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Constructing a model of 3D radiogenic heat production in Ireland

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Heat production values in the crust and mantle rock inform heat flow density data to provide crucial information about the structure of the Earth's lithosphere. In addition, accurate models of horizontal and vertical distribution of heat production can help to define geothermal exploration targets. Low-enthalpy district scale space heating and Enhanced Geothermal Systems (EGS) using hot, dry rock may provide sustainable energy resources in regions currently perceived as having low geothermal energy potential.

Ireland is located within stable lithosphere, unaffected by recent tectonism and volcanism, and has an estimated heat flow range below the measured global continental average. Nevertheless, borehole data indicate that heat production is variable across the island, with anomalously high rates observed, for example, in Cavan, Meath and Antrim. Data coverage is, however, poor.

Radioactive isotopic decay generates heat in rock. By using established heat production constants and known concentrations of unstable isotopes of uranium, thorium and potassium, along with rock density values, a heat production rate in μW m $^{-3}$ is obtained.

With the objective of compiling the first comprehensive database of information about the Irish lithosphere, in three dimensions, the authors present here initial results obtained from published and unpublished whole-rock major and trace element analyses. The presence of systematic trends correlating heat production to properties such as age and lithology are also investigated.

Offering insight into the vertical component of heat production distribution, Irish xenoliths emplaced in Lower Carboniferous volcanics are regarded as a reliable proxy for the present-day lower crust. Their geochemical composition gives heat production values that are higher than expected for the depths indicated by their thermobarometric data, suggesting that heat production rates do not simply reduce with depth.