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The lithospheric structure beneath British Isles from integrated geophysical-petrological modelling of magnetic and other geophysical data

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The availability of unprecedented resolution aeromagnetic data in Ireland (Tellus project, http://www.tellus.ie/) in conjunction with new satellite magnetic data (e.g., ESA′s Swarm mission) has opened the possibility of detailed modelling of the Irish subsurface magnetic structure. A detailed knowledge of the magnetic characteristics (susceptibility, magnetite content) of the crust is relevant for a number of purposes, including geological mapping and mineral and geothermal energy prospection. In this work we model the magnetic structure of Ireland and surrounding areas using primarily aeromagnetic observations but also other geophysical data sets. To this aim we use a geophysical-petrological modelling tool (LitMod) in which key properties of rocks (i.e. density, electrical conductivity and seismic velocities) that can be inferred from geophysical data (gravity, seismic) are self consistently determined based on the thermochemical conditions (based on Perple_X petrological software). In contrast to the situation in the mantle, where thermodynamic equilibrium is prevalent, in the crust metastable conditions are dominant, i.e. rock properties may not be representative of the current, in situ temperature and pressure conditions. Instead, the rock properties inferred from geophysical data may be reflecting a phase equilibrium (mineralogy) stable at the formation conditions, which can be quite different from the present day ones. In addition, temperature plays a major role in the distribution of the long wavelength crustal magnetic anomalies. Magnetite retains its magnetic properties below its Curie temperature (585 ºC) and the depth of Curie's isotherm provides an estimate of the thickness of the magnetic crust. Hence, a precise knowledge of the crustal geotherm is required to consistently model crustal magnetic anomalies. In this work LitMod has been modified to account for metastable crustal lithology, to predict susceptibility in the areas below Curie's temperature, and to compute magnetic anomalies based on a spherical forward approach (magnetic tesseroids). The modified version of the code has been applied to forward model magnetic, gravity, elevation, heat flow and seismic data in Ireland and surrounding areas. Residual magnetic anomalies are inverted and interpreted in terms lateral variation of susceptibility and iron content.