MAFIC GRANULITES OF THE LIŠOV MASSIF, SOUTHERN BOHEMIA: RELICS OF A LATE DEVONIAN MAGMATIC ARC?

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The Lišov granulite Massif (LGM) differs from other granulite bodies in southern Bohemia by a higher proportion of intermediate/mafic and Opx-bearing types (gabbroic granulites to charnockites: Vrána & Jakeš, 1982), association with Spl peridotites and pyroxenites as well as absence of eclogites. The evidence for the HP metamorphism is limited (Kotková, 1998), being largely wiped out by a prolonged MP–HT equilibration (Vrána, 1990). Available is only a single U–Pb Zrc age from a tonalitic granulite (345 ± 5 Ma: van Breemen et al., 1982).

The nature and age of protolith to mafic granulites have remained enigmatic. For this reason we have undertaken a combined study of internal zoning (CL) and LA ICP-MS dating of zircon in a quartz diorite Li–4 (Zvíkov) and a tonalite Li–3 (Vlkovice). In both cases the zircon populations reflect two periods of growth. Many prismatic to needle-like crystals preserve igneous zoning; only some are perhaps recrystallized (blurred primary zones, convoluted zoning: Hoskin & Black, 2000) and/or resorbed and overgrown by irregular, featureless metamorphic rims. Other grains are oval-shaped/anhedral, lacking the internal structure. While the weighted average of 206Pb/238U ages for metamorphic grains/overgrowths in Li-4 is 341 ± 5 Ma (2σ, n = 8), the igneous-looking crystals give 360 ± 4 Ma (MSWD = 0.6, n = 8). A few of the grains contain even older inherited cores (c. 430–600 Ma). An average of 206Pb/238U ages for zircons with metamorphic appearance from Li-3 is 335 ± 6 Ma (MSWD = 1.3, n = 7); igneous grains yield 362 ± 4 Ma (MSWD = 1.2, n = 14). The both data sets thus point consistently to a protolith age of c. 360 Ma and HP metamorphism at c. 340 Ma, the latter age corresponding to the established timing of the metamorphism in the region (Kröner et al., 2000).

The two-pyroxene, essentially Grt-free quartz dioritic–gabbroic granulites (qtzDG) constitute two larger (~4 km²) bodies in the E part of the LGM. Their mineral assemblage is Opx + Cpx + Bt + Pl + Qtz (± Kfs, Hbl). Accessories include Ilm, Ap and Zrc. The protolith to the qtzDG was intruded by thin fine-grained picritic dykes. Even though the dykes show the lowest SiO₂ (~43.5 %) and εNd³⁴ = +2.7, they cannot be little fractionated mantle-derived magmas due to their low Cr (~70 ppm), Ni (~26 ppm), mg# (~62) and high FeO*/MgO (~1.1) (Tatsumi & Eggins, 1995). The qtzDG preserve locally well-developed modal layering; elsewhere they enclose small pyroxenite enclaves (εNd³⁴ = +0.3) that seem to represent disrupted mafic cumulates crystallized from a magma parental to the qtzDG.

The metaluminous granulites qtzDG are rather Na-rich (K₂O/Na₂O = 0.2–0.8), with moderately LREE-enriched REE patterns (CeN/YbN = 5.8–6.4) and slight Eu anomalies (Eu/Eu* = 0.80–0.86). The spiderplots are enriched in LILE, starting at >40 × NMORB (Cs, Rb) and falling to ~0.8 × NMORB (HREE). Most of the patterns feature troughs in Nb as well as bumps in Ba and Pb; P and Zr are depleted only in some samples. Similar LILE/HFSE enrichments are typical of basic igneous rocks from continental arc settings (Tatsumi & Eggins, 1995). The qtzDG show Sr–Nd isotopic signature more primitive (⁸⁷Sr/⁸⁶Sr³⁴₀ = 0.706–0.707; εNd³⁴₀ = -1.7 to -2.4) than the tonalitic, charnockitic and granitic granulites from the LGM (⁸⁷Sr/⁸⁶Sr³⁴₀ = 0.709–0.730; εNd³⁴₀ = -4.2 to -5.4) (Valbracht et al., 1994; Janoušek et al., 2003).
The petrology, age, whole-rock and Sr–Nd isotopic composition of mafic Lišov granulites resemble Late Devonian–Early Carboniferous medium–K calc-alkaline igneous complexes, e.g., the Sázava suite of the Central Bohemian Batholith (354.1 ± 3.5 Ma: Janoušek et al., 2000, 2004) or orthogneisses in the batholith’s roof (373 ± 5 Ma, 365 ± 5 Ma: Košler, 1993; Košler et al., 1993). The mafic Lišov granulites are thought to have originated by Viséan burial and metamorphic reworking of plutonic rocks forming a part of a Late Devonian magmatic arc. The geochemical variation can be explained by extensive fractionation and contamination (AFC/magma mixing) of depleted-mantle melts. The major-element trends for the qtzDG demonstrate that the protolith could have developed by crystallization dominated by Mg- and Ca-rich amphibole and calcic plagioclase, analogously to the model assumed for the Sázava mass (Janoušek et al., 2000). On the other hand, the pyroxenites contain various amounts of diopsidic Cpx cumulate, with subordinate Amph and Opx, presumably derived from more basic members of the suite that could have developed by (Ol–) Cpx fractionation.


