

# AusLAMP Southeast Australia: Imaging the Tasmanides

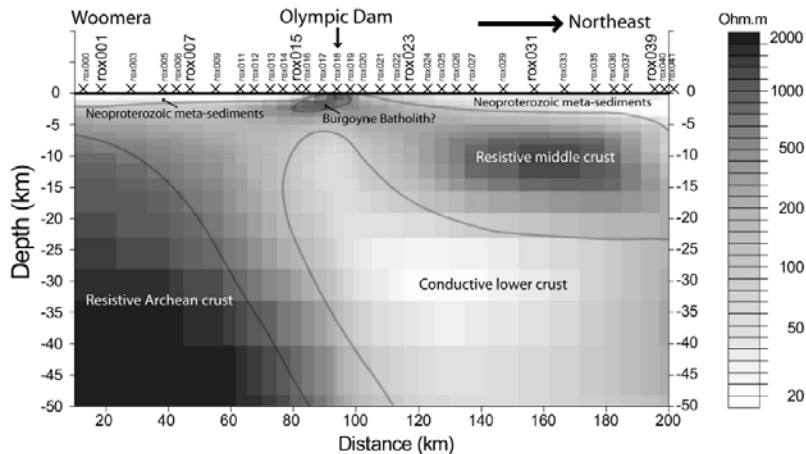


Alison Kirkby, Darren Kyi, Ned Stolz, Jingming Duan, Bob Musgrave, Karol Czarnota, Michael Doublier, Dave Taylor

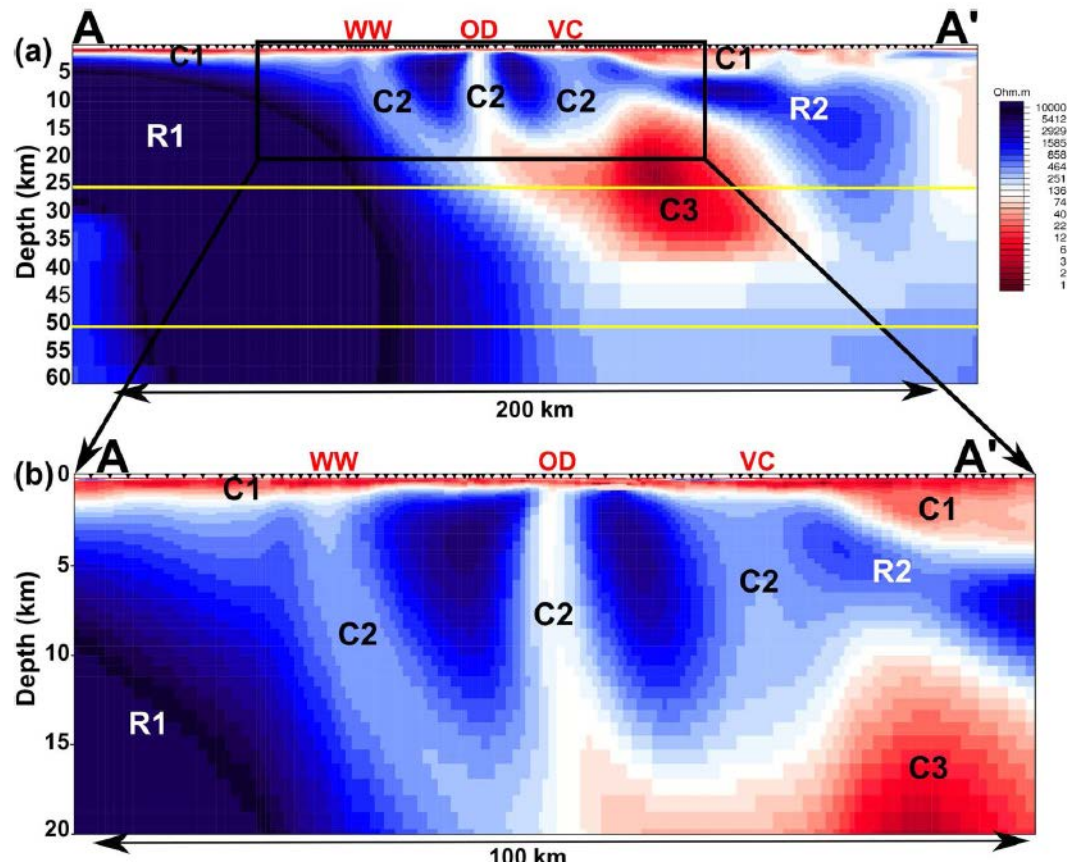
*Plus many others at GA, GSNSW & GSVic*



# Imaging mineral systems with MT



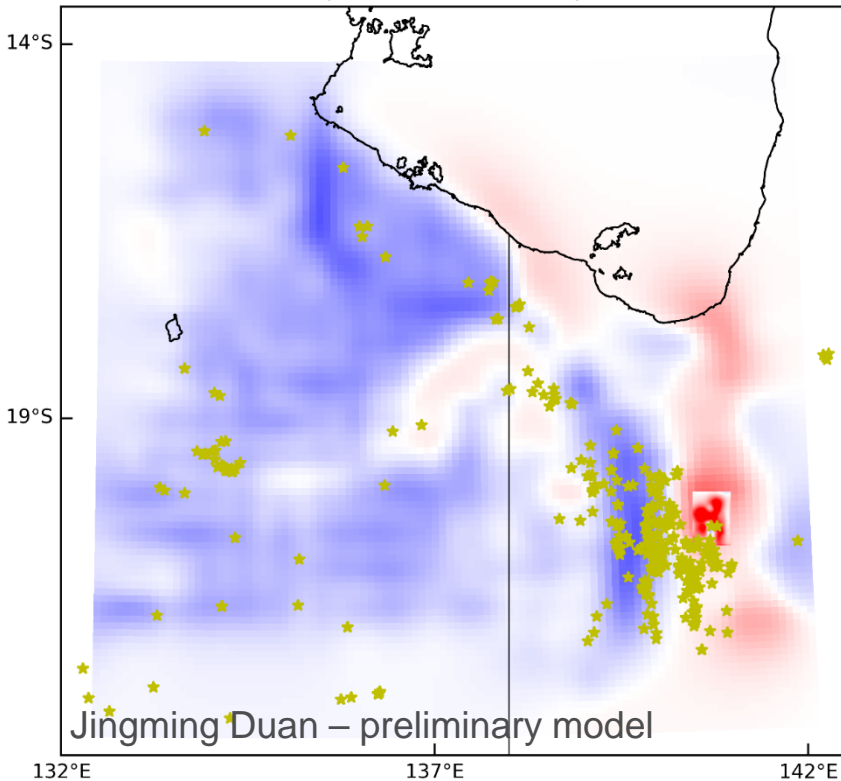
Heinson et al 2006



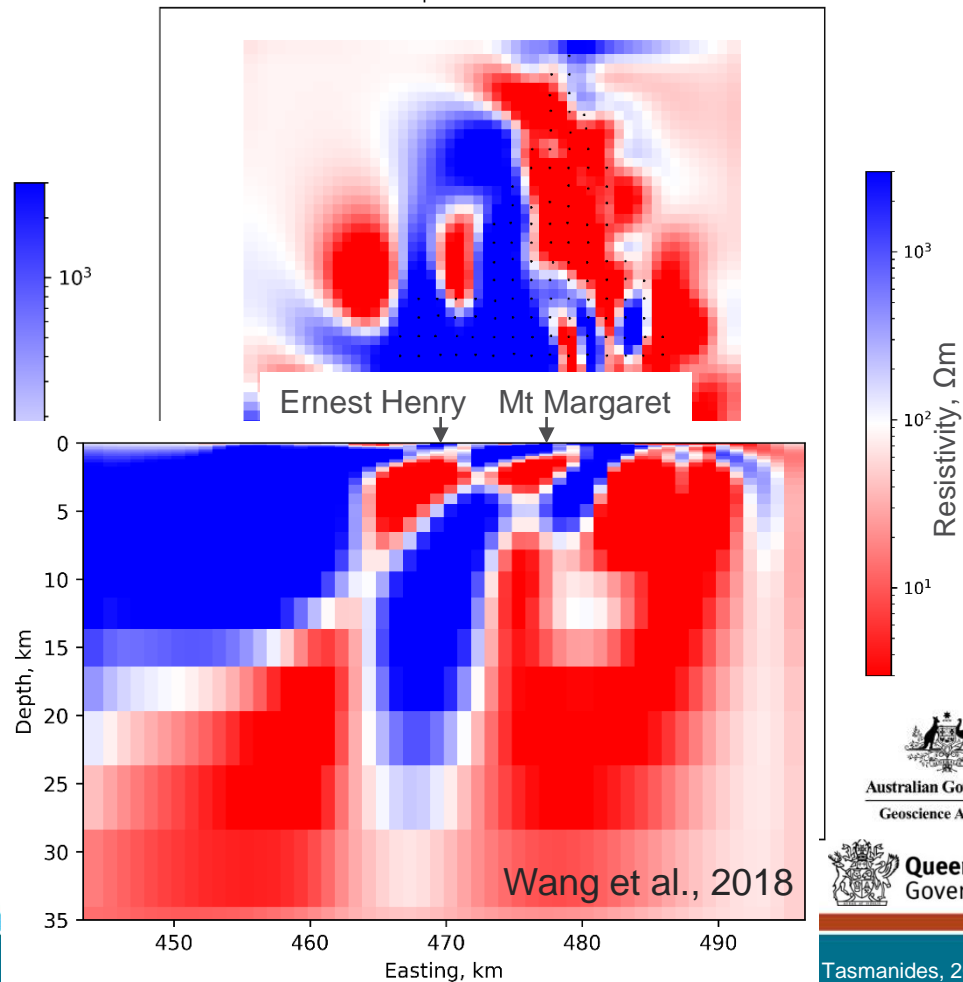
Heinson et al 2018

# Cloncurry

Depth slice at 28 km depth



Depth Slice at 2 km



# Magnetotellurics to map architecture

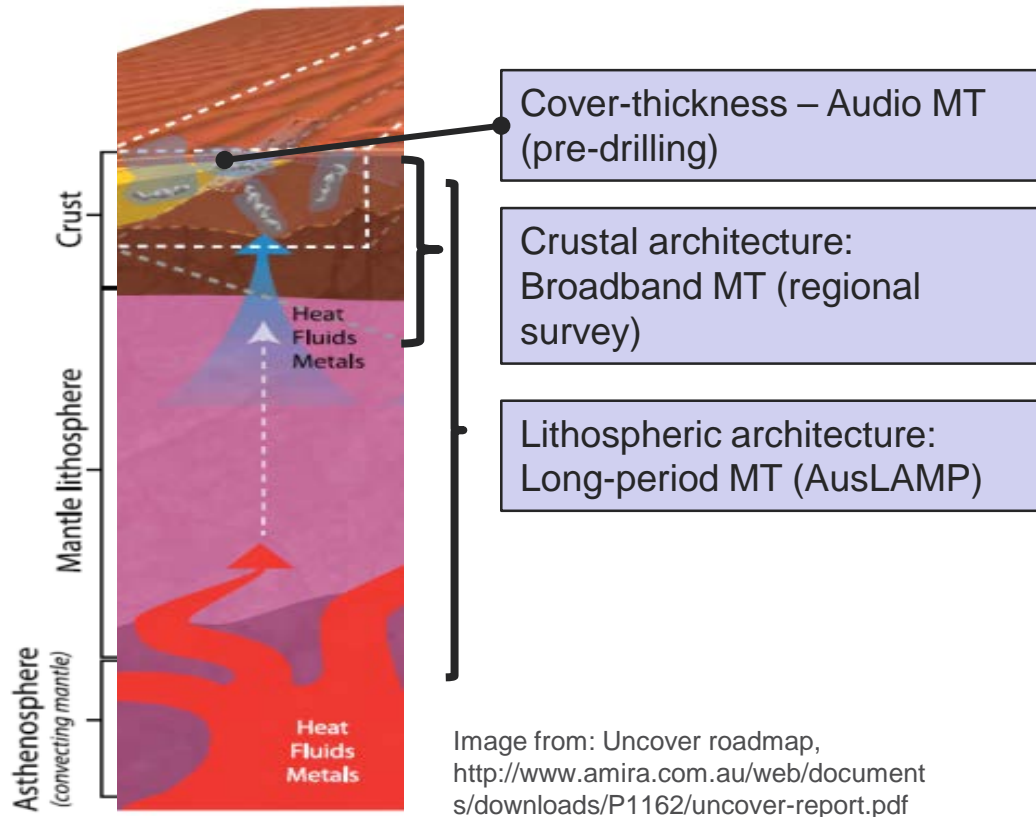
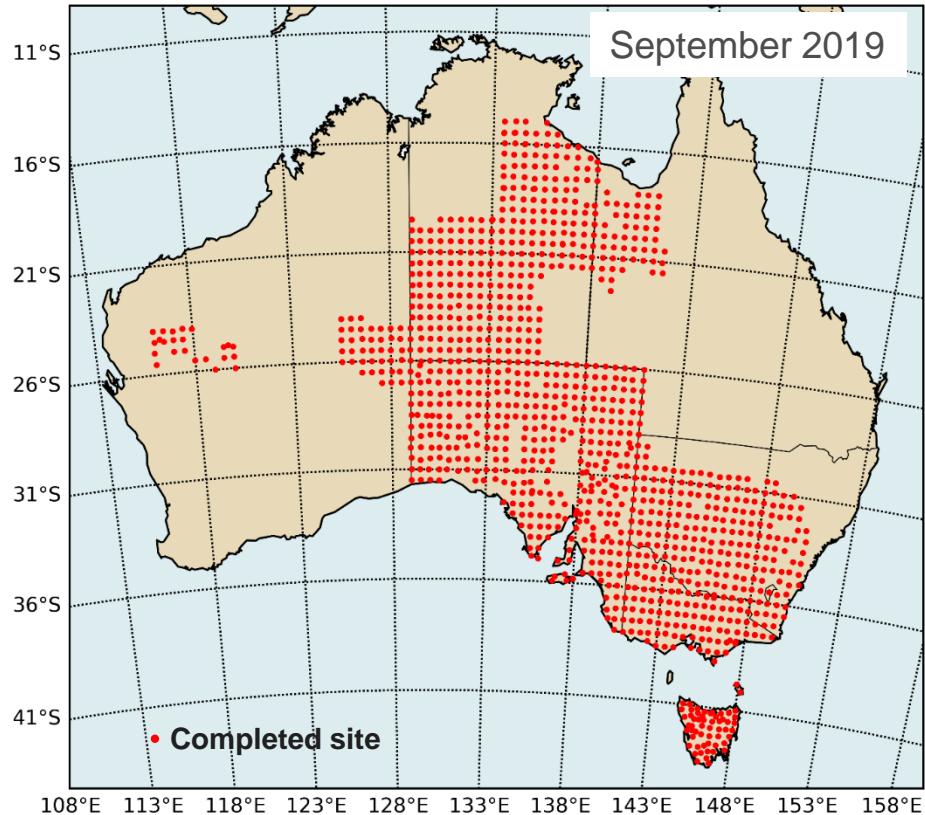


Image from: Uncover roadmap,  
<http://www.amira.com.au/web/documents/downloads/P1162/uncover-report.pdf>

- MT one of the few techniques that can image the very upper crust to the base of the lithosphere
- Different ‘flavours’ of MT essentially differ in recording time and sampling rate
- Image crustal architecture => mineral deposit locations
- One of the highest priorities of UNCOVER

# AusLAMP



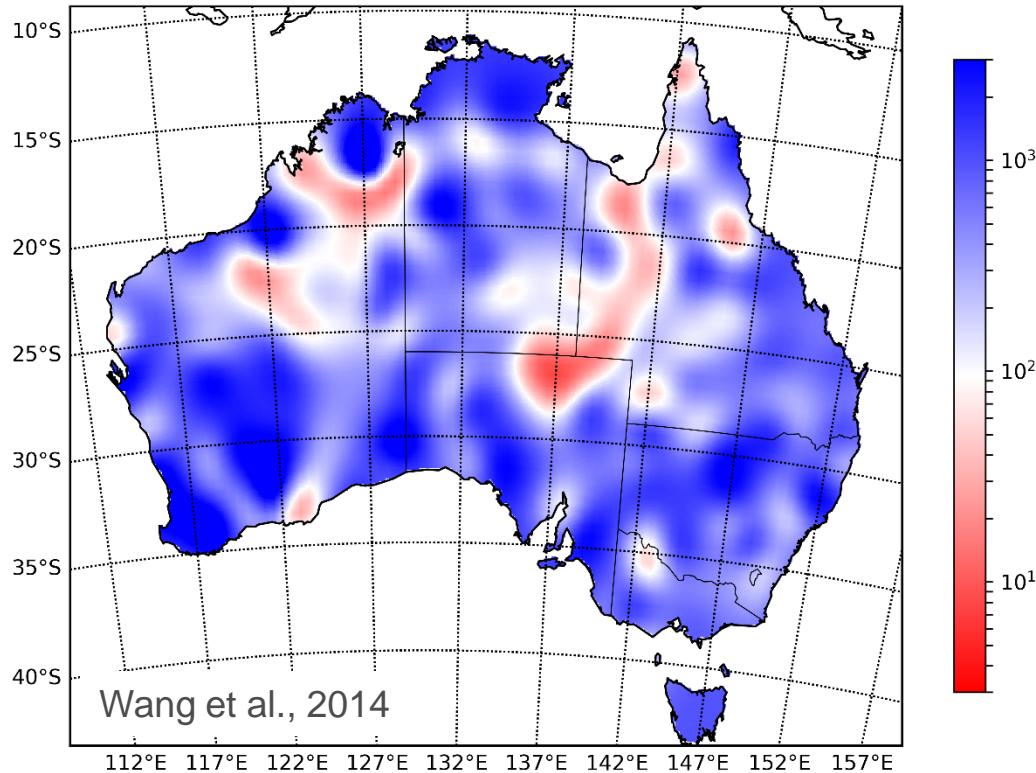
- Australian Lithospheric Architecture Magnetotelluric Program
- Commenced late 2013; collaborative project with universities/State surveys
- Completed ~1300 of ~3000 sites every 0.5°
- Most advanced continental scale MT survey in the world

## GA contribution:

- **Northern Australia**
- **New South Wales (GA + GSNSW)** fieldwork ongoing since 2016
- **Victoria (GA + GSVic)** – data released: <https://data.gov.au/dataset/australian-lithospheric-architecture-magnetotelluric-project-auslamp-victoria-data-release-repo>

# National conductivity map

Depth slice at 36 km depth



- “AusLAMP v0.0”: from magnetic observatory stations (Wang et al. 2014)
- 57 stations Australia-wide
- Magnetic field only

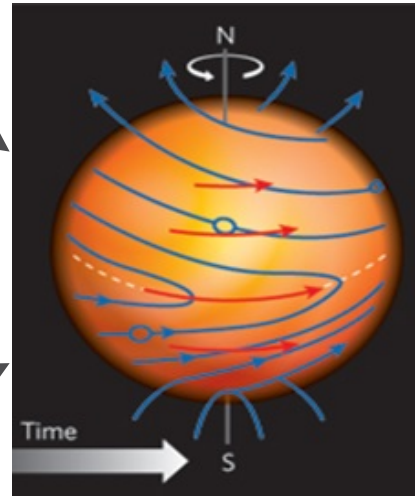
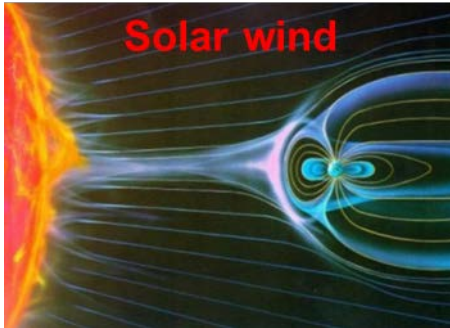
# Magnetotelluric method

# What is MT?

>1 Hz signal  
generated by  
world-wide  
thunderstorms



<1 Hz signal  
from interactions  
of Earth's  
magnetic field  
variations with  
solar wind



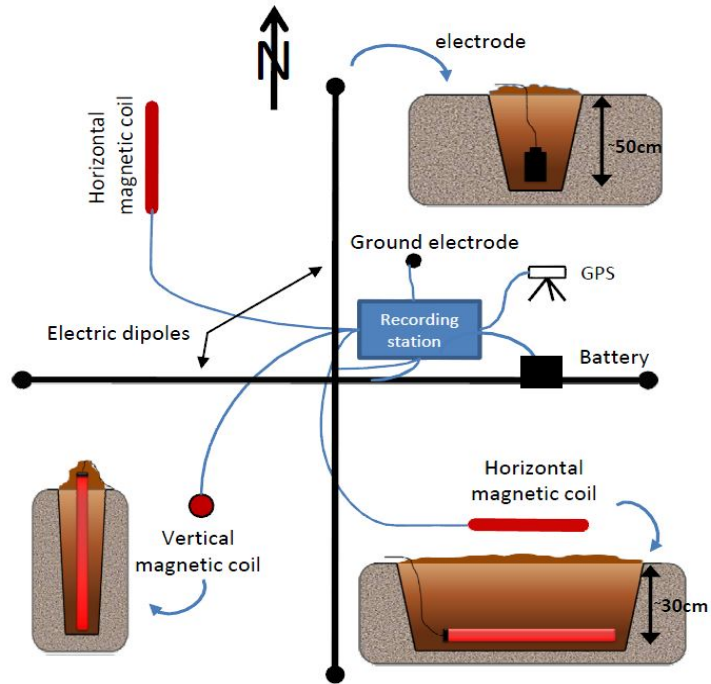
Measure time variations  
of Earth's electric and  
magnetic fields



Derive Earth's electrical  
conductivity structure (or  
resistivity)



# MT data acquisition



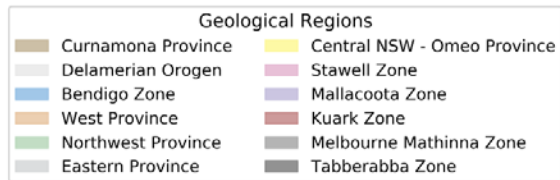
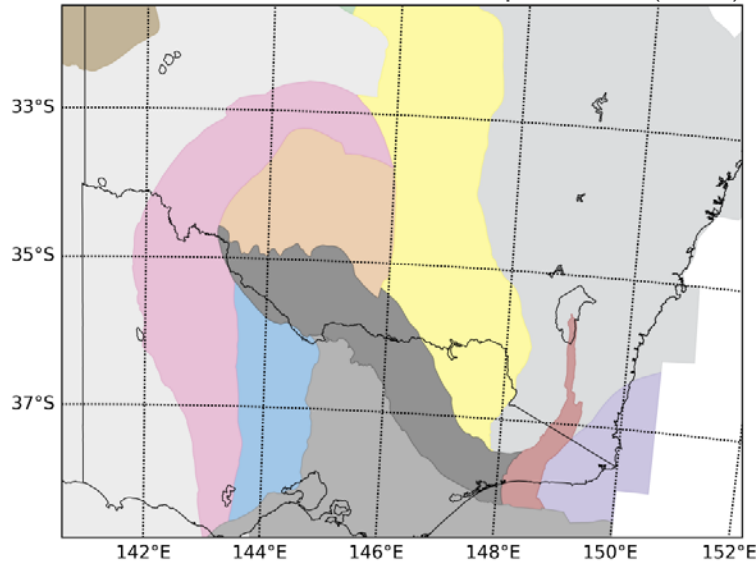
Schematic MT field layout, modified from Schmoldt (2011)



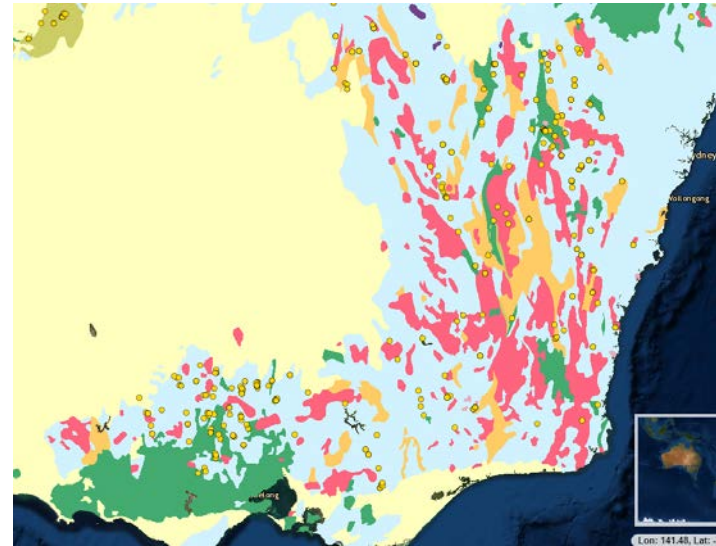
# New South Wales geology

# Geology of SE Australia

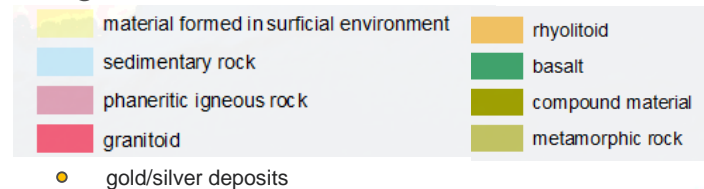
GA tectonic provinces (2013)



GA 1:2500k Surface geology [portal.ga.gov.au](http://portal.ga.gov.au)



## Legend

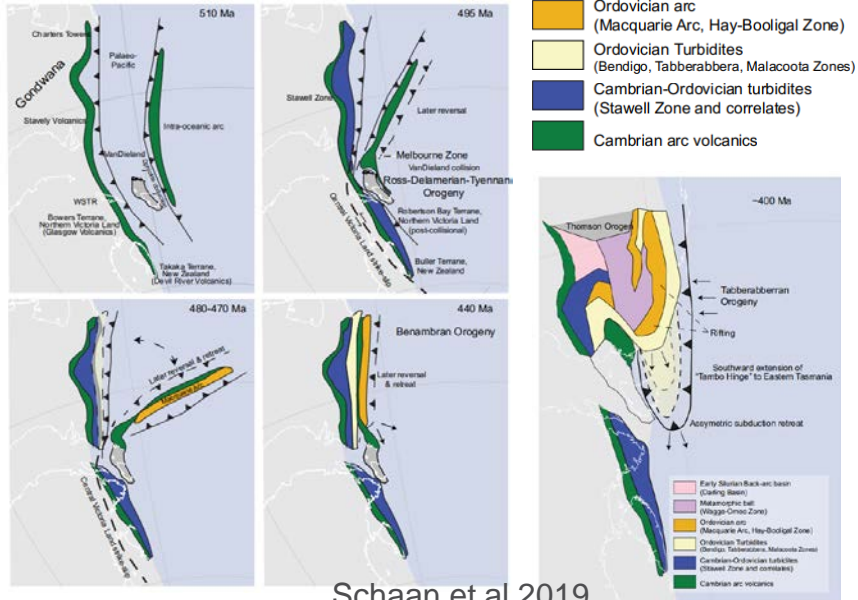


# Tectonic development

## Meffre & others:

(Schaan et al 2019)

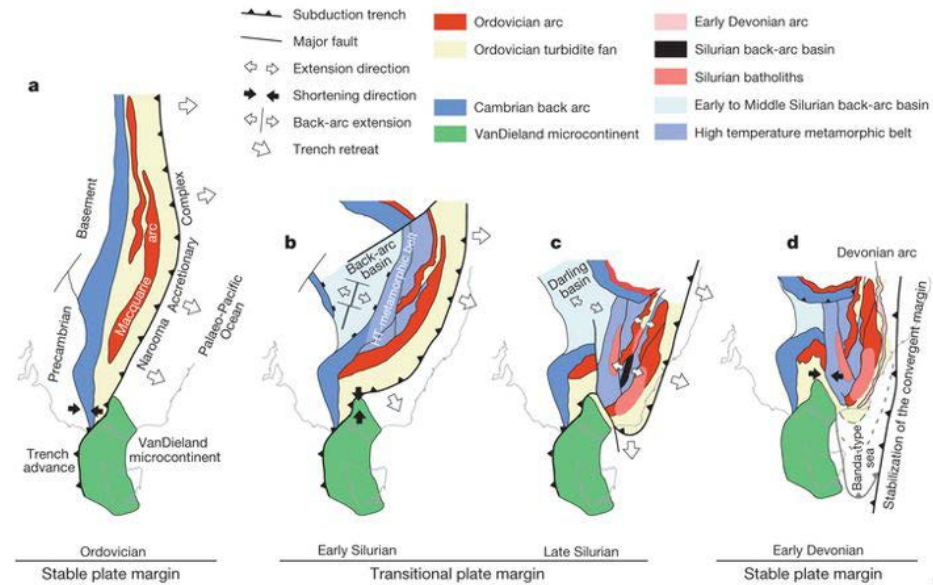
## Concurrent subduction zones



## Cayley & others:

(Cayley 2011; Moresi et al., 2014; Cayley 2015 & in prep)

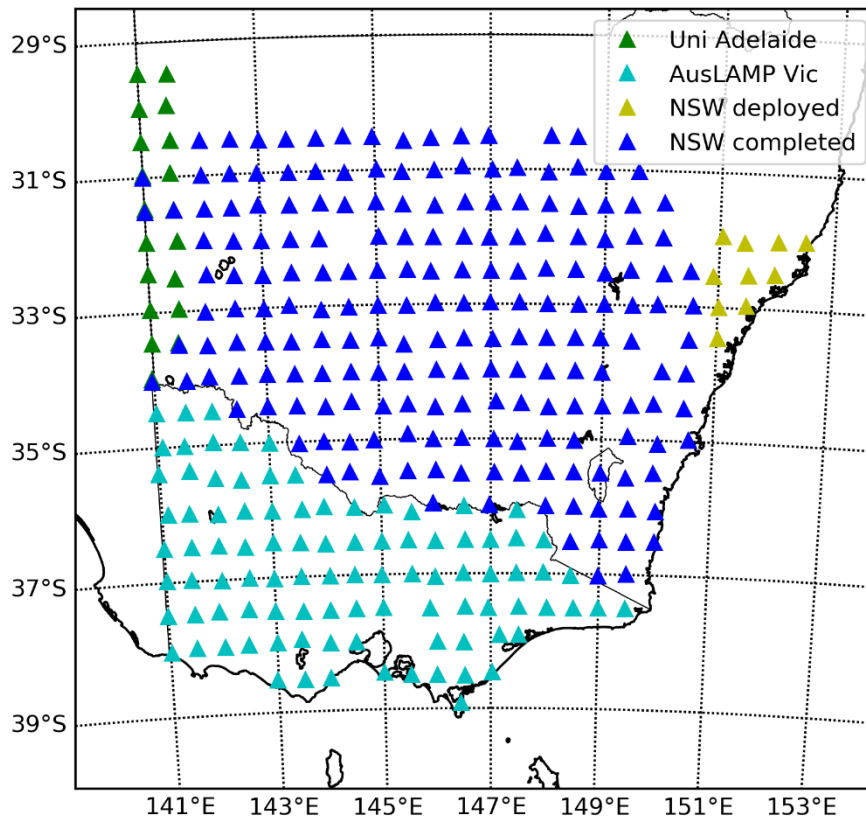
## Rotation during microcontinent accretion



# AusLAMP NSW/Vic magnetotelluric data

# AusLAMP NSW

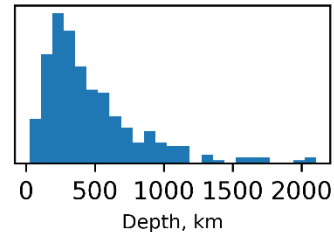
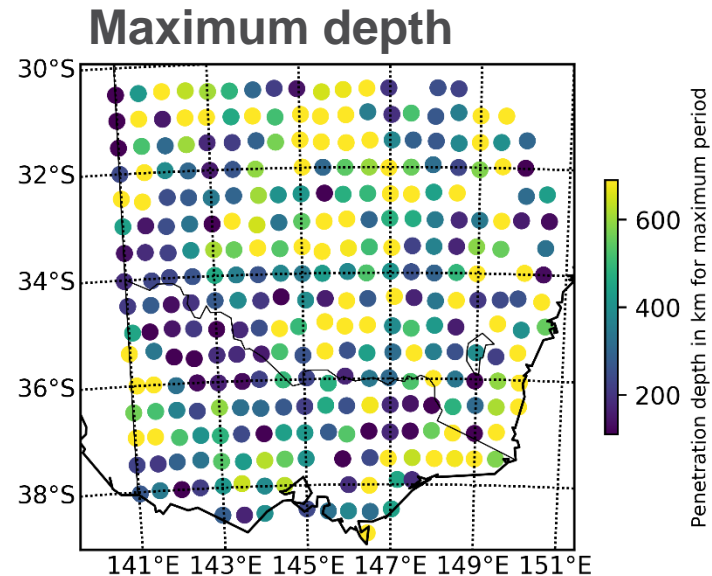
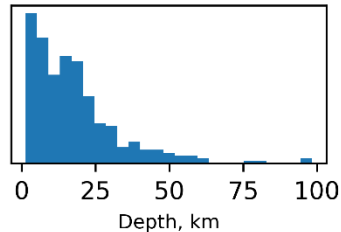
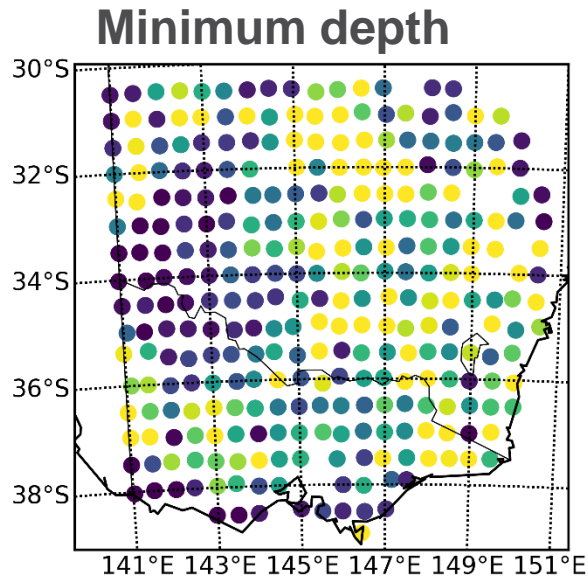
- Funding & land access from GSNSW / GSVic
- Ongoing acquisition (~10 instruments during northern field season, more in wet season)
- 203 sites completed in NSW out of 320 (+ 95 in Victoria)
- Recording time ~30 days + (at most sites)
- Period range 6.4 to (up to) 40000 s



Victoria data from Duan & Kyi, 2018  
Uni Adl data from Robertson et al., 2016



# Signal penetration depth (estimate)

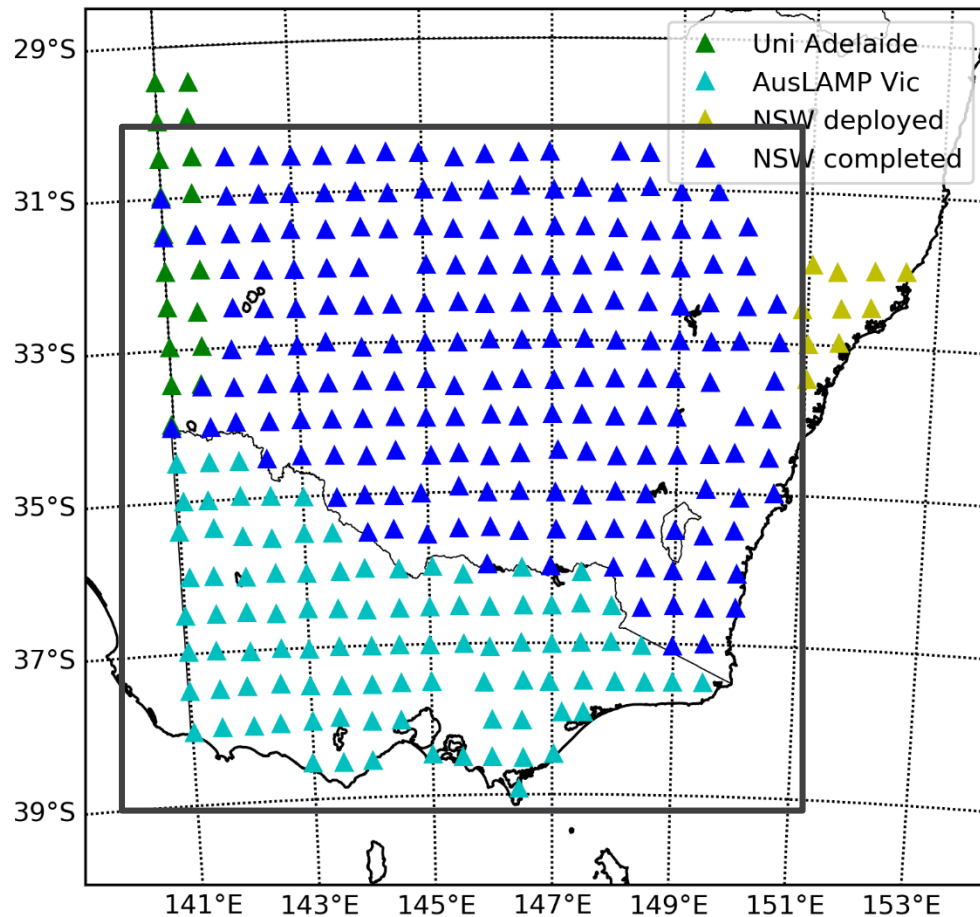


# AusLAMP NSW model



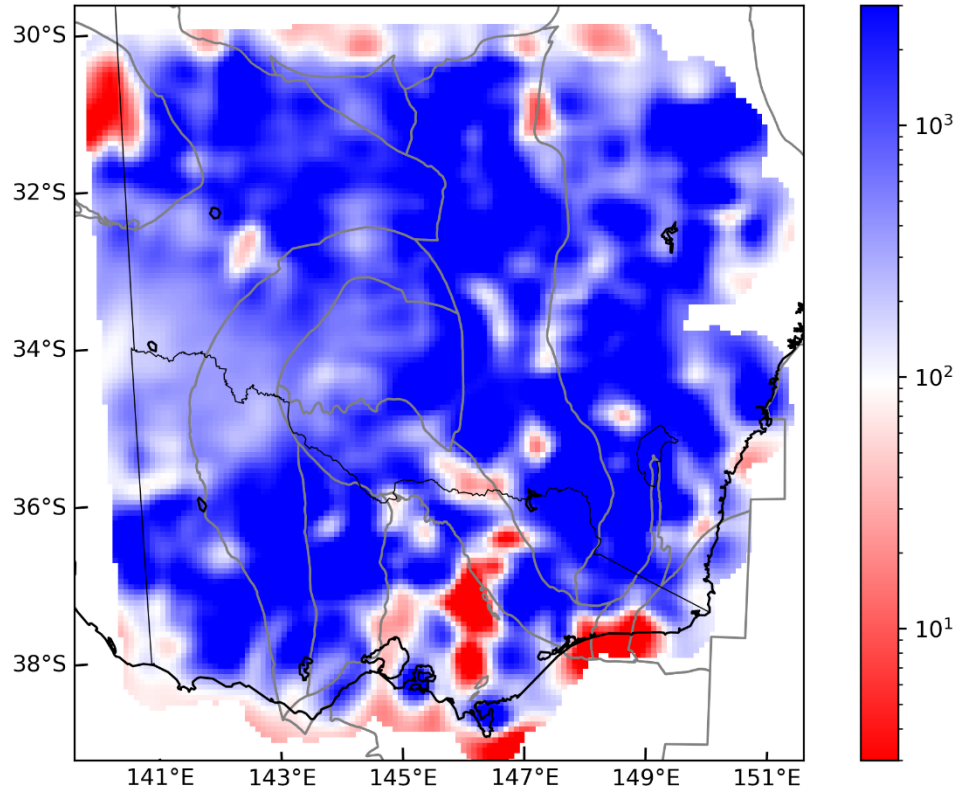
# AusLAMP NSW - Model

- Stations collected to July 2019
- 193 new sites + 10 sites (UofA) + 95 (Victoria) = **298 sites** in model
- (excludes 18 further sites awaiting processing/modelling)
- Grid cell size 7.5 x 7.5 km
- Compute time ~ 16 days
- RMS misfit 1.8



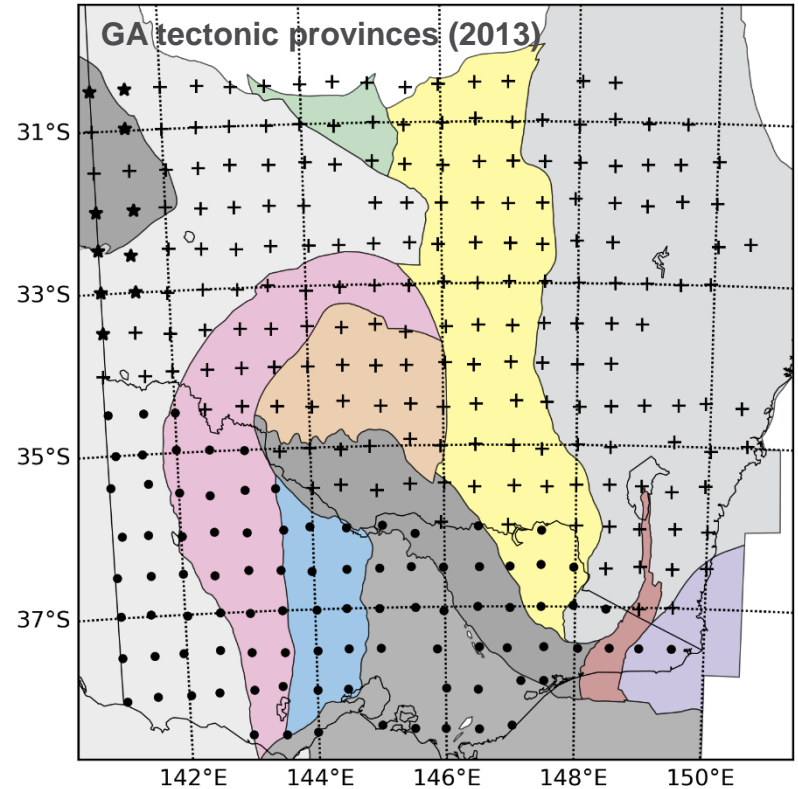
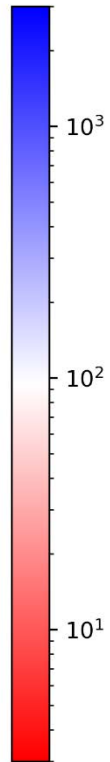
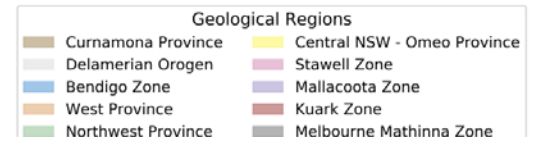
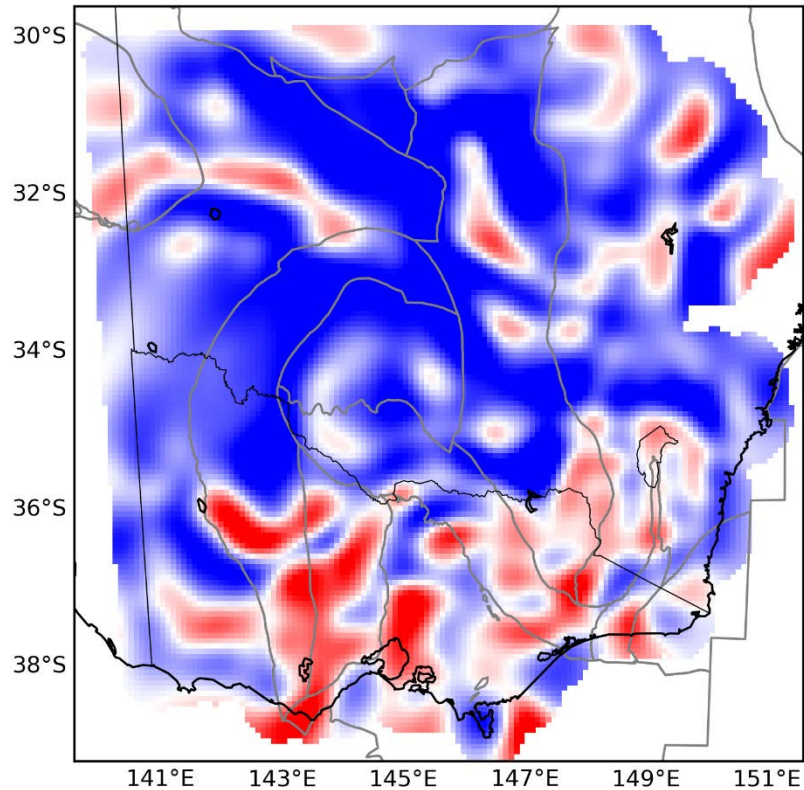
Victoria data from [Duan & Kyi, 2018](#); Uni Adelaide data from [Robertson et al., 2016](#)

# Depth Slice 10 km

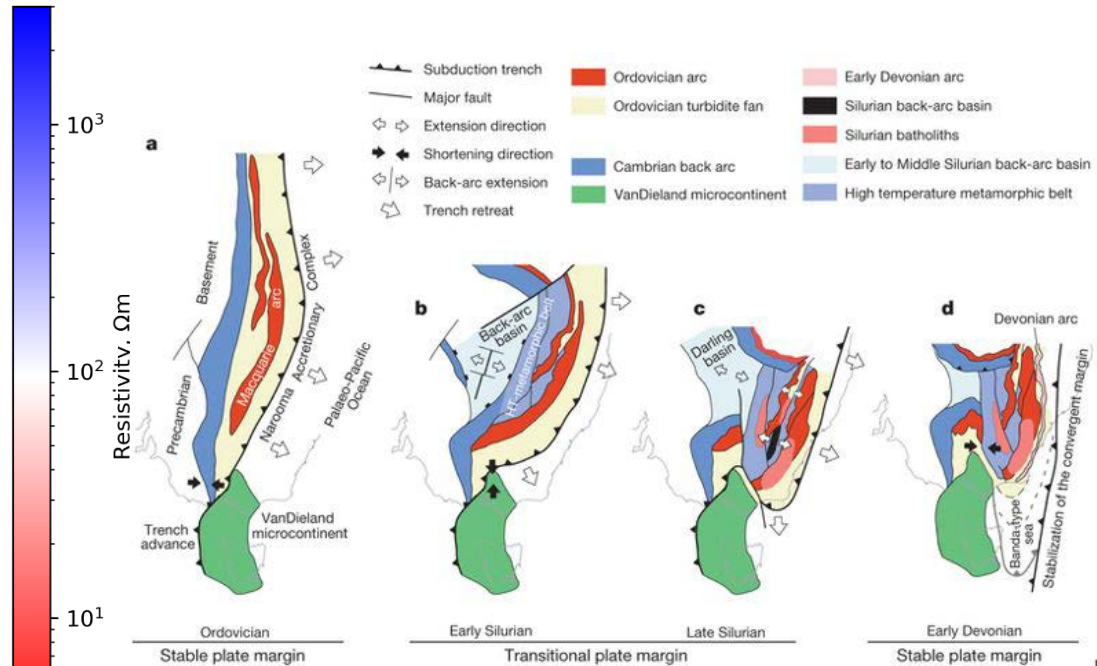
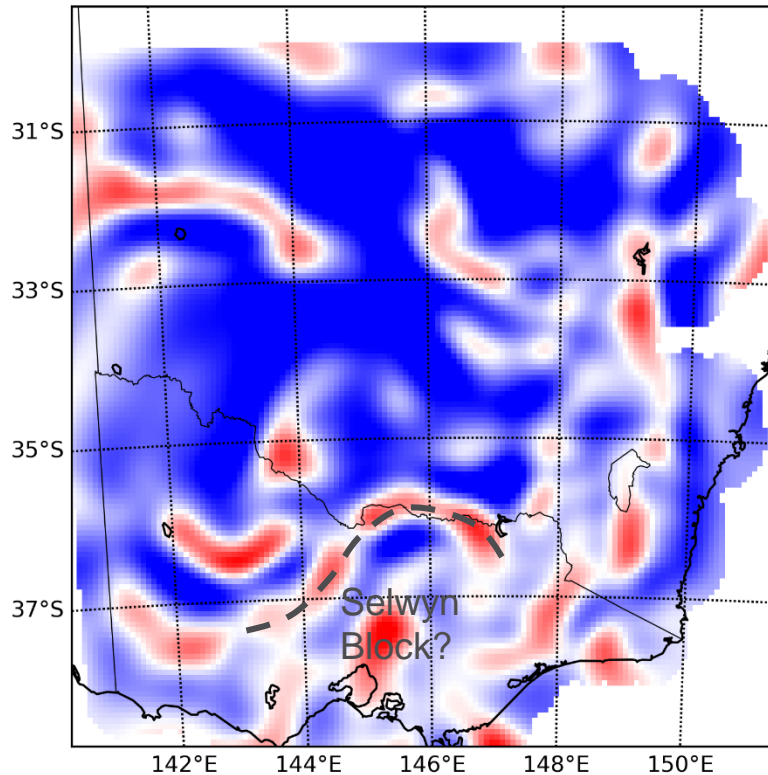


- Masked  $> 0.5^\circ$  from stations
- Mostly resistive, except:
  - Mesozoic – Cenozoic basins
  - Curnamona conductor (Robertson et al 2016)
  - Conductor in Melbourne Zone

# Depth Slice 30km

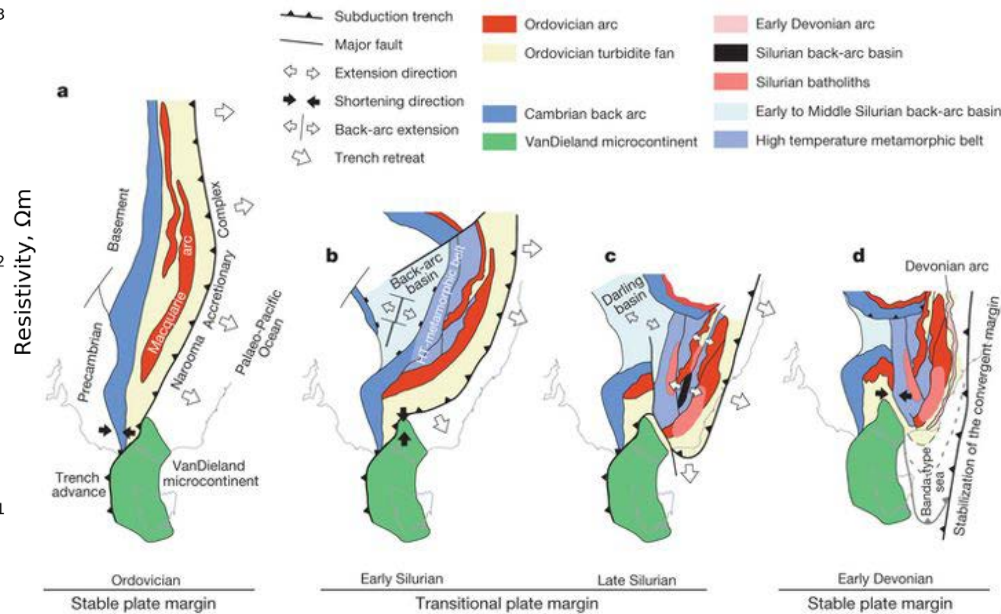
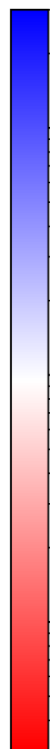
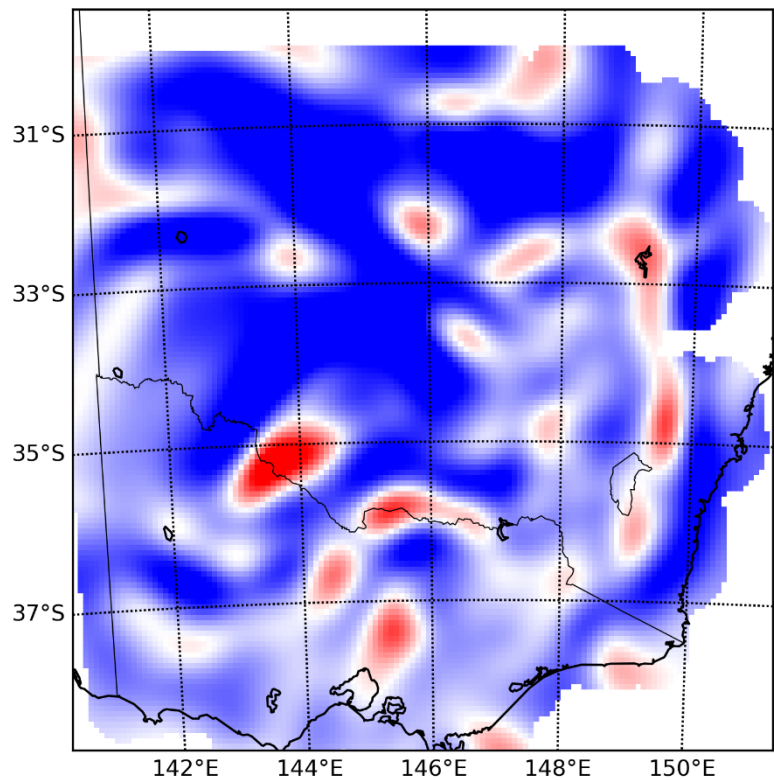


# Depth Slice 40km (base of the crust)



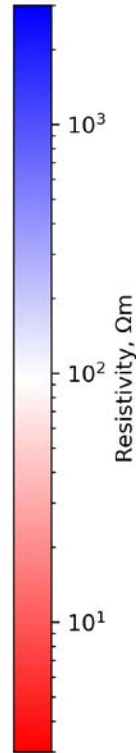
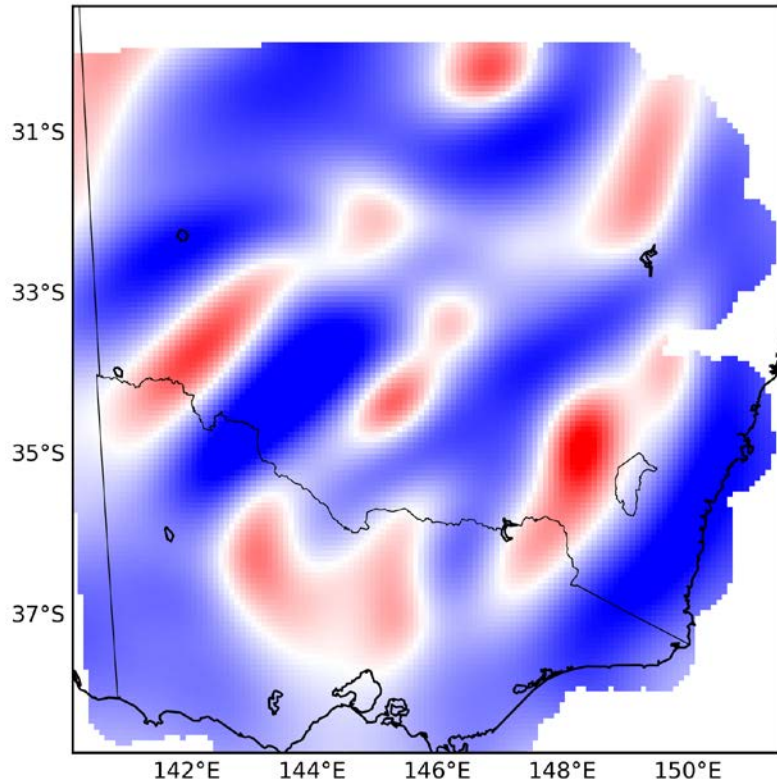
Moresi et al., 2014; Cayley 2011

# Depth Slice 60km (mantle lithosphere)

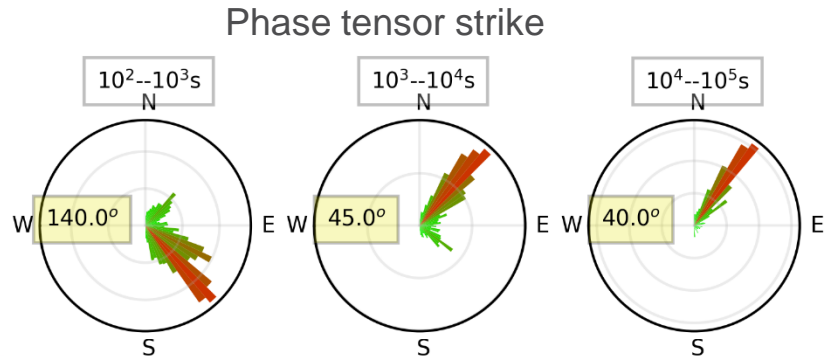


Moresi et al., 2014; Cayley 2011

# Depth Slice 140km (mantle)

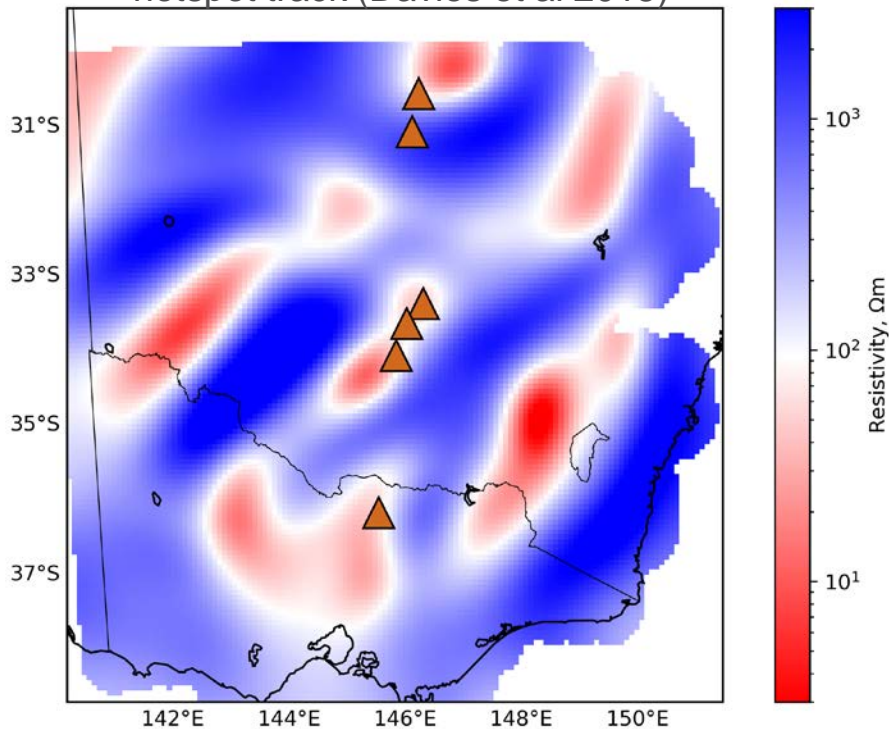


- Central Victoria conductor
- New South Wales – northeasterly alignment
- Similar to Australian plate motion

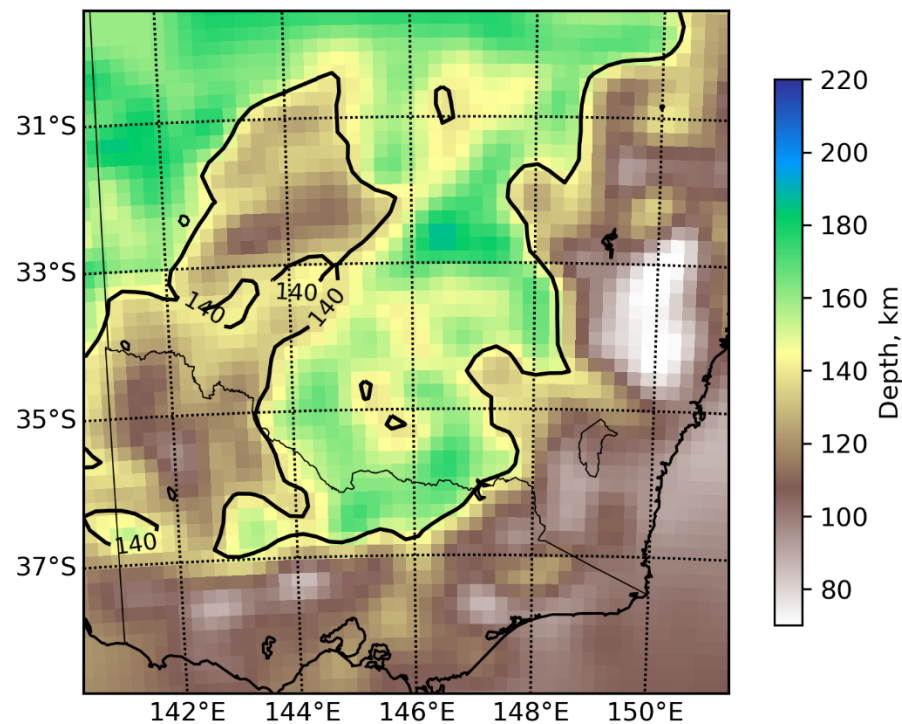


# Depth Slice 140km (mantle)

▲ Leucitite volcanoes along Cosgrove hotspot track (Davies et al 2015)



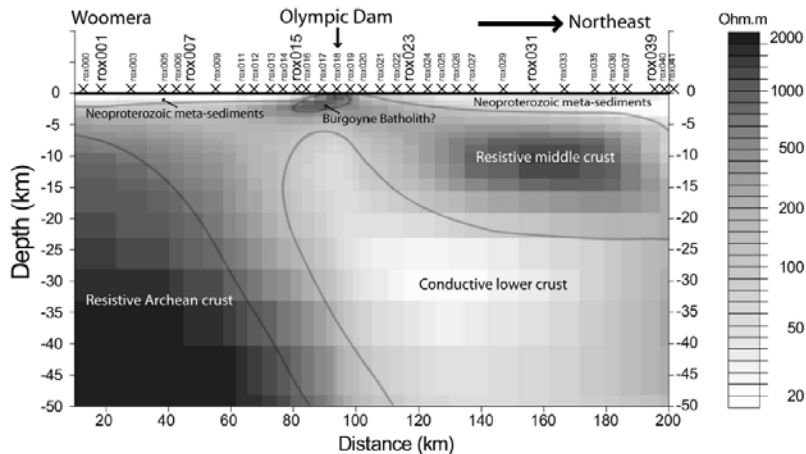
# Lithosphere-Asthenosphere Boundary (Davies et al 2015)



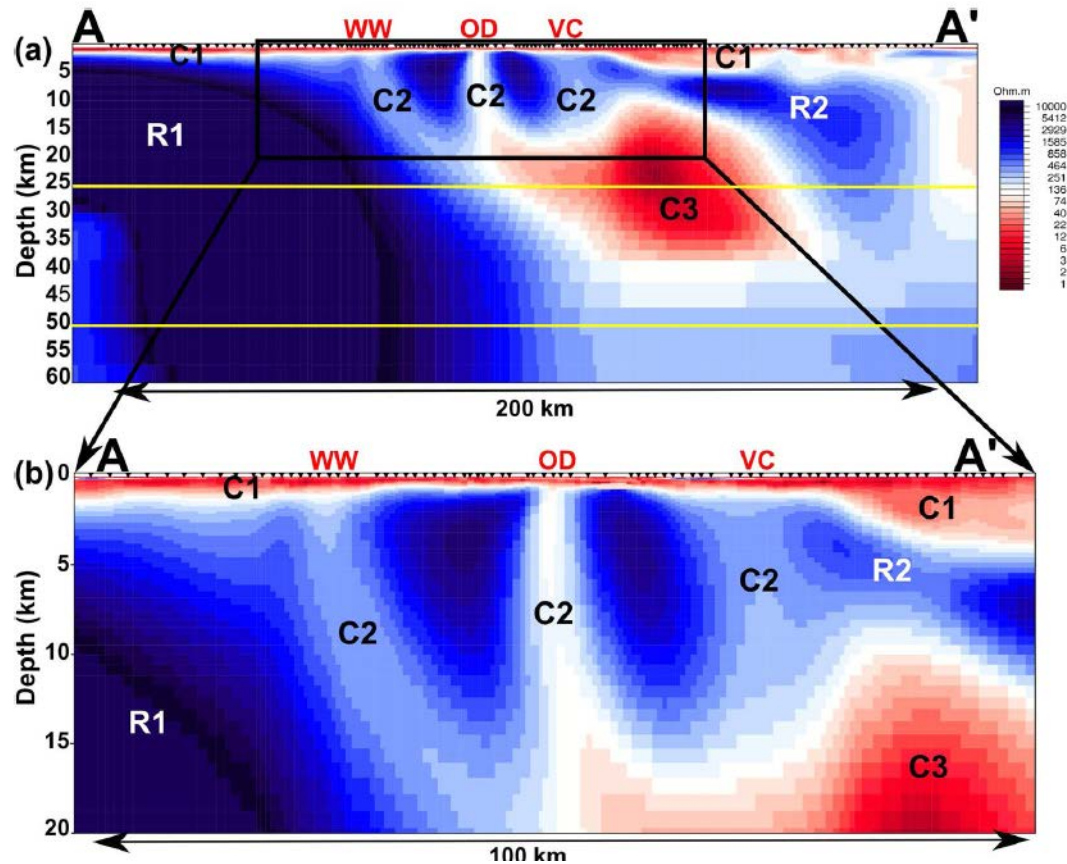
# Implications for prospectivity



# Imaging mineral systems with MT



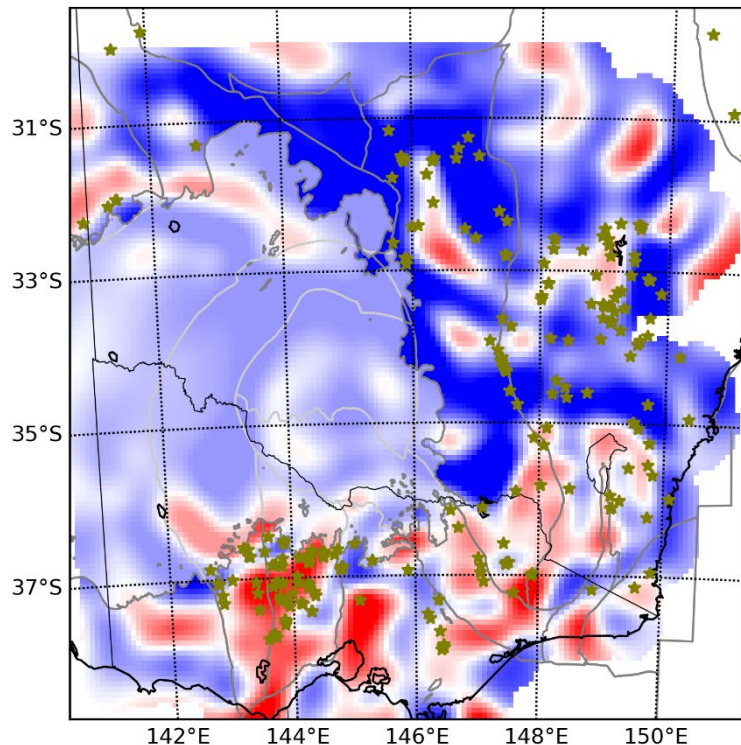
Heinson et al 2006



Heinson et al 2018

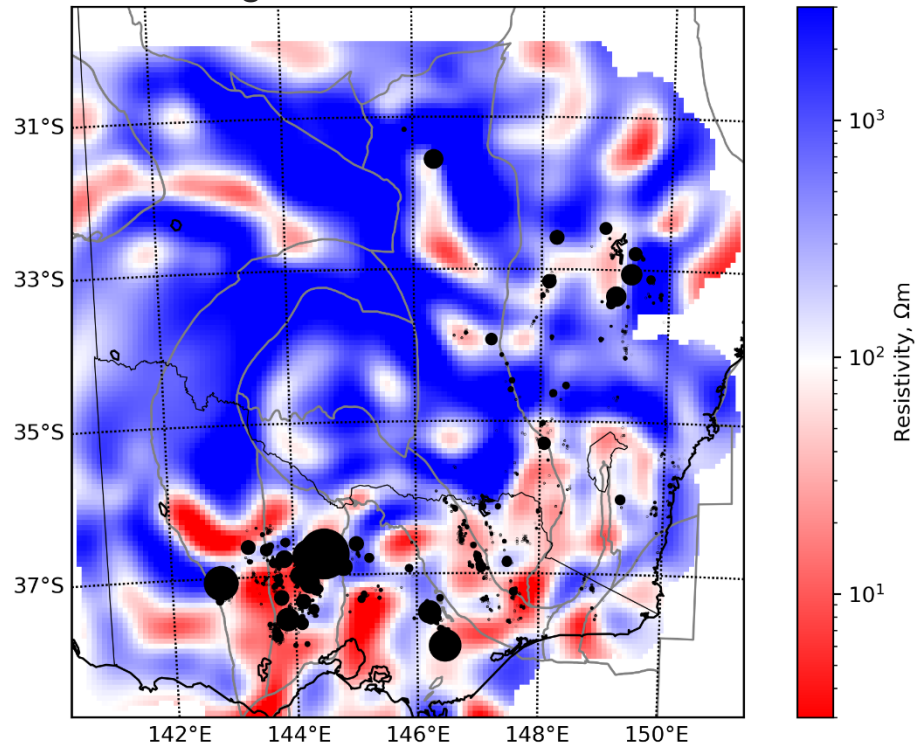
# Depth Slice 30km and gold

## All Gold



Occurrences from Australian Mines Atlas

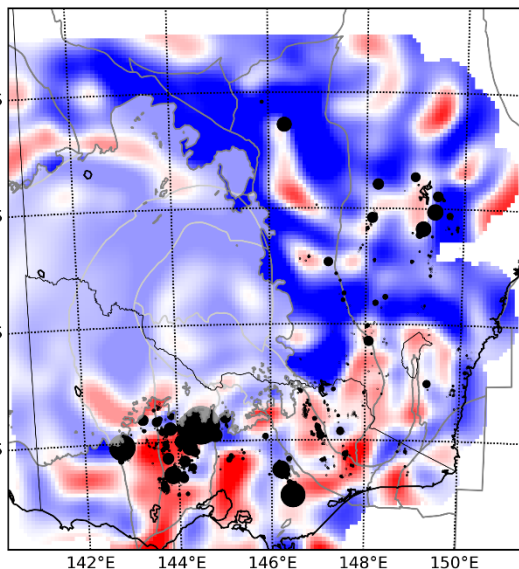
## Orogenic Gold



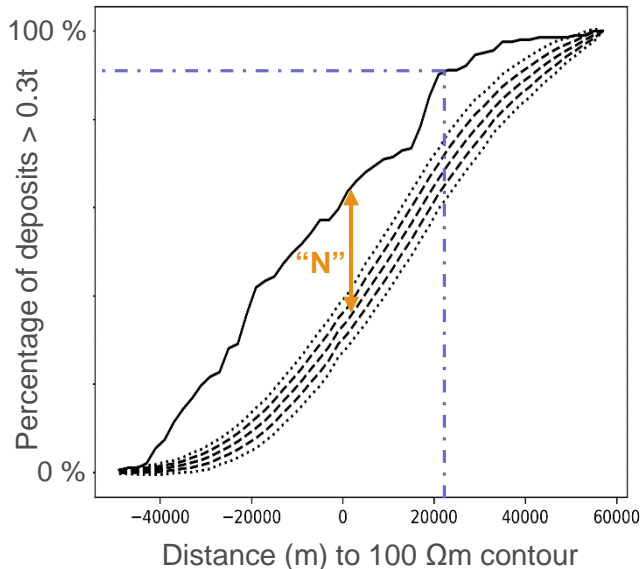
NSW production + contained resource from GSNSW;  
Vic production from GSVic; + contained resource from GA (AIMR, 2018)

# Statistical Analysis

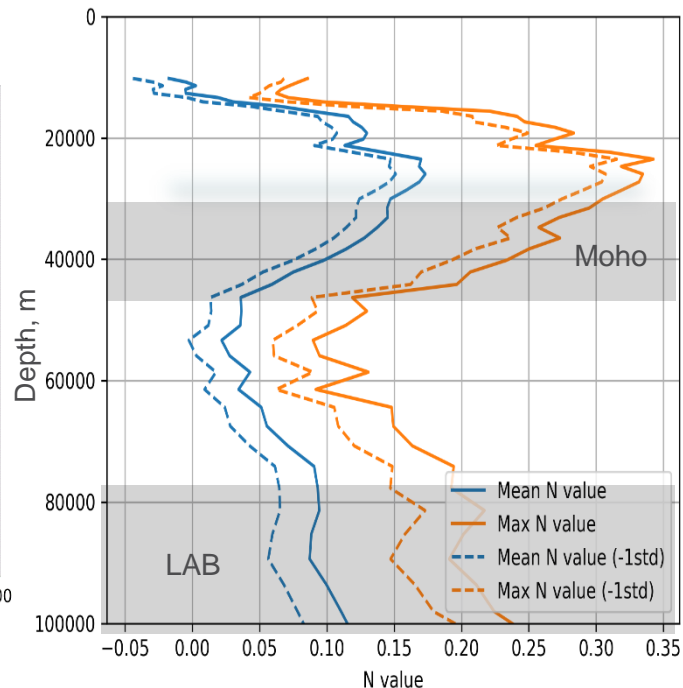
## Orogenic Gold



90 % of deposits within ~20km of the 100 ohm-m contour

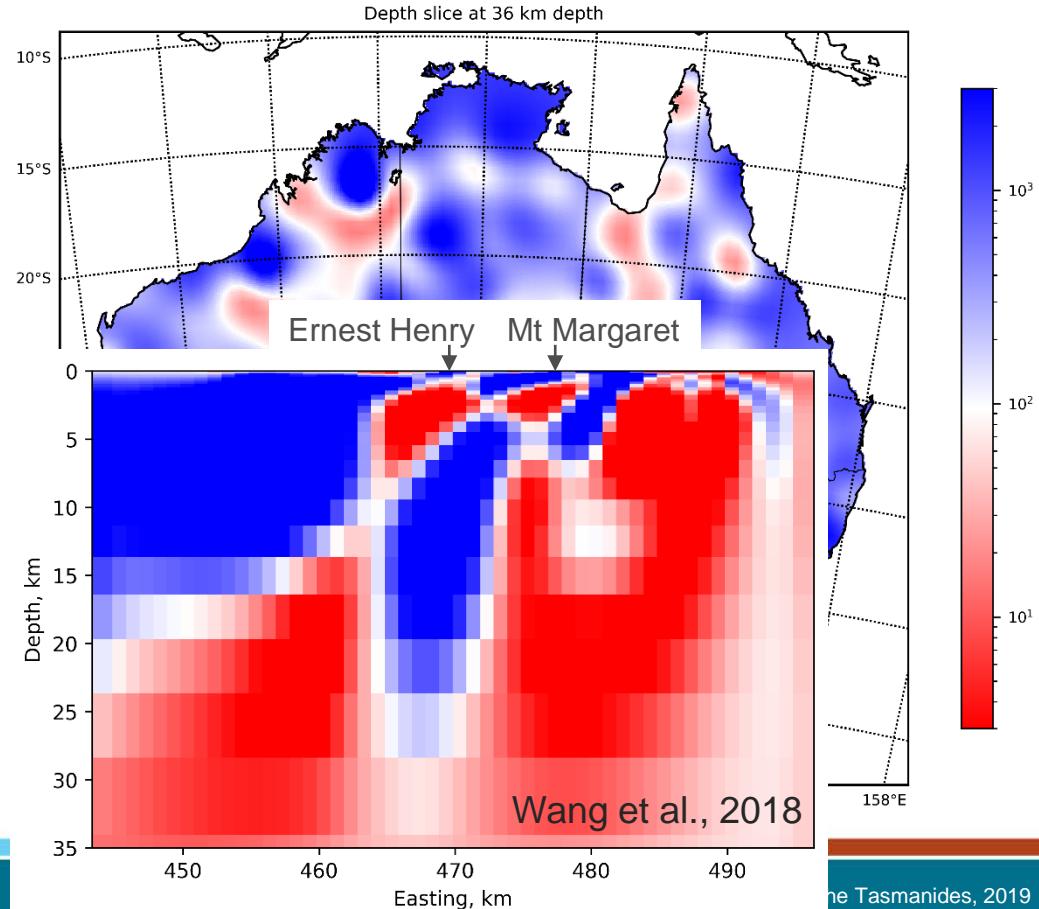


- True deposit locations
- - - Random locations (excluding Murray Basin)



# National conductivity map (with detail in SE Australia)

- New AusLAMP model provides increased detail in SE Australia
- In NSW/Vic, we have taken the first step from “AusLAMP light” => AusLAMP
- Demonstrating power to resolve lithospheric architecture and regions of interest
- Next step: infill



# Acknowledgements

## State survey partners:



Government of Western Australia  
Department of Mines and Petroleum



## AuScope, ANSIR (instrument pool), and AusLAMP university partners:



AuScope



THE UNIVERSITY OF  
WESTERN AUSTRALIA

ModEM inversion code:



## Acknowledgements (cont'd)

Geoscience Australia acknowledges the traditional custodians of the country where this work was undertaken.

We also acknowledge the support provided by individuals and communities to access the country, especially in remote and rural Australia.



Australian Government

Geoscience Australia



# Questions?

Alison Kirkby, *Discovery in the Tasmanides*, 2019