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IRETHERM: A New Project to Develop a Strategic and Holistic Understanding of Ireland's Geothermal Energy Potential

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Little is currently known of the potential of Ireland's subsurface geology to provide geothermal energy for district-scale space-heating and electricity generation. Both applications require identification and assessment of deep, permeable aquifers or large-volume, hot, radiogenic granitic intrusions. Ongoing technological advances in utilizing medium-temperature (110–160°C) groundwaters provide real potential for electricity generation within the upper range of thermal gradients observed in Ireland (∼28°C/km). However, such potential can only be realised in the future if deep (4–5 km) geothermal source rocks can be identified within the country's subsurface. IRETHERM is a new academic-government-industry collaborative project starting in 2011, funded by Science Foundation Ireland, which aims to develop a holistic understanding of Ireland's (all-island) low-enthalpy geothermal energy potential through integrated modelling of new and existing geophysical and geological data.

Ireland is located within stable lithosphere, lacks high-enthalpy geothermal systems associated with recent tectonism/volcanism and is characterised by a marked increase in surface heat-flow from ∼40 mW/m2 in the south to >80 mW/m2 in the north, with thermal gradients in the range 8–32°C/km. The overarching research objective, over a $4\frac{1}{2}$ year period of funding, is to establish those geological settings and localities in Ireland with the greatest potential to provide significant volumes of hot geothermal waters or hot, dry rock. We plan to:
(i.) Develop multi-parameter modelling, inversion and interpretation software tools that advance state-of-the-art geophysical (electromagnetic, gravity, seismic) imaging of shallow and deep aquifers and granitic intrusions.
(ii.) Understand both the 3D spatial variation in Ireland's radiogenic crustal heat-production and the origin of the local and regional heat-flow variations. New measurements of crustal heat-production in 3D (using mid- to lower-crustal xenoliths and borehole core) and of temperature and heat-flow variation will be modelled with existing constraints on the structure and thermal properties of the crust and lithosphere.
(iii.) Test a strategic set of eight "type" geothermal targets with a systematic program of field EM surveys (MT, CSEM), interpreted using our new modelling tools. Aquifer prospectivity will be based on high estimated porosity, subsurface continuity and depth, while granite (EGS) prospectivity will be based on large volume and depth extent and high radiogenic heat-production, in both cases in the presence of an elevated temperature gradient.

Our paper evaluates currently-available temperature/heat-flow, geophysical and geological data that relate to low-enthalpy geothermal energy potential within Ireland and considers the settings (and shortcomings in knowledge) associated with several known, promising targets. While a borehole drilled in the Newcastle area of the Dublin Basin is yielding encouraging results (46.2°C at 1.4 km depth), knowledge of the geological context is insufficient to predict whether comparable potential may be found elsewhere. In the Lough Neagh Basin (N. Ireland), where promising geothermal potential is indicated in Permo-Triassic sandstone aquifers, development of advanced, integrated modelling tools that exploit the comprehensive geological and geophysical dataset there would provide an enhanced capacity to evaluate the aquifer and the means to assess its potential nearby where less data are available. The depth and lateral extent of Ireland's many radiogenic granites is also poorly known, and their heat-generation potential is uncertain. We outline the approaches and strategies that IRETHERM will adopt to meet the objectives outlined above, and discuss the rationale for the eight target types we plan to investigate: (1) Permo-Triassic sandstones, (2) heat-flow/temperature anomalies, (3) warm-spring lineaments, (4) exposed and buried granites, (5) deeply penetrating fault zones (secondary porosity), (6) gravity anomalies of unknown origin, (7) areas of current seismic activity (secondary porosity) and (8) basal Carboniferous and Devonian sediments.