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Tourmaline-rich features in the Heemskirk and Pieman Heads granites from western Tasmania, Australia: Characteristics, origins, and implications for tin mineralization

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Abstract

Distinctive magmatic-hydrothermal, tourmaline-rich features have developed in the Heemskirk and Pieman Heads granites from western Tasmania, Australia. They are categorized as tourmaline-rich patches, orbicules, cavities, and veins, based on their distinctive morphologies, sizes, mineral assemblages, and contact relationships with host granites. These textural features occur in discrete layers in the roof zone of granitic sills within the Heemskirk and Pieman Heads granites. Tourmaline patches commonly occur below a tourmaline orbicule-rich granitic sill. Tourmaline-filled cavities have typically developed above the tourmaline-quartz orbicules in the upper layer of the white phase of the Heemskirk Granite. Tourmaline-quartz veins penetrate all exposed levels of the granites, locally cutting tourmaline orbicules and cavities.

The tourmalines are mostly schorl (Fe-rich) and foitite, with an average end-member component of schorl$_{45}$ dravite$_{6}$ tsilaisite$_{1}$ uvite$_{0}$ Fe-uvite$_{3}$ foitite$_{31}$ Mg-foitite$_{4}$ olenite$_{10}$. Element substitutions of the tourmalines are controlled by $FeMg_{-1}$, $^{Y}Al^{X}\square(R^{2+}Na)_{-1}$, and minor $^{Y}AlO(R^{2+}OH)_{-1}$ (where $R^{2+} = Fe^{2+} + Mg^{2+} + Mn^{2+}$) exchange vectors. Several trace elements in tourmaline have consistent chemical evolutions grouped from tourmaline patches, through orbicules and cavities, to veins. There is a progressive decrease of most transition and large ion lithophile elements, and a gradual increase of most high-field strength elements. These compositional variations in the different tourmaline-rich features probably relate to element partitioning occurring in these phases due to volatile exsolution and fluxing of aqueous boron-rich fluids that separated from the granitic melts during the emplacement of S-type magmas into the shallow crust (4 to 5.5 km).

Tourmalines from the Heemskirk Granite are enriched in Fe, Na, Li, Be, Sn, Ta, Nb, Zr, Hf, Th, and rare earth elements relative to the tourmalines from the Pieman Heads Granite, but depleted in Mg, Mn, Sc, V, Co, Ni, Pb, Sr, and most transition elements. These results imply that bulk compositions of the host granites exert a major control on the chemical variations of tourmalines. The trace element compositions of tourmalines from the Sn-mineralized Heemskirk Granite are different from those of the barren Pieman Heads Granite. Trace element ratios (e.g., Zn/Nb, Co/Nb, Sr/Ta, and Co/La) and Sn concentrations in tourmaline can distinguish the productive Heemskirk Granite from the barren Pieman Heads Granite.

Keywords: Tourmaline, orbicules, mineral chemistry, granites, Tasmania