I am going to talk about geothermal energy, and more specifically about the low temperature resources that we can find in abandoned flooded mines. My researches focus in understanding the temperature distribution in coal mines in the UK, the sources of heat and recharge mechanisms to evaluate their geothermal potential.

1. Background

Why is it important?

* Most of the UK and Scotland have underground coal workings
* Now all abandoned and flooded as pumping ceased
* Fiona estimated that this warm water could provide 7% of UK requirement of heat
* This could participate to the UK target to decarbonizing heat and meet the 2024 requirements

A few case studies of GSHP on coal mines already exist worldwide, including 2 implemented systems in the UK and Scotland.

However, a recent study showed that there is no clear correlation between temperature and depth, in the measurements taken in shafts and boreholes of several mines.

Estimate the long term potential and suitability of heat production from coal mine is difficult without a good understanding of the source of heat and recharge mechanisms.

1. Introduction

* How can we get heat from mines?
* Research question?
* Methods
* Conclusion

1. Heat mining from coal mines

* Mine gets flooded when mining stops
* Temperature ranges from 12 to 20 °C at 200-800m depth (to check)
* GSHP can be used to extract heat from the ground or from the water using open-loop systems. It does not need to be hot (as in Iceland), as only a DT=5°C allows providing the heat exchanger with enough temperature difference to heat space or water:
* Injection/production of cold/hot water can be reversed seasonally

Extracting water can induce inflow of recharge water (from infiltration, lateral aquifers), or re-injection can be performed.

1. Research questions

* What are the main heat sources / controls on the mine water temperature?
* What features of mine geometry are important?
* What is the area affected by heat extraction and the sustainable rate? How long does it take to water to heat up?

1. Methods

The research will involve numerical modelling of mines, calibrated and validated using real data from 2 different areas:

* Bilston Glen in Scotland
* Dawdon in NE England

Difficulty in mine systems (which differs from usual aquifers) is the necessity to solve for water, heat and mass transport in a system composed of a porous media (Darcy flow) and open void (pipe flow) that can lead to numerical instability.

Examples: here is 3 selected examples:

* Guo
* Jasmin
* Virginie

1. Conceptual models to evaluate the main parameters influencing the temperature distribution in mines. Different parameters will be assessed:

* natural heat flow / geothermal gradient
* local heat generation (i.e. radioactive day, pyrite oxidation)
* solar influx
* groundwater flow
* geological structure (i.e. geological formation with specific material, thermal and hydraulic properties, faults)
* Extent/connectivity of mine workings.

Simulation of cold water injection/recharge will allow determining, through sensitivity analysis, the parameters the more likely to influence mine water temperature.

1. Mine plans are complex. A certain level of simplification is necessary. To what extent can we simplify it and what features are really important?

A series of model will be created through the development of a methodology to generate a representative statistical distribution of mine working network / roadways. Calibration and validation of model using existing data.

1. What is the time necessary for water to heat up and what is the geothermal potential of mines?

Based on calibrated model, evaluation of the recharge rate / heat recovery rate of mine water. How long can it be sustained? what is the footprint area for providing heat for domestic heating?

1. Conclusion

Output: a predictive tool allowing to assess production temperature in mine over time

+ guide the licensing of heat by the coal authority

+ help dimensioning mine-water based GSHP