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The geothermobarometric potential of tourmaline, based on experimental and natural data

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ABSTRACT

The geothermobarometric potential of tourmaline has been assessed by investigating element exchange among tourmaline and coexisting minerals in metamorphosed pelites and graywackes, and in experimental exchange between tourmaline and biotite. In the natural samples, a temperature dependence of tourmaline Mg-Fe exchange with biotite, staurolite, garnet, chlorite, and muscovite, and Ca-Na exchange with plagioclase is observed. Equilibrium calculations for the complete mineral assemblage show that tourmaline is in compositional equilibrium with all coexisting phases, which would allow for an internally consistent set of thermometers among all these phases to be defined. However, a prohibitively large spread is present in the K_D vs. T relations. This is not caused by analytical effects, compositional zoning, or disequilibrium among the minerals. The experimental results show that it is the result of inter-site partitioning of elements over the Y and Z octahedral sites of tourmaline. Variations in the element distribution over these sites, their relative participation in the exchange and differences in the temperature dependence of exchange with each site, strongly affects the K_D vs. T relation observed, with the slope actually changing sign depending on the elements residing at each site. Non-ideal interactions among the elements at each site will also affect this, and furthermore link every exchange to the bulk tourmaline composition, and hence the element mobility in the rock. The promising potential of tourmaline geothermobarometry can therefore not be fulfilled until effects of inter-site partitioning and non-ideal interactions are known.

Keywords: Tourmaline, mineral exchange, experiments, geothermobarometry, inter-site element distribution