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Apatite Sm-Nd and U-Pb isotopes unravel crust-mantle interactions in the Fraser Zone, Western Australia

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The U-Pb and Sm-Nd systematics of apatite have proven to be a valuable tool in understanding magmatic and metamorphic processes [1]. The prevalence of apatite in silica- undersaturated lithologies offers an advantage over other established geochronological tracers (e.g., zircon) to track crustal evolution [2]. The evolution of the Mesoproterozoic Fraser Zone (Albany-Fraser Orogen, Western Australia), a region prospective for orthomagmatic Ni-Cu mineralization and comprising dominantly mafic lithologies, is not well constrained despite its economic and tectonic significance. Here we present apatite and bulk rock Sm-Nd isotopic data from gabbroic rocks of the Fraser Zone, with isotopic maps decrypting its enigmatic architecture. Apatite U-Pb ages reveal an orogen-wide cooling episode (<600 °C) at c. 1150 Ma, towards the end of the last major orogenic event in the region. Some samples scatter from a single common–radiogenic mixing line consistent with recrystallization. Apatite Sm-Nd, with a higher closure temperature of >700 °C, yields c. 1300 Ma isochrons, consistent with magmatic crystallization as elsewhere determined by zircon for the host mafic magmas. In spite of similar crystallization ages, initial Nd isotopic ratios vary between and sometimes even within samples, the latter interpreted as either a result of dissimilar crystallization fluid (e.g., incomplete mixing of juvenile, mantle-derived magma with an evolved crustal source) or variable recrystallization that disturbed the Sm-Nd system. Overall, isotopic patterns in apatite and bulk rock reveal that the eastern margin of the Fraser Zone exhibits a stronger crustal influence (εNd(t) up to –22) and becomes more juvenile towards the west (εNd(t) >0). The wide array of εNd values throughout the orogen is consistent with variable proportions of crustal recycling and assimilation of underlying Archean lithosphere, which might have controlled mineralization in the Fraser Zone.

[1] Kirkland, Yakymchuk, Szilas, Evans, Hollis, McDonald & Gardiner (2018), *Lithos* **318-319**, 143-157

[2] Piccoli & Candela (2002), *Reviews in Mineralogy and Geochemistry* **48**, 255-292