Source Enrichment Processes Responsible for Isotopic Anomalies in Oceanic Island Basalts

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Various schemes have been proposed to classify the isotopic observations from OIBs, but it is not clear whether any of them reflect the processes that produce the fractionation between parent and daughter elements. The obvious way forward is to use the correlation between isotopic ratios and elemental concentrations to extract the composition of the enriched material. But doing so is not straightforward for several reasons.

The mantle is surprisingly inhomogeneous, and, if more than two sources contribute to the composition of the melt, it is difficult to use the observations to disentangle the effects of magma mixing. Some of the larger oceanic islands are underlain by plumes, where the upwelling velocities reach 0.5 m/a. Therefore the composition of the material undergoing melting may change on a time scale as short as 10,000a. Another problem concerns the accuracy of the isotopic measurements, which may need to be made on samples as small as individual olivine melt inclusions.

The necessary measurements have now been made on a number of sample suites, in particular on post-glacial basalts from Iceland erupted in the last 10 ka. These show that the centre of Iceland is dominated by EMORB enrichment, in contrast to magmas from the far northeast and southwest, which have signatures like those of basalts from Reunion and model ages of about 400 Ma. The Icelandic data shows the importance of determining the composition of the enriching material from magmas that are erupted in a limited area in a short time interval. In SW Iceland there is no correlation between elemental concentrations and isotopic ratios from whole rock samples, but there is between ion probe measurements on melt inclusions.