Centre for Doctoral Training (CDT):
Geoscience and its Role in the Low Carbon Energy Transition
(2021 start)

Project Title: The influence of subsurface microbiology on geoenergy systems

Host institution: University of Exeter

Supervisor 1: Laura Newsome

Supervisor 2: Rich Crane

Background: A geoenergy renaissance is required for a low carbon economy and energy security of supply. Geoenergy systems that have been proposed include disused coal workings for district heating and granites for geothermal electricity. These involve circulating fluids from and into the subsurface, which is a habitat for microbial life, although the UK subsurface is poorly characterised. Considering microbes is important because they catalyse mineralogical changes, influence aqueous geochemistry, and may impact on the effectiveness of geoenergy system operation. For example, coal workings contain pyrite; microbial pyrite oxidation generates iron oxides, acidity and dissolved metals which are serious pollutants and can impede geoenergy system operation through clogging and corrosion. Microbial activity may also produce corrosive sulfide, which may damage pipework, and microbes can form biofilms which may impede fluid flow in the subsurface or infrastructure.

Project description: This project will test the hypotheses that diverse microbial communities are present in the geological environments that are proposed to be used for geoenergy systems, and that by understanding their composition and functioning we can predict and mitigate the impacts associated with any enhanced microbial activity that may occur during geoenergy system operation via (a) analysing groundwater samples from geoenergy systems to quantify and characterise microbial communities; (b) identifying links between microbial community composition, function, geochemistry and lithology; (c) designing *in situ* passive samplers to grow microorganisms in the subsurface and assess the potential for biofilm potential; and (d) isolating microorganisms from geoenergy systems to consider the likelihood of adverse microbial metabolisms (e.g. S cycling).

Methodologies: *Field work*: collection of groundwater samples, design and deployment of passive samplers in different lithology geoenergy formations. Geochemistry: measurement of groundwater composition by ion chromatography, ICP-MS etc. *Microscopy*: scanning electron microscopy, optical microscopy to count cells, characterise biofilms. *Microbiology*: culturing, isolation and microcosm experiments. *Molecular biology*: next generation DNA sequencing. Flexibilities exist for the student to be involved in experimental design and in decisions regarding choice of analytical techniques.

Training: The student will be supervised by experts in geomicrobiology and biogeochemistry (Newsome) and aqueous geochemistry and applied field research (Crane), and will be part of the EM3 research group within Camborne School of Mines. The student will have access to a wealth of training opportunities from the University of Exeter's Researcher Development Programme.

Stated link to CDT theme: Geothermal opportunities

Any Additional Research Costs: Not beyond the £20k RTSG.

Has access to data been secured? Some samples have already been obtained from Cornish Lithium and the UKGEOS site. We have links with United Downs, Rosemanowes and the Coal Authority.

Career routes: Multiple: energy industry, environmental industry, academia, public sector.