Preservation of Variscan garnet in Alpine metamorphosed pegmatite from the Veporic Unit, Western Carpathians: Evidence from Mm-Nd isotope data

(1 fig.)

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The Sm-Nd isotope system has been used for dating of garnet in the Alpine metamorphosed pegmatite from the southeastern part of the Veporic unit. During the Cretaceous orogeny, metamorphism in this area reached c. 500–620 °C and 7–10 kbar (Janák et al., 2001). The purpose of this study was to determine the age of magmatic crystallization of this, apparently recrystallized pegmatite, because of relatively high closure temperature for the Sm-Nd system in garnet (e.g. Hensen – Zhou 1995).

The investigated rocks occur in the quarry near Rimavská Baňa. The aplite/pegmatite vein is a fine-grained, leucocratic rock consisting of quartz, albite (An_{1-2}), white mica, garnet, chlorite and apatite.

Garnet occurs as small, euhedral to subhedral grains without any distinct microtextural inhomogeneities. They often form clusters and aggregates. Garnet composition is Fe and Mn-rich, with 55–64 mol % of almandine and 32–42 mol % of spessartine component, pyrope (2–4 %) and grossular (0.3–0.4 %) contents are very low. Garnet grains are compositionally homogeneous or only weakly zoned, with Mn and Fe/(Fe+Mg) ratio slightly increasing from core to rim.

White mica occurs as larger subhedral flakes, which are interpreted to be primary magmatic, whereas secondary white micas form small grains replacing both plagioclase and K-feldspar. The subhedral flakes are muscovite with 6.0–6.2 Si p.f.u. The small grains replacing albite are enriched in phengite (6.3–6.45 Si p.f.u.) and the smallest K-white mica, forming along the fractures in Kfs is phengite containing up to 6.6–6.7 Si p.f.u.

Bulk rock composition is acidic (SiO_2 = 75.36%) and strongly peraluminous (A/CNK = 1.32). The content of trace elements is low, being largely controlled by presence of garnet and apatite. REE_N vary between 3–5, showing a flat pattern and negative Eu anomaly. The rock has the character of a slightly fractionated pegmatite (Rb 102, Sr 39, Ba 96, Zr 24 ppm; elevated Sm/Nd ratio). The initial Nd isotopic composition of e (t) = –3.1 indicates a mature crustal, probably metapelitic source.

The host rock of metapegmatite is a fine-grained garnet-biotite gneiss. The mineral assemblage is garnet + biotite + white mica + chlorite + epidote + plagioclase + quartz + rutile/ilmenite.

Garnets are texturally and compositionally inhomogeneous, with apparently older cores and newly-formed rims. Garnet cores are almandine (71 mol %), spessartine (14 %) and pyrope (12 %) rich, the grossular content is low (3 mol %). The garnet cores show fairly homogeneous element distribution, only Mn content and the Fe/(Fe+Mg) ratio slightly increase from core to rim. Garnet rims are grossular (25 mol %) rich, with lower almandine (61 %), spessartine (8 %) and pyrope (8 %) contents.

Biotite has the Fe/(Fe+Mg) ratio between 0.50 and 0.56, and TiO_2 is varying from 0.84 to 1.76 wt %. White mica is phengite with 6.3–6.4 Si p.f.u. Plagioclase is inhomogeneous, the compositions range from An_3 to An_{25}.

Metamorphic pressure – temperature conditions have been estimated from gneiss, using several standard as well as internally consistent geothermobarometric methods. Mineral compositions of co-existing phases in textural equilibrium with garnet rims have been employed. Obtained *P-T* values suggest peak conditions of c. 550 ± 30 °C and 8 ± 1 kbar, corresponding to chloritoid + chlorite + garnet zone during Alpine metamorphism in the southeastern part of the Veporic unit (Janák et al., 2001).

For garnet Sm-Nd isotopic analysis, the grain size of 0.15–0.45 mm and defined magnetic fraction from pegmatite sample RIB2 was hand-picked using a binocular microscope. An optically pure (99.9%) garnet concentrate, and the whole rock, were analysed at the Institute of Geological Sciences, University of Vienna.

The result is a garnet–whole rock isochron age of 339.0 ± 7.7 Ma, and an initial $^{143}Nd/^{144}Nd$ ratio of 0.512040 ± 0.000016 and $\sum$ (t) Nd = –3.1 (Fig. 1).

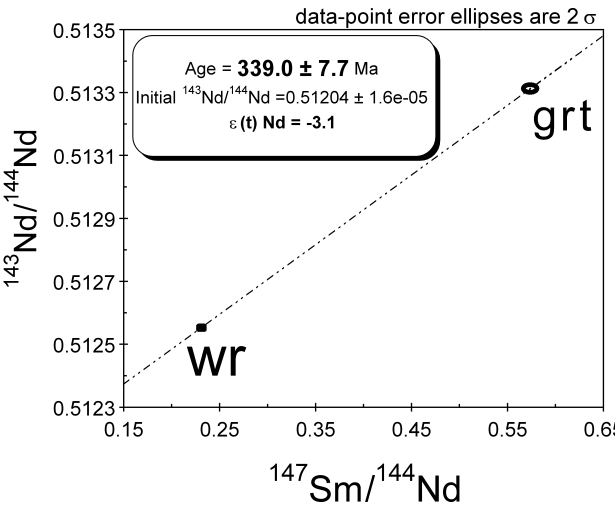

Fig. 1 Sm-Nd garnet (grt)–whole rock (wr) isochron diagram for the studied metapegmatite from the Veporic unit.

High spessartine content (42 %) and the fairly homogeneous element distribution point to a magmatic origin of these garnets. The Sm-Nd result is therefore interpreted as primary crystallization age, probably reflecting the time of emplacement of the pegmatite melt. The obtained Variscan age is compatible with high precision zircon datings from the Tatric unit, where the data range between 340–360 Ma (Poller et al. 2000), recording a main granite-forming event in the Western Carpathians during the Carboniferous. Our results also show that Alpine metamorphism at a temperature of 550–580 °C did not reopen the Sm-Nd isotope system in magmatic Variscan garnet.

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Recrystallisation of zircons during granulite facies metamorphism (Germany, Central Erzgebirge)

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High pressure granulites occur in various parts of the Variscan collisional belt. They form small volumes in the Central Erzgebirge within muscovite orthogneisses („Red Gneisses“). Willner et al. (1997) determined maximum PT conditions of 700–800 °C and 13–20 kbar for granulite gneisses, whereas in adjacent muscovite gneisses maximum conditions do not exceed 10–12 kbar and about 700 °C. Dating of euhedral zircons indicates a protolith age of 480–500 Ma for muscovite ortho-gneisses (Kröner – Willner, 1995; Rötzler et al., 1997; Tichomirowa et al., 2001; Tichomirowa, 2003). Near spherical zircons from granulite gneisses yield $^{207}Pb/^{206}Pb$-evaporation ages of about 340 Ma, interpreted as the age of metamorphic zircon growth during granulite peak conditions (Kröner – Willner, 1995; Mingram – Rötzler, 1999).

In this study samples for zircon dating were selected within a granulite gneiss body and at different distances to this body in the adjacent muscovite gneiss. Zircons of the granulite gneiss are obviously rounded with mostly near spherical and stubby shapes. With increasing distance to the granulite gneiss body zircons of muscovite gneiss samples show less rounded shapes and are more euhedral and prismatic. These changes in morphology are accompanied by an increasing mean $^{207}Pb/^{206}Pb$ zircon evaporation age of the muscovite gneiss samples. Cathodo-luminescence images of zircons show various indications of metamorphic overprint (cores, bright recrystallised zones, low luminescence zones, bright overgrowths, fir-tree zoning). U/Pb spot analyses with ion microprobe within different zones of these zircons are in progress and should contribute to a better understanding of resorption and recrystallisation processes as well as U/Pb reset of zircons during granulite facies metamorphism.

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