

Magnetotellurics and Airborne
Electromagnetics as a combined method
for assessing basin structure and
geometry.

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MAGNETOTELLURICS AND AIRBORNE ELECTROMAGNETICS AS A COMBINED METHOD FOR ASSESSING BASIN STRUCTURE AND GEOMETRY.**MT & AEM AS A COMBINED EXPLORATION METHOD****ABSTRACT**

Unconformity-type uranium deposits are characterised by high-grade and constitute over a third of the world's uranium resources. The Cariewerloo Basin, South Australia, is a region of high prospectivity for unconformity-related uranium as it contains many similarities to an Athabasca-style unconformity deposit. These include features such as Mesoproterozoic red-bed sediments, Paleoproterozoic reduced crystalline basement enriched in uranium (~15-20 ppm) and reactivated basement faults. An airborne electromagnetic (AEM) survey was flown in 2010 using the Fugro TEMPEST system to delineate the unconformity surface at the base of the Pandurra Formation. However highly conductive regolith attenuated the signal in the northern and eastern regions, requiring application of deeper geophysical methods. In 2012 a magnetotelluric (MT) survey was conducted along a 110 km transect of the north-south trending AEM line. The MT data was collected at 29 stations and successfully imaged the depth to basement, furthermore providing evidence for deeper fluid pathways. The AEM data were integrated into the regularisation mesh as a-priori information generating an AEM constrained resistivity model and also correcting for static shift. The AEM constrained resistivity model best resolved resistive structures, allowing strong contrast with conductive zones. There was not enough resolution in the MT models to establish the presence of uranium mineralisation.

KEYWORDS

Magnetotellurics, electromagnetic induction, airborne electromagnetics, static shift,

Cariewerloo Basin, Pandurra Formation, uranium, exploration, unconformity

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Figure 3 Stratigraphic column of the Cariewerloo Basin adapted from Cowley (1991). Archaean to Paleoproterozoic Gawler Craton is overlain by uranium enriched Gawler Range Volcanics and the intrusive equivalent Hiltaba Suite granites, which is unconformably overlain by the Pandurra Formation, a medium-coarse grained sandstone. This is overlain by Adelaidean Sequences including the Tapley Hill Formation, Whyalla Sandstone, and other Quaternary sediments.

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Figure 2 Schematic diagram of an unconformity related uranium deposit adapted from Tuncer *et al.* (2006). There are two types of unconformity deposits; egress (right) and ingress (left). Egress-type deposits are formed when reduced basement fluids flow into the sandstone reacting with oxidised fluids. Ingress-type deposits are formed when oxidised basinal fluids flow along faults into the basement, reacting with reduced basement lithologies. Ingress-type deposits are smaller than Egress-type, but both generally show mineralisation surrounded by a silicified cap with clay alteration.

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Figure 4 Phase Tensor Pseudosection of the Cariewerloo Basin, South Australia. The phase tensor is not susceptible to galvanic distortion so provides a robust estimation of the dimensionality. The shape of the ellipse indicates the dimensionality, the direction of elongation point in the direction of current flow with a 90° ambiguity. The phase tensor pseudosection of the Cariewerloo Basin can be divided into three broad regions; A is a region of short periods (shallow depths) which generally have circular ellipses with very little skew indicating this region is mostly 1D; B is a region showing elongated ellipses, pointing in a northwest – southeast direction indicating 2D or 3D body; C shows a region of circular and moderately circular ellipses, indicating the deepest region is predominately 2D or 3D region.

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Figure 12 A geological interpretation overlain onto the AEM constrained MT model which uses the AEM as a-priori information. The shallow interpretation consists of conductive layer, Qs, which are the Quaternary sediments and Adelaidean Sequences which contain high amounts of salt. Pf is the Pandurra formation which is resistive sandstone, GrV are the resistive Gawler Range Volcanics and also includes deeper crystalline basement. Rx is an anomalous resistive body and Cf and Cx are regions of lower resistivity thought to be palaeo fluid paths. Two thrust faults are observed, F1 and F2, which offset layers Cs1 and Pf. The unconformity surface is highlighted by the dashed line. 40