Two-phase geodynamics of continental and oceanic rifting (RIFT-O-MAT)

Supervisory Team

- Prof. Richard Katz – https://www.earth.ox.ac.uk/people/richard-katz/
- Prof. David May – moving from Oxford to UCSD/Scripps
- Dr. Adina Pusok – lead RIFT-O-MAT postdoc

Key Words

Geodynamics, rifting, magmatism, mid-ocean ridges

N.B. Funding from the European Research Council means that applicants of all nationalities are eligible for this project. If/when Brexit occurs, the project will be supported by the UK Government under identical rules.

Overview

There is widespread recognition of the central role of magma at divergent plate boundaries (rifts). In numerical models, however, magmatism has been treated as a by-product and excluded from the dynamics. A thorough understanding of continental rifts and mid-ocean ridges, which are fundamental to plate tectonics, requires consistent models of magma intrusion into the lithosphere and crust. This studentship is part of a project to develop and analyse models in which magmatism is an integral thermal, chemical, and mechanical component, and hence to better understand the basic functioning of plate tectonics.

For continents, a comparison of available tectonic force to inherent lithospheric strength indicates that magmatic intrusion is required to weaken plates sufficiently for rifting. For mid-ocean ridges, bathymetric analysis suggests that modest variation in the magma supply may be recorded by crustal emplacement and faulting. These phenomena cannot be understood and modelled in the context of single-phase flow. The project breaks new ground in employing a theory that accounts for deformation of solid rock and liquid magma.

Methodology

This project will use continuum mechanical theory to represent the dynamics of partially molten rocks. The theory is based on conservation equations for mass, momentum and energy. To analyse the two-phase dynamics from the ductile asthenosphere to the elastic/brittle lithosphere, the theory will incorporate a viscoelastic/plastic rheology. This will enable models of diking, faulting, and their interaction. The models will be computational, but will require benchmarking against carefully constructed analytical solutions or approximations. The code will be applied to continental rifts and mid-ocean ridges to better interpret observations.

Timeline

The timeline will depend on the specific interests and role of the student within the project. The following is an example.

Year 1: (optional) DTP training courses, literature review, independent study of two-phase fluid dynamics and rheology, introduction to code use.

Years 2 and 3: code development, systematic testing and investigation, comparison with simpler models and available data.

Year 4: Data integration, thesis completion, papers for international journals/conference presentation.

This project is suitable for applicants with a training in applied mathematics, physics, theoretical and applied mechanics, engineering and geodynamics.
Training & Skills
The Oxford Doctoral Training Programme offers courses in mathematical and computational methods for geoscientific research, plus a variety of short courses to increase the breadth of your knowledge. These are optional.

The supervisory team in Oxford are leaders in the use of scientific computing and the application of two-phase physics to geodynamic problems of partially molten rocks. You will join a group of other students and postdocs who are developing expertise in these areas. The supervisors will provide training in aspects of the software development, underpinning mathematics, and associated physics. You will learn to visualise and postprocess the software output for comparison with observations. You will attend at least one summer school in fluid dynamics or geodynamics, as appropriate to your background.

References & Further Reading


Further Information
Contact: Richard Katz
(richard.katz@earth.ox.ac.uk)
Research group: http://foalab.earth.ox.ac.uk