Geophysical Research Abstracts
Vol. 19, EGU2017-10984, 2017
EGU General Assembly 2017

G.O.THERM.3D - Providing a 3D Atlas of Temperature in Ireland's Subsurface

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We introduce the recently initiated project G.O.THERM.3D, which aims to develop a robust and unique model of temperature within Ireland's crust and to produce a 3D temperature atlas of the country. The temperature model will be made publicly available on an interactive online platform, and the project findings will be reported to appropriate state energy and geoscience bodies. The project objective is that an interactive, publicly available 3D temperature model will increase public awareness of geothermal energy. The aim is also that the project findings will focus and encourage geothermal resource exploration and will assist in the development of public policy on geothermal energy exploration, mapping, planning and exploitation.

Previous maps of temperature at depth in Ireland's subsurface are heavily reliant on temperature observations in geographically-clustered, shallow boreholes. These maps also make insufficient allowance for near-surface perturbation effects (such as the palaeoclimatic effect), do not allow for the 3D variation of petrophysical parameters and do not consider the deep, lithospheric thermal structure.

To develop a 3D temperature model of Ireland's crust, G.O.THERM.3D proposes to model both the compositional and thermal structure of the Irish crust using the LitMod3D geophysical-petrological modelling tool. LitMod3D uses an integrated approach that simultaneously accounts for multiple geophysical (heat-flow, gravity, topography, magnetotelluric, seismic) and petrological (thermal conductivity, heat-production, xenolith composition) datasets, where the main rock properties (density, electrical resistivity, seismic velocity) are thermodynamically computed based on the temperature and bulk rock composition. LitMod3D has been applied to study the lithosphere-asthenosphere boundary (LAB) beneath Ireland (at a depth of $\sim$ 100 km) and is typically used to investigate lithospheric-scale structures. In the previous studies focussing on the LAB beneath Ireland, LitMod3D models the crust as two fixed homogenous layers with laterally constant physical properties (upper-middle crust and lower crust).

G.O.THERM.3D proposes to adapt the LitMod3D tool to model the heterogeneous nature of the crust, e.g. the variable distribution of heat production and the variation of thermal conductivity with lithology and temperature, with an appropriate lateral and vertical resolution. The thermal modelling process will also employ palaeoclimate-corrected heat-flow and other available complementary data sets (e.g. seismic, magnetic, radiometric and electromagnetic). Existing and emerging lithospheric-regional temperature models will be used to apply thermal boundary conditions to the crustal model of G.O.THERM.3D. The resulting crustal temperature model of G.O.THERM.3D may in turn be used to provide boundary conditions on more focussed modelling on a shallower scale (e.g. within a sedimentary basin to depths of $\sim$ 5 km). In this way, a nested approach can be adopted to model compositional and thermal structures on various scales and resolutions within the crust (subject to the availability of appropriate data), while maintaining consistency with the wider setting.

G.O.THERM.3D will also make additional thermal conductivity measurements, the primary motivation for which being the critical importance of thermal conductivity data in constraining temperature modelling.