The 3D Electrical Structure of the Australian Lithosphere

Thesis submitted in accordance with the requirements of the University of Adelaide for an Honours Degree in Geophysics

Andrew Jon May

November 2013

THE UNIVERSITY of ADELAIDE

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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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