Titanium isotopic investigation of magma generation and evolution on the Earth and Moon

Supervisors

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Project description

Magmas erupted at the surface of the Earth and Moon offer a wide array of opportunities to study the compositional heterogeneity and dynamics of the terrestrial and lunar mantles, as well as magma evolution in crustal magma reservoirs. However, classical geochemical tools often give incomplete or ambiguous answers to important questions such as: what minerals are involved during partial melting and magma evolution? What is the water content of the mantle source and resulting magma? Can the tectonic setting of past volcanism be inferred from magma compositions?

The aim of this PhD project is to use the novel titanium stable isotope system to provide answers to these questions. Amongst the flurry of chemical elements available for isotopic study, titanium has the unique ability to be able to solely trace the involvement of oxide minerals in magma genesis and evolution[1].

The student will perform ultra-high precision Ti stable isotope measurements[2] of magmatic rocks and their minerals to study a range of questions related to the generation and evolution of terrestrial and lunar magmas. Analytical work will be carried out in the newly set up state-of-the-art isotope geochemistry laboratory at Cardiff University. In addition, the student will use the recently installed FEG-SEM (Field Emission Gun – Scanning Electron Microscope) facility at Cardiff University to determine the budget of Ti in selected samples. This system is designed to enable rapid mapping of mineral compositions at high spatial resolution over large areas.

The combined dataset will allow the student to attain the following research objectives:

1. Determine Ti isotope partitioning effects during partial melting and magma differentiation.
2. Measure the Ti stable isotope composition of a range of lunar samples in order to model the evolution of the lunar magma ocean.
3. Evaluate the effects of melt water content and oxygen fugacity on the behaviour of Ti isotope during magma differentiation.
4. Determine the Ti stable isotope composition of a range of terrestrial lavas and, in doing so, their water content and the tectonic context in which they were emplaced.

Overall, this project will allow for a much clearer understanding of magma generation and evolution on the Earth and Moon.

References:

[1] Millet M-A et al. (submitted to EPSL) Titanium stable isotope investigation of magmatic processes on the Earth and Moon

[2] Millet M-A and Dauphas N. (2014) Ultra-precise titanium stable isotope measurements by double-spike high resolution MC-ICP-MS *J. Anal. At. Spectrom.*, 2014, 1444-1458