

Deciphering the chemical and isotopic evolution of the Iceland mantle plume

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The background to the project: Plumes of upwelling hot mantle from the core-mantle boundary are an intrinsic part of mantle convection, and are predicted by models heat loss from the core. Despite several decades of study there is little consensus on the mantle source of plumes. Do plumes tap a layer of primordial mantle that has been isolated from convection for the life of the Earth, or are they the remains of billions of years of subducted oceanic crust?

The project: The earliest basalts produced by the Iceland plume – the Palaeogene picrites from Baffin Island and West Greenland - have the highest $^3\text{He}/^4\text{He}$ measured in terrestrial basalts and originate in mantle that is enriched in primordial volatiles [1]. This primordial He isotope signature is present in modern and mid-Tertiary basalts from Iceland, albeit more diluted. Modern Iceland basalts have O and Pb isotopic compositions that require ancient oceanic crust in the mantle source [2]. The presence of recycled oceanic crust in the earliest Iceland plume basalts would support a causative link between deep subduction and the initiation of mantle plumes, and place constraints on the origin of high $^3\text{He}/^4\text{He}$ mantle.

The main objectives of this study are (i) to determine when the Iceland plume mantle acquires recycled oceanic crust, and (ii) assess whether recycled oceanic crust is associated with the primordial helium. In the later stages effort will focus on a comparison study of picrites from the Afar plume, Ethiopia.

What the student will do: The student will undertake extensive study of the O isotope composition of olivine phenocrysts from Tertiary basalts from West & East Greenland, Baffin Island, Iceland and Ethiopia, using the laser fluorination system at SUERC. This data will be complemented by new Pb isotope measurements from Iceland plume basalts. A new suite of mid-Tertiary picrites will be collected from NW Iceland in the early stages of the study. Training will be provided in major and trace element analysis, as well as mineral composition studies by EMP.

[1] F.M. Stuart et al. (2003) *Nature* 424, 57-59.

[2] C.G. Macpherson et al. (2005) *Earth Planet. Sci. Lett.* 233, 411–427.