2000. Vysvetlivky ku geologickej mape Spišskej Magury 1: 50000. Bratislava, Vyd. D. Štúra, GÚDŠ, 174 s.
KOVÁČ M., KRÁĽ J., MÁRTON E., PLAŠIENKA D. and UHER P., 1994. Alpine uplift history of the Central Western Carpathians: geochronological, paleomagnetic, sedimentary and structural data. *Geol. Carpath.*, 45, 2, 83-96.
KRÁĽ J., 1977. Fission Track Ages of Apatites from Some Granite Rocks in Western Carpathians, Geol. Zbor., *Geologica Carpathica*, 28: 269-276.
PLAŠIENKA D., SOTÁK J. and PROKEŠOVÁ R., 1998. Structural profiles across the Šambron-Kamenica Periklippen Zone of the Central Carpathian Paleogene Basin in NE Slovakia. *Mineralia Slov.*, 29: 173-184.
STRUZIK A.A., ZATIN M. and ANCZKIEWICZ R., 2003. Wstepne waniky analizy trakowej apatytow z glównych jednostek tektonicznych Karpat Zachodnich. VI Karpackie Warstaty Tektoniczne, Kraków 28. 02.–1. 03. 2003, 35-36.

Garnet Pyroxenites from Eastern Transylvanian Basin: an Integrated Textural and Geochemical Study

Attila TÓTH[1], Gábor DOBOSI[2], Andy BEARD[3], Hillary DOWNES[3], Enikő BALI[1] and Csaba SZABÓ[1]

[1] Lithosphere Fluid Research Lab, Eötvös University, 1117 Budapest, Hungary
[2] Hungarian Academy of Sciences, Institute for Geochemical Research, Budapest, Hungary
[3] School of Earth Sciences, Birkbeck, London, United Kingdom

Since the lower crust and the upper mantle cannot be sampled and studied directly, deep seated xenoliths from basaltic, kimberlitic and lamproitic extrusions provide important information on the petrologic and geochemical composition, rheological state, thermal evolution of the lithosphere. These xenoliths, fragments of wall rocks entrained by magmas at upper mantle and lower crustal levels, have been carried to the surface by alkaline basalts extreme rapidly, probably in less then 60 hrs (Kushiro et al. 1976, Mercier 1979).

Petrologically, the mantle xenoliths are mainly peridotites (lherzolite or harzburgites) with lower amount of spinel and garnet pyroxenites which represent less than 10 % of the total volume of shallow mantle in the Carpathian–Pannonian Region based on our experience. Pyroxenite layers (veins? lenses?) can be seen as small-scale heterogeneities in the geophysical studies, however these methods cannot offer a detailed picture of the lower crust and the upper mantle (Chen et al. 2001). Garnet pyroxenite xenoliths are rare in alkaline basalts; some examples are: Israel (Esperanca and Garfunkel 1986, Mittlefehldt 1986), SE Australia (Irving 1974, Wilkinson 1974, Griffin et al 1984, O'Reilly and Griffin 1995), SW USA (Shervais et al. 1973), Hawaii Islands (Wilkinson 1976, Frey 1980) and Eastern Transylvanian Basin, Romania (this study).

The Persani Mts. in the Eastern Transylvanian Basin is the easternmost Plio-Pleistocene alkaline basaltic volcanic field in the Carpathian–Pannonian Region. The products of the volcanic activity are lava flows and pyroclastic rocks, in which peridotites as xenoliths from the upper mantle can often be found. Besides peridotite xenoliths, spinel and garnet pyroxenites are also common. Garnet-bearing pyroxenites composed mainly of primary garnet, spinel, ortho- and clinopyroxene. The secondary mineral phases in the studied xenoliths are plagioclase, amphibole, spinel and ortho- and clinopyroxene. Textural observations suggest deformation events and mineral reactions, as the results of changes in stress, P-T conditions and melt/rock interaction during the evolution of the upper mantle beneath the region. Primary clino- and orthopyroxene frequently contain exsolution lamella of the other pyroxene (sometimes they are curved). Garnet often contains, amphibole, ortho- and clinopyroxene inclusions, exsolved needles of rutile and is always surrounded by symplectitic intergrowth of secondary ortho- and clinopyroxene, spinel and plagioclase.

Thermobarometric calculation was carried out based on electron probe microanalysis data of the primary rock forming minerals. Equilibrium pressure was estimated using garnet-orthopyroxene barometry (Harley and Green 1982), yielded between 1.4 and 1.7 GPa, whereas equilibrium temperatures are in the range of 1030–1140 °C (based on the garnet-clinopyroxene thermometers of Ellis and Green, 1979). The majority of the primary clinopyroxenes shows the usual chondrite normalized REE pattern of upper mantle clinopyroxenes coexisting with garnet (i.e. enriched in LREE and depleted in HREE). However, some of them are enriched in HREE, which is a simple enrichment in HREE of "normal" clinopyroxenes without changing their LREE concentration. The REE pattern of primary garnets shows depletion in LREE and enrichment in HREE, whereas that of the symplectite coronae around primary garnets is slightly enriched in LREE, showing flat REE pattern, sometimes with negative Ce anomaly. The bulk trace element composition of the garnet pyroxenites was calculated based on the garnet and clinopyroxene compositions and their modal abundance. The calculated trace element patterns are quite similar to each other and very similar to MORB composition, too.

The wide petrologic variability of the studied mantle xenoliths shows that the upper mantle beneath the Eastern Transylvanian basin is more heterogeneous than it was described previously (e.g., Vaselli et al. 1995, Chalot-Prat and Boulier 1997). Based on the textural relationships (e.g. the appearance of symplectites, plagioclase, curved exsolution lamellae) and the thermobarometric results, the evolution of the xenoliths can be outlined, indicating deformation and pressure decrease (upwelling) in the lithospheric mantle before alkaline basaltic volcanism. The inferred P-T-path of the Persani Mts. garnet pyroxenites agrees well with the previously studied former garnet peridotites (Falus et al. 2000).

The estimated paleogeotherm (older than the Plio-Pleistocene) beneath the region, shows slightly higher temperature than the present day heat flow calculations and, therefore, indicates significant cooling of the upper mantle after the cessation of the alkaline basaltic volcanism in the Persani Mts.

References

CHALOT-PRAT F. and BOULIER A.M., 1997. Metasomathism in the subcontinental mantle beneath the Eastern Carpathians (Romania): new evidence from trace element geochemistry. *Cont. Min. Pet.*, 129: 284-307.

CHEN S., O'RELLY S.Y., ZHOU X., GRIFFIN W.L., ZHANG G., SUN M., FENG J. and ZHANG M., 2001. Thermal and petrological structure of the lithosphere beneath Hannuoba, Sino-Korea craton, China: evidence from xenoliths. *Lithos*, 56: 267-301.

ELLIS D.J. and GREEN D.H., 1979. An experimental study of the effect of Ca upon garnet-clinopyroxene Fe-Mg exchange equilibria. *Cont. Min. Pet.*, 71: 13-22.

ESPERANCA S. and GARFUNKEL Z., 1986. Ultramafic xenoliths from the Mt. Carmel (Karem Maharal volcano), Israel. *Lithos*, 19: 43-49.

FALUS Gy., SZABÓ Cs. and VASELLI O., 2000. Mantle upwelling within the Pannonian Basin: evidence from xenolith lithology and mineral chemistry. *Terra Nova*, 12: 295-302.

FREY F.A., 1980. The origin of pyroxenites and garnet pyroxenites from Salt Lake Crater, Ohau, Hawaii: trace element evidence. *American Journal of Science*, 280-A: 427-449.

GRIFFIN W.L., WASS S.Y. and HOLLIS J.D., 1984. Ultramaffic xenoliths from Bullenmerri and Gnotuk maars, Victoria, Australia: Petrology of a sub-continental crust-mantle transition. *J. of Pet.*, 25: 53-87.

IRVING A.J., 1974. Geochemical and high pressure experimental studies of garnet pyroxenites and pyroxene granulite xenoliths from Delegate basaltic pipes, Australia. *J. of Pet.*, 15, 283-322.

MITTLEFEHLDT D.W., 1986. Petrology of high pressure pyroxenite series xenoliths, Mount Carmel, Israel. *Cont.Min.Pet.*, 94: 245-252.

O'REILLY S.Y. and GRIFFIN W.L., 1995. Trace element partitioning between garnet and clinopyroxene in mantle-derived pyroxenites and eclogites: P-T-X controls. *Chem. Geol.*, 121: 105-130.

SHERVAIS, J.W., WILSHIRE, W.G. AND SCHWARZMAN, E.C., 1973. Garnet clinopiroxenite xenolith from Dish Hill, California. *Earth Planet. Sci. Lett.*, 19: 120-130.

VASELLI O., DOWNES H., THIRWALL M.F., DOBOSI G., CORADOSSI N., SEGHEDI I., SZAKACS A. and VANUCCI R., 1995. Ultramafic xenoliths from Plio-Pleistocene alkali basalts from Eastern Transylvanian Basin: depleted mantle enriched by vein metasomatism. *J of Pet.*, 38: 23-54.

WILKINSON J.F.G., 1974. Garnet pyroxenite inclusions from diatremes in the Gloucester area, New South Wales, Australia. *Cont. Min. Pet.*, 46: 275-299.

WILKINSON J.F.G., 1976. Some subcalcic clinopiroxenites from Salt Lake Crater, Ohau and their petrogenetic significance. *Cont. Min. Pet.*, 58: 181-201.

Neotectonic Character of the Horná Nitra Depression

Rastislav VOJTKO[1], Filip PLENCNER[2], Jozef HÓK[2], František MARKO[2], Ľubomír SLIVA[2] and Peter REICHWALDER[2]

[1] Department of Geology and Paleontology, Faculty of Natural Sciences, Comenius University, Mlynská dolina pav. G, 842 15 Bratislava, Slovak Republic

[2] Department of Geology and Paleontology, Faculty of Natural Sciences, Comenius University, Slovak Republic

The Horná Nitra Depression is situated in the western part of the Central Western Carpathians, and it is the elongate Upper Miocene to Quaternary structure in the N-S direction. This depression is bound by fault structures which were observed and measured during the neotectonic research. The aim of this work is to identify and define the main fault structures on the basis of the relevant tectonic geomorphology and structural geology methods used. The next step was the dating of fault activity during the Plio-Quaternary Period, and testing its ability to generate seismic events. The faults observed in the Horná Nitra Depression have been divided into three categories.

The first category consists of neotectonic active faults. In the Horná Nitra Depression, these consist of the Malá Magura fault and the north-west segment of the Pravno fault. These are faults whose activity during the Plio-Quaternary Period was able to be independently determined using several methods. The Malá Magura fault is the tectonic structure which divides the Tatric crystalline basement of the Malá Magura Mts. from the sedimentary fill of the Horná Nitra Depression. It is a typical mountain-front fault with a N-S striking and a dipping to the east. The dominant component of the movement on the fault plane is a normal slip, and the length of the fault is 16.71 km. The neotectonic activity is shown by the superposition of the Quaternary alluvial fans, by the value of the mountain-front sinuosity, by the mountain-front faceting, by the valley floor-to-height ratio, by the valley cross-section ratio, by the interpretation of aerial photographs and satellite images, and also by the geophysical measurements. The north-west segment of the Pravno normal fault is also neotectoni-