PROJECT TITLE: **Understanding pyroxenite melting in the mantle using chromium and titanium isotope fractionation**

DTP Research Theme(s): Dynamic Earth,
Lead Institution: University of Bristol

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Project keywords: Isotope Geochemistry, Mantle Petrology, Experimental Petrology

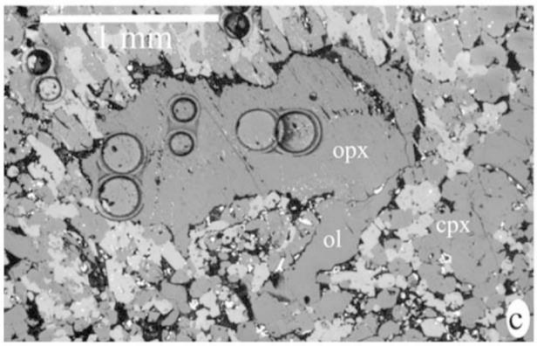

Image Caption Back-scattered electron image of a reacted orthopyroxene in a mantle xenolith from Grenada, Lesser Antilles.

Image Caption Mantle xenolith containing olivine, orthopyroxene, Cr-diopside and Cr-spinel.

Project Background

The stable isotopes of transition elements such as Cr, V, Fe and Ti can be fractionated at magmatic temperatures, by processes such as partial melting, crystal fractionation, diffusion and redox changes. However data for Cr and particularly Ti isotopes in magmatic systems are scarce. Initial studies of Cr suggested there was little variation in either mantle rocks or melts. However a recent study suggests that as much as 2‰ variation in $\delta^{53}Cr$ exists in mantle peridotites and pyroxenites. The origin of this large variation has been postulated to relate to a combination of melt percolation and melting, while the relatively slow diffusion of Cr allows for the preservation of these signatures in the mantle. Titanium isotopes are fractionated during melting with residual Ti-phases and therefore coupled Cr and Ti isotopes provide a means to tracing a variety of pyroxenitic/metasomatic materials in the source region of basaltic melts.

Project Aims and Methods

Pyroxenites and metasomatised mantle contribute to the source region of basaltic melts from a variety of tectonic settings. The large range in Cr isotopes observed in some pyroxenites and in Ti isotopes from melts from eclogites suggests Cr and Ti isotopes will provide complimentary data to traditional methods (e.g. radiogenic isotopes) of tracing such materials in basaltic source regions. The aim of the project is to provide a thorough understanding of the origins of Cr and Ti isotopic fractionation in the mantle; we will approach this in the two different ways.

1) The candidate will produce an extensive set of high precision Cr and Ti isotope data for well-characterised mantle peridotites and pyroxenites, including individual mineral phases.

Key basaltic samples in which radiogenic and trace elements suggest a role for pyroxenitic melting will also be analysed. Chromium and Ti isotopes will be measured by established double-spike techniques.

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. The student will integrate the natural and experimental data to produce a quantitative model for producing stable Cr and Ti isotope variation in the mantle. There will be potential for the student to input to the balance between isotopic and experimental studies in the project.

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.

Training

The project will be based around obtaining high-precision isotope data on rocks and their constituent minerals. Therefore, we will provide training in clean laboratory techniques and mass spectrometry (Bristol and Cardiff). The student will undertake high-temperature experiments to assess isotopic fractionation and will be trained in the experimental petrology laboratories in Bristol. Additional training will be given in microbeam techniques and numerical modelling of diffusion. We also hope to collect some samples in the field (potentially France and Western USA) and so will provide training in field skills.

References / Background reading list

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The application deadline is 1600 hours GMT Monday 6 January 2020 and interviews will take place between 10 and 21 February 2020

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