

Magnetotelluric imaging of a Palaeozoic Andean margin subduction zone in western Victoria

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

Michael Stepan

November 2014



THE UNIVERSITY
of ADELAIDE

ABSTRACT

The geological setting for the accretion of the Lachlan and Delamerian Orogens in southeastern Australia is controversial, with two different models proposed. The Lachlan Orogen resulted from either subducting oceanic crust and wedge accretion, or shortening and compression between two continental blocks. Broadband magnetotelluric (MT) data recorded over the transition between the Delamerian and Lachlan Orogens impose new constraints on the formation of southeastern Australia. The east-west MT survey extended for approximately 120 km, recording at 44 stations. A 2D inversion of the data in the bandwidth of 0.05-2000 s yielded a resistivity model to a depth of 150 km, with resistivity ranging from 1-10 000 Ωm . The upper crust was most resistive ($>10\ 000\ \Omega\text{m}$), and transitioned to a relatively flat conductor of 50-100 Ωm at ~ 20 km. The upper mantle is resistive ($>1\ 000\ \Omega\text{m}$) and uniform below this layer. The Escondida, Moyston and Avoca Faults are imaged as low resistivity pathways (100-200 Ωm) extending to the surface. Faults may be anomalously conductive from alteration to serpentinite, and other trace mineralisation such as graphite. The Lachlan Orogen likely formed from west dipping subduction of mafic to ultramafic oceanic crust. This crust was altered to serpentinite, with magnetite coating grain boundaries. Imaged conductive bodies show where shearing caused interconnectivity of the magnetite.

KEYWORDS

Tasmanides, magnetotellurics, western Victoria, subduction

Table of Contents

Introduction	1
Geological Setting and Background	2
Models of orogenesis	6
MT response	8
Methods	8
MT methods	8
Phase tensor	9
Data acquisition	10
Processing and pre-inversion	12
Results	12
Data	12
Phase and pseudo-sections	14
2D inversion	16
Discussion	18
Integrated geophysics	19
Alteration of mafic and ultramafic oceanic crust	25
Reconstructed geological history	29
Conclusions	31
Acknowledgements	31
References	32
Appendix A: Quality Assessment	36

List of Figures

1.	Location map	3
2.	Compressional and extensional history of southeastern Australia	5
3.	Competing models of formation of the Lachlan Orogen	6
4.	Gravity and total magnetic intensity surface maps	11
5.	Apparent resistivity and phase pseudo-sections	13
6.	Phase ellipse pseudo-section	15
7.	A 2D inversion of the MT data at three vertical scales	17
8.	Interpreted seismic sections coincident to the MT line	20
9.	Phase ellipses overlain on gravity and total magnetic intensity maps	22
10.	Magnetite volume percentage plotted against resistivity	27