Combined extraction of energy and metals from ultra-deep ore bodies: the potential of Cornwall, UK

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An innovative solution to address increasing demand for both energy and metals is 'Combined Heat, Power and Metal Extraction' (CHPM), which is being investigated by the European Union-funded CHPM2030 project. The concept involves an enhanced geothermal system (EGS) within a deep (>4 km) mineralised sequence ('orebody-EGS') with elevated heatflow. This is combined with surface-based metal and energy harvesting technology. This integrated and potentially revolutionary process could improve security of supply of vital resources, enhance the economic viability of geothermal energy and the mining of ultra-deep orebodies. It could also address some of the sustainability challenges of the mineral-energy nexus.

The Variscan terrane of south-west England appears particularly favourable for CHPM due to a combination of: high heat flow from extensive radiogenic granites; structural permeability associated with Variscan tectonics; and abundant, multi-stage mineralisation of varying styles (including enrichment in 'critical' metals). However, extrapolation of the plentiful near-surface geological data (which rarely extends below 1 km) to the >4 km target depths of an EGS system is challenging. Predicting features such as fracture geometry and permeability in crystalline rocks and the potential styles of mineralisation at great depth is particularly difficult.

We have focussed on the north side of the Carnmenellis granite in western Cornwall as a pilot study area to assess the regional potential for orebody-EGS. We describe the results of a synthesis of data arising from the long history of mineral exploration and mining in Cornwall, previous geothermal research (including drilling to depths of 2600 m and heatflow models), and recent geochemical and geophysical surveys of the region. This analysis provides new insights into the ultra-deep geology, the potential distribution of mineralisation and geothermal fluid flow pathways. We also describe new data from ongoing laboratory-based experiments under simulated in-situ conditions (up to 200°C, 500 bar) using the three principal types of mineralisation in Cornwall. These are being used to quantify the directions, rates and magnitudes of metal release using a variety of leaching agents.

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