NERC GW4+ DTP Projects 2020

PROJECT TITLE: **The geometry of melt and crystal networks in solidifying basalt: a study of lava lake drill cores from Kilauea Volcano, Hawaii.**
DTP Research Theme(s): Dynamic Earth
Lead Institution: University of Bristol
Lead Supervisor: Professor Katharine Cashman (Univ Bristol, School of Earth Sciences)
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Project keywords: Kilauea, crystallization, melt permeability

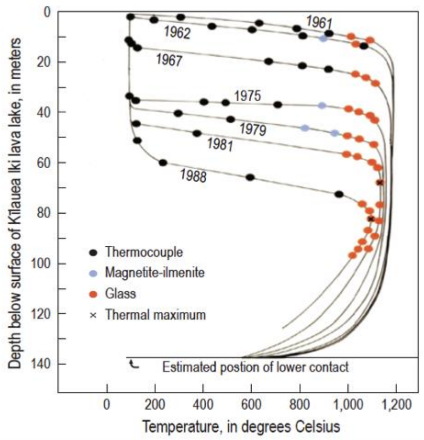

Figure 1. Depth-temperature profiles obtained from cores drilled from the Kilauea Iki lava lake in 1961-1981.

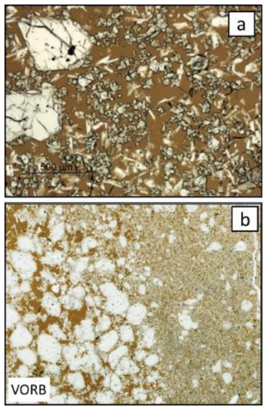

Figure 2. Thin section images illustrating different melt geometries (brown phase) in the lava lake.

Project Background

Our understanding of magmatic processes is undergoing a fundamental paradigm change from a melt-dominated magma chamber to a magma body that is primarily a crystal-rich "mush". If magmatic systems are crystal-rich, then many traditional models of melt evolution (e.g., crystal settling) may not apply, while new models (e.g., reactive flow) need to be developed. For this purpose, it is important to understand the spatial evolution of melt-crystal systems with changes in both the volume fraction of crystals and the phases formed. Most magma mushes are deep underground and so can only be studied through fragments entrained by erupting magmas, supplemented with theoretical modelling and geophysical data. This project takes advantage of drillings through accessible magma mushes formed in Hawaiian lava lakes that captured their evolution over decades. The available samples span a range of temperatures (Fig. 1) and, as a result, melt contents and melt geometries (Fig. 2). As such they provide ideal targets to study how melt geometries change across the solidification interval with applications not only to lava lakes but magma mushes throughout the crust.

Project Aims and Methods

The goal of this studentship is to analyse the 2D and 3D geometry of melt networks in drill cores from Kilauea lava lakes as a function of time and crystallising assemblage. The cooling and crystallisation conditions are exceptionally well characterised, as are the changes in phase composition in space and time. For this reason, these samples provide a superb sample suite in which to study the physical evolution of both melt pathways and olivine accumulations. This will be done using both 2D (thin section) and 3D tomographic imaging, combined with image analysis and permeability modelling. Of primary interest is determining the effect of both grain size and shape (which is both time- and phase-dependent) on the melt transport properties, and would include the characteristics of late-stage segregation veins and VORBS (vesicle- and olivine-rich bodies; Fig. 2b). There is flexibility for the student to add either a petrologic component, which would involve detailed measurements and models of crystal zoning profiles, or analogue experiments designed to assess the permeability of different melt geometries in the laboratory. There are also opportunities for field work.

Candidate Requirements

The project will suit students interested in both the physical and chemical processes that control magma evolution. Tomographic experience is not required, but the student should have some computer skills.

Training

The student will receive training in both 2D and 3D image analysis, in using the 3D images to model permeable flow paths and in basalt petrology (including analysis of individual phases and kinetics of crystallization). Additional opportunities include: techniques of analogue experiments; diffusion modelling and comparison with known cooling time scales; links with the Krafla drilling project (Iceland); field-based work in Hawaii and/or the high desert lava plains of Oregon (USA), depending on project direction.

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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