Why are some mine waters hotter than others? Understanding the natural hydrogeological processes controlling the temperature of legacy mine workings and delimiting their geothermal resource.

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Project Background
A recent Scottish government study on the geothermal potential of Scotland (AECOM, 2013) showed there is a significant variation in the temperature of fluids down to a depth of circa 1500 m. Temperature gradients ranging from 3.7°C km\(^{-1}\) to 45°C km\(^{-1}\) have been recorded in some 61 boreholes. Recently, legacy mine workings have been increasingly viewed as a low carbon source of heat or cooling ("Coolth") and are a major research area currently (e.g. http://www.bgs.ac.uk/ukgeoenergyobs/home.html). Mine workings access a large volume of rock, are easily accessible from the surface and are often situated near built up areas. Understanding why the mine waters have reached a certain temperature is critical to being able to estimate realistically the heat resource present.

Several factors are considered to contribute to the temperature profile, including natural heat flow, the architecture of the near surface geology, groundwater flow regime, connectivity of the workings and extent of the workings. Examining only the mine water temperatures (figures below) indicate that there is no clear relationship with depth of measurement. Other factors must be dominant; the purpose of this PhD is to determine what they are.

Methodology
The scope of this PhD is to collate available mine water temperature data from the Coal authority, then investigate the key controls on mine water temperature. You will be involved in data collection, development of hydrogeological conceptual models, numerically modelling the temperature profiles and interpretation of the results, particularly with relevance to scoping out the size of the temperature resources available to use. The data will include information from in situ sensors, seasonal data based on your own measurements, legacy data available in various archives and geological data. Your work is expected to include the use of numerical tools to demonstrate convective flow in highly connected subsurface voids, demonstrate the influence of natural heat flow, and the influence of local and regional groundwater flow. A key outcome of your work will be the development of a predictive tool/model or conceptual approach that enables the scientific estimation of the extent and nature of the geothermal heat available from mine workings.

Training
A comprehensive training programme will be provided comprising both specialist scientific training and generic transferable and professional skills”. A key skill set learned will be development of conceptual hydrogeological models based on available data, and numerical modelling skills. Interaction with multiple stake holders and a number of presentation skill will also be learnt.

Requirements
Applications are sought from numerate geoscientists with experience in hydrogeology, engineering geology, geophysics, numerical modelling, or other natural science or engineering degrees with a numerate emphasis.
**Figure 1.** Scottish mine water temperatures, data from “AECOM 2013 Study into the potential for deep geothermal energy in Scotland volume 2.”

**References**


UK Geoenergy Observatories. [http://www.bgs.ac.uk/ukgeoenergyobs/home.html](http://www.bgs.ac.uk/ukgeoenergyobs/home.html)

**Project Summary**

Why are some mine waters hotter than others? What controls the mine water temperature available for geothermal use? Can the water temperature and its resilience be modelled and predicted?