Fractionation of Li and Fe isotopes at magmatic temperatures

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Variations of Li and Fe isotopes in high temperature environments have been extensively studied over the last 5 years. Both isotope systems show significant isotope fractionation at mantle temperatures. The largest fractionation for Li, which can exceed 10‰ [1, 2], appears to be driven by diffusion. Equilibrium fractionation, e.g. between mantle minerals is also feasible [3], but is an order of magnitude smaller than kinetic fractionation. There is currently little evidence for Li isotope fractionation during partial melting in the mantle. The large extent of iron isotope fractionation in the mantle (up to 1‰) is likely also driven by disequilibrium processes [4, 5]. Fe is also fractionated between mantle minerals (e.g. Beard and Johnson, 2004), but most likely this fractionation is also caused by kinetic processes. In contrast to Li however, Fe isotopes are most likely fractionated during partial melting or at least between the lithospheric mantle and the crust [4-8]. This is indicated by two observations: (1) basalts and other crustal rocks are isotopically heavier than peridotites (by $\approx 0.1‰$ on average), and (2) peridotites display correlations of the Fe isotope composition and the degree of depletion. However, we have currently little evidence, as to whether this fractionation documents equilibrium between mantle minerals and melt or is caused through kinetic processes, e.g. during melt percolation in the mantle.

We have commenced investigating Li and Fe isotope systematics at magmatic temperatures between basaltic melts and olivine and pyroxene phenocrysts. As these phenocrysts evolved from the melt, we can assume conditions, which are close to isotopic equilibrium. Accordingly, isotope fractionation between melt and such phenocrysts can be used as an indicator for the extent of isotope fractionation that may occur during equilibrium melting.

[1] Rudnick & Ionov (2007) *EPSL* **256**, 278-293. [2] Ionov & Seitz (2008) *EPSL* **266**, 316-331. [3] Seitz *et al.* (2004) **212**, 163-177. [4] Williams *et al.* (2005) *EPSL* **235**, 435-452. [5] Weyer & Ionov (2007) *EPSL* **259**, 119-133. [6] Weyer *et al.* (2005) *EPSL* **240**, 251-264. [7] Schönberg & von Blanckenburg (2006) *EPSL* **252**, 342-359. [8] Weyer *et al.* (2007) *EPSL* **256**, 638-646.

Cumberland batholith petrogenesis: Implications for Paleoproterozoic crustal and orogenic processes

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Paleoproterozoic, large volume, felsic plutonic belts, such as the ~124,000 km^2, ca. 1.86 Ga Cumberland batholith (CB) Trans-Hudson orogen, have often been interpreted as continental arc batholiths. CB petrogenesis, tectonic context and implications for crustal growth/recycling were examined based on a 900 km geochemical-isotopic (Nd-O) transect across the CB and into bounding Archean Rae (central Baffin Is.) and Superior (south Baffin Is.) cratons.

Results include: CB emplaced over >17 Ma; largely at granulite-grade; mainly high-K but includes low- and medium-K compositions; mainly metaluminous to slightly peraluminous; infracrustal-derived granitoid $\delta^{18}O$ (VSMOW) values (+6 to +10‰); includes arc, within-plate and post-collisional affinity granites; volumetrically minor mafic rocks with both arc and non-arc features; granite $(La/Yb)_{CN}$ range of <1 to 225; ε_{Nd} 1.86 Ga signatures (-12 to -2) mostly more radiogenic than bounding basement blocks (-8 to -15); paucity of xenocrystic zircon; and, zircon saturation temperatures >800 ºC.

The CB is interpreted as ‘imaging’ an accreted Meta Incognita microcontinent (average T_{DM} = 2.4 Ga) and its bounding Archean cratons. It likely encompasses many non-consanguineous magmatic suites/pulses generated at deep- to mid-crustal depths. Rather than CB being an arc batholith, we suggest a post-accretion, slab-breakoff-related origin and, based on its width and by analogy to the Paleozoic Appalachian orogen, that it may reflect multiple accretion-breakoff events.