PROJECT TITLE: Thermomechanical controls on unrest and pre-eruptive processes: A comparison of the Auckland volcanic field and Mt Ruapehu, New Zealand

DTP Research Theme(s): Solid Earth

Lead Institution: University of Bristol

Main Supervisor: Prof. Jo Gottsmann, School of Earth Sciences
Co-Supervisor: Dr. James Hickey, Camborne School of Mines, University of Exeter
Co-Supervisor: CASE partner: GNS Science, New Zealand, Dr. Geoff Kilgour

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Left: Map of the Auckland Volcanic Field. Right: Arial view of Mt Ruapehu
(Imigane credit: GNS Science)

Project Background

The thermomechanical state of the crust exerts a fundamental control on the generation, accumulation and mobility of magma. A prerequisite for any magmatic eruption is that magma leaves its reservoir and migrates through the crust to emerge at the surface. The migration of magma usually occurs along pathways which either need to be first formed, for example by fracturing of encasing rocks or via existing pathways of previous magma ascent. Migration of magma through a cold crust with few prior invasions of magma (cold flow) is more likely to occur by brittle fracturing of rocks and to end in the solidification by cooling before reaching the surface. In contrast, a hot crust, which has been thermally primed by previous invasions may promote inelastic migration because the crust can deform in a ductile manner. As a result magma in hot flow environments should avoid freezing and more likely erupt at the surface.

Project Aims and Methods

Using the Auckland volcanic field and Mt Ruapehu as case studies, the project will investigate stresses and strains resulting from the migration of magma in cold and hot flow environments to predict resultant volcano deformation. Although volcano deformation data are used to infer properties of and processes in subsurface magma reservoirs, the inferences are fundamentally dependent on the boundary conditions assumed for the thermomechanical conditions of the crust. This project will develop numerical models that can be applied to different volcanic settings and thermomechanical crustal conditions using finite element analysis. After a phase of parameter space exploration and generic model development and testing, the student will apply the models to the AVF and Ruapehu to illuminate stress concentrations and unrest deformation patterns and their temporal evolution. Key to this approach will be the amalgamation of published data from other disciplines such as seismology and petrology to parameterise boundary conditions of complex subsurface thermomechanics. Pre-eruptive monitoring records for the AVF do not exist. As a result, there is little understanding of the nature and duration of pre-eruptive unrest. Pre-eruptive records are available for Ruapehu volcano and will be exploited as part of the project.
Candidate
The project is aimed at a student who enjoys tackling complex problems in the Earth Sciences using a combination of quantitative and descriptive skills. An interest in geophysical data sets is of advantage as well as a desire to learn the use and application of numerical models to investigate complex sub-surface processes in active volcanic areas.

Case Award Description
GNS Science has a statutory obligation to provide accurate and timely scientific advice to government agencies on the state of volcanoes within New Zealand. Volcanoes in New Zealand are varied and the country hosts the entire gamut of compositions from intraplate basalts to arc rhyolites. GNS Science will provide significant support to this project by providing geological insight and by ensuring that scientists with relevant expertise are consulted to make a success of the project. I estimate that the in-kind contribution to this project is approximately £30,000. This value includes staff time in the project, the use of field equipment and access agreements.

Training
The student will receive bespoke training by the supervisors and CASE partner to develop a portfolio of skills including numerical modelling, computer programming/scripting, analysis of multi-parameter datasets and their interpretation, as well as an array of volcano monitoring techniques and field observations. In addition the student will receive training in science communication and outreach and will have the chance to develop their teaching skills by supporting undergraduate courses. The student will participate in training as part of the wider GW4+ DTP activities with partner institutions. The student will spend considerable time (up to 6 months) with CASE partner GNS Science in New Zealand as well as up to 1 month per project year with co-supervisor Dr. Hickey at the University of Exeter.

References / Reading List


Links
School webpage - http://www.bristol.ac.uk/earthsciences/courses/postgraduate/

NERC GW4+ DTP Website: http://nercgw4plus.ac.uk/
Bristol NERC GW4+ DTP Prospectus: http://www.bristol.ac.uk/study/postgraduate/2017/doctoral/phd-great-western-four-dtp/

Application deadline: 23.59 GMT, Sunday 7 January 2018
How to apply to the University of Bristol: http://www.bristol.ac.uk/study/postgraduate/apply/

General Enquiries:
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