GeoNetZero CDT
The Centre for Doctoral Training (CDT) in Geoscience and the Low Carbon Energy Transition

Integrated multiphysical reservoir characterisation and monitoring of low-enthalpy geothermal resources in flooded mines (UKGEOS observatory, Glasgow)

UNIVERSITY OF ABERDEEN · 1495   HERIOT WATT UNIVERSITY   BGS British Geological Survey

Supervision

Drs Jean-Christophe Comte and Andres Quiros | **University of Aberdeen**

Dr Romain Chassagne | **Heriot-Watt University**

UKGEOS Team (Edinburgh) and Geophysical Tomography Team (Keyworth) | **British Geological Survey**

Project description

With thousands of flooded abandoned coal mines, many located near major population centres, these low-enthalpy geothermal resources can be harvested to provide a major contribution to decarbonising energy supply in the UK, with district and industrial applications. In mine water geothermal systems, heat transport and storage are controlled by the hydro- and thermodynamic interactions between a complex network of conduits (mine galleries) and a heterogeneous rock matrix characterised by intergranular and/or fracture porosity. Long-term sustainable use of mine water geothermal resources requires a good understanding of the hydrodynamic and thermal properties of the conduit-matrix system, which can be attained with a robust characterisation and monitoring routine. Electrical geophysical methods are sensitive to spatio-temporal changes of these properties, including heat storage and transport. Surface and borehole acquisition procedures are therefore potentially well suited to outscale 1D borehole physico-chemical profiles in order to map geological properties and remotely monitor subsurface water flow and temperature at high spatiotemporal resolutions.

Conceptual model of the Glasgow UKGEOS mine water system with existing and planned geophysical instrumentation

The PhD project will **develop the capability of the joint use of time-lapse borehole and surface-to-hole geoelectrical data to characterise and monitor geothermal resources in flooded coal mines towards optimal and sustainable exploitation and management of the resource**. This study will use the new Glasgow UK GeoEnergy Observatory (UKGEOS), run by the British Geophysical Survey.

Project objectives

[**O1**] to map the reservoir seasonal and interannual variations of the system's hydro- and thermodynamic conditions based on collection and analysis of existing hydrological and geophysical data, and acquisition of new time-lapse electrical data (surface resistivity, chargeability, and self-potential data);

[**O2**] to quantify the heterogeneity of hydro- and thermo-dynamic properties and assess the role of conduits vs. rock matrix in terms of heat storage and release, based on a data assimilation workflow (hydrothermal, electrodynamic and geophysical) into a coupled multiphysics model;

[**O3**] to better estimate the site geothermal potential and design the monitoring tool needed for sustainable exploitation.

Surface and borehole geophysical surveys
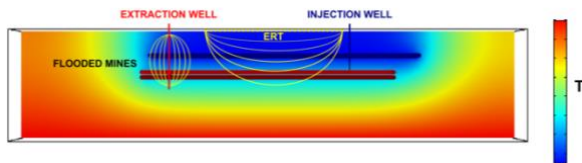
Geophysically-aided hydrogeothermal modelling of abstraction-injection scenarios

Project deliverables

[**D1**] a conceptual model of hydrothermal conduit-matrix interactions in flooded mines;

[**D2**] a first 4D (space-time) hydro-thermo-electro-dynamic model of the UKGEOS reservoir;

[**D3**] a robust methodology for monitoring;

[**D4**] a data assimilation framework for low-enthalpy geothermal resources management.

Project location

The PhD will be based in Aberdeen under primary supervision by Jean-Christophe Comte (hydrogeology/hydrogeophysics) and Andres Quiros (multiphysics modelling), with additional expertise provided by Jan Vinogradov (reservoir engineering) and David Healy (structural geology), and will involve placements with co-supervisors at Heriot-Watt, Edinburgh (Romain Chassagne, data assimilation) and at the British Geological Survey, Nottingham (Jonathan Chambers, Paul Wilkinson, Oliver Kuras, geophysical tomography) and Edinburgh (UKGEOS team, hydrogeology).
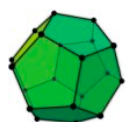
Data access

The project will benefit from existing datasets, including monitoring data, at the site: geological and mine 3D models; 11 new boreholes hydraulically tested, monitored for water level, chemistry, temperature and equipped with telemetric fibre optic for temperature profiles and cross-hole, time-lapse electrical resistivity tomography.

Training and career routes

The student will gain training in multiple field geophysical methods, interdisciplinary computer modelling, understanding of geothermal and hydrogeological processes from the project team. This includes through taking an active role in the design of the surveys, including health and safety. They will also have access to the broad range of geosciences training offered by the GeoNetZero CDT, and generic skills training offered by the University of Aberdeen. This will make them highly employable across the energy and environmental industry, government agencies, academia.

Further information

For further information, please contact Jean-Christophe Comte (jc.comte@abdn.ac.uk).

GeoNetZero CDT
The Centre for Doctoral Training (CDT) in Geoscience and the Low Carbon Energy Transition