Tourmaline Mineral Chemistry as a Tool to Discriminate Mineralized from Barren Sn Granites, Western Tasmania, Australia

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Several world-class Sn-W skarn deposits in western Tasmania (e.g., Renison Bell, Mt. Bischoff, and the King Island field) are associated with I- and S-type granitic intrusions emplaced following the Tabberabberan orogeny. The Heemskirk and Pieman Heads granites are well exposed along the western coast of Tasmania. More than 30 historical Sn-W workings, Pb-Zn-Ag veins, and Fe skarn and rare Ni deposits occur within and adjacent to the Heemskirk batholith. In contrast, no mineralization has been discovered yet with the Pieman Heads Granite, despite geological and geochemical similarities with the Heemskirk batholith. The Heemskirk batholith is divided into a white and a red phase, determined simply by the color of orthoclase. Zircon U-Pb age constraints suggest that the White Heemskirk and Pieman Heads granites were emplaced contemporaneously (364.1 ± 6.7 and 365.5 ± 3.9 Ma, respectively). Yet the mineralized intrusion (mainly the white phase) has slightly more felsic contents, higher Rb/Sr ratios, and incompatible elements, indicating that it has more strongly experienced fractional crystallization than the barren pluton.

Both the White Heemskirk and Pieman Heads granites share analogous magmatic-hydrothermal textures which include tourmaline patches, tourmaline-quartz orbicules, and tourmaline veins, whereas tourmaline-filled cavities and quartz-dominated unidirectional solidification textures only occur in the White Heemskirk Granite. These tourmaline-rich textures are broadly developed in the apical regions of the intrusions and, specifically, the tourmaline orbicules (or cavities) commonly occur in a layer higher than the tourmaline patches. Crosscutting relationships observed in the field indicate that tourmaline veins formed after the tourmaline orbicules. EMPA and LA-ICP-MS analyses of tourmaline show that Al, Mg, Sc, V, Co, Ni, Pb, Sr, and rare earth elements are more enriched in tourmaline from the Pieman Heads Granite relative to tourmaline from the Heemskirk Granite. Tourmaline from the Heemskirk Granite is enriched in Fe, Na, Sn, Ta, Nb, Zr, Hf, and Th relative to tourmaline from the Pieman Heads Granite. Trace element concentrations in tourmaline also vary between the different tourmaline-rich textures. In both granites, most transition elements (e.g., Sc, V, Cr, Co, Ni) and large ion lithophile elements (e.g., Sr, Pb) decrease, whereas high field strength elements (HFSEs) increase in concentration sequentially from tourmaline patches to orbicules and to veins. Tourmaline in veins commonly has higher Sn concentrations than tourmaline from all other textural groups. Overall, Sn displays a positive correlation with HFSEs (e.g., Ta, Nb, Th, Hf, Zr), but a negative correlation with Sc, V, Cr, Co, Ni, Pb, and Sr. The chemical heterogeneities between individual tourmalines herein are interpreted to constrain bulk composition of the host rocks, volatile exsolution of the crystallizing magmas, redox state, and multiple-phase fluids as well as possible crystallographic effects. The magmatic-hydrothermal fluids exsolved from associated granites tend to play a first-order control on the chemical variations of tourmalines in igneous systems. Since tourmaline can directly record the nature of the fluids it precipitates, we tentatively consider that tourmaline grains which are enriched in Fe, Na, and HFSEs but depleted in transition elements have the potential to provide beneficial clues in distinguishing fertile tin-forming intrusions from barren granites.