The Upper part of the sequence, 200–300 m thick, is composed of dark shaley flysch and thick-bedded sandstones from the Metovo beds and finally overlapped by black marls and shales of the Luh beds (Smirnov, 1973). In the Terebla River section we found Eocene and Oligocene (Rupelian) calcareous nanoplankton in the Metovo and Luh beds, respectively. The Oligocene deposits in this section resemble Grybów/ Dusyno bituminous marls known from the Fore-Magura units in Poland and Ukraine. In our opinion the Vezhany succession could be regarded as the equivalent of the Fore-Magura thrust sheet in the Żywiec area of Poland. The Monastyrets Unit is composed of Coniacian-Early Santonian calcareous flysch with intercalations of red shales (Kalyna beds, Vialov et al., 1988) and followed by thin-bedded flysch and variegated shales from the Shopurka (Sushmanets) beds (Lower-Middle Eocene) and thick-bedded Drahovo sandstones (Middle-Upper Eocene). The Monastyrets succession, up to 2000 m thick (Smirnov, 1973) resembles the Rača development of the Magura Nappe in Poland and Slovakia (see also Żytko, 1999). The Monatyrets Unit makes contact along sub-vertical fault with the PKB. On Romanian territory the equivalents of the Monastyrets Unit are known as the Leordina and Petrova nappes. These units composed of the Maastrichtian-Chattian deposits are regarded as the prolongation of the Magura Nappe (Sandulescu, 1988, Aroldi, 2001). South of the Bohdan Woda fault this unit passes into the Wild Flysch Nappe. Between Botiza and the Wild Flysch nappe, the Poiana Botizei Klippens (Middle Jurassic-Oligocene) are edged. These klippens are regarded as the SE termination of the PKB (Aroldi (2001) or as the intra-Magura (like Hluk Klippe in Moravia) klippens (Bombita et al., 1992). The Magura Nappe and Marmarosh Flysch revealed not only the same geotectonic position but also a similar diachronic distribution of Eocene/Oligocene facies in the basins. It makes possibly to regard some similarities between the Marmarosh Massif and buried Silesian Ridge (see Sandulescu, 1988, Oszczypko, 1992).

References

AROLDI C., 2001. The Pienides in Maramures-sedimentation, tectonics and paleogeography, Cluj Univ. Press, Cluj-Napoca.

BOMBITA G, ANTONESCU E., MALATA E., ION J., MÜLLER C., NEAGU T., (et al.), 1992. Pieniny-type Mesozoic formation from Maramures, Romania (second part). *Acta Geol. Hung.*, 36(2): 117-144.

DABAGYAN N.V., SAVITSKAYA N.A. and SMIRNOV S.E., 1989. Paleontological characteristic of the Upper Cretaceous deposits on the Terebla River (Marmarosh Zone). *Paleontologicheskyj Sbornik*, Lvov, 26: 58-65 (In Russian).

OSZCZYPKO N., 1992. Late Cretaceous through Paleogene evolution of Magura Basin. *Geologica Carpathica*, 43, 6: 333-338;

SMIRNOV S.E., 1973. Paleogene of the Marmarosh and Pieniny zones of the Ukrainian Carpathians. Nedra Press, Moskva (in Russian).

SANDULESCU M., 1986. Cenozoic tectonics history of the Carpathians. *Memoir of AAPG*, 45: 17-26.

VYALOV O.S., 1988. Kalina Beds. In: S.I. PASTERNAK (Editor), The stratotypes of the Creteceous and Paleogene deposits of the Ukrainian Carpathians. *Nukova Dumka Press*, Kijev, pp. 67-70 (in Russian).

ŻYTKO K., 1999. Correlation of the main structural units of the Western and Eastern Carpathians. *Prace Pan. Int. Geol*., 168: 135-164.

Position of the Late Cretaceous – Palaeocene Source Areas of the Magura Basin – Evidence from Heavy Mineral Study

Nestor OSZCZYPKO[1] and Dorota SALATA[1]

[1] Jagiellonian University, Institute of Geological Sciences, Oleandry 2a, 30-063 Kraków, Poland

The Late Cretaceous-Palaeocene deposits of the Magura Nappe in Poland are surrounded by the Hulina spotty marls (Albian-Cenomanian) at the base and variegated shales of the Łabowa Fm. (Early Eocene) at the top. The basal portion of the Upper Creteceous sequence is represented by variegated shales of the Malinowa Fm. Their upper boundary is diachronous – older in the Rača zone (Santonian) and younger in the Krynica zone (Campanian/ Maastrichtian). The variegated shales are followed by the Senonian-Palaeocene flysch deposits traditionally referred as the Inoceramian Beds. These deposits, 200–400 m thick, could be divided into several divisions: Kanina, Jaworzynka and Ropianka (Mutne) beds in the Rača zone, and Kanina, Szczawina Sandstones and Ropianka beds in the Bystrica zone. These deposits display paleocurrent directions from the NW and SE in the Rača and Bystrica zones respectively (see Książkiewicz (Ed), 1962). On the contrary, the variegated shales in the Krynica zone are overlapped by the Jarmuta (Maastrichtian/Palaeocene) and Szczawnica (Palaeocene/Lower Eocene) formations supplied from the south-eastern direction.

Heavy mineral assemblages occurring in these sediments are dominated by stable and ultrastable minerals. They are zircon, tourmaline and rutile, which are present in all the studied samples in various amounts. For heavy fractions of deposits deriving from NW great amounts of garnets are characteristic. In some samples of heavy fractions of the Jarmuta and Szczawnica fms considerable amounts of garnets are also occur. In the sediments deriving from the SE direction, except Szczawina Sds, significant amounts of chromian spinels have been counted. They comprise up to 13 % (in the Szczawnica Fm.) of the studied heavy mineral assemblages (Salata, 2002).

Analyses of chemical composition of the listed mineral groups displayed that tourmalines represent schorl-dravite series, deriving mostly from metamorphic rocks and in minor amounts from igneous rocks of granitoide type. In garnets composition the amount of Almandine end-member dominates over Pyrope, Grossularite, Spessartine and Andradite. Chemistry of these minerals indicated that they crystallized under low to medium grade metamorphic conditions. Therefore their parent rocks could be shists, gneisses or amphibolites. Chemistry of chromian spinels is characteristic for those deriving form harzburgites, lherzolites and/or cumulates building ophiolite sequences.

The northern source area is commonly connected with the Silesian Ridge. During the Late Cretaceous-Palaeocene the material of the north source area supplied several lithostratigraphic units in the Magura Basin (Książkiewicz (ed), 1962, Oszczypko, 1992): Jaworzynka Beds (biotite-glauconitic beds), Ropianka Beds and Mutne Sandstones (Senonian-Palaeocene) and their equivalents (Solan Fm). The uplift of the Silesian Ridge is probably an effect of the Late Cretaceous-Palaeocene inversion tectonics, which affected the European foreland.

Position of the southern source is still speculative (Oszczypko, 1992). It was uplifted during the Maastrichtian - Palaeocene, being most active during the Eocene. The facies interfingering between the Jarmuta Fm. of the Grajcarek Unit of PKB and Szczawnica Fm. of Krynica Subunit suggest that these deposits were formed in continuous sedimentary area on the basinal slope of the accreted fragments of PKB and Inner Carpathians. The features of heavy minerals and components of sandstones suggest that the great part of clastic material of the formations was reworked many times. The investigations of chemical composition of heavy minerals allow concluding that the southern source area was build of low- to medium grade metamorphic as well as igneous rocks associated with ophiolite sequences. Chemical composition of minerals deriving from NW indicates that they crystallized mainly in medium- to high-grade metamorphic rocks.

The Szczawina sandstones, which contain only traces of chromian spinels and display paleotransport from SE, form different lithosome without any connection with the litofacies of Szczawnica and Jarmuta fms. It suggests that between the Krynica and Bystrica zones could existed an ephemeral uplifted area which supplied the Szczawina submarine fan.

References

OSZCZYPKO N., 1992. Late Cretaceous through Paleogene evolution of Magura Basin. *Geologica Carpathica*, 43, 6: 333-338.

SALATA D., 2002. Provenance of chromian spinels of the Szczawnica (Magura nappe) and the Jarmuta (Pieniny Klippen Belt) formations in the light of their chemical composition. *Geologica Carpathica*, 53: 12-13.

KSIĄŻKIEWICZ M., 1962 (ed). Geological Atlas of Poland – stratigraphy and facial problems. Fascile 13-Cretaceous and Early Tertiary in the Polish Carpathians. Wyd. Geol. Press. Warszawa

Evolution of Neogene-Quaternary Magmatism in the Carpathian Arc and Intra-Carpathian Area: Geodynamic Implications

Zoltán PÉCSKAY[1], Jaroslav LEXA[2], Alexander SZAKÁCS[3], Ioan SEGHEDI[3], Kadosa BALOGH[1], Vlastimil KONEČNÝ[2], Tibor ZELENKA[4], M. KOVACS[5], T. PÓKA[6], A. FÜLÖP[5], E. MÁRTON[7], C. PANAIOTU[8] and V. CVETKOVIC[9]

[1] *Institute of Nuclear Research of the Hungarian Academy of Sciences, P.O. Box 51, Bem ter 18/c, H-4001 Debrecen, Hungary*
[2] *Geological Survey of Slovak Republic, 817 04 Bratislava, Slovakia*
[3] *Institute of Geodynamics, 19-21, str. Jean-Luis Calderon, Bucharest 70201, Romania*
[4] *Geological Survey of Hungary, Stefania str. 15, Budapest, Hungary*
[5] *North University, 62A, Victor Babes Str., 4800, Baia Mare, Romania*
[6] *Lab. for Geochemical Research of Hungarian Academy of Sciences, Budaörsi Str., 45, Budapest, Hungary*
[7] *ELGI, Columbus u., 17-23, 1145, Budapest, Hungary*
[8] *University of Bucharest, Paleomagnetism Laboratory, Bălcescu 1, 70111 Bucharest, Romania*
[9] *Faculty of Mining and Geology, Dept. of Petrology and Geochemistry, University of Belgrade, Dusina 7, 11000 Belgrade, Yugoslavia*

Neogene to Quaternary volcanism in the Carpathian-Pannonian region was related to the youngest evolutionary stage of the Carpathian arc and the intra-Carpathian basins, with subduction, extension and asthenospheric upwelling as the main driving mechanisms. Volcanism occurred between 20 and 0.1 Ma, and showed a distinct migration in time from west to east (fig. 1). Several groups of calc-alkaline magmatic rock-types (felsic, intermediate and mafic varieties) have been distinguished, and several minor alkalic types also occur, including shoshonitic, K-trachytic, ultrapotassic and alkali basaltic. From their spatial distribution, relationship to tectonic phenomena and their chemical composition, the volcanic formations can be divided into: (1) areally distributed felsic calc-alkaline formations related to the initial stages of back-arc extension, (2) areally distributed intermediate calc-alkaline formations related to advanced stages of back-arc extension, (3) "arc-type" andesite volcanic formations with a complex relationship to subduction processes, and (4) alkali basaltic magmatism related to post-convergence extension. Petrologic and geotectonic models of these magmatic groups place significant constraints on geodynamic models of the youngest stage in evolution of the Carpathian-Pannonian area. Subduction and back-arc extension were not contemporaneous across the whole Carpathian arc and intra-Carpathian area. Instead, three major geographic regions can be defined (Western, Central, Eastern regions) that show progressively younger timing of subduction roll-back and back-arc extension: 20–11 Ma,