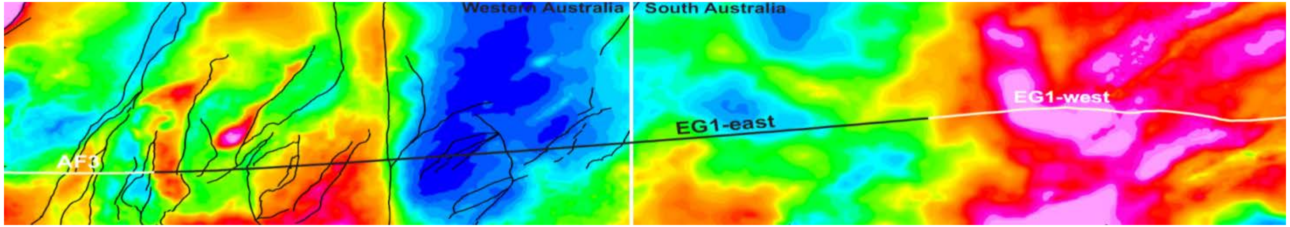
Government of Western Australia
Department of Mines and Petroleum

EXPLORATION INCENTIVE SCHEME

Interpretation of gravity data of the Madura and Coompana Provinces along the deep crustal seismic survey 13GA–EG1



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Government of South Australia
Department of State Development

Australian Government
Geoscience Australia

AuScope

Gravity and Aeromagnetic data 13GA EG-1

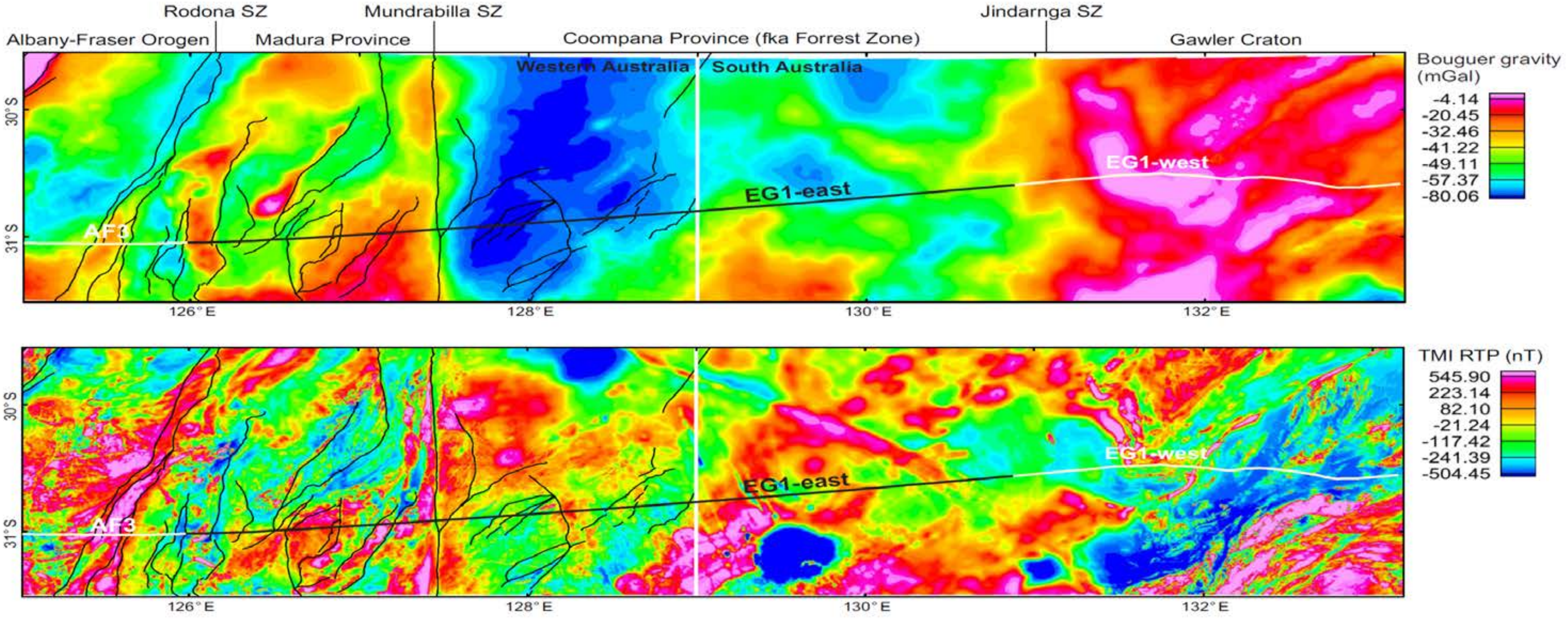
Gravity data

- Along seismic line, station spacing = 500 m, in vicinity, station spacing = 2 – 11?km
- Grid cell size = 400 m

Magnetic data

- Flight-line spacing = 200 – 400 m
- Grid cell size = 80 m

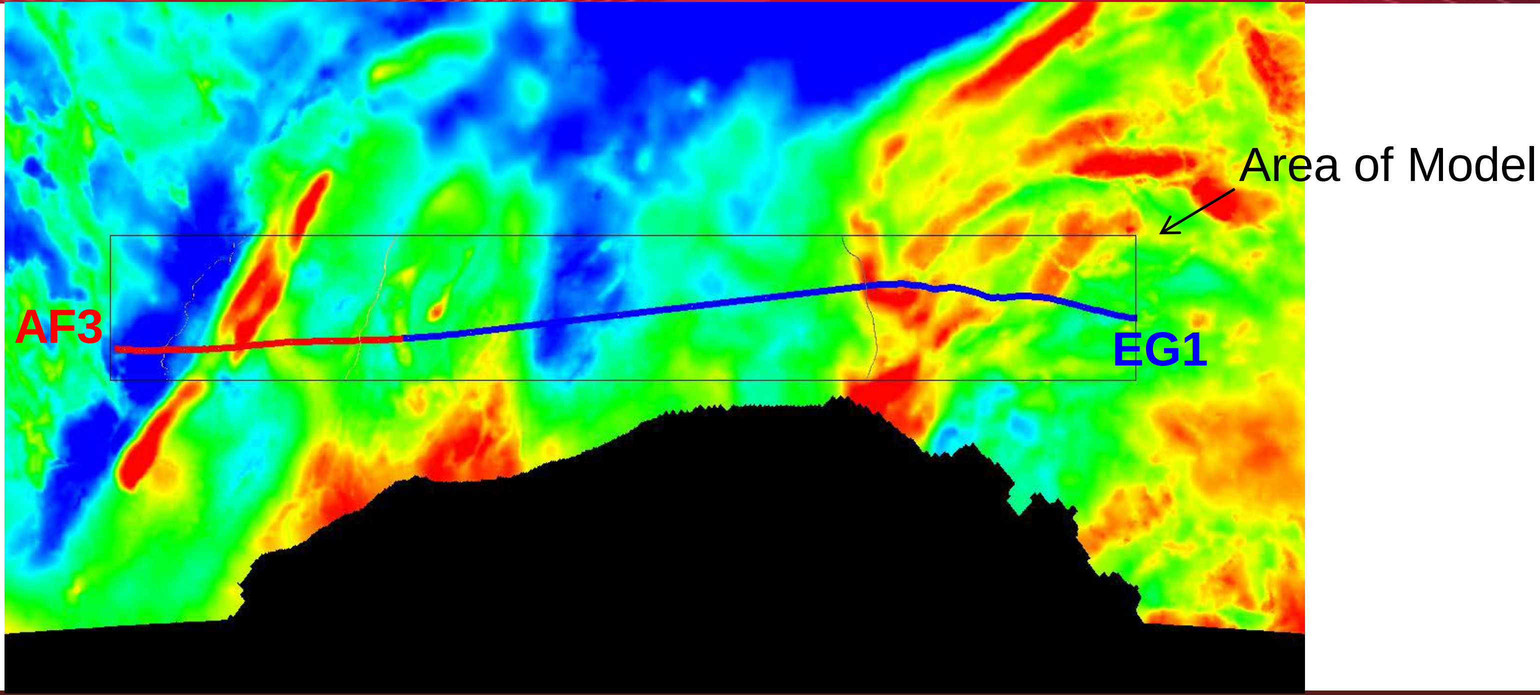
Observed potential field data



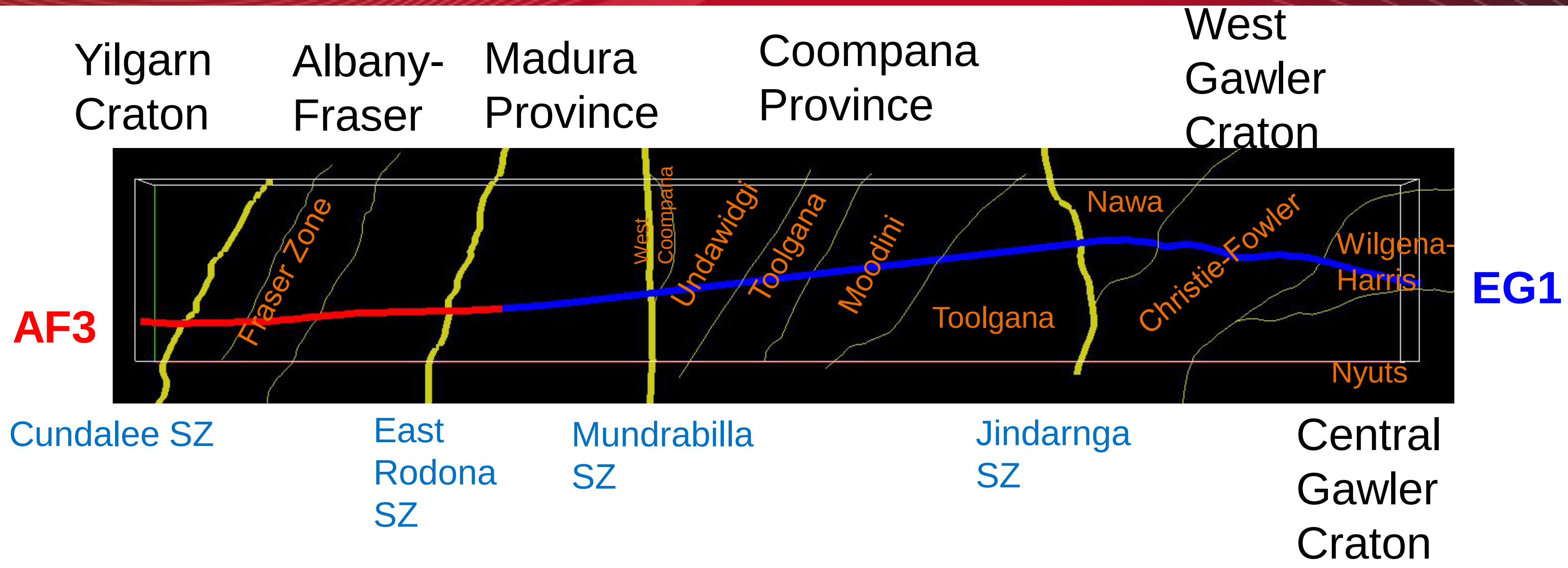
Methods

1. 3D gravity inversions (GOCAD)
2. 2D gravity and magnetic forward modelling (GM-SYS)

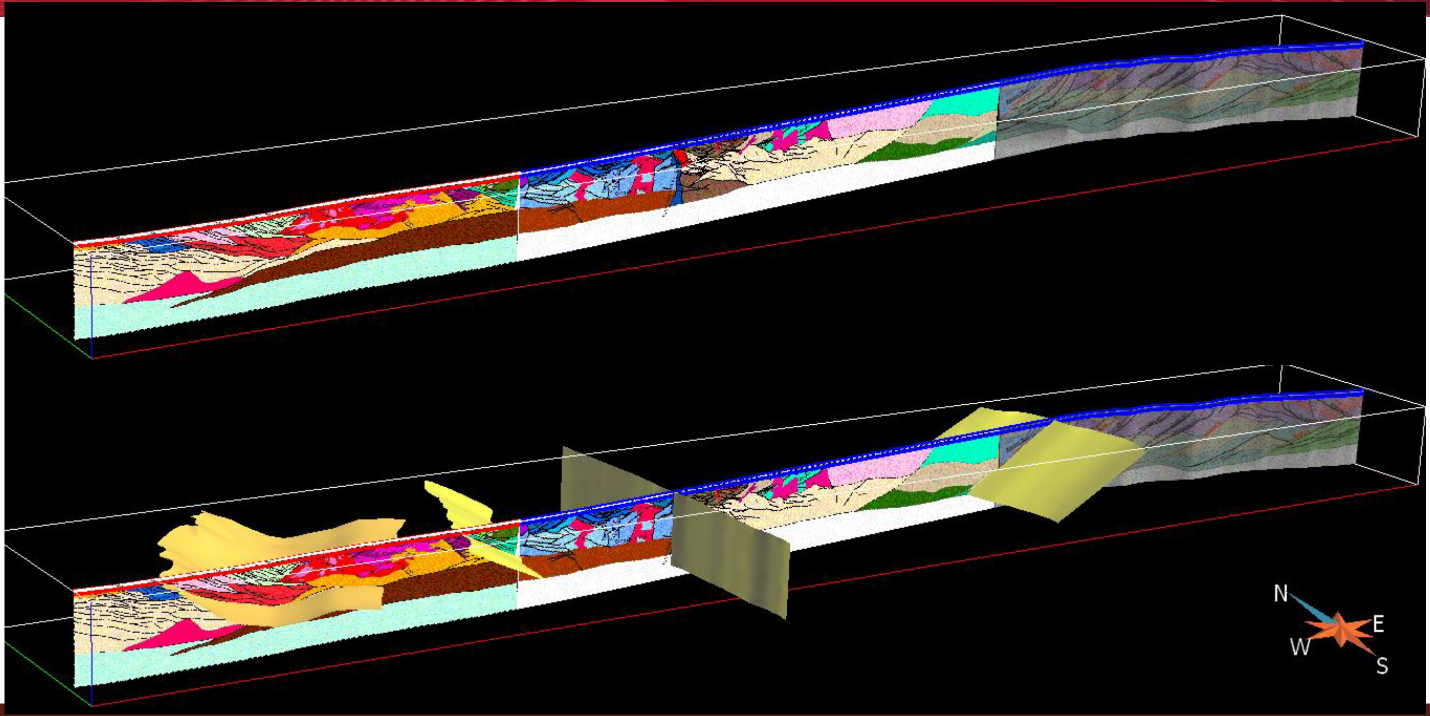
3D Gravity inversions



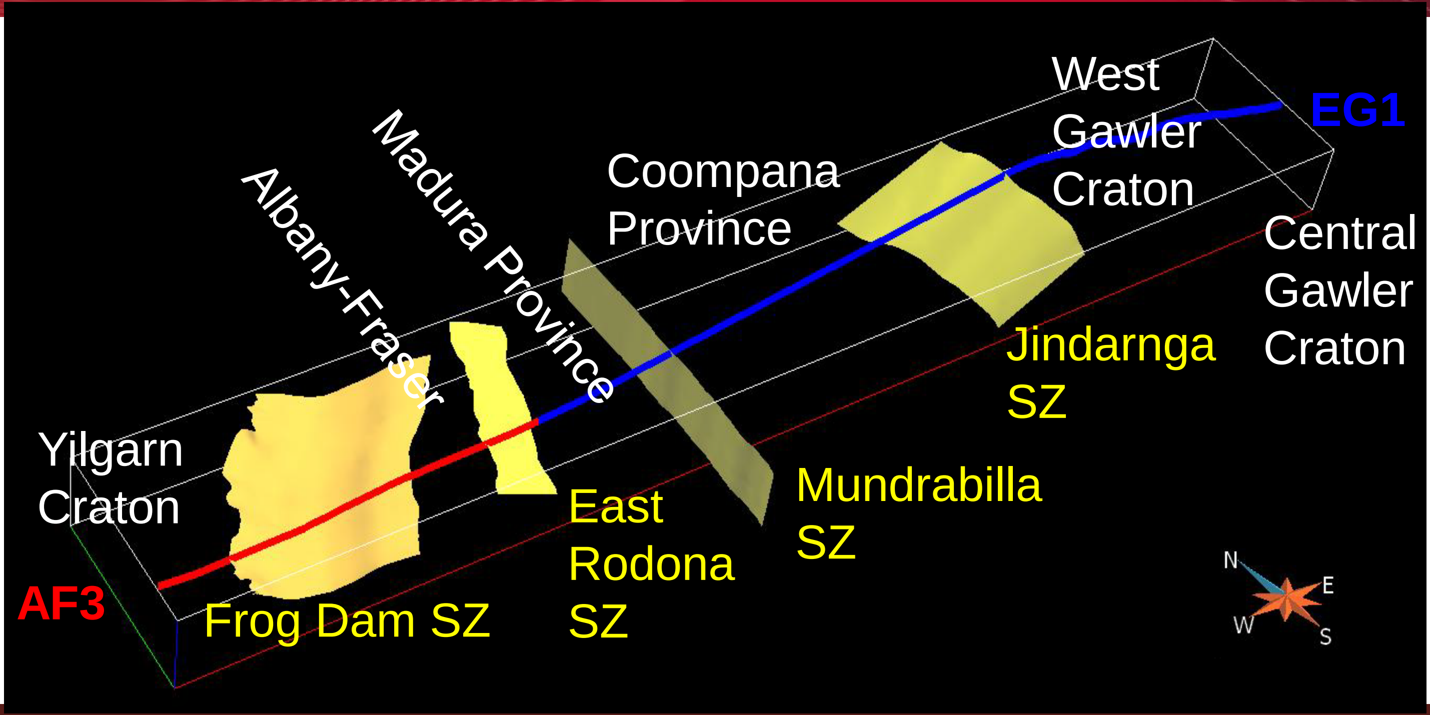
3D model area



Seismic Interpretation

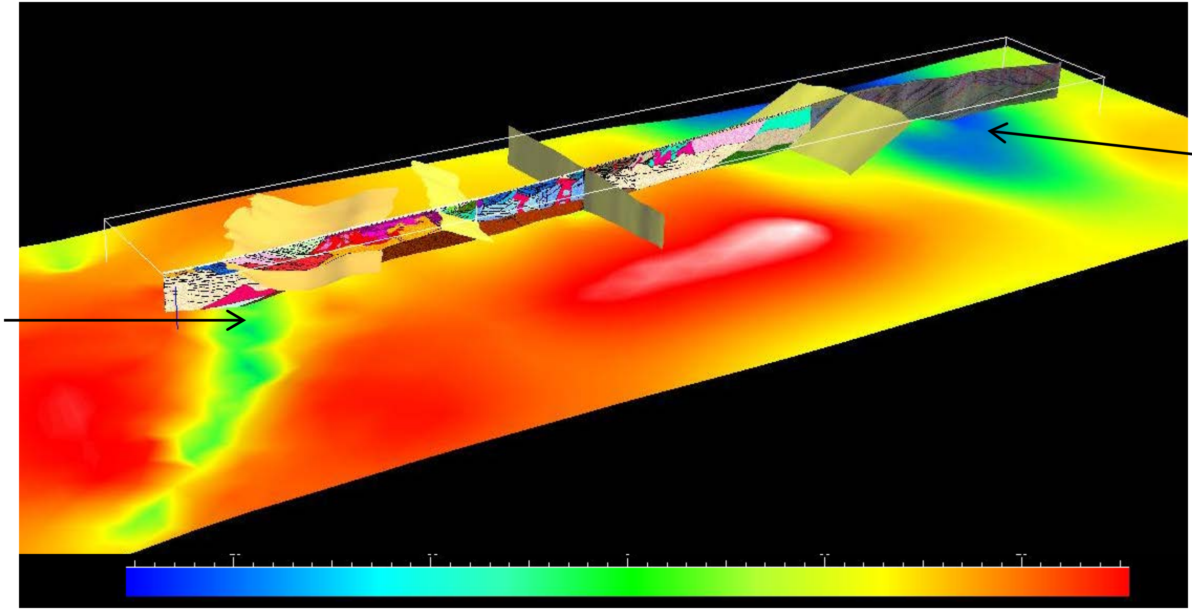


3D model based on domains



Moho

Yilgan-Albany Fraser "ditch" (Sippl *et al.* in prep)

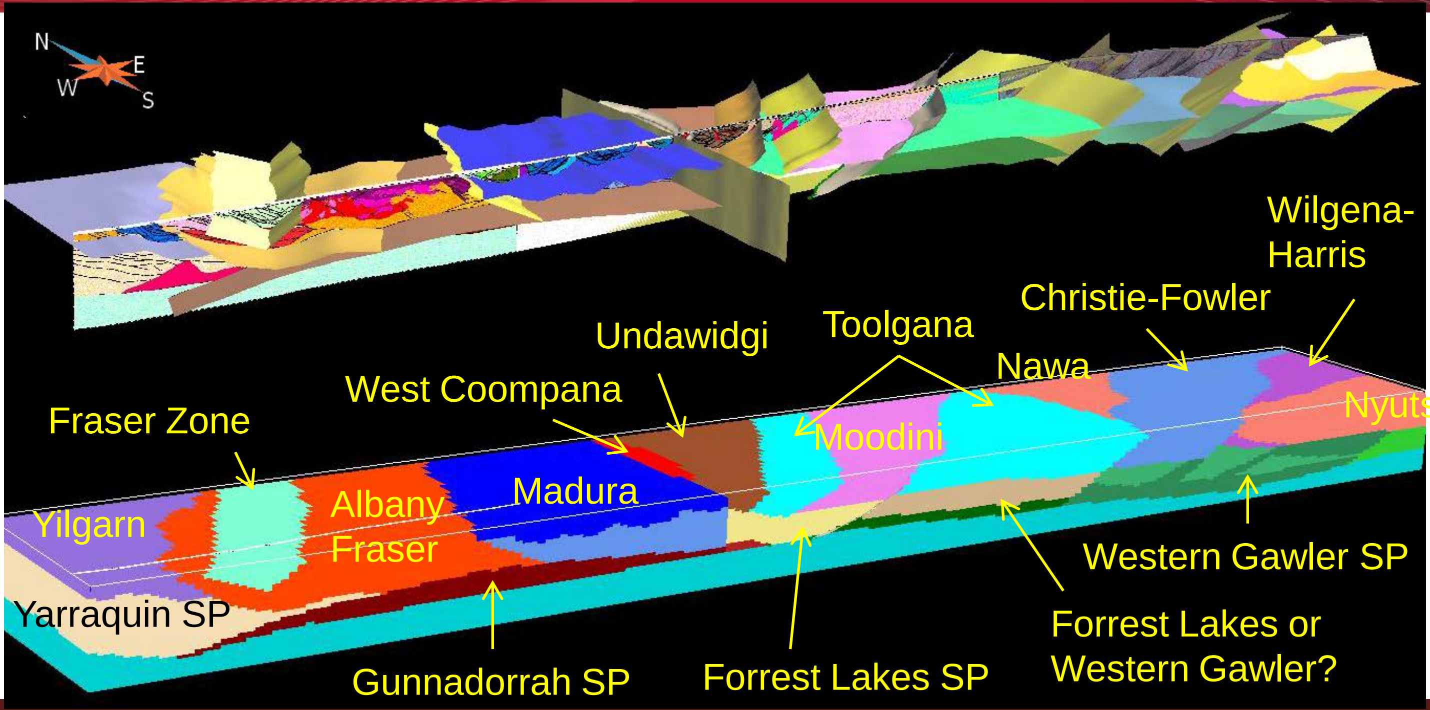


Double dip under West Gawler

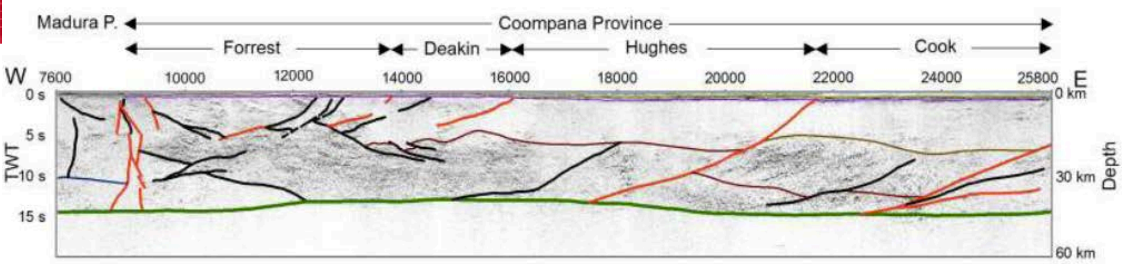
50km

30km

Surfaces & Block model

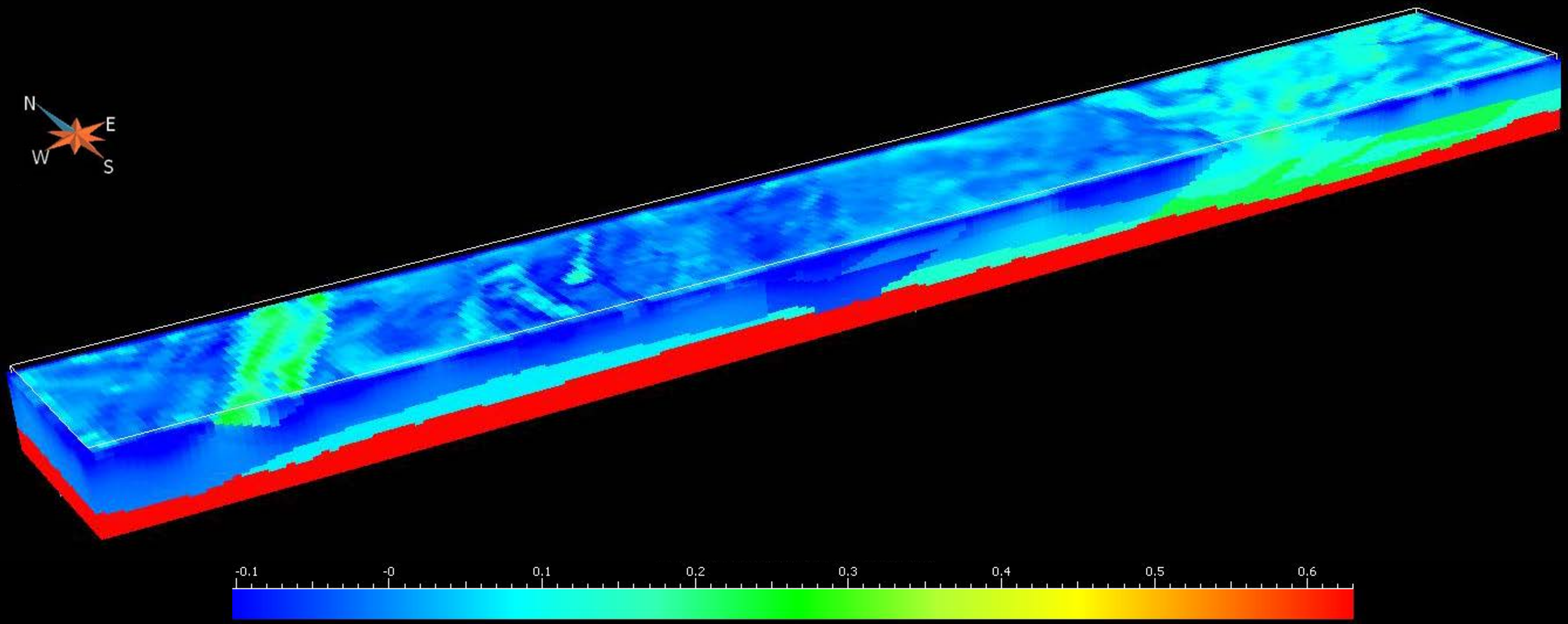


Inversions – gravity 3D

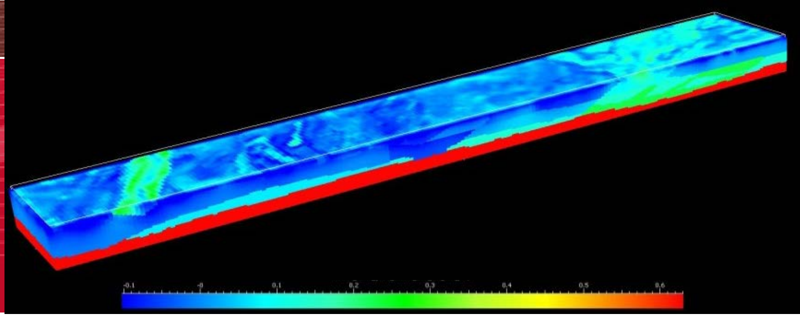


1) Initial model lower crust 2.8, middle crust 2.7, upper crust 2.67 except 2.8 Fraser Z.)
2) Homogeneous block inversion using the 20 km upward cont.
3) Geometry inversion
4) heterogeneous density inversion using the upward continued data where just the middle layers are allowed to very in density – fixed bottom layers. This is making the assumption that the long wavelength variation is in the middle crust
5) Vary upper crust vary heterogeneously using the full gravity field including the high frequency component, but middle crust is still available to vary

Inversions - gravity



3D Inversion comments



- Lots of assumptions need to be fine tuned
- Initial results:
  - West Gawler Seismic Province appears to be high density all through the crust
  - The Toolgana middle-lower crust has a similar density to the West Gawler SP – possibly is part of West Gawler ?
  - Yarraquin SP and Albany Fraser have similar densities with the Madura middle crust having a slightly higher density.
  - The Yilgarn and Upper Madura have low densities
  - The Fraser Zone with a high gabbroic content has a very high density
  - The Coompana Province upper crustal domains have similar densities to the Albany Fraser
  - The Forrest Lakes middle crust requires a very low density to underlie the moderate densities of the upper crust

2D Gravity Forward Model - Method

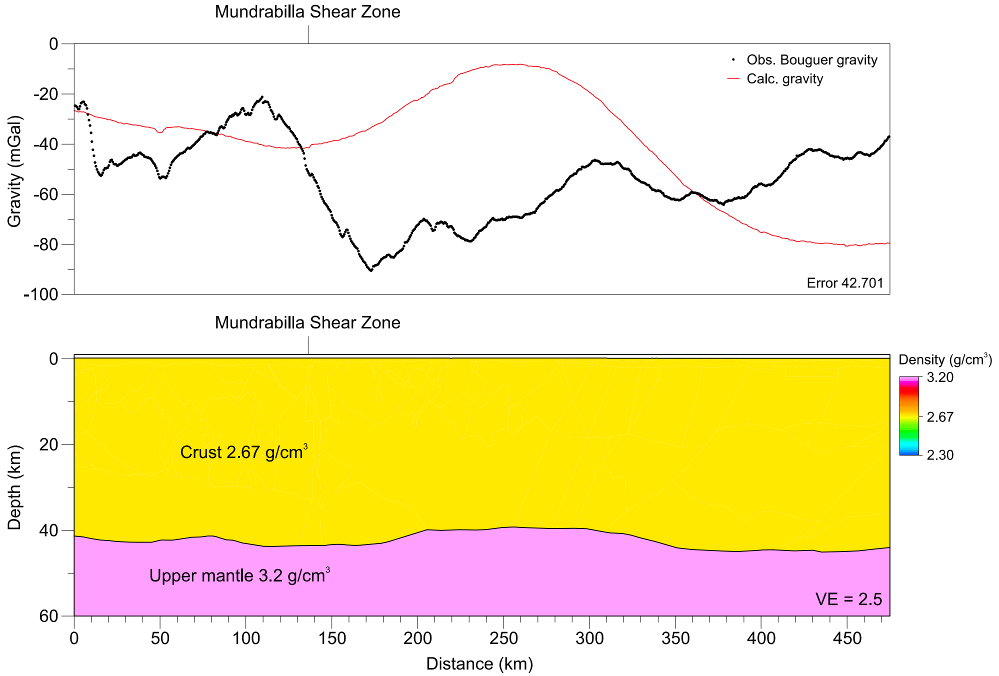
EG1-west model setup:

- GM-SYS 2D forward modelling software
- RTP aeromagnetic data and Bouguer gravity data sampled every ~500 m along EG1-west
- Model extends from the topographic surface to 70 km depth and west and east of the ends of the profile to reduce edge effects
- Observed magnetic data set at 80m above topography
- Gravity stations at 1 m above topography

Forward modelling approach:

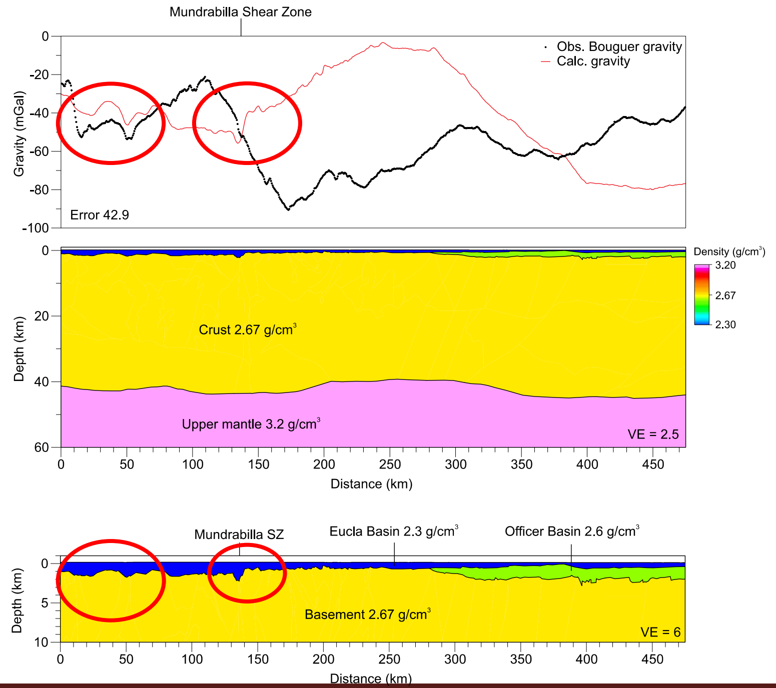
- Basins and Moho constrained using seismic interp.
- Properties (density and susceptibility) constrained using petrophysical data (particularly the upper crust) and properties used in adjacent seismic lines (AF3 and EG1-east)

2D Forward Model - Moho



- ~4 km thinning produces ~33 mGal increase in calc. Gravity
- **The ~33 mGal increase in calc. gravity occurs where we see a large (~70mGal) decrease in observed Gravity**
- The crust thickens again to east (by ~5km), approaching the Gawler Craton, producing a ~72 mGal decrease in gravity

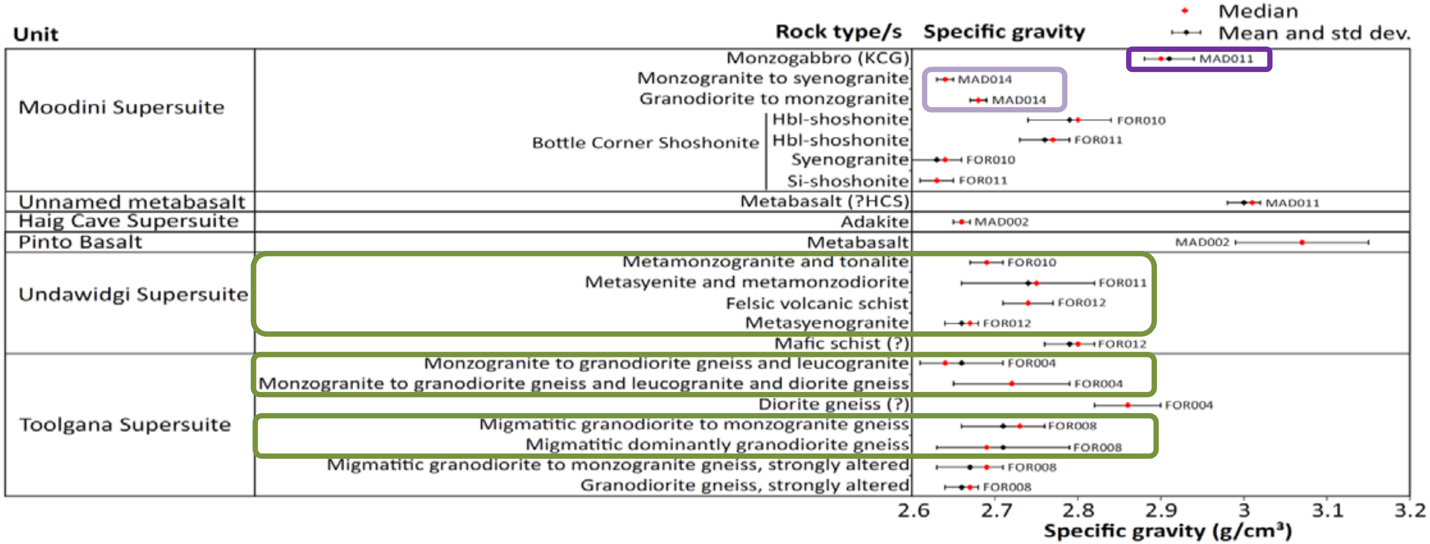
Moho plus Eucla and Officer Basins



- Eucla Basin = 2.30 g/cm3; Officer Basin = 2.60 g/cm3 (van der Wielen et al., 2015)
- Lateral Eucla thickness variation account for some higher frequency anomalies.
- Several examples where basin thickening, associated with basement faults produces a high frequency trough in the Bouger gravity data
- e.g Nuria Scarp is associated with a 20 m topographic depression and deepening of Eucla Basin (by ~800 m) and produces gravity trough (~6 mGal obs. gravity)

Eucla basement specific gravity

Specific gravity – Eucla stratigraphic drill core



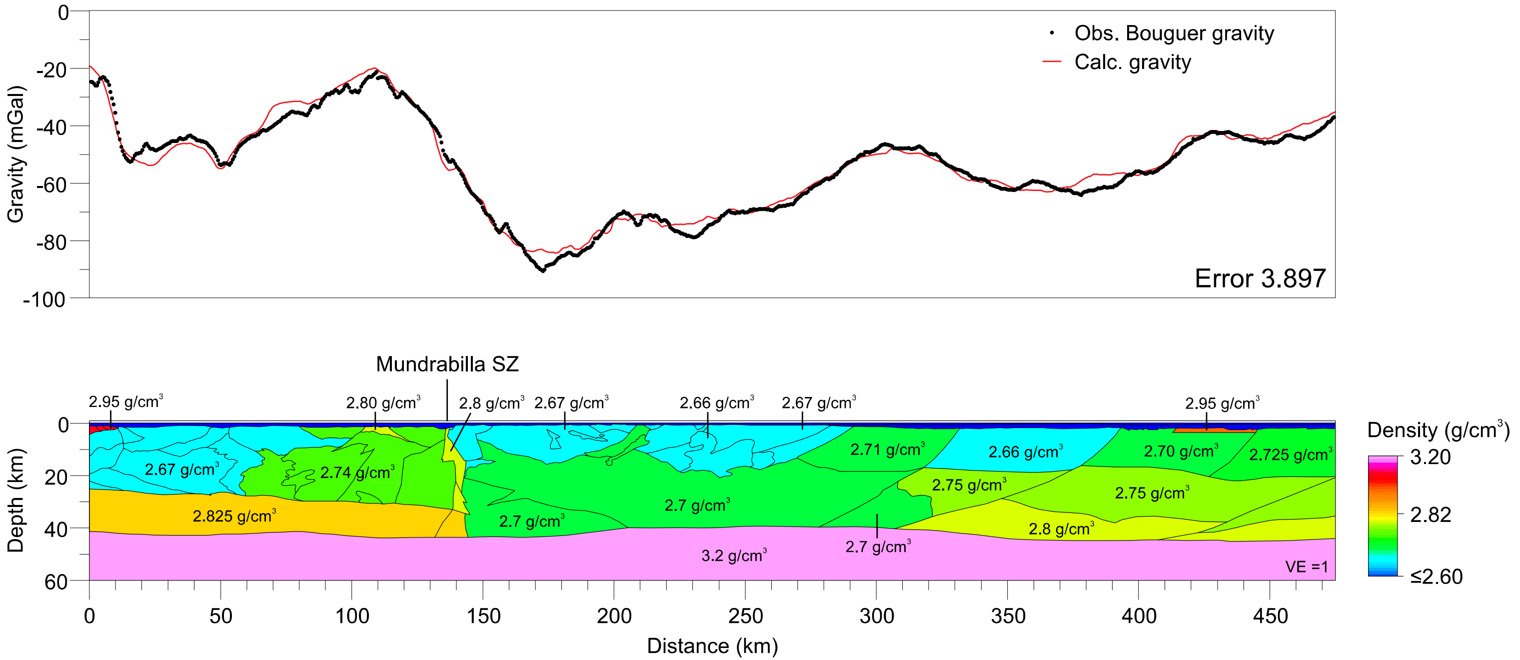
Madura Province

- Includes dense basalts (incl. Pinto Basalt) and monzogabbro (KCG, MS)
- Also inlcudes felsic/intermediate MS granites
- Dense Loongana, Haig, Serpent rocks?

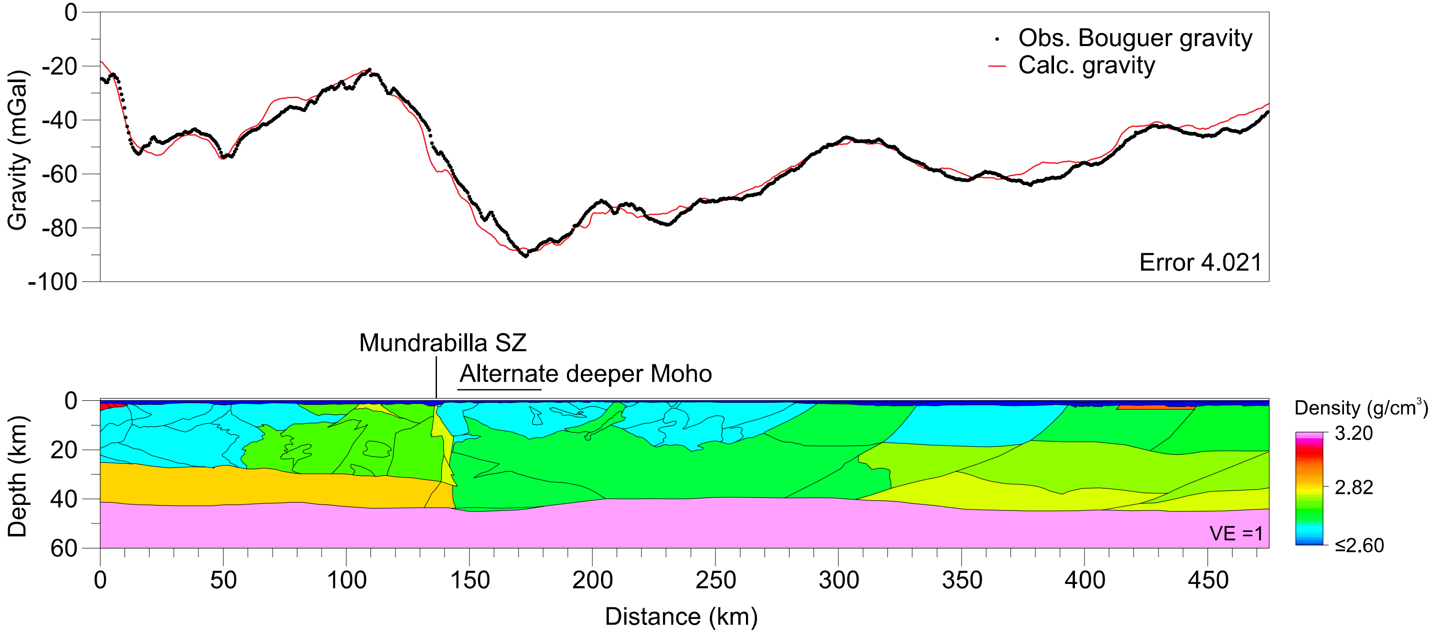
Western Coompana

- TS and US average/slightly above average densities
- Exceptions include mafic components and Si-rich (evolved) shoshonites

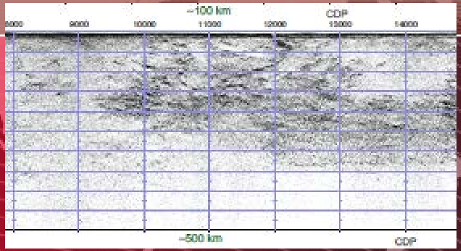
2D Forward Model – Moho and Crust

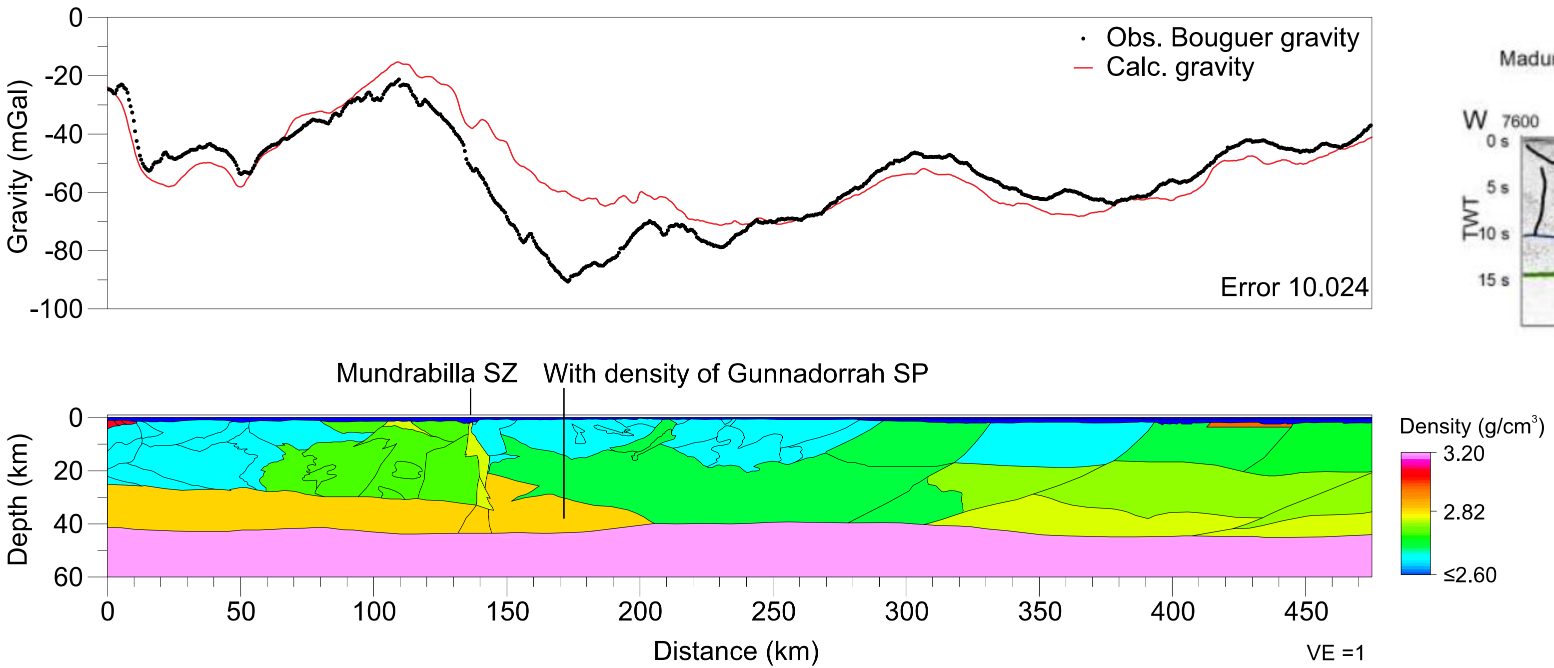


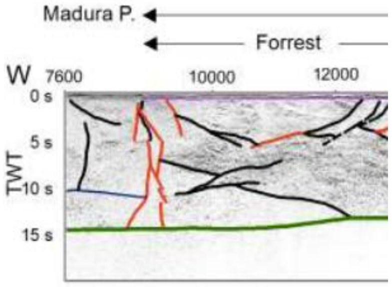
Alternative Moho depth



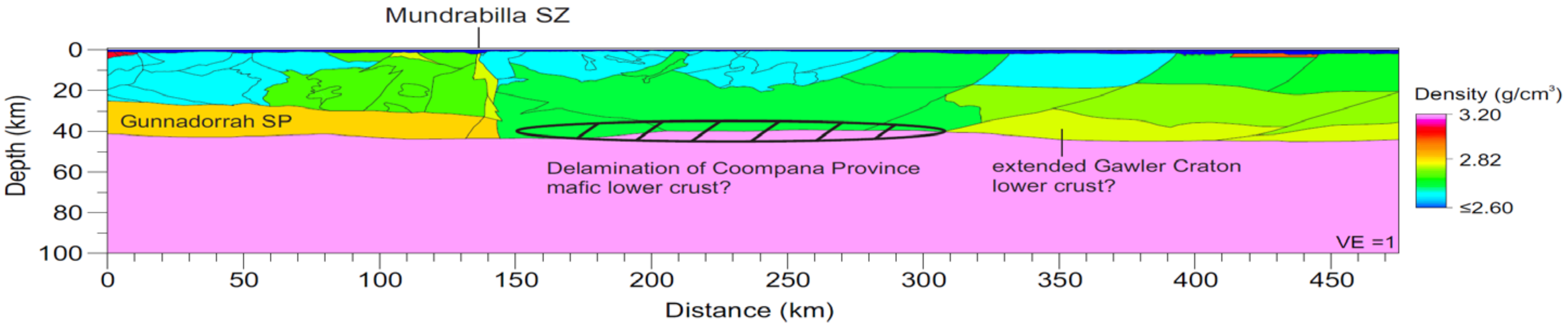
Can ‘the wedge’ be Gunnadorrah?







What happened to the Coompana lower crust?

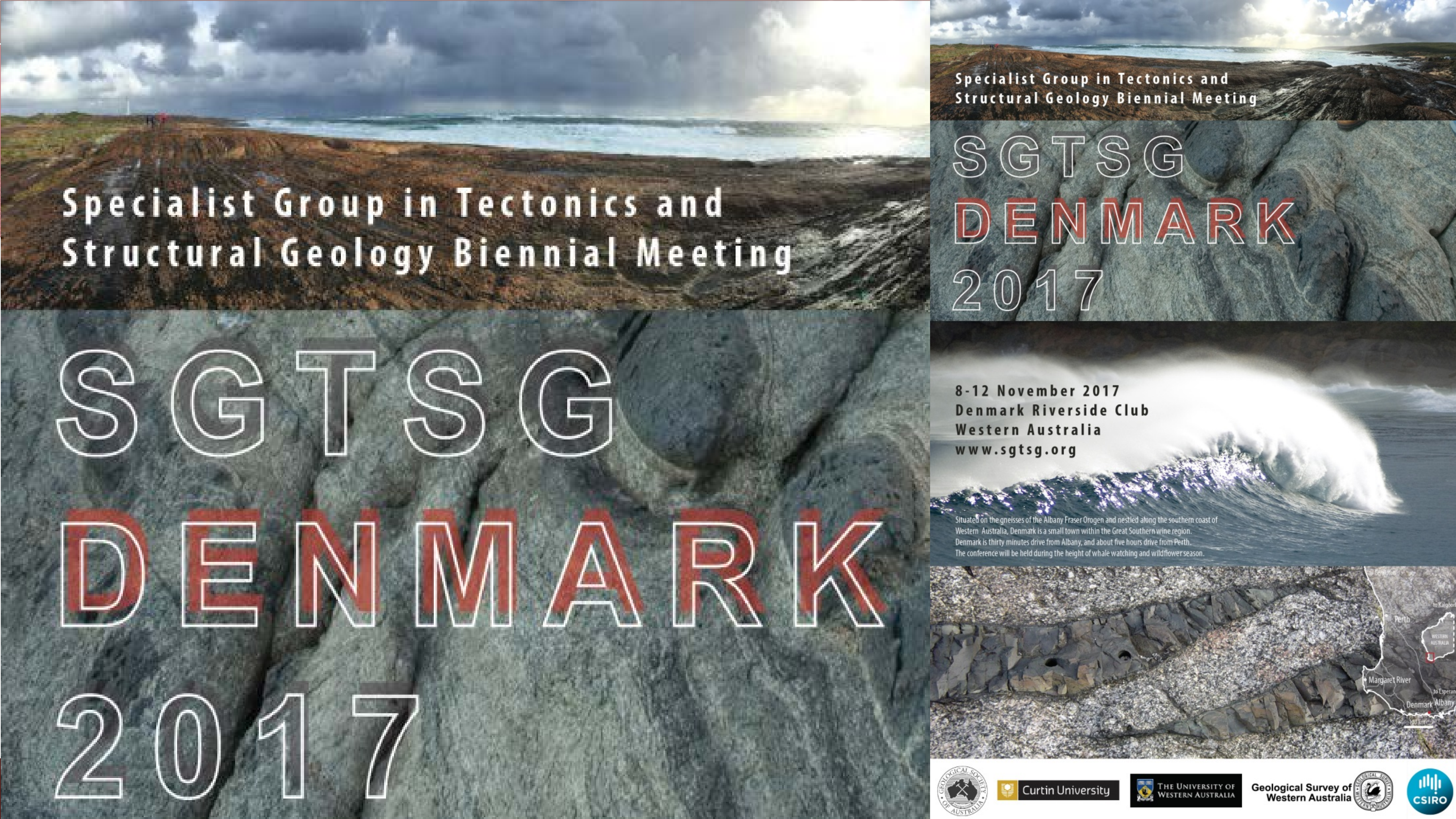


Learnings

1. Mundrabilla SZ separates significantly different crustal domains
2. W' Coompana differs in **thickness, structure and composition**
3. Better understanding of petrophysics needed across the study area (electrical, density, velocity, …) that will help understand craton, craton margins and 'oceanic domains' anywhere in WA and Australia

Progress: Better Questions

1. If common ancestry across MSZ – what chain of events involving which processes reworked either side of MSZ?
2. Can we assume homogeneous mantle density across MSZ?
3. Aside from MSZ – what do the structural transitions in the lower and mid-crust between W' Coompana to the west and east mean?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Situated on the gneisses of the Albany Fraser Orogen and nestled along the southern coast of Western Australia, Denmark is a small town within the Great Southern wine region. Denmark is thirty minutes drive from Albany, and about five hours drive from Perth. The conference will be held during the height of whale watching and wildflower season.
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