# Magnetotelluric inversions using structural constrains derived from a probabilistic workflow

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Understanding the architecture of mineral systems from deep sources to shallow mineral deposits has become of great interest for the Australian geoscience community. The structures controlling the formation of a mineral system are generally associated with the presence of fluids migrating from deep sources towards the surface. These structures present strong electrical signatures which can be detected using magnetotelluric (MT) geophysics. Even when dense AMT/MT surveys are carried out the precise and reliable detection of the conductivity anomalies related to mineral deposits are limited by the presence of a thick conductive cover. In these situations, deterministic MT inversion requires significant constraints and regularisation to overcome high non-uniqueness.

We propose an MT data-driven workflow for deriving structural constraints, to enhance the resolution of the conductivity models obtained. We first perform probabilistic inversions using 1D trans-dimensional Markov chain Monte Carlo samplers for estimating subsurface conductivity and its associated uncertainty for each site along a 2D line. These inversions are designed to be robust to non-1D effects present in the data. Next, using a lateral prior and prior petrophysical knowledge, the 1D probabilistic models are fused to form a low resolution 2D posterior ensemble. This is used to derive structural constraints on identified interface locations and layer resistivities. Finally, model roughness penalties are formulated to constrain the 2D deterministic inversion.

This workflow is assessed using synthetic data computed from a realistic 3D Earth. It is then applied on a real dataset to confirm the applicability of the workflow to image complex geological structures and to deal with field MT data. Synthetic and field data results are compared to unconstrained 2D and/or 3D inversions to quantify the improvement in reliability and resolution.