Granitoid gneisses with relict orbicular metagranitoids from the Varied Group of the southern Bohemian Massif Moldanubicum: protolith derived from melting of Archaean crust?

(2 figs)

F. PATOČKA[1] – V. KACHLÍK[2] – J. DOSTAL[3] – J. FRÁNA[4]

[1] Institute of Geology, Academy of Sciences of the Czech Republic, Prague, Czech Republic, pat@gli.cas.cz
[2] Institute of Geology & Palaeontology, Charles University, Prague, Czech Republic, kachlik@prfdec.natur.cuni.cz
[3] Department of Geology, Saint Mary's University, Halifax, Canada, jdostal@stmarys.ca
[4] Institute of Nuclear Physics, Academy of Sciences of the Czech Republic, Řež, Czech Republic, frana@ujf.cas.cz

Amphibolite facies granitoid gneisses occur as tectonic slivers in a metasedimentary sequence of the Varied Group of Moldanubicum of the southern Bohemian Massif (in vicinity of the town of Český Krumlov). Relicts of orbicular metagranitoids were found within the largest granitoid gneiss body in isolated boulders (Cílek *et al.* 1986) and small outcrops (this work). The magmatic age of the granitoid gneisses was dated by the U-Pb method on zircons at ca. 2.1 Ga (Wendt *et al.* 1988, 1993). The granitoid gneisses occur exclusively along the South Bohemian Main Thrust dividing the Varied and Monotonous Groups of Moldanubicum and marked by lenses of eclogites and ultrabasic rocks (e.g., Vrána 1979). According to Fiala *et al.* (1995) the granitoid gneisses belong to a Precambrian basement where an accretionary wedge of the Varied (Drosendorf) Group was accumulated.

Rocks similar to the studied granitoid gneisses in mineral composition, protolith age and tectonostratigraphic position appear as rare relicts throughout the Variscan Belt of Europe – e.g. rocks embedded in metasedimentary gneisses of Odenwald (Todt *et al.* 1995, Mallard – Rogers 1997), granitoid gneisses in the Icartian basement of the Armorican Massif (Auvray *et al.* 1980, Vidal *et al.* 1981), and possibly also some gneisses in the Precambrian of the Cantabrian Massif (e.g., Mallard – Rogers 1997). Nance and Murphy (1994) interpret the presence of these gneisses as a specific feature of Cadomian terranes that were formerly adjacent to the West African craton of NW Gondwana. According to Rogers (1996), the magmatic origin of these rocks may be related to an early Proterozoic collisional event (Eburnean orogeny at ca. 2 Ga in West Africa) resulting in the amalgamation of West Gondwana (Atlantica) continent.

The granitoid gneisses correspond to quartz diorites, tonalites and granodiorites in mineral composition. Green hornblende, brownish green biotite, quartz, plagioclase (oligoclase, $An_{25–30}$) and microcline are the major minerals of the specimen collected. The rocks are texturally highly variable – some display very well defined planar and linear fabrics whereas some show only indistinct banding and nearly massive appearance; up to X0 mm long porphyric alkali feldspars are preserved in granitoid gneisses with distinct L to LS fabric.

The orbicular metagranitoids (orbicular tonalites to granodiorites) consist of ellipsoidal orbicules (50 to 200 mm in diameter) and a rather heterogeneous matrix which is ranging in composition and texture from biotite gneiss to granodiorite–tonalite(±aplite). The nuclei of the orbicules correspond to granodiorite–tonalite and/or gneiss. The nuclei are surrounded by nearly homogeneous plagioclase rims (20 to 30 mm thick) covered with a thin biotite surface. The orbicular metagranitoids show either no or very weak deformation, and may be interpreted as extremely rare low-strain domains preserved within the granitoid gneiss body.

The granitoid gneisses and orbicular metagranitoids (with SiO_2 abundances 62 to 73 wt. %) represent a chemically uniform group of rocks as evidenced by the contents of lanthanides and less mobile trace elements (e.g. Th, Nb, Zr and Y). The REE distributions of the studied samples (Fig. 1) are characterized by very steep patterns given by advanced LREE/HREE fractionation (La_N/Lu_N ~ 18–32), significant HREE-depletion (Yb_N <8) together with substantial internal fractionation of heavy lan-

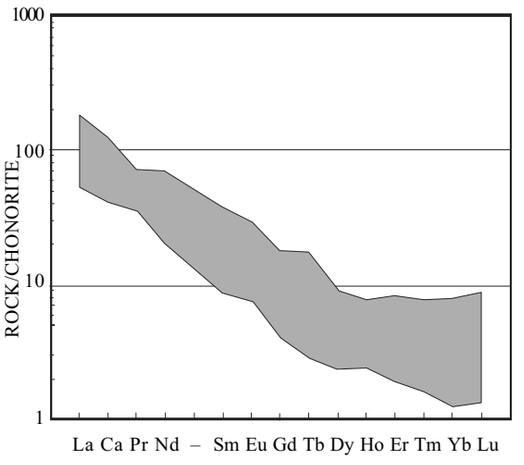

Fig. 1 Chondrite-normalized distributions of REE concentrations in the early Proterozoic granitoid gneisses and orbicular metagranitoids of the Varied Group of Moldanubicum (southern Bohemian Massif). Data by J. Dostal (ICP-MS) and J. Frána (INAA). Normalizing values after Anders and Grevesse (1989).

thanides (Gd_N/Lu_N ~ 2–3), and the absence of a Eu-anomaly (Eu/Eu* ~ 0.9–1.1). The rocks are depleted in Th (<10 ppm), Nb (~ 7 ppm) and Y (~ 12 ppm), and slightly enriched in Sc (~ 5–10 ppm) in comparison with the vast majority of granitoids of the Bohemian Massif (data were kindly provided by J.K. Novák, Inst. of Geology, AS CR).

The ORG-normalized trace element compositions of the granitoid gneisses and orbicular metagranitoids are similar to modern volcanic arc/active continental margin granitoids (Fig. 2). The granitoid gneisses were classified as I-type granitoids also with regards to Nd-isotope systematics (Wendt *et al.* 1988). According to these authors, the $Í_{Nd(T)}$ value of –25 obtained for the granitoid gneisses corresponds to a DM model age of ca. 3 Ga, and proves that the granitoid gneiss protolith was presumably derived from melting of Archaean crust.

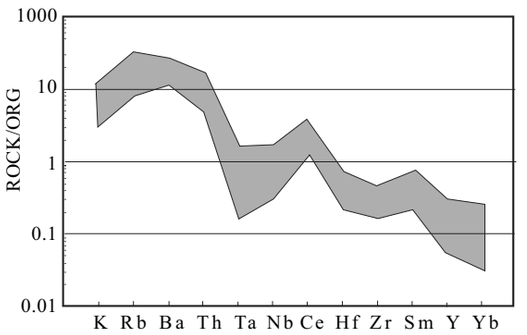

Fig. 2 ORG-normalized distributions of trace element concentrations in the early Proterozoic granitoid gneisses and orbicular metagranitoids of the Varied Group of Moldanubicum (southern Bohemian Massif). Data by J. Dostal (ICP-MS) and J. Fráná (INAA). Normalizing values after Pearce *et al*. (1994).

The chemical features of the granitoid gneisses and orbicular metagranitoids described above correspond to principal characteristics of TTG (tonalite-trondhjemite-granodiorite) suites (cf., McLennan – Taylor 1991, Martin 1994, Sylvester 1994) of pre-2.5 Ga high-grade complexes composing most of the crust of presumed Archaean age (Windley 1984, Condie 1997, Kearey – Vine 1999). This chemical inheritance seems to prove a substantial involvement of the Archaean TTG suite during the magmatic origin of the granitoid gneisses and orbicular metagranitoids of the southern Bohemian Moldanubicum. The early Proterozoic intrusion of the protolith (cf. Wendt *et al.* 1993) may be associated with convergences and collisions of island arc-continent and continent-continent types during the Eburnean orogeny of West Gondwana.

These investigations follow the Research Scheme CEZ: Z3-013-912 (AS CR).

References

Cílek, V. – Synek, J. – Rajlich, P. (1986): Orbicular rocks from Muckov near Černá v Pošumaví. – Sbor. Jihočes. Muz. v Čes. Budějovicích, Přír. Vědy, 26: 101–106.

Fiala, J. – Fuchs, G. – Wendt, J. I. (1995): Moldanubian zone: stratigraphy. – *In:* Dallmeyer, R. D. – Franke, W. – Weber, K. (eds): Pre-Permian Geology of Central and Eastern Europe, 417–428, Springer Verlag. Berlin.

Mallard, L. D. – Rogers, J. J. W. (1997): Relationship of Avalonian and Cadomian terranes to Grenville and Pan-African events. – J. Geodynamics, 23: 197–224.

Nance, D. – Murphy, J. B. (1994): Contrasting basement isotopic signatures and the palinspastic restoration of peripheral orogens: Example from the Neoproterozoic Avalonian-Cadomian belt. – Geology, 22: 617–620.

Rogers, J. J. W. (1996): A History of Continents in the Past Three Billion Years. – J. Geology, 104: 91–107.

Sylvester, P. J. (1994): Archean granite plutons. – *In:* Condie K. C. (ed.), Archaean Crustal evolution. Elsevier, Amsterdam, pp. 261–314.

Vidal, P. – Auvray, R. – Charlot, R. – Cogné, J. (1981): Precadomian relicts in the Armorican Massif: their age and role in the evolution of the Western and Central European Cadomian-Hercynian Belt. – Precambrian Res., 14: 1–20.

Windley, B. F. (1984): The Evolving Continents (2nd ed.). – J. Wiley and Sons, London.

Condie, K. C. (1997): Plate tectonics and crustal evolution. – Elsevier, Amsterdam.

Kearey, P. – Vine, F. J. (1999): Global tectonics (2nd ed.). – Blackwell Science, Oxford.

Wendt, J. I. – Kröner, A. – Todt, W. – Fiala, J. – Rajlich, P. – Liew, T. C. – Vaněk, J. (1988): U-Pb zircon ages and Nd whole-rock systematics for Moldanubian rocks of the Bohemian Massif, Czechoslovakia. – *In:* Kukal, Z. (ed.), Proceedings of the 1st International Conference on the Bohemian Massif, Prague, Czechoslovakia, Sept. 26-Oct. 3, 1988, 346.

Wendt, J. I. – Kröner, A. – Fiala, J. – Todt, W. (1993): Evidence from zircon dating for existence of approximately 2.1 Ga old crystalline basement in southem Bohemia, Czech Republic. – Geol. Rundsch., 82: 42–50.