Multi-scale magnetotelluric surveys – mapping from the deep lithosphere to the near surface for geological interpretation and mineral prospectivity

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SUMMARY

Magnetotellurics (MT) is one of a few techniques that can provide multi-scale datasets to help understand geology and mineral potential in covered terranes. We demonstrate the value of scaled MT surveys starting from mapping large-scale conductivity structures in the deep lithosphere through to the resolution of finer scale structures in the crust suitable for camp-scale targeting.

The Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP) is a national collaboration between Geoscience Australia, state and territory government geological surveys, universities and AuScope. It acquires long-period MT data on a half-degree grid across Australia. We have used AusLAMP as a first-order reconnaissance survey to resolve large-scale lithospheric architecture. For example, the Northern Australia AusLAMP model revealed a remarkable connection between conductive anomalies and giant mineral deposits in highly endowed mineral provinces. Similar conductive features were mapped in greenfield regions where mineralisation has not been previously recognised. In these regions we undertook higher-resolution infill MT surveys to refine the geometry of crustal structures. We summarise the results from two infill surveys – in the East Tennant region of northern Australia and in the Curnamona-Delamerian region of southern Australia. The East Tennant data revealed crustal architecture linking lower fertile source regions with potential depositional sites in the upper crust. The Curnamona-Delamerian data provided new insights for understanding the geodynamic processes associated with the transition from Proterozoic Australia in the west to the Phanerozoic Tasmanides in the east. The conductive anomalies may represent large trans-crustal structures that place fundamental controls on the distribution and formation of mineral systems. In addition to these insights, interpretation of high-frequency MT data has helped to characterise cover and assisted with selecting targets for stratigraphic drilling.

Keywords: Magnetotellurics, AusLAMP, lithosphere, crustal architecture, mineralisation