Iron isotopes from EM1 to HIMU: processes vs source inheritance and pyroxenite vs carbonatite

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Oceanic Islands at hot spot localities are the result of unusually hot mantle melting in ascending plumes from the deep Earth's interior. Radiogenic-stable isotope investigations of trace elements have provided conclusive evidence for components in plume mantle matrices that once resided at or near the Earth's surface, leading to models of complex crustal recycling mechanisms in the mantle. The major, multivalent element Fe is abundant in the mantle, mobilised during partial melting mass transfer and subject to resolvable stable isotope fractionation in high temperature processes. Crustal rocks show highly divers Fe isotope compositions, testimony of complex process-induced fractionation. Mantle rocks however, have a more limited range, and their derivatives at ridges and away from convergent margins show a narrow range in Fe isotopes, pointing to a rather homogeneous mantle. Available oceanic island lavas, however, seemingly bridge the disparity between juvenile and evolved crust, likely as a result of crustal recycling in their source. Nonetheless, reported isotope data appears to be rather random without any direct link between recylced crustal components and Fe isotope composition in erupting OIB.

Here, we present Fe isotope data for two type-locailities of recycled crustal components in plumes at the Pacific islands of Pitcairn (enriched mantle 1) and Mangaia (high-μ). We applied a correction for Fe isotope fractionation induced by igneous differentiation. The resultant mantle source signatures reveal that Pitcairn lavas inherit their Fe isotope signatures from their pyroxenitic mantle source. A two-stage process of eclogite melting and pyroxenite formation effectively explains the diversity in Fe isotopes with considerable implications for plume buoyancy. Mangaia lavas, rennowend for their extreme yet homogeneous radiogenic isotope signatures (Hf-Nd-Pb), however, show scatter in Fe isotopes without any apparent systematics. However, their spread extends towards isotopically light data, which can be best explained through carbonatitic metasomatism. Their recently proposed carbonatite origin may relate to ubiquitous carbonatitic metasomatism so often observed in lithospheric mantle.