Assessing the feasibility for the installation of high temperature, mine thermal energy storage technologies in metalliferous mines in Cornwall, UK.

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1. PROJECT OBJECTIVES

United Downs is the '**Follower Site**' for the development of high temperature **MTES** technologies. GEL and project partners, chiefly the BGS, are conducting a feasibility study for the installation of MTES technologies, utilising excess heat from the United Downs Geothermal Power Plant. The study aims to:

1. Characterise the structural, hydraulic and thermal properties of local mines. Identify a section of local mines where MTES may be possible.
2. Investigate heat storage systems and identify a potential best option for United Downs. Generate subsurface models of selected MTES system.
3. Establish a regulatory pathway for the installation of MTES technologies in UK metal mines.
4. Conduct early-stage community engagement.



Fig. 1: Drone shot of the United Downs Power Plant (September 2024).

Case Study:

The United Downs Power Plant will generate power from hot geothermal brine, pumped from a 5,275 m production well (MD) drilled into a fractured granitic reservoir.

Geothermal waters will enter the plant at ~ 170 °C. Post power production, 'spent' waters will be ~ 70 °C.

There is potential for use of heat post power production or waste heat from the plant.

2. ACTIVITIES TO DATE

Mine Evaluation and Selection:

Two mines local to the geothermal plant were assessed for detailed study: **Great Consolidated Mines** and **United Mines.** The latter was ruled out due to reported historic contamination, lack of accessible open shafts for sampling and proximity to a recently-covered land-fill.



Fig. 2: Map of the United Downs area showing location of Consolidated and United Mines relative to the United Downs Geothermal Power Plant.

Great Consolidated Mines is an amalgamation of several 19th century copper and tin mines, extending to 475 m depth. Mine workings are largely flooded. Little information is available on chemical/thermal properties of the mine waters, or connectivity between workings.

The mines are intersected by the Great County Adit, which outflows into the Carnon River.

Historic mine plans and maps were acquired from local archives. Shafts that are presently open and accessible were identified on historical maps and correlated with plans.

Sampling and Fieldwork:

2023: Preliminary identification, assessment and sampling.

2024: Sampling of six shafts and the adit outflow ('Great County Adit'). Mine water sampled for chemical (BGS) and microbiological analysis (BRGM). Loggers installed (x4) to monitor water level and temperature variations. Temperature profiles were measured down the open length of flooded shafts to identify cross-flow or stratification.

2025: Levels loggers re-installed in original (x4) and additional (x2) shafts. Additional temperature profiles measured.



Fig. 3: photographs of [a] Davey's mine shaft at the surface being sampled in 2023, [b] taking temperature profiles in Taylor's shaft in 2024, [c] sampling Taylor's shaft with a bailer in 2024.

Conceptual Model Formation:

A conceptual model is being generated to form the basis of both hydrological and numerical models.



Fig. 4: Map showing location of key shafts in both Consolidated and United Mines relative to the United Downs Geothermal Plant. Shaft numbers align with Table 1.

Table 1 Shaft	Reported Mined Depth (m)	Measured Depth to Obstruction (m)	Depth to Water (m)
1. Taylors Shaft (Consolidated)	≥ 420	146.7	64.2
2. Davey's South Shaft (Consolidated)	≥ 320	347.2	79.9
3. William's Shaft (East Wheal Maid)	≥ 36	55.2	50.7
4. Old Sump Shaft (Consolidated)	≥ 365	155.7	49.1
5. Taylors Shaft (United)	≥ 420	247	84.4
6. Davey's Shaft (Consolidated)	≥ 439	-	56.7

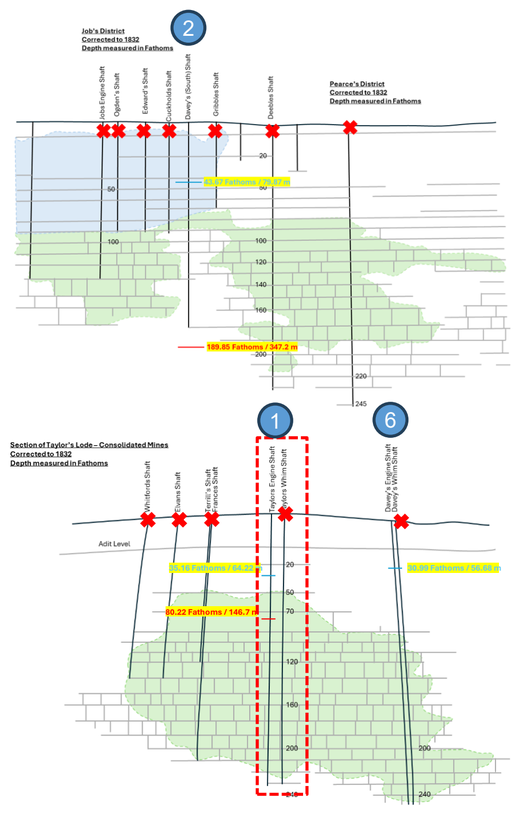
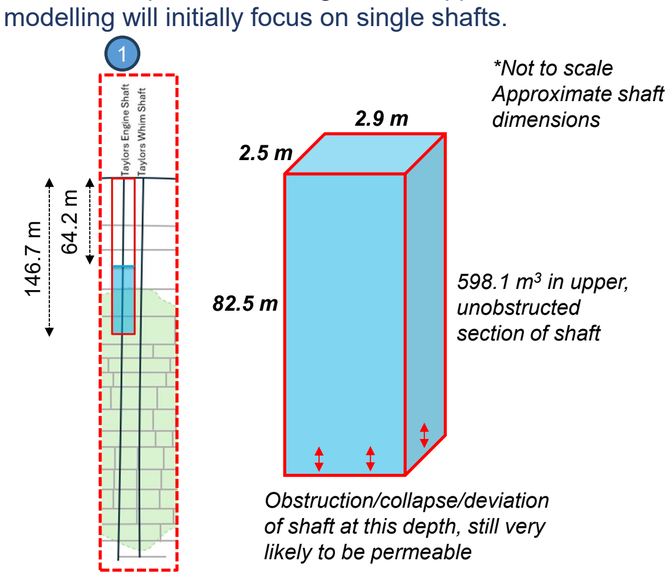


Fig. 5: Simplified sketches of the Jobs District and Taylor's lode sections of the Consolidated Mine plans highlighting open and covered shafts.

Numerical Models:

Due to the complexity of the target mines and the uncertainties in the extent of interconnectivity, backfill and/or collapse of working and stopped areas etc., modelling will initially focus on single shafts.



Modelling will initially focus on a simple closed loop system in the upper, open section of a key shaft. Later iterations will include connection to obstructed deeper shaft and mine workings, intersections of permeable structures and stoping / void space.

3. PLANNED ACTIVITIES

Remaining planned activities include:

1. Continued development of Conceptual model:
   i. Primarily to inform shallow hydrological model of the area. Further GPS and field data required.
   ii. Processing of level log data (Spring/Summer 2026).
   iii. Tracer tests (unconfirmed date).
2. Numerical Modelling:
   i. Model different single shaft MTES scenarios (BGS) and later, the geochemical impacts of these systems (BRGM).
3. Develop a regulatory pathway for the installation of MTES technologies in UK metal mines:
   i. Early engagement with regulatory authorities has taken place – will develop as potential models for MTES are produced.
4. Ongoing societal engagement work:
   i. Continue to contribute to other WPs.
   ii. Plan community mine relationship review.
   iii. Community exhibition at end of project.
5. Work on economic feasibility of heat storage in mine water at United Downs.

4. RISKS AND OPPORTUNITIES

Key Issues/Questions/Problems

- GPS issues slowing progress on shallow hydrological model – lacking accurate elevation data. Seeking OS benchmarks and will aim to survey area. This will require addition time and fieldwork, whilst relying on BGS expertise.
- How to assess cross flow? (presences and extent). Planning to conduct further temperature and conductivity profiles of open section – limited by shaft obstructions.
- Difficulty in finding 'small isolated' part of mine system that can be proved to be unobstructed to model – will now focus on the upper part of single shafts in modelling – aiming to build on these models as more data is collected.

5. CALL TO ACTION

- BGS are continuing to assist in all facets of WP1 work.
- Any recommendations for surveying or on assessing cross flow/stratification down shaft would be appreciated – happy to discuss at the GA.
- We have been slow to recontact BRGM due to small delays with fieldwork and data collection – will contact in the coming weeks

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