PROJECT TITLE: Unravelling Mantle Heterogeneities utilising Radiogenic and Stable Isotopes

DTP Research Theme(s): Dynamic Earth

Lead Institution: University of Bristol

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Project keywords: Isotope Geochemistry, Mantle Petrology, Experimental Petrology

**Figure 1.** Lead isotope data from sulphide inclusions in abyssal peridotites [1] and MORB [2] and unpublished data for the oceanic crust.

**Figure 2.** Back-scattered electron image of a reacted orthopyroxene in a mantle xenolith from Grenada, Lesser Antilles.

**Project Background**

The long-lived radiogenic isotope composition of mantle melts have conventionally been used to understand the heterogeneity in mantle sources [3]. However, it is increasingly clear that stable isotopes compositions of heavy elements can provide additional insights into source heterogeneity and melt transfer processes [4]. It is thought that that mixing and reaction during melt ascent act to mask the ‘true’ extent of heterogeneity in the mantle in the final melts erupted [5]. Surprisingly, our new isotope data for primary magmatic minerals in MORB and oceanic gabbros suggest a more complicated story in which MORB and gabbros from the shallowest part of the oceanic crust are derived from enriched mantle sources, whereas intrusive rocks deeper in the crust originate from depleted mantle lithologies (Fig. 1); similar surprises may occur in melts from other tectonic settings. It is clear that only by carefully studying individual mineral phases in primitive melts and exploring the range in radiogenic and stable isotope compositions in mantle peridotites and pyroxenites can we fully understand how melts record mantle heterogeneity.

**Project Aims and Methods**

The principle aim of the project is to study how pyroxenites and metasomatised mantle contribute to the source region of basaltic melts from a variety of tectonic settings.

1) The candidate will produce an extensive set of high precision radiogenic (Sr, Nd, Pb and Os) and Cr stable isotope data for well-characterised mantle peridotites and pyroxenites, including individual mineral phases.

2) Equilibrium mineral/melt isotopic fractionation factors for key phases will be derived by undertaking experiments at controlled temperature, pressure and oxygen fugacity. Additionally, kinetic isotope fractionation factors will be derived from diffusion/reaction experiments.

3) The student will integrate the natural and experimental data to produce a quantitative model how radiogenic and stable isotope variation in the mantle is delivered by melts to the Earth’s surface.
Candidate requirements
The successful applicant should have a background in either Earth Sciences or a related physical science, preferably to MSc/MSci level. A strong interest in Earth or planetary sciences is essential. We welcome and encourage student applications from under-represented groups. We value a diverse research environment.

Project partners
The collaboration between Bristol and Cardiff will allow the candidate to access a suite of world-class analytical equipment and laboratories across the two institutions.

Training
We will provide training in clean laboratory techniques, mass spectrometry and microbeam techniques. (Bristol and Cardiff). The candidate will undertake high-temperature experiments to assess crystallization histories and will be trained in the experimental petrology laboratories in Bristol.

Background reading and references

Useful links
http://www.bristol.ac.uk/earthsciences/courses/postgraduate/

Bristol NERC GW4+ DTP Prospectus:
http://www.bristol.ac.uk/study/postgraduate/2023/doctoral/phd-great-western-four-dtp/

How to apply to the University of Bristol:
http://www.bristol.ac.uk/study/postgraduate/apply/

Please note: If you wish to apply for more than one project please contact the Bristol NERC GW4+ DTP Administrator to find out the process for doing this.

The application deadline is Monday 9 January 2023 at 2359 GMT. Interviews will take place during the period 22 February – 8 March 2023.

NERC GW4+ DTP Website:
For more information about the NERC GW4+ Doctoral Training Partnership please visit https://www.nercgw4plus.ac.uk.

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