

The 3D Electrical Structure of the Australian Lithosphere

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THE 3D ELECTRICAL STRUCTURE OF THE AUSTRALIAN LITHOSPHERE**ABSTRACT**

The broad-scale electrical resistivity structure of the Australian continent is poorly known due to the lack of continent-wide observations. These observations are used to constrain lithospheric conduction and petrophysical conditions. In this study, models of electrical resistivity are developed using various constraints, and these are tested against known observations. Three approaches have been employed. Firstly, using the AWAGS array of 58 magnetotelluric sites across Australia spaced approximately 500 km apart, I analyse geomagnetic depth sounding induction vector data, which are then compared with the broad-scale tectonic components of Australia. Secondly, I have developed an upper crustal and surrounding ocean model of electrical conductance using ocean depth information (ETOPO1) and depth to Proterozoic basement (SEEBASE) with a spatial resolution of approximately 17 km. Thirdly, estimates of seismic shear wave velocity of the lithosphere from 50 to 200 km depth from the AuSREM data, at a spatial resolution of approximately 50 km, were converted to electrical resistivity using an empirical relationship. The induction vectors were then compared with three dimensional modelling developed through two approaches. To good approximation I have been able to demonstrate, that the observed AWAGS induction vector data are explained to first order by the conduction of the oceans and sedimentary basins. Second-order effects of resistivity variations in the deeper lithosphere are significant, but induction vectors are less sensitive to these. Finally, I demonstrate from a 3D inversion of the observed AWAGS data that there are additional crustal conductors that cannot be explained from sediment thickness alone, but require additional conduction mechanisms in the crust over significant depths.

KEYWORDS

Electrical resistivity, conductance, lithosphere, Australia

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Figure 2 Surface conductance derived from depth to basement topography and water depth databases of the Australian continent with AWAGS induction vectors plotted at a period of 1000 s. Areas of notably high conductance have been highlighted with red circles, in particular the Canning Basin and the Arunta region. **18**

Figure 3 The fit to the cross plot of $1/\log$ (resistivity) against shear wave velocity at five different cluster points represented by different colours. Each cluster point is fitted with a robust centroid represented by the black dots as well as error bars one standard deviation. Dashed black lines are inferences taken from a cross plot showing varying water content in major lithospheric minerals such as olivine. The blue lines represent expected extreme conditions such for water contents of 200, 300, and 0 in ppm for Opx, Cpx and Gt respectively. Adapted from Jones et al. (2013). **20**

Figure 4 Map view of resistivities at depths of 50 km and 100 km with a spatial resolution of approximately 50 km, derived from the AuSREM shear-wave velocity and the empirical relationship equation from Jones et al. (2013). Location of cratons and basins are adapted from Betts et al. (2002) **21**

Figure 5 Apparent resistivity plotted at 1000 s with the electrical field in a north-south orientation (x) and the magnetic field in the east west orientation (y). Phase has been plotted in the same orientation for the Australian continent. Major sedimentary basins and the oceans surrounding Australia have a major effect on the MT responses, with known sedimentary basins clearly identifiable within the MT responses. **24**

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