Garnet as a recorder of metasomatism in the sub-continental lithospheric mantle

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Metasomatism by fluid or melt is commonly attributed as the cause of chemical and modal heterogeneity observed in peridotite xenoliths from the sub-continental lithospheric mantle. Documented manifestations are (1) perturbation of the oxygen fugacity (fO_2), which may affect the stability of carbon-bearing phases, and (2) trace-element enrichment, typified by the shape of REE_N patterns. Garnet, which contains Fe^{2+} and Fe^{3+} in measurable quantities, and exhibits prominent variation in REE_N patterns between samples, may record the metasomatic history of the mantle.

Here we report variations of fO_2 and trace element concentrations for a suite of 22 garnet-bearing peridotite xenoliths from the Louwrensia kimberlite, south-central Namibia. The xenoliths span an estimated pressure range between 2.7 and 4.5 GPa. $Fe^{3+}/\sum Fe$ of garnet was determined by Fe K-edge XANES spectroscopy. Concomitant fO_2 was calculated using the oxybarometer calibration of Miller et al. [1]. The trace element concentrations of all phases were determined by LA-ICP-MS.

A global dataset comprising 454 garnet REE_N patterns from 19 kimberlites has been compiled. The REE_N pattern of each sample was fit to orthogonal polynomial functions that parameterise the abundance, slope, quadratic curvature, and cubic curvature [2]. Quadratic and cubic curvature correlate with abundance, albeit with considerable scatter. There is, however, an absence of correlation between REE_N patterns and fO_2, depth, or modal abundance. This is in contrast to correlations and trends observed for basaltic melts that clearly identify petrogenetic trends. The partitioning of REEs between garnet and co-existing phases in these samples highlights pronounced trace-element disequilibrium and hence question the validity of considering garnet REE_N in isolation as a means of discerning metasomatic history.

[1] Miller, Holland & Gibson (2016), *J. Pet.* 57, 1199-1222.
[2] O'Neill (2016), *J. Pet.* 57, 1463-1508.