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Mapping of Curie point depth distribution beneath Ireland from Tellus aeromagnetic data

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The low-temperature geothermal potential of Ireland has become in recent years a subject of great interest for several scientific projects, including the IRETHERM project (investigation of near-surface potential thermal resources and overall thermal regime), and G.O.THERM 3D (development of a thermal model of Ireland by geophysical-petrological modelling). A key piece of information in these projects is an understanding of the background thermal regime in the form of the distribution of geothermal gradient or surface heat flow (SHF)

The current regional-scale understanding of Ireland's thermal subsurface environment is based on extrapolation of predominantly shallow (total depth <3000 m) boreholes, and surface heat flow measurements. Several flaws have been identified in the methodologies that lead to the current geothermal understanding, including the non-uniform distribution of boreholes, lack of deep (>500m) boreholes, and the inclusion of surface heat flow measurements in close proximity to radiogenic granites.

The Curie point of a material is defined as the temperature above which ferromagnetic behaviour ceases; for the purposes of investigation of the Earth within typical Irish crust, we can focus on the Curie point of magnetite, 580 °C. Thus, if a depth for the base of a regional-scale magnetic source can be defined, and safely assumed to be related to magnetite approaching its Curie point, the 580 °C isotherm (Curie point depth, CPD hereafter) can be defined. Methodologies of determining CPD based upon spectral analysis of magnetic methods have been developed and applied with success in multiple regions around the world, allowing estimation of the geothermal gradient distribution without the pitfalls of insufficient boreholes or biased surface measurements.

As much of Ireland is covered by high spatial density aeromagnetic data of the Tellus and associated projects, we have applied the spectral analysis approach to generate a map of the Curie point depths (CPD) across the areas of Ireland. Furthermore, a geothermal gradient can be defined by considering the temperature drop over the distance from the CPD to the surface. The new geothermal gradients implied by spectral analysis of aeromagnetic data are unaffected by the bias sources identified in current estimates from boreholes, and can hence be used as independent points of comparison for other geothermal research.