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Compositional asymmetry in replacement tourmaline—An example from the Tauern Window, Eastern Alps

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Abstract

Tourmaline, partially replacing pre-existing tourmaline from a tectonically dismembered tourmalinite vein, has developed distinctive compositional asymmetry that reflects influx of reactive fluids. The tourmalinite clast, enclosed in a quartzite from the Tauern Window, Eastern Alps, experienced a clockwise *P-T-t* path with maximal burial depths of 35–40 km (10–11 kbar), peak temperatures of ~550 °C, and major deformation preceding peak thermal conditions. The primary tourmaline of the tourmalinite clast, generation-1, is texturally and compositionally heterogeneous, ranging from schorl to dravite [Mg / (Mg + Fe) = 0.27 – 0.61] with highly variable Al consistent with combinations of the $^{X}\square Al(NaR)_{-1}$ and $AlO[R(OH)]_{-1}$ exchange vectors, where $^{X}\square$ represents X-site vacancy and R is Fe^{2+} + Mn + Mg. Generation-2 tourmaline is manifest as distinctive compositionally asymmetric bands of colorless foitite (zone 1) and blue schorl (zone 2) replacing generation-1 tourmaline. Replacement takes place along a scalloped margin and advances preferentially towards the analogous pole (-c) of generation-1 tourmaline. The two zones of generation-2 range from foitite to schorl with a restricted ratio of Mg / (Mg + Fe) of 0.32 – 0.41, but with variable $^{X}\square$, Al, Na, and R predominantly reflecting $^{X}\square Al(NaR)_{-1}$. Post-deformational generation-3 tourmaline ranges from schorl to foitite and partially pseudomorphs generations-1 and generations-2 tourmaline. Deformation and fracturing of primary tourmaline (generation 1) from the tourmalinite clast provided access to reactive fluids with adequate chemical affinity to produce partial tourmaline replacement. It is likely that the reactive fluid was a neutral-to-alkaline aqueous fluid phase with relatively low Na contents.

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