Joint Probabilistic Inversion of 3D Magnetotelluric and Seismic Data in Southeast Australia

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SUMMARY

Multi-observable inversions are gaining popularity for imaging the structure of the lithosphere (Afonso et al., 2016). Of particular interest is the joint inversion of magnetotelluric (MT) with seismic data as their complementary sensitivity to the thermal structure, hydrogen content and small volumes of fluid or melt offer a powerful means to detect fluid pathways in the lithosphere including the locus of partial melting, ore deposits and hydrated lithologies. This unique potential has given impetus to the acquisition of collocated MT and seismic data over large regions (e.g., AusLAMP/AusArray in Australia).

Probabilistic inversions provide complete information about the unknown parameters and their uncertainties conditioned on the data and modelling assumptions. Joint probabilistic inversions of MT and seismic data have been successfully implemented in the context of 1D MT data only. For the cases of 2D and 3D MT data, however, the large computational cost of the MT forward problem has been the main impediment for pursuing probabilistic inversions. To overcome this limitation, we have presented a novel strategy (Manassero et al., 2020, 2021) that reduces the computational cost of the 3D MT forward solver and allows us to perform full joint probabilistic inversions of MT and other datasets for the 3D imaging of deep thermochemical anomalies and fluid pathways.

As part of the Exploring for the Future program, we present preliminary results of the first joint probabilistic inversion of 3D MT in southeast Australia using the AusLAMP data and a seismic velocity model derived from teleseismic tomography (Rawlinson et al.,2016). We also make interpretations of our conductivity models using the code MATE (Özaydin and Selway, 2020). These results demonstrate the capabilities of our conceptual and numerical framework for 3D joint probabilistic inversions of MT with other geophysical data sets and open up exciting opportunities for elucidating the Earth's interior in other regions.

Keywords: 3D Magnetotellurics, Probabilistic Inversion, Joint Inversion, Numerical modelling, Lithospheric structure