

**GeoNetZero Centre for Doctoral Training (CDT):
Geoscience and its Role in the Low Carbon Energy Transition
(2022 start)**

Project Title: Potential environmental impacts of shallow aquifer geothermal systems in urban areas
Host institution: Newcastle University
Supervisor 1: Yit Arn Teh (School of Natural and Environmental Sciences)
Supervisor 2: Cees van der Land (School of Natural and Environmental Sciences)
Supervisor 3: Ross Stirling (School of Engineering)
Supervisor 4: David Manning (School of Natural and Environmental Sciences)

Project description (250 words max.):

Low enthalpy shallow geothermal resources are proven to be an effective geological resource for decarbonising heating and cooling of the built environment, shifting consumer dependence away from current carbon-intensive technologies. Assessment of the environmental impact of shallow aquifer geothermal systems have focussed on the protection of ground water, however the wider potential impacts on biogeochemical cycling have not been widely investigated.

During geothermal energy production, subsurface temperatures are perturbed, with both the heating and cooling of groundwater, the surrounding rock matrix, and soils. Previous studies on undisturbed and locally observed groundwater temperatures have identified that anthropogenic temperature anomalies (i.e. urban heat islands in the subsurface) can lead to physical and biogeochemical changes within aquifers, with knock-on effects for key biogeochemical processes, such as soil C sequestration, mineral weathering, elemental cycling or pollutant biodegradation.

This project will investigate the impact of geothermal heat production in different aquifer types on biogeochemical processes. The work will combine data from existing water abstraction wells and onshore oil and gas wells, together with experimental work in the laboratory and field. Modelling of heat perturbations will link the experimental and observational work. The project will come to a process-based understanding of impact of temperature perturbations, as result of geothermal energy production, on biogeochemical systems. Understanding the benefits and trade-offs of shallow aquifer systems in urban settings could become increasingly important as the UK evaluates the opportunity to expand the implementation of shallow geothermal systems.

Stated link to the overarching theme of the CDT i.e. The Role of Geoscience in the Energy Transition and the challenge to meet the net zero emission targets (NOTE: In order to qualify for NEO Energy CDT funding, there must be an explicit link to the Energy Transition with a clear application to the UK's Continental Shelf (UKCS). For projects supported by 100% matched funding from your University, links to the broader Energy Transition remit are sufficient):

The project falls under the remit of the "Environmental Impacts and Dependencies resulting from continued exploration and/or the deployment of low carbon technologies" theme, as it will provide insights into the wider environmental benefits and trade-offs of low enthalpy geothermal.

Details of mapping/fieldwork locations/data to be used by the project and confirmation of access to key data being secured (please attach map as an appendix if relevant):

PhD Proposal: GeoNetZero CDT (2022 start)

Fieldwork will be conducted in the North East, leveraging existing GSHP infrastructure in areas such as Newcastle, Gateshead and Northumberland.

Outline of planned work schedule for the 4-year research period:

Activity	2022				2023				2024				2025			
	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS
Literature review, collection and synthesis of existing datasets & experiment planning																
Identification and preliminary testing of geothermal and biogeochemical models																
Set-up of lab and field experiments																
Implementation of lab and field experiments																
Paramaterisation, adaptation and testing of geothermal and biogeochemical models																
Use of process-based models to extrapolate findings from experimental plots to larger spatial scales																
Data analysis																
Preparation of PhD chapters																

Any Additional Research Costs (NOTE: Each CDT studentship includes an individual Research Training and Support Grant (RTSG) budget of £20k for the full 4-year study period)

Supervisory arrangements and involvement of external partners (NOTE: Please indicate the area(s) of expertise covered by each supervisor. External collaboration is encouraged, but if proposed partner is not currently providing support to the CDT, please outline the extent of the partner's involvement with the project.)

Yit Arn Teh (SNES), Cees van der Land (SNES) and Ross Stirling (Engineering) will jointly supervise the PhD student, providing expertise in biogeochemistry, microbe-mineral interactions and geotechnical engineering, respectively. David Manning (SNES) will also provide supervisory input, lending expertise soil chemistry and geothermal energy systems.

Likely graduate career routes:

This PhD project will prepare the graduate for a career in: research (e.g. as an academic or as part of research institutes such as CEH, BGS, etc.), environmentally-focused private sector organisations (e.g. environmental consulting, water companies), third sector organisations (e.g. Woodland Trust, WWF, The Nature Conservancy), government agencies or statutory bodies (e.g. Defra, Environment Agency) and environmentally-focused intergovernmental organisations (e.g. UN Environment Programme, Green Climate Fund).