Identifying metasomatic components within the SCLM using halogens and noble gases

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Recycling of volatiles back to the mantle at subduction zones has a profound, yet poorly constrained impact on the geochemical evolution of Earth's mantle. Halogens and noble gases with seawater and marine pore-fluid signatures have previously been discovered in volcanic-front peridotites, suggesting that marine volatiles can survive the subduction cycle to subarc depths and modify the sub-continental lithospheric mantle (SCLM) beneath subduction zones [1]. In order to understand the extent to which volatiles can be subducted past the volcanic front, and how these volatiles are modified during subduction, we have investigated the halogen and noble gas characteristics of xenoliths originating from Antarctica (10-20 Ma) and the Siberia (150-360 Ma).

Both localities show evidence for a recycled volatile component with halogen concentrations orders of magnitude greater than MORB as well as air-like noble gas signatures [2]. Values of Br/Cl and I/Cl are distinct from both MORB, and each other. Antarctic xenoliths show an enrichment in I with I/Cl ratios ranging from a MORB-like (0.1×10^{-3}) to highly enriched values of 54.6×10^{-3}. Siberian xenoliths however, show an enrichment in Br with Br/Cl ratios ranging from MORB-like (1.2×10^{-3}) to 19.0×10^{-3}.

The Br/Cl and I/Cl within the Antarctic xenoliths are similar to marine pore fluids, whilst Siberian xenoliths appear similar to eclogitic fluids [3]. Differences in halogen ratios suggest compositionally distinct subduction-derived fluids. The similarity of the Antarctic xenoliths to marine pore fluids indicates the SCLM has incorporated fluids released from a downgoing slab, whilst the eglogitic signature of the Siberian xenoliths suggests that the Siberian SCLM contains a fractionated fluid component trapped within a subducted lithology. Halogens and noble gases are therefore, able to identify the source and constrain the history of subducted fluids introduced across the SCLM.

[1] Kobayashi *et al*., 2013 Mineral. Mag. **77**, 1484. [2] Broadley *et al*., 2016, GCA, **176,** 139-156. [3] Svenson *et al*., 1999 Geology **27**, 467.