Meeting report – Coal Authority, Mansfield Office

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Morning (10:00 – 12:00)

* Visit of the office, introduction to the Water and Licensing teams
* Contact details for train tickets refund
* Look at Younger *et al.,* 2002 textbook
* Discussion about potential conferences to attend
  + International Mine Water Association 2002 in Wales
    - Look at previous conference Proceedings available on the Internet
    - See Mine Water and the Environment Journal (i.e. Case study in Germany)
  + Paper from Mylene’s research Master submitted at the World Geothermal Congress 2020 - Reykjavik
* 11:00 – 12:00: Fiona’s talk
  + phD subject: development of a coupled (thermo-)hydro-mechanical model using GeoSys software to understand stresses/strains on mine pillars (pillar-and-stall configuration) under water flow
  + research question: how does water fluctuations (linked to reversed production/ injection scheme in summer/winter) affect the stability of pillars (understanding of the geo-mechanical behavior of rocks)?
  + data: 2-year rising water level data (steady state steps of 20m and 40m)
  + results:
    - maximum uplift of ?? mm in agreement with InSAR uplift data
    - shear stresses on pillars can cause system to fail
  + Future: create fully coupled THM model adding heat flow data, create 3D model to see how heat impact stresses on pillars (heat preferably flows between pillars)
  + Questions: consider dipping layer at Bilston Glen? Consider mechanical property changes over time / temporal evolution of rising water (transient model)?

Afternoon (13:00 – 17:00)

1. Meeting Jeremy Crooks, Head of Innovation (Ian, Fiona, Mylene)

* Main research point of phD:
  + Understand the range of temperature in mines
  + Identify the extent of the heat supply around the well (what is the zone of influence of water treatment / heat extraction scheme? How does the heat dissipate?) + Assess sustainability of heat supply
  + Evaluate the heat recharge mechanisms in a mine + impact of solar energy
  + Consider storage mechanisms (i.e. where would heat go if reinjected? What is the maximum temperature/amount of heat that can be stored? How does this relate to the GSHP efficiency? Are there heat losses in blocks?)
  + Can this understanding be used to develop a new scientific approach to the licensing of heat (see Mine Heat Recovery license / heat access agreement)? Define “simple” key rules for defining licensing.
* Potential case study
  + Mine water scheme in Dawdon/Hawthorn/Seaham (pumping implemented in 2004/2008):
    - Project of implementation of a heating scheme (3 MW) for a new village (14000 houses, school…) in December 2019 (starting of heat extraction in 2020-20021?)
    - Commercial / HP retro-fit opportunities. Support of the Zero-Carbon objective. 20M£ provided by the Cabinet Office.
  + Lanchester: has been using heat from a loop system of production/injection for 6 months (only 1 MW extracted over the 4 MW planned).

1. Data overview (Ian, Mylène)

* Layers of Data accessible at <http://mapapps2.bgs.ac.uk/coalauthority/home.html> + *Inferis* intranet at the Coal Authority
  + Shafts (depth, sealed or not…) 🡪 look at differential heat transfer above filled shafts
  + Underground workings (seam codes, thickness in cm, type, Z-depth value at each corner), based on 1 km x 2 km digitalized mine plans (more information available on original Mine Plan maps). 3D view at Bilston Glen
  + Spotheight: seam level (floor level, OD)
  + Roadways / Pit Bottom Roadways, in separated layers from workings & not always digitalized (see original Mine Plans). Preprocessing required before integration into numerical models. Roadways may represent major flow path at the bottom of shafts (central part of working network, strongly built so not likely to collapse). Unlicensed data > 25 yrs old
  + Monitoring points (outflow, temperature).
  + Coal seams outcrops
  + Geological disturbances
  + Shallow coal (<30 m) + buffer indicating collapse hazards (i.e. Blindwells site: opencast in East Lothian Coalfield)
* Mine abandonment Plans (*nVision* internal system at the Coal Authority): details of the map depend on the surveying strategy (might impact the density of faults mapped)
* BGS paper to be published in December (correlation between 100 yrs old rock temperature and current water temperature in the mine)
* Monitoring data: data available at 260 location is being reported in a Summary Excel Sheet + min/max temperature, flow rates at shaft, depth to water.
  + Temperature
    - Temperature VS time (i.e. Junkies outflow. Is the recent temperature increase correlated to observed change in chemistry of the water?). Continuous logging only at a few sites
    - Temperature/conductivity VS depth (i.e. ETC log, can be repeated over time)
    - Water level logger: inform on the temperature at the depth of the sensor BUT no information on the depth of the sensor. Can inform on seasonal changes in temperature.
    - Manual measurements
  + Pumping tests: step by step increase/decrease in pumping rates over long time periods (6 months – x years) until equilibrium between water recovery/pumping rate is reached. i.e. Note:
    - Fluctuations due to tidal effects
    - Measures of Iron concentrations. Change of water quality when water pumped from greater depth / at greater rate (increase in salinity / conductivity) correlated to temperature change?
    - Limitation: data acquired manually, responsible for unwanted noise

Short term objective:

* Read article: <https://www.ft.com/content/4587032c-a4a6-11e9-a282-2df48f366f7d>
* More readings about structure of mines, heat transfers and existing case study abroad
* Learn numerical modeling (Chris MD course material + OpenGeoSys modeling software: https://www.opengeosys.org/ )
* Develop conceptual model of heat transfer mechanisms in mines (heat replenishment, recharge from shallow zone/outcrops, how solar energy flows down, advection of water, change in geothermal gradient, time for new equilibrium to be reached, heat scheme sustainability…)
* Find rock properties from mine sampled (BGS?)
* Summary Sheet is being filled: choose best study area depending on data available (both temporal and z temperature variations) or ask to focus researches on a specific area
* Book Conference in London (Nov. 5): <https://www.geolsoc.org.uk/GSL-7th-London-Geothermal-Symposium>