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Chemical and boron isotope microanalysis of tourmalines as a guide to fluid-rock interaction in the Habachtal emerald deposit, Tauern Window, Austria

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Tourmalines from the Habachtal emerald deposit in the Eastern Alps formed together with emerald in a ductile shear zone during blackwall metasomatism between pelitic country rocks and a serpentinite body. Electron microprobe and secondary ion mass spectrometric (SIMS) analyses provide a record of chemical and B-isotope variations in tourmalines which represent an idealized profile from metapelites into the blackwall sequence of biotite and chlorite schists. Tourmaline is intermediate schorl-dravite in the country rock and become increasingly dravitic in the blackwall zones, while F and Cr contents increase and Al drops. Metasomatic tourmaline from blackwall zones is typically zoned optically and chemically, with rim compositions rich in Mg, Ti, Ca and F compared with the cores. The total range in delta-11B values is -13.8 to -5.1 permil and the within-sample variations are typically 3 to 5 permil. Both of these ranges are beyond the reach of closed-system fractionation at the estimated 500-550C conditions of formation, and at least two boron components with contrasting isotopic composition are indicated. A key observation from tourmaline core analyses is a systematic shift in delta-11B from the country rock (-14 to -10 permil) to the inner blackwall zones (-9 to -5 permil). We suggest that two separate fluids were channeled and partially mixed in the Habachtal shear zone during blackwall alteration and tourmaline-emerald mineralization. A regional metamorphic fluid carried isotopically light boron as observed in the metapelite country rocks. The other fluid is derived from the serpentinite association and has isotopically heavier boron typical for MORB or altered oceanic crust.