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Stable Fe-Zn Isotopes Trace Lithological Heterogeneity in the Icelandic Mantle

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Trace element and radiogenic isotope systematics of mantle-derived melts clearly demonstrate that the Earth's mantle is geochemically heterogeneous in space and time. However, the extent to which geochemical variability reflects mantle lithological heterogeneity remains uncertain. In particular, questions remain about the existence of fusible, olivine-poor lithologies as distinct mantle components, and the longevity of such lithologies in an actively convecting mantle. Developing geochemical tracers with the capability to detect lithological heterogeneities in mantle-derived melts is central to understanding their distribution in the mantle. The combined Fe-Zn stable isotopic composition of mantle-derived melts offers a potential approach for detecting mantle lithology. An olivine-poor mantle source is predicted to produce isotopically heavy stable Fe compositions [e.g. 1], whilst stable Zn isotope variations have been attributed to both magmatic processes (e.g. partial melting or metasomatism) and source heterogeneity (e.g. pyroxenite, recycled carbonates and spinel-bearing sources) [e.g. 2]. Here we present Fe-Zn stable isotopic compositions for a suite of well-characterised, post-glacial Icelandic picrites [3]. These geographically dispersed picrites range from very depleted to relatively enriched Sr-Nd-Hf-Pb radiogenic isotopic compositions [3, 4, 5]. δ^{56}Fe and δ^{66}Zn compositions display positive covariation, ranging from very light values to typical MORB compositions. Furthermore, Fe-Zn stable isotopes co-vary with Nd, Hf and Pb radiogenic isotopes. After assessing the influence of olivine fractionation on δ^{56}Fe compositions, we interpret the Fe-Zn variations to reflect contributions from an olivine-poor mantle source. δ^{56}Fe and δ^{66}Zn show distinct regionality across Iceland, reflecting the present-day plume head and refractory components in the mantle. We speculate that the high degree of melting of the post-glacial picrites minimises isotope fractionation induced by partial melting processes, making variations in Fe-Zn isotopes resolvable and reflective of their mantle source. Finally, we compare interpretations of combined Fe-Zn studies across a range of tectonic settings to assess the broader utility of a combined stable-radiogenic isotope approach.

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