Stable Isotope Composition of the Archean Slave Subcontinental Lithospheric Mantle as a Tracer of Metasomatism

The mechanisms behind the formation and stabilization of Archean crustal provinces and the underlying lithospheric mantle are poorly understood. There are two end-member models for the formation of the Archean subcontinental lithospheric mantle (SCLM): 1) decompression melting within a plume; and 2) subduction-related melting followed by accretion. Stable isotopes are a powerful tool for examining material fluxes between the Earth's surface and interior, and thus may provide a means of testing the above models for lithosphere formation. In particular, pairing stable isotope data with geochemical tracers of subduction can be an effective, yet underutilized, method for detecting subducted components in the mantle. Here we present oxygen, calcium, and hydrogen isotope data for garnet lherzolite xenoliths from the Archean Slave Craton, NWT, Canada. Garnets from this sample suite are characterized as having high Cr_2O_3 content (>5 wt%) either due to the metamorphic formation of garnet from spinel peridotites or by interactions with a metasomatic fluid/melt. In general, $\delta^{18}O_{gt}$ values and $\Delta^{18}O_{gt\text{-}olv}$ are lower (avg = +5.30‰ and -0.01‰, respectively) than expected equilibrium values at mantle temperatures and show a strong correlation of decreasing values with increasing garnet H_2O and Na_2O content, suggesting garnet growth is due to interaction with a metasomatic fluid/melt with low $\delta^{18}O$. Ca isotope data from the Slave SCLM has an average $\delta^{44/40}Ca_{cpx}$ = +0.97‰ (n = 7, ranging from +0.81‰ to +1.12‰), with a correlation of decreasing $\delta^{44/40}Ca_{cpx}$ values with increasing whole rock SiO_2 content. This trend is consistent with interaction with a ^{40}Ca-enriched metasomatic melt/fluid that is possibly related to the Si-enrichment commonly observed in Archean mantle xenoliths [1]. These observations suggest the Slave SCLM was metasomatized by an isotopically distinct component that could be either subduction-derived or related to the kimberlitic magma that entrained these xenoliths. The presence of hydrous, multi-mineral kelyphitic rims ($\delta D_{average}$ = -124‰) around garnet suggests garnet breakdown is related to kimberlite metasomatism. Further constraining the timing and nature of this metasomatism will provide insight into the role of subduction (if at all) during Archean Slave SCLM formation.

[1] Canil and Lee (2009), *Geology* 37, 667-670.