Linking Western and South Australia – insights from magnetotelluric profiling

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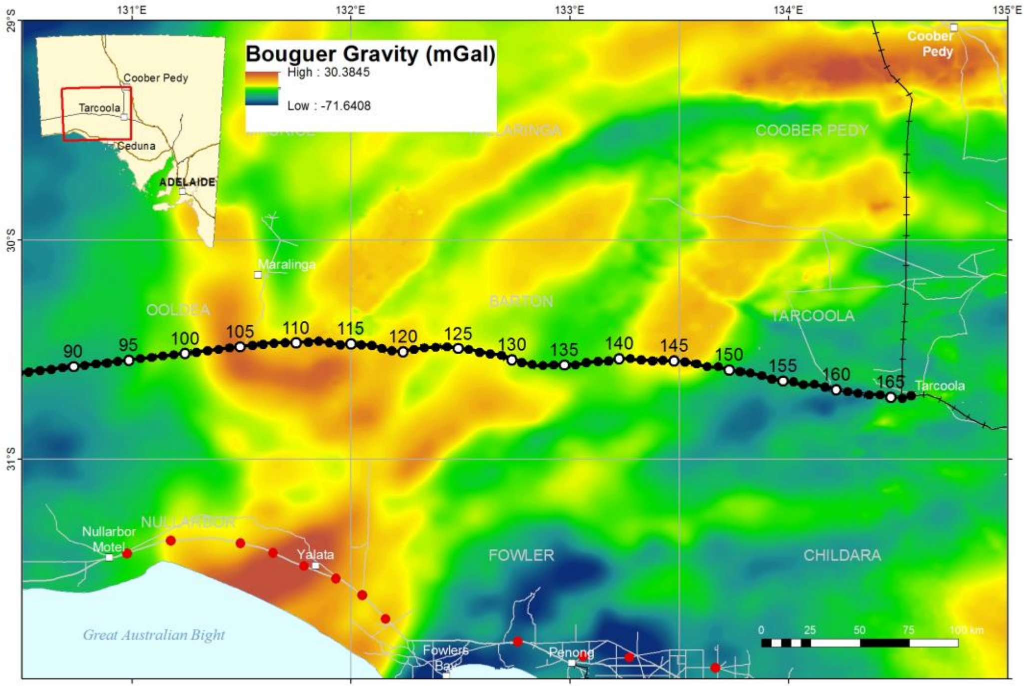
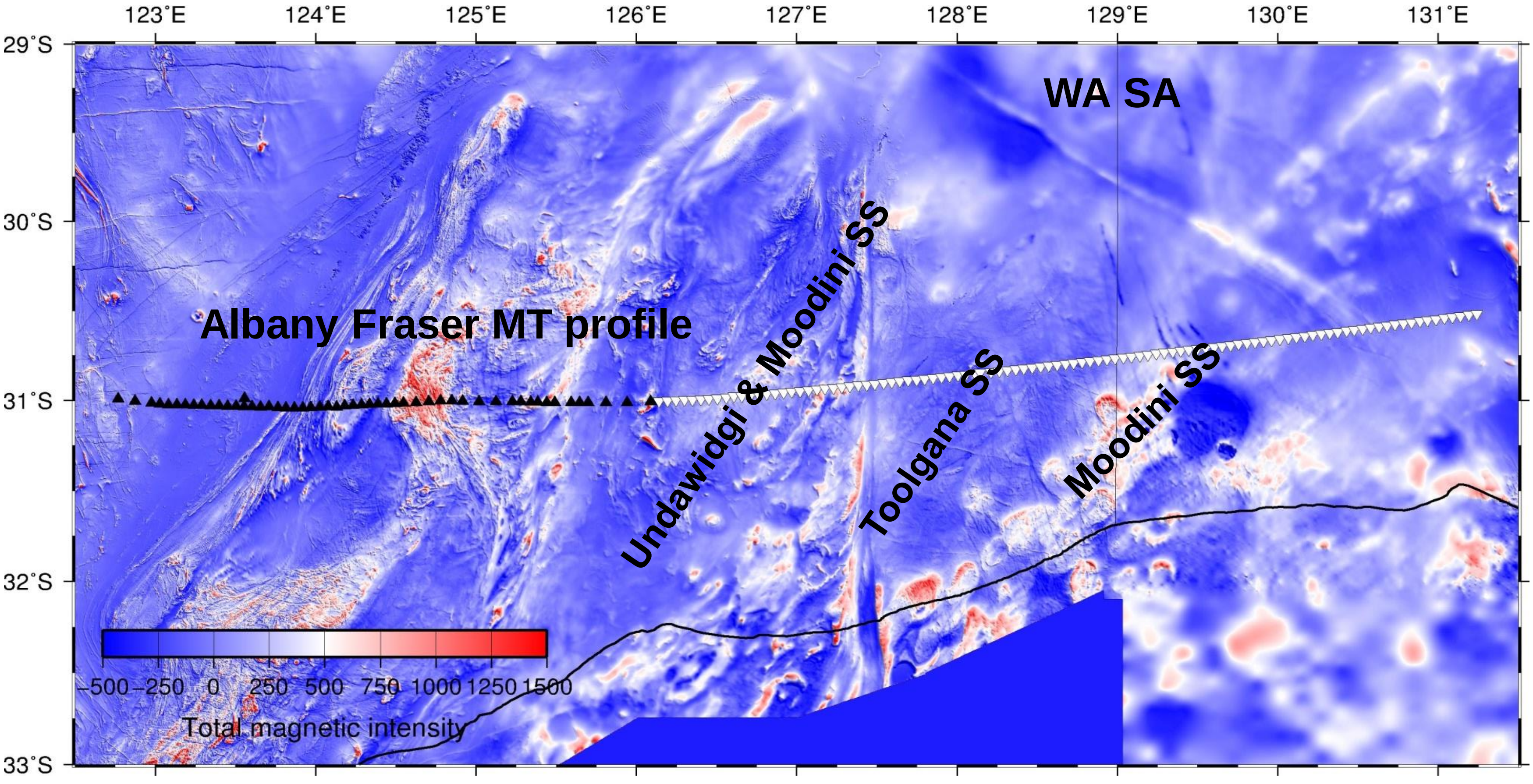
13GA-EG1 MT traverse – Gawler part

- 167 broadband (0.0025 – 2000 s) MT stations acquired along ~840 km profile along Trans-Australian railway
- Collected by Moombarriga Geoscience
- Mix of Phoenix and Metronix MT systems
- Based on overlap with seismic interpretation
- Consistent crustal strike across the Gawler Craton and Coompana/Madurah Province

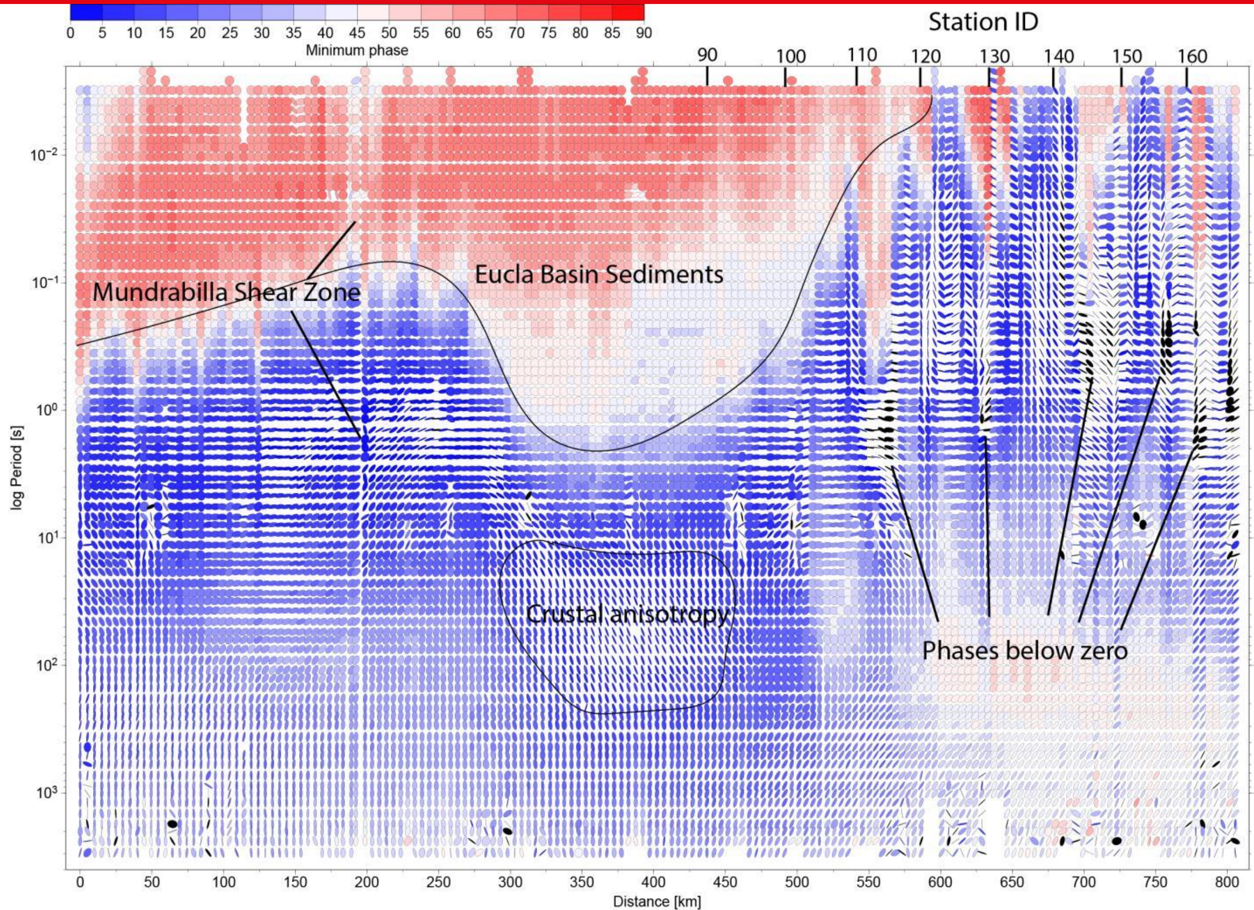


13GA-EG1 MT traverse – Coompana/Madura – Albany Fraser part



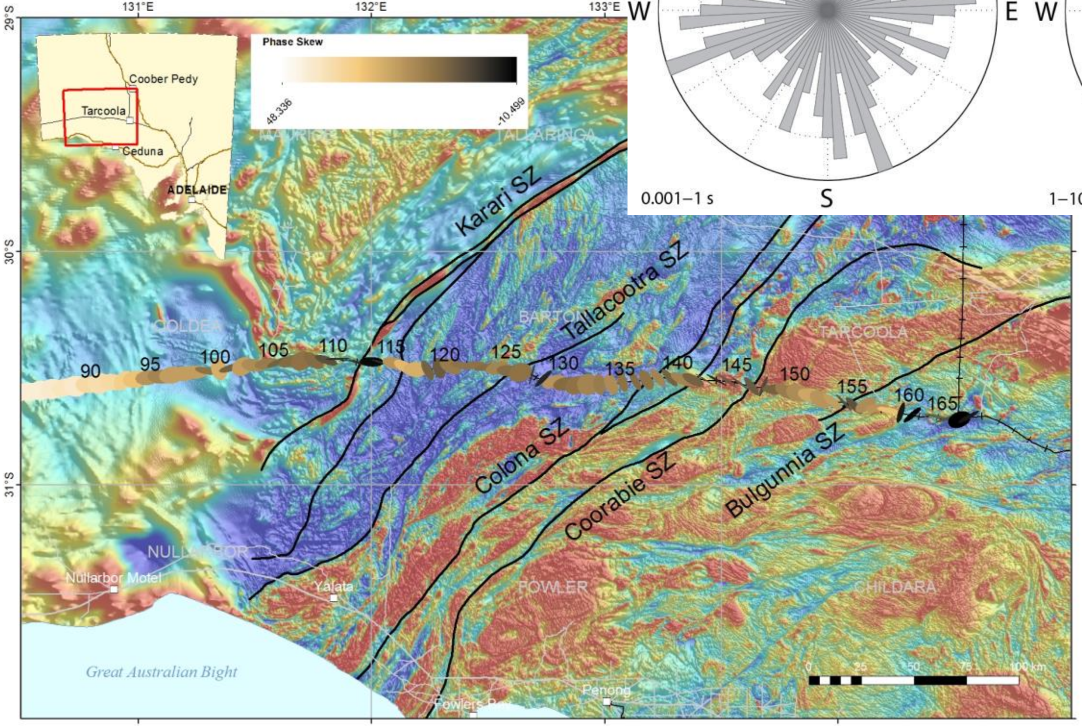
Data of the entire 13GA-EG1 line

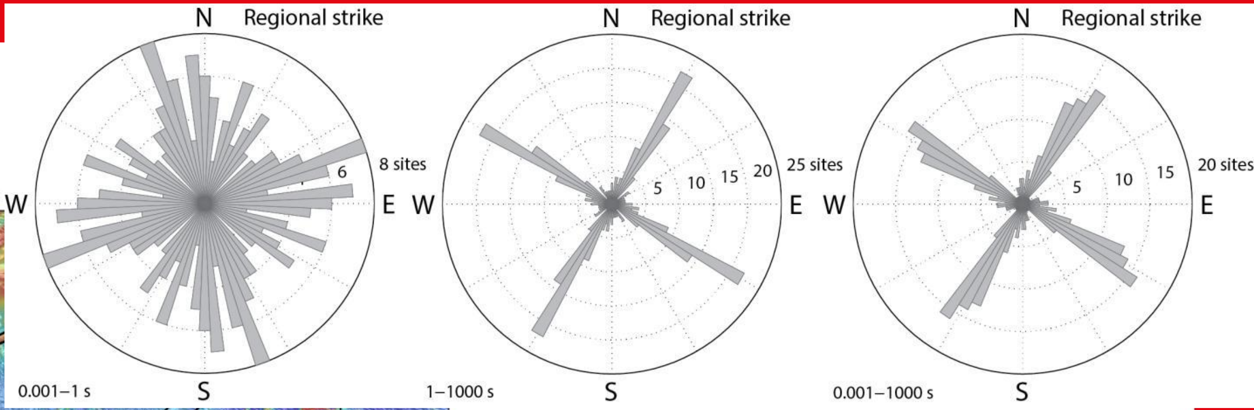
- Data quality very good, no vertical magnetic field information (train line noise)
- Minimum phase illustrates resistivity changes with depth
- $\Phi_{min} > 45$ resistivity decreases
- $\Phi_{min} < 45$ resistivity increases (e.g. sediment to basement)



Strike analysis of the 13GA-EG1E Gawler part (90-167)

TMI & phase tensors (1s period)

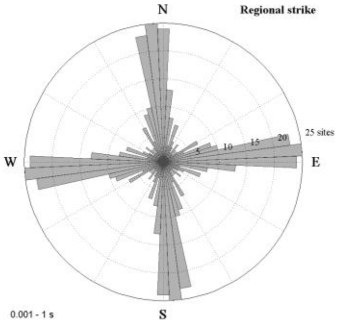


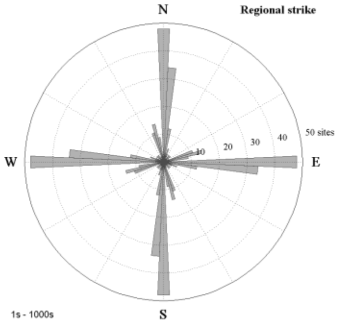


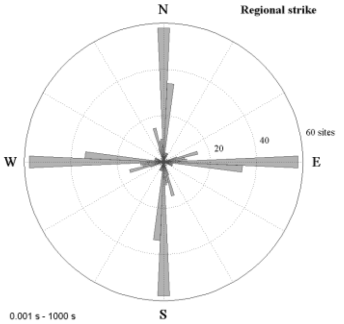
- Geoelectric strike N27°E
- Masked 3D data and phases below 0°
- Distortion removal prior to modelling (Becken and Burckhard, 2004, GJI)

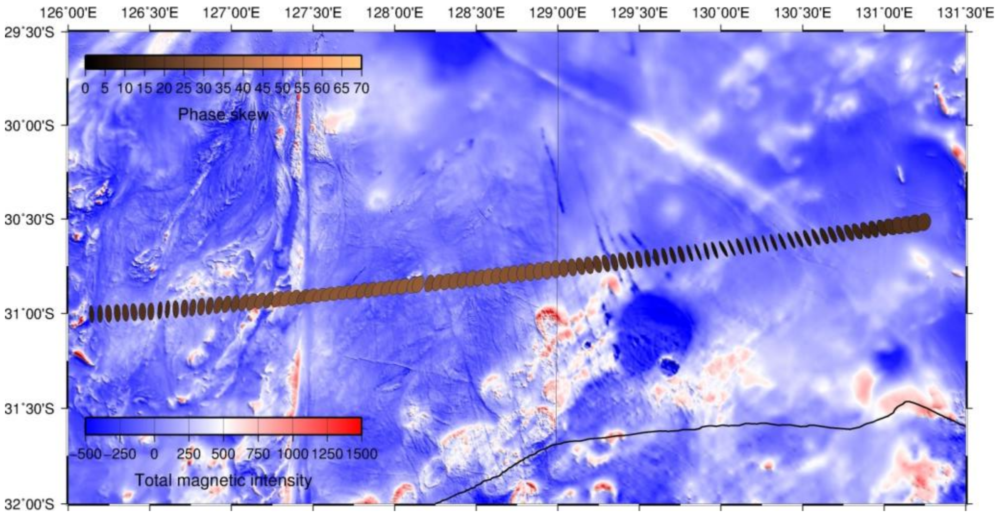
Strike analysis of the 13GA-EG1 Coompana-Madura-Albany Fraser part (station 1-100)

TMI & phase tensors (100s period)



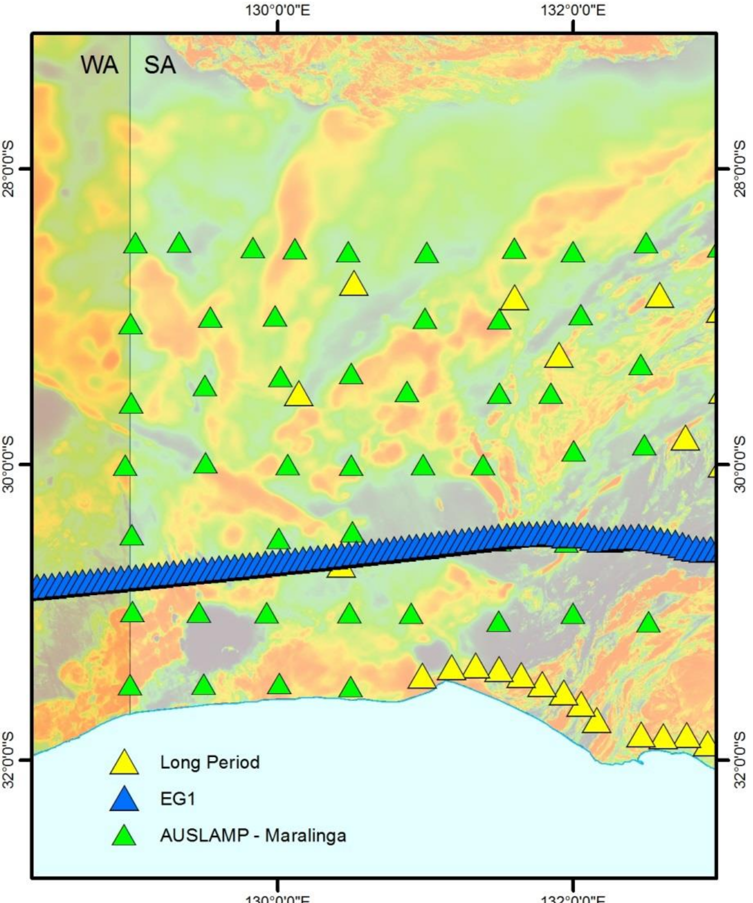




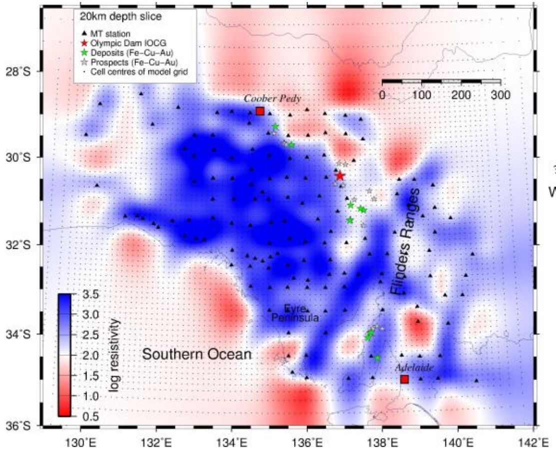


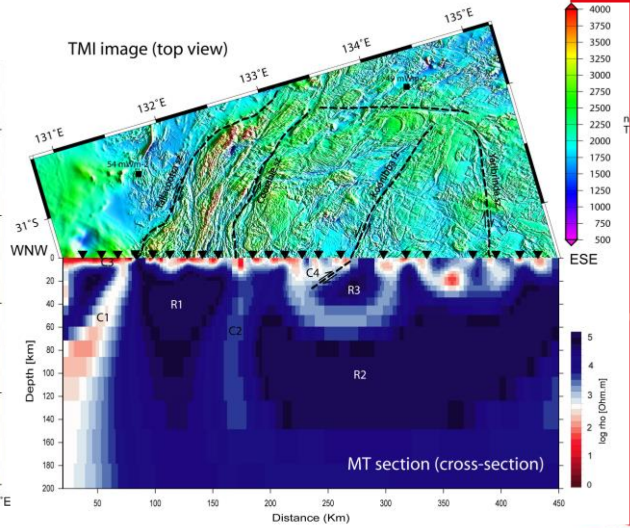
- Geoelectric strike N0°E
- Masked 3D data and phases below 0°
- Distortion removal prior to modeling (Becken and Burckhard, 2004, GJI)

13GA-EG1E line in context of AusLAMP MT array

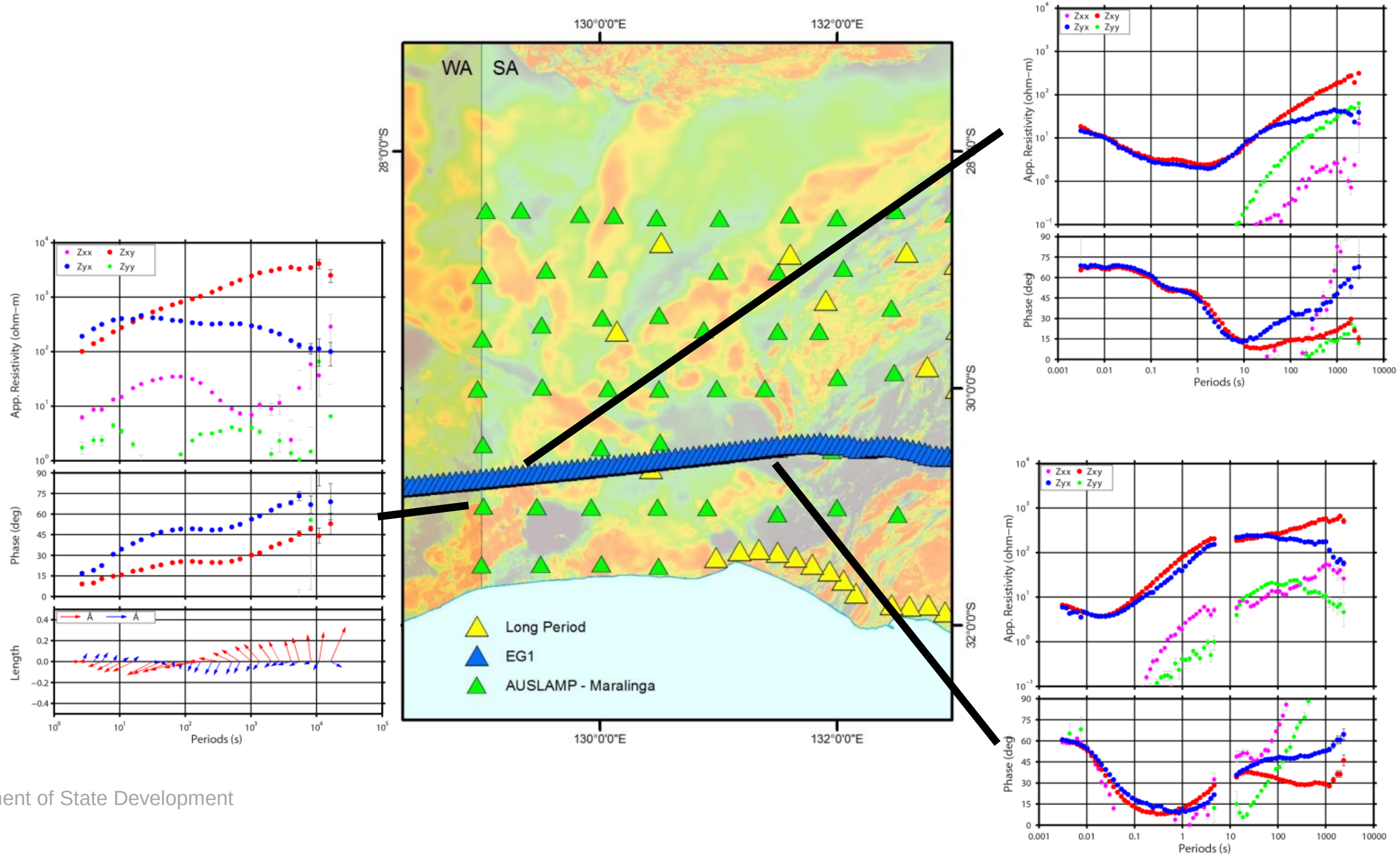


- Long-period MT data (yellow; Thiel et al., 2010, 2013)
- AusLAMP long-period MT stations Sep-Dec 2015 (green; GSSA, GA, Uni of Adelaide); site spacing 50 km
- EG1 broadband MT profile; site spacing 5 km (blue)

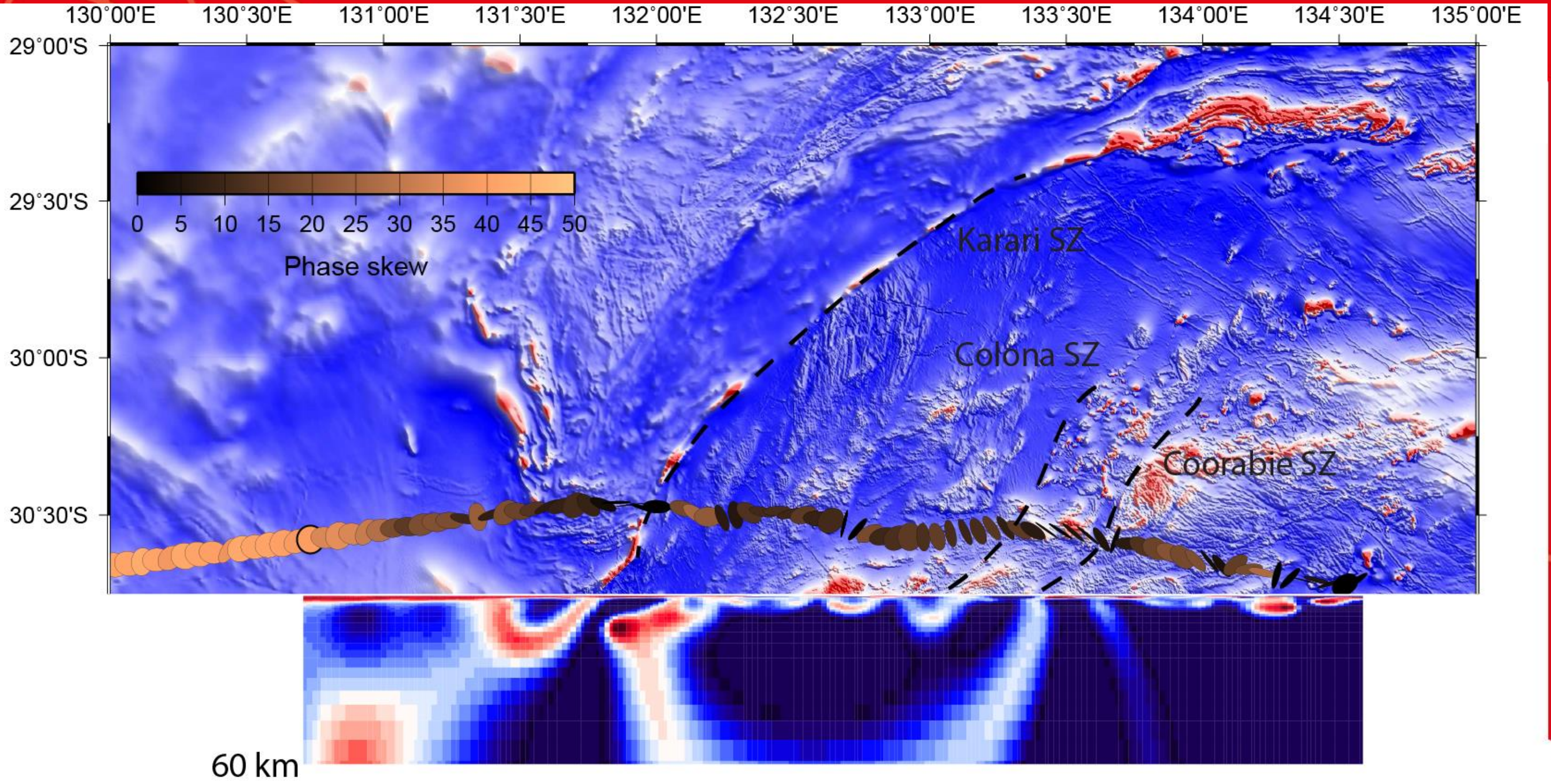




13GA-EG1 MT traverse – Gawler part

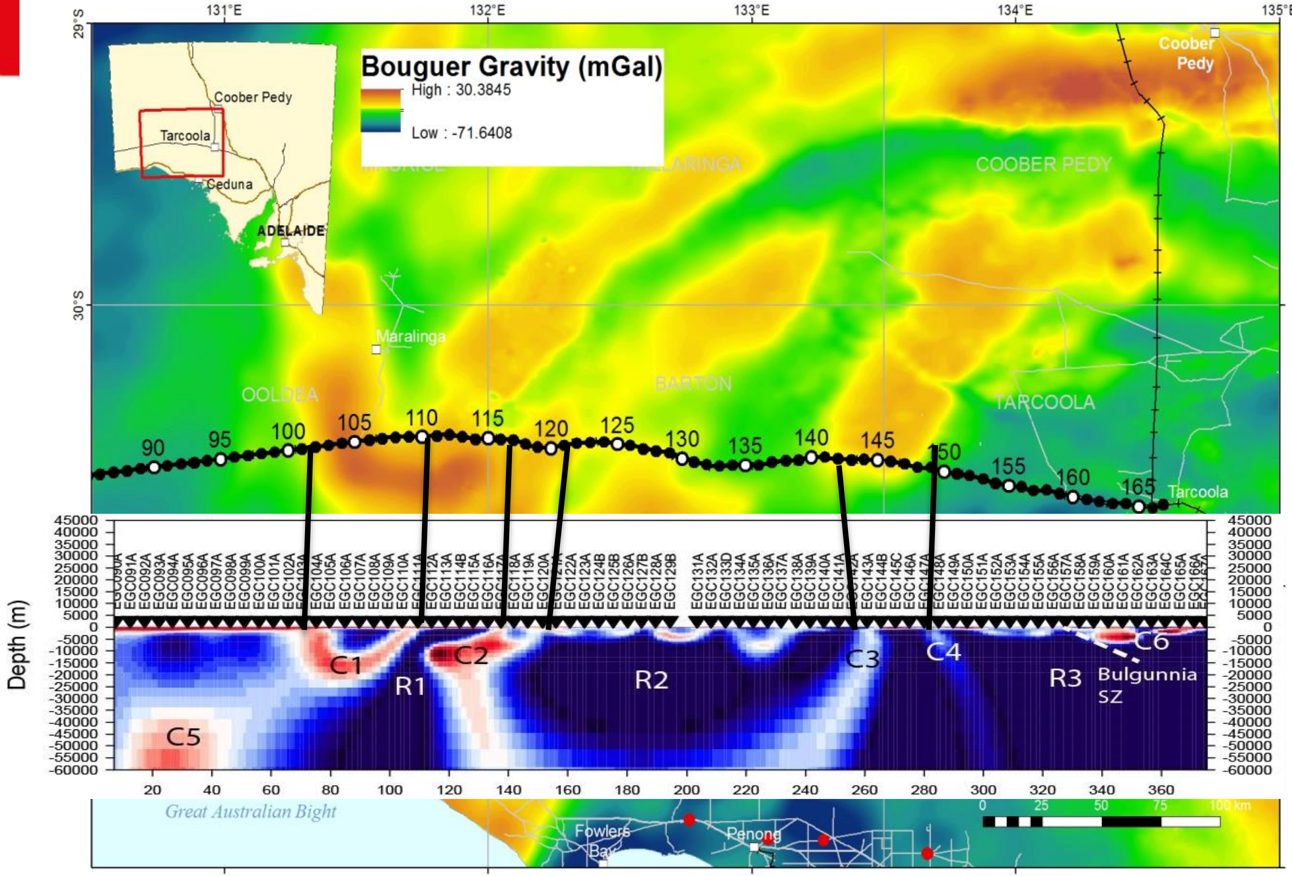


TMI and resistivity model correlation – Gawler part

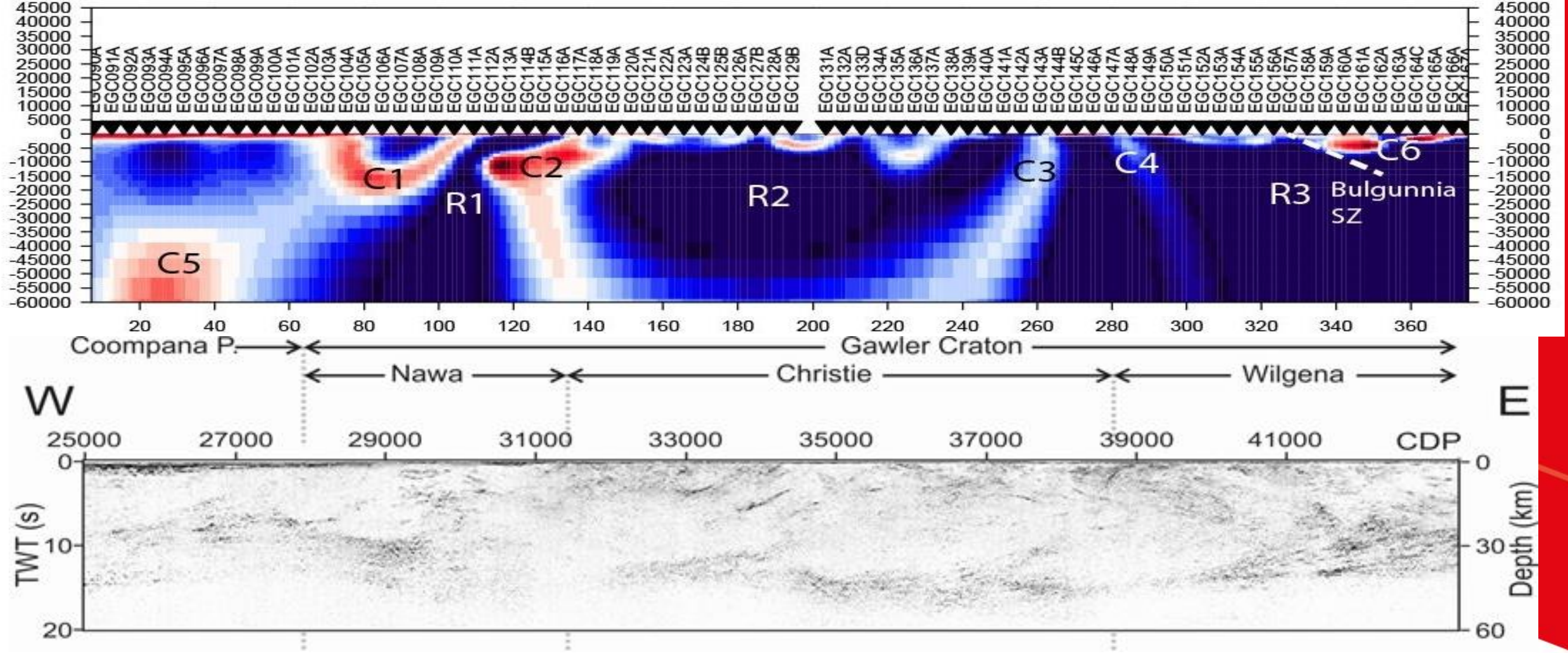


Gravity and resistivity comparison – deformation zones along margins of gravity defined blocks

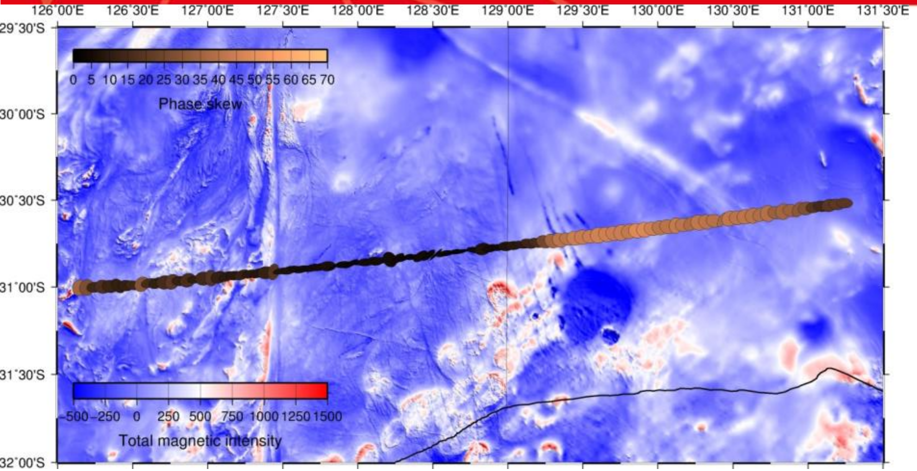
- C2-R1 contact is eastern contact of the Karari deformation zone
- About 10 km wide
- C6 – Tallacootra formation (interbedding of quartzite with laminated carbonaceous and pyritic siltstone)
- Upper crustal half-graben structures

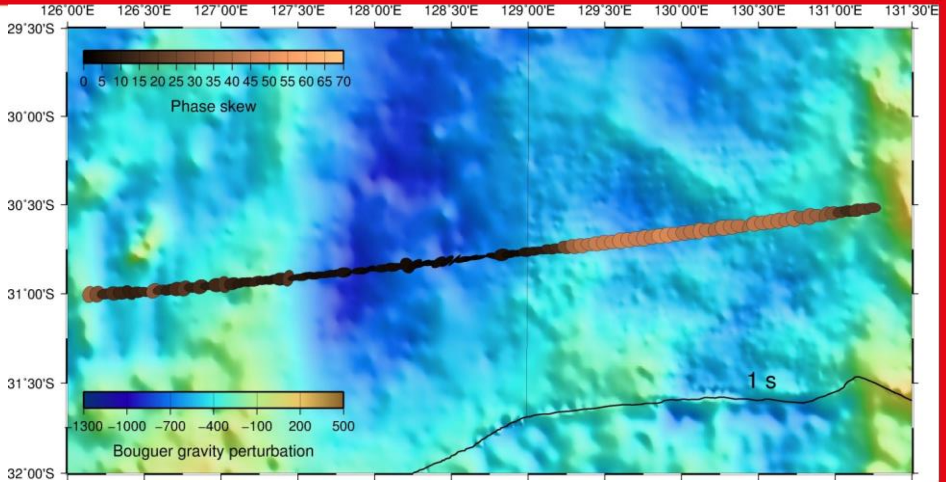


Comparison of 2D profile to seismic reflection



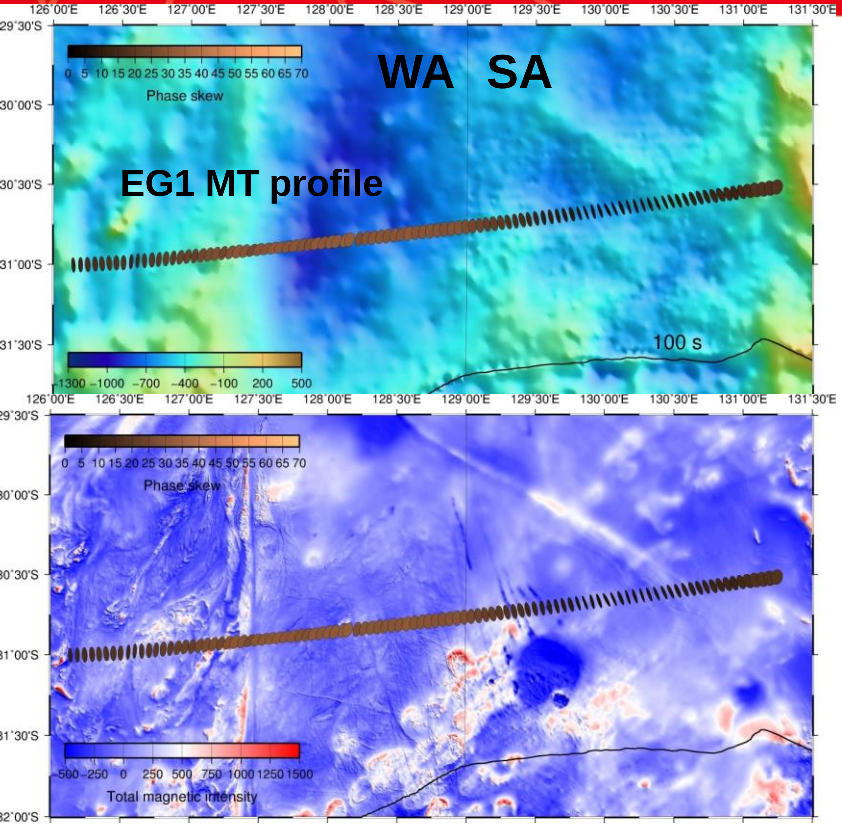
Coompana-Madura 13GA-EG1 section - Sediment to upper crustal structures

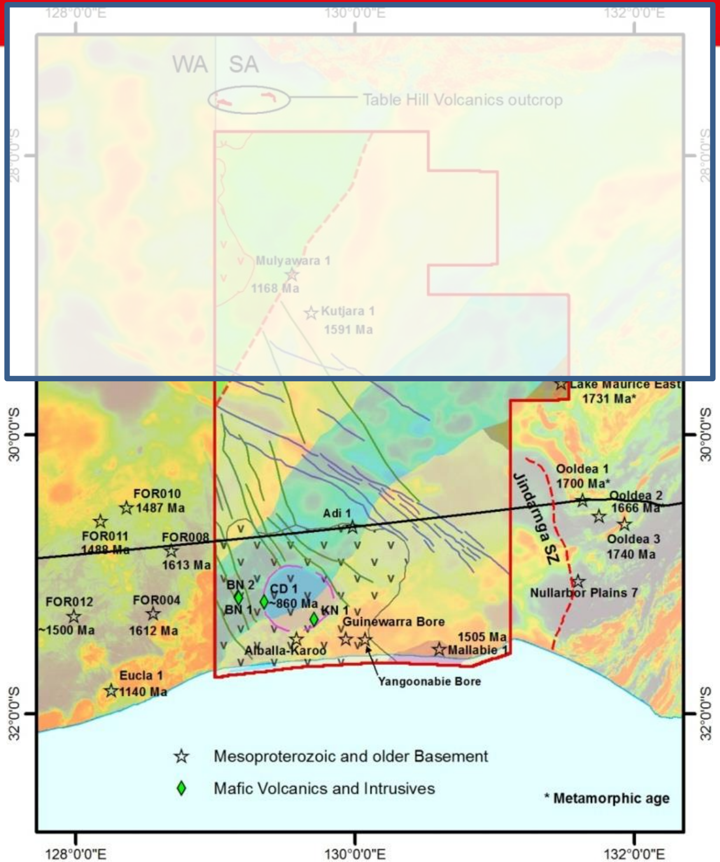




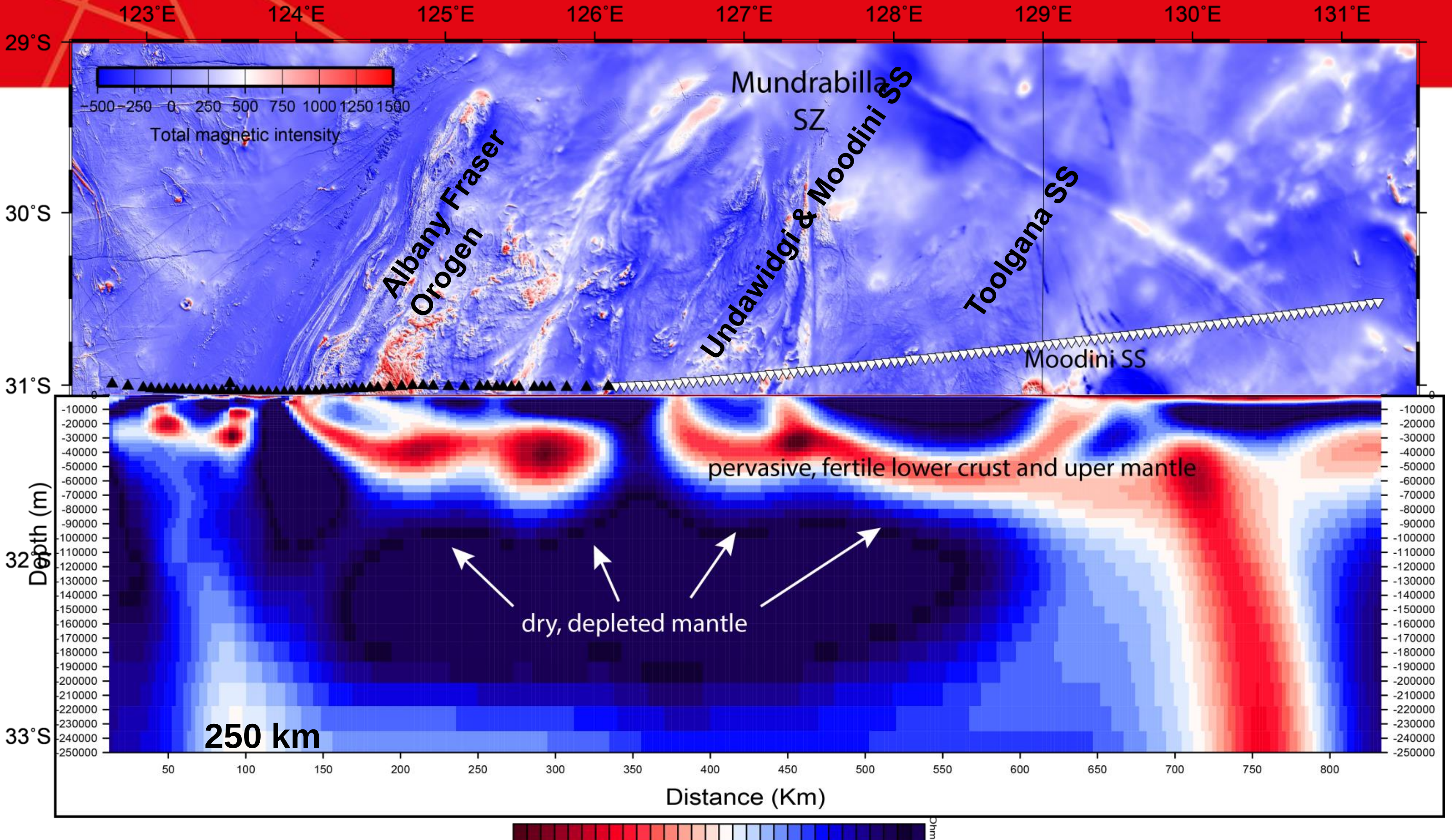
- Light coloured circles denote thicker sediments
- Dark ellipses denote shallower sediments and basement structure

Mid to lower crust

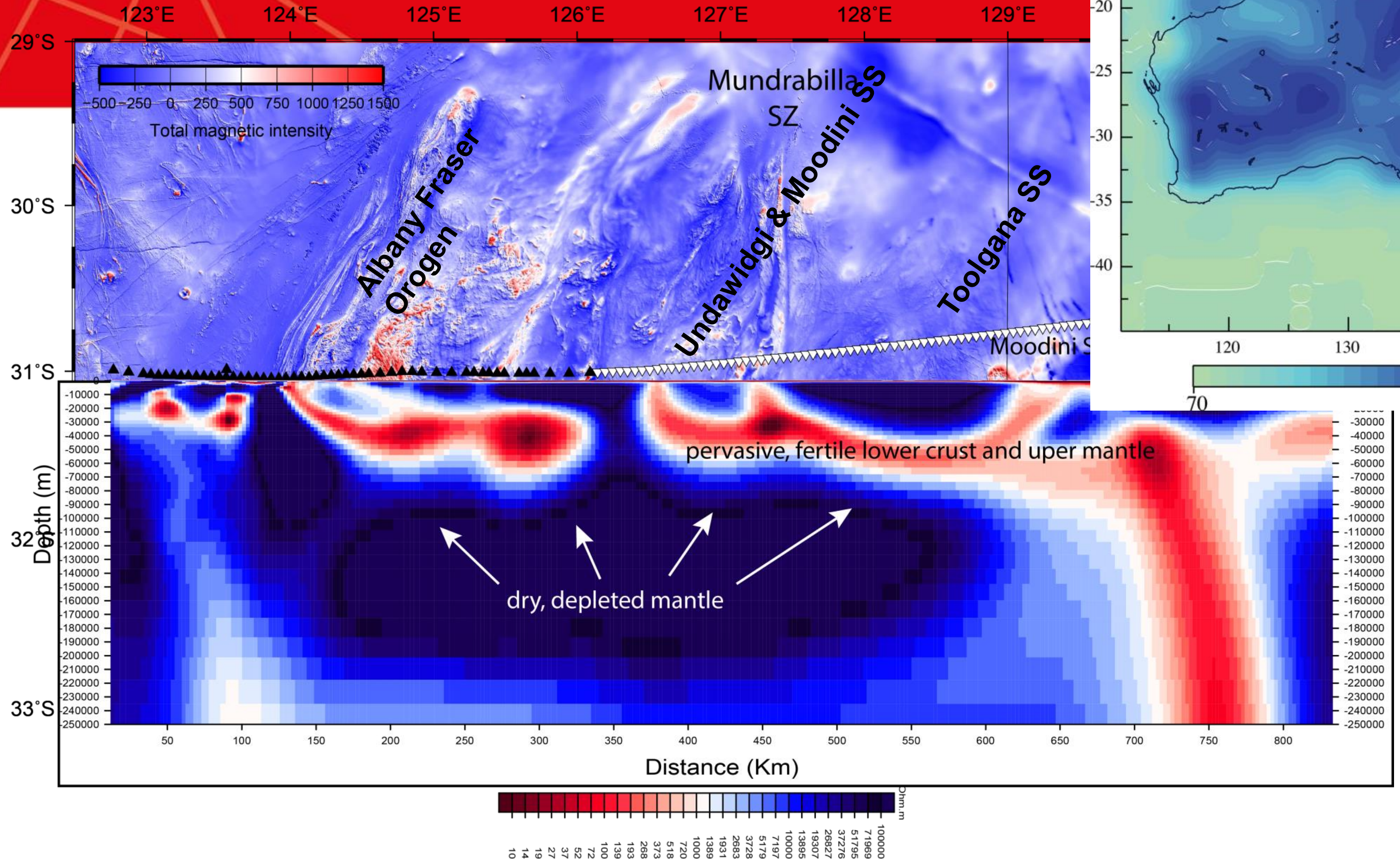


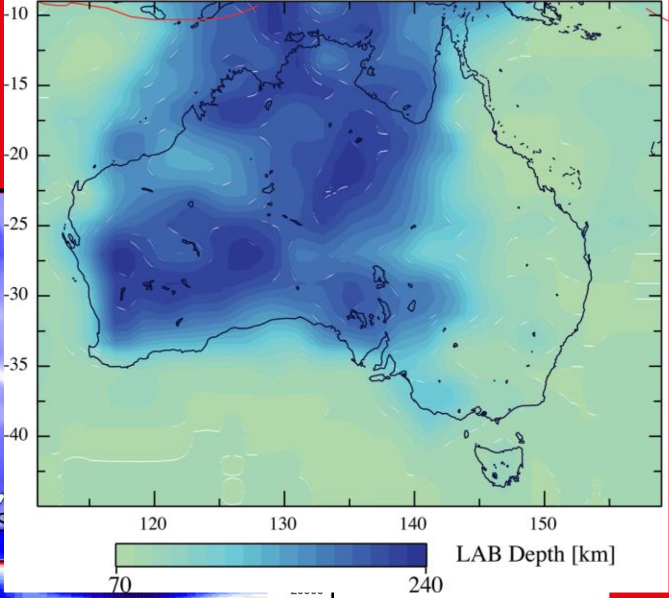


Coompana-Madura-Albany Fraser with TMI

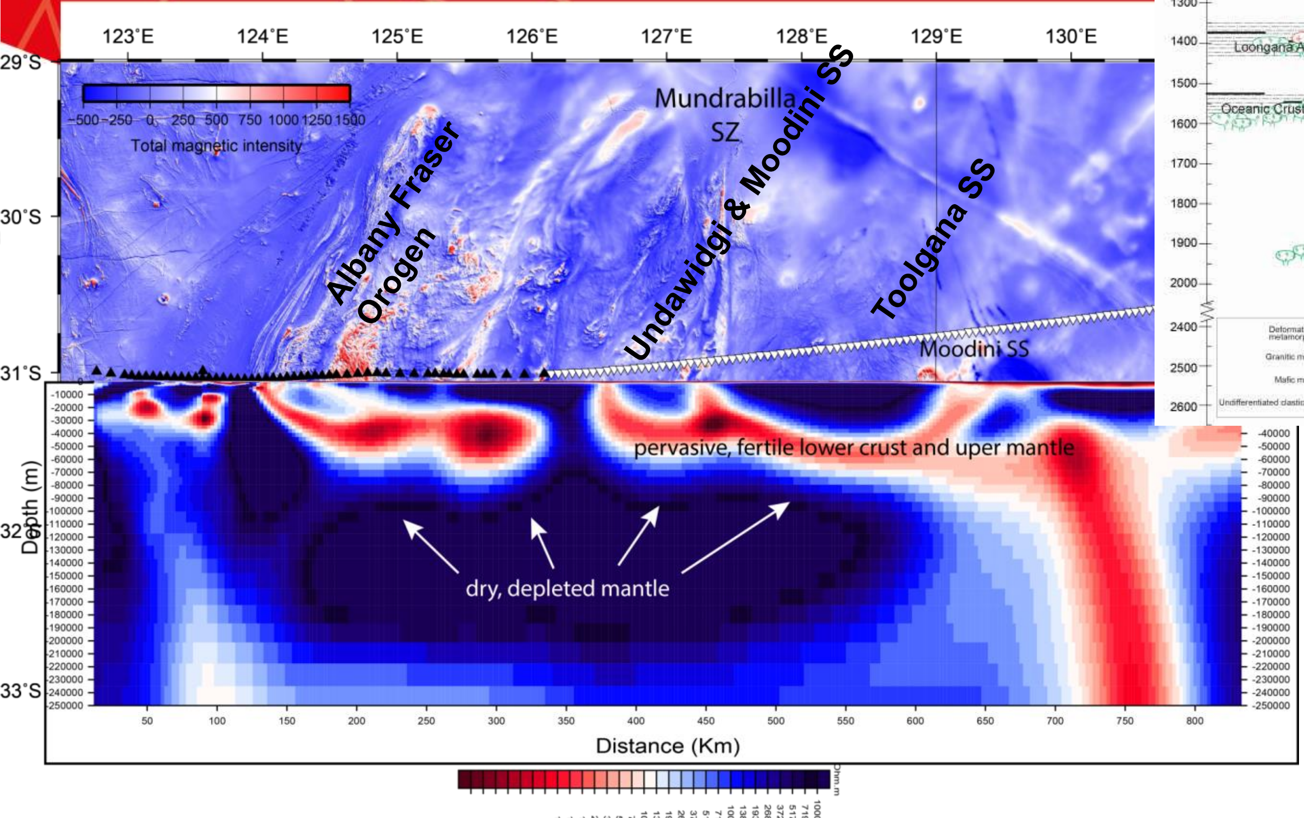


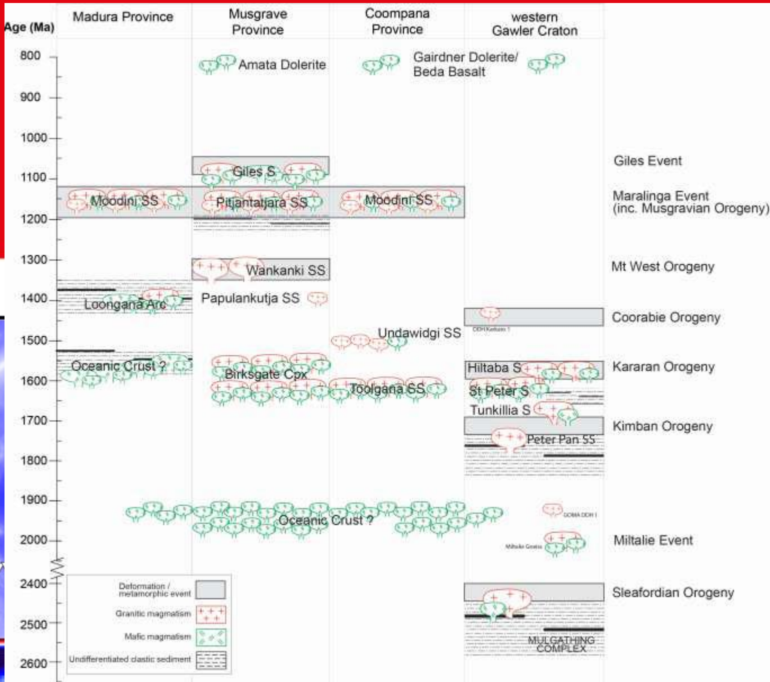
Comparison of 2D profile to LAB





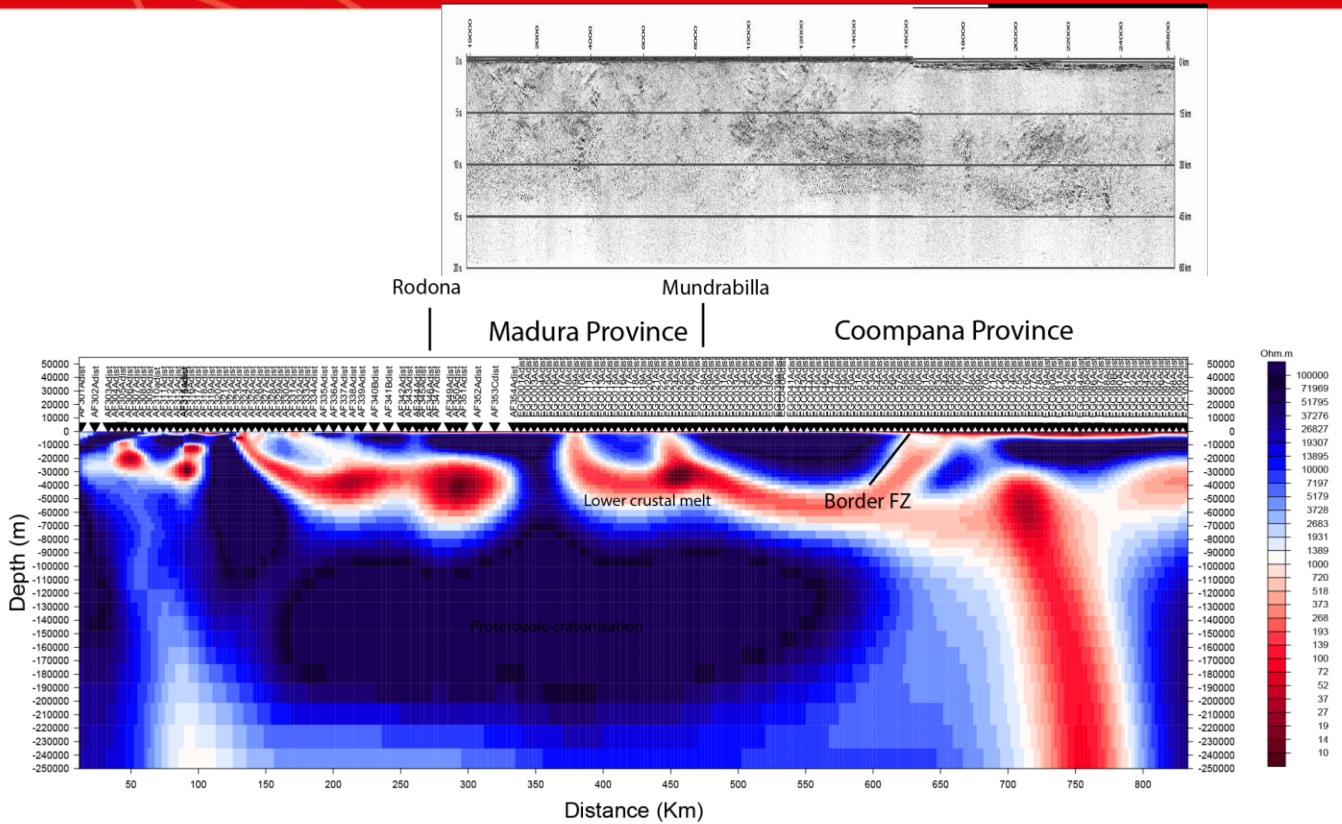
Conductive lower crust over resistive depleted mantle - Insights form tectonic history across Coompana-Madura



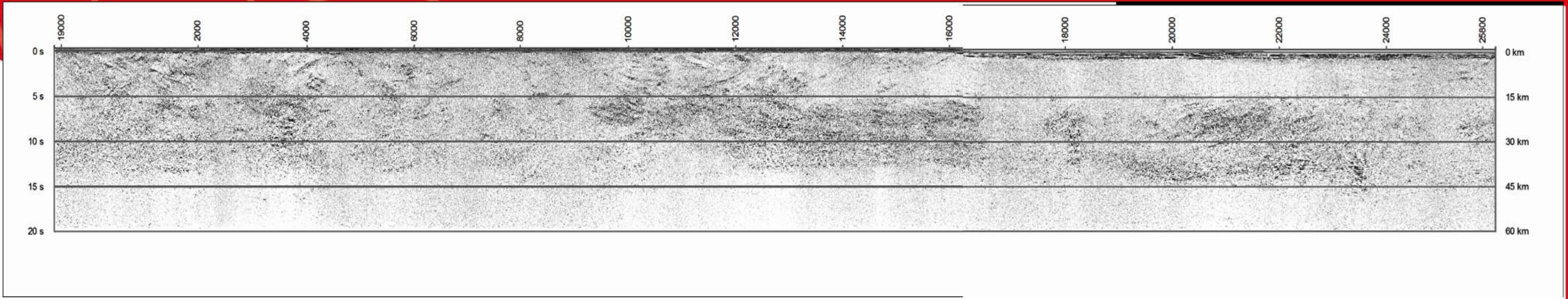


Moodini SS:
UHT metamorphism,
high KFe series, high Th

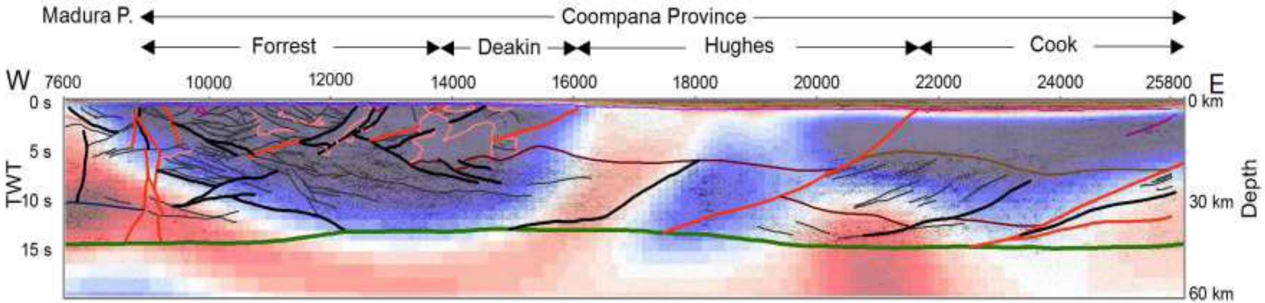
Nature of lower crust in the Coompana-Madura Province



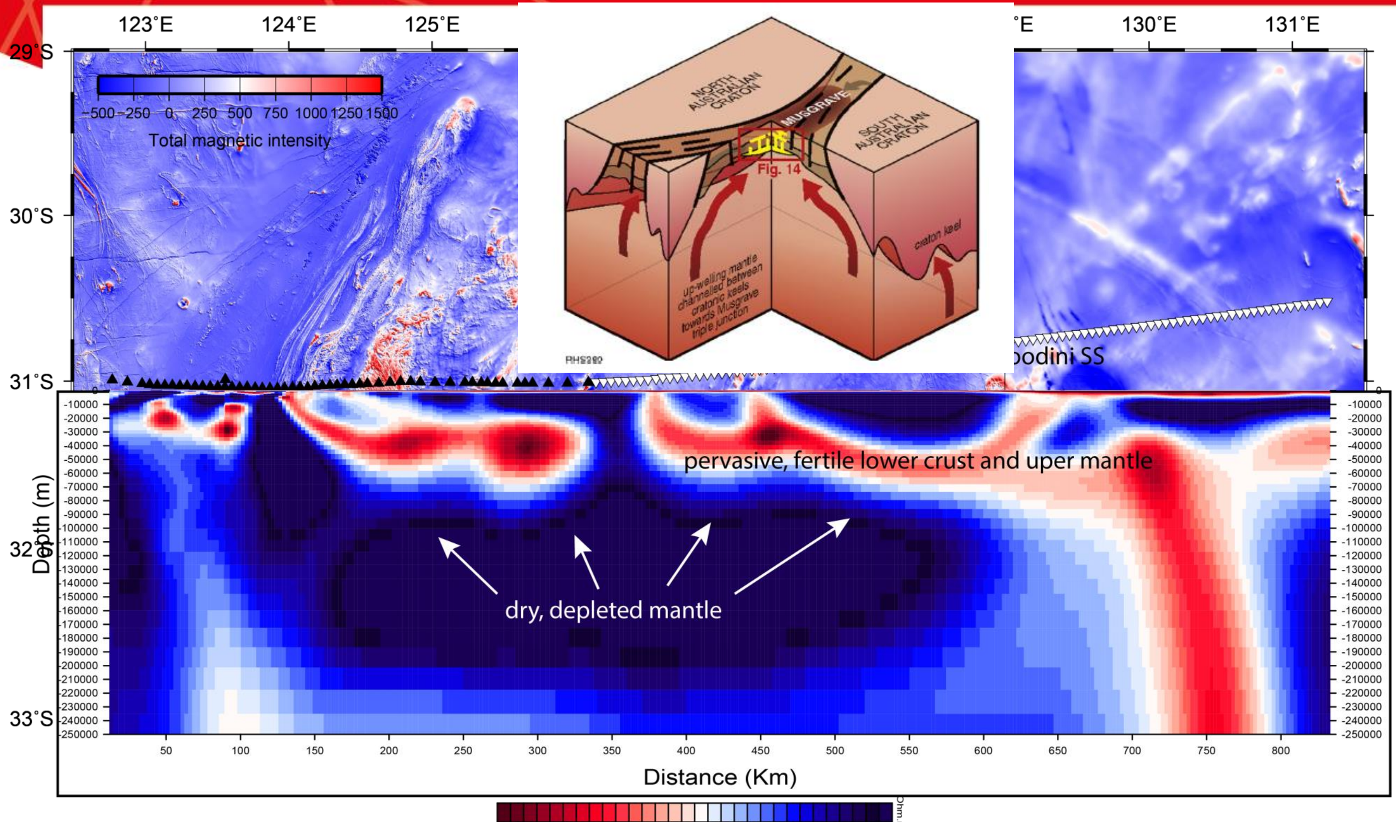
Nature of lower crust in the Coompana-Madura Province

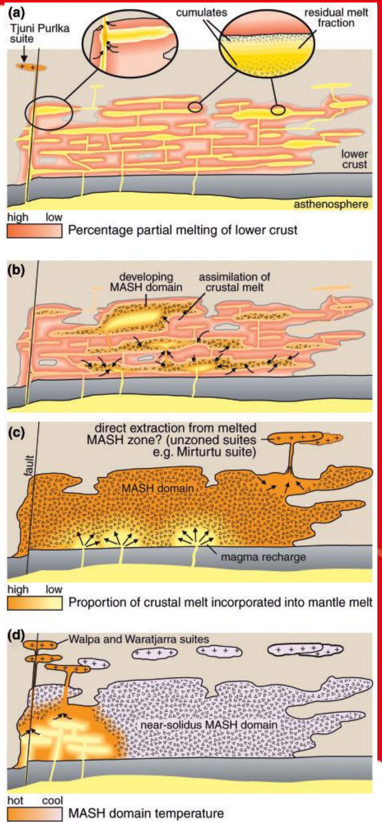


- Correlation between zones of low resistivity and low reflectivity zones
- Seismics suggests homogeneous crust void of deformational structures
- Low resistivity denote fertile crust (magnetite, fluorine, A-type granites)
- Similar in correlation to Olympic Dam (also A-type granites)



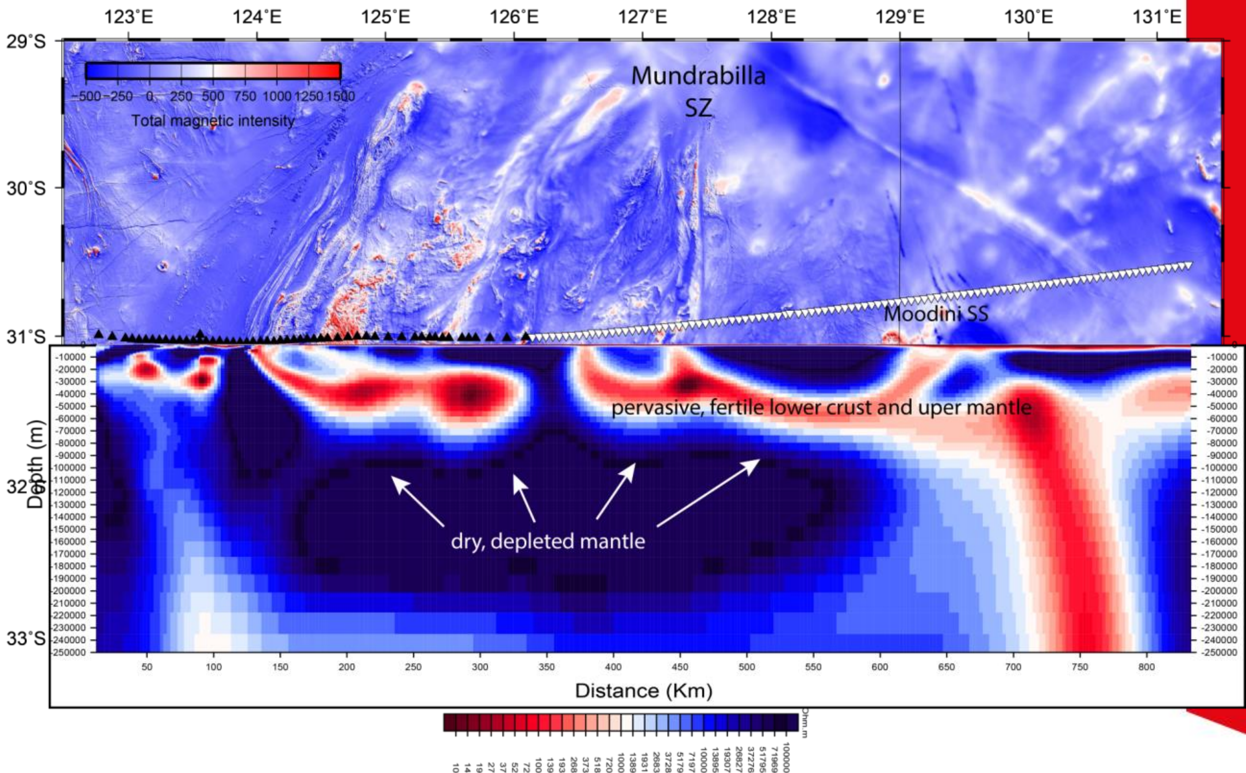
Pervasive lower crustal conductance – MASH zones?



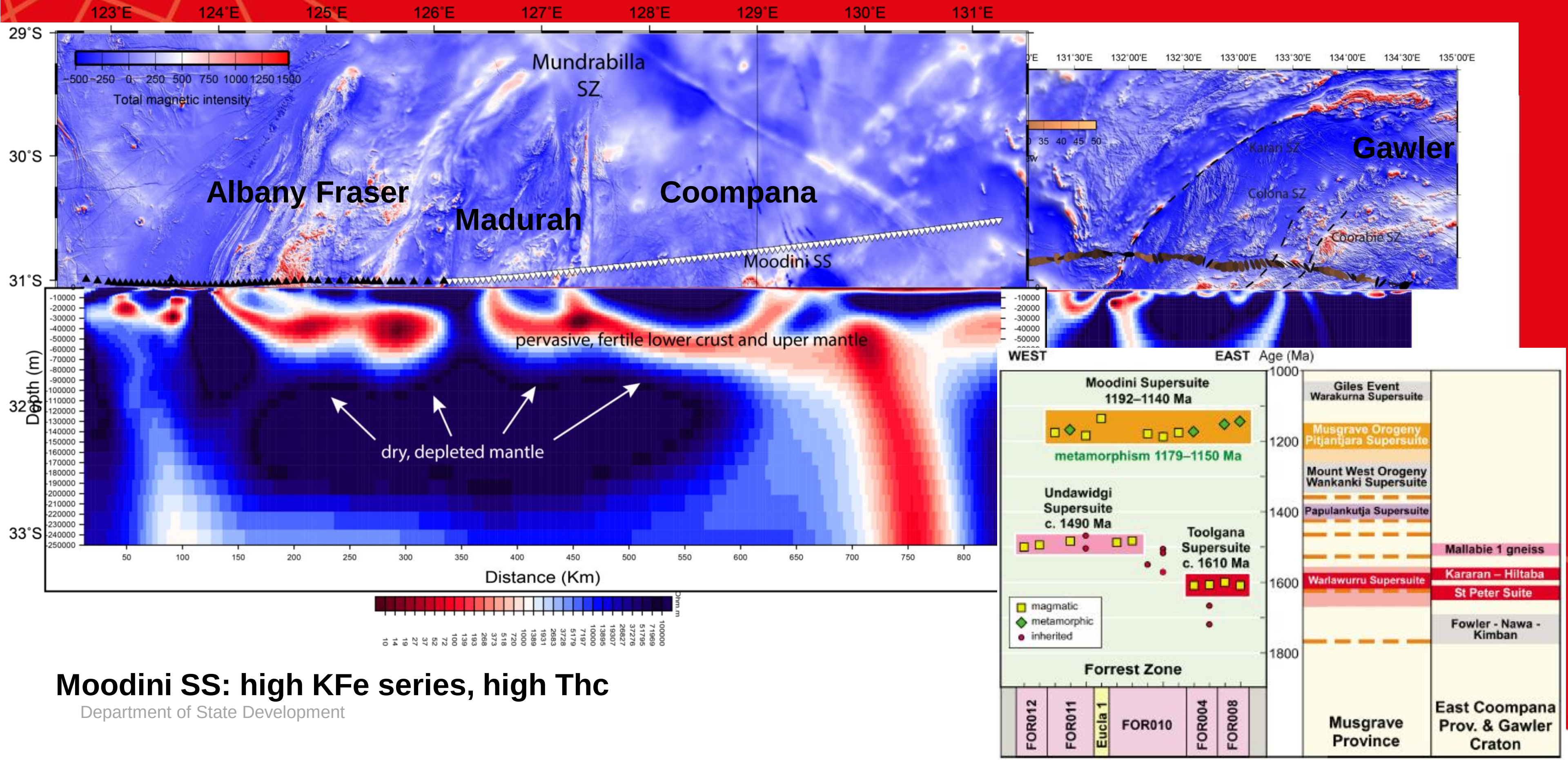


Resistivity footprint of Proterozoic cratonisation

- Oldest age across Coompana-Madura ~1900 Ma, derived from oceanic lithosphere
- Lower crustal enrichment during the Maralinga event
- UHT metamorphism, high KFe, high Th
- Development of lower crustal MASH zone
- Process depletes the lithospheric mantle
- Has to cool enough to produce high mantle resistivity (also relativetely fast seismic wavespeeds)
- Building a craton in the Proterozoic



Stitched resistivity profile



Moodini SS: high KFe series, high Thc

Conclusion

- Different character between the Gawler and Coompana/Madura
- Subvertical conductivity zones in the Gawler separating resistive lithospheric blocks
- Pervasive lower crustal/upper mantle low resistivity zones across the Coompana/Madura (low resistivity – low reflectivity)
- Resistive and depleted mantle lithosphere beneath the Coompana-Madura
- Archaean character – yet isotopically Proterozoic and oceanic
- Proterozoic cratonisation?

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