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Plume-lithosphere interactions and pyroxenite components in mantle plumes – new constrains from Fe isotopes in Hawaiian xenoliths

H.M. Williams (1) and M. Bizimis ()

(1) Department of Earth Sciences, Durham University, Durham DH1 3LE, UK (h.m.williams2@durham.ac.uk), (2) Department of Earth and Ocean Sciences, University of South Carolina, Columbia, SC 29208, USA

Previous studies have shown that Fe stable isotopes in igneous rocks are a potential tracer of changes in mantle oxidation state [1, 2] complimenting other tracers, such as V/Sc ratios [3] and V partitioning data [4]. However, it has also been shown that Fe isotopes are fractionated by processes such as partial melting, metasomatism [5] and magma differentiation [6, 7]. In order to investigate this further, a series of highly characterised [8] peridotite and pyroxenite xenoliths from Salt Lake Crater, Oahu, Hawaii, which display extreme variations in fO_2 [9], were analysed for their Fe isotope compositions. Recent studies have suggested that the Oahu peridotites represent ancient (1–2 Ga), recycled and depleted mantle lithosphere present within the upwelling Hawaiian plume [10]. In contrast, the garnet pyroxenite are considered to originate from the Pacific lithosphere/asthenosphere boundary [11] and represent high pressure accumulates formed from magmas sampling the Hawaiian plume. These samples provide a unique means of studying processes associated with crustal recycling and its impact on the geochemistry of the Hawaiian plume as well as the interaction of plume lavas with the overlying Pacific lithosphere.

The Fe isotope compositions of both separated minerals and bulk samples from the peridotite xenoliths display striking negative correlations with indicators of melt extraction such as Mg/Mg+Fe, HREE and Hf isotope compositions. No correlation exists between Fe isotopes and fO_2, Sr or Nd isotopes or highly incompatible elements such as the LREE, which are all considered to have been reset by metasomatic processes. Iron stable isotopes therefore have the potential to "see through" metasomatic events and record primary melt extraction processes. The Fe isotope compositions of the pyroxenites are elevated to "heavier" values, which are positively correlated with incompatible element abundances. Modeling of this data suggests that melts in equilibrium with the pyroxenites also possess distinct isotopic compositions, such that Fe isotopes could potentially be used as a tracer of pyroxenite components in mantle source regions.

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