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# Geochemical provincialism in ocean islands: a new perspective on double chain volcanism from Iceland

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Bilateral spatial structure in the chemical composition of mantle plumes has been observed in a number of Pacific ocean islands, notably Hawaii. This has led to models proposing a role for plume-lithosphere interaction, or deep mantle low velocity domains, in controlling the spatial distribution of chemical components in the shallow mantle. However, volcanism on most ocean islands provides a highly processed sample of the mantle's spatial structure, as melt is focused, mixed and erupted at a limited number of dominant volcanic edifices. In contrast, Iceland, with $500\ \mathrm{km}$ of rift zones and unparallelled sampling density, offers a high resolution spatially continuous sample of the Earth's mantle. This coverage enables us to constrain the progressive nature of the geochemical shifts that occur in the Icelandic mantle, providing a guide to interpreting the spatial geochemical structure in other ocean island settings.

We present new Pb-Sr-Nd isotope, major and trace element data on a group of basalts from central Iceland. We combined this new data with existing datasets and interrogated the data using spatial statistical methods. We identify three types of spatial structure, all of which are most strongly observed in the Pb isotopes. Firstly, the mean Pb-isotopic composition of basalts shifts from south to north Iceland to become progressively more depleted, with our central Iceland dataset falling at intermediate compositions. Secondly, there is a shift in the binary mixing array that samples fall along in Pb isotope space, occurring as the volcanic zones are stepped through south to north. Lastly, there is a shift in the Pb isotopic variability across Iceland, with neovolcanic zones in the southwest exhibiting a greater variance in Pb isotopes than those in the north and east. This offset in variance persists across the full range of Mg# of the basalts, indicating that it originates in the mantle, rather than by crustal processing.

The spatial trends we observe on Iceland are similar to those seen on Hawaii between the Loa and Kea volcanic chains, which also show shifts in mean Pb isotopic composition and binary mixing array. However, on Iceland we are able to see that rather than representing dichotomous compositional domains on either side of the island, the change in mean composition and mixing array occurs continuously—only showing segmentation on the scale of a volcanic zone ($\sim 100\ \mathrm{km}$).

Even with the spatially continuous sampling of the mantle present at Iceland, melt transport and mixing places severe limitations on our ability to resolve the scale of mantle heterogeneity. The spatial statistical methods we use attempt to maximise the information on heterogeneity scale available from the geochemical data. However, our results emphasise the need for a better understanding of melt region geometry and melt transport processes before the sizes of mantle heterogeneities can be constrained on a $< 100\ \mathrm{km}$ scale.