Bayesian fusion of MT and AEM probabilistic models with geological data: Examples from the eastern Gawler Craton, South Australia

H. Seillé[1], S. Thiel[1], K. Brand[2], S. Mulè[1], G. Visser[1], A. Fabris[3] and T. Munday[1]
[1]CSIRO, Mineral Resources, Perth/Adelaide, Australia
[2]Bureau Of Meteorology, Adelaide, Australia
[3]Geological Survey of South Australia, Adelaide, Australia

SUMMARY

We present our findings from Seillé, H., Thiel, S., Brand, K., Mulè, S., Visser, G., Fabris, A., Munday, T. (2023). *Bayesian fusion of MT and AEM probabilistic models with geological data: examples from the eastern Gawler Craton, South Australia. Exploration Geophysics, 1-20. https://doi.org/10.1080/08123985.2023.2222766*

When building 3D models of the subsurface, reconciling several geological and geophysical data of diverse nature, resolutions, coverage, or sensitivity, is challenging, both numerically and petrophysically. In this work, we propose a workflow for mapping selected geological features and characterise their uncertainty using a Bayesian Estimate Fusion algorithm. Different datasets such as 1D probabilistic models derived from geophysical data, drillholes and geological data are combined to produce probabilistic maps of selected geological boundaries, relying on petrophysical and geological assumptions. Leveraging large, high-quality geophysical datasets acquired in the eastern Gawler Craton in South Australia, we demonstrate the applicability of our approach with two examples: 1) we map in 3D the top of a stratigraphic unit in the cover, the Tregolana Shale, using 1D magnetotelluric (MT) and 1D Airborne Electromagnetic (AEM) probabilistic models, drill holes and surface geology; 2) we map the depth to basement using 1D probabilistic MT models, drill holes and interpreted structural information. Our results show that the different resolution, data sampling, depth of investigation and reliability of the utilised datasets can be combined in a complementary fashion, overcoming their respective limitations, to find solutions/models that satisfy all the datasets. We show that probabilistic workflows permit characterisation and reduce uncertainty when mapping the location of features of interest, but also permit the testing of geological hypotheses against other geophysical and geological data. These types of models are valuable to better characterise, interpret, and conceptualise the subsurface, enabling better exploration targeting and supporting efforts to discover new mineral deposits.

Keywords: magnetotellurics; airborne electromagnetics; Bayesian fusion; Bayesian inversion; uncertainty