Tourmaline orbicules in leucogranites as indicator of geochemical fractionation of late solidus to early subsolidus magmatic fluids

D. BURIÁNEK – M. NOVÁK

Institute of Geological Sciences, Masaryk University, Kotlářská 2, 611 37 Brno; opal@sci.muni.cz, mnovak@sci.muni.cz

Tourmaline-rich orbicules in peraluminous leucogranites are frequently related to Sn mineralization (e.g., Sinclair and Richardson, 1992; Hutchison and Leow, 1963). Such a relationship suggests tourmaline orbicules to be an indicator of greisenitization and ore mineralization (Rozendaal and Bauwer, 1995). In the Moldanubicum texturally very similar tourmaline orbicules occur in primitive, leucocratic, medium- to fine-grained, muscovite-biotite granites.

Orbicular tourmaline granites (OTG) in the Moldanubicum are spatially associated with the durbachite plutons (Třebíč, Milevsko, Rastenberg etc.). The OTG compose small intrusive bodies and dykes, scarcely up to 200 m thick, which cut durbachites and host metamorphic rocks. Quartz + tourmaline ± feldspars orbicules, up to 10 cm in diameter, or rare veins, up to 2 cm thick, are randomly distributed or concentrated in several m thick zones within bodies of leucocratic granites. Subhedral tourmaline is intersticial between euhedral grains of feldspars and quartz, and it replaces dominantly plagioclase and K-feldspar. The accessory minerals include apatite, andalusite, cordierite, ilmenite-pyrophanite, zircon, allanite, xenotime and monazite in granite; apatite is fairly abundant in orbicules.

The OTG exhibit very similar geochemical signature; they are syn- to post-collisional peraluminous S-type granites: ASI = 1.0–1.3; Fe_2O_{3tot} = 0.42–2.08 wt%; X_{Fe} = 0.75–0.92; CaO = 0.49–0.87; Rb = 194–234 ppm; Ba = 101–887 ppm; Sr = 38–191 ppm; Sn = 0,5–32 ppm; Zn = 1–35 ppm; K/Rb = 115–283; ∑REE = 20.1–99.8 ppm with slight LREE enrichment La_N/Lu_N = 1.9–6.8. Low CaO /Na_2O = 0.1–0.2 indicates melts derived from clay-rich, plagioclase-poor pelitic rocks (Sylvester, 1998). Tourmaline orbicules and host granites exhibit comparable concentrations of Sn = 12 ppm, Zn = 16–2 ppm and Sn = 0.5–16 ppm, Zn = 4–14 ppm, respectively.

Tourmaline (Al-rich schorl-dravite to foitite) exhibits: X_{Fe} = 0.90–0.14, commonly 0.84–0.45; Al^Y = 0.85–0.12; *apfu* Na = 0.89–0.31 *apfu;* Ca = 0.13–0.0 *apfu*; F = 0.4–0.0 *apfu*. Low concentrations of Mn, Zn and Ti are typical. Increase in Al^Y and X_{Fe} and decrease in Na and Ca in tourmaline during crystallization are typical. Tourmaline may locally exhibit apparent zoning.

Tourmaline-rich orbicules from greisen-related granites (Rozendaal and Bauwer, 1995; Sinclair and Richardson, 1992) are situated in marginal and apical parts of granite bodies or near Sn-Zn-(W) vein mineralization. Granites are leucocratic, peraluminous: ASI = 1.06–1.38; Fe_2O_{3tot} = 0.72–2.19 wt%; X_{Fe} = 0.89–0.97; Rb = 327–1809 ppm; Ba = 13–405 ppm; Sr = 9–176 ppm; K/Rb = 18.3–147.2. The concentrations of Sn = 0.4–42.6 ppm and Zn = 88–477 ppm in orbicules are significantly higher relative to host granites with Sn = 9–13 ppm and Zn = 17–31 ppm.

Tourmaline (Al-rich schorl to schorl) in orbicules from greisen-related granites shows: X_{Fe} = 0.99–0.76; Al^Y 0.0–0.77 *apfu*; Na = 0.98–0.52 *apfu*; Ca = 0.0–0.06 *apfu*; F = 0.94–0.20 *apfu*. Tourmaline exhibits slight increase in Al^Y during crystallization.

The tourmaline-quartz orbicules seem to be a product of crystallization of evolved, B-rich fluids during late solidus to early subsolidus stage of granite formation. These granites exhibit different degree of fractionation expressed by composition of tourmaline (X_{Fe}, F), tourmaline orbicules (X_{Fe}, Sn, Zn) and host granites (X_{Fe}, K/Rb, Sr, Ba) as well. Formation of tourmaline orbicules is not related exclusively to highly evolved granitic rocks and its composition may be used as a useful indicator of geochemical fractionation of the host granite.

References

Clarke, D. B. (1992): The mineralogy of peraluminous granites: A review. – Can. Mineral. 19, 3–17.

Hutchison, C. S. – Leow J. H. (1963): Tourmaline greisenization in Langkawi, northwest Malaya.– Econ. Geol. 58, 587–597.

Rozendaal, A. – Bruwer L. (1995): Tourmaline nodules: indicators of hydrothermal alteration and Sn-Zn-(W) mineralization in the Cape Granite Suite, South Africa. – Journal of African Earth Siences 21, 1, 141–155.

Sinclair, W. D. – Richardson, J. M. (1992): Quartz-tourmaline orbicules in the Seagull batholith, Yukon Territory. – Can. Mineral. 30, 923–935.

Sylvester, P. J. (1998): Post-collisional strongly peraluminous granites. – Lithos 45, 29–44.