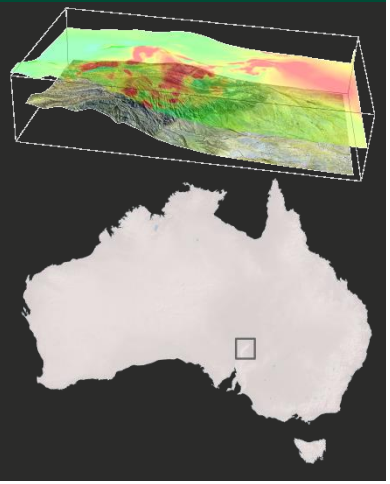
MONASH University

School of Earth, Atmosphere and Environment

High-heat geodynamic setting during the Palaeozoic evolution of the Mount Painter Province, SA, Australia: evidence from integrated field structural geology and joint potential-field inversions



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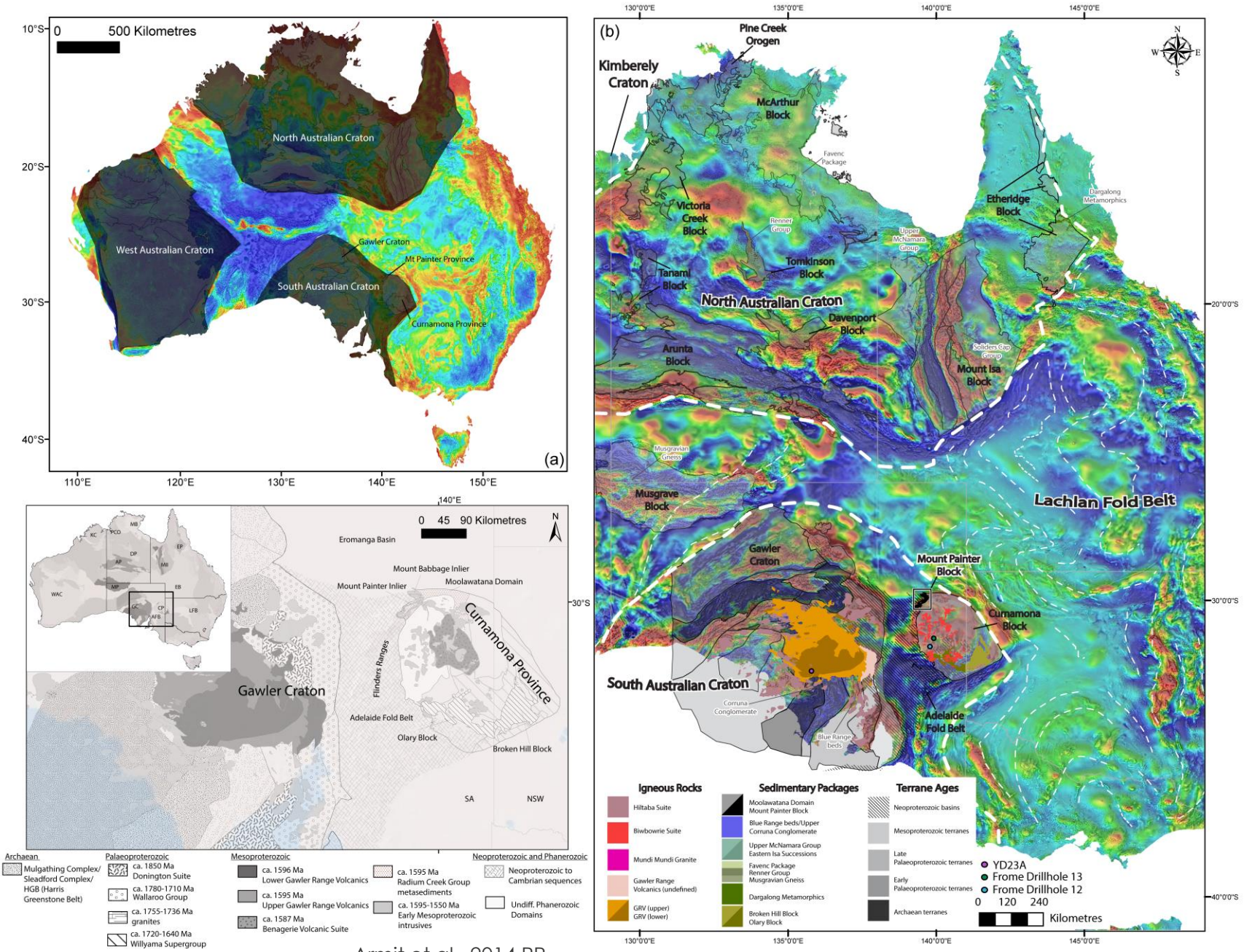
ARC LP0882000

GEMOC

Government of South Australia
Department for Manufacturing, Innovation, Trade, Resources and Energy

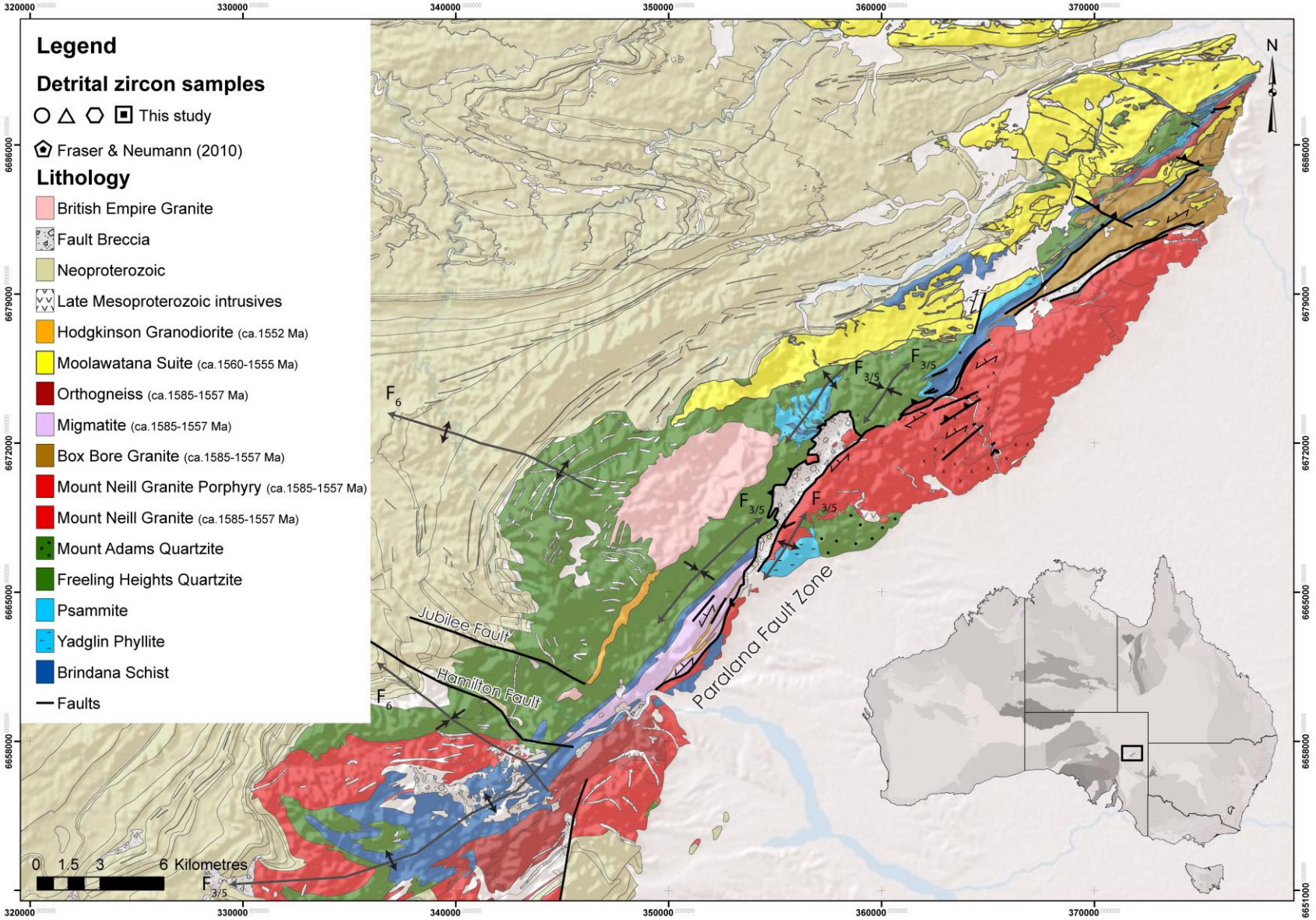
Outline

- Characterise the structural evolution of the Mount Painter Province.
- Assess the geological models of the region using potential-field data.
- Use of constrained potential-field inversions for subsurface recognition of blind geological bodies.
- Implications for the geodynamic evolution of the Province.



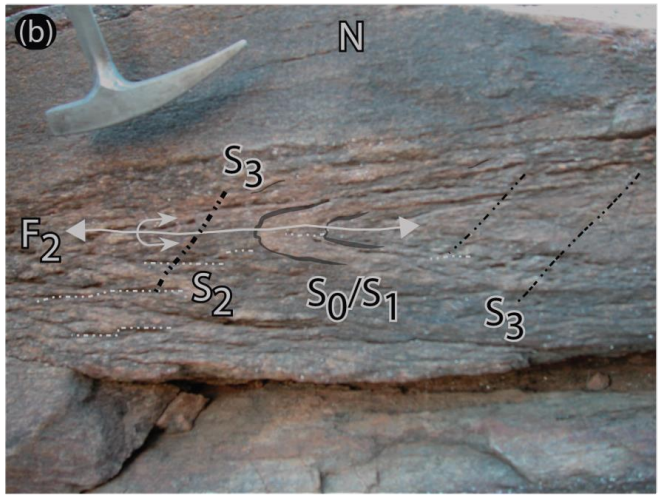
Armit et al., 2014 PR

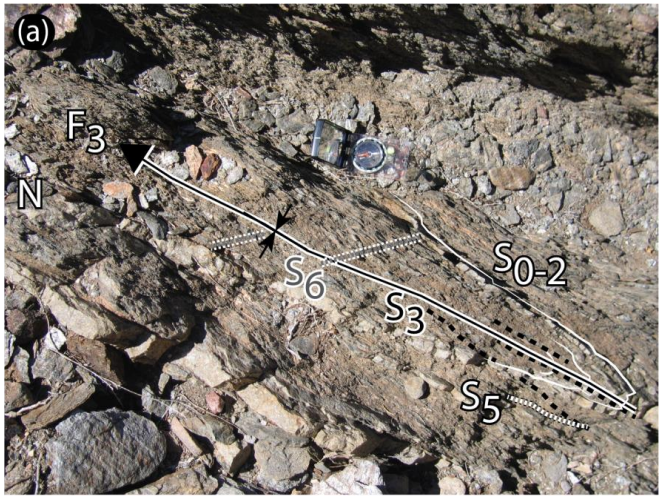
Introduction

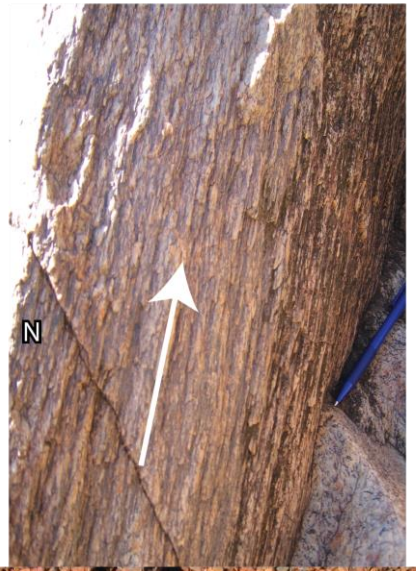


Structural evolution

- Poly-phase deformation from Early Mesoproterozoic to present neo-tectonic activity.
- D_1- D_3 ductile early thin skinned recumbent to thick skinned NE-SW upright folding.
- Phanerozoic deformation including;
  - Open, upright, shallow doubly plunging F_5.
  - F_6 very open folds warping the S_0-S_5 fabrics.
  - Brittle fault reactivation.
  - Emplacement of the Ordovician-Silurian British Empire Granite.

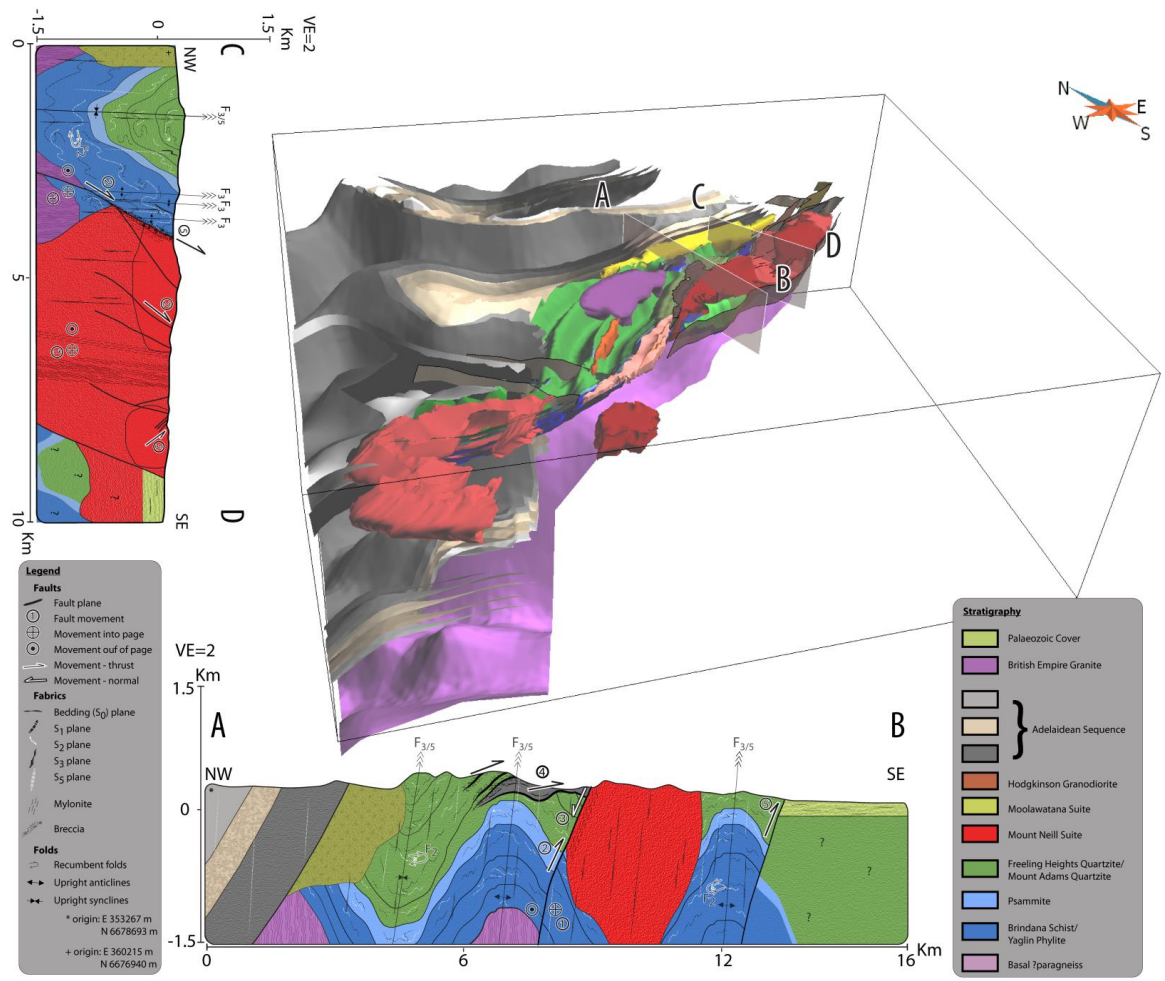


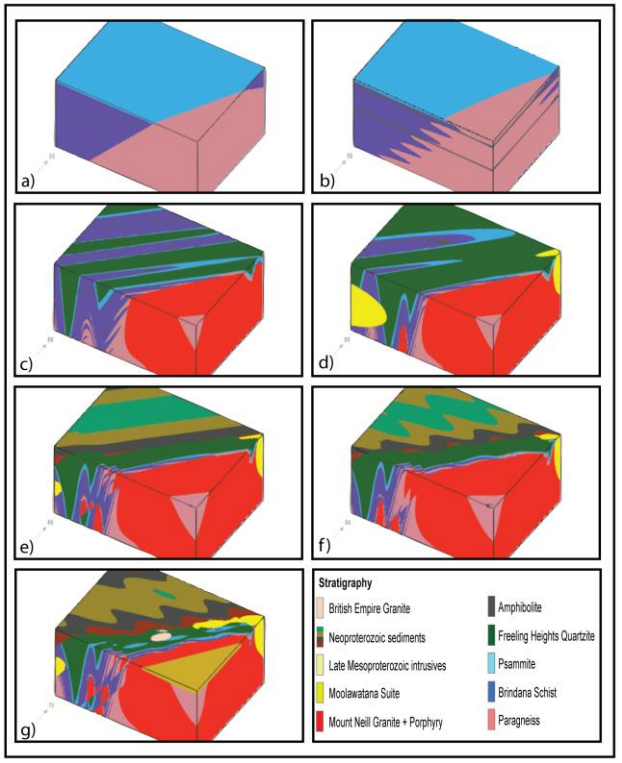


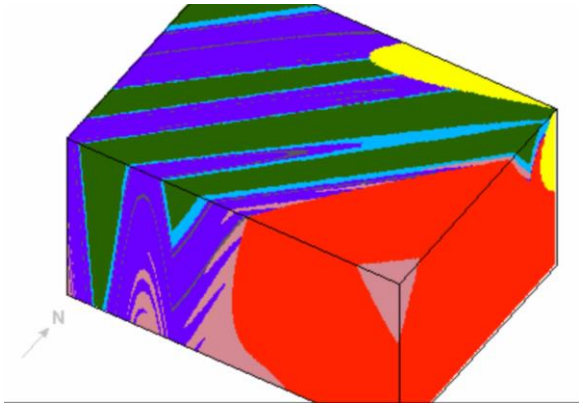


Armit et al., 2012 GR

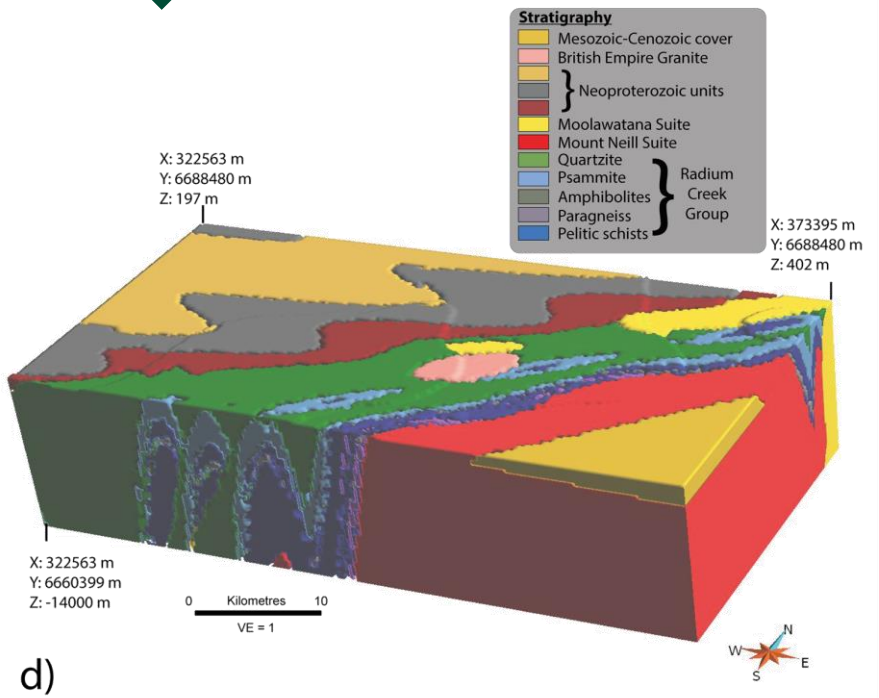
3D Structural mapping and modelling





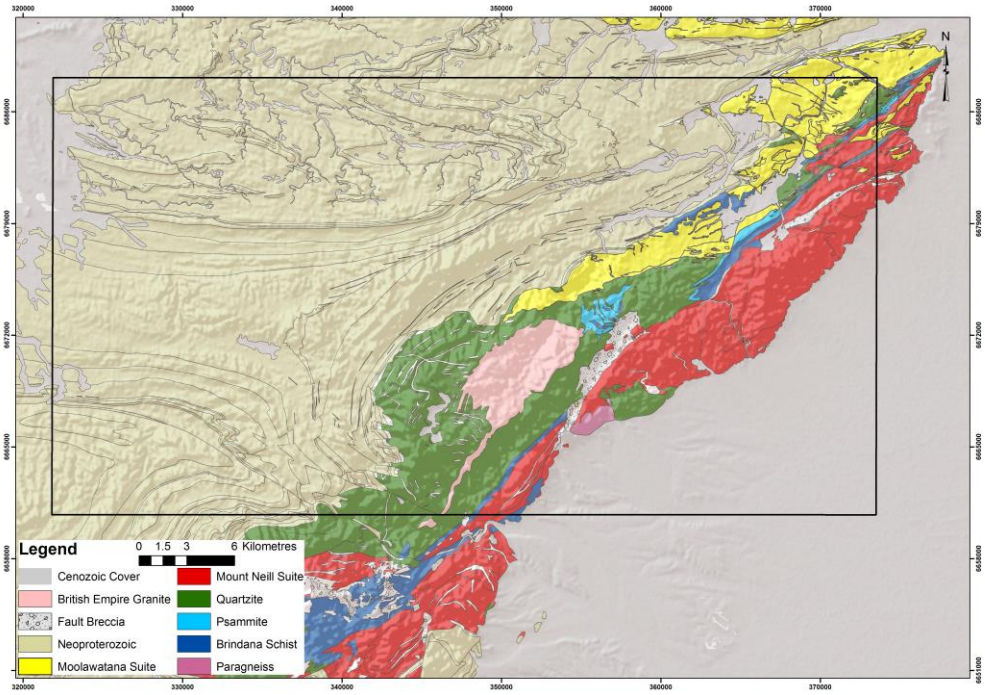


Reconciling the geological model

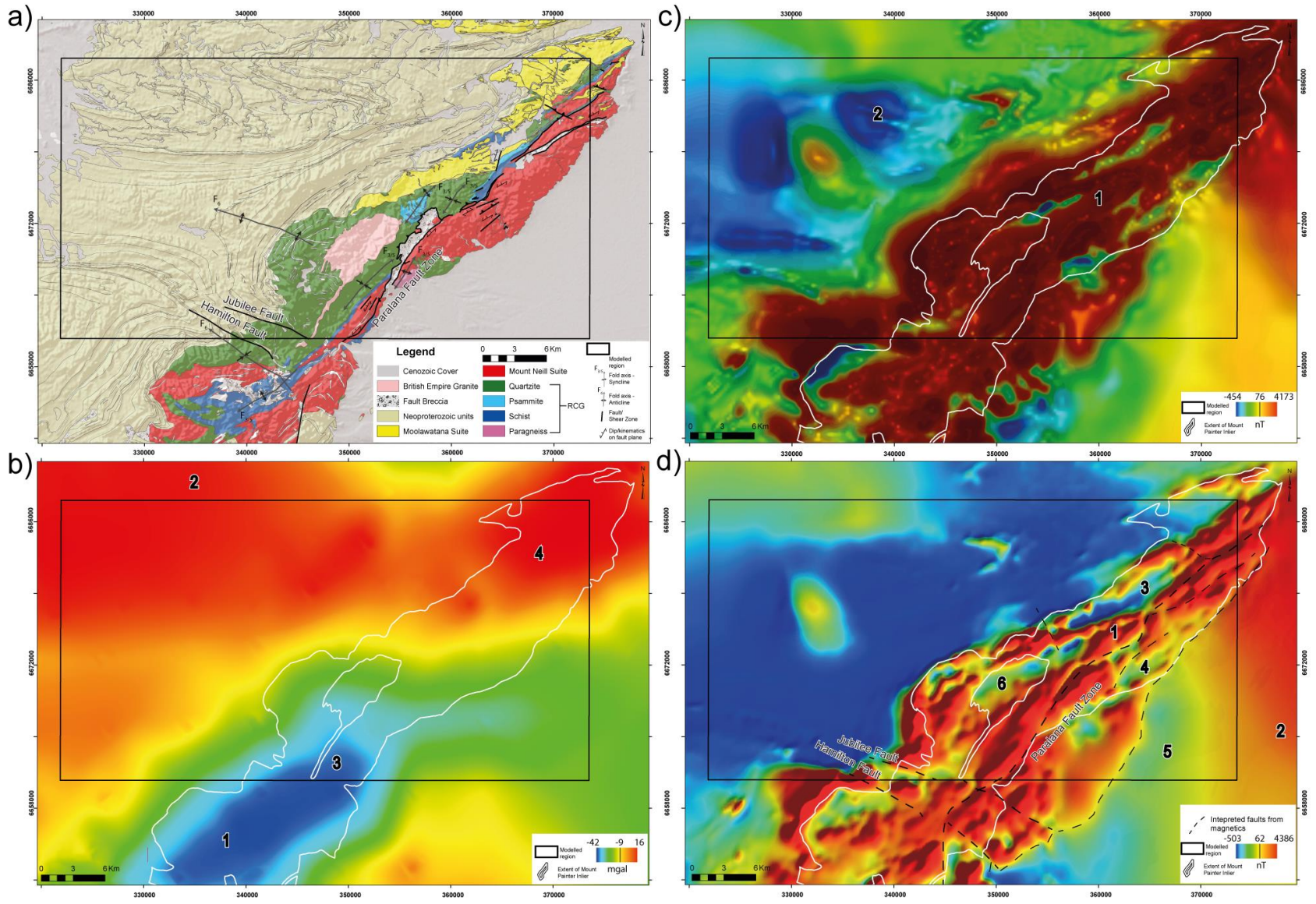


d)

- Good fit between 3D model and surface mapping.
- However how valid is this model in the subsurface?

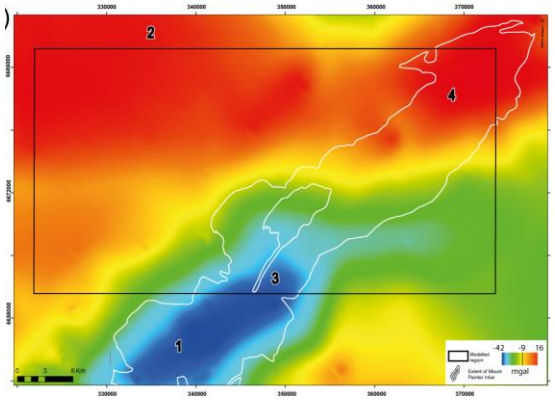


Assessing the validity of the geological model with geophysical data

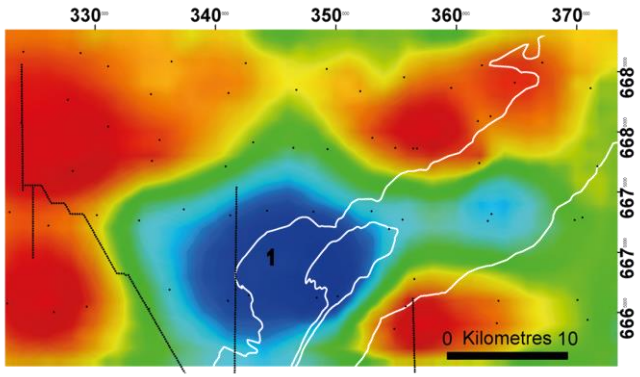


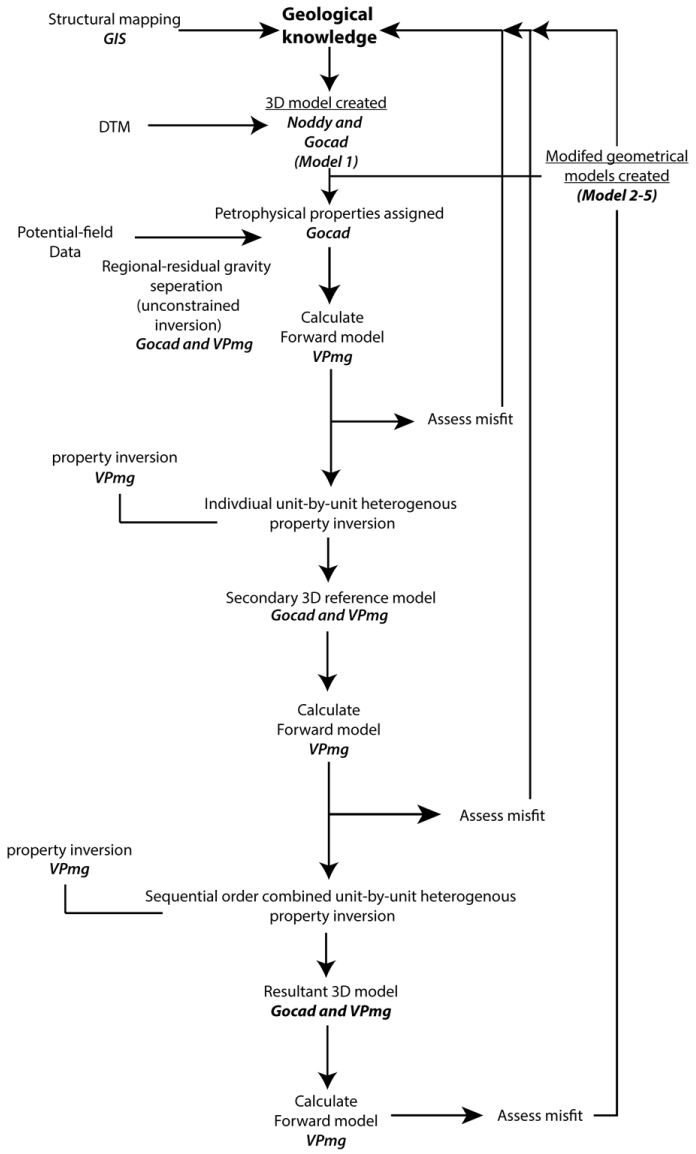
Geophysical modelling - workflow

Regional gravity

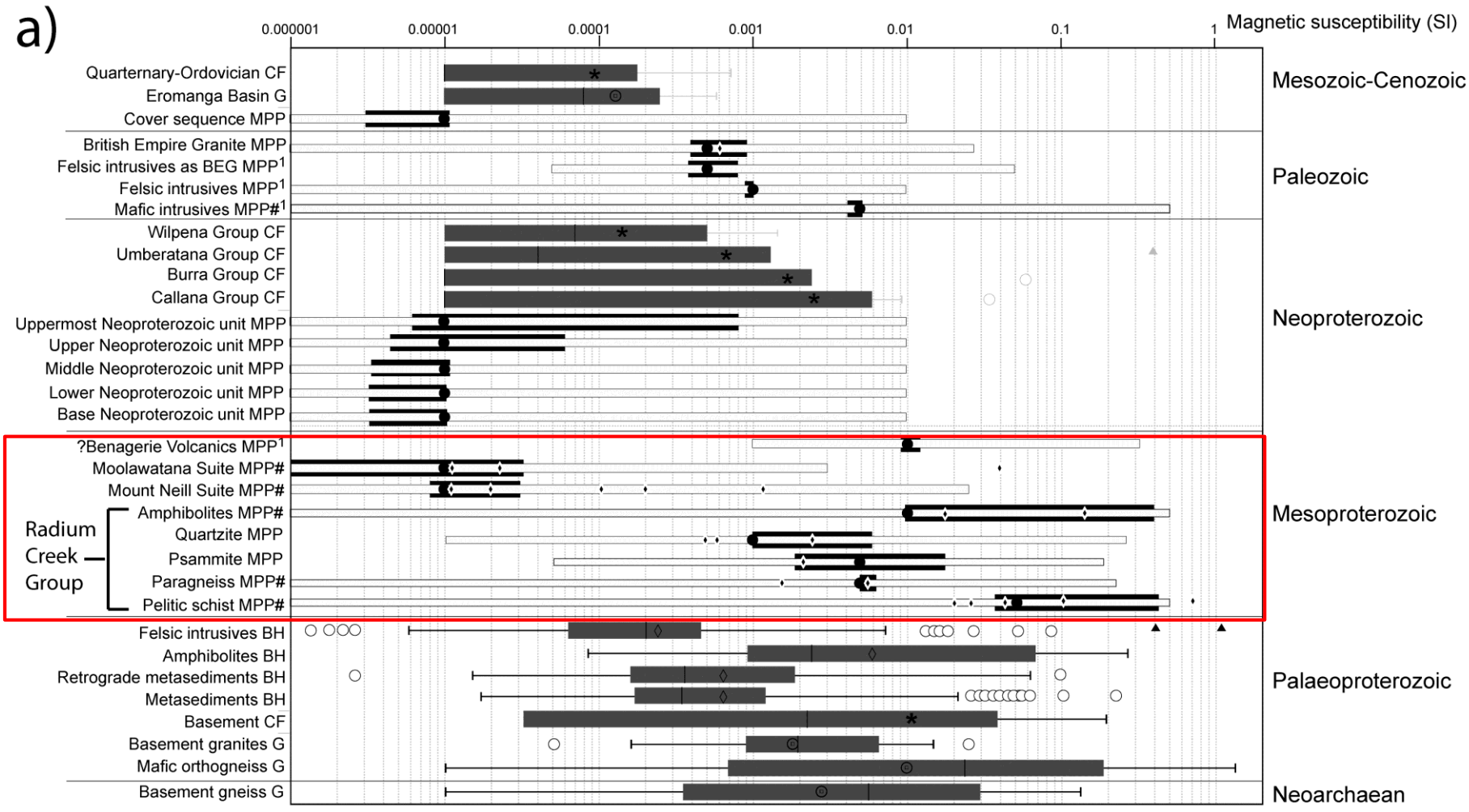


Residual gravity

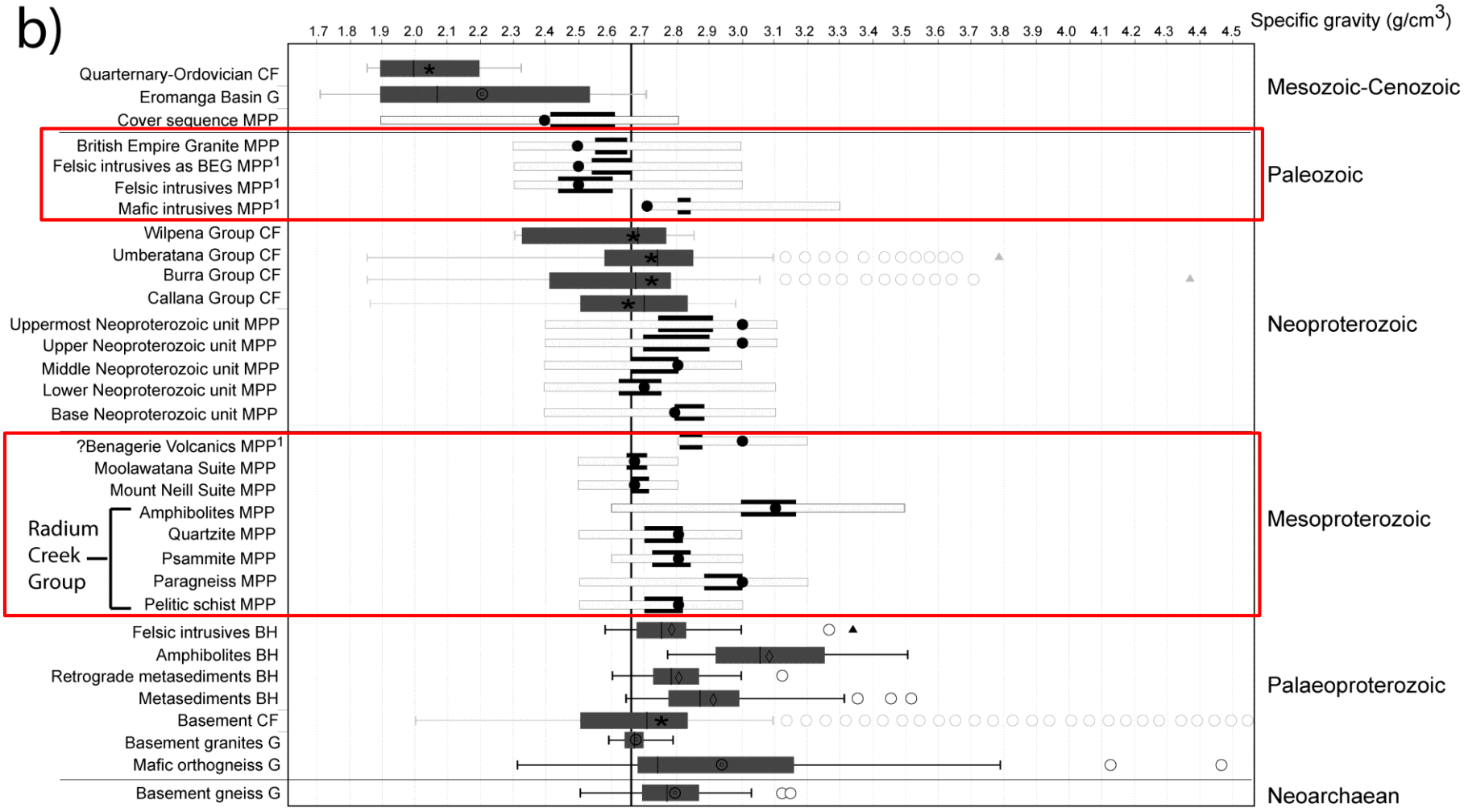




Petrophysics – Mag Sus

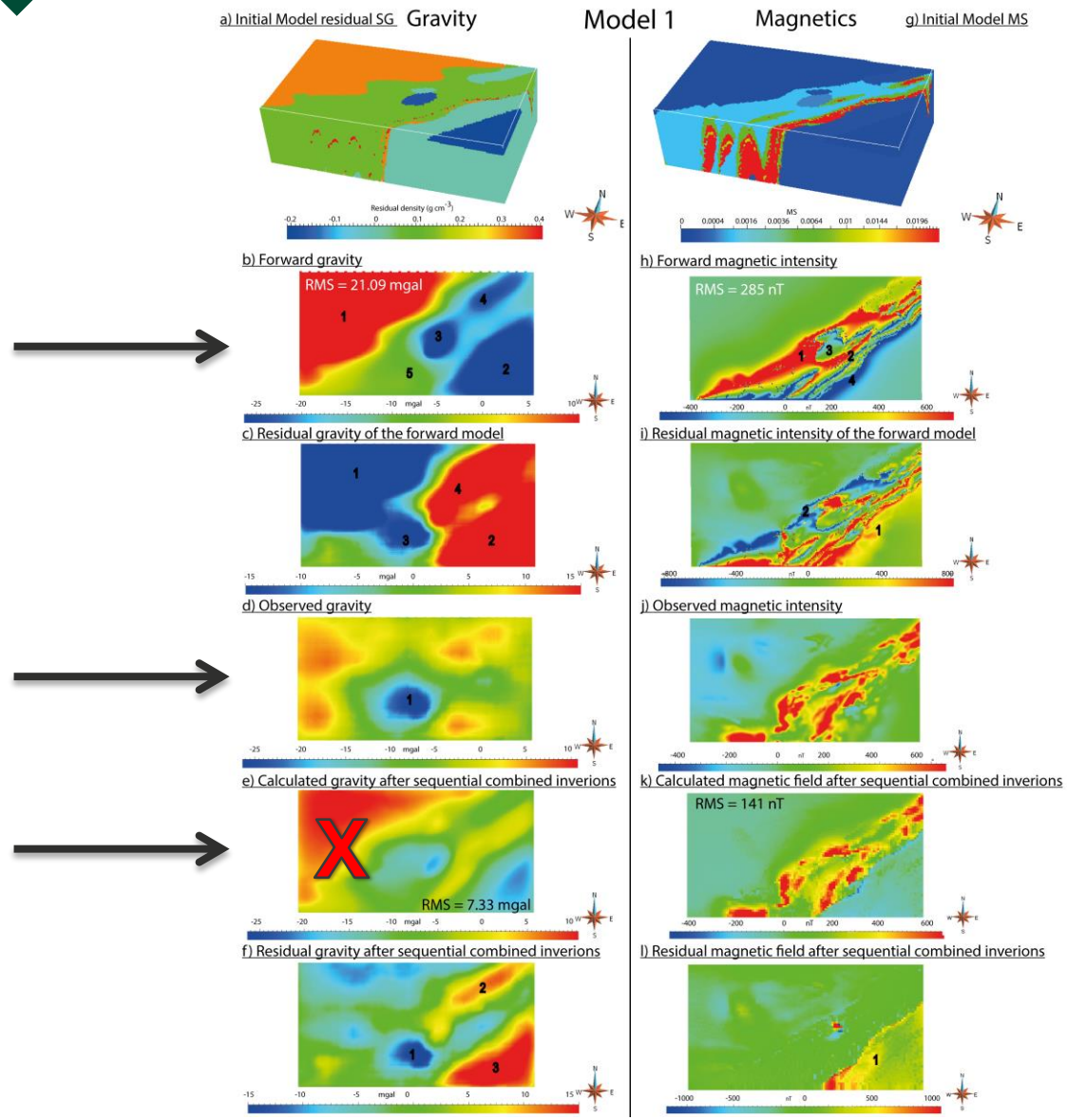


Petrophysics – densities



Armit et al., 2014 GJI

Geophysical modelling – a-priori model



- Assess the initial forward model in respect to the observed signal.
- Assess the sequentially combined inversion models.
- Magnetics fairly good fit (6% and 4% of DR).
- Gravity poorly fitted (56% and 19.5% of DR).

Geophysical modelling – identifying the misfit

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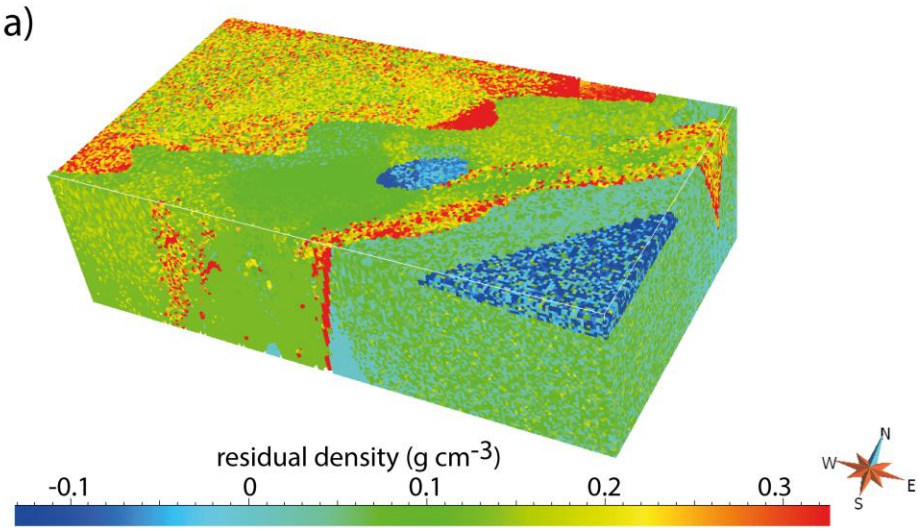
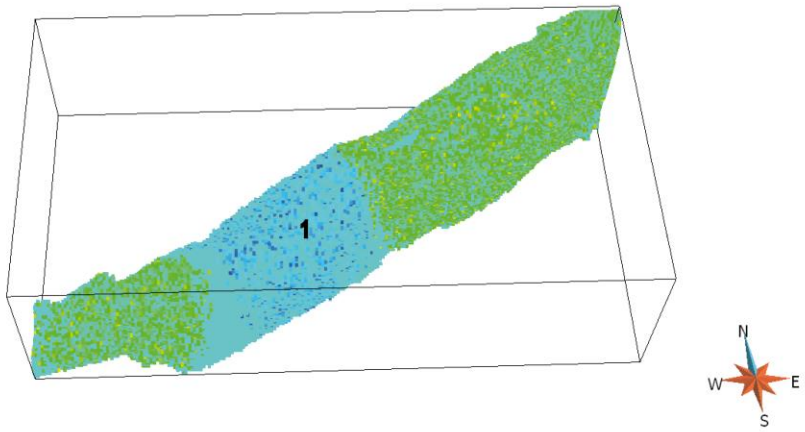
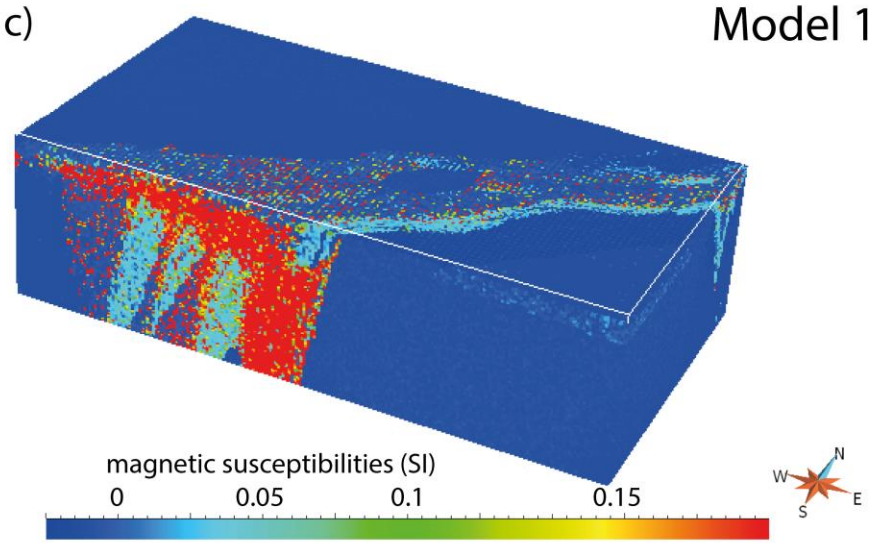
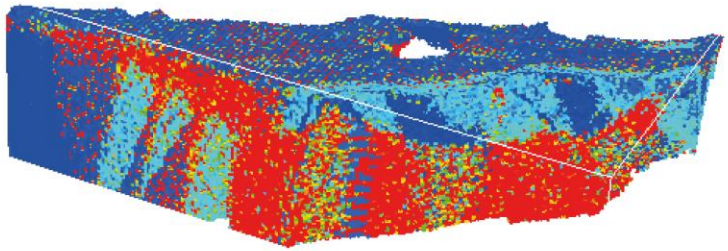
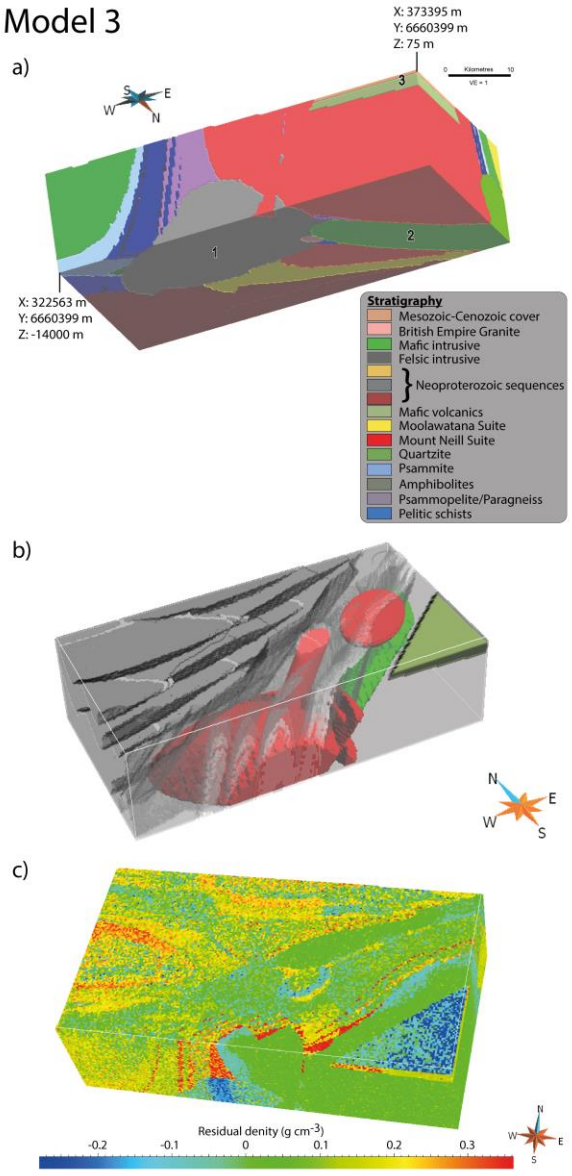


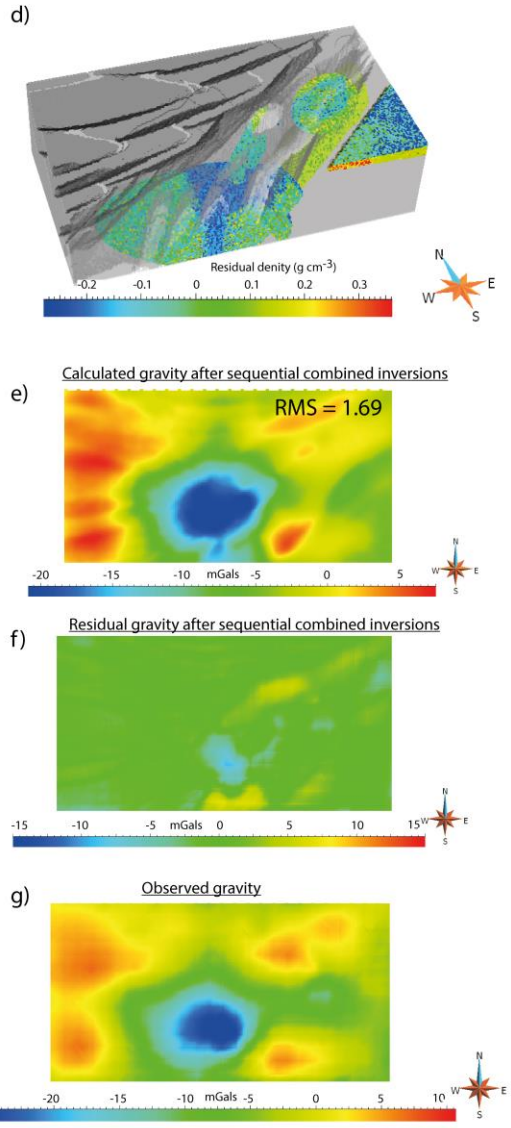






Geophysical modelling – reducing the misfit





- Additional large felsic bodies.
- Additional mafic layers.
- Misfit reduced to 4.5% of DR.

Geophysical modelling – reducing the misfit

- Additional large felsic bodies.
- Additional mafic layers.
- Misfit reduced to 3.02% of magnetic DR.
- Residual likely to reflect too much offset on NW-SE trending faults.

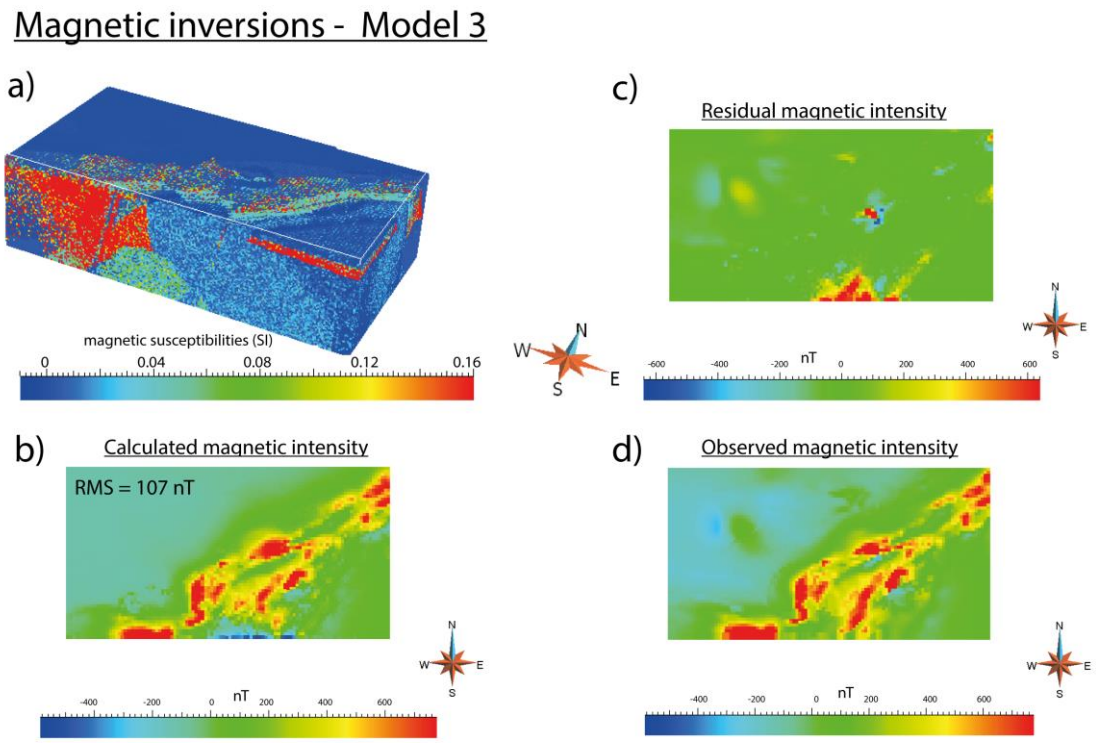
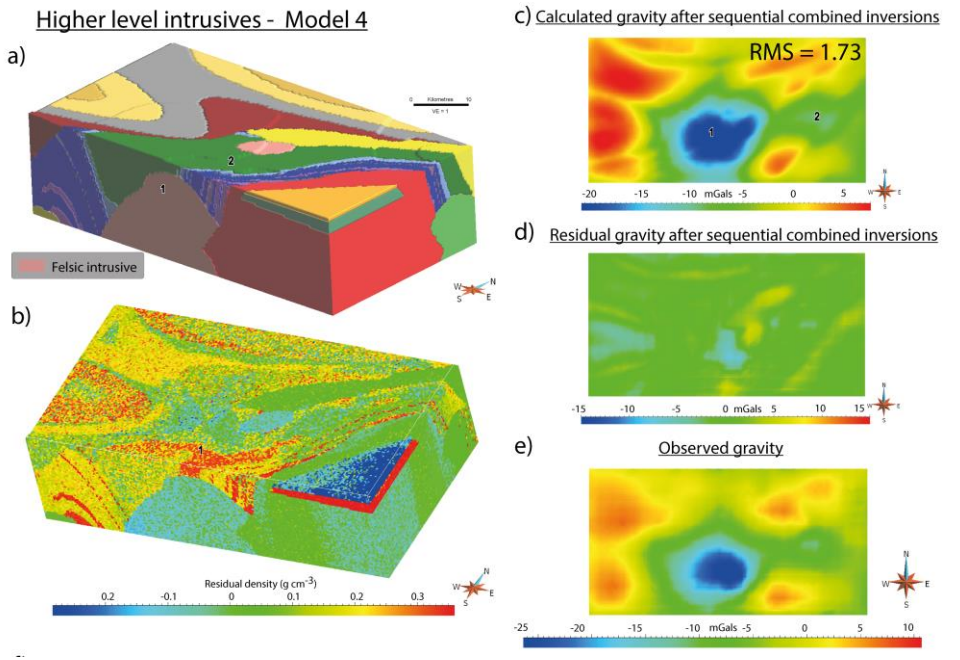
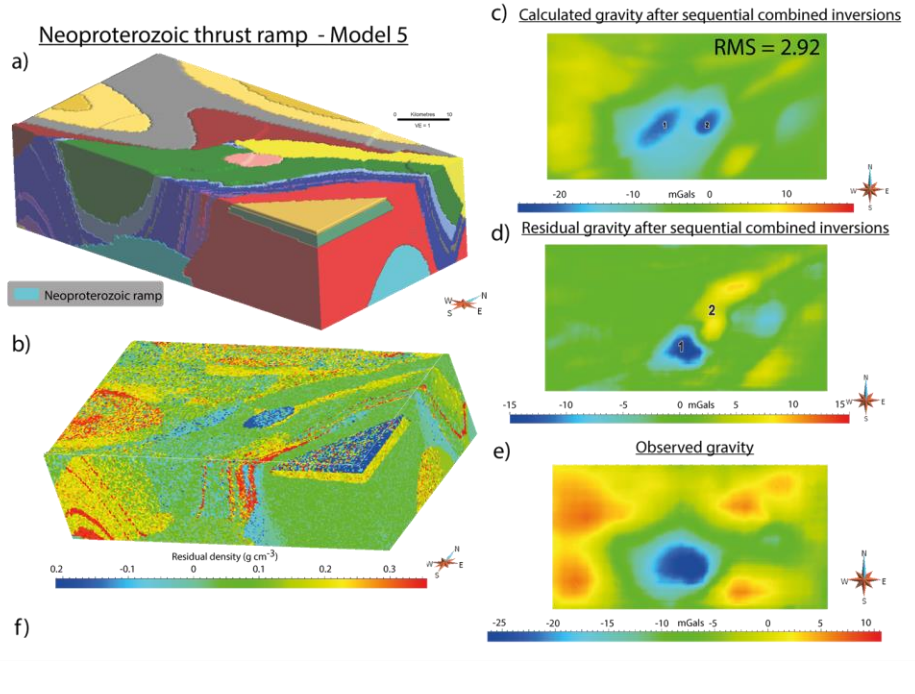


Fig. 12. Magnetic inversions for Model 3; a) 3D magnetic susceptibility distribution resulting from heterogeneous property inversions; b) calculated magnetic intensity with a RMS misfit of 107nT; c) Residual magnetic intensity; d) observed magnetic intensity of the region.

Geophysical modelling – alternative models

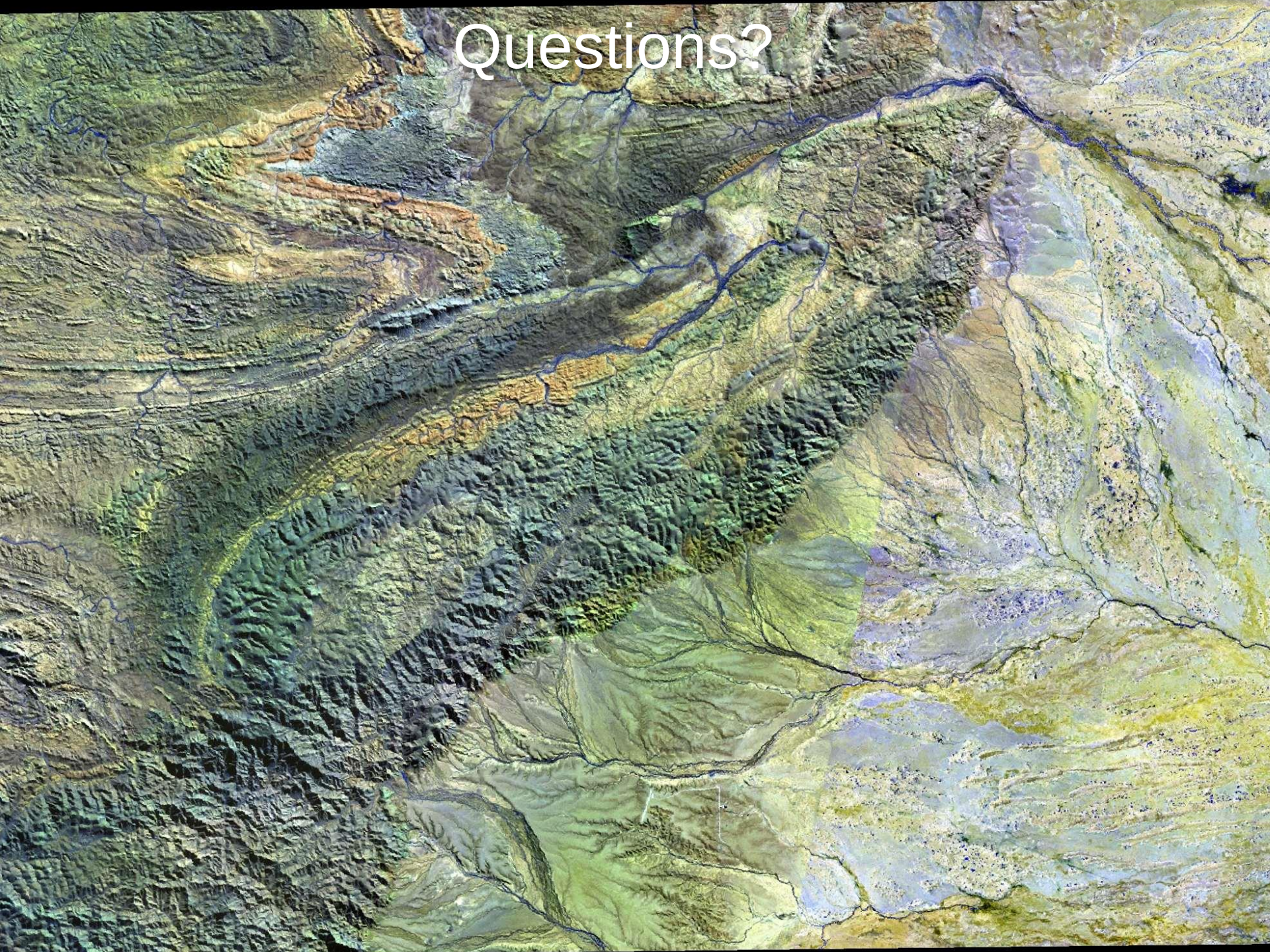
- Alternative scenarios modelled:
  - Different geometries for the intrusive bodies
  - Neoproterozoic thrust ramp model





Conclusion

- Detailed surface mapping in the Mount Painter Province provides excellent structural control in the construction of 3D models of the region.
- Assessing these models using combined geological and potential-field constrained inversion modelling highlights sub-surface mismatches.
- Density constrained inversion modelling indicates that an additional large body of relatively low density material ($10^{12}m^3$) is needed within the model space to account for a distinct negative gravity anomaly.
- Through sensitivity analysis of multiple geometrical and varied potential-field property inversions, the best-fitting model records a reduction in gravity RMS misfit from 21.9 to 1.69 (56 to 4.5%).
- The low density material impinges on the central-west of the Mount Painter Inlier and overlying Neoproterozoic sequences.
- The spatial association and circular geometry of these granitoid bodies suggests an affinity with the Palaeozoic ~460–440 Ma British Empire Granite.
- The intrusion of this additional material in the Palaeozoic could either be the product of; or contributed to, an increased local geotherm and heat flow in the region during the Palaeozoic.
- ?Link between intrusives and hydrothermal mineralisation (e.g. Mt Gee, Yudanamutana).


Questions?