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Geological controls on upper crustal heat flow for deep geothermal energy

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The United Downs Deep Geothermal Project is the first geothermal power project to commence in the UK, situated near Redruth, Cornwall, SW England. Two deep deviated geothermal wells have recently been completed to measured depths of 2393 m and 5275 m (2214 m and 5054 m true vertical depth) in June 2019. The wells target the NNW-SSE-trending Porthtowan Fault Zone (PTFZ) which cuts an Early Permian granite batholith and is hoped to form a natural fault-hosted geothermal reservoir.

SW England is a particularly favourable region for geothermal power production because it has the highest heat flow values in the UK, c. 120 mW m-2 at on-granite locations. Challenges exist for modelling the high surface heat flow values due to uncertainties relating to the radioelement concentrations at depth and the volume and distribution of the granites. The granites have a heterogeneous U, Th and K content controlled primarily by the temperature and degree of source rock partial melting and fractional crystallisation processes. Secondary to this, fluid rock interaction can leach and redistribute radioelements.

The aims of this research are to resolve the heat flow issues by investigating the radioelement concentration and thermal conductivity of the granite using data from the United Downs Deep Geothermal Project. Detailed mineralogical and geochemical analyses will be carried out to define different granite types and understand the host minerals of U and Th. These analyses in combination with wireline spectral gamma data will allow a detailed characterisation of the radioelements with depth and allow a high-resolution heat production profile to be produced. In addition to this, coupled thermal conductivity measurements will be carried out to examine the temperature dependence of thermal conductivity and characterise thermal conductivity with depth. The results of this will improve the thermal resource and sub-surface temperature evaluation of the granites.

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