

EPSRC Industrial CASE PhD Studentship

Long-term performance of a geological disposal facility in response to permafrost and climatic variation.

Supervisors:

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Dr. Rob Cuss (British Geological Survey)

Dr. Simon Norris (Radioactive Waste Management Ltd)

Project Outline

The student appointed to this EPSRC (www.epsrc.ac.uk) Industrial Case PhD project will use the combined laboratory facilities of the Rock & Ice Physics Laboratory at University College London (UCL) and the Transport Properties Research Laboratory at the British Geological Survey (BGS) to examine the impact of permafrost and freeze-thaw processes on the long-term properties of rocks and associated geomaterials under conditions replicating those in a deep Geological Disposal Facility (GDF). This will be accomplished through integrating experimental measurements with numerical modelling. Industrial experience will be obtained by placement at the headquarters of the BGS at Keyworth, Nottingham, by collaboration with the industrial partner (Radioactive Waste Management Limited (RWM)) and through regular project meetings between UCL, BGS and RWM.

The United Kingdom has a growing body of radioactive waste, from civil, industrial and military sources. Some of the waste is from over 60 years ago and is potentially hazardous. Though the majority of the radioactivity will decay relatively quickly, some radioactivity will remain for hundreds of thousands of years. Geological disposal – placing of this waste deep underground – is internationally recognised as the best way to ensure long term safety. It is UK government policy to dispose of the UK's higher activity radioactive waste in an underground GDF. Such geological disposal involves isolating radioactive waste deep inside a suitable rock volume to ensure that no harmful quantities of radioactivity ever reach the surface environment. The waste would be contained inside multiple barriers to provide protection over hundreds of thousands of years.

The safety case for a GDF typically considers a time-scale up to 1 million years into the future. Over this time period, colder climate will affect the UK. Recent work by the BGS (e.g. Busby et al., 2015; 2016) shows that permafrost production in the UK is a likely scenario, and that it may extend to hundreds of metres below the surface. It is therefore possible that components of a UK GDF will directly undergo future freeze-thaw as a result of climatic variation. Other effects of permafrost formation and decay, e.g. changes in groundwater salinity, may also impact on any GDF constructed in the UK. The micro-structure of a potential host-rock for a GDF or of overlying rocks, and properties of 'geomaterials' used in a GDF (bentonite or cement) as part of a multiple barrier system, could also be impacted.

The Rock & Ice Physics Laboratory (RIPL) is a major research facility within Earth Sciences Department at UCL. It has over 15 members and comprises a suite of laboratories, housing over £7M of research equipment, supported by over £2 million of current peer-reviewed funding. It has a

unique breadth of experience and ability to design and build its own experimental apparatus. We study the physical, mechanical and transport properties of rocks and ice that make up the surface and interior of the Earth, so as to constrain the tectonic and environmental processes of crustal dynamics and evolution. Our research is nationally unique and multi-disciplinary, being based on integration of experiment and theory

For more information, see: <http://www.ucl.ac.uk/earth-sciences/research/ripl>

The Transport Properties Research Laboratory at BGS was founded in 1993 and undertakes research to examine the processes and mechanisms governing the movement of fluids (gas, water and solutes) in low permeability materials (clay rich media, bentonite, landfill liner clays, mudrocks and shales) using custom designed experimental apparatus. Studies have focussed on the development of process understanding associated with single/multiphase flow and accompanied rock deformation.

For more information, see: <http://www.bgs.ac.uk/sciencefacilities/laboratories/research/tpri.html>

Radioactive Waste Management Limited (RWM) are responsible for delivering a GDF and for provision of radioactive waste management solutions. RWM carries out preparatory work to plan and design a geological disposal. This work is generic because no specific site has yet been identified.

References

Busby, J. P., Lee, J. R., Kender, S., Williamson, P., & Norris, S. (2016). Regional modelling of permafrost thicknesses over the past 130 ka: implications for permafrost development in Great Britain. *Boreas*, 45(1), 46-60.

Busby, J. P., Lee, J. R., Kender, S., Williamson, J. P., & Norris, S. (2015). Modelling the potential for permafrost development on a radioactive waste geological disposal facility in Great Britain. *Proceedings of the Geologists' Association*, 126(6), 664-674.

Heap, M.J., Vinciguerra, S., Meredith, P.G. (2009). The evolution of elastic moduli with increasing crack damage during cyclic stressing of a basalt from Mt. Etna volcano. *TECTONOPHYSICS*, 471 (1-2), 153-160. doi:10.1016/j.tecto.2008.10.004

Mitchell, T. M. & Faulkner, D. R. (2008). Experimental measurements of permeability evolution during triaxial compression of initially intact crystalline rocks and implications for fluid flow in fault zones. *Journal of Geophysical Research - Solid Earth* 113 (B11)

Requirements:

- Applicants must meet the UCL graduate school requirements (listed here <http://www.ucl.ac.uk/prospective-students/graduate/research/requirements>), which notably include a valid English language proficiency certificate for non-native English speakers.
- Applicants are preferred to have strong quantitative and scientific programming skills. Applicants that hold a Master degree in geosciences, physics, or material sciences, and are highly motivated to work in an international team will be favoured.

- Knowledge on high-pressure techniques, mineral and rock physics, condensed matter will be appreciated

Application Procedure

- You must send the below documents to tom.mitchell@ucl.ac.uk with the subject line of the email entitled “**Application for EPSRC Industrial CASE PhD Studentship**” . In the email, you should include the following attachments
 - **Curriculum vitae (CV)/resumé** (3 page max). Please include the contact details of at least two referees.
 - **Cover Letter** (2 pages max) Please identify your research interests and explain why you are interested in this PhD, and explain how your current qualifications and skills map onto the requirements for this project.
 - **English Language Certification** Generally, if you are from an EU country other than the UK, and wish to be considered you do need to meet [UCL’s English Language requirements](http://www.ucl.ac.uk/prospective-students/undergraduate/application/requirements/english-requirements) (<http://www.ucl.ac.uk/prospective-students/undergraduate/application/requirements/english-requirements>). Please read the Eligibility section for more information.
 - Before we can give full consideration to your application, we will need to receive two academic references. These will be sent to your referees upon submission of your application.
- Deadline for applications: **8th July 2016**. This deadline will be extended if the position is not filled. Position will ideally start in the **September-November 2016 period**. The position is fully funded for 4 years with a competitive stipend.