Local monitoring of low-enthalpy geothermal resources in flooded mines using hydrogeophysical and citizen science methods to foster energy citizenship (UKGEOS observatory, Glasgow)

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Co-supervisors: Dr Paula Duffy, University of Aberdeen; Dr Andres Quiros, British Geophysical Survey

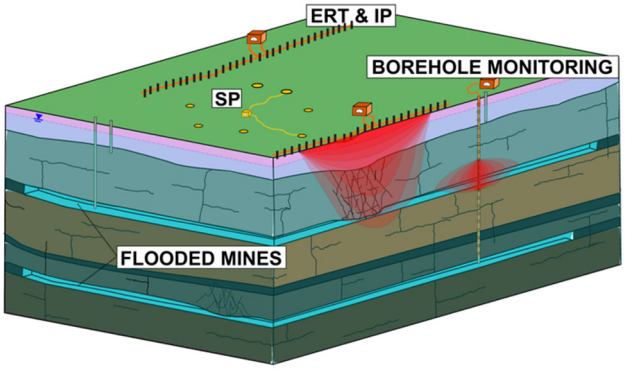
Project Highlights:

- Flooded mines host low-enthalpy geothermal resources that can provide a major contribution to decarbonising energy supply in the UK
- The project will assess geoelectrical techniques for monitoring mine water geothermal resources
- It will pilot the optimisation of the techniques towards a citizen science tool to enhance public understanding and acceptance

Overview:

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 both the hydrodynamic and thermal properties of the conduit-matrix system and public acceptance of geothermal energy as part of wider energy systems. The first of can be attained with a robust characterisation and monitoring routine. Surface and borehole electrical geophysical methods are potentially well suited to outscale 1D borehole physico-chemical profiles in order to map geological properties and monitor subsurface water flow and temperature at flexible spatiotemporal resolutions (Quiros et al., 2024). However, fostering public acceptance of geothermal energy can be challenging as understanding of geothermal resources amongst the public are low, nevertheless, it has been suggested that public involvement in the development of these capacities could enhance this (Pellizonne et al 2017). Therefore, adapting local monitoring of geothermal resources for citizen science monitoring approaches offers the potential to enhance public understanding and in turn foster Energy citizenship amongst local communities (Gooding et al 2024).

The PhD project will develop the capability of time-lapse borehole and surface geoelectrical data to locally monitor geothermal resources in flooded coal mines. It will optimise local monitoring techniques for a citizen science approach and evaluate the efficacy of citizen science on improving levels of public understanding and acceptance of geothermal resources. This study will use the new Glasgow UK GeoEnergy Observatory (UKGEOS), run by the British Geophysical Survey.



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

Methodology:

The research will:

- map the seasonal and interannual variations of the system's hydro-thermodynamic conditions based on analysis of existing field hydrological and geophysical data, and acquire new time-lapse electrical data (resistivity, chargeability, and self-potential);
- assess the role of conduits (mine galleries) vs. rock matrix in terms of heat storage and release, based on coupled hydrological-geophysical modelling;
- design and pilot a local monitoring tool using a citizen science approach in the local area;
- develop a social survey tool to evaluate levels of public understanding and acceptance over time, to be administered before and after the implementation of citizen science monitoring of geothermal resources.

It will deliver:

- a framework for geoelectrical monitoring of low enthalpy mine water geothermal resources;
- a conceptual model of hydrothermal conduit-matrix interactions in flooded mines;
- a methodology for citizen science monitoring using light hydrogeophysical sensors;
- a local assessment of public understanding and acceptance of mine water geothermal resources.

Possible Timeline:

Year 1: scientific international and local (UKGEOS) literature review; compilation of geological, engineering, hydrological, and geophysical data for the UKGEOS site; design and deployment of additional geoelectrical monitoring (resistivity, chargeability, self-potential).

Year 2: continue geoelectrical monitoring; geophysical and hydrological data analysis and reservoir modelling; social surveys of public understanding and acceptance; optimisation and deployment of citizen science monitoring tool.

Year 3: joint analysis of citizen science monitoring and social survey datasets, journal manuscript preparation; thesis write up.

Training and skills:

TARGET researchers will participate in a minimum of 40 days training over the 3.5 years of study composed of:

- an annual one-week workshop dedicated to their year group, and tailored to that cohort's needs in terms of skills development – *for the first three years of their study*;
- an annual all-TARGET workshop with cross-year interactions, advanced training and opportunities to specialise in particular areas – *all years of study*;
- a number of one-day workshops;
- additional online events and in-person workshops attached to relevant conferences.

Partners and collaboration (including CASE):

The PhD will be based in Aberdeen under supervision by Comte (hydrogeology, hydrogeophysics) and Duffy (sustainable development, socio-economic inequalities, energy transition, community participation), and will involve placements with co-supervisor Quiros at the BGS, Edinburgh (hydrogeothermal modelling).

The project will benefit from existing geological, geophysical and hydrological datasets available for the UKGEOS observatory and managed by BGS; plus recent data from pilot geoelectrical experiment by the team (Quiros et al. 2024). Social science data will be subject to ethical approval and gathered using questionnaire survey methods, with local communities participating in the citizen science monitoring.

Further reading:

Quiros, A., Receveur, M., Macallister, D. J., Comte, J.-C, Walker-Verkeuil, K. (2024). Self-Potential Responses to Geothermal Tests at the UK Geoenergy Observatory, Glasgow. British Geological Survey Internal Report, IR/24/013. 22pp.

Pellizzone, A., Allansdottir, A., De Franco, R., Muttoni, G., & Manzella, A. (2017). Geothermal energy and the public: A case study on deliberative citizens' engagement in central Italy. Energy Policy, 101, 561-570.

Gooding, L., Pateman, R. M., & West, S. E. (2024). Citizen science and its potential for aiding low carbon energy transitions. Energy Research & Social Science, 117, 103702.

Further details:

Please visit https://target.le.ac.uk/ for additional details on how to apply.

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