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Characterising the hydrothermal circulation patterns beneath thermal springs in the limestones of the Carboniferous Dublin Basin, Ireland: a geophysical and geochemical approach.

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A hydrogeological conceptual model of the sources, circulation pathways and temporal variations of two low-enthalpy thermal springs is derived from a multi-disciplinary approach. The springs are situated in the Carboniferous limestones of the Dublin Basin, in east-central Ireland. Kilbrook spring (Co. Kildare) has the highest recorded temperatures for any thermal spring in Ireland (maximum of 25.0 °C), and St. Gorman's Well (Co. Meath) has a complex and variable temperature profile (maximum of 21.8 °C). These temperatures are elevated with respect to average Irish groundwater temperatures (9.5 – 10.5 °C), and represent a geothermal energy potential, which is currently under evaluation. A multi-disciplinary investigation based upon audio-magnetotelluric (AMT) surveys, time-lapse temperature and chemistry measurements, and hydrochemical analysis, has been undertaken with the aims of investigating the provenance of the thermal groundwater and characterising the geological structures facilitating groundwater circulation in the bedrock.

The hydrochemical analysis indicates that the thermal waters flow within the limestones of the Dublin Basin, and there is evidence that Kilbrook spring receives a contribution from deep-basinal fluids. The time-lapse temperature, electrical conductivity and water level records for St. Gorman's Well indicate a strongly non-linear response to recharge inputs to the system, suggestive of fluid flow in karst conduits. The 3-D electrical resistivity models of the subsurface revealed two types of geological structure beneath the springs; (1) Carboniferous normal faults, and (2) Cenozoic strike-slip faults. These structures are dissolutionally enhanced, particularly where they intersect. The karstification of these structures, which extend to depths of at least 500 m, has provided conduits that facilitate the operation of a relatively deep hydrothermal circulation pattern (likely estimated depths between 240 and 1,000 m) within the Dublin Basin. The results of this study support a hypothesis that the thermal maximum and simultaneous increased discharge observed each winter at both springs is the result of rapid infiltration, heating and re-circulation of meteoric waters within a structurally- and recharge-controlled hydrothermal circulation system.