Fluid sources of the Panasqueira W-Sn-Cu deposit (Portugal): evidence from chemical and boron isotopic compositions of tourmaline

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The Panasqueira W-Sn-Cu vein-type deposit in Portugal is Europe's largest tungsten deposit. The subhorizontal W-Sn-Cu-bearing quartz veins are hosted by metasedimentary units of the Beira Schists and spatially related to a greisenized cupola of a late-Variscan, peraluminous, S-type granite [1]. Tourmaline is absent in the greisen but abundant in wallrock alteration zones which predate the main ore stage. Tourmaline is also found in late-stage vugs. The origin of the mineralizing fluids and the hydrothermal processes controlling ore formation are still debated.

We report results from high-resolution in-situ measurements (microprobe and SIMS) showing the variations in chemical and boron isotopic compositions of tourmalines from the Panasqueira deposit. All tourmalines have intermediate schorl-dravite compositions and display optical and chemical zoning. The results show a systematic increase in Fe, as well as a tendency for F and Na to increase from core to rim, while Mg, Al and Ca tend to decrease in the same direction. The B-isotope compositions at Panasqueira are remarkably homogeneous at $\delta^{11}B$ -9 ± 2 ‰, including tourmaline from the wallrocks and vugs. These values are compatible with either metasedimentary or granitic sources. However, given the great volume of tourmaline in the wallrocks as well as the association with other elements such as F, W, Sn, Ta, Nb, we consider a boron source from the adjacent S-type granite more likely.

The results suggest a dynamic hydrothermal system with multiple injections of magmatic-dominated fluids [2]. The variations in tourmaline composition are interpreted to reflect a combination of cooling and changes from wallrock- to fluid-dominated conditions.

[1] Kelly and Rye (1979) Econ. Geol. **74**: 1721-1822.
[2] Foxford *et al.* (2000) J. Struct. Geol. **22**:1065-1086.