Gravity modelling of crooked line traverses to constrain Southeast Lachlan Crustal Transect 2D seismic reflection interpretations in the Australian Alps

GEOLOGICAL SURVEY OF VICTORIA

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Background

The Southeast Lachlan Crustal Transect (SLaCT) is a 629 km route across the geology of northeast Victoria and southeast New South Wales in southeast Australia (Figure 1). In 2018 two-dimensional deep crustal reflection seismic and detailed ground gravity surveys were acquired along three transects (18GA-SL1,18GA-SL2 and 18GA-SL3) crossing the Australian Alps to investigate the 3D geometry of the fundamental geological building blocks of southeast Australia and address research questions that inform on mineral prospectivity and geological hazard assessments for this region[1].

Modelling of gravity data along seismic transects is a useful way to inform, test and refine seismic interpretations. A workflow of iterative seismic interpretation refinements informed by, and integrated with forward modelling of the new detailed gravity data[2] has been applied. Forward modelling results are constrained by mapped geology, geoscientific interpretations, petrophysical data and complimentary geophysical datasets.

Access limitations due to extreme terrain confined the SLaCT route to tracks navigable by vibroseis trucks, resulting in crooked traverses along sections of the routes. This presented challenges for forward modelling of the detailed new gravity profile data along the traverses.

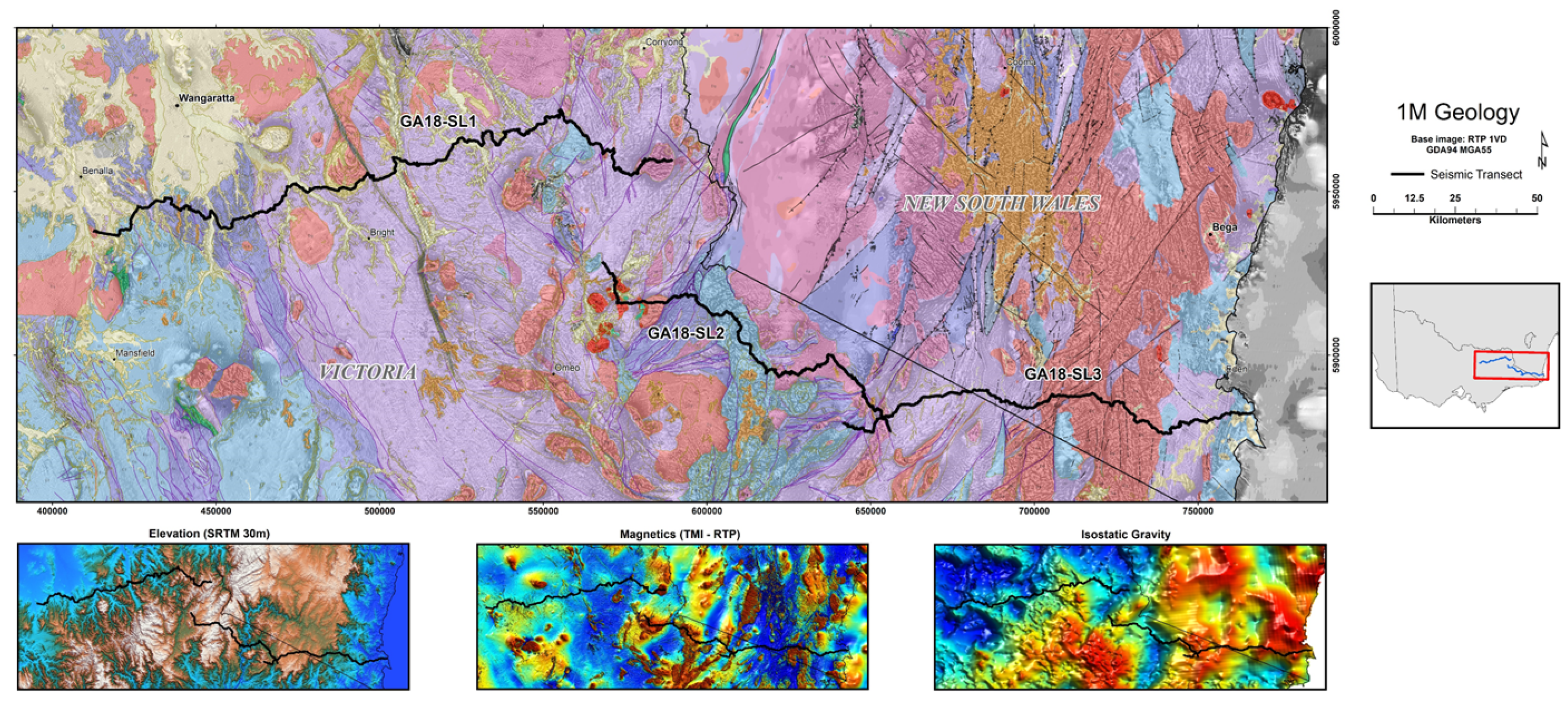
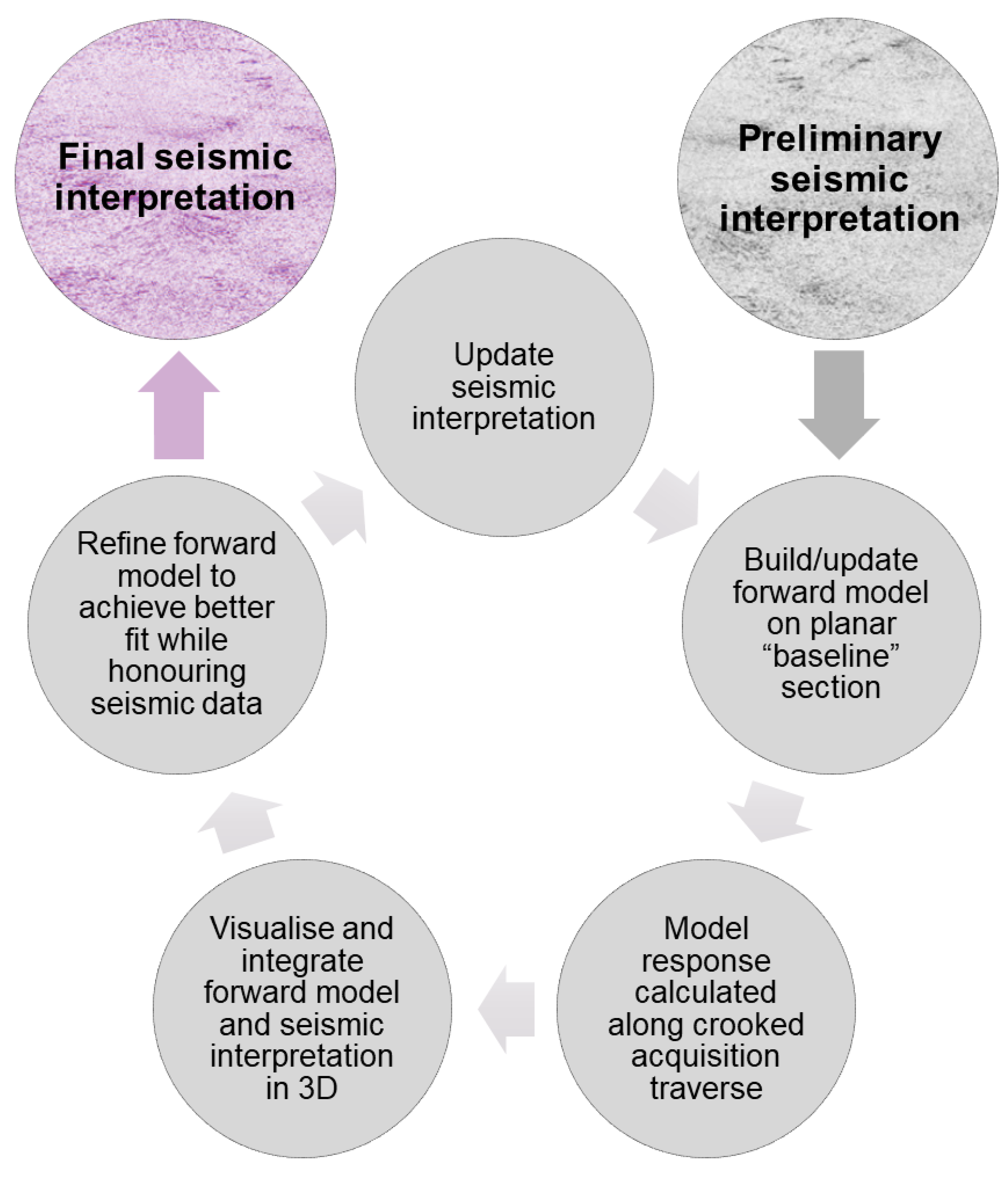


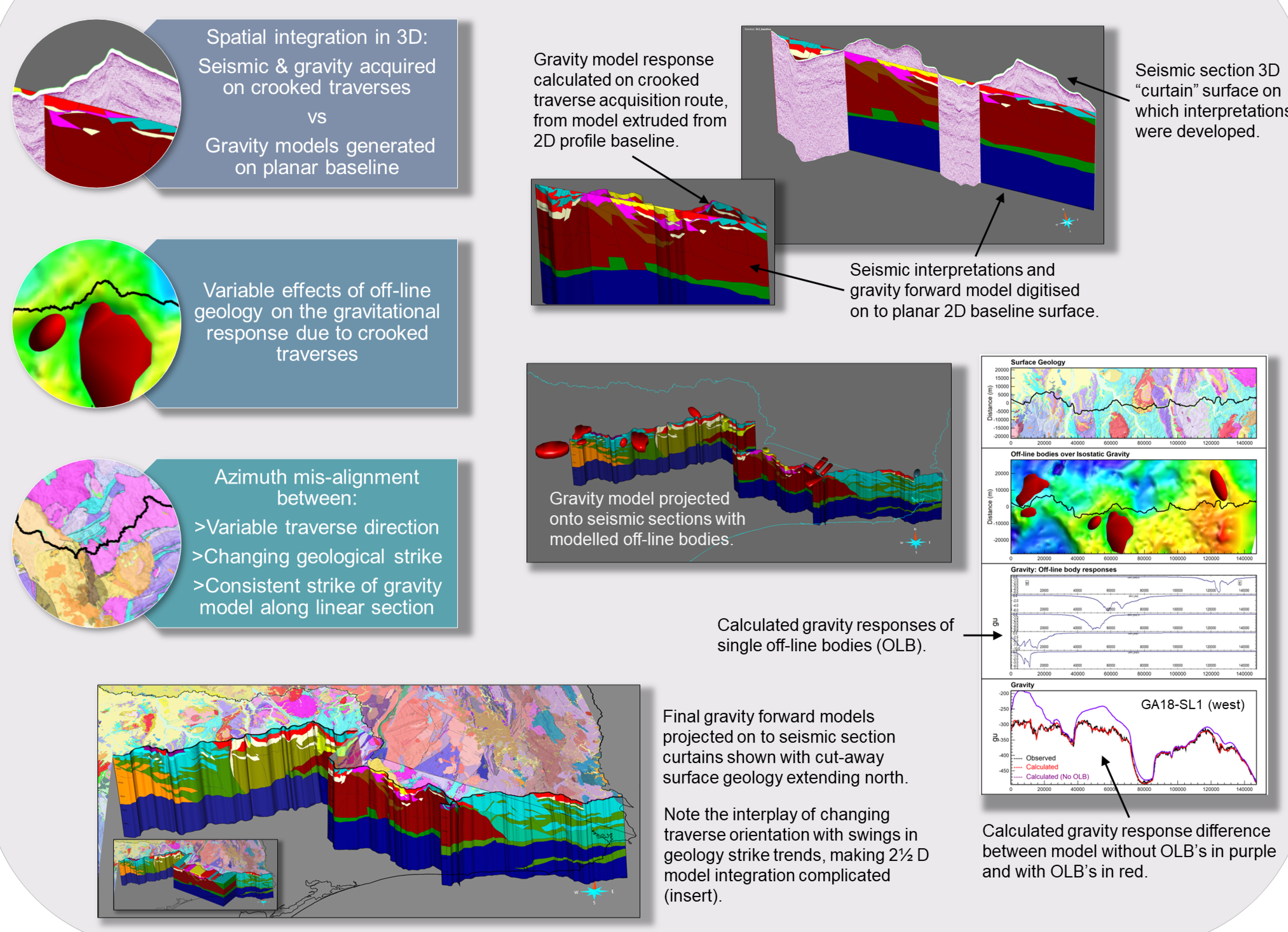
Figure 1. Location of the 2018 SLaCT seismic lines and gravity traverses on 1:1M geology, potential field geophysics and topography. The extremely crooked acquisition routes passing over variable topography provided challenges for the processing, modelling and interpretation of the seismic and gravity data. 1:1M geology source: Geoscience Australia.

Gravity modelling workflow

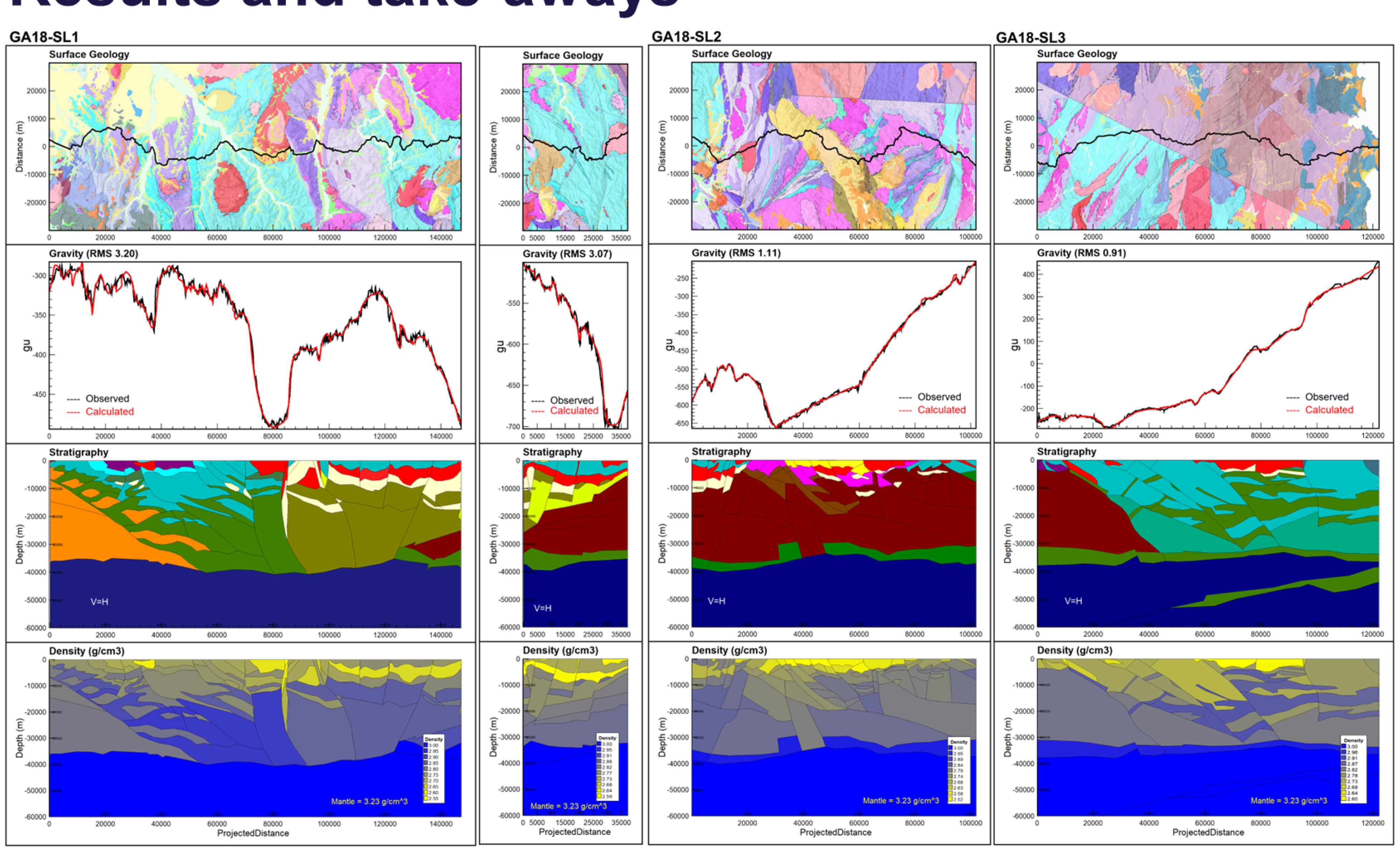


- **3D visualisation (SKUA-GOCAD) was a critical tool in the modelling workflow,** enabling the spatial alignment of 3D seismic section curtains with 2D planar gravity model sections and the projection of 2½ D gravity model bodies onto the seismic and gravity acquisition traverses.
- **Consideration of off-line geology density contrasts (including buried geology) played an important role in modelling crooked 2D traverses** – some complexity in the observed gravity response can be attributed to the influence of varying proximity of anomalous geology (e.g. intrusives) along the crooked traverse.

Challenges of crooked traverse profile modelling



Results and take-aways



Stratigraphic Legend

Buchan Rift Volcanics	Devonian
Merimbula Group	Devonian
Intrusives	Devonian / Silurian
Yalmy Group/Thorkidaan Volcanics *	Silurian
Cobbannah Group	Silurian
Migmatite	Silurian
Migmatite (mix Girilambone Group)	Silurian / Ordovician
Bendoc Group	Ordovician
Pinnak SST/Adaminaby Group	Ordovician
Pinnak SST (mix Cambrian Volcanics)	Ordovician
Macquarie Arc (sediment rich)	Ordovician
Macquarie Arc	Ordovician
Girilambone Group	Ordovician
Volcanics	Cambrian
Selwyn Block (pC)	Pre-Cambrian
Mantle	

* May also incorporate minor Ordovician Bendoc Group sediments.

Figure 2. Final gravity forward model sections and stratigraphy legend. From top to bottom, panels show surface geology and gravity/seismic traverse; gravity profiles; gravity model (stratigraphy); gravity model (density). Line GA18-SL1 has been split due to a significant bend in the traverse. Regional has been removed and Complete Spherical Cap Bouguer Anomaly data modelled using ModelVision v17.0 software.

- Preliminary seismic interpretations (used to generate a priori gravity forward models) were **refined by iterative gravity forward modelling to derive a more robust final seismic interpretation** which reconciles both geophysical datasets, and existing geological mapping (Figure 2).
- Modelling of the new detailed gravity data, in concert with the SLaCT seismic interpretations, has produced **a close match of observed to calculated gravity response, giving confidence to crustal scale regional geological models.**
- Final **interpretation and modelling results provide significant new insights** for the Paleozoic geology, geodynamic evolution and mineral potential of eastern Victoria and New South Wales, with implications for eastern Australia[1].

References

[1] CAYLEY, R.A., et al., in prep. Geological interpretation of deep 2D seismic reflection survey lines 18GA-SL1, 18GA-SL2 and 18GA-SL3 undertaken as part of the Southeast Lachlan Crustal Transect. Geological Survey of Victoria Technical Record. Geoscience Australia Record. Geological Survey of New South Wales Record.

[2] HAYDON, S.J., et al., 2023 (in prep.). Southeast Lachlan Ground Gravity Survey 2019. Geological Survey of Victoria Technical Record. Geological Survey of Victoria. Department of Energy, Environment and Climate Action. Melbourne, Victoria.

Acknowledgements

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