Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.23213

Investigation of F and Cl in mantle xenoliths from Tariat, Mongolia and Eastern Australia.

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The critical role of F-Cl as tracers for upper mantle fluid activity requires a profound understanding of these elements during mantle melting and metasomatism. Here we use intraplate lava hosted mantle xenoliths from two locations; first with different degrees of melt depletion; and second with different degrees of known metasomatism to study their behaviours.

Sensitive High-Resolution Ion MicroProbe (SHRIMP) has been used to measure F, Cl, and H_2O in olivine, orthopyroxene, clinopyroxene, and Al-Cr spinel from variably depleted lherzolites from Tariat, Mongolia, and variably enriched lherzolites from Eastern Australia (Atherton, Toowoomba, and Victoria).

We find that nominally anhydrous minerals in mantle xenoliths from each region contain 0.6-308 ppm F and only 0.2-2.4 ppm Cl. As in previous studies, halogens are preferentially incorporated into clinopyroxene, which has minimum concentrations of 6.3 ppm F and 0.3 ppm Cl. Relative mineral compatibility can be ranked as clinopyroxene > orthopyroxene >> olivine > spinel for F, and clinopyroxene > orthopyroxene ≥ olivine > spinel for Cl.

The Tariat samples have MgO ranging from 39 to 45 wt.% reflecting different degrees of melt depletion. The samples with the highest MgO have the lowest concentrations of F and Cl consistent with extraction of incompatible elements from depleted samples. The Australian xenoliths are variably enriched in LREEs. On average, Atherton xenoliths are depleted (La/Sm = 0.2-1.8), Toowoomba xenoliths are more enriched (La/Sm = 1.1-8.4), and the Victorian xenoliths are the most enriched (La/Sm = 0.8-9.9). Average F concentrations for each location broadly correlate with enrichment but all the xenoliths are similarly depleted in Cl irrespective of La/Sm enrichment.

Whole rock powders prepared from dominantly fresh Australian xenoliths were measured for F and Cl by Combustion Ion Chromatography. Bulk rock F shows reasonable agreement with calculated concentrations based on SHRIMP data and model mineralogy. In contrast, bulk rock Cl concentrations are up to 18x higher than calculated concentrations based on SHRIMP data. The high Cl concentrations in bulk rock are likely due to incipient alteration, despite seemingly fresh samples (petrographically and with negative LOI values), demonstrating caution is required during interpretation of bulk rock Cl data for peridotites.