the Central Paratethys. The paleobathymetric analyses could also argue a different tectonic history (?relief inversion) of the particular blocks in the Middle Moravia during the Lower Badenian and in the Post-Badenian.

M. KROBICKI[1] and A. WIERZBOWSKI[2]: **Stratigraphy of the Jurassic (Bajocian) crinoidal limestones in the Pieniny Klippen Belt in Poland and the problem of the Czertezik Succession**

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The most important set of the Jurassic crinoidal limestones in the Pieniny Klippen Belt (PKB) in Poland is subdivided into three formations: the Smolegowa Limestone Fm., laterally replaced by the Flaki Limestone Fm., and both capped partly by the Krupianka Limestone Fm. The Smolegowa Limestone Fm. consists of light grainstones typically developed in SE shelf/slope of the Czorsztyn Ridge (the Czorsztyn Succession – shallowest part of the basin), and in a little bit deeper – the Niedzica Succession, as well as some parts of the Czertezik Succession, whereas the Flaki Limestone Fm. consists of grey crinoidal-spiculitic grainstones with multicoloured cherts (some parts of the Czertezik Succession). The spongiolites, crinoid marlstones, and filament limestones, micritic limestones and marls, attributed also to the Flaki Limestone Fm., are recognized in a deeper part of the basin (Branisko Succession). The Krupianka Limestone Fm. is represented by red crinoidal limestones occurring from the Czorsztyn Succession to the Niedzica Succession, and partly in the Czertezik Succession.

The onset of the crinoidal sedimentation, as proved by ammonite faunas, took place during the Early Bajocian – in the latest Propinquans Chron, and it was preceded in more shallow areas of the PKB (Czorsztyn, Niedzica and Czertezik successions) by a marked stratigraphical hiatus. The hiatus covers the bulk of the lowest Bajocian (mostly Laeviuscula Zone and a bulk of the Propinquans Zone). This hiatus corresponds to the origin and uplift of the Czorsztyn Ridge, and it is not recognized in a deepest part of the basin (Branisko and Pieniny successions) where the deposits of the Fleckenkalk/Fleckenmergel-type facies (Harcygrund Shale Fm.), fulfils the stratigraphical interval in question.

The development of the crinoidal limestones occurred in a very dynamic environments controlled by the synsedimentary movements of submarine blocks, which resulted in strong differentiation of the thicknesses of the crinoidal formations. The end of the crinoidal limestone sedimentation corresponded to a general subsiding of the Czorsztyn Ridge which promoted the appearance of the pelagic Ammonitico Rosso facies (Czorsztyn Limestone Fm., Niedzica Limestone Fm.). As proved by ammonite faunas recognized in the Czorsztyn and Niedzica successions, this replacement of the facies (sometimes related with hiatus) took place during the latest Bajocian (from the Garantiana Chron to the Parkinsoni Chron).

A different interpretation of stratigraphy of the crinoidal limestones was given originally by Birkenmajer (1977, *Studia Geol. Pol.*, 45) who postulated a wider stratigraphical range of the crinoidal formations – from the Lower Bajocian up to the end of Callovian. This interpretation remained nowadays especially strongly controversial in relation to the Czertezik Succession. According to Birkenmajer (2007, *Studia Geol. Pol.*, 127) the crinoidal limestones span a wide stratigraphical interval of the Middle Jurassic in the Czertezik Succession being a lateral equivalent of the lowest Ammonitico Rosso facies of the Niedzica Succession. The current studies of the present authors do not confirm, however, the presence of such a long ranging "stratigraphical chimney" of the crinoidal limestones in the Czertezik Succession. The ammonites found in the Ammonitico Rosso facies in the typical area of occurrence of the Czertezik Succession (Zamkowa Mt. in the Trzy Korony Range, and a fallen block off the Czertezik Mt. above Zawiasy) have revealed the presence of the uppermost Bajocian – lowest Bathonian ammonites such as *Parkinsonia* (*Parkinsonia*) *parkinsoni* (Sow.), *Parkinsonia* (*Gonolkites*) sp., *Oxycerites* sp. This fauna indicates that sedimentation of the crinoidal limestones in the Czertezik Succession took place during the Bajocian, as the overlying Ammonitico Rosso facies appeared here already in the uppermost Bajocian – lowest Bathonian, similarly as in other successions of the PKB. These new findings make the difference between the Czertezik Succession, and other successions of the PKB much smaller than originally proposed (Birkenmajer, 1959; *Acta Geol. Pol.*, 9), and confirm the interpretation of the present authors (Wierzbowski et al., 2004; *Ann. Soc. Geol. Pol.*, 74).

K. KRONOME and M. SÝKORA: **Preliminary results of the new field research of the Upper Triassic limestones near Silická Brezová (Slovak Karst)**

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The studied profile is located near the Silická Brezová village in the Slovak Karst and belongs to tectonic unit of Silicicum. Profile is built by Upper Triassic (Tuvalian to Sevatian) limestones: Tisovec – Waxenec limestones, Hallstatt limestones and Dachstein limestones. The latest are in tectonic contact with the underlying Hallstatt limestones. The thickness of profile is 134 m.

This work focuses mainly on the microfacial study and statistical analyses of Hallstatt limestones. Studied sediments are mostly developed in the facies of bedded grey-rose and terracotta bioclastic limestones with indication of nodularity. The sediments represent an open shelf environment influenced by the episodic deep water input.

The profile was uncovered in the 1996 during the biomagnetostratigraphic study. Stratigraphic and biomagnetostratigraphic interpretations have been made by an international team led by J. E. T. Channell. The stratigraphic interpretations were made by H. Kozur on the basis of conodont fauna distribution. Recently, a detailed documentation of the profile has been performed and completed by rock material, especially from the interval of Carnian – Norian boundary, which will be used to specify the stratigraphy, microfacial analysis and capacity of stable isotopes (O and C) in the whole profile.

Our microfacial study has shown the following results:

The microfossil association in the studied profile indicates an energic environment and normal salinity prevailed in the Tuvalian (0.0–28.8 m). The occurrence of intraclasts probably reflects an influence of storm ripple. Foraminiferal community and also the other bioclasts suggest a carbonate platform environment. In this part of profile, the light shallow-water Tisovec (Waxenec) limestones, which are very well developed in the Silicicum unit, appear the last time. In the upper part of Tuvalian (28.8–46.0 m), the majority of micrite matrix and the presence of radiolarians and planktonic crinoids show the influence of the deep see environment. A special feature of the analysed samples is the occurrence of carbonatic ooids suggesting continuing communication with the shallow water environment.

The association and content of microfossils, particularly radiolarians and "filament" types of bivalves in the Lower Norian – Alaunian interval (46.0–86.9 m) show the deepening of area and communication with the open see environment. The breccias beds positions, interrupted with synsedimentary slip fold, indicate a slope area, probably simultaneous with the seismic activity and possible sea-level fluctuation. The upward granularity refinement might document the gradual ending of the mentioned influences or sea-level rising.

The presence of ammonites, smaller extent radiolarians and thin-shell bivalve bioclasts in the lower part of Sevatian limestones (86.9–134.0 m) show that the open see conditions persisted during this interval. The rich presence of porifera spicules and some lumachelle layers are also observed. In this section, the peloid grainstones, which structurally and qualitatively sharply contrast with the microfacies of underlying and overlying layers, are present in two samples. Typical bioclasts are absent in these grainstones. The sedimentation of these layers was probably influenced by gravitational flows, which brought material from the coastal platform area.

Overlying beds of light grey limestones are macroscopically and microscopically different from the underlying rocks. This might result from their tectonic contact. These layers belong to the Dachstein limestones (grainstones to grapestones), which contain the green algae – *Dasycladaceae*, agglutinated Foraminifera, segments of echinoderms and intraclasts.

Acknowledgement. This work was supported by the Slovak Research and Development Agency with the contracts Nos. APVV-0571-06, VEGA 1/4035/07 and APVV-0280-07.

J. KUČEROVÁ: **Preliminary results from the paleobotanical research on the locality Spišská Nová Ves**

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The locality Spišská Nová Ves is situated in the Hornádska kotlina intramountain basin (Western Carpathians, Slovakia). Studied plant assemblage occurs in the Tomášovce Member, a part of the Podtatranská (Subtatric) Group and represents the uppermost member of the Borové Formation (Priabonian – Lower Oligocene). Preliminary research yielded determination of fossil plants belonging to the families *Fagaceae (Eotrigonobalanus, Quercus), Lauraceae (Laurophyllum, Daphnogene)* and taxa *Leguminosites* sp. div., Pinus, Picea and Quasisequoia. Following research is focused on the anatomical interpretation of leaf macrofossils, statistics, quantitative paleoecology and taphonomical interpretation. Floral composition, diversity, equitability and dominancy are discussed.

O. LINTNEROVÁ[1], M. KNIETL[1], D. REHÁKOVÁ[1], P. SKUPIEN[2] and Z. VAŠÍČEK[2]: **Diagenetic and dolomitization history of the Štramberg limestones**

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The Štramberg sequence is a part of tectonic megaslices detached from the reef complex which originally (Tithonian) had bordered the eastern slope of Bohemian Massif and later were deposited as a shallow water mound limestone. A grey bedded dolomite occurred in some clefts of this tectonically deformed carbonate complex. Light and SEM microscopy studies have been completed by microprobe analyses of dolomite crystals, by elemental (Sr, Na, Mg, Ca, Mn, Fe) analyses of HCl-leachable part of the samples, and by C and O-isotopic analyses of calcite and dolomite phases to document sedimentary and diagenetic/burial history of this sequence. Grain size (0.05–0.2 mm) and idiotopic to hypidiotopic dolomite rhombs mosaic could indicate rather low-temperature (50–60 °C) diagenetic recrystallization of low-Mg calcite. There occur mainly Ca-enriched dolomite rhombs with other Fe and Mn substitution, which is strong argument supporting burial or late diagenetic model of dolomite formation. Character of dolomitization fluids indicated rather common zoned crystals. Dark rhomb Mn--enriched cores are (syntaxially) enclosed by (light) high Fe and less Fe enriched zones in direction to the rhombs edge and documented progressive chemical changes of marine fluid composition in buried sediment. Moreover δ^{13}C (2.38 to 2.58 ‰) values exclude a meteoric origin of the dolomitization fluids and the δ^{18}O (-3.58 to -4.34 ‰) excludes a hypersaline origin and calculated δ^{18}O-dolomite temperatures coincide with the estimated diagenetic temperature range. Large part of originally grey bedded dolomite is recrystallized to yellow-brown de-dolomite. Subhedral to anhedral grains (xenotopic mosaics) of new-formed calcite with low content of Mg and Sr and higher content of Fe, Mn and Na, decreased δ^{13}C (-0.01 to -1.72 ‰) and δ^{18}O (-5.73 to -6.36 ‰) data documented de-dolomitization – a process of Mg leaching by fluids enriched to sulphates obviously. Analyses of grain documented rest of dolomite molecule in calcite which substituted rhombs probably in sub surface conditions. Other history of dolomitization occurred in cavity infillings of reef limestones. The phase analyses of the calcite and dolomite from infilling offer more negative isotope data in dolomite (δ^{13}C -0.88 to -0.11 ‰, δ^{18}O -4.12 to -7.94 ‰) and in the same time more positive δ^{18}O in reef limestone (-1.92 to -0.53 ‰). It could indicate the earlier dolomitization due to meteoric or saline water seepage into the reef. However the dolomite is unstable mineral and its geochemical history could be easily re-set by recrystallization. The dolomitization and de-dolomitization timing must be reviewed taking into mind global and local sea level changes, local hydrologic regime, weathering and climate as well as complicated tectonic history of the studied klippen limestone.

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F. MARKO[1], R. VOJTKO[1], J. MADARÁS[2], J. BETÁK[3], V. GAJDOŠ[4], K. ROZIMANT[4], A. MOJZEŠ[4] and F. PREUSSER[5]: **Structural, morphotectonic record and age determination of the Vikartovce fault activity (Western Carpathians)**

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The Vikartovce fault is one from the most pronounced faults in the Western Carpathians, being very evident in the geological architecture of an area. It creates E–W trending, perfectly linear northern boundary of the narrow Vikartovce Depression filled up by the Paleogene sediments of the Central Carpathian Paleogene Basin (CCPB). North of the fault, the basin is rimmed by the distinctive morphostructural elevation, created by volcanosedimentary successions of the Hronic unit. This horst called the Kozie chrbty is gently plunging to the east, where submerges under the CCPB sediments near Spišský Štvrtok village. Due to linearity of the Vikartovce fault map trace and its influence to geological structure we have no doubts about fault origin of this linear phenomenon. However, nontectonic explanation of the Vikartovce Depression as a narrow sea bay exists as well. Nevertheless we evaluated this fault as a very suspected event of neotectonic activity. The reasons were linearity, morphotectonic expressions and its evident relation to distribution of the Quaternary travertines at Spišské Podhradie. As the most important argument supporting neotectonic, even subrecent reactivation of the Vikartovce fault are published evidences of abrupt change of rivers traces due to fault activity. According to this, ancient rivers flowing to the north were amputated by the Vikartovce fault. It led to the change of the paleo-rivers network. Possible mechanism to do it was the block tilting, where E–W faults in the area operated as a boundary normal faults. To confirm, or exclude this model a complex methodology has been applied in the frame of the neotectonically oriented project. Structural research, morphotectonic analysis, geophysical research (VES, emanometry), Quaternary sediments dating by Optically Stimulated Luminescence method (OSL) and palinological analysis have been realized. Strong effort was focussed to localization and sampling of amputated and buried alluvial sediments preserved at recently dry saddle (Visová) crosscutting Kozie Chrbty horst, formed by ancient river flow. The age of these alluvial deposits dates the age of river interruption that means the age of the Vikartovce fault latest activity. Based upon geophysical profiles, three shallow boreholes with core recovery were situated and drilled. The third borehole penetrated brownish/yellowish sandy loam in the upper part of the profile (deluvium), deeper (at cca 13–17 m depth) occurred the sequence of grey sands intercalated by clays, and pebble clays. Samples for OSL dating were selected from this horizon, which is very probably of alluvial origin, representing remnants of fault-amputated river sediments. Poor sorting of this sediment points to short transport. Surprisingly, the bedrock was not reached by drilling, but in the lower part of the profile, up to 22 m depth, strongly weathered horizon of eluvium was observed.

The Vikartovce fault represents neotectonically active structure proved by many morphotectonic attributes. The latest – Quaternary activity is going to be confirmed by absolute dating of amputated alluvial sediments. Samples were successfully selected and currently are dated. The results of OSL dating shall be compared with the results of palinological analysis as well.

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J. MICHALÍK[1], D. REHÁKOVÁ[2], E. HALÁSOVÁ[2] and O. LINTNEROVÁ[3]: **West Carpathian stratotype of the Jurassic/Cretaceous boundary: the Brodno section (the Kysuca Unit, Pieniny Klippen Belt, Western Carpathians)**

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This contribution discusses the results of an integrated biostratigraphic study using three microplankton groups (calpionellids, calcareous dinoflagellates and nannofossils), as well as stable isotope data ($\delta^{18}O$, $\delta^{13}C$) in the Brodno section, which is proposed here as the candidate for a Western Carpathian regional J/K boundary stratotype. The distribution of the stratigraphically important planktonic organisms revealed several coeval calpionellid and nannofossil bioevents recorded in the pelagic carbonate sequence of the Jurassic/Cretaceous boundary age. The stable isotope data underline environmental changes during the studied interval. The biostratigraphical study based on the distribution of calpionellids allowed us to distinguish the Dobeni Subzone of the Chitinoidella Zone in the Brodno sequence for the first time. The J/K boundary interval can be characterized by several calpionellid events – the onset, diversification, and extinction of chitinoidellids (Middle Tithonian); the onset, burst of diversification, and extinction of crassicollarians (Upper Tithonian); and the onset of the monospecific *Calpionella alpina* association close to the J/K boundary. The J/K boundary in the Brodno section is traced between the Crassicollaria and Calpionella Zone. This limit is defined by the morphological change of *Calpionella alpina* tests. The base of Crassicollaria Zone is correlated with the reverse Kysuca Subzone, and the base of standard Calpionella Zone is located just below the reverse Brodno Subzone. Abundance peak of obliquipithonellid cysts in the Semiradiata Zone isochronous with flourishing *Conusphaera* spp. was used as the indicator of warmer surface waters.

For the first time, two nannozones: the Conusphaera mexicana mexicana- and the Microstaurus chiastius zones were distinguished in the Western Carpathians. Calcareous nannofossils from the lower half of the studied sequence are correlated with the Lower to Middle Tithonian Conusphaera mexicana mexicana Zone (NJ-20). This zone comprises the Polycostella beckmanii Subzone; the latter consisting of the Hexalithus noeliae- or NJK-A, NJK-b- and NJK-c subzones. Calcareous nannofossils show poorly diversified associations at the J/K boundary. The abundance of *Watznaueria* spp., *Cyclagelosphaera* spp., *Conusphaera* spp., and *Polycostella* spp. in the studied section is relatively high. Other nannofossils are rather rare. *Conusphaera* predominates in the Tithonian nannofossil assemblage (showing the Middle Tithonian peak). *Polycostella* increased in abundance during the Boneti Subzone of the Chitinoidella Zone. On the basis of the appearance of the *Polycostella beckmannii* nannoliths, the Lower/Middle Tithonian boundary was located in the Polycostella beckmannii Subzone. The Middle/Upper Tithonian boundary was determined by the FO of *Helenea chiastia* coccolith accompanied by the first small nannoconids. Small nannoconids appeared during Upper Tithonian and increased in abundance during Berriasian. *Polycostella* group diminished in abundance towards the onset of the Crassicollaria Zone. The Upper Tithonian interval was dated more precisely by the appearance of *Hexalithus noeliae* and *Litraphidites carniolensis* within the frame of the Microstaurus chiastius Zone. From the point of view of nannofossil stratigraphy, the Tithonian/Berriasian boundary interval should be limited considering the FO of *Nannoconus wintereri* together with small nannoconids at the base, and the FO of *Nannoconus steinmanni minor* to the top. Evolution of nannofossil, calpionellid and dinoflagellate genera coincided with assumed paleoceanographical changes across the J/K boundary interval.

Stable isotopes ($\delta^{18}O$, $\delta^{13}C$) analyses indicated relative cold period occasionally disturbed by warm episodes during uppermost Tithonian. This is documented also by low contents of organic carbon. Near the J/K boundary the oxygen isotope values indicated temperature and salinity changes probably influenced by an invasion of warm water (or stagnancy of cold water input) into the basin resulting in nannoconid bloom episodes. Upper Tithonian cooling was followed by temperature increase during very end of Tithonian and at the beginning of the Berriasian. According to the International Commission of Jurassic Stratigraphy, there is necessary to search for complete section, which can provide continuous record of both sedimentation and biotic events across stage boundaries. Although the Brodno section lacks ammonite record, it is presented here as a potential candidate considering its continuously well exposed and biostratigraphically properly documented succession, at least for the Western Carpathian region.

Acknowledgement. This is the contribution to the projects APVV--0465-06, APVT-51-011305, APVV-0280-07, APVV-0248-07 and to the IGCP UNESCO Project No. 506.

J. MICHALÍK[1], D. REHÁKOVÁ[2], E. HALÁSOVÁ[2] and O. LINTNEROVÁ[3]: **Possible Jurassic/Cretaceous** boundary regional stratotype for Western Carpathian area near Žilina, Slovakia**

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Continuous Jurassic-Cretaceous pelagic limestone sequence of the Kysuca Unit (Pieniny Klippen Belt) of the Brodno section offers the best possibility to document the J/K passage in a wide area of the Western Carpathians. Good calpionellid and nannofossil stratigraphic record completes the older paleomagnetic data. High-resolution quantitative analysis of calpionellids, dinoflagellates and calcareous nannofossil assemblages indicates major variations in their abundance and composition. Correlation of the calcareous microplankton distribution and stable isotope analyses was used in the characterization of the J/K boundary interval as well as in the reconstruction of the paleoceanographical proxies during this time.

The calpionellid study allowed us to distinguish the Dobeni Subzone of the Chitinoidella Zone in the Brodno sequence. The J/K boundary interval can be characterized by several calpionellid events – the onset, diversification, and extinction of chitinoidellids (Middle Tithonian); the onset, burst of diversification, and extinction of crassicollarians (Upper Tithonian); and the onset of the monospecific *Calpionella alpina* association just on the J/K boundary. The J/K boundary in the Brodno section is situated between the Crassicollaria and Calpionella Zone (C24A-C24B). It is defined by morphological change of *Calpionella alpina* tests. The base of Crassicollaria Zone is coinciding with the reverse Kysuca Subzone (in L99), and the base of standard Calpionella Zone is located just below the reverse Brodno Subzone (in C24B). Abundance peak of obliquipithonellid cysts in the Semiradiata Zone (L69-L74) isochronous with flourishing *Conusphaera* spp. was used as the indicator of warmer surface waters.

For the first time, two nannozones: the Conusphaera mexicana mexicana- and the Microstaurus chiastius zones were distinguished in the Western Carpathians. Calcareous nannofossils from lower half of the studied sequence (L52 to L96) are correlated with the Lower to Middle Tithonian Conusphaera mexicana mexicana Zone (NJ-20). This zone comprises the Polycostella beckmanii Subzone; the latter one consists of the Hexalithus noeliae- or NJK-A, NJK-b- and NJK-c subzones. Calcareous nannofossils formed poorly diversified associations at the J/K boundary. The abundance of *Watznaueria* spp., *Cyclagelosphaera* spp., *Conusphaera* spp., and *Polycostella* spp. in the studied section is relatively high. Other nannofossils are rather rare. *Conusphaera* predominates in the Tithonian nannofossil assemblage (showing the Middle Tithonian peak). *Polycostella* increased in abundance during the Boneti Subzone of the Chitinoidella Zone. On the basis of the appearance of the *Polycostella beckmannii* nannoliths, the Lower and Middle Tithonian boundary was located in the Polycostella beckmannii Subzone. The Middle and Upper Tithonian boundary was determined by the FO of *Helenea chiastia* coccolith accompanied by the first small nannoconids. Small nannoconids appeared during Upper Tithonian and increased in abundance during Berriasian. *Polycostella* group diminished in abundance towards the onset of the Crassicollaria Zone. The Upper Tithonian interval was dated more precisely by the appearance of *Hexalithus noeliae* and *Litraphidites carniolensis* within the frame of the Microstaurus chiastius Zone. From the point of view of nannofossil stratigraphy, the Tithonian/Berriasian boundary interval should be limited by the FO of *Nannoconus wintereri* together with small nannoconids up to the FO of *Nannoconus steinmanni minor*. Evolution of nannofossil, calpionellid and dinoflagellate genera coincided with assumed paleoceanographical changes across the J/K boundary interval.

Sequence stratigraphy and stable isotope ($\delta^{18}O$, $\delta^{13}C$) data gave good results, too, enabling the sequence comparison with important key sections in the Mediterranean Tethys area. Stable isotopes ($\delta^{18}O$, $\delta^{13}C$) analyses indicated relative cold conditions disturbed by several warmer episodes. This is documented also by low content of organic carbon. Near J/K boundary the oxygen isotope values indicated temperature and salinity changes probably influenced by an invasion of warm water (or stagnancy of cold water input) into the basin resulting in nannoconid bloom episodes. Upper Tithonian cooling was followed by temperature increase during very end of Tithonian and at the beginning of the Berriasian.

V. MIKUŠ[1], R. PAŠTÉKA[1], M. BIELIK[1], M. ŠUJAN[2] and H. ZEYEN[3]: **The detail profile gravity measurements in the scope of the Pieniny Klippen Belt (locality Jarabina)**

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The Pieniny Klippen Belt (PKB) is geologically the most contrasting zone of the Western Carpathians. Being only a few km wide, it extends in a broad arc for several hundreds kilometres from the Alpine-Carpathian junction as far as northern Romania. PKB also provides a link between the Tertiary accretionary wedge of the external zone and Cretaceous nappe system of the Central Western Carpathians. Regardless of its considerable length and very complex internal structure, the PKB retains to some extent its tectonic integrity, indicated especially by the omnipresence of its typical Oravic units that do not occur in other Carpathian zones. The surface structure of the PKB shows the "klippen tectonic style", where mostly tectonically separated klippen (rigid Jurassic–Lower Cretaceous limestone blocks) are embedded in the "klippen mantle" formed by incompetent Lower Jurassic and Upper Cretaceous to Paleogene marlstone and flysch formations.

The area, researched in this work, is situated in the Pieniny section of the Klippen Belt, in the eastern Slovakia, near the village Jarabina. The aim of survey was to clarify the tectonic structure of the subsurface parts through interpretation of the detail gravity measurements. As the basis served the high accurate sectional measurements of the gravity acceleration and its processing into attributes of Bouguer anomalies. The input of geological knowledge, lithological mapping and attributes of density from the rocks was important. Modelling and interpretation was done by the software GM-SYS. The output is displayed like geological–geophysical profile and shows the lithological members and their density parameters. Interesting is also the comparison with the results of the geoelectrical and seismic methods used in the same locality.

The output of the software GM-SYS is the geometric profile with anomaly bodies and their density parameters. Clearly visible is the influence of surrounding geological units on the south and north. They represent large sedimentary basins, filled by masses of light rocks. The rocks included in the PKB have higher density and the graph of the Bouguer anomalies creates an elevation above it. Then the lateral limitation of PKB was relatively clear. The anomalies within the frame of PKB were not so sharp, what results from small differences between the density values of lithological members. Another problem was formed by the lack of information about the klippen mantle (the filling material between klippen), which were visible only in few outcrops and consequently tweaked in the modelling process. That was the reason for two variants of interpretation models. The small variances on graph curve are caused by frequent changes of lithology and were modeled by little klippen bodies. Most of them were observed by the geological mapping on surface, but some klippen in the depth were required during the model creation. The problem of continuation of the klippen bodies from the surface to the depth and their geometrical limitation was defined in the software GM-SYS. The computed graph line responded considerably to the klippen structures continuing to the depth, the bodies by the surface had only weak effect on it. In both variants the division into two domains with a certain difference in densities of klippen mantle was expressed evidently. To make the interpreted model more accurate it is necessary to extend the area of geological mapping, clarify the tectonic evolution and relationships between geological members in studied locality.

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N. OSZCZYPKO and E. MALATA: **Some new arguments in the discussion about the age of the "black flysch" deposits in the Grajcarek thrust--sheets (Magura nappe, Poland)**

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In Poland there have been the long lasting discussion and controversy related the age of the "black flysch" deposits in the contact zone of the Magura nappe and the Pieniny Klippen Belt (Grajcarek thrust-sheets). This discussion has been renewed after the publication by Oszczypko et al. (2004) which proved by new data the Albian–Cenomanian age of the "black flysch" (Szlachtowa and Opaleniec fms.), and Cenomanian to Campanian age of the overlying variegated deposits of the Malinowa Fm. These ideas were rejected by Birkenmajer and Gedl (2004) and Birkenmajer et al. (2008), who repeated the previous biostratigraphical arguments for the Jurassic age of the Szlachtowa and Opaleniec fms., and suggested contamination provenance of the Cretaceous foraminifera in these beds.

For the last few years we have studied and sampled several sections in the Grajcarek thrust-sheets which record the relation between the "black flysch" and red shales of the Malinowa Fm. In all studied sections "the black flysch" appears in the core of imbricated folds or thrust-sheets, whereas the limbs are composed of the Malinowa and Jarmuta fms. In the Sztolnia sections the transitional beds (Cenomanian correlation horizon) between the "black flysch" and the Malinowa Fm. are developed as green and black, bituminous shales with manganese oxide coatings, green radiolarites with pirite framboids, cherty limestones, and finally very thin layers of dark non-calcareous shales. In this cherty limestone the Albian-Cenomanian calcareous nannoplankton was found (see: Oszczypko et al., 2004). The cherty limestones and green radiolarites were noticed in several sections in the same position. In the previous papers they were regarded as the tectonic blocks of the Pieniny Limestone Fm. (Tithonian-Barremian).

Our new biostratigraphical investigations have revealed similar sequence of microfauna assemblages in all studied sections. In the calcareous shales of the Szlachtowa Fm. there are some representatives of the superfamily *Nodosariacea* and rare Cretaceous agglutinated taxa. In the spotty marls of the Opaleniec Fm. there are radiolarian moulds accompanied by rare nodosarids. The green shales with manganese coating contain abundant radiolaria in various state of preservation and finely, the Malinowa Fm. yields the characteristic assemblages with *Tritaxia gaultina* and *Uvigerinammina jankoi*.

In the studied sections we have observed two types of transition from the black flysch to Upper Cretaceous variegated deposits. In the southern sections there is gradual transition from the calcareous sediments of the Szlachtowa Fm. through the spotty marls of the Opaleniec Fm. to red marls followed by red shales. In the northern sections the spotty marls are replaced by the cherty limestones and radiolarites passing into green radiolarian shales and red shales.

Such a sequence of deposits is typical for the Outer Carpathian basins and records the global Middle Cretaceous phenomena in the world ocean and development of Cretaceous oceanic red beds (CORB).

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N. OSZCZYPKO[1] and E. JUREWICZ[2]: **The position of the so-called autochtonous Magura Paleogene in the Małe Pieniny Mts. (Magura nappe and Pieniny Klippen Belt, Poland)**

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The Pieniny Klippen Belt (PKB) represents the suture zone separating the Central Carpathians from the Outer Carpathians. In Poland the PKB runs a length of ca 60 km, and has a maximum width of up to 5–6 km, reaching its highest point between the villages of Czorsztyn and Krościenko. The PKB is composed of Jurassic and Cretaceous strata, separated from the north and south by flysch deposits of the Magura nappe and the Central Carpathian Paleogene Basin. Both boundaries are tectonic and represented by Neogene sub-vertical faults. According to Birkenmajer (1977 and bibliography therein) the PKB sedimentary sequences in Poland can be divided into five successions (Pieniny, Branisko, Niedzica, Czertezik and Czorsztyn), which during the orogenic movements transformed into more or less individual tectonic units. An alternative viewpoint was proposed by Książkiewicz (1977), who distinguished two nappes: the lower – Czorsztyn nappe (Czorsztyn, Czertezik and Niedzica successions) and the upper – Pieniny nappe (Branisko and Pieniny successions), folded together. In 1986 Birkenmajer proposed a multi-stage tectonic model of the evolution of the PKB. According to this model the Laramian accretionary wedge (Grajcarek Unit) at the front of the Pieniny fold-arc was formed from the Jurassic--Maastrichtian succession of the southern part of the Magura Basin. During the Paleocene the Grajcarek Unit was back thrust over the PKB tectonic units and then subsided and filled with Magura autochtonous Paleocene – Eocene flysch. These deposits are well preserved inside the PKB in the Małe Pieniny Mts. and located east of the Dunajec river. The concept of back thrusting of the Grajcarek Unit over PKB was questioned by Golonka and Rączkowski (1984) as well as Jurewicz (1997, 2006). According to these opinions the Grajcarek Unit inside the PKB, appears in the tectonic windows. In the Małe Pieniny Mts. at the front of the PKB there is a wide zone of strongly folded Magura nappe deposits, flatly overthrust by the Czorsztyn-Niedzica nappe. Inside the PKB, between the Czorsztyn-Niedzica and Branisko-Pieniny nappes, appears a wide zone (up to 1 km) known as the "autochthonous Magura Paleogene". Its development reveals lithological features which are common to the Jarmuta-Proč and Magura formations. According to our preliminary data, the age of these deposits is not older than Middle Eocene. Recently we have also studied the structural relationship of the "autochthonous Magura Paleogene" to the Czorsztyn-Niedzica and Branisko-Pieniny nappes. In all studied sections between the Polish/Slovakian state border in the east and the Krupianka stream in the west, the folded thick-bedded Magura type sandstones with intercalations of Jarmuta-Proč conglomerates emerge under the Czorsztyn-Niedzica and the Branisko-Pieniny nappes. In the contact zone between the PKB nappes and these deposits there are small fragments of Cretaceous "black flysch" and red shales typical for the Grajcarek thrust sheets edged at the front of PKB. According to our observations the "autochtonous Magura Paleogene" in the Małe Pieniny Mts. occurs in the tectonic windows, beneath the PKB nappes. We can also state that the contact zone between PKB and Magura nappe in the Małe Pieniny Mts. is different to other parts of PKB, and a high angle frontal fault is replaced by the flat thrust. Its origin may be explained by the probably Eocene gravitational sliding. During the Miocene compression, connected with nappe and thrust processes within the Outer Carpathians, the southernmost part of the Magura nappe was refolded together with olistoliths and partly thrust southward along the high-angle dipping faults. Taking into account this opinion, the boundary between PKB structure and Magura nappe (with megaolistoliths of klippen units) should be located south of the tectonic windows, along the northern slopes of Wysoka Mt. and Watrisko Mt.

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N. OSZCZYPKO and P. WÓJCIK-TABOL: **Comparison of the ?Cretaceous "black shales" and CORB in the Grajcarek thrust-sheets basing on geochemical features (Magura nappe, Poland)**

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In Poland there are still controversy on the age of the "black flysch" deposits: Aalenian-Bajocian (see Birkenmajer, 1977; Birkenmajer et al., 2008) or Albian-Cenomanian (see Sikora, 1960; Książkiewicz, 1977; Oszczypko et al., 2004 and bibliography therein). These deposits occur in the contact zone of the Magura nappe and the Pieniny Klippen Belt (Grajcarek thrust-sheets). Recently in the Sztolnia and Krupianka creeks the following formations have been sampled: Szlachtowa and Opaleniec fms., green radiolarian shales with pyrite framboids (Cenomanian) and red shales of the Malinowa Formation (Cenomanian-Turonian). The aim of our studies was to establish geochemical relationship between these deposits. We report measured concentration values of major oxide and trace elements in studied samples by an inductively coupled plasma mass spectrometer (ICP--MS). The results show variation in major and trace elements with respect to the post-Archean Australian Shale (PAAS) – typical terrigenous deposit supplied from upper continental crust. The most samples show major oxide contents (Al_2O_3, K_2O, TiO_2, P_2O_5) comparable to these of PAAS. However, the samples are enriched of CaO. The samples of Szlachtowa and Opaleniec fms. are characterized as mixtures of terrigenous--detrital matter with varying amount of calcium carbonate. The negative correlation between Al_2O_3 and SiO_2 may be explained by the predominance of biogenic silica, diluted by terrigenous particles. The high content of silica may indicate relative increase in productivity. In this case, silica content correlates with biophile elements absorbed by planktonic organisms in surface water. A good correlation between SiO_2, Al_2O_3, K_2O and TiO_2, and correlation with the minor elements Zr, Rb and Nb in the sections depend on the detrital provenance of the Opaleniec and Szlachtowa fms. The constant, low ratio of Ti/Al indicates the negligible eolian input thus the fluvial input was dominating during deposition of studied deposits. The Al-normalized concentrations of redox-sensitive elements are relatively low. Their distribution depends on organic matter content irregularly; it correlates rather with increasing values of S within the Opaleniec Fm. and radiolarians shales, and presence of H_2S in pore water during deposition and/or during diagenesis of the Opaleniec Fm. and Cenomanian green shales. The black shale samples (Szlachtowa Fm.) are poorer in trace-elements (Mo, V, Ni, Zn, Pb, Cd, Ag, Se). The concentration mechanism might have been limited by reduced amount of terrestrial organic matter or efficient scavenging of dissolved sulphide by Fe. Good correlation of Se/Al with Mo/Al and S/Al likewise shows the fixation of Se in sediments under reducing conditions as metal-selenides. The high values of V/V + Ni ratio along studied section suggest an anoxic condition during deposition that corresponds with relatively low ratio of Mn/Al. The bulk of samples contain negligible amounts of terrigenous, fluvial-derivation material. The deposition took place under oxygen deficiency condition. Organic carbon-rich sediments were formed due to abundant organic supply. The trace-element distribution characterizes the hemipelagic regime of deposition of the Opaleniec Fm. and Cenomanian radiolarian shales that developed during increasing sea-level. Enrichment in redox-sensitive elements match was probably due to scavenging by H_2S-rich pore fluids. It suggests that spotty shales of the Opaleniec Fm. and the Cenomanian radiolarian shales were formed under very similar sedimentary conditions.

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I. PEŠKOVÁ and J. HÓK: **The double-vergent structures of the western part of the Pieniny Klippen Belt**

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The Pieniny Klippen Belt (PKB) belongs among the most complicated structures in the Western Carpathians. The PKB represents the contact zone between the Outer Western Carpathians (OWC) and the Central Western Carpathians (CWC). According to occurrences of the different lithostratigraphic units and the different inner structures is the PKB divided into specific segments. The fan-like tectonic architecture is conspicuous feature of the western part of the PKB. The rock sequences of the OWC as well as the CWC are integrated in the double-vergent structures. The different tectonic arrangement of this structure has been observed. The rocks sequences of the PKB and adjacent portion of the OWC are thrust to the south. The elements of the CWC are strogly affected by the south vergent tectonics. The axis of the opposite – north vergent displacement is situated in the OWC tectonic unit in the northernmost part of investigated area. The latter situation is in the southwest. The rocks sequences of the PKB and the OWC are thrust to the north–northwest while the CWC units are thrust to the south–southeast. The axis of the double-vergent structure is situated in the CWC units. The different tectonic architecture of the fan-like structures depends on the ratios of the vertical and lateral escape during the collision. The ratio of the vertical and lateral escape is determined by angle of the rigid indentor inclination.

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D. PIVKO and N. HUDÁČKOVÁ: **Sarmatian biomicritic limestone with ooids from unknown locality used in building of Medieval St. Emmeram Church of Nitra**

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The most of stone building blocks on faces of Romanic St. Emmeram Church of Nitra is cut from Sarmatian limestone. The blocks in secondary position probably come from the first stone church in our territory of the 9th century that was built by Pribina prince (Pivko, 2007).

The stone blocks are from whitish porous biomicritic limestone. It is the most often homogenous, medium-grained (to coarse-grained) limestone with grains about 0.3–0.5 mm, rarely it is evidently oomicritic, sometimes fine-grained biomicrite. Micrites are locally washed. Many shells are dissolved. Locally there are large fossils diffused in finer matrix or as very coarse layer with gastropods and bivalve molds, worm tubes and algaes. In one stone block the lumachelle with probably carbonate clasts up to 4 cm also bored are present.

In thin section the limestones are strongly porous micrites (packstones to wackestones) with forams (miliolids, elphidias, nubecularians), ostracods, less coralline algae and worm tubes. Ooids are mostly imperfectly developed and irregular with small amount of laminas. Some of them are probably microoncoids. The cavities (e.g. after molluscs) are covered by tiny calcite crystals. Clastic addition (quartz) is rare. Larger amount of lithoclasts is of coarse type with monocrystalline and polycrystalline quartz from metamorphic (igneous) rocks and dolomite(?). Limestone was formed in normal or hypersaline environment (Piller and Harzhauser, 2005) in calm under surf zone.

Foraminifers found in thin section and in the wash residuas also show terminal Lower Sarmatian up to Middle Sarmatian age. Lower Sarmatian index foraminifers as *Elphidium reginum* (Orb.) are missing. Lower to Middle Sarmatian genera are present: *Articulina sarmatica* (Karrer), *Articulina problema* Bogdanowicz, *Varidentella reussii* (Bogdanowicz), *Elphidium* div. sp. The most common species is *Pseudotriloculina consobrina* (Orb.). According to previous works (Zapletalová and Brzobohatý, 1964–1972) mentioned association is ranked to informal "zone of small miliolids". In contrary to Piller and Harzhauser (2005), similar association of foraminifers was assumed as mesohaline and polyhaline waters organic-carbon-rich substrate dwellers (e.g. Lidz and Rose, 1989; Eichler et al., 2007).

Similar limestones were found in boreholes or small outcrops in the Kozmálovce Hills. The more distant localities of related limestone are situated in Hainburg Hills (Wolfsthal), Leitha Hills (Breitenbrunn), Malé Karpaty Mts. (Bratislava, Rohožník, Prievaly), Biele Karpaty Mts. (Holíč) and vicinity of Budapest (Mišík, 1997; Schafarzik, 1904).

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D. PLAŠIENKA: **Structure of the Pieniny Klippen Belt in eastern Slovakia and the role of synorogenic tectonosedimentary breccias**

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Thrusting-related, mass-flow sediments carrying coarse-grained, terrigenous material from offshore or slope environments to frontal basins may provide important constraints to the age determination and to the character of shortening structures developed in the source areas. The Western Carpathians and the Pieniny Klippen Belt in particular offer numerous examples of synorogenic sedimentation. However, in many cases their exact age and position in tectonic evolution remain poorly understood, in spite of a long--termed research and lots of data (e.g. the Cretaceous "exotic" conglomerates in the Klape and Kysuca units). We present some new data about such sediments occurring in the Pieniny sector of the Klippen Belt in eastern Slovakia, which are known as the Gregorianka Breccia (Nemčok et al., 1989). Their role as a paleotectonic indicator has been probably overestimated by the same author (Nemčok, 1980), but overlooked by others.

Though the Gregorianka breccias are seldom well outcropped, their structural and stratigraphic position seems to indicate in a good way the age and emplacement mechanisms of related thrust structures. At the classic locality Gregorianka near the Jarabina village, breccias of probably latest Cretaceous to earliest Paleogene age terminate the stratigraphic succession of the underlying Czorsztyn unit and are directly overlain by a sheet-like thrust body of Jurassic to Cretaceous rocks of the Pieniny nappe. Here the breccias are exclusively composed of clastic material derived from the overriding thrust sheet (predominantly limestones and cherts of the Pieniny Fm.).

In a somewhat more external position in the Klippen Belt (Litmanová, Hajtovka, Kyjov, Kamenica, Miľpoš), the tectonosedimentary breccias are of most probably Paleocene to Lower Eocene age and are inserted within the more-or-less continuous Cretaceous–Paleogene stratigraphic succession dominated by deep-marine clastic sediments (flysch to "wildflysch" of the Jarmuta and Proč fms.). These breccias only contain material from the Czorsztyn and/or Niedzica units (Skrzypne shales, Smolegowa, Krupianka and Dursztyn limestones, Czajakowa radiolarites). Breccias were deposited by debris falls or flows to high-density turbidity currents and contain numerous, variously-sized slide blocks (olistoliths) of the same rocks. It seems that in this area numerous Czorsztyn or Niedzica "klippens" represent in fact olistoliths. We therefore favour the model of Jurewicz (1997) and consider the Gregorianka or Jarmuta breccias in this position to be olistostromes deposited in front and in response of thrusting or gravity sliding of Czorsztyn-type units approaching the marginal parts of the Magura Basin. Their exact stratigraphic age determination (the work in progress) could then narrowly constrain the time of thrusting events in the Klippen Belt.

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M. PUTIŠ[1], W. FRANK[2], P. SIMAN[2], M. SULÁK[1] and A. BIROŇ[2]: **^{40}Ar/^{39}Ar ages of the K-white mica across the central Western Carpathians Cretaceous–Eocene orogenic wedge**

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The central Western Carpathians are subdivided into the Infratatric, Tatric, North-Veporic, South-Veporic and Gemeric tectonic units by distinct shear zones. The K-white mica (K--Wmca) of lower- to medium temperature/medium-(less lower) pressure blastomylonitic rocks was separated from different microstructural and grain-size domains to distinguish the age of D-stages represented by the different Wmca generations. The samples, containing more or less one Wmca generation of a D-stage were preferably dated by the ^{40}Ar/^{39}Ar method.

The Infratatric unit in the Považský Inovec Mts. (Putiš et al., 2006, 2008) shows the following Ar/Ar plateau ages in basement micaschist-gneisses: 138.0 ± 3.1 (5–10 μm Wmca fraction, the Inovec nappe), and/or anchimetamorphosed cover rocks: 101.2 ± 2.9 Ma, 83.4 ± 2.2 Ma (5–10 μm fraction, Permian sandy shale, the Inovec nappe); 114.0 ± 2.4 Ma and 106.2 ± 3.7 Ma (5–10 μm fraction, Lower Cretaceous shale, the Belice nappe).

The ages of 107.7 ± 1.3 Ma (2–3 mm fraction) and/or 48.3 ± 2.2 Ma (5–10 μm fraction) were found from the ultra-blastomylonitized granites at the base of the Tatric Panská Javorina nappe within the Hrádok-Zlatníky shear zone. The blastomylonitized granite at the base of the Tatric Bratislava--Modra nappe within the Prepadlé shear zone in the Malé Karpaty Mts. was dated to 79.7 ± 3.3 Ma (5–10 μm fraction). The blastomylonitized gneiss at the base of the Tatric nappe in the Malá Fatra Mts. was dated to 74.2 ± 2.7 Ma (5–10 μm fraction).

The North-Veporic unit blastomylonites (phyllonites) in the Nízke Tatry and Vepor Mts. show these plateau ages: 124.2 ± 3.6 Ma (0.2–0.3 mm fraction), 93.2 ± 1.5 Ma, 91.9 ± 2.3 Ma (5–10 μm fraction), however 84.6 ± 1.7 Ma, 84.3 ± 3.0 Ma close to Pohorelá sinistral thrust-fault. The youngest ages of 80 ± 1.0 Ma and 78.4 ± 2.7 Ma were found from the Razdiel part of the Tribeč Mts. or the frontal part of the North-Veporic unit. Remnants of a coarse-grained Wmca in the Infratatric, Tatric and North-Veporic units range in 313–295 Ma, rarely around 260 or 230 Ma.

The South-Veporic rocks in the hanging wall of the Pohorelá thrust-fault were dated to 87.7 ± 0.2 Ma (Permian metarhyolite); 85.0 ± 1.7 and 86.7 ± 1.5 (Lower Triassic metaquartzite). The South-Veporic rocks from the footwall of the Gemeric nappe were dated to 99.3 ± 3.5 Ma (Permian metaarkose), 90.1 ± 0.9 Ma (0.2–0.3 mm fraction) and/or 86.1 ± 3.7 Ma (5–10 μm fraction; Lower Triassic metaquartzite).

The hanging wall Upper Carboniferous dark shales of the Gemeric nappe in the Lubeník sinistral thrust fault were dated to 83.7 ± 2.0 Ma.

The ages indicate formation of a collision wedge in time interval of ca. 140–90 Ma in the Veporic unit, due to a NW-vergent nappe thrusting and synmetamorphic thickening of a collision wedge. Similar ages from the Veporic unit, published by Dallmeyer et al. (1993, 1996), Kráľ et al. (1996), Kováčik et al. (1997) or Plašienka et al. (1999) are interpretable as formation of footwall-propagation thrust-faults in a collisional orogenic belt. The ENE–WSW trending sinistral transpression, combined with a top-to-ESE extension collapse (Putiš, 1991, 1994) occurred at 90–84 Ma. New data indicate that collision in the frontal part of the North-Veporic unit as well as the Tatric and Infratatric units continued to about 75 Ma. Lateral extrusion of the Tatric unit toward NE occurred in Lower Eocene, at ca. 48 Ma – a reactivation age of the Hrádok-Zlatníky thrust-fault (107.7 ± 1.3 Ma), following the formation of a frontal Infratatric wedge.

D. REHÁKOVÁ[1], E. HALÁSOVÁ[1] and A. LUKENEDER[2]:

The J/K boundary strata at the Nutzhof section (Gresten Klippen Belt, Lower Austria): Integrated stratigraphy

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The authors discuss the results of an integrated study of three microplankton groups (calpionellids, calcareous dinoflagellates and nannofossils) and macrofauna (ammonites, belemnites and aptychi) in the Nutzhof section. The stratigraphic investigation of the microfauna revealed that Nutzhof comprises a sedimentary sequence of Early Tithonian to Middle Berriasian age. Based on the distribution of the stratigraphically important planktonic organisms, several coeval calpionellid, dinocyst and nannofossil bioevents were recorded along the Jurassic-Cretaceous boundary beds. The Nutzhof section is situated in the Gresten Klippen Belt at Nutzhof (Lower Austria) located in the southern Flysch Zone. It yields a record of pelagic marine sedimentation built of well bedded, light yellowish-brown marly limestone with the thin interbeds of marlstone and marls. The presented data show that the succession of studied pelagic limestone offers the possibility to clearly document the J/K boundary interval in the Austrian Klippenbelt based solely on the good calpionellid, dinoflagellate and nannofossil stratigraphic record.

The biostratigraphic study based on the distribution of calpionellids (Reháková et al., in print) allowed us to distinguish the *Boneti* Subzone of the *Chitinoidella* Zone in the Nutzhof section. The J/K boundary in this section is situated between the *Crassicollaria* and *Calpionella* Zone. This base is defined by the morphological change of *Calpionella alpina* tests. The base of the *Crassicollaria* Zone approximately coincides with the onset of *Tintinnopsella remanei* Borza and the base of the standard *Calpionella* Zone, with the monospecific calpionellid association being dominated by *Calpionella alpina* Lorenz. Two further Subzones (*Ferasini* and *Elliptica*) of the standard *Calpionella* Zone were recognized in radiolarian-calpionellid and calpionellid-radiolarian wackestones in the overlying topmost part of the investigated sequence.

Calcareous nannofossils from the Nutzhof section (Reháková et al., in print) belong to poorly diversified, because of the lithology. Nevertheless, the appearance of several important genera was determined, allowing the studied deposits to be attributed to the Lower, Middle and Upper Tithonian, the approximation of the Tithonian-Berriasian boundary, and the definition of the Lower Berriasian nannofossil zones. The results show the major role of the coccoliths of the family Watznaueriaceae and nannoliths of the genera *Conusphaera*, *Nannoconus* and *Polycostella* in the assemblage composition. The interval between the FAD of *Nannoconus wintereri* co-occurring with small nannoconids (the uppermost Tithonian) and the FAD of *Nannoconus kamptneri minor* (lowermost Berriasian; 143.92 Ma after Hardenbol et al., 1998) is interpreted as the Tithonian-Berriasian boundary interval. The nannoconid dominance (*"Nannoconus world"*, Tremolada et al., 2006) starts, also in Nutzhof profile, in the lowermost Berriasian.

The macrofauna is represented especially by ammonoids, belemnoids, aptychi and bivalves (Lukeneder, in print). The whole section yielded about 46 ammonites. The sparse and selective occurrence of the ammonites within the Nutzhof log and the lithological character of the formation made sampling difficult. The stratigraphic investigation of the cephalopods, microfauna and nannofauna revealed that the Nutzhof section comprises Tithonian to Berriasian sediments. The cephalopod fauna consists solely of Mediterranean elements. The ammonite fauna comprises 6 different genera, dominated by the perisphinctid-type. Ammonitina are the most frequent component (60 %; *Subplanites* and *Haploceras*), followed by the Phylloceratina (25 %; *Ptychophylloceras* and *Phylloceras*), and the Lytoceratina (15 %; represented by *Lytoceras* and *Leptotetragonites*). The described descendants of *Subplanites* display the first evidence of these ammonoids within the Gresten Klippen Belt. The cephalopod fauna from the Nutzhof section correlated with micro- and nannofossil data from the marl-limestone succession, indicating Early Tithonian to Middle Berriasian age (*Hybonoticeras hybonotum* Zone up to the *Subthurmannia occitanica* Zone). According to the correlation of the fossil (Reháková et al., in print; Lukeneder in print) and magnetostratigraphic data (Pruner et al., in print), the entire log of the Nutzhof section embraces a duration of approx. 7 million years (approx. 150–143 Ma).

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P. RUCIŃSKI and M. CIESZKOWSKI: **Geology of the Piotrus Mt. massif in the Dukla nappe, Outer Carpathians, Poland**

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Geology of the Dukla nappe between Zawadka Rymanowska and Tylawa (Polish sector of the Outer Carpathians, south from Dukla) has been investigated by detail mapping as well as tectonic, stratigraphic and sedimentological methods. Field mapping and teledetection methods were taken in order to construct detail geological map (1 : 10 000). Investigated area joins from the east to the Jaśliska Sheet of the Detail Geological Map of Poland 1 : 50 000 (Cieszkowski et al., 1990; Ślączka et al., 1991).

The Outer Carpathians belt consists of several nappes, which were sheared off from its basement and rested in front of the Pieniny Klippen Belt (Książkiewicz, 1977). The nappes were mutually overthrust and also completely thrust over Miocene molasse deposits of the Carpathian Foredeep. The sequence of nappes from the innermost zone (contact with the Pieniny Klippen Belt) is the following: the Magura nappe, the Fore-Magura group of nappes (Fore-Magura Zone), the Silesian nappe, the Subsilesian nappe and the Skole nappe – outermost one.

The most interesting and most important part of the Fore--Magura group of nappes is the Dukla nappe (Ślączka, 1971). This unit crops out on surface in a belt extending from Nowy Żmigród, through north-eastern Slovakia to Bilyj Czeremosz river in Ukraine. During formation of imbrication structure of the Carpathians the Dukla nappe was partially differentiated. Now it can be divided into smaller tectonic subunits. The largest parts of the Polish Dukla nappe are southern (inner) and northern (outer) tectonic subunits (Ślączka, 1971; Ślączka et al., 1991). These units consist of several folds and thrust-sheets which are separated by thrusts and also normal, strike-slip and transverse faults.

The Piotrus Mt. (728 m a. s. l.) is the highest and one of the most sceneric mounts of the Beskid Dukielski Range, which is an eastern part of the Beskid Niski Mountains (Klimaszewski, 1978). It is a crescent shaped massif, covered by wood, with highly distinctive morphology, extending meridian-like from north (Zawadka Rymanowska) to the south (Tylawa surroundings). The mount is limited by the valley of the Biały creek and passes northwards into Wołowy Mt. (521 m a. s. l.). From the south Piotrus is cut by sceneric gorge of the Jasiołka river valley and passes southwards into Ostra Mt. (692 m a. s. l.). The Piotrus Mt. and its surrounding valleys emphasize mutual relationship between geology and river system. On the hill-sides of Piotrus the radial river system is observable (Zuchiewicz, 1987). Double questa on the eastern hill-side of the Piotrus is a result of unequal erosion rate, lower is shaped on the Przybyszów Sandstones and upper one on the Mszanka Sandstones. Remarkable rock walls and crests on top of the Piotrus Mt. are formed by thick-bedded sandstones and conglomerates of the Mszanka Sandstones. Three small caverns ("Studnia", "Jaskinia Wodna" and "Szczelina") have been discovered over last ten years on eastern (Mszanka Sandstones) and western slopes (Cergowa Sandstones) of the Piotrus Mt. There are two holy wells springs on its western slopes: "Murowana Studnia" and "Święta Studnia".

Geological location and development of the Dukla nappe in the Piotrus surroundings is very interesting and complex. Investigated area is situated in the western most part of the southern (internal) subunit of the Dukla nappe. The sedimentary succession of the Dukla Series is represented here by the Upper Cretaceous–Paleogene flysch deposits. The Łupków and the Cisna Beds, Upper Cretaceous–Paleocene in age, typical for this unit, do not occur in Piotrus Fold, but are replaced by the Inoceramian Beds (Ropianka Fm.). Eocene is represented here by thin-bedded shale--sandstone flysch of the Hieroglyphic Beds with the thick--bedded Przybyszów Sandstones and horizons of variegated shales, by the Green Shales and Globigerina Marls. Oligocene Menilite Beds consists of several lithostratigraphic divisions with distinguished members: the Mszanka Sandstones, the Jawornik Marls, the Cergowa Sandstones or Cergowa Shales with Tylawa Limestones horizons, Menilite cherts and brown bituminous shales. Up the section the Menilite Beds passes to the Krosno Beds.

The Piotrus Mt. is generally structured by Oligocene flysch deposits of the Piotrus fold, which belongs to the inner subunit of the Dukla nappe. Main axis of the Piotrus fold is oriented NNW–SSE, even occasionally N–S in the northern and central part, but on the south (Ostra Mt. area) it forms characteristic synclinal bend. With reference to the main Outer Carpathian fold structure orientation (E–W or WSW–ENE on the west, and NNW–SSE or NW–SE on the east) investigated part of the Dukla nappe forms some kind of sigmoidal curve structure. The Piotrus fold forms irregular syncline. Its western flank is almost entirely reduced and forming the Oligocene deposits contact tectonically to the Eocene Hieroglyphic Beds of the Tylawa Fold. Eastern flank is represented here by older deposits of the Inoceramian and Hieroglyphic beds forming several secondary sheets overthrusted each other and also thrusted westwards over outer subunit. Along Jasiołka river valley extends large parallel-like dislocation with highly distinctive tectonized zone called Jasiołka fault (cf. Cieszkowski et al., 1990; Ślączka, 1970; Ślączka et al., 1991). This dislocation deforms and rotates westwards the southern part of the Piotrus fold. In Tylawa region it passes into a thrust zone separating this unit from Tylawa fold. On the south the Piotrus fold is separated from Czerenin–Kanasiówka–Tokarnia fold by a large dislocation of the Zyndranowa Fault that extends NE–SW.

Northwards the Piotrus fold passes into the Kamionka fold. This structure is developed as a reversed half-syncline and separated from outer subunit by thrust zone on the north. The Kamionka fold sequence is similar to the Piotrus fold sequence being represented by the following divisions: the Eocene Hieroglyphic Beds, Green Shales and Globigerina Marls; the Oligocene Menilite Beds divided to several following members: the Mszanka Sandstones, the Jawornik Marls, the Cherts and the Cergowa Sandstones. Deposits that form this fold are highly tectonically deformed. The innermost part of the Kamionka fold is cut by thrust fault and there normally lying beds are thrust over reverse beds. Tectonics of the Kamionka fold is varied by subordinate normal, strike-slip and transverse fault.

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A. RUMAN and N. HUDÁČKOVÁ: **Miocene chitons (Mollusca: Polyplacophora) from the Slovak part of the Vienna basin (Central Paratethys)**

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On the basis of 5.137 disarticulated shell plates of chitons, collected during 1999–2005, knowledge about Middle Miocene chitons from the Vienna basin (Central Paratethys) area has been summarized. Research was focused on the Slovak part of the basin – particularly on the localities Devínska Nová Ves – loam pit, Devínska Nová Ves – Útočnica, Rohožník – loam pit and borehole Kúty 45. Studied specimens, belonging to 13 species of the families Leptochitonidae, Hanleyidae, Ischnochitonidae, Callochitonidae, Chitonidae and Acanthochitonidae, are described. The most common in the collected material were *Leptochiton sulci* (20 %), *Chiton corallinus* (19 %) and *Callochiton laevis* (11 %). Other species represents no more than 10 % each in studied assemblages. Taking into account the morphological characteristics of the intermediate valves a group of few specimens previously determined as *Acanthochitona faluniensis* has been studied and described separately and will be classified as a new species.

The sediment origin interpretations were provided in the studying areas. Sediments containing chitons valves were formed by turbidity currents, or by destroying the bioherm bodies, therefore studied assemblages are completely allochthonous from the paleoecological point of view, but not stratigraphical. Paleoecological environment of the source areas was interpreted as well.

According to the similarity index (Sorensen Index) between assemblages from the Lower Badenian and Upper Badenian localities Korytnica, Lychów and Niskowa from the Polish part of Central Paratethys there was found out that assemblages stem from our localities are more similar to Lower Badenian Korytnica´s assemblages than to Upper Badenian Lychów and Niskowa.

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T. SEGIT: **Phosphatic shales in the Aalenian of the Pieniny Klippen Belt (Carpathians): New data from Poland and Slovakia**

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The Middle Jurassic crinoidal limestones of the Smolegowa Limestone Fm. and the Flaki Limestone Fm., especially their basal parts, often contain black phosphatic nodules. This feature was described from several sites in the central section of the Pieniny Klippen Belt (PKB) by Krobicki and Wierzbowski (2004, Vol. Juras. II). In the stratigraphically underlying, dark clayey deposits only few phosphatic nodules have been found so far, e.g. in the Biała Woda section at Jaworki village. Highly bioturbated rocks exposed here have been attributed to the Skrzypny Shale Fm. and ascribed to the Lower Bajocian by Tyszka (1994, Bull. Pol. Acad. Sci. Earth Sci., 47, 1). Newly acquired data do not confirm this stratigraphical assessment – there were found some imprints of coarse-ribbed ammonites of Graphoceratidae and dinocysts belonging to the species: *Nannoceratopsis gracilis*, *N. dictyambonis*, *N. triceras*, *Kallosphaeridium praussi* and *Phallocysta elongata*, which have first appearance in the Aalenian or even earlier. Already done research works at Zaskale near Szaflary yielded new data on the Skrzypny Shale Fm. depositional history – there has been recognized the Aalenian phosphatic black shale for the first time in the PKB. Previously unknown type of phosphatic nodule-bearing deposits overlying Skrzypny Shale Fm. was also discovered in the quarry near Kamienka village (Stará Ľubovňa District, Slovakia). These findings shed a new light onto the final period of a clayey sediment deposition in the Pieniny Klippen Basin, coeval with an initial stage of the Czorsztyn Ridge elevation.

The temporarily exposed rocks of the Krempachy Marl Fm. and Skrzypne Shale Fm. at Zaskale yielded, for more then a century ago, uppermost Toarcian, Aalenian and supposedly earliest Bajocian ammonites (Birkenmajer, 1963; Stud. Geol. Pol., 9). Quite recently the ammonites indicative of the Upper Aalenian (e.g. *Graphoceras concavum*) have been found in a tectonic scale of black shale comprising numerous, usually small, brown-grey, phosphatic concretions. Dinocyst assemblage recovered from these strata is largely dominated by Nannoceratopsis gracilis, but also other taxa, e.g. *Phallocysta elongata*, *N. dictyambonis*, *N. evae*, *Scriniocassis priscus* and *Mancodinium semitabulatum* do occur; they are common in the Aalenian deposits of Europe and were previously noted from other localities of the

Skrzypny Shale Fm. (Segit, 2005; unpub. Msc thesis, Univ. Warsaw). Anyhow, the results of the studies do not prove the Bajocian age of the Skrzypny Shale Fm., even its upper, phosphatized part.

The Jurassic strata mostly resembling those of the Czertezik/Niedzica successions occur in an abandoned quarry on the east slope of the Riečka stream valley near Kamienka and Litmanová villages. The oldest exposed beds are black shales with siderite concretions yielding ammonites *Brasilia* sp. indicative of the Middle Aalenian Bradfordensis Zone. Upward in the section the siderite concretions disappear, black shales pass into the massive, black mudstones. Above them the harder dark grey-greenish siltstones finally passing to a hard, intensive green siltstones and shales occur. Black phosphate nodules scattered through the grey-greenish beds become very frequent in the green ones. From the black mudstones *Graphoceras* sp. was collected, there were also identified dinoflagellate cysts: *Nannoceratopsis gracilis*, *N. dictyambonis*, *N. triceras*, *Pareodinia* sp., *M. semitabulatum*, *Phallocysta elongata* and *Dissiliodinium* sp. Green siltstones also yielded fragments of phosphatized casts *Graphoceras* sp. Total thickness of the described Upper Aalenian beds probably does not exceed 3 m; it is hard to set it out precisely because of tectonic disturbances.

Phosphatic deposits from Zaskale and Kamienka probably originated during the fertile period of upwelling in the Pieniny Klippen Basin. Phosphate nodule-bearing muddy sediments must have been the primary source of reworked concretions occurring above the base of crinoidal limestones in the Kamienka quarry and in many other places in the central section of the PKB. The phosphatized ammonite casts found in the limestone belong, however, mainly to the earliest Bajocian genera (Krobicki and Wierzbowski, 2004). The phosphatic event originally distinguished by Krobicki (2002, abstr. VI Int. Symp. Juras. Sys. Palermo) started obviously in the Upper Aalenian Concavum Zone and continued up to the lowermost Bajocian.

V. ŠIMO[1] and P. KLEPSATEL[2]: **Examples of Badenian borings as trace fossils on bivalve shells from Devínska Kobyla, Borský Mikuláš and Rohožník (Slovakia)**

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Badenian borings were studied on several shells of *Glycymeris pilosa deshayesi* from Borský Mikuláš on internal mould from Devínska Kobyla and on fragment of shell from Rohožník. Two groups of borings were recognized: endoskeletozoans and episkeletozoans. Endoskeletozoans comprise *Entobia*, *Gastrochaenolites*, *Meandropolydora* and *Oichnus*. Episkeletozoans comprise traces of bryozoa etchings, traces of etching of vermetid gastropods, etchings of serpulid and other unidentified traces. *Gastrochaenolites dijugus* was preserved in two forms: as hollow clavate borings and as natural casts. Natural casts of *G. dijugus* are composed from fine preserved calcite lining. Two cavities of borings contain shells of producer *Gastrochaena* sp. Other natural casts of sponge borings belong to *Entobia* isp. One example of *Oichnus* represents the trace fossil of predation. Only shells which contain *Meandropolydora* were pathological deformed.

P. WÓJCIK-TABOL: **Organic geochemical characterization of black shales from the Szlachtowa Formation (Grajcarek Unit, Pieniny Klippen Belt, Poland)**

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Organic geochemical investigations were carried out on Szlachtowa Formation from two sample sites in the Grajcarek Unit (Pieniny Klippen Belt) to characterize the sedimentary organic matter. These black shales have a variable bulk and molecular geochemical composition reflecting changes in the quantity and quality of the organic matter.

TOC contents between 0.09 and 4.2 wt.% and hydrogen indices between 28 and 112 (mg HC/g TOC) indicate hydrogen-poor organic matter (Type III/II kerogen). Hydrocarbon contents correlated with TOC values qualify these black shale sequences as poor oil-prone source rocks. Tmax values obtained from Rock-Eval pyrolysis (420–448 MC) confirm a mature level of thermal maturation. Organic petrological studies indicate that the kerogen is almost entirely composed of unstructured vitrinite. Vitrinite is hydrogen-poor organic matter, typically derived from woody land plants.

Total lipid analyses shows that the biomarkers mostly comprise long-chain n-alkanes (C25–C30). It can suggest the predominance of terrigenous organic matter. Terrestrial derivation of organic matter finds confirmation in the pristan/n-C17 and phytan/C-18 ratios. The studied organic particles were accumulated under oxic to suboxic conditions. An influence of secondary processes (i.e.: biodegradation) has been not recognized.

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