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Constraining heat production rates in Ireland's basement rocks: measurements of exposed basement and correlations from across the Caledonides

Nicola Willmot Noller and Stephen Daly
University College Dublin, UCD School of Geological Sciences, Dublin, Ireland (nicola.willmot-noller@ucdconnect.ie)

Ireland is situated on stable lithosphere and much of its surface geology features thick Upper Palaeozoic sedimentary sequences, and a few shallow Permo-Triassic basins, for which measured geothermal gradients are generally moderate. Nevertheless, crystalline rocks beneath these basins might produce enough heat for a viable deep-drilled, low enthalpy geothermal resource. Accurate knowledge of the lateral and vertical distribution of radiogenic heat production is, therefore, important in helping to define geothermal exploration targets.

The crystalline basement of Ireland is interpreted as an assemblage formed from the convergence of Laurentia and Gondwanan terranes during the closure of the Iapetus Ocean and the Caledonian orogenic event. Despite the extensive sedimentary cover observed today, folding and faulting episodes during the Caledonian and the subsequent Variscan orogenies enabled exhumation of a wide range of Precambrian and Palaeozoic rocks, albeit exposed at relatively few sites across Ireland. A mean calculated heat production rate (HPR) derived from these outcrops is used as a proxy for the equivalent stratigraphic unit at depth. This has been achieved using established heat production constants, rock density and known concentrations of uranium, thorium and potassium, combined with a knowledge of geological mapping and geophysical data.

To further constrain the vertical component of heat production distribution, Irish metapelitic xenoliths emplaced in Lower Carboniferous volcanics in the Iapetus Suture Zone (ISZ) in central Ireland are regarded as a reliable representation of the present-day lower crust there. The xenoliths have a mean HPR of 1.7 μW/m^3; this is similar to a mean HPR of 1.9 μW/m^3 measured in exposed Ordovician sedimentary rocks in the south east of Ireland. The slightly lower HPR in the xenoliths is a consequence of reduced uranium concentrations, probably owing to the radioelement's mobility. It is likely that these Ordovician rocks are subjacent to the Mid/Late Palaeozoic sedimentary basin between the ISZ and their outcrop in SE Ireland.

In addition, Newfoundland Appalachians are interpreted as part of the relict collision zone from the Caledonian orogenic event, separated from the Irish Caledonides by rifting as the Atlantic opened. This region offers extensive exposure of Precambrian, Lower Palaeozoic supracrustal and plutonic rocks many of which can be regarded as equivalent to those in Ireland. The Canadian geochemical dataset thus provides an opportunity to test the validity of assigning to Ireland's basement, heat production rates obtained from otherwise limited exposures.