SPITFIRE

NERC SCIENCE OF THE ENVIRONMENT

SPITFIRE Doctoral Training Partnership (DTP)

Research Experience Placement 2017

Project Brief

Applications close at Noon, Friday, 2 June 2017

Lead Supervisor:	Dr Thomas Gernon
Email:	Thomas.Gernon@noc.soton.ac.uk
University/Research Organisation:	University of Southampton
Department:	Ocean and Earth Science
Project Title:	Characterising kimberlitic perovskites

Total Student Support Costs: £	£2500 (£200 for 10 weeks plus £500 research and training support grant)
Based on a minimum of £200/week full time for a minimum of 8 weeks and maximum of 10 weeks and a £500 Research and Training Support Grant.	

Proposed Start Date: **Monday, 10 July 2017**	Proposed End Date: **Friday, 15 September 2017**
Projects should run over the summer vacation and we recommend that projects will have terminated by 15 September 2017.	

Brief Summary – please provide a brief summary (maximum 300 words) of the project.

This should include:

- *Project outline;*
- *Links to staff/School/Centre activity as appropriate;*
- *Supervisory arrangement;*
- *How space/equipment/supporting resource demands will be met;*
- *Elements of the project that will incorporate elements other than computer/modelling e.g. fieldwork and data collection;*
- *How the project will enhance the skills of the appointed student;*
- *Any intellectual property rights concerns that may arise from the work.*

Kimberlite is a complex volcanic rock, famous for containing diamonds derived from the Earth's mantle, ~150 km beneath the surface. Kimberlites contain a variety of other unusual mineral phases including perovskite, a calcium titanium oxide ($CaTiO_3$) enriched in Rare Earth Elements (REE). Perovskite exhibits unique properties including ferroelectricity, colossal magnetoresistance, and superconductivity—giving it a wide range of uses, for example in fuel cells, catalytic converters and memory devices. The perovskite crystal structure is highly sensitive to changes in pressure, offering hitherto untapped potential as a geo-barometer to constrain conditions of kimberlite (and inferentially diamond) formation. Here, we propose to uniquely combine characterisation of perovskites, studies of their corresponding atomic-scale structure, and geochemical modelling, to glean important information on their origin and mode of formation. The supervisor, Dr TM Gernon (Associate Professor, Earth Sciences) possesses a large collection of kimberlites from 20 of the world's largest diamond mines, mainly from across southern Africa (De Beers). Here, the student will quantitatively characterise thin sections of a number of the most perovskite-rich rocks, using

the Scanning Electron Microscope (SEM) facility at OES (with Dr Pearce). Backscattered electron images and (major) element maps will guide the next analytical phase, involving application of laser ICP-MS (OES) to determine trace/REE concentrations and model geochemical trends. This will allow us to explore any variability within discrete crystals resulting from changing conditions during crystal growth. The student will work alongside Dr ME Light (Chemistry, Southampton) to apply X-ray diffraction and scattering techniques to determine the atomic-scale structure of representative perovskite compositions. The project offers an opportunity for a student to gain expertise from a range of disciplines, capitalise on unique materials sets and UoS facilities, and contribute to a high-impact research publication. The quantification of geochemical trends will lead to better fingerprinting in the diamond industry.

Please give an indicative timescale for the student's work over the length of the project: (maximum 150 words).

This should include:

- *The broad tasks the student will undertake;*
- *An indicative timescale for these tasks.*

Thin sections of samples from diamond mines in Lesotho (Letseng-la-Terae, Kao and Pipe-200), South Africa (Venetia K1 and K2), and Botswana (Orapa and Jwaneng) will be prepared in advance. The geology of all these mines are well documented (previous studies by Gernon), meaning the context of the samples is already known. Weeks 1-3 will be spent characterising kimberlite-hosted perovskites, supervised by Dr Gernon, using the SEM, laser ICP-MS facilities, and an electron microprobe externally.

During weeks 3-6, the student will be based at Chemistry, supervised by Light (X-Ray Diffraction Manager), an internationally renowned expert in determining complex atomic-scale structures through their interactions with X-ray. Here the student will benefit from additional training.

The geochemical and crystallographic datasets will then be consolidated (weeks 7-10). Modelling will allow any correlations between geochemical and crystallographic structural changes to be evaluated. Novel approaches will be developed to constrain the pressure-conditions of kimberlitic diamond formation.

Proposed procedure for appointing students, including selection criteria:

Please identify specific criteria that should be considered for the selection of placement students e.g. specific quantitative skills that may be required, subject knowledge etc. If a student has been pre-selected, or the research area has been led by the student, please provide the student's contact details, and a summary of their suitability for the SPITFIRE DTP REP programme.

Ideally we are looking for someone with good analytical and/or modelling skills. Accordingly, the project would be suited to either: an (inorganic) chemistry student with a background in structural characterisation; a physicist interested in physicochemical structures; or a materials engineer with good numerical modelling skills willing to learn some mineralogy and chemistry.