Tourmaline: The Perfect Accessory

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The search to provide insights into the Earth's evolution is increasingly found in the chemistry of accessory minerals. Members of the tourmaline supergroup retain signatures spanning the realm of processes; from magmatic growth, to thermal and baric conditions of burial, to infiltrative fluid compositions and their origins, to sedimentary provenance, and to the age of the rock's formation and its resurfacing. In some cases, all of these can be found in a single crystal. While decoding the processs information is more complete in some areas, recent advances in, for example, provenance studies, trace-element compositions, and thermochemistry, yield new insights into the petrogenetic utility of tourmaline. New directions manifest, in part, from tourmalines' ever- expanding compositional realm.

Since the 2011 Tourmaline issue, the number of tourmaline species has nearly doubled (from 18 to 30). Twelve new species have been reported, predicted based on interplay of the crystal chemical and crystallographic constraints (Henry *et al* 2011). Many of the new endmembers involve occupany of the (W) anion site to produce oxy- and fluor- dominant species, compositions that typically track their (hydrothermal) fluid envelope. For instance, the oxy-dravite - povondraite (O-P) trend appears to be diagnostic of growth in low temperature hypersaline environments, compositional signatures that are retained through metamorphism. Fluorine content in tourmaline often reflects magmatic fractination. In tourmaline in contrast, ultra-high pressure environments appears to be characterized by high K contents in the large X cation site. Thus, tourmaline's geochemical thermal-baric-fluid fingerprint extends from near surface conditions to the deep mantle.

These chemical identities are used increasingly as an exploration tool for precious metal deposits or for reconstructing paleogeography. As sediment provenance is increasingly used to track changes in sediment supply and drainage patterns, tourmaline - long known as one of the 'big three' heavy minerals - is now capable of providing subtle chemical signatures that elludicate specific rock units and information on paleotopographic evolution. This richness in tourmaline chemistry lends itself to new techniques for determining provenance.

As one of the earliest formed minerals in the crust, tourmaline contines to record the geologic history across the environmental spectrum of the Earth.

[1] Henry, D. J. *et al* (2011) *Am. Min.* **96**, 895-913