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Joint Interpretation of Magnetotellurics and Airborne Electromagnetics in the Rathlin Basin, Northern Ireland

Robert Delhaye (1,2), Volker Rath (1), Alan G. Jones (1), Derek Reay (3), and the IRETHERM team (1)

(1) Dublin Institute for Advanced Studies, School of Cosmic Physics, Dublin, Ireland (vrath@cp.dias.ie), (2) Department of Earth and Ocean Sciences, National University of Ireland, University Road, Galway, Ireland, (3) Geological Survey of Northern Ireland, Colby House, Stranmillis Court, Belfast, UK

In this study we present results from geophysical investigation of the sedimentary Rathlin Basin in Northern Ireland in order to assess the potential for low-to-medium enthalpy geothermal aquifers within the porous Permian and Triassic sandstone groups. The area and groups were identified as a potential geothermal resource due to the presence of both an elevated geothermal gradient (observed in two deep boreholes onshore) and favourable hydraulic properties (measured on core samples in the offshore part of the basin). Previous seismic experiments were not able to fully characterise the sediments beneath the overlying flood basalt. Complementing these earlier results, magnetotelluric data were acquired on a grid of 56 sites across the north-eastern portion of the onshore Rathlin Basin, and an additional 12 sites on the nearby Rathlin Island, in order to image the thickness, depth, and lateral continuity of the target sediments. Analysis and 3D modelling, including the effects of the highly conducting ocean, has been successful in deriving a resistivity model that maps the variation in the top of the sediments (base of the basalts) and the truncation of the basin sediments against the Tow Valley Fault, and gives a reasonable estimate of the thickness of the sediment fill.

However, the resulting models show significant effects from distortion caused by near-surface inhomogeneities in the responses that cannot be resolved using the given frequency range and site density. Fortunately, for the area of Rathlin Basin, airborne electromagnetic data from the TELLUS project (http://www.bgs.ac.uk/gsni/tellus/contact/index.html) are available. These data were measured at four frequencies between 0.9 kHz and 25 kHz in a verical-coplanar loop configuration, with the dipole axis in flight direction. The spatial sampling distance was less than 25 m, with about 200 m distance between flight lines. Survey altitudes vary between 56 m and 244 m. Thus, for the top $\approx$100 m penetrated by these frequencies an additional data set of more than 300 000 sites were available. To use these data with the existing MT array, the data were interpreted by a pointwise 1D inversion using the AirBeo code from the AMIRA collection (http://www.amirainternational.com/). Subsequently these results were upscaled to the resolution of the 3D MT model, and used for static shift correction for the MT soundings. This procedure produced very promising results, which will be presented in this contribution.

Whilst the simple approach used up till now only solves one of the aforementioned problems, namely the static shift at the MT sites, joint interpretation of the two methods shows improved model formation continuity between MT sites, even at depth. Regional-scale features, however, are mostly retained. Currently more sophisticated procedures are being developed with the aim of using the full amount of information from the airborne electromagnetics to improve spatial coverage at the high-frequency range of the MT data, and thus improving model realism near the surface.