nearly indentical despite of differences in petrographic types. Their typical features are sloping form as a result of differenciated enrichment LREE/HREE (La_N/Yb_N = 3.48 –5.28) and negative Eu anomaly (Eu/Eu* = 0.74 – 0.91) caused by fractionation of plagioclase. Such patterns are typical for calc-alkaline basalts of the active continental margins. Calc-alkaline character of studied rocks also follows from application of all relevant discriminant diagrams based mostly on HFSE distribution.

The production of calc-alkaline basalts and basaltic andesites are practically unambiguously related on destructive lithospheric plate margins (island arc and active continental margins), where are generated in the chains of volcanoes referred to as volcanic arcs. Studied calc-alkaline basaltic rock pebbles associated at all conglomerate layers of the Klape Unit with calc--alkaline andesite, dacite and rhyolite pebbles. Fluidal glassy rocks, ignimbrites and welded tuffs mostly of acidic composition are relatively widespread among them. Tuffaceous rocks have been also found. These facts indicate that all these volcanic association could be produced as subareal deposits of stratovolcanoes. Areal distribution of all these volcanic association not only in conglomerates of the PKB (Klape and Manín Units) but also in analogical conglomerates in Tatric and Fatric Megaunits suggests for large extent of the original source area – – may be magmatic arc. Petrographical and geochemical identity of studied rocks and volcanic rocks of the Malužiná Formation allow us to speculate about the Permian age of this arc. HP/LT metamorphic alteration of some calc-alkaline volcanic rock pebbles with the identical age of metamorphism to that in Meliatic Unit (inner Western Carpathians) support the concept of the southern exotic (ultragemeric?) nappes (an accretion prism?) as a direct source of the material in the Klape Unit conglomerates.

Disequilibrium Melting in Early Devonian (406 Ma) Orthogneisses from the Western Tatra Mts.

Marian JANÁK[1], Igor PETRÍK[1] and Ulrike POLLER[2]

[1] Geological Institute, Slovak Academy of Sciences, Dúbravská 9, 842 26 Bratislava, Slovak Republic
[2] Max-Planck-Institut für Chemie, Abt. Geochemie, Postfach 3060, D-55020 Main, Germany

Disequilibrium between melt and its residuum can arise because components generally have much greater diffusivities in silicate melts than in solid silicates. Therefore, if a melt is produced and segregated rapidly from its residuum, chemical equilibrium may not be attained and the melts are depleted in trace elements with the lowest diffusivities, such as Zr, Th, Hf and LREE relative to their source rocks (e.g. Sawyer 1991). These depletions are commonly attributed to disequilibrium between monazite and/or zircon and water-undersaturated granitic melt owing to slow dissolution rates of these minerals and their retention in the residuum (Watt and Harley 1993). In this study, we provide arguments for disequilibrium melting in Early Devonian orthogneisses from the pre-Alpine basement of the Tatra Mountains.

Investigated orthogneisses are from the Variscan basement of the Western Tatra Mts. They occur near the base of the upper structural unit, belonging to the HP/HT kyanite zone metamorphism (Janák et al. 1999). Orthogneisses are coarse-grained with augen-like K-feldspars, or fine-grained, foliated, with distinctive mylonitic fabric. Surrounding rocks are amphibolites with boudins of retrogressed eclogites and kyanite-bearing metapelites. Both amphibolites and pelitic gneisses show a migmatitic texture. All these rocks show intense deformation and retrogression related to Variscan uplift and Alpine (mostly brittle) overprint.

The orthogneisses are granitic in composition. Quartz is platy and ribbon-textured, K-feldspar is perthitic, often with microcline twinning and signs of dynamic recrystallization. Plagioclase is albite to oligoclase (X_{An} = 0.09 – 0.11), myrmekite has locally developed. The micas form a "mica-fish" texture. Biotite is Fe-rich (X_{Fe} = 0.7 – 0.8), often replaced by chlorite. Muscovite is slightly phengitic, some $^{40}Ar/^{39}Ar$ spectra are discordant due to an Alpine overprint. Garnet is rich in almandine (70 to 75 mol%) and spessartine (15 to 22 mol%), partly replaced by biotite and chlorite. Accessory minerals are apatite, zircon and monazite.

Metamorphic conditions in the kyanite zone metapelites – – a possible source rocks of granitic melts – reached c. 850 °C and 13 kbar according to the TWQ 2.02 (Berman 1991) and THERMOCALC 2.75 (Holland and Powell 1998) calculations. Such *P-T* conditions would be sufficient for dehydration-melting of biotite according to dehydration-melting reaction: biotite + kyanite ± plagioclase + quartz = garnet + K-feldspar + melt (Carrington and Harley 1995 and references therein), generating granitic melt and peritectic garnet + K-feldspar in the orthogneisses. However, the melt was mostly separated from its associated mafic selvages, being segregated into the veins and larger (several m) bodies.

The REE content of the orthogneiss UP1002 shows typical features of non-equilibrium melting with respect to accessory phases: a moderately fractionated pattern at low overall REE abundances, with distinct positive Eu anomaly (Fig. 1). Such a pattern, showing a dominant role of alkali feldspars with suppressed influence of accessory phases (monazite or garnet), is in contrast with other orthogneiss sample (e.g., 16/93). This sample has much higher REE abundances with a pattern typical of S-type granites: fractionated LREE, pronounced negative Eu anomaly and flat HREE. Similar features are known from migmatite terrains where both REE patterns occur in leucosomes (e.g., Watt and Harley 1993). The REE behaviour is mimicked

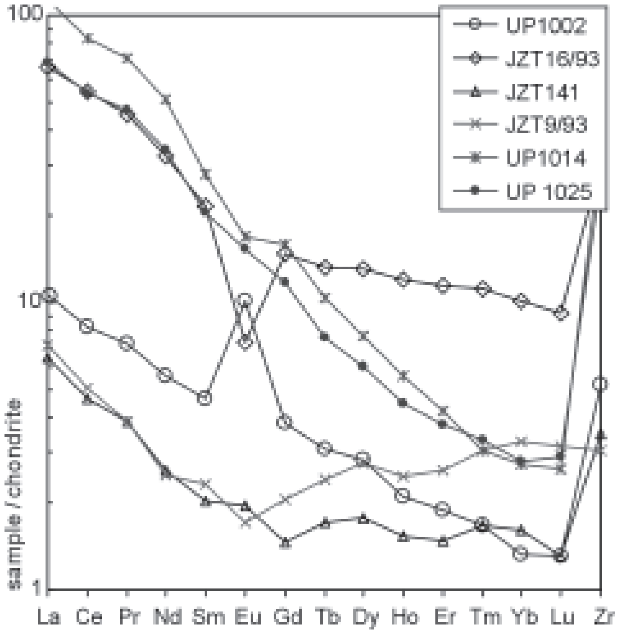

Fig. 1.

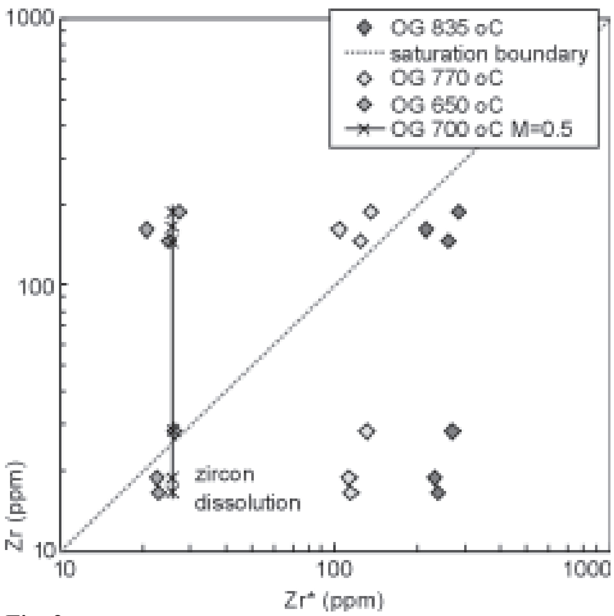

Fig. 2.

by Zr, which is low (28 ppm) in the first, REE-depleted sample and high (168 ppm) in the second one. In sample UP1002, cathodoluminescence study (Poller et al. 2000) revealed zircon cores overgrown by magmatic rims. U-Pb dating of these zircons (Poller et al. 2000) provided the *lower* intercept age of 406 ± 5 Ma, recording magmatic zircon crystallization, whereas the upper intercept of 1980 ± 37 Ma age indicates an inherited material in the zircons. The age of orthogneiss 16/93 was not determined but some other, younger (c. 370 to 350 Ma) granitoids (Poller et al. 2000) with high REE and Zr are constrained by the *upper* intercept ages. This means that in the first case, in spite of high peak metamorphic conditions, zircon was only partly dissolved and minor zircon precipitated from the melt. In the latter case, zircon dissolved and reprecipitated during the magmatic crystallization. The growth of new zircon requires a change in *P-T-X* conditions so that a crystallizing melt parcel would shift into zircon (and monazite) stability fields. This is accomplished by temperature decrease, due to a change in the melt composition (as expressed by the M parameter of Watson and Harrison 1988), or a change in the local Zr concentration around older zircons undergoing melting. All possibilities are illustrated in Fig. 2 where measured Zr is compared with Zr* (equilibrium concentration required to saturate the melt). While at the peak conditions all samples lie deeply in the field of zircon dissolution, with falling temperature, first high-Zr, and later also low-Zr orthogneisses would shift to and beyond the saturation boundary. Although the required temperature drop is considerable (close to the solidus), a change in the local major and trace element chemistry both around dissolving zircons and crystallizing major phases (feldspar, biotite) enables the Zr saturation to be reached at higher temperatures (700 °C, M = 0.5). In any case, the 406 Ma age of orthogneiss UP1002 zircons most probably does not record the melting event at the peak metamorphic conditions (c. 850 °C; 13 kbar) but zircon crystallization at somewhat *lower P-T* conditions during uplift.

Nevertheless, this magmatic stage is clearly distinctive from a younger (c.370–350 Ma) granitoid event.

References

BERMAN R.G., 1991. Thermobarometry using multi-equilibrium calculations: a new technique, with petrological applications. *Canad. Mineral.*, 29: 833-855.

CARRINGTON D.P. and HARLEY S.L., 1995. Partial melting and phase relations in high-grade metapelites: an experimental petrogenetic grid in the KFMASH system. *Contrib. Mineral. Petrol.* 120: 270-291.

HOLLAND T.J.B and POWELL R., 1998. An internally consistent thermodynamic data set for phases of petrological interest. *J.metamorphic Geol.*, 16: 309-343.

JANÁK M., HURAI V., LUDHOVÁ L., O´ BRIEN P.J. and HORN E.E., 1999. Dehydration melting and devolatilization during exhumation of high-grade metapelites: the Tatra Mountains, Western Carpathians. *J. metamorphic Geol.*, 17: 379-395.

POLLER U., JANÁK M, KOHÚT M and TODT W., 2000. Early Varsican magmatism in the Western Carpathians: U-Pb zircon data from granitoids and orthogneisses of the Tatra Mts. (Slovakia). *Int. J. Earth Sci.*, 89: 336-349.

SAWYER E.W., 1991. Disequilibrium melting and the rate of melt-residuum separation during migmatization of mafic rocks from the Grenville Front, Quebec. *J. Petrol.*, 32: 701-738.

WATT G.R. and HARLEY S.L., 1993. Accessory phase controls on the geochemistry of crustal melts and restites produced during water-undersaturated partial melting. *Contrib. Mineral. Petrol.*, 114: 550-566.

WATSON E.B. and HARRISON T.M., 1982. Zircon saturation revisited: temperature and composition effects in a variety of crustal magma types. *Earth Planet. Sci. Lett.*, 64: 295-304.