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ORIGINAL PAPER

Tourmaline occurrences within the Penamacor-Monsanto granitic pluton and host-rocks (Central Portugal): genetic implications of crystal-chemical and isotopic features

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Abstract Tourmalinization associated with peraluminous granitic intrusions in metapelitic host-rocks has been widely recorded in the Iberian Peninsula, given the importance of tourmaline as a tracer of granite magma evolution and potential indicator of Sn-W mineralizations. In the Penamacor-Monsanto granite pluton (Central Eastern Portugal, Central Iberian Zone), tourmaline occurs: (1) as accessory phase in two-mica granitic rocks, muscovite-granites and aplites, (2) in quartz (±mica)-tourmaline rocks (tourmalinites) in several exocontact locations, and (3) as a rare detrital phase in contact zone hornfels and metapelitic host-rocks. Electron microprobe and stable isotope ($\delta^{18}O$, δD, $\delta^{11}B$) data provide clear distinctions between tourmaline populations from these different settings: (a) schorl–oxyschorl tourmalines from granitic rocks have variable foititic component ($^{X}\square$ = 17–57 %) and Mg/(Mg + Fe) ratios (0.19–0.50 in two-mica granitic rocks, and 0.05–0.19 in the more differentiated muscovite-granite and aplites); granitic tourmalines have constant $\delta^{18}O$ values (12.1 ± 0.1 ‰), with wider-ranging δD (−78.2 ± 4.7 ‰) and $\delta^{11}B$ (−10.7 to −9.0 ‰) values; (b) vein/breccia oxyschorl [Mg/(Mg + Fe) = 0.31–0.44] results from late, B- and Fe-enriched magma-derived fluids and is characterized by $\delta^{18}O$ = 12.4 ‰, δD = −29.5 ‰, and $\delta^{11}B$ = −9.3 ‰, while replacement tourmalines have more dravitic compositions [Mg/(Mg + Fe) = 0.26–0.64], close to that of detrital tourmaline in the surrounding metapelitic rocks, and yield relatively constant $\delta^{18}O$ values (13.1–13.3 ‰), though wider-ranging δD (−58.5 to −36.5 ‰) and $\delta^{11}B$ (−10.2 to −8.8 ‰) values; and (c) detrital tourmaline in contact rocks and regional host metasediments is mainly dravite [Mg/(Mg + Fe) = 0.35–0.78] and oxydravite [Mg/(Mg + Fe) = 0.51–0.58], respectively. Boron contents of the granitic rocks are low (<650 ppm) compared to the minimum B contents normally required for tourmaline saturation in granitic melts, implying loss of B and other volatiles to the surrounding host-rocks during the late-magmatic stages. This process was responsible for tourmalinization at the exocontact of the Penamacor-Monsanto pluton, either as direct tourmaline precipitation in cavities and fractures crossing the pluton margin (vein/breccia tourmalinites), or as replacement of mafic minerals (chlorite or biotite) in the host-

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