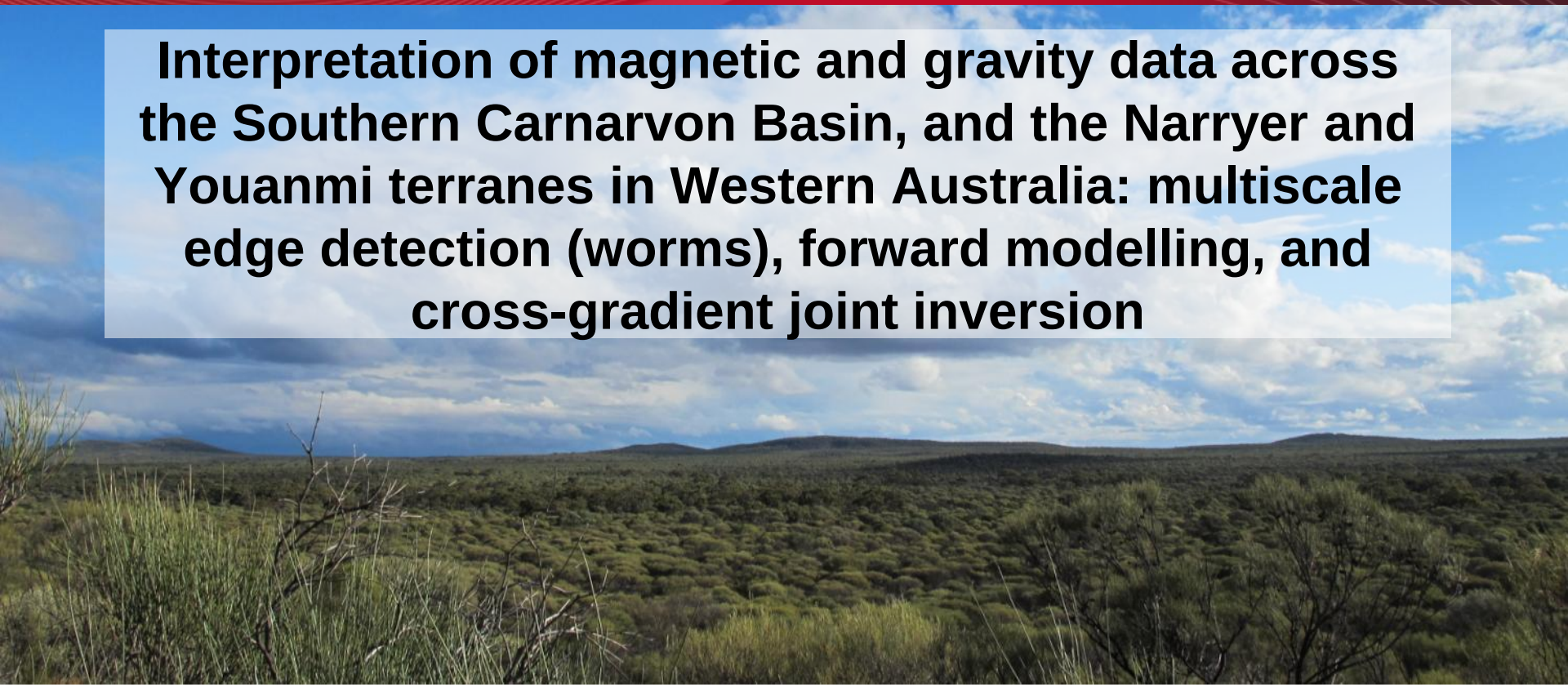
Government of **Western Australia**
Department of **Mines and Petroleum**

Interpretation of magnetic and gravity data across the Southern Carnarvon Basin, and the Narryer and Youanmi terranes in Western Australia: multiscale edge detection (worms), forward modelling, and cross-gradient joint inversion



Klaus Gessner, Tim Jones, James Goodwin, Luis Gallardo, Peter Milligan, John Brett, and Ruth Murdie

ROYALTIES FOR REGIONS

Australian Government
Geoscience Australia

Geological Survey of Western Australia

Purpose of the Potential Field Interpretation

- Add rigor / confidence to the interpretation of the reflection surveys by constraining the interpreted structure against the observed potential field

- Creating a template for potential field interpretation away from the seismic lines

Datasets and Methods

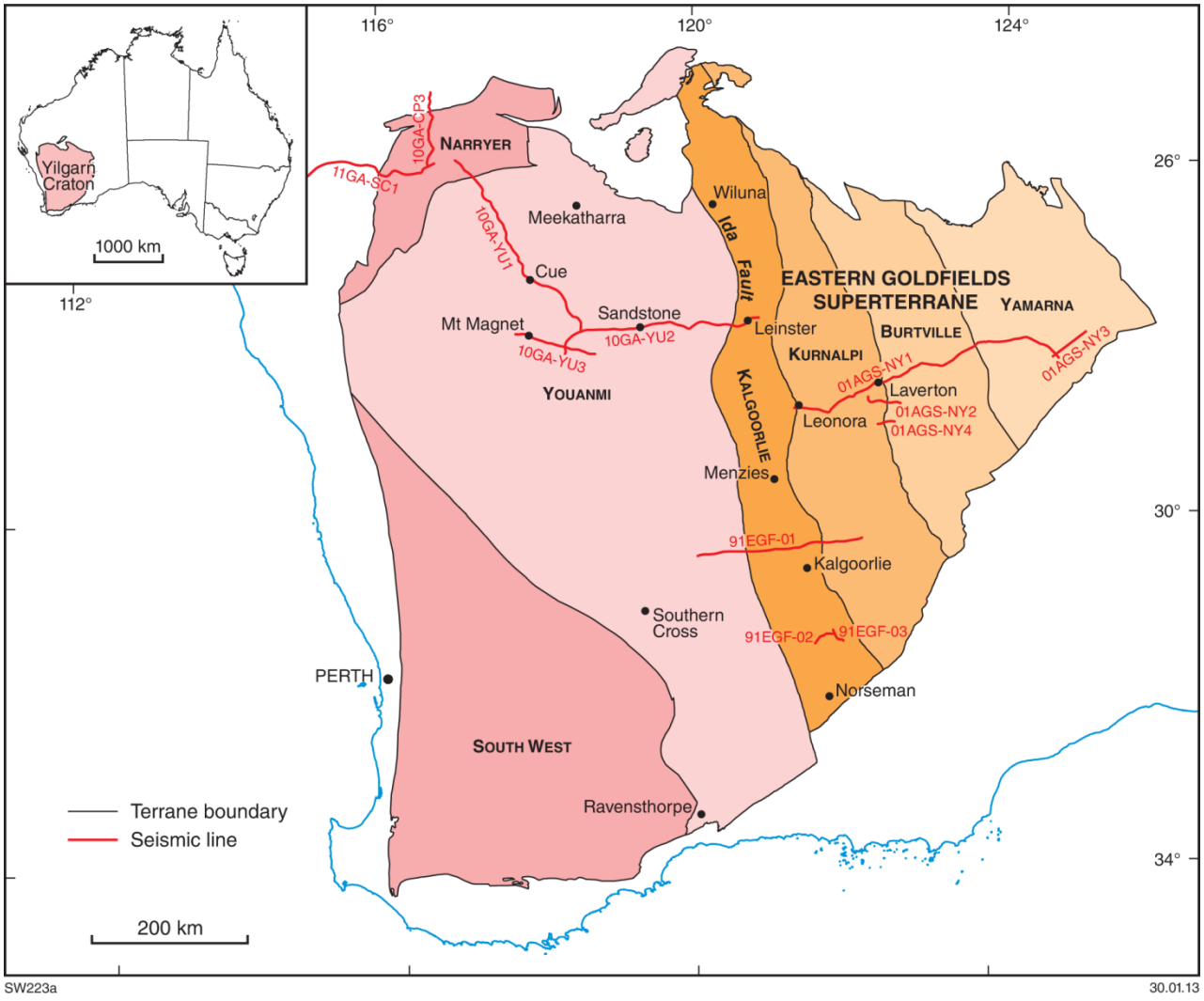
Data

- National Gravity Database plus new data collected along the seismic traverses
- WA State merge grid of TMI data

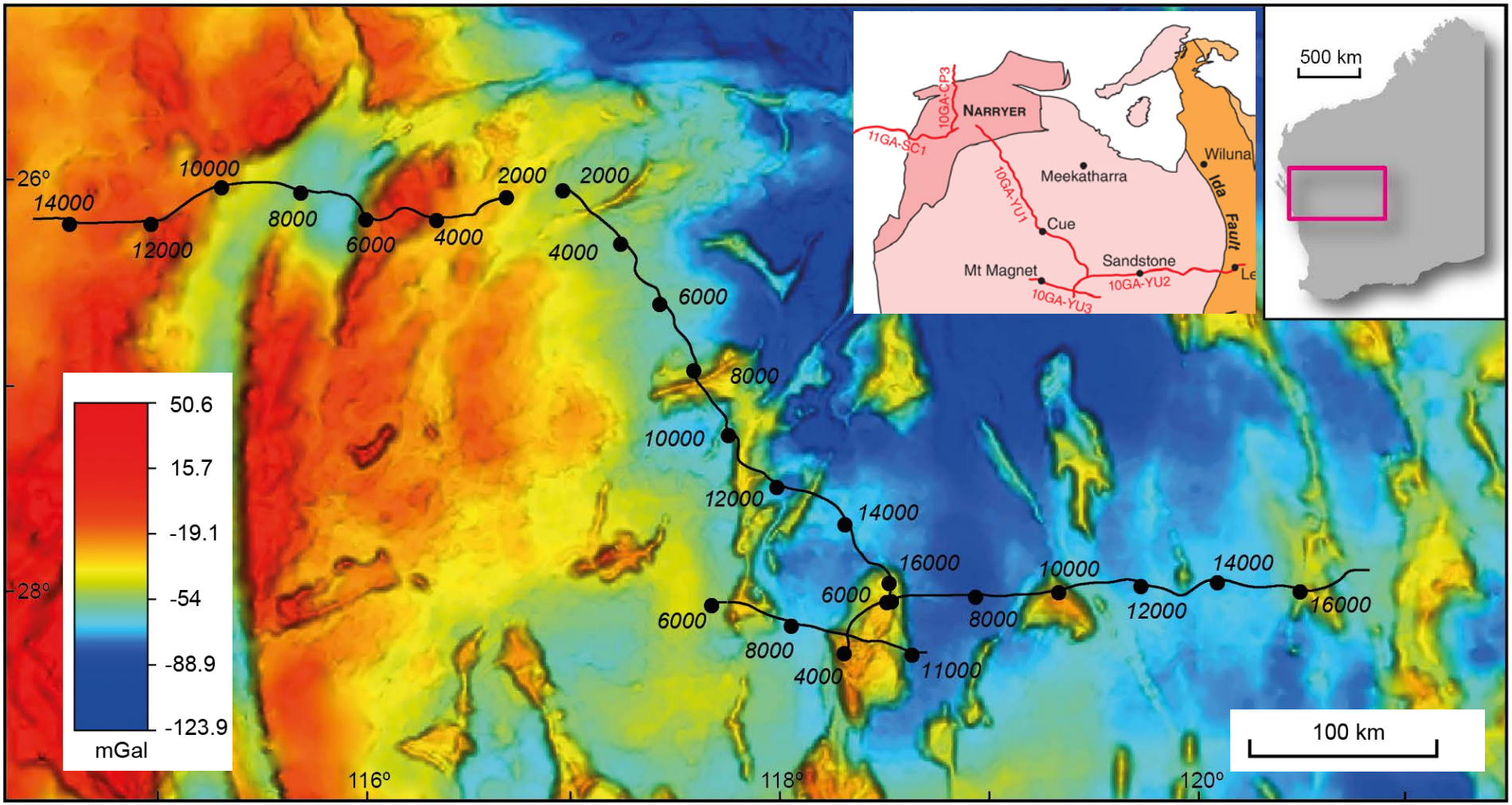
Methods

- Multiscale edge detection (‘worms’) using Intrepid software (Peter Milligan, GA)
- 2.5 D Forward Modelling using ModelVision v.11.0 (James Goodwin and Tim Jones, GA)
- Cross gradient joint inversion (Luis Gallardo, CICESE, Mexico)

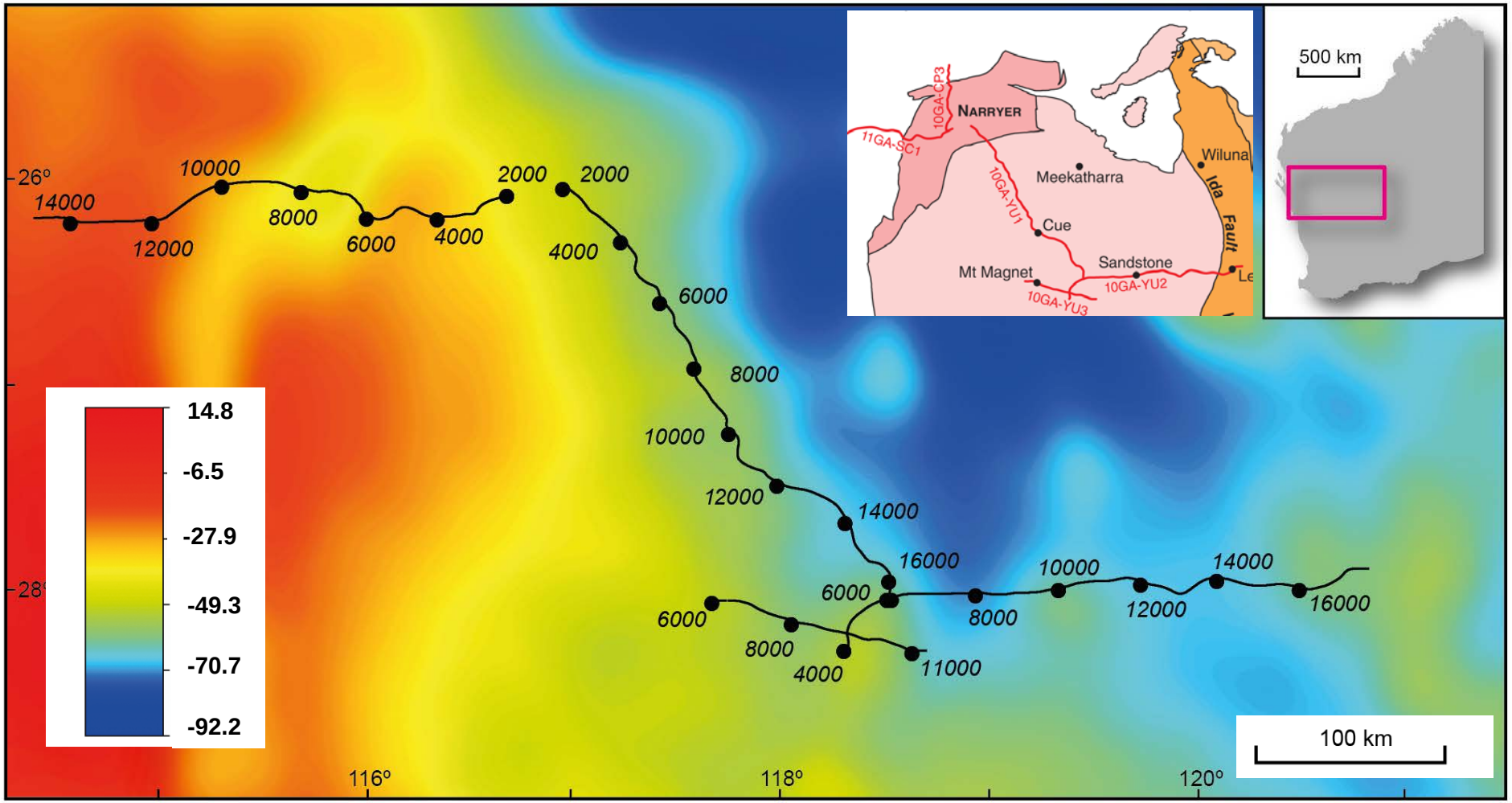
Tectonic Units



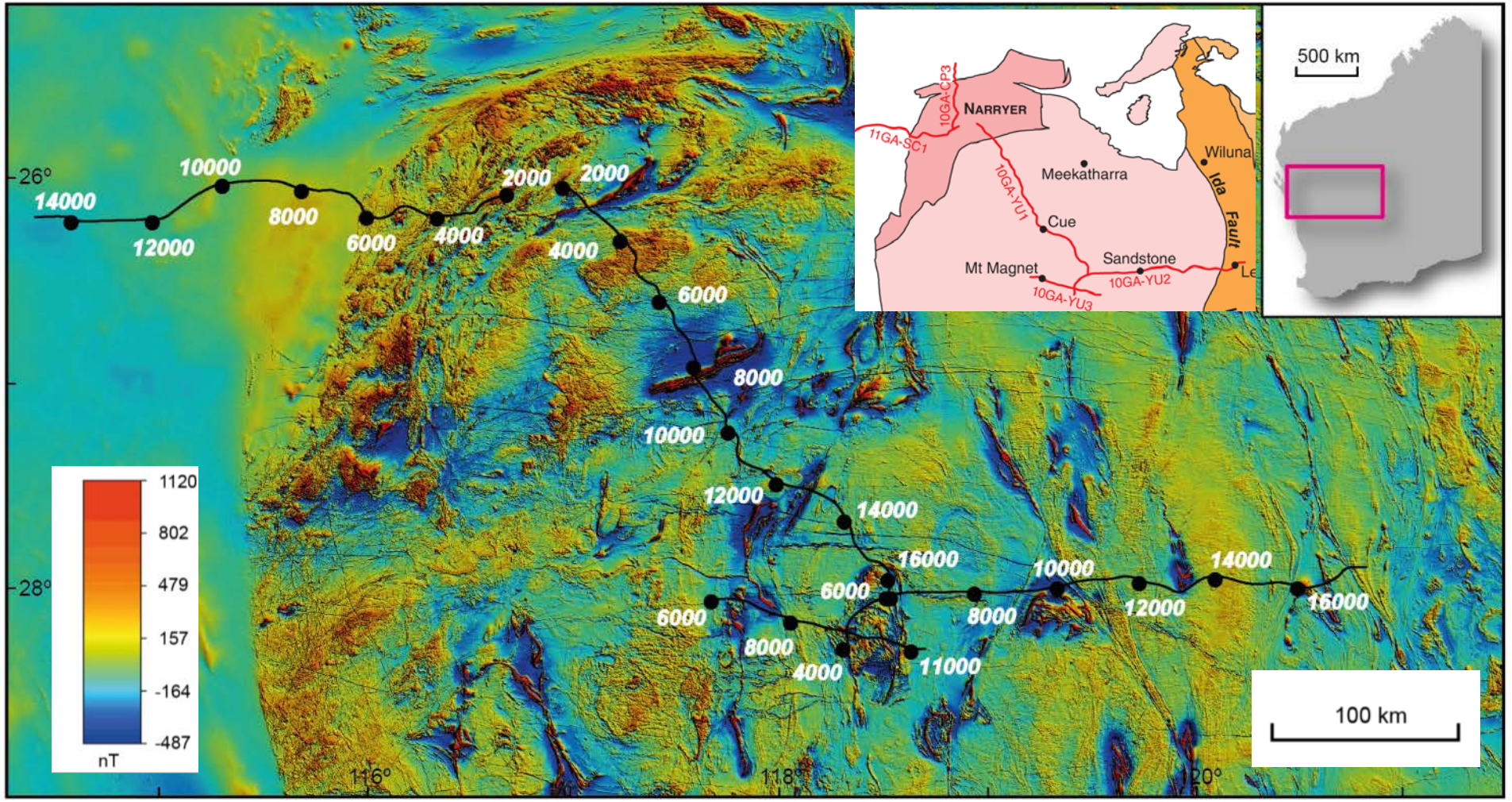
Gravity Anomaly



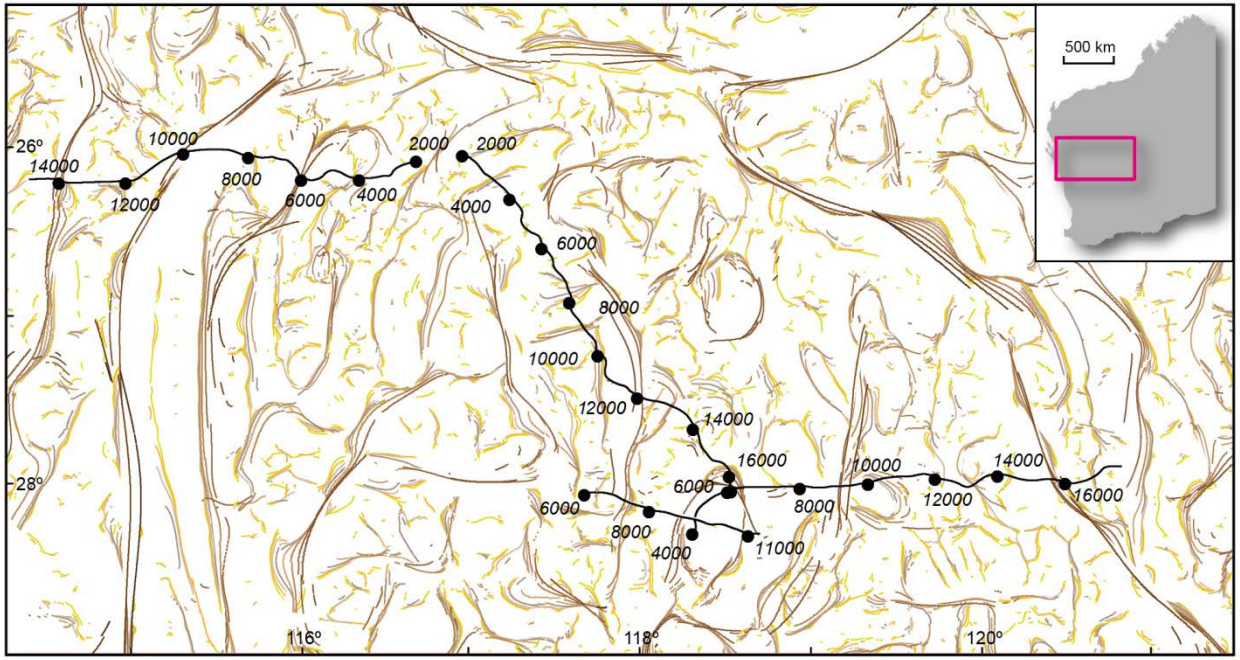
Gravity Anomaly 20 km upward ctd.

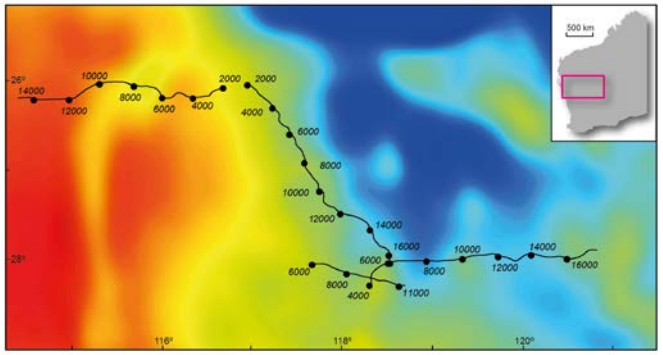


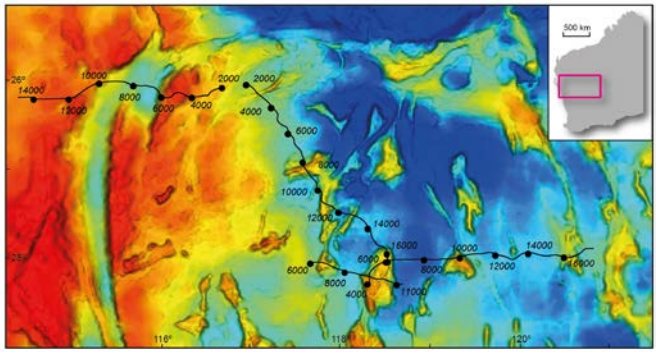
Magnetic Anomaly



Gravity Worms







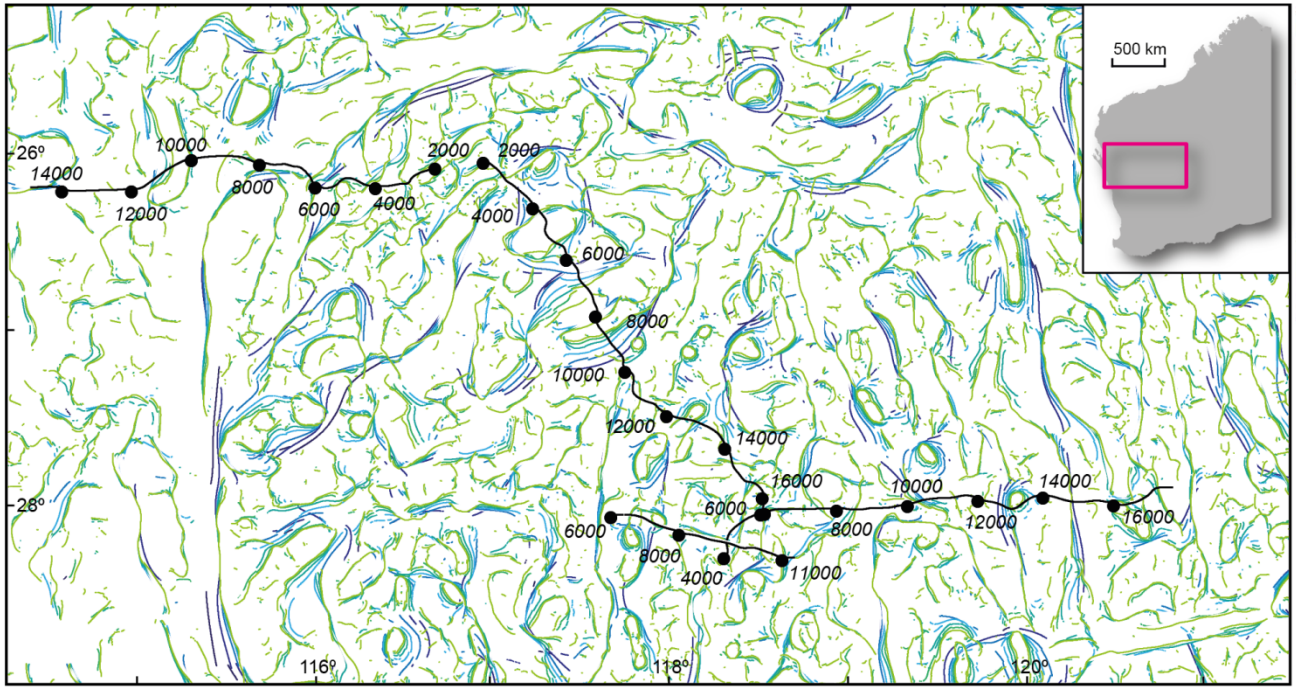
UPWARD CONTINUATION
LEVEL OF GRAVITY 'WORMS'

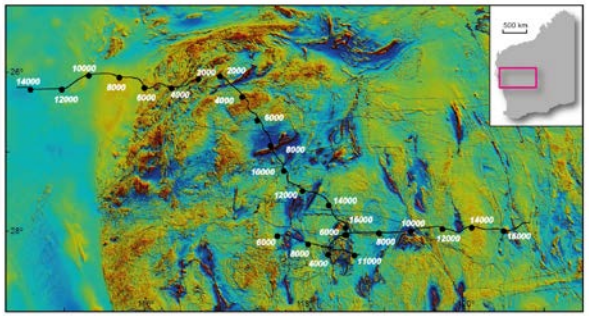
- 4,218 m
- 5,905 m
- 8,267 m
- 11,575 m
- 16,204 m
- 22,686 m
- 31,760 m
- 44,464 m
- 62,250 m

4000 Location of seismic line and Common Depth Points (CDPs)

100 km

Magnetic Worms





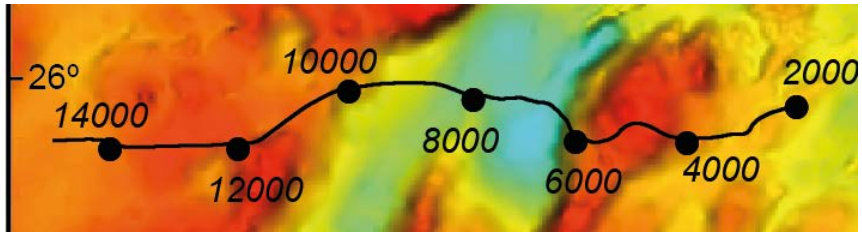
UPWARD CONTINUATION
LEVEL OF MAGNETIC 'WORMS'

- 5,792 m
- 8,109 m
- 11,353 m
- 15,894 m
- 22,252 m
- 31,1539 m
- 43,614 m

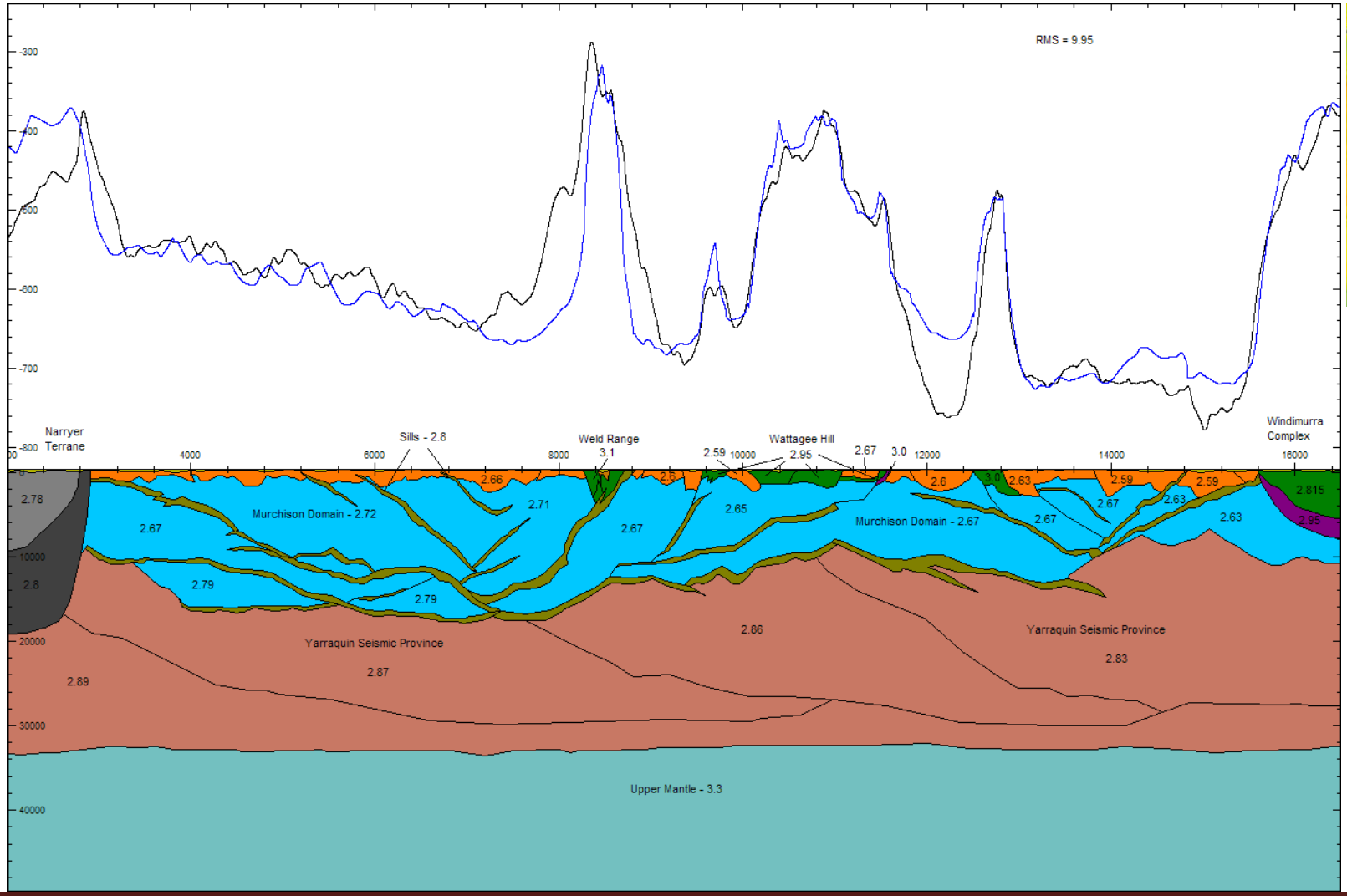
4000 Location of seismic line and Common Depth Points (CDPs)

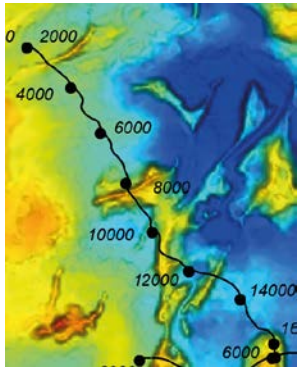
100 km

Forward Model 11GA-SC1

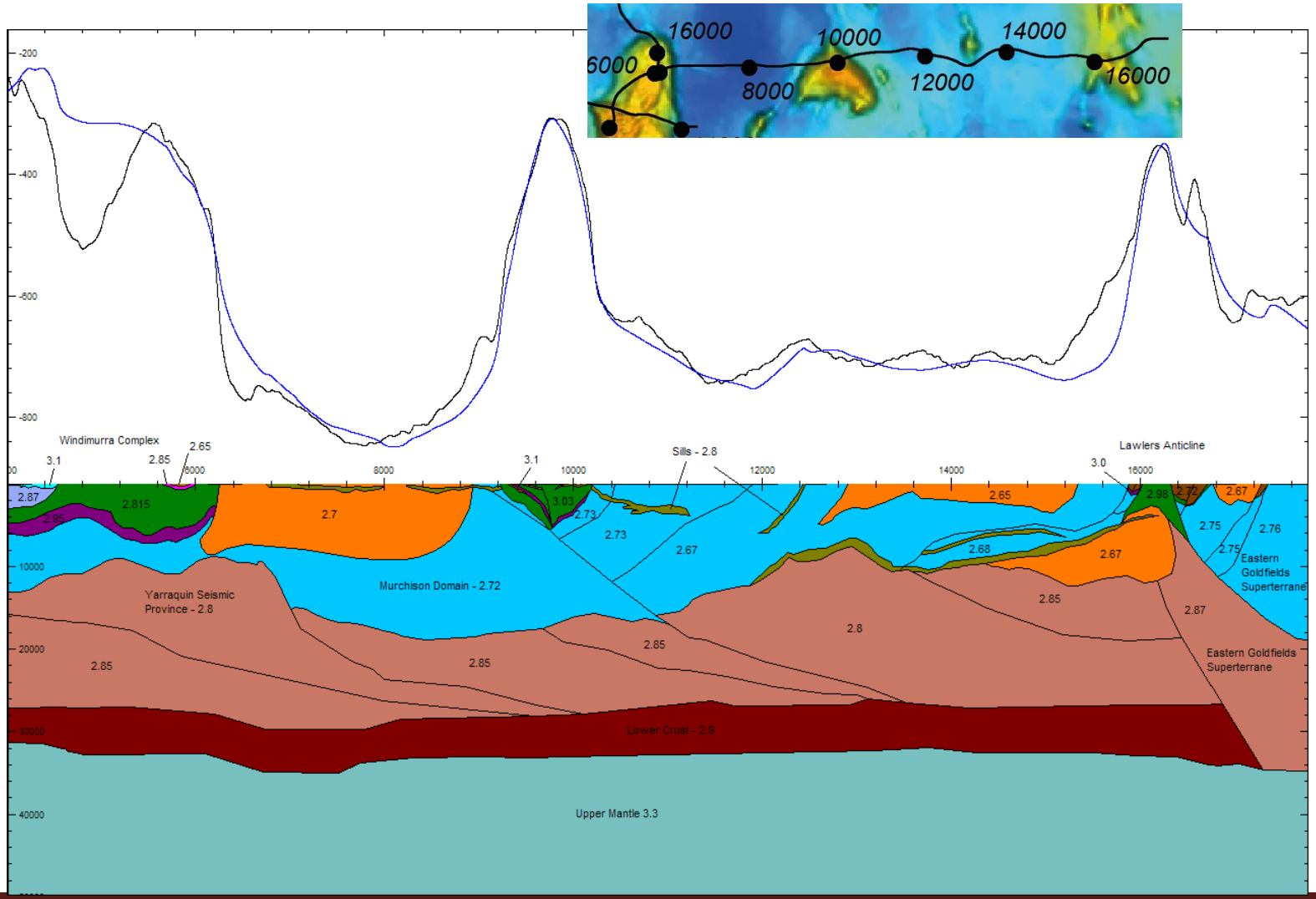


Forward Model 10GA-YU1

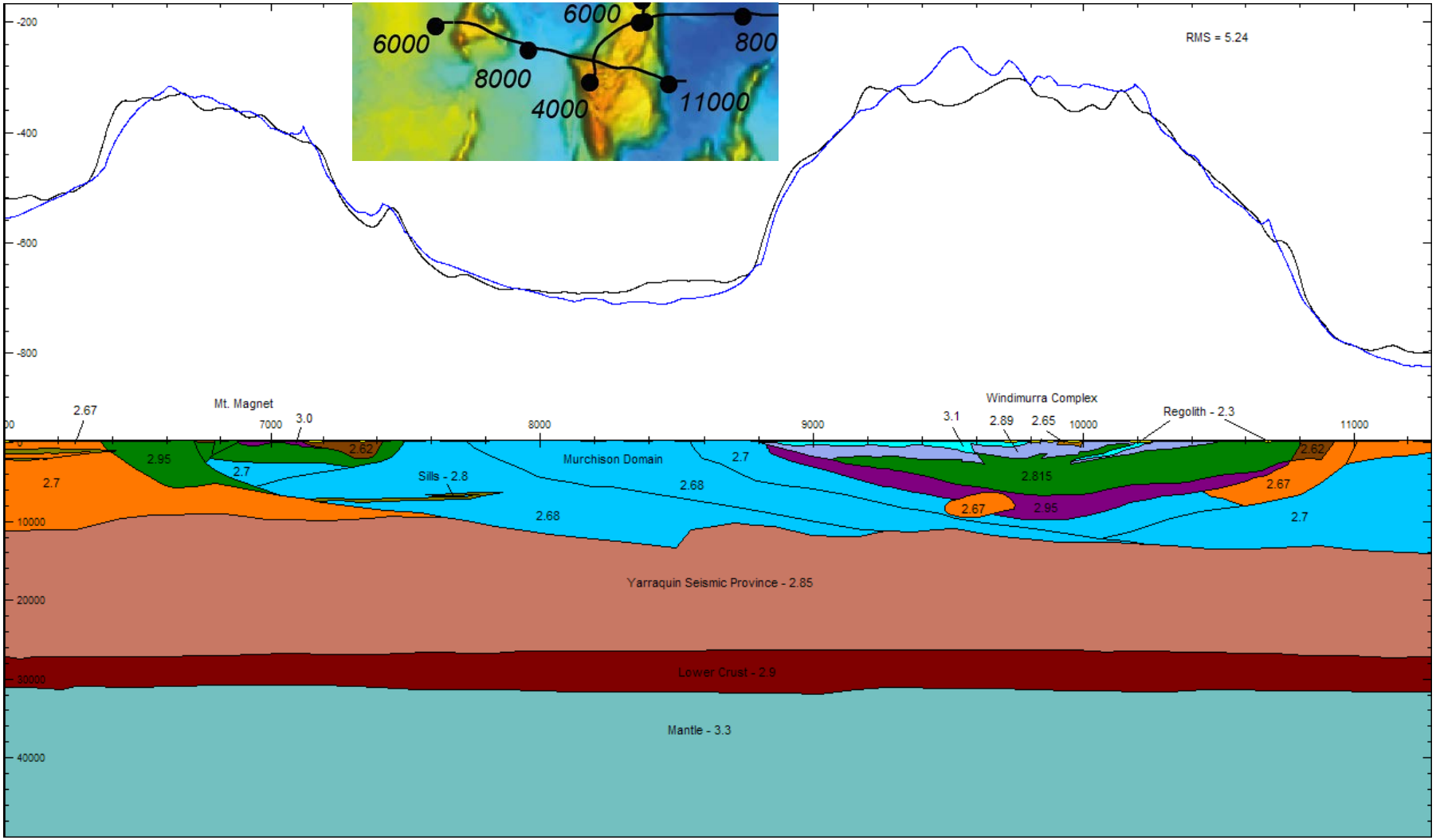




Forward Model 10GA-YU2



10GA-YU3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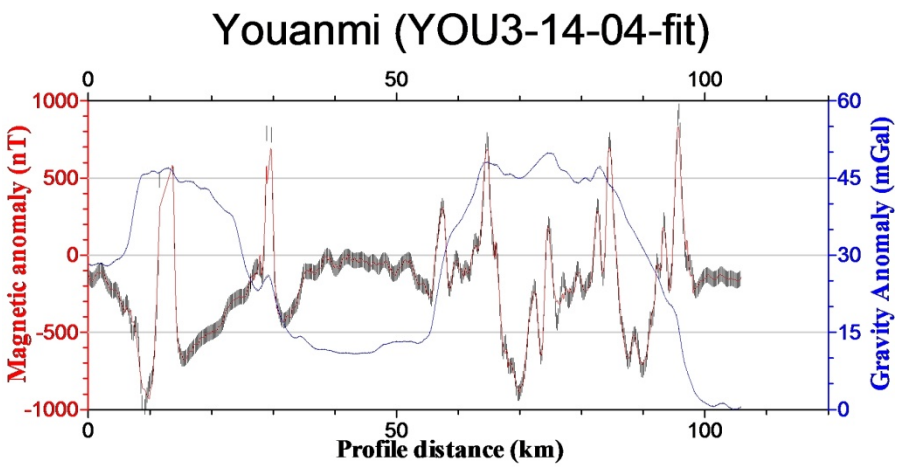
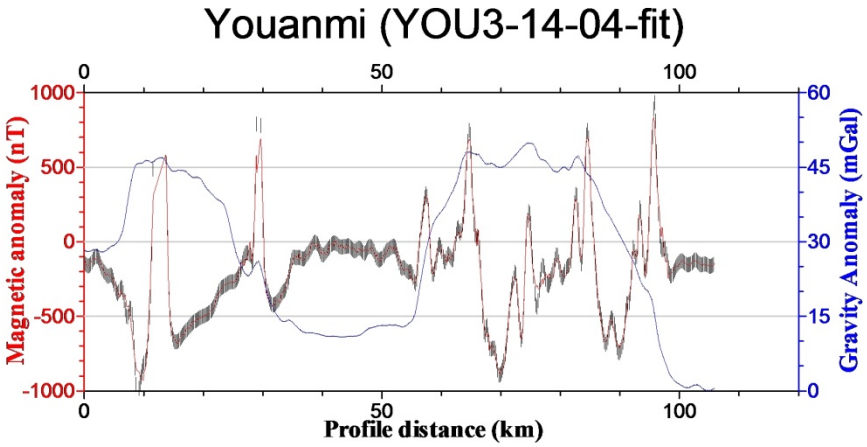
6000
8000
4000
11000
800
-200
-400
-600
-800
Mt. Magnet
Windimurra Complex
Regolith - 2.3
Murchison Domain
Sills - 2.8
Yarraquin Seismic Province - 2.85
Lower Crust - 2.9
Mantle - 3.3
2.67
3.0
3.1
2.89
2.65
2.95
2.7
2.62
2.68
2.815
7000
8000
9000
10000
11000
20000
30000
40000

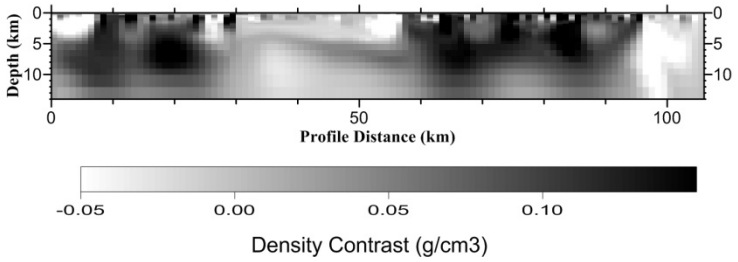
Cross Gradient Joint Inversion

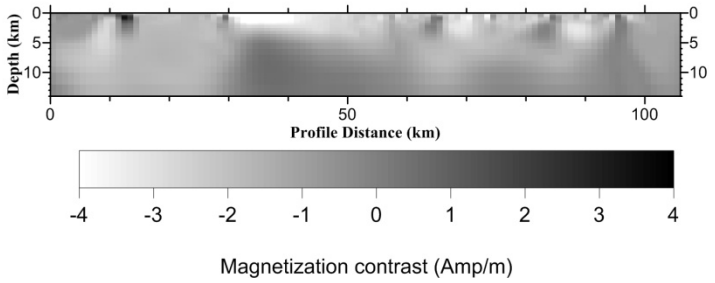
- Developed by Luis Gallardo (CICESE, Mexico)
- Iterative method to calculate structurally matching material models that satisfy gravity and magnetic data
- Assumes features have both magnetic and density expression
- No rock properties are used as input
- Focus on upper crustal features
- Result: ‘Geospectral Images’
- Colour scale can tentatively be linked to rock types

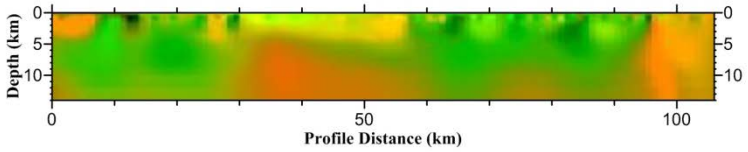
Cross Gradient Joint Inversion



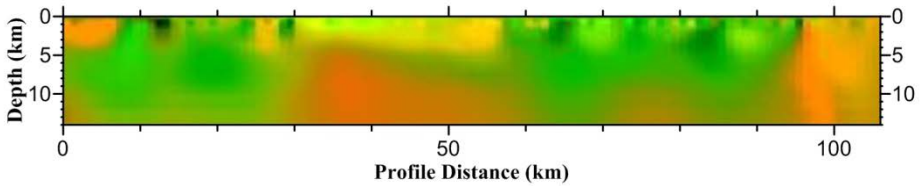


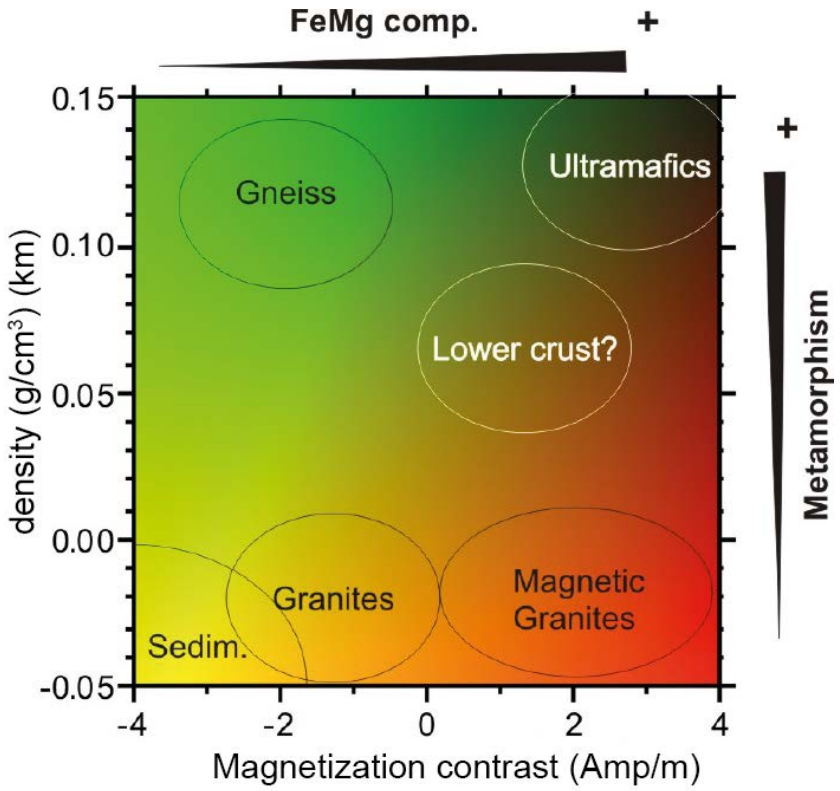




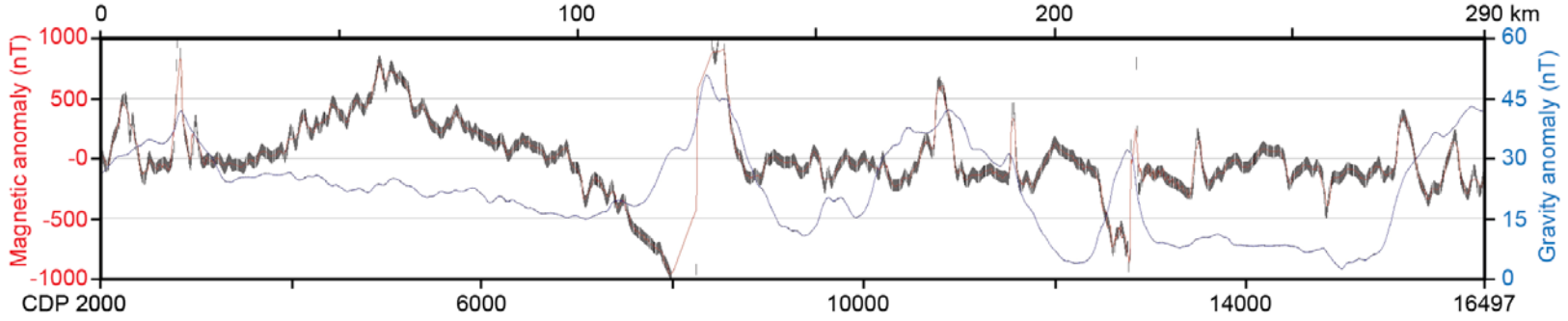


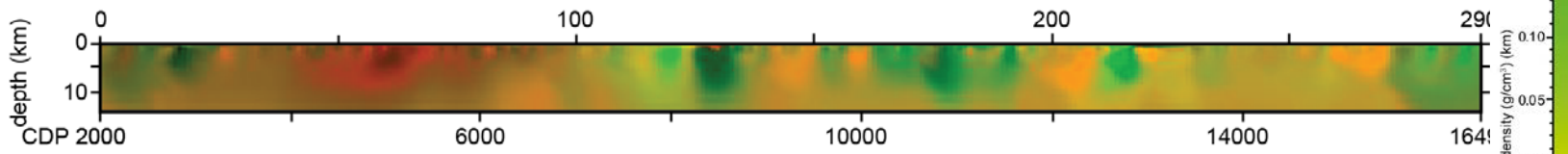
Colour scale can tentatively be linked to rock types

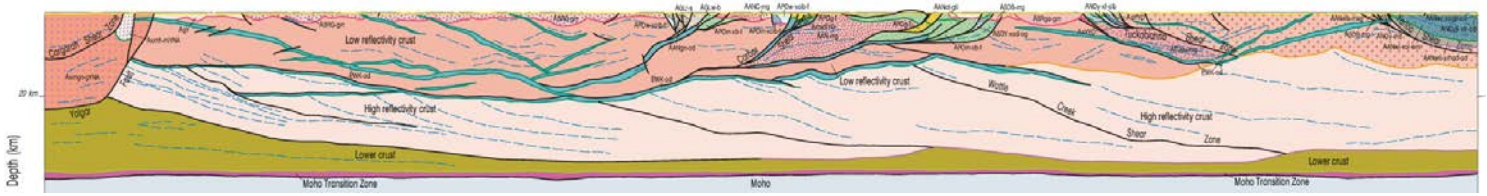


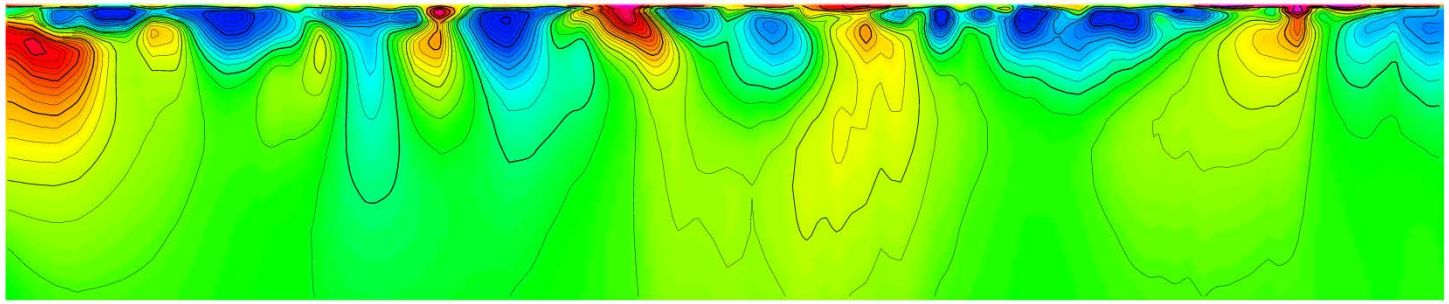


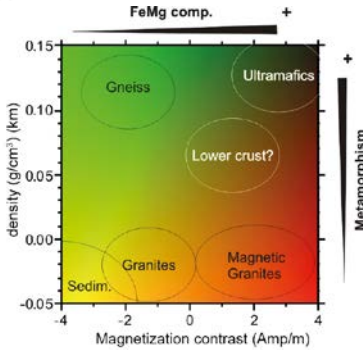
YU1 Inversion





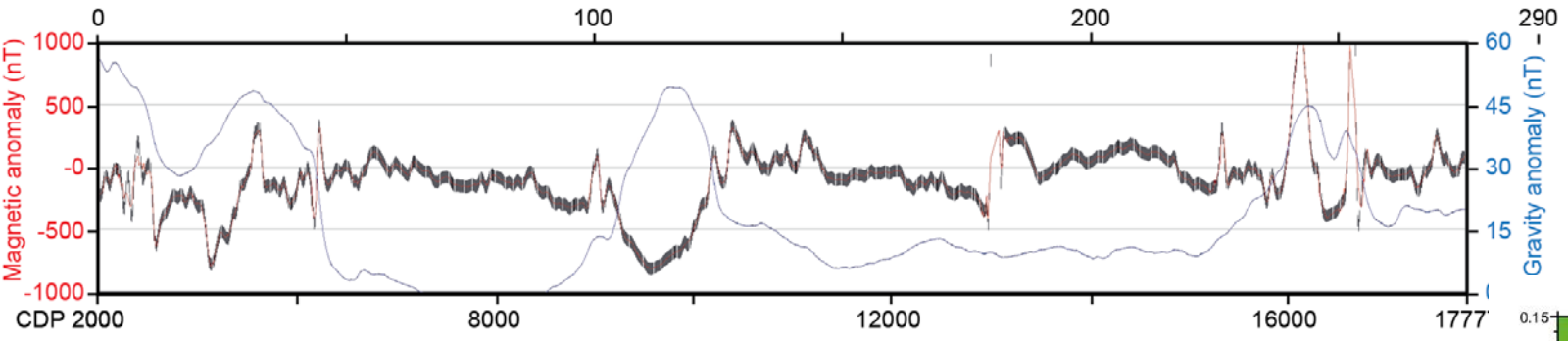


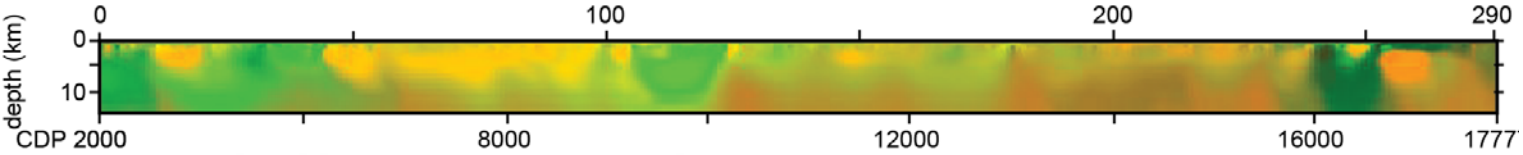


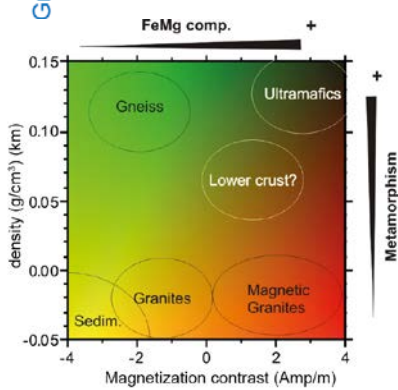


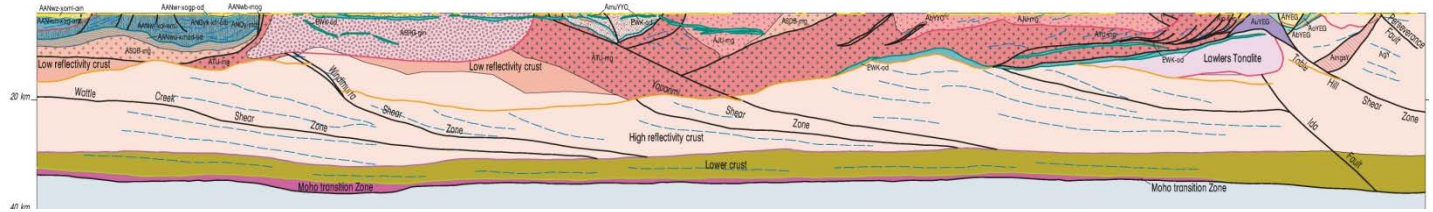
MT

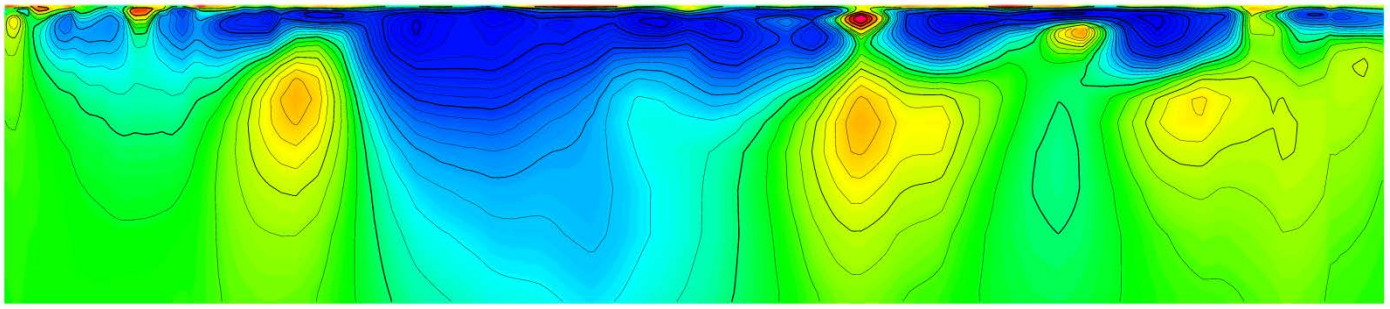
YU2 Inversion





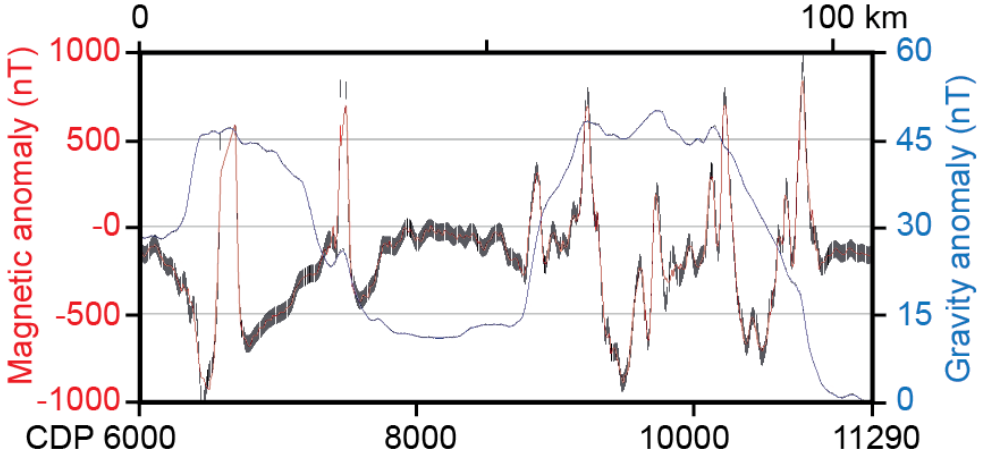


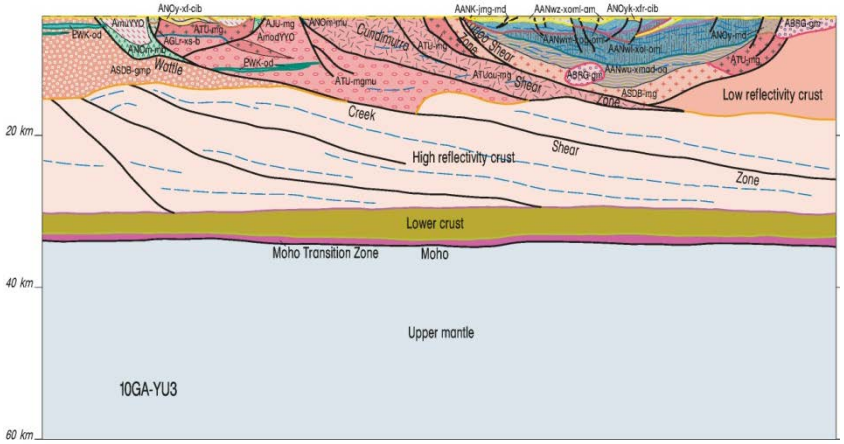


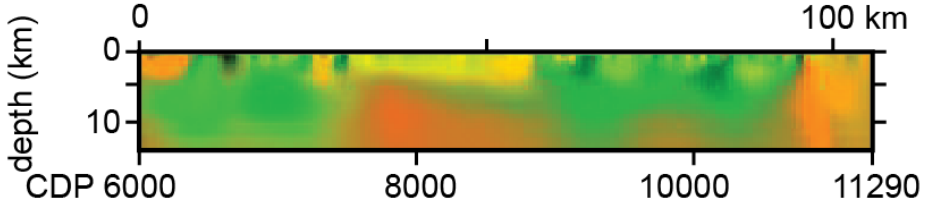


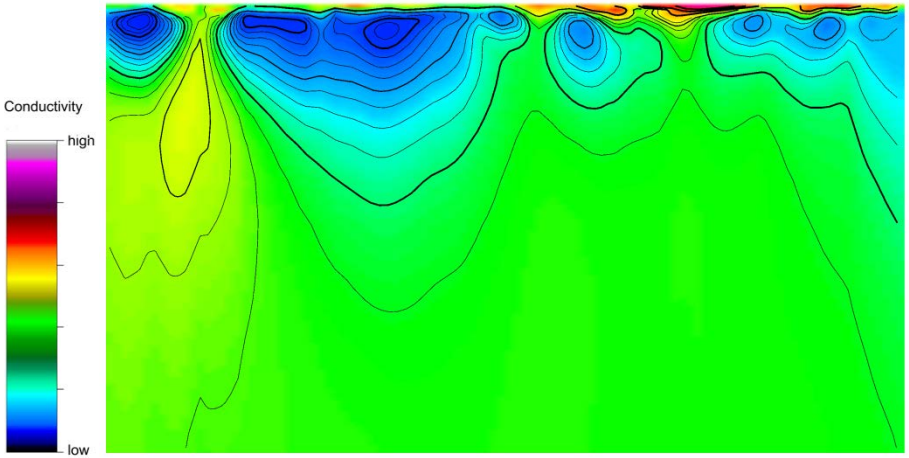
MT

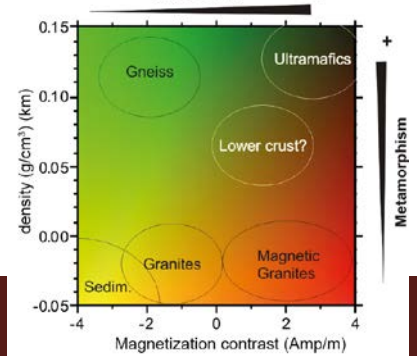
YU3 Inversion











MT

Conclusions

- The potential field data and inversions can be related to the seismic interpretation and the surface geology without too much mismatch
- Given the flat Moho across the YU-survey area the changes in the gravity and magnetic fields are either due to variations in mantle density or the lateral changes in crustal material → 'topography' of the reflective lower crust (Yarraquin seismic province) / late granites
- The joint inversion results relate to structures in the seismic profile, and also to the MT models, particularly regarding the location of the reflective lower crust