Fully Funded PhD Studentship

'Understanding the consequences of steam formation for the sealing performance of barrier bentonites'

Importance of the Research Area:

The long-term geological disposal of radioactive waste is an ongoing challenge. The disposal of HHGW will take place in specially constructed underground waste disposal vaults, using the favourable containment properties of the available geology, in conjunction with an engineered barrier system (EBS) to trap potential environmental contaminants. Bentonite is commonly proposed for use as the EBS due to its low permeability and high swelling capacity. European radioactive waste disposal concepts assume maximum disposal temperatures of 100°C and 125°C in the EBS for higher-strength host rocks and lower-strength sedimentary host rocks respectively. The disposal site footprint for HHGWs is dictated by the allowable emplacement temperature.

At temperatures above 100°C there are a number of chemical and physical processes that could affect the sealing performance of bentonite (altering the swelling capacity or permeability). These include the accelerated illitisation of montmorillonite, and the generation of steam within the partially saturated bentonite that is initially expected to exist close to the hot canisters at early times in the repository's life cycle. Thus, the upper temperature limits are being challenged to understand the effects of reducing the disposal area and increasing emplacement temperatures on the performance of the EBS.

Project Description:

This project will investigate the effects of steam formation within partially saturated bentonite and its subsequent performance on the engineered barrier system. Maintaining and demonstrating an adequate EBS sealing performance will be of fundamental importance to safety assessments for the disposal of HHGWs. This PhD will specifically address two key questions: (i) whether the interaction between partially saturated bentonite and steam results in a marked reduction in the bentonite swelling capacity, and (ii) whether the bentonite permeability is increased as a consequence. The PhD will answer these questions by conducting a series of experiments in bespoke testing apparatus at the British Geological Survey (BGS) to establish the swelling capacity and permeability of steam treated bentonites under a range of repository conditions. The experiments will also investigate

the effects of differences in bentonite dry density, initial exposure temperature, pore pressure and bentonite composition. The role of bentonite additives, such as graphite, to more quickly dissipate heat will be studied. This PhD project will use a combination of both cutting-edge laboratory (SEM/EDS, XRD, XRT, TEM, XPS, Raman) and synchrotron (XANES, XRD, XAFS, XPS, SAXS) techniques. Small-scale characterisation of the bentonite samples pre- and post-test will be undertaken, identifying any changes in bentonite mineralogy and structure.

Laboratory experimentation will be conducted both within the Transport Properties Research Laboratories at the BGS and using the state-of-the-art facilities at the University of Bristol Interface Analysis Centre, at which the student will have membership.

Application and Funding:

This project is funded by Radioactive Waste Management Ltd's (RWM) Research Support Office (RSO). The studentship provides funding for tuition fees, stipend (standard UKRI rate), and a research training and support grant subject to eligibility. If you are interested in applying for the position, please get in touch with Katherine Daniels (katdan@bgs.ac.uk), Peter Martin (peter.martin@bristol.ac.uk) or Tom Scott (t.b.scott@bristol.ac.uk).

A formal application needs to be submitted through the University of Bristol online application: http://www.bristol.ac.uk/study/postgraduate/apply/.

Please choose "Physics PhD" as course, and mention "'RWM BGS Bentonite" as corresponding studentship advert and "Peter Martin" as contact person. Applications should include a Curriculum Vitae, contact information for two potential referees and a short letter outlining the applicant's scientific interests, suitability and motivation to work on the topic.

Deadline and Further Information:

Applications close online at **5pm on Friday 25th June 2021**. Alongside completing the online application form, applicants are required to upload a short CV.