

Tectonic evolution of the Leichhardt River Fault Trough

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- This presentation is based on a paper submitted to Precambrian Research in May 2016.
- Other relevant papers related to the Leichhardt River Fault Trough include:

Spampinato, G. P. T., Betts, P. G., Ailleres, L. & Armit, R. J. 2015. **Structural architecture of the southern Mount Isa terrane in Queensland inferred from magnetic and gravity data.** Precambrian Research. 269, 261 - 280.

Bierlein, F. P. C. & Betts, P. G. 2004. **The Proterozoic Mount Isa Fault Zone, northeastern Australia: is it really a ca. 1.9 Ga terrane-bounding suture?** Earth and Planetary Science Letters. 225, 279 - 294.

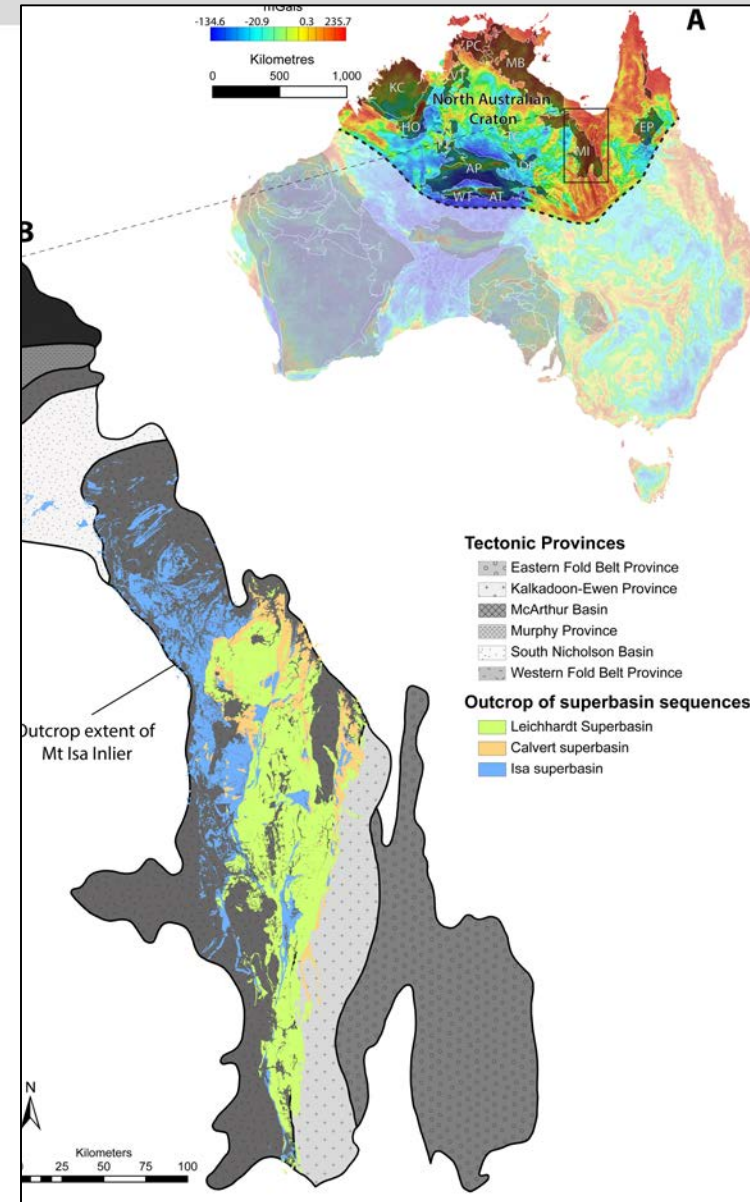
Betts, P. G. & Lister, G. S. 2002. **Geodynamically indicated targeting strategy for shale-hosted massive sulfide Pb-Zn-Ag mineralisation in the Western Fold Belt, Mt Isa terrane.** Australian Journal of Earth Sciences. 49, 985 - 1010.

O'Dea, M.G., Lister, G.S., Betts, P.G., Pound, K. S., 1997. **A shortened intraplate rift system in the Proterozoic Mount Isa terrain, NW Queensland, Australia.** Tectonics 16, 425-441.

Mount Isa Inlier

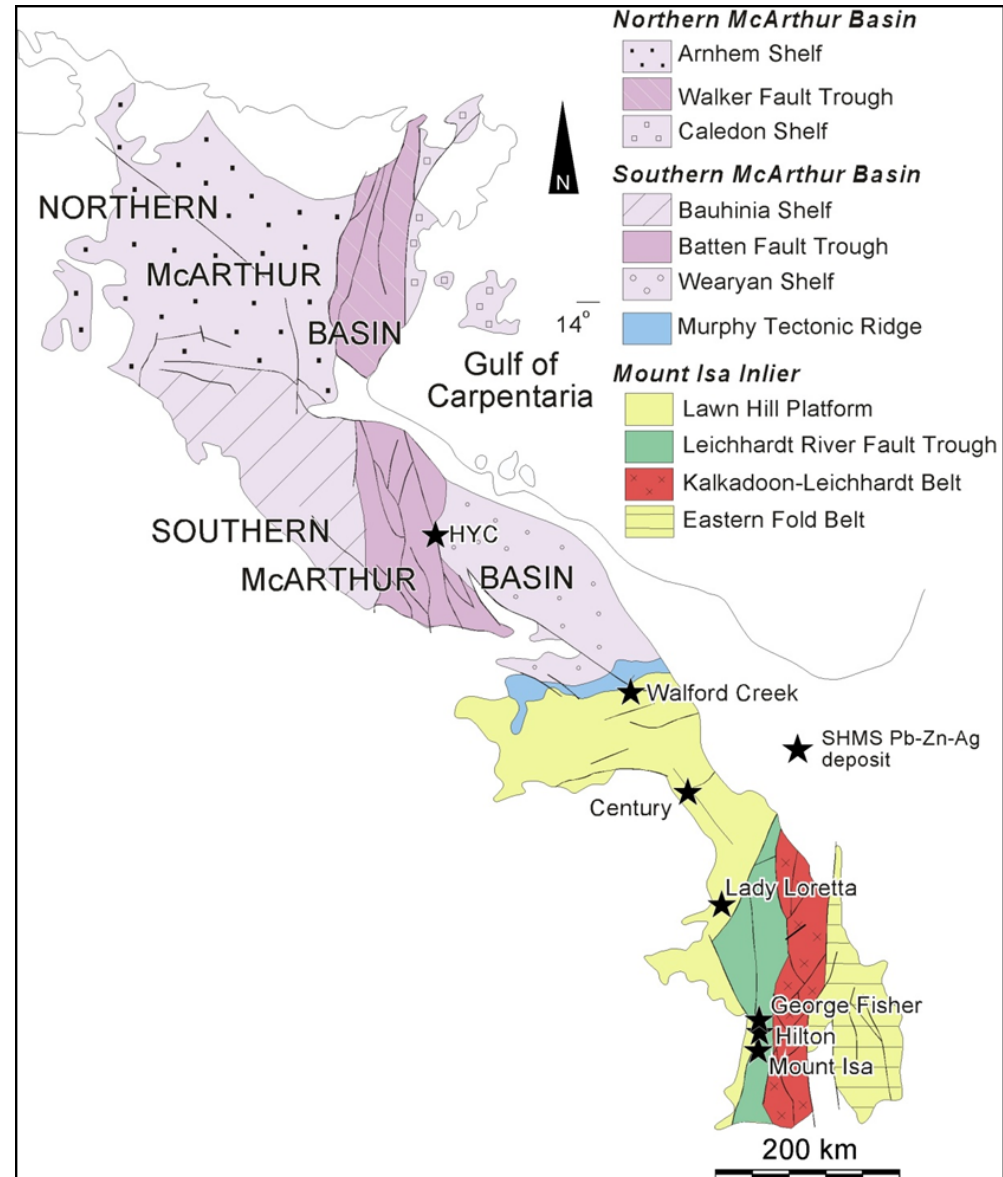
- Mount Isa Inlier – 1870-1500 Ma geological evolution of the eastern North Australian Craton.
- Western Fold Belt – 3 superimposed and unconformity bound superbasins
- Leichhardt Superbasin (ca 1800 Ma – 1740 Ma).
- Calvert Superbasin (1725-1680 Ma).
- Isa Superbasin (1670-1575 Ma).

(GA NABRE project, Nuemann, Gibson, and GSQ)



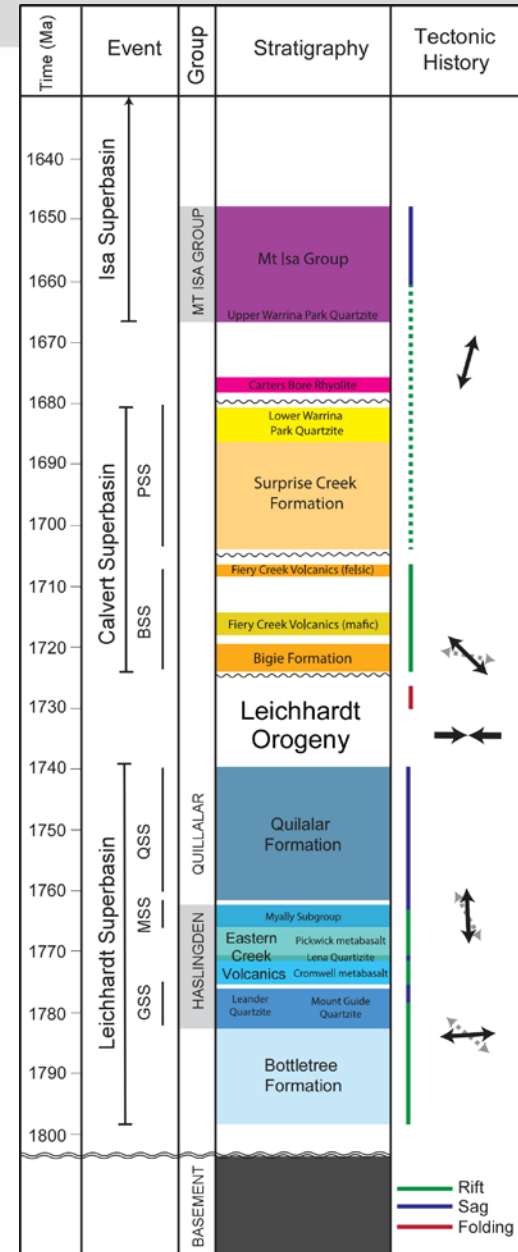
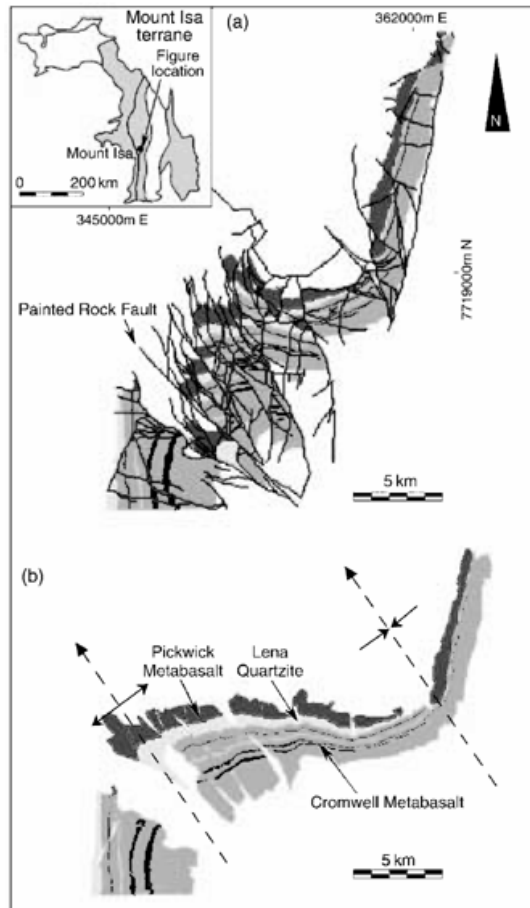
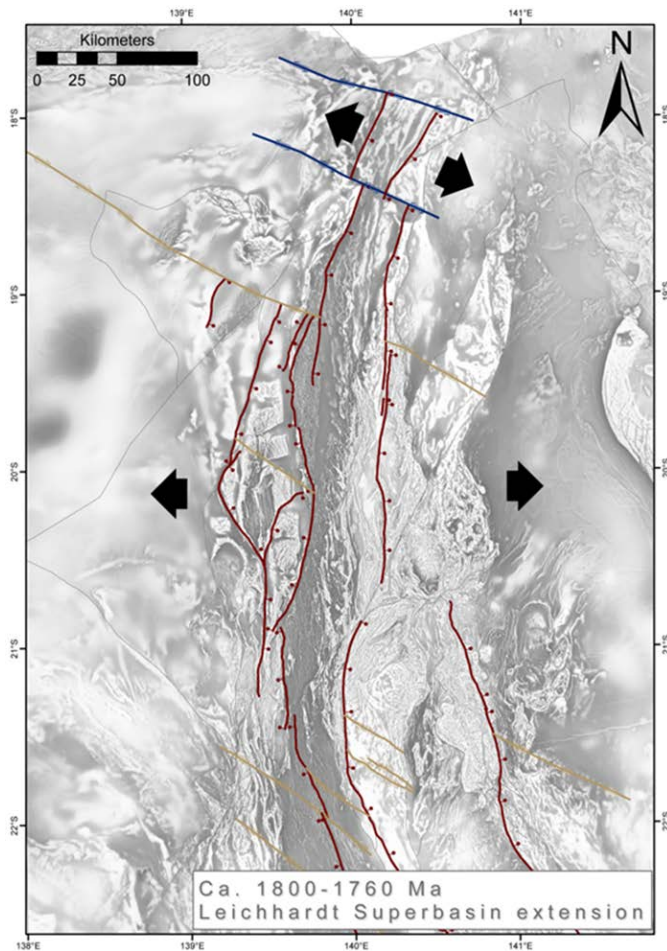
Mount Isa Inlier

- Hosts some of the largest base metal deposits on the planet.
- Basins have had a complex evolution.
- Multiple extension direction.
- Different fault architectures.
- Fault controlled basin formation.



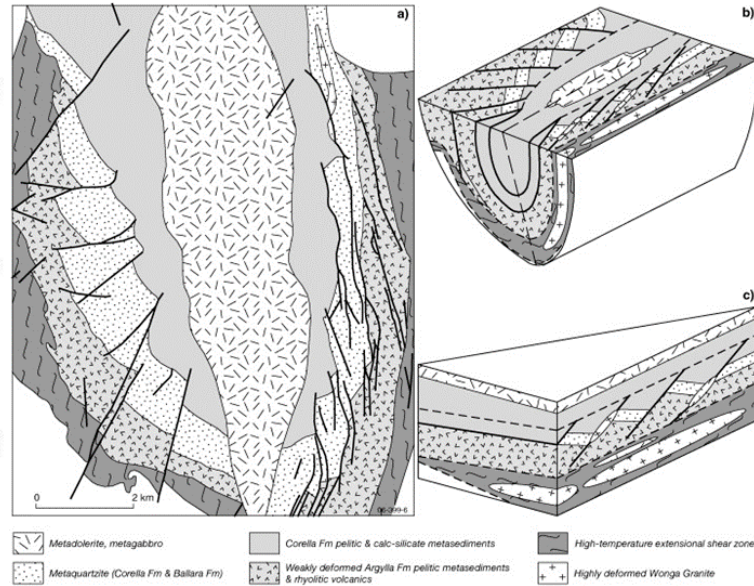
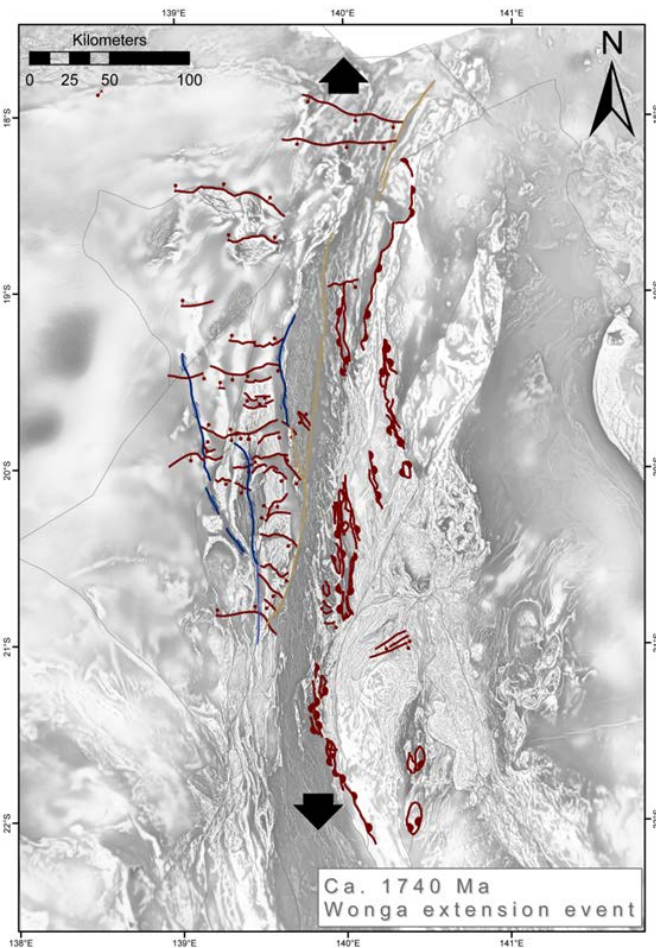


- Leichhardt and Calvert superbasins exhibit considerable fault control of basin depocentres and sub-basins
- Large shifts in the extension direction - fault orientations

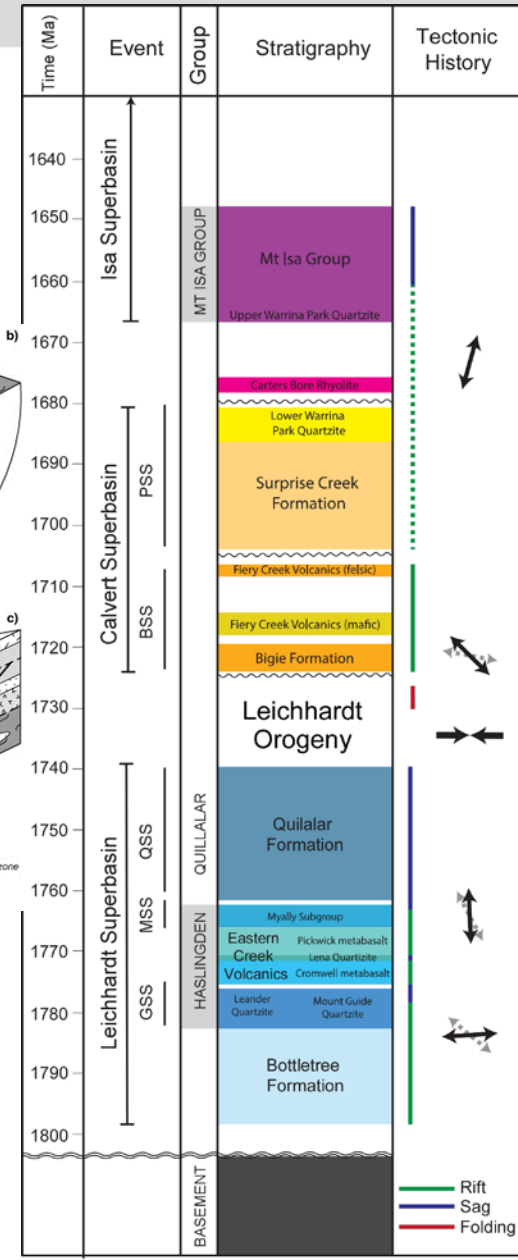


Wonga Extension

- Wonga Extension event ca 1760-1740 Ma
- N-S extension (different crustal levels)

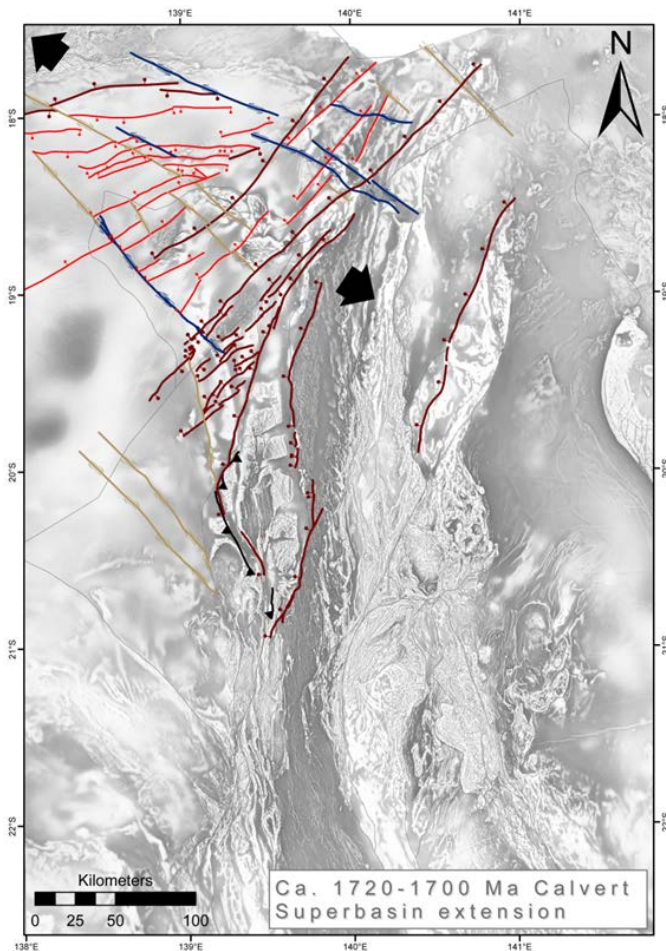


After GSQ 2012, Holcombe et al., 1991 and Gibson et al. 2008

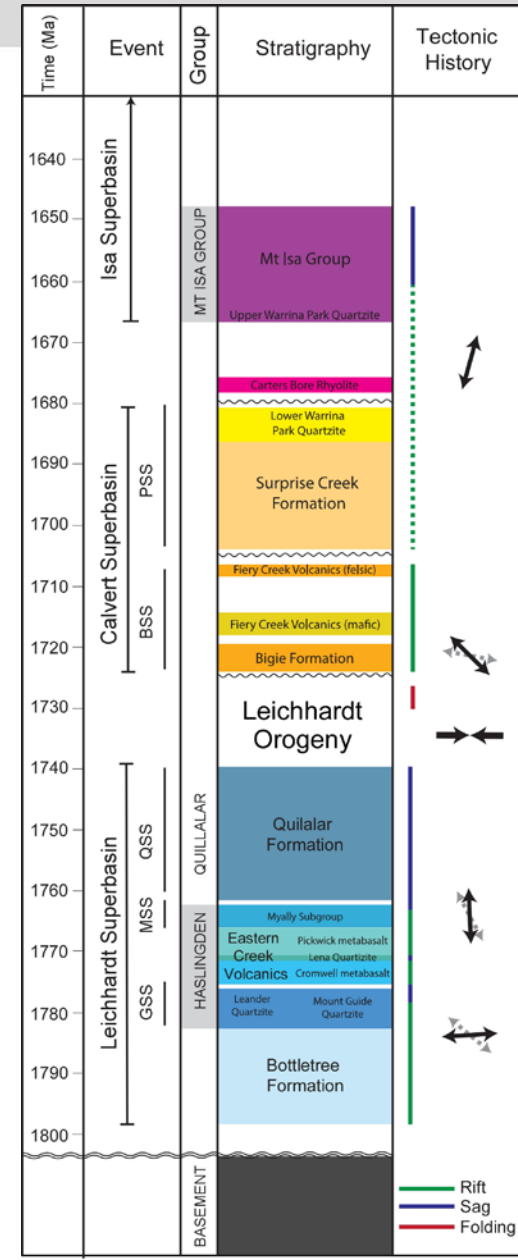


Calvert Superbasin

- Calvert superbasin NW-SE extension in the Lawn Hill Platform – controlled lower CSB stratigraphy
- Bound SE-thickening half graben

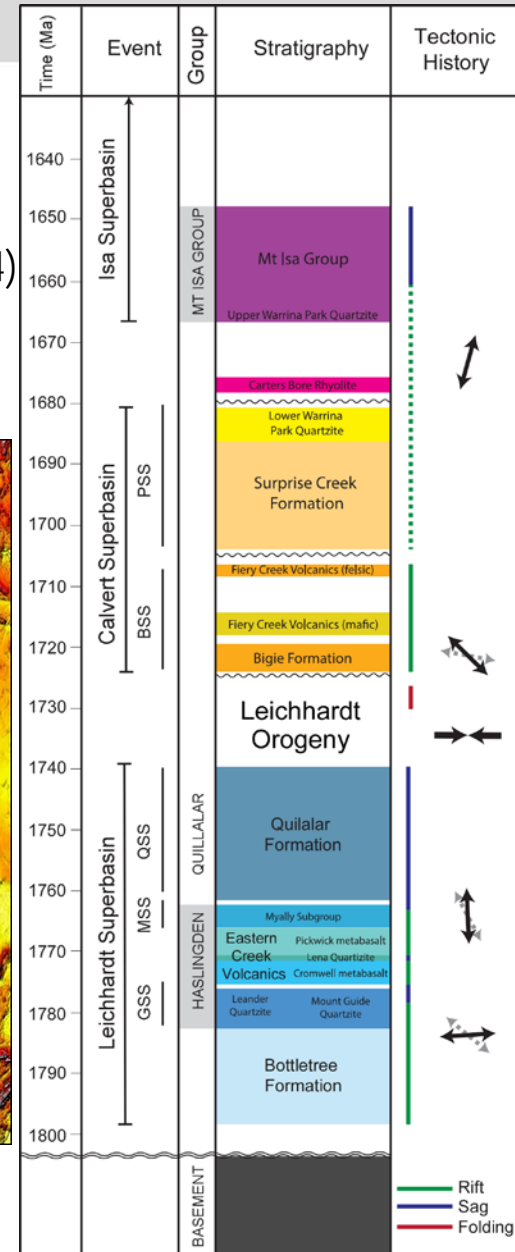
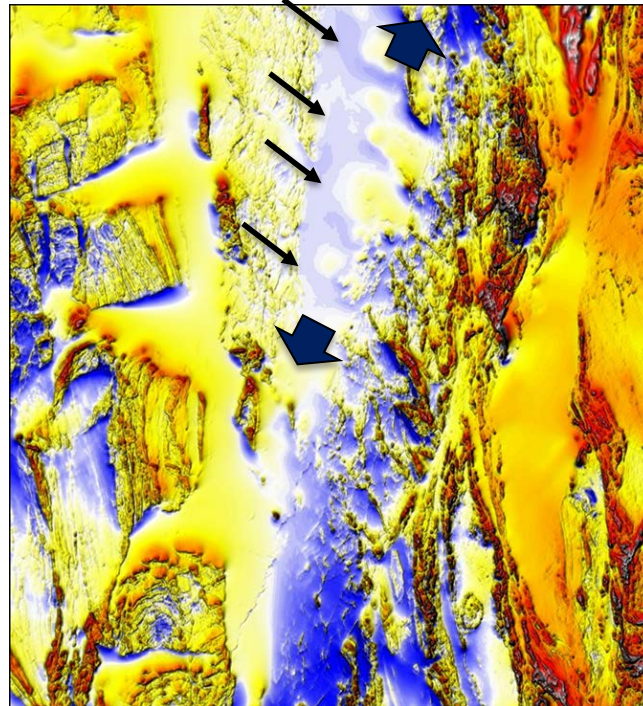
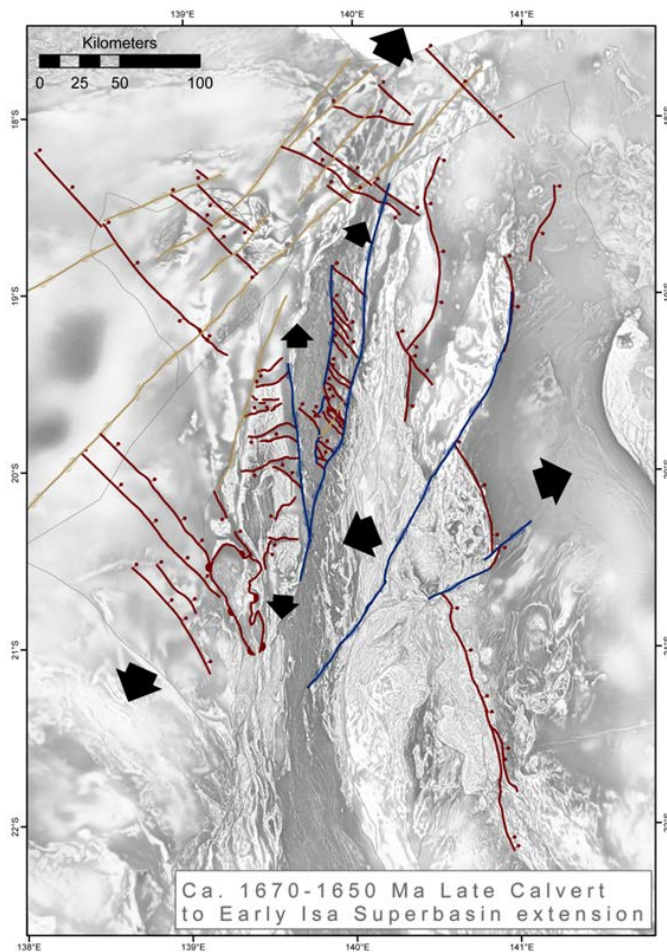


Look for colour figure in papers
Folder of original paper

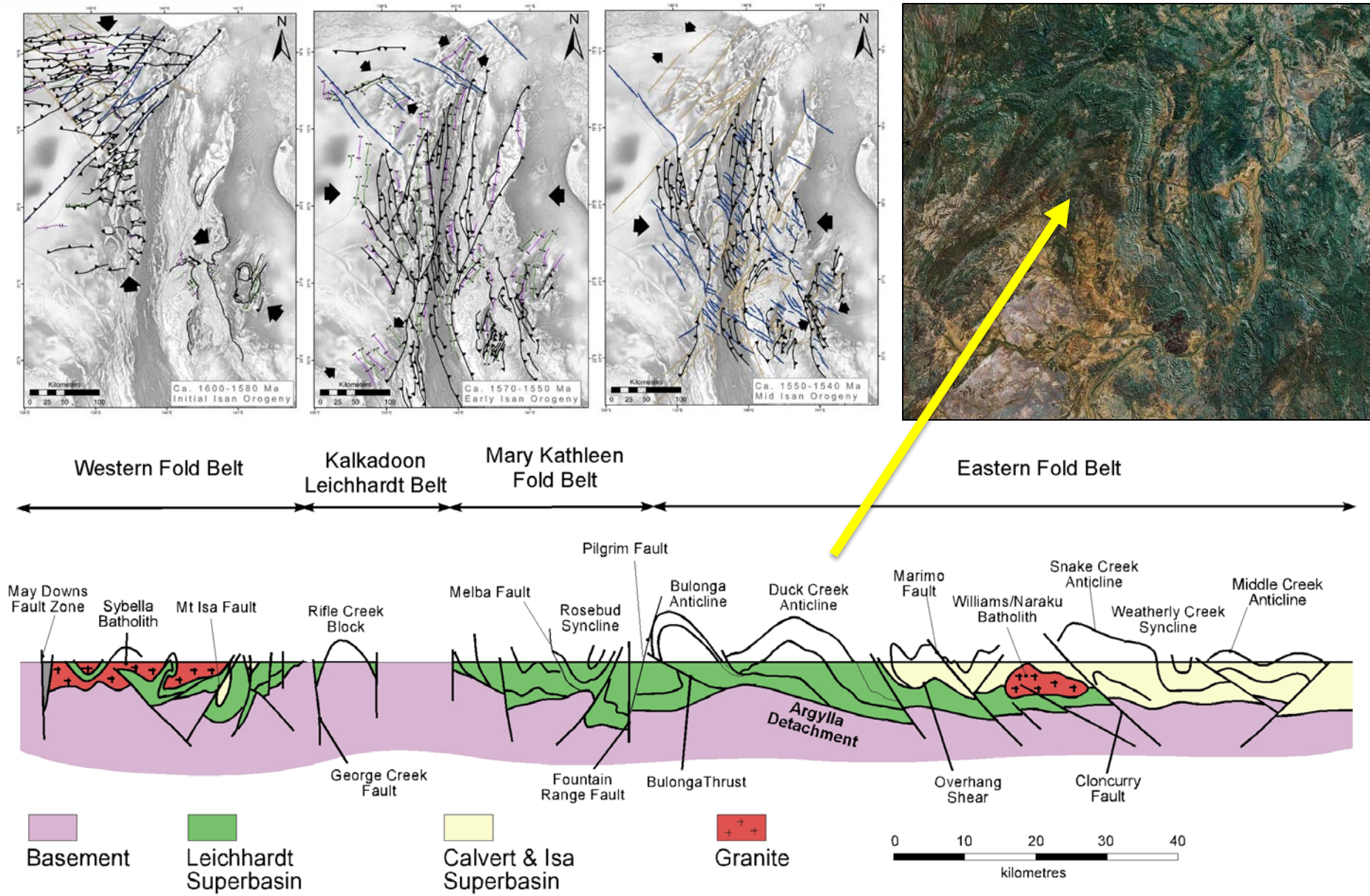


Calvert-Isa superbasin

- Calvert to Isa superbains NNE-SSW extension – normal fault on the Myally sub-shelf
- Metmc core complex Sybella Granite (Gibson et al., 2008; Gordon, 2004)

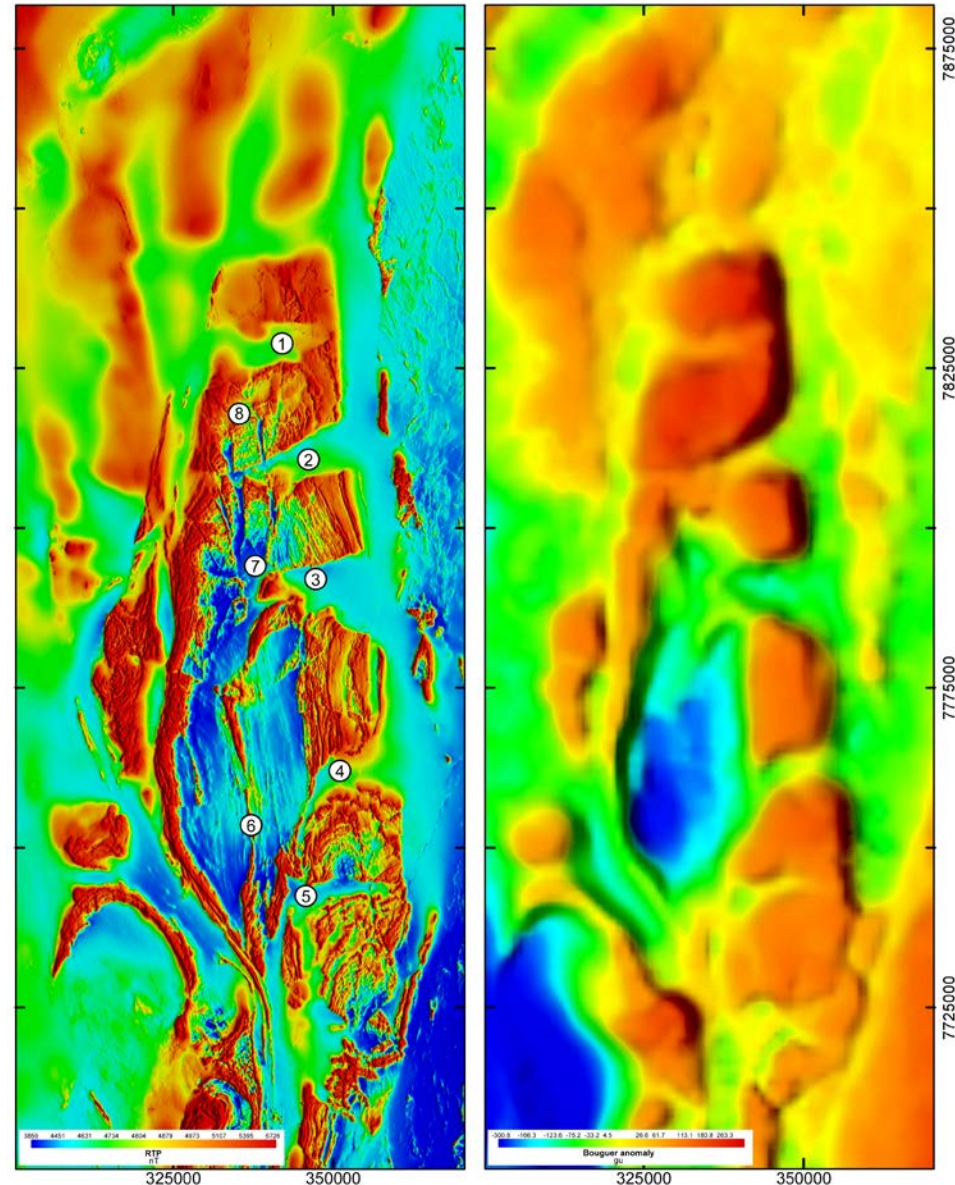
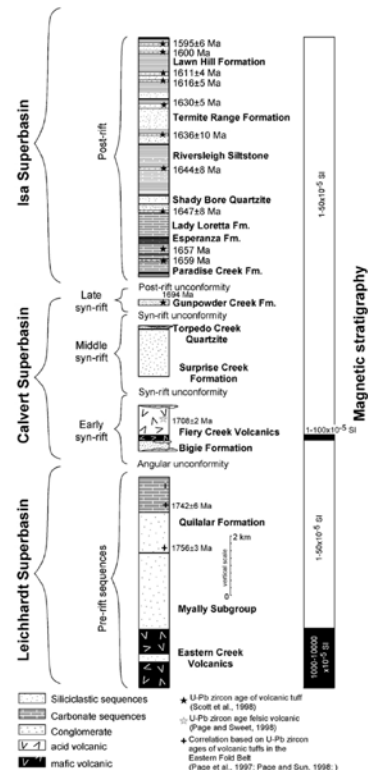


Ca 1600-1500 Ma Isan Orogeny - inversion

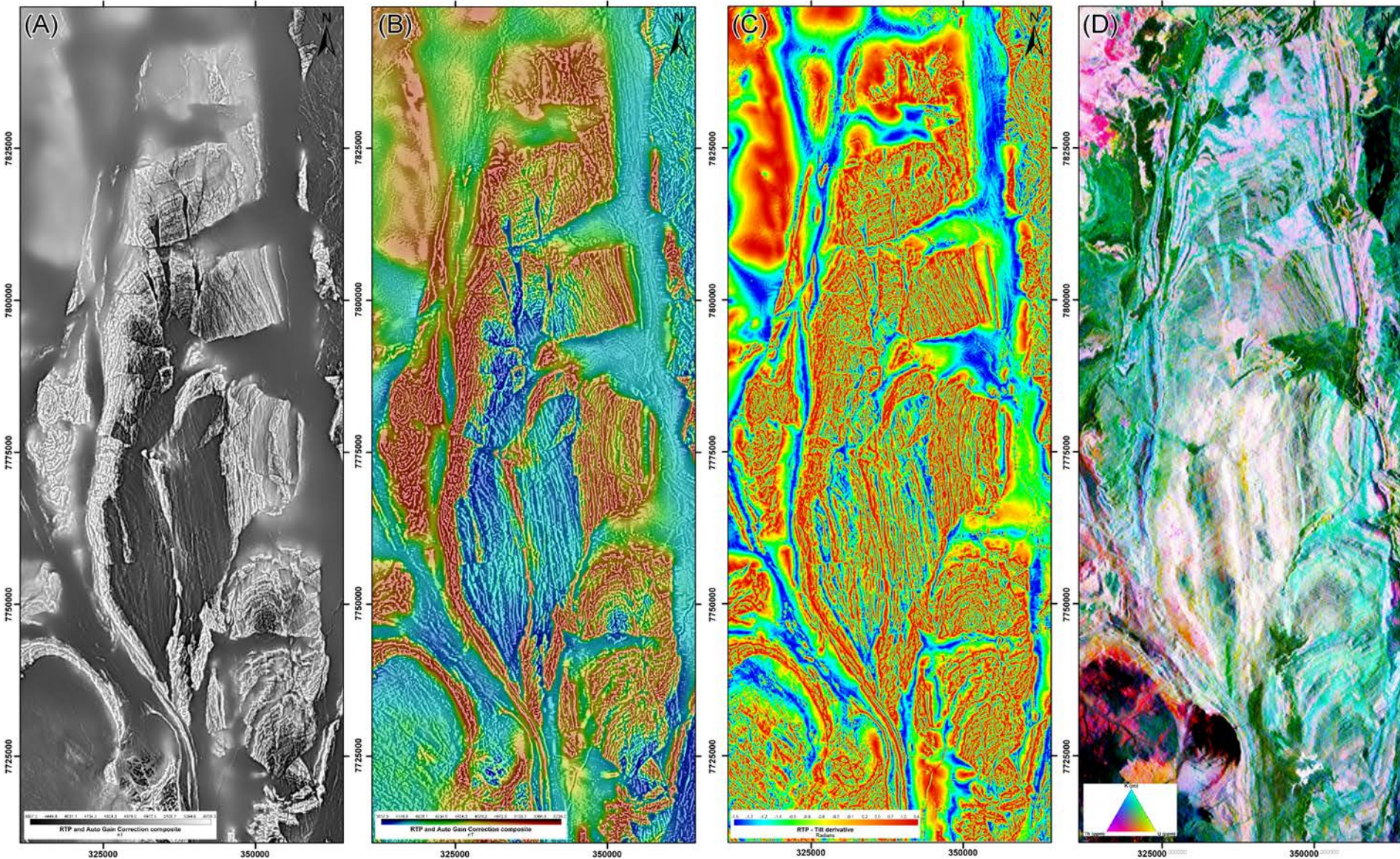


Central Leichhardt River Fault Trough

- Ancient Rift axis
- 5+ km of continental tholeiitic flood basalts.
- Complex fault architecture.
- Stacked sub-basins at high angle to the N-S rift axis.
- Spectacularly imaged in the magnetic and gravity data.

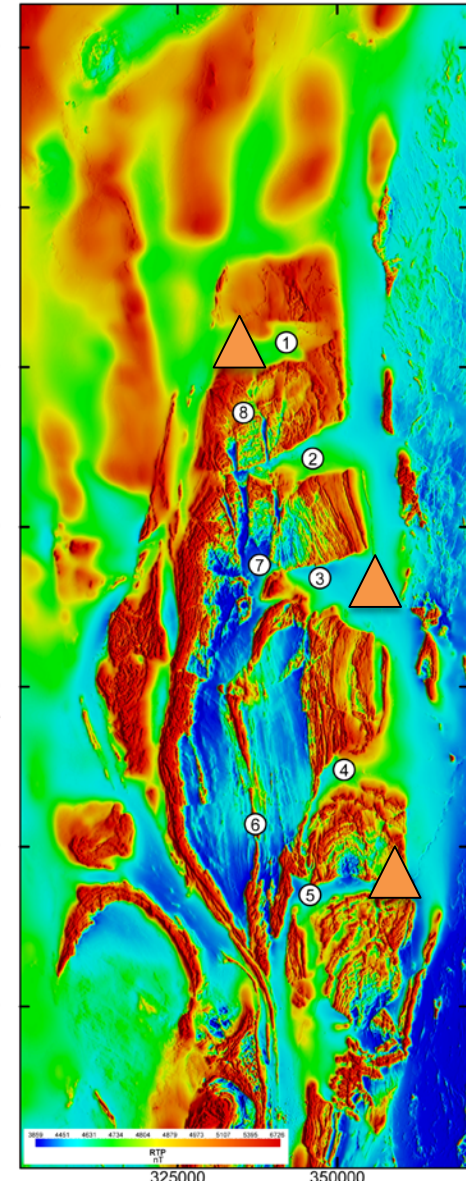
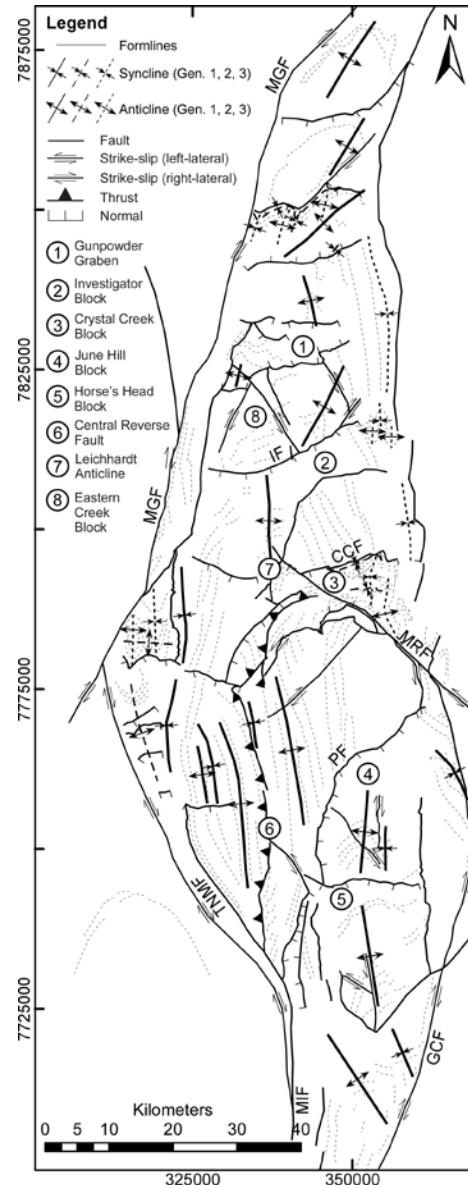


Central Leichhardt River Fault Trough



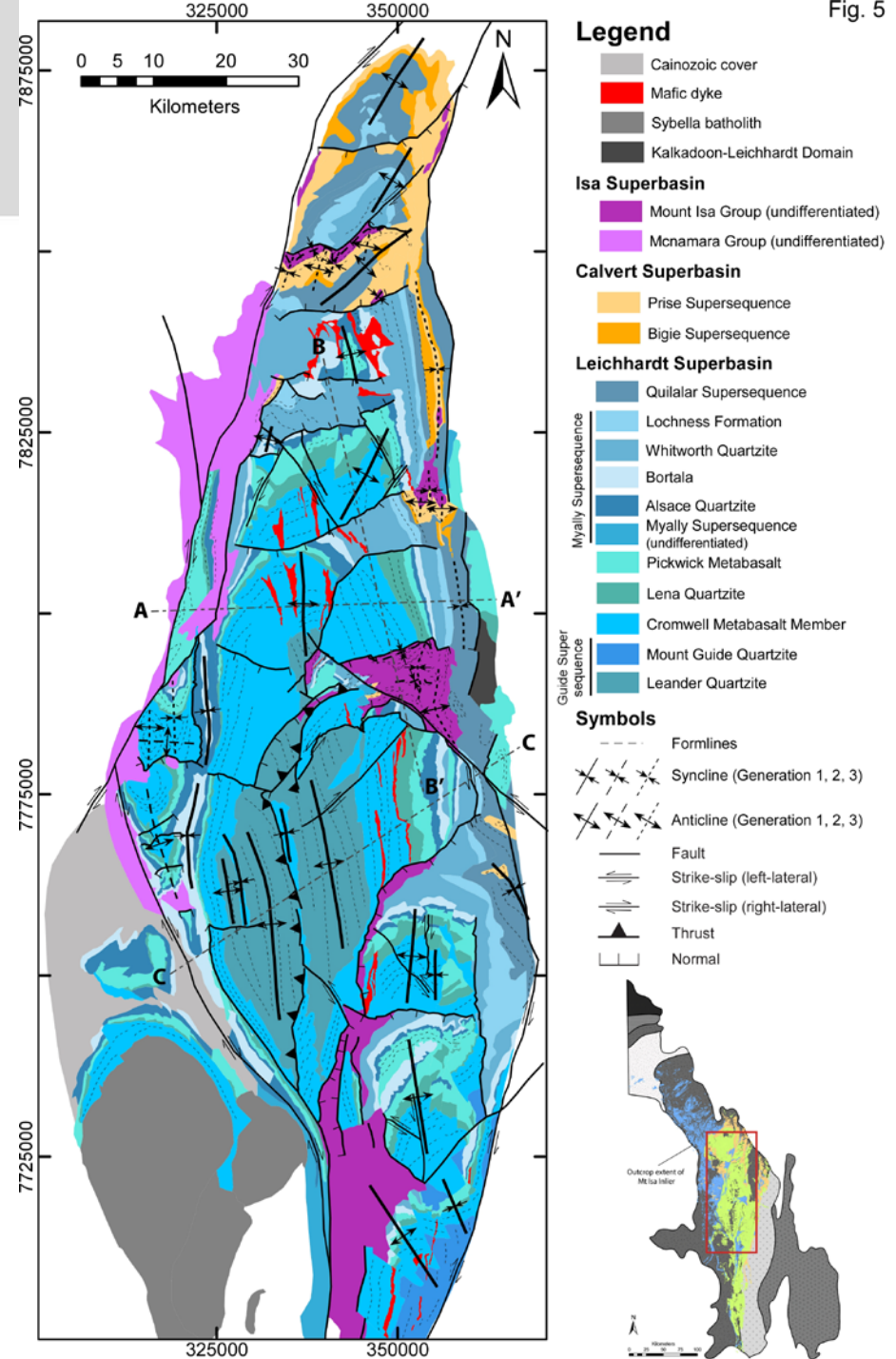
Interpretation strategy

- Excellent exposure and rock property data
- Geophysics was informing overprinting relationships and a regional scale.
- Map out major packages and fault systems and interpret them in light of the 3D architecture
- Leichhardt Anticline (previously interpreted as Isan structure)
- Overprinted by sub-basins infilled with Calvert and Isa superbasin stratigraphy.
- Evidence for inversion of the LRFT before deposition of the Calvert Superbasin

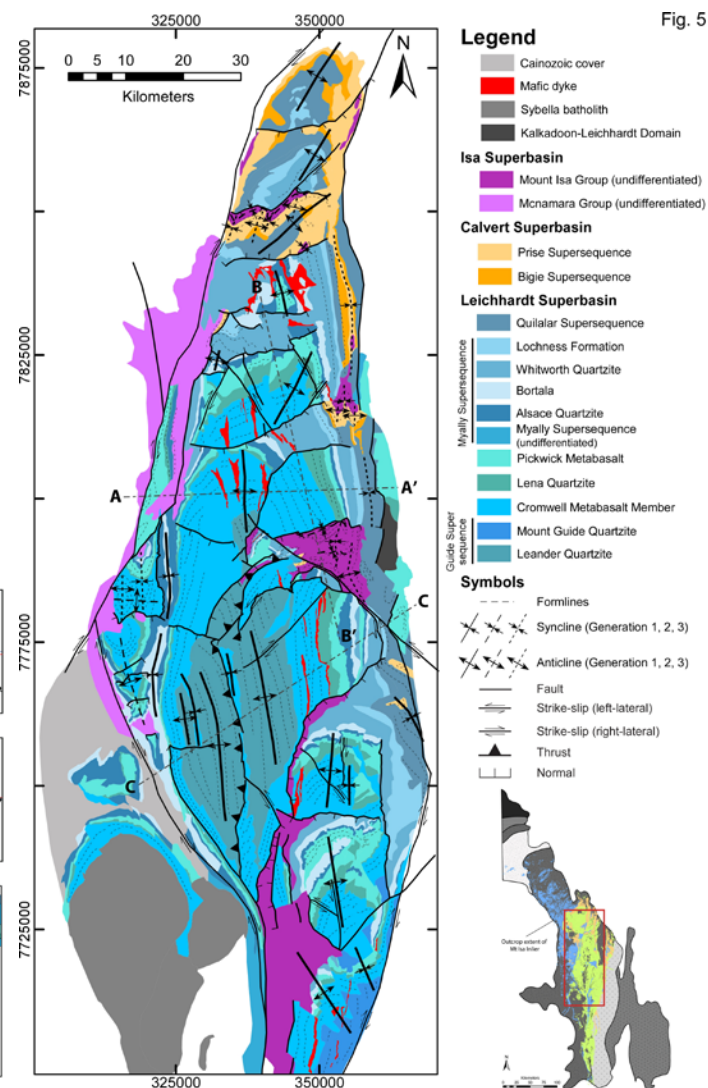
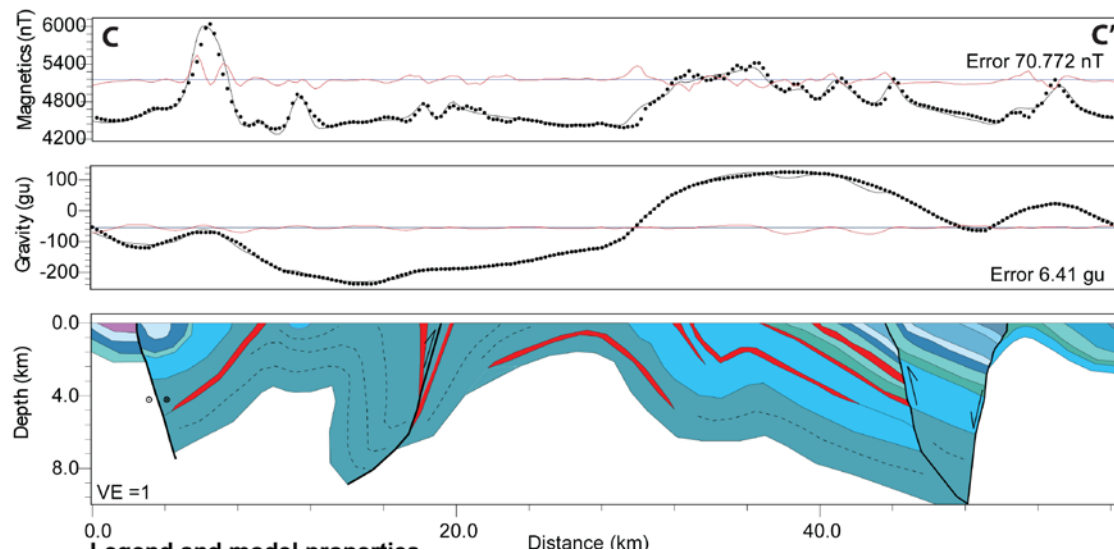
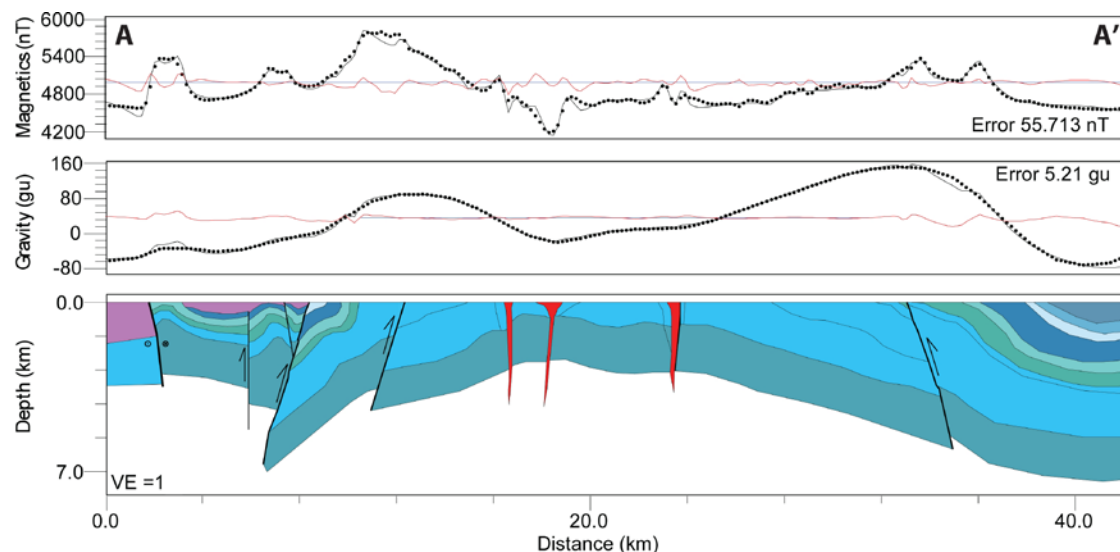


Mount Isa Inlier

- E-W profiles illustrate the intensity of the folding in the LRFT.
- Leichhardt Anticline is a relatively long-wavelength fold.
- Duplicated in the central LRFT – reverse faulting.
- Axial trace offset in the south.
- Folds have shorter wavelengths and are tighter in the clastic sedimentary rocks of the Calvert and Isa superbasins on the limbs of the Leichhardt Superbasin.

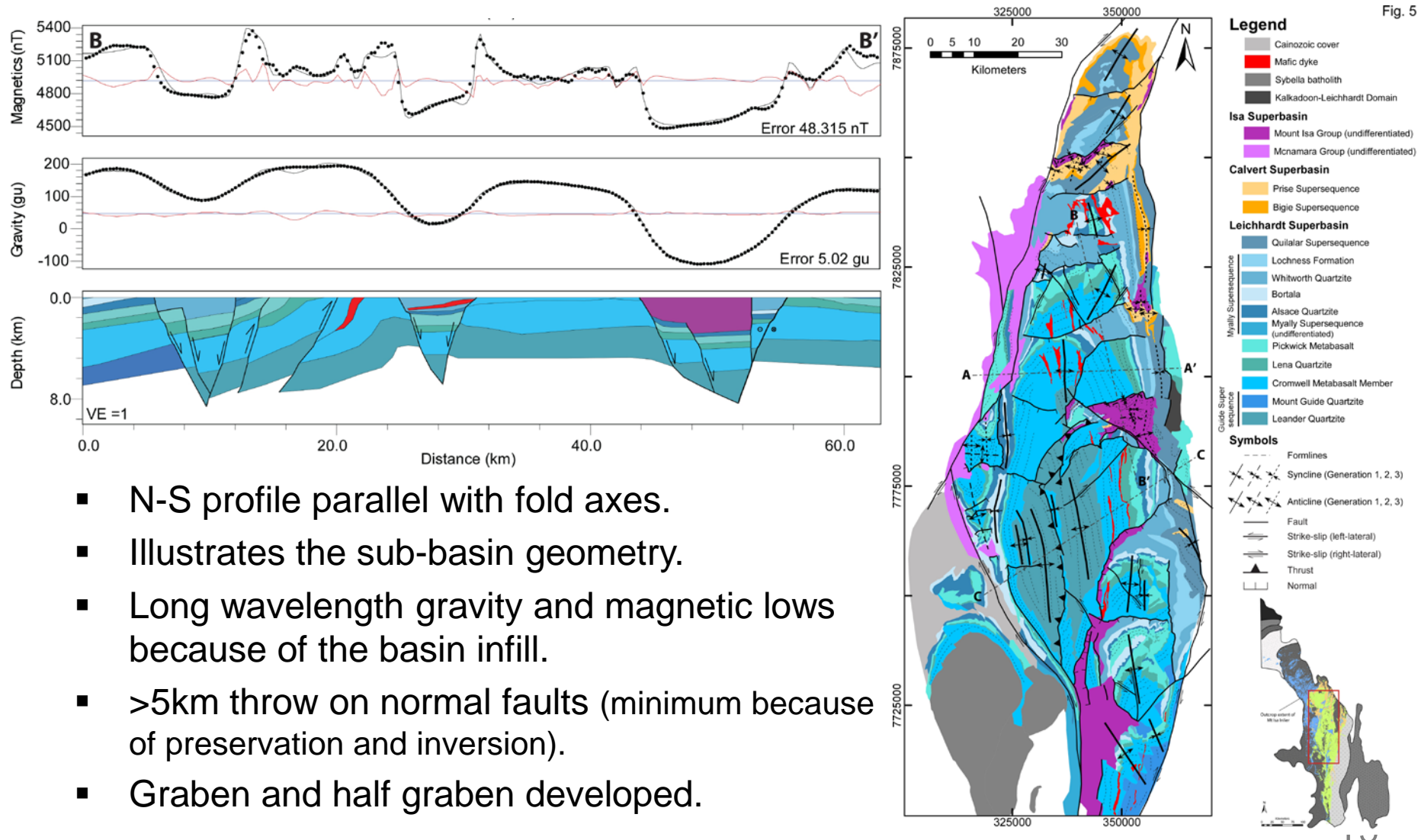


E-W profiles



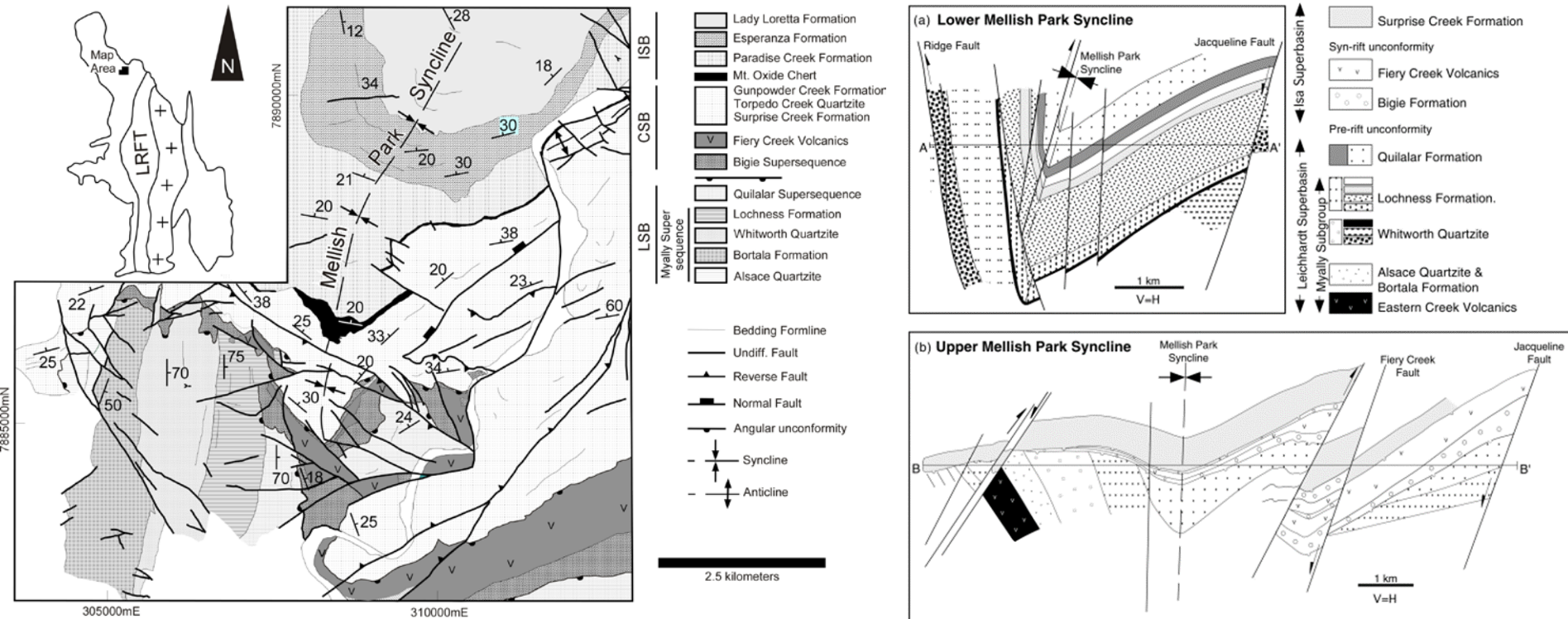
N-S profile

Fig. 5



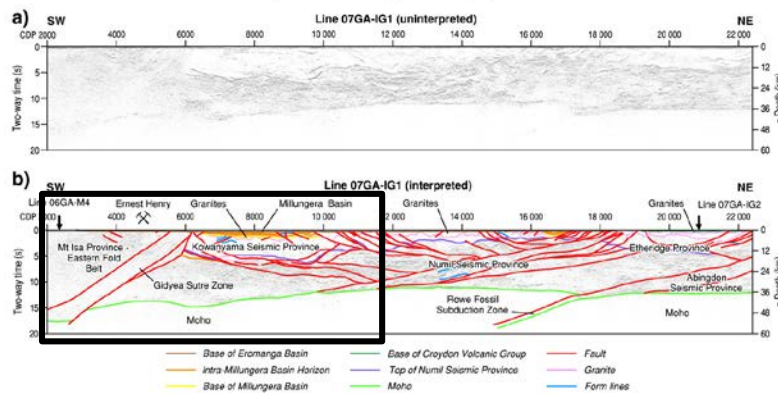
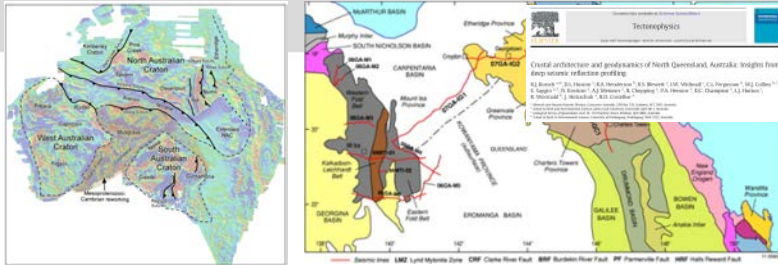
- N-S profile parallel with fold axes.
- Illustrates the sub-basin geometry.
- Long wavelength gravity and magnetic lows because of the basin infill.
- >5km throw on normal faults (minimum because of preservation and inversion).
- Graben and half graben developed.

Extent of LO – Lawn Hill Platform

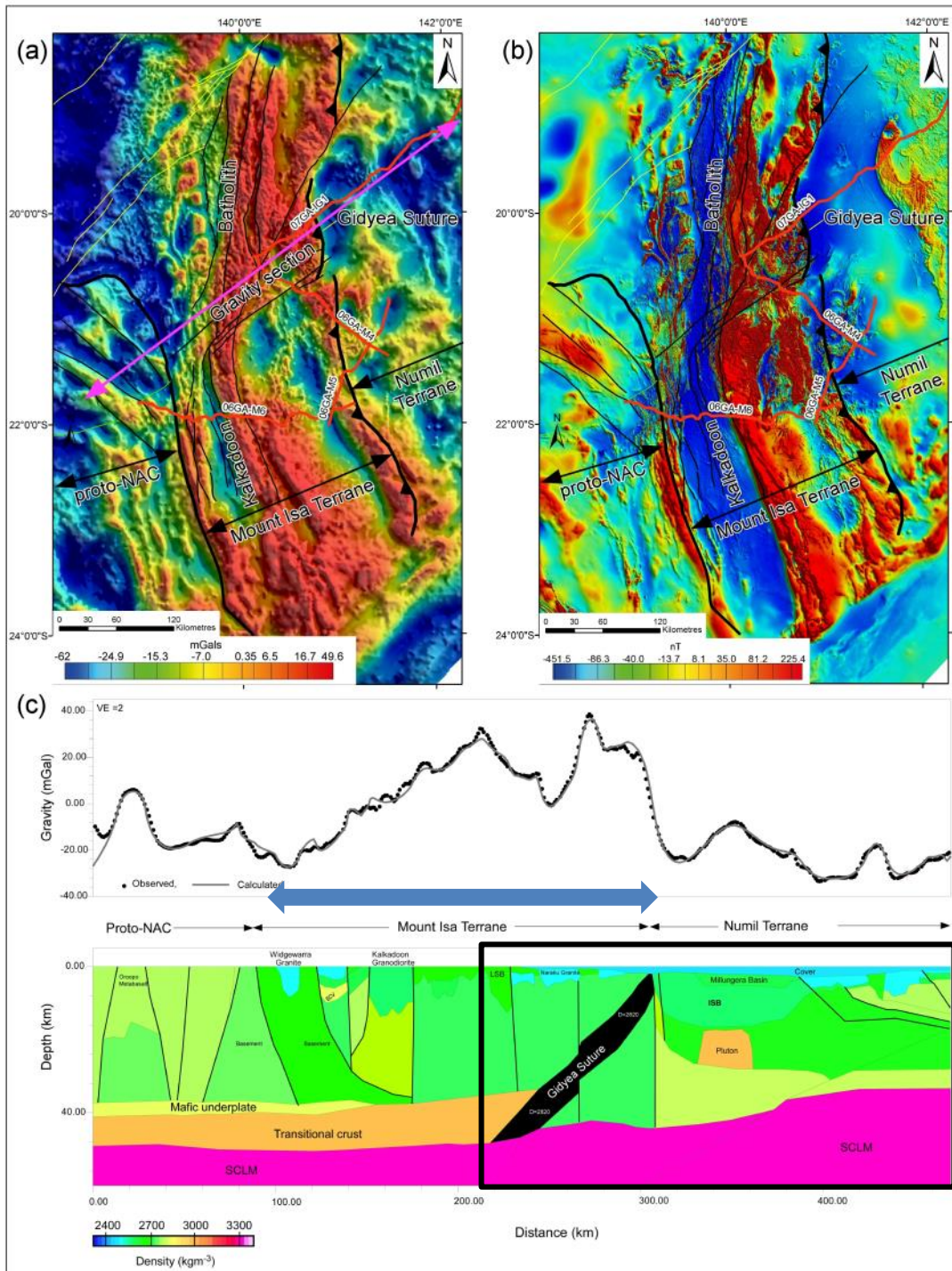


- Evidence for the inversion over a larger region of the Western Fold Belt.
- Mellish Park Syncline – very high angular unconformity (Betts, 1999).
- Tighter folding beneath the LSB-CSB unconformity.
- Correlates in timing with the Mid Tawallah inversion in the McArthur Basin (Bull and Rogers, 1996).

What caused the LO?



- Geophysically defined suture.
- West dipping subduction zone.
- Stitched by the CSB and ISB equivalents
- Pre-dates ca 1710 Ma.
- Collision between the Numil terrane and Mount Isa Inlier.
- Alternative – Rowe Subduction Zone

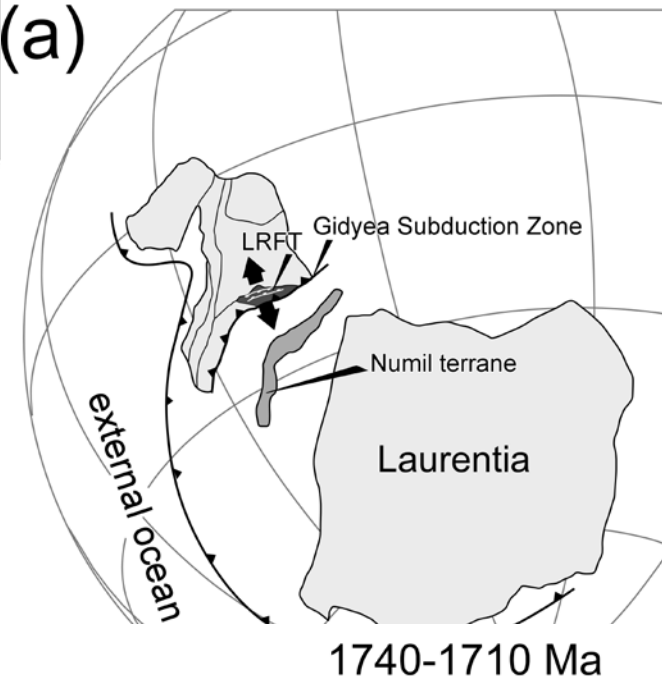


1790-1760 Ma



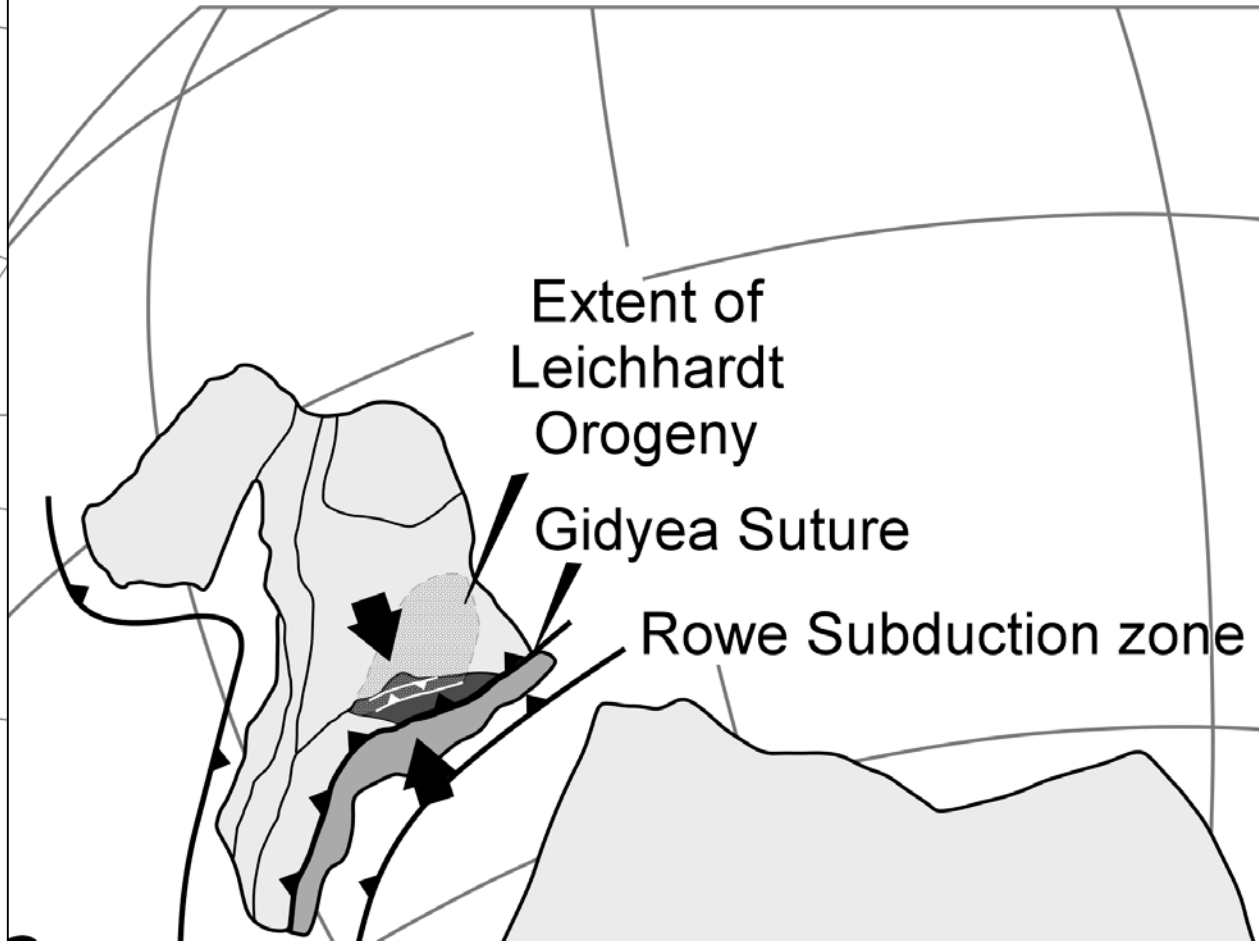
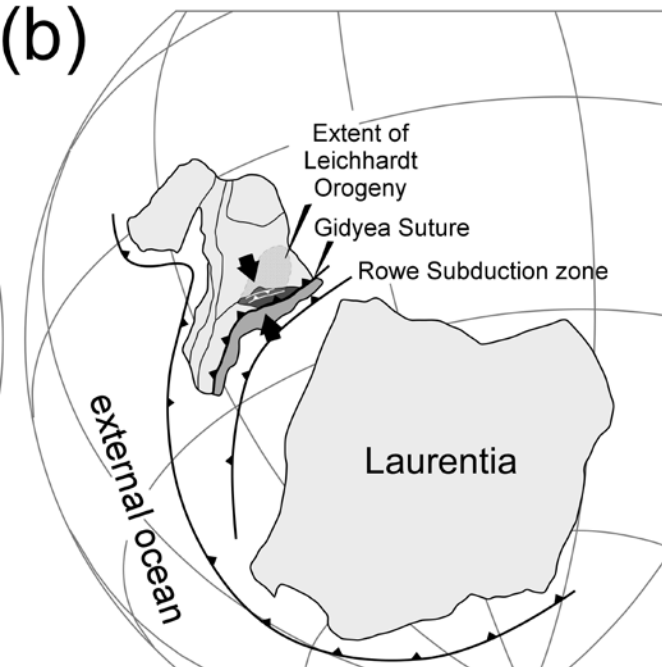
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(a)



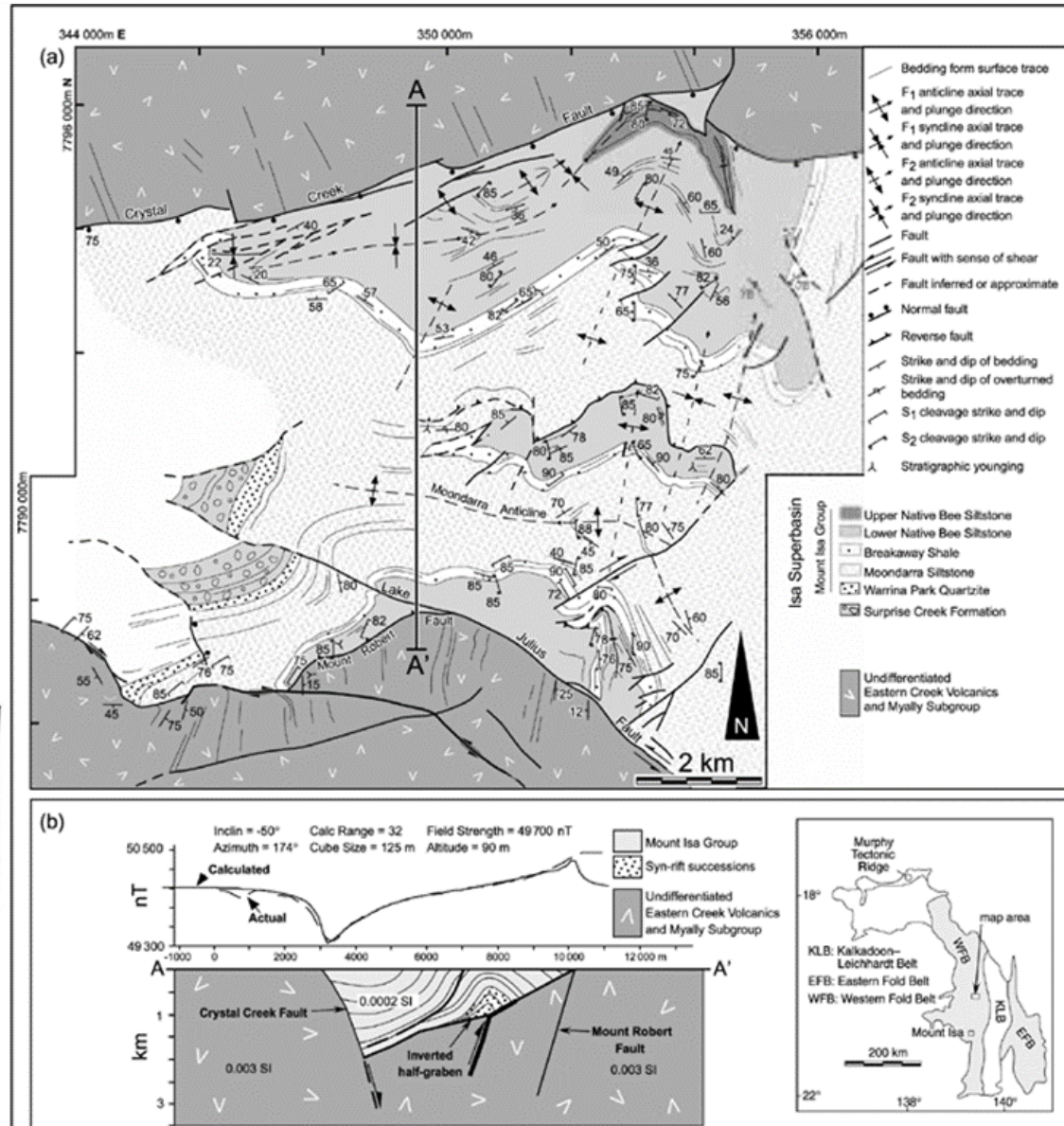
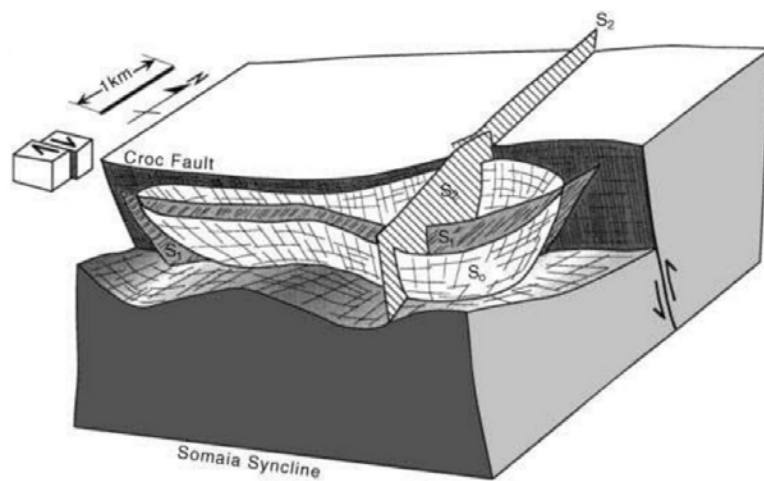
1740-1710 Ma

(b)



How did we miss this?

- Scale of observation
- History developed in Calvert and Isa superbasin succession.
- Isan Orogeny: N-S foliation overprinting E-W foliation in sub-basin
- Leichhardt Anticline - Type 0 interference pattern



Conclusion

The Geophysical interpretation of the Leichhardt River Fault Trough provides new insight into the tectonic evolution of the region, that was not apparent from the geological relationships (mine at least 😊).

Major inversion event following the Leichhardt Superbasin between 1740 Ma and 1710 Ma – Leichhardt Orogeny.

Requires a re-assessment of how we interpret the evolution of the eastern parts of the NAC