ments. The strata are characterised by numerous local facies changes.

Our studies were focused on two basins associated with the Chay River Fault and three basins associated with the Red River fault. The composition of the clast assemblages shows strong variability both in particular basins and between the basins. In all studied basins, the local source areas located outside of the DNCV are clearly marked. Clasts derived from the DNCV are recognized only in a few sites. The occurrence of these clasts in the basins associated with the Chay River fault show distinct differentiation. The clasts of the DNCV gneisses are observed in two exposures of deformed conglomerates in the Bao Yen Basin. The gneiss clasts were not observed in the second basin.

Along the Red River fault, in the Lao Cai Basin, only single clasts of gneisses were observed. The vast majority of the clasts are formed of granitoid clasts derived from Ailao Shan massif. It is not clear if the gneisess are derived from the DNCV. Further SE, in the Yen Bai Basin, the clasts of gneisses occur in undeformed conglomerates what suggest post-motion age of the conglomerates. In the Co Tiet Basin, clasts of DNCV gneisses occur in deformed, probably Miocene, strata. Like as the gneiss clasts, detrital garnets are common only in some samples of heavy minerals separated from Paleogen/Neogene sandstones of studied basins. Composition of these detrital garnets points to differentiation of metamorphic source area: from amphibolite to greenschists facies.

Presented results show that only for small portion of the fill of the basins, the high metamorphic DNCV was a source area. Poor dating of the sediments filling basins (palyonological data only) does not allow to precise stratigraphic position of strata containing clasts derived from the DNCV. Basing on degree of deformation of sampled strata it seams that the relationship between sedimentation of gneisses-bearing strata and deformation related to RRFZ activity is different for particular basins. Only in vicinity of Bao Yen and Cot Tiet basins uplift and exhumation of the DNCV was coeval or pre-dated deformation recorded in the sedimentary rocks. For these basins the offset along the RRFZ up to 200 km cannot be excluded.

References

LELOUP P.H., ARNAUD N., LACASSIN R., KIENAST J-R., HARRISON T.M., PHAN TRONG T.T., REPLUMAZ A. and TAPPONNIER P., 2001. New constraints on the structure, thermochronology, and timing of the Ailao Shan-red River shear zone, SE Asian. *Journal of Geophysical Researches*, 106: 6683-6732.

WYSOCKA A. and ŚWIERCZEWSKA A., 2003. Alluvial deposits from the strike-slip fault Lo River Basin (Oligocene/Miocene), Red River Fault Zone, north-western Vietnam. *Journal of Asian Earth Sciences*, 21: 1097-1112.

Structural Analysis and Paleostress Reconstruction of the Spišská Magura and Podhale Region

Eva TOKÁROVÁ, Rastislav VOJTKO and Ľubomír SLIVA

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

The area of Spišská Magura and Podhale region is composed mostly of Mesozoic and Paleogene sequences. The most measurements were done in the Paleogene sediments.

In the study area we distinguished ten deformation stages connected with 1) E-W compression generated in strike-slip stress regime (?Paleocene), 2) NW-SE compression and perpendicular (NE-SW) tension generated in compressive strike – slip regime (Egerian–Eggenburgian), 3) NNW-SSE extension generated in pure extensive tectonic regime (Eggenburgian – Ottnangian), 4) NE-SW extension generated in pure extensive stress regime (Ottnangian–Karpatian), 5) NW-SE extension generated in pure extensive stress regime (Karpatian), 6) NW-SE compression activated in pure compressive stress regime (Badenian), 7) NNW-SSE compression generated in pure compressive stress regime (Sarmatian–Pannonian), 8) NE-SW compression activated in compressive strike-slip stress regime (?Pannonian), 9) NW-SE extension activated in pure extensive stress regime (?Pontian–Pliocene), 10) ENE-WSW extension generated in pure extensive stress regime (?Pliocene–Quaternary).

These ten deformation stages we divided in two groups.

The first group contains structures that were rotated to their recent position depending on uplift of the crystalline core of the High Tatras Mts. that started in Upper Miocene, according to FT dates from apatites (Kráľ 1977, Kováč et al. 1994, Struzik et al. 2003). This group contains the first six deformation stages originated from ?Paleocene up to the Badenian period.

The second group contains last four deformation stages that are the youngest structures originated after tilting of the High Tatras Mts. from ?Sarmatian up to the Quaternary period.

References

HÓK J., BIELIK M., KOVÁČ P. and ŠUJAN M. 2000. Neotektonický charakter Slovenska. *Mineralia Slovaca*, 32, 459-470.

JANOČKO J., GROSS P., POLÁK M., POTFAJ M., JACKO Ml.S., RAKÚS M., HALOUZKA R., JETEL J., PETRO Ľ., KUBEŠ P., BUČEK S., KÖHLER E., SIRÁŇOVÁ Z., ZLINSKÁ A., HALASOVÁ E., HAMRŠMÍD B., KAROLI S., ŽEC B., FEJDIOVÁ O., MILIČKA J., BOOROVÁ D. and ŽECOVÁ K.,

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