Rb-Sr and Sm-Nd systematics of tourmaline from the highly fractionated Mole Granite, eastern Australia

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Multiple generations of tourmaline commonly accompany cassiterite-bearing Sn deposits, both within the granite and associated with mineralisation in veins, breccia pipes and greisens; this results from the incompatible behavior, and consequent enrichment of boron during granite fractionation into late-stage melts and fluids. To explore the use of tourmaline for determining primary compositions and subsequent evolution of melts and fluids leading to Sn mineralisation, we determined the Sm-Nd and Rb-Sr isotopic compositions of tourmaline, and whole rock granite samples from magmatic and hydrothermal environments within and surrounding the Mole Granite in the New England batholith of eastern Australia.

Magmatic and hydrothermal tourmaline, and whole rock analyses of the Mole Granite define a $^{147}Sm/^{144}Nd$ vs. $^{143}Nd/^{144}Nd$ isochron age of 243 ± 59 Ma and an initial $^{143}Nd/^{144}Nd_{(i)}$ of 0.512421 or εNd of –4.23. This isochron age is consistent with numerous zircon U-Pb ages for the Mole Granite (e.g. Schaltegger et al. 2005), and indicates that the parental magmatic and hydrothermal fluids of the tourmaline were in isotopic equilbrium in regards to Sm-Nd. In addition, 15 whole rock granite compositions from this study and the literature define a $^{87}Rb/^{86}Sr$ and $^{87}Sr/^{86}Sr$ isochron with an age of 246.1 ± 3.0 Ma and $^{87}Sr/^{86}Sr_{(i)}$ of 0.7085 ± 0.0059. Conversely, Rb-Sr isotope compositions of hydrothermal tourmaline do not define an isochron. Magmatic to hydrothermal tourmaline displays a trend from $^{87}Sr/^{86}Sr_{(i)}$ of 0.71064 and 0.70997 within the granite to 0.70632–0.70843 in hydrothermal settings within and surrounding the granite. We attribute this contrast in $^{87}Sr/^{86}Sr_{(i)}$ between magmatic and hydrothermal environments to prolonged open-system behaviour of Rb-Sr within the granite boundaries, sustained by a high heat flux. Conversely, hydrothermal fluids cooled quickly when injected into the cooler surrounding rocks. Using estimates of the Rb/Sr of the melts and fluids, we constrain the duration the Rb-Sr system remained open within the granite mass for approximately *ca* 300 ka.