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New data and new concepts for the Paterson Orogen

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Geoscience Australia

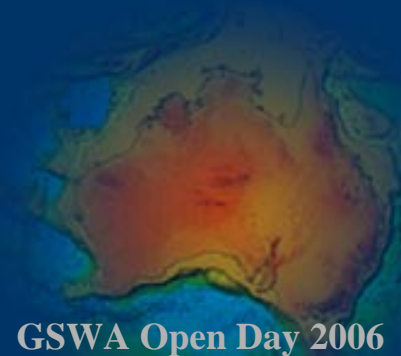
Leon Bagas
Geological Survey of Western Australia



**Geological Survey of
Western Australia**

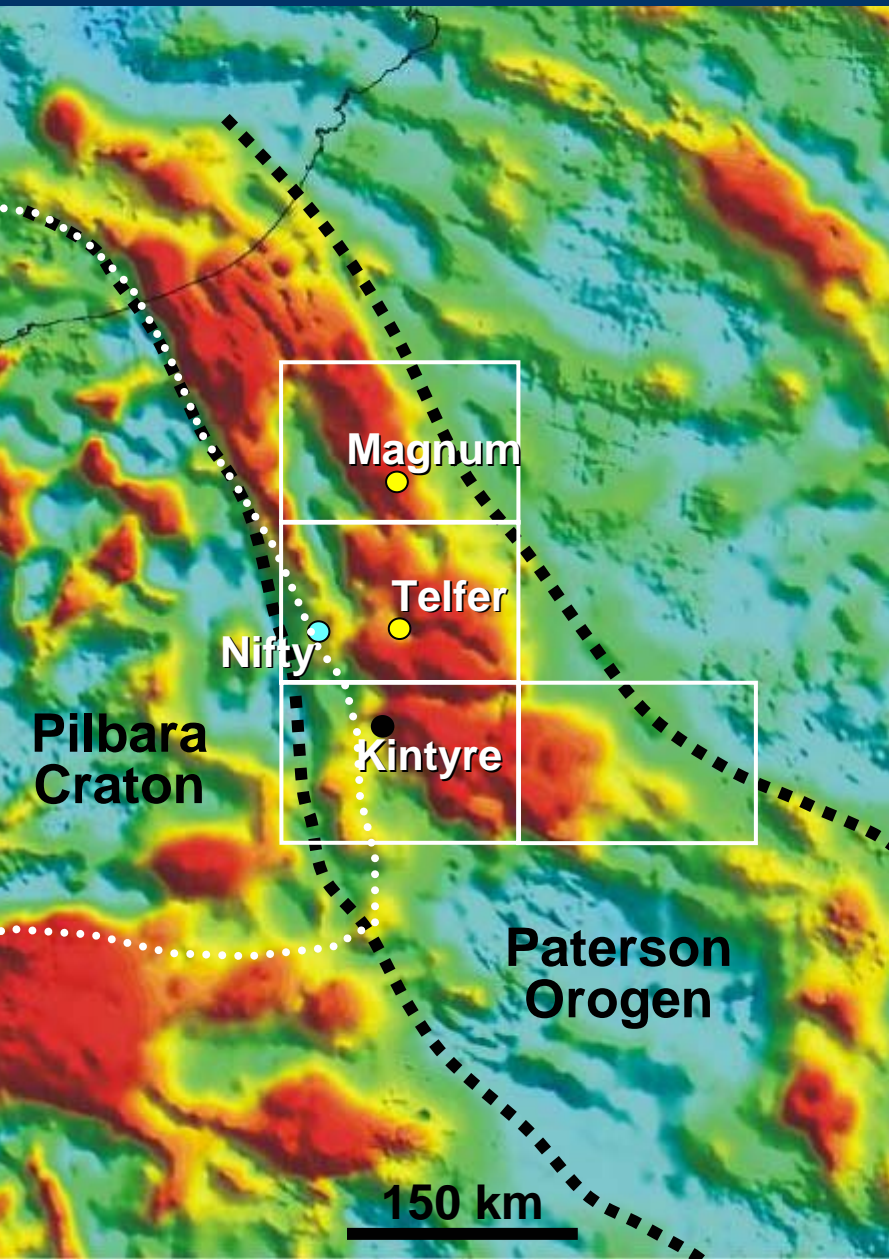


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GSWA Open Day 2006

NGA Paterson Project



- Paterson Orogen: Paleo- to Neo-proterozoic sedimentary-volcanic rocks and felsic-mafic magmatism
- mineral systems: Au-Cu (Telfer, Magnum), Cu-Zn-Pb (Nifty, Maroochydore), U (Kintyre)
- limited understanding of basin formation, deformation & magmatism
- focus on new data and concepts

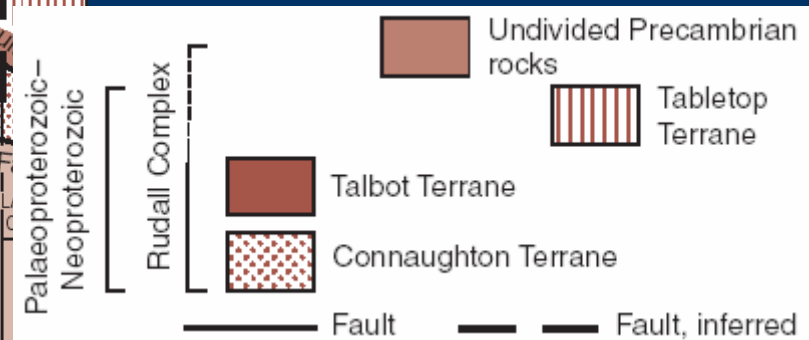
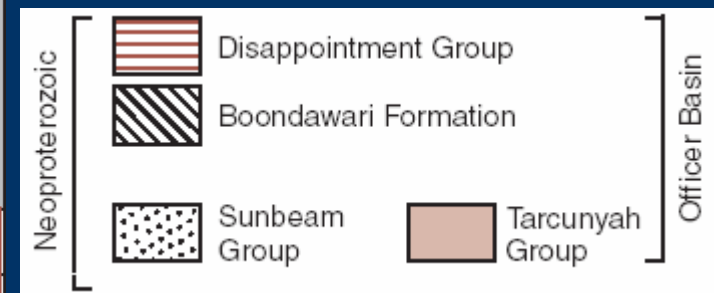
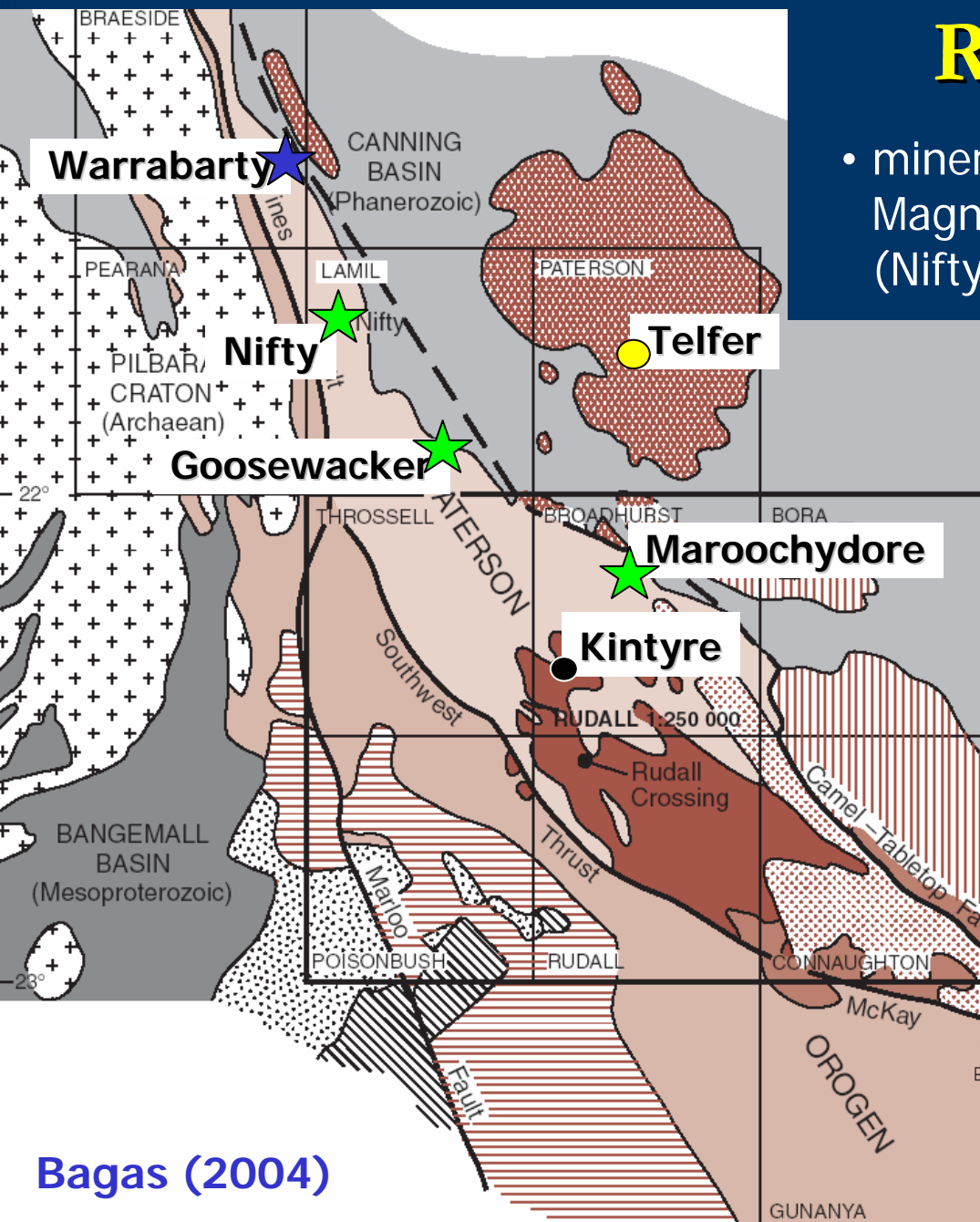
**PROVIDE AN IMPROVED
GEOLOGICAL & MINERAL SYSTEM
FRAMEWORK**

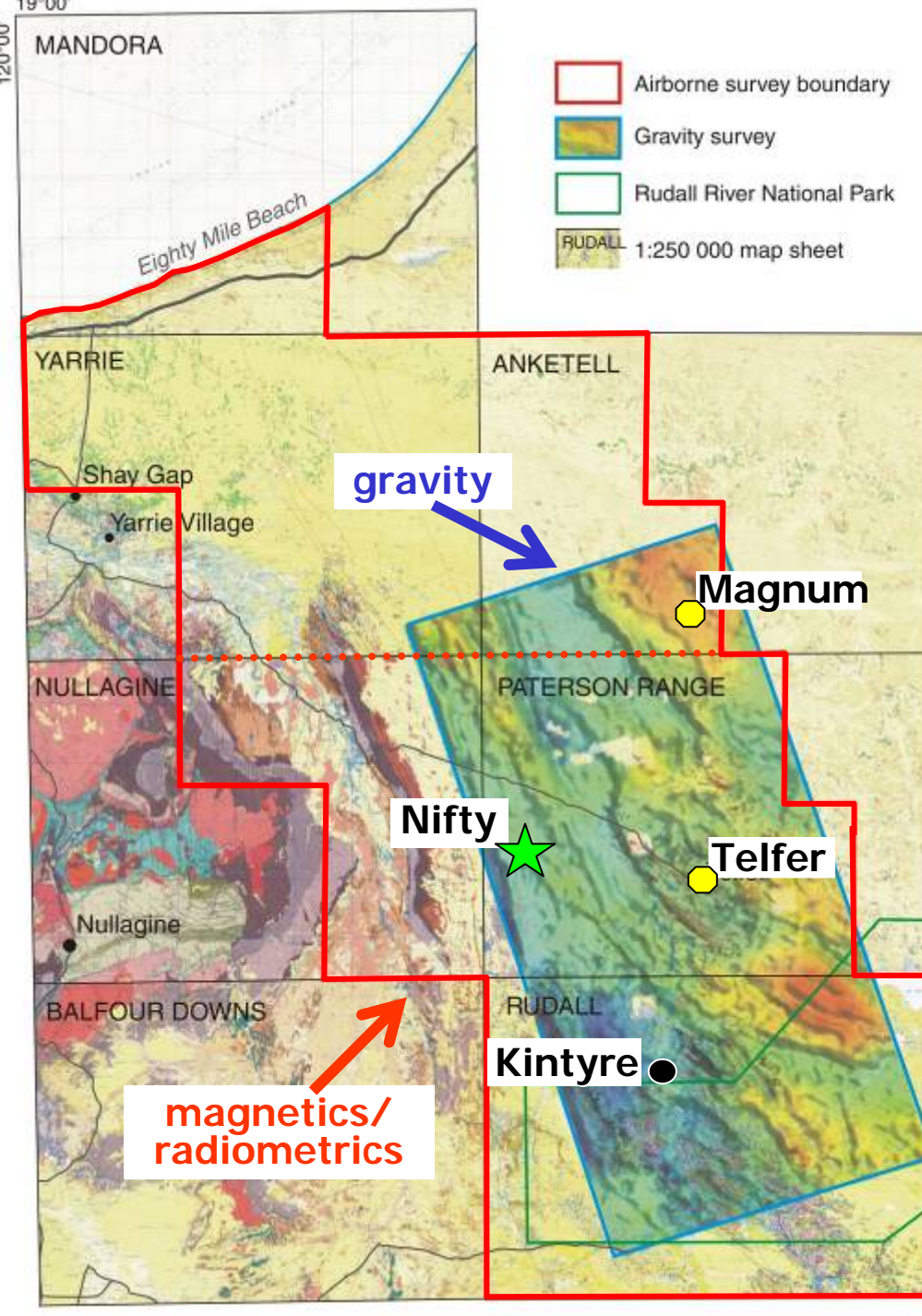


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Regional geology

- mineral systems: Au-Cu (Telfer, Magnum), Zn-Pb (Warrabarty), Cu (Nifty, Maroochydore), U (Kintyre)





2005-06 program

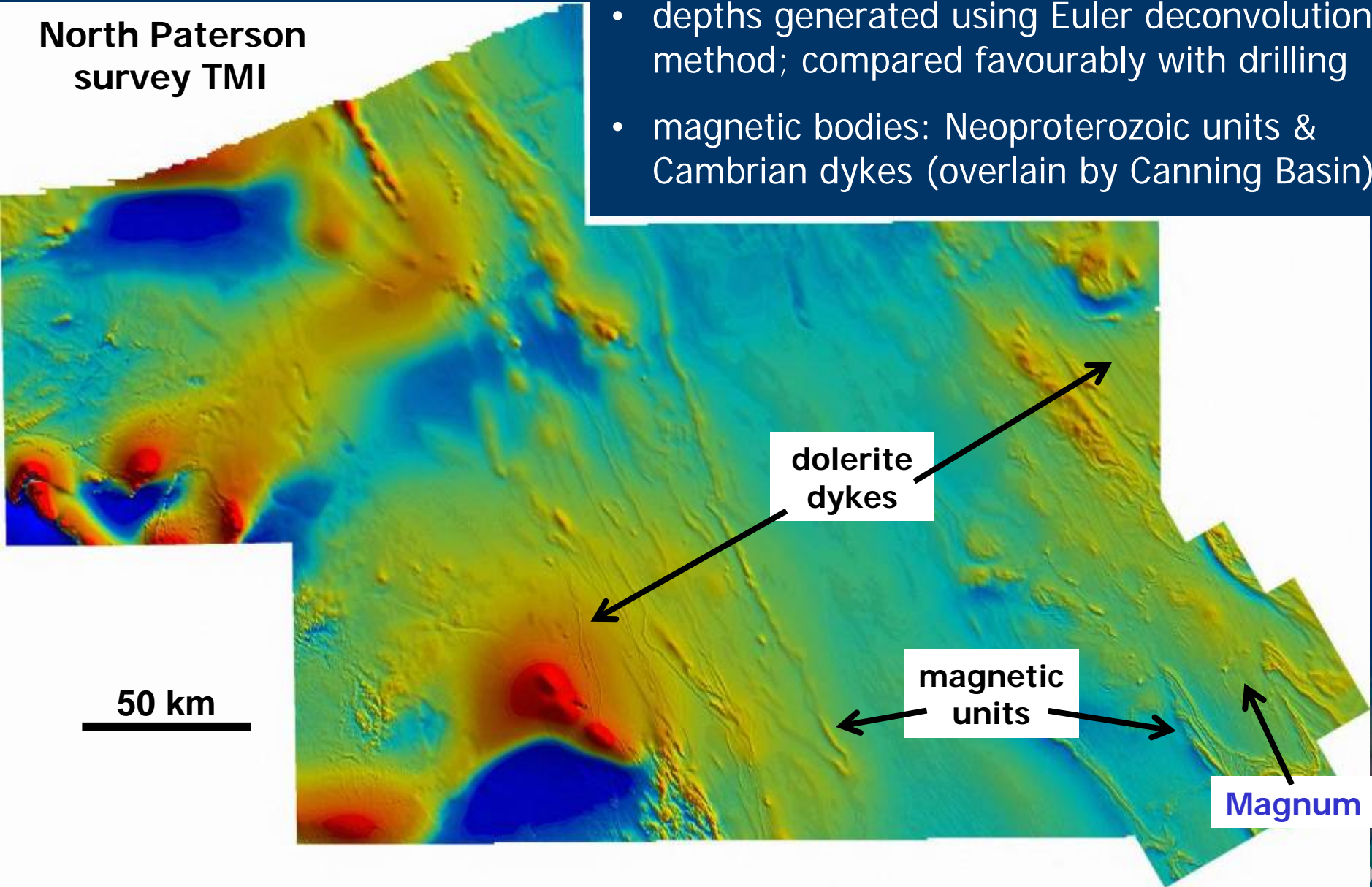
- ❖ geophysical data:
 - magnetic/radiometric (400 m)
 - gravity (~2.5 x 2.5 km)
- ❖ construct a sequence stratigraphic framework
- ❖ constrain timing and processes of basin development, magmatism, deformation and mineral systems
- ❖ constrain depth-to-basement (Neoproterozoic)



Depth-to-magnetic basement

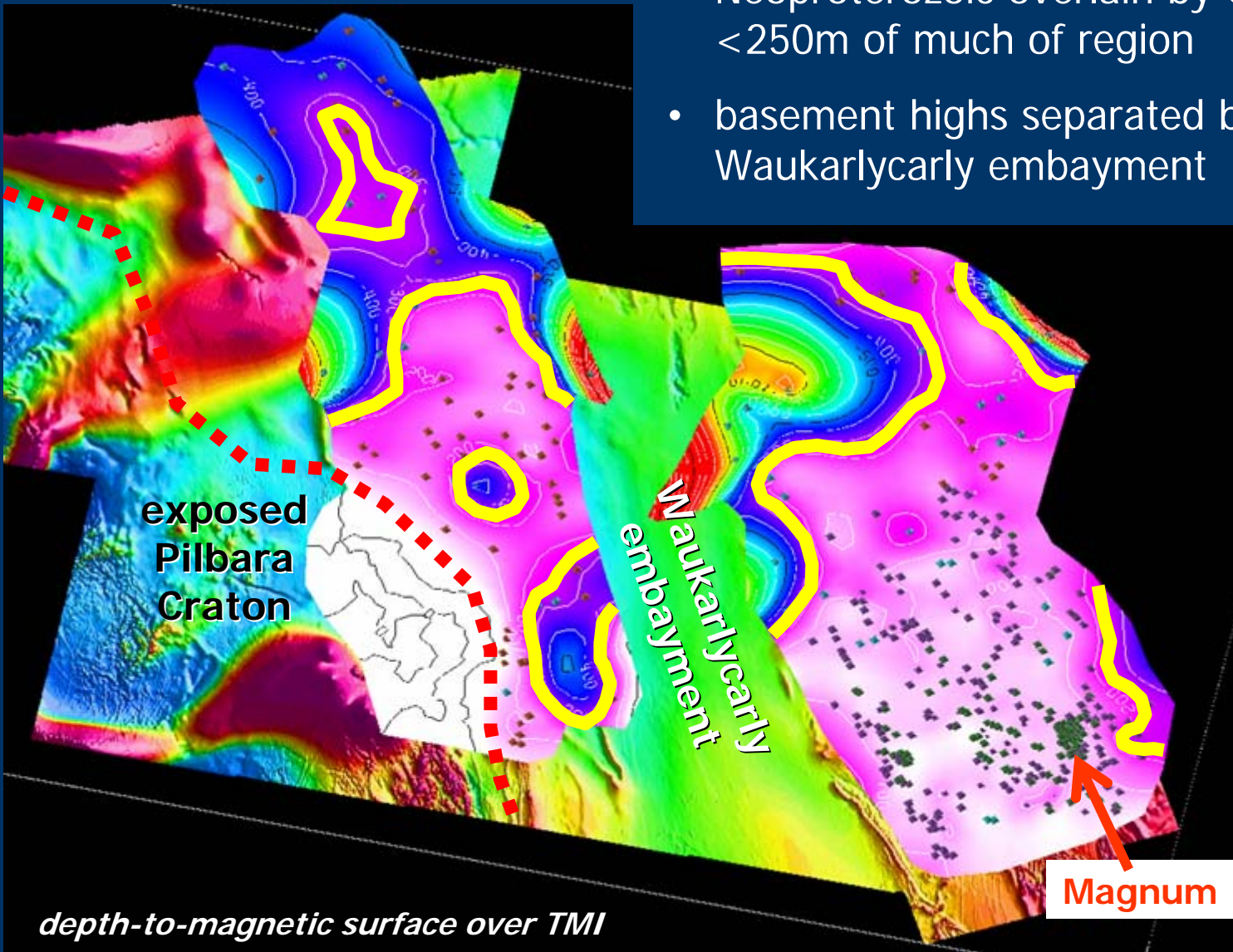
North Paterson
survey TMI

- depths generated using Euler deconvolution method; compared favourably with drilling
- magnetic bodies: Neoproterozoic units & Cambrian dykes (overlain by Canning Basin)

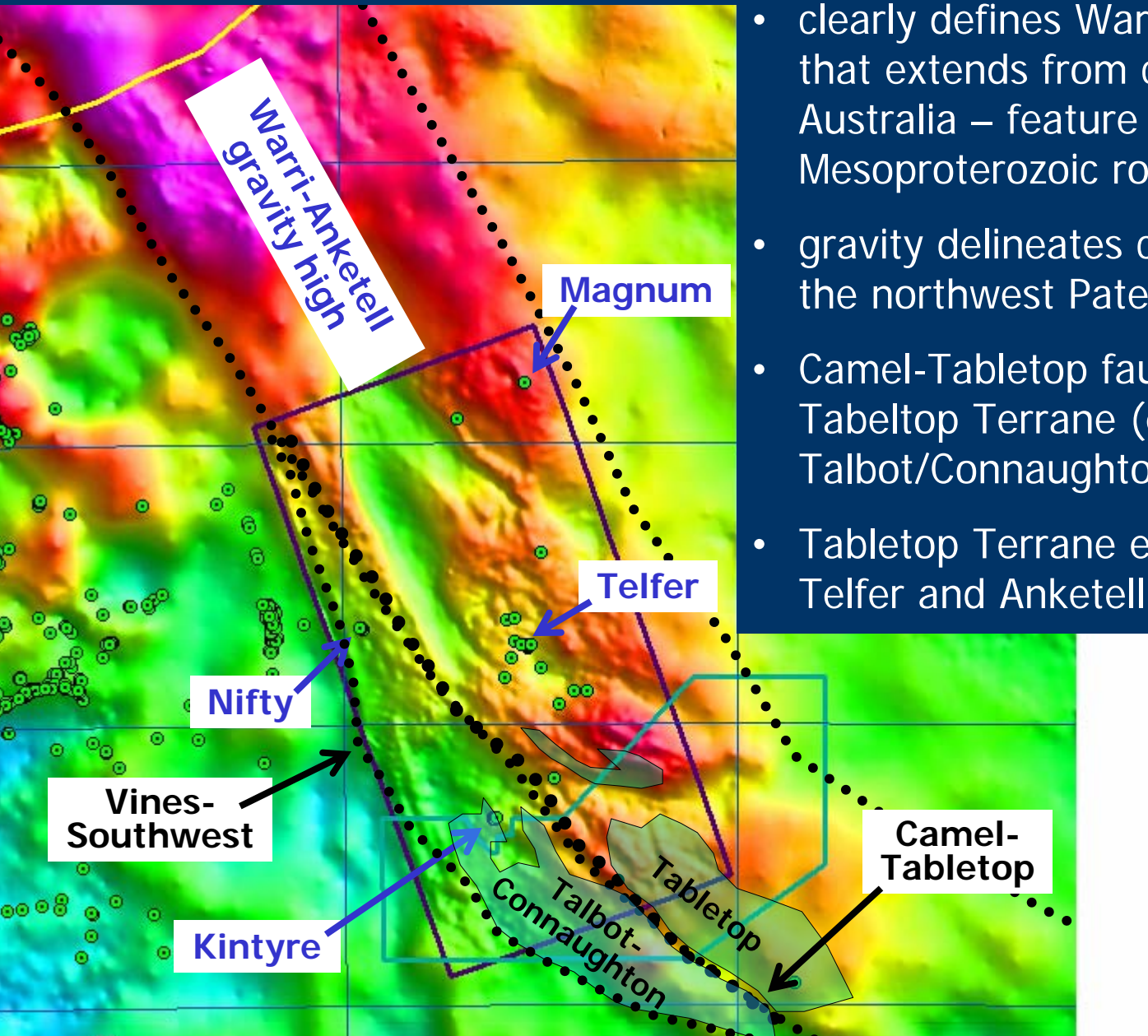


Depth-to-magnetic basement

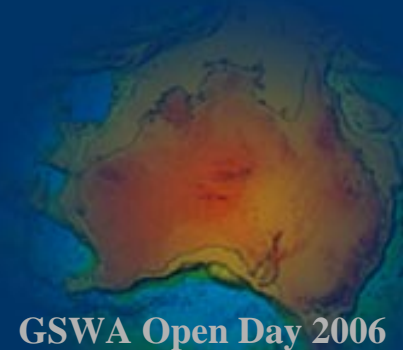
- Neoproterozoic overlain by Canning basin; <250m of much of region
- basement highs separated by deep (>2 km) Waukarlycarly embayment



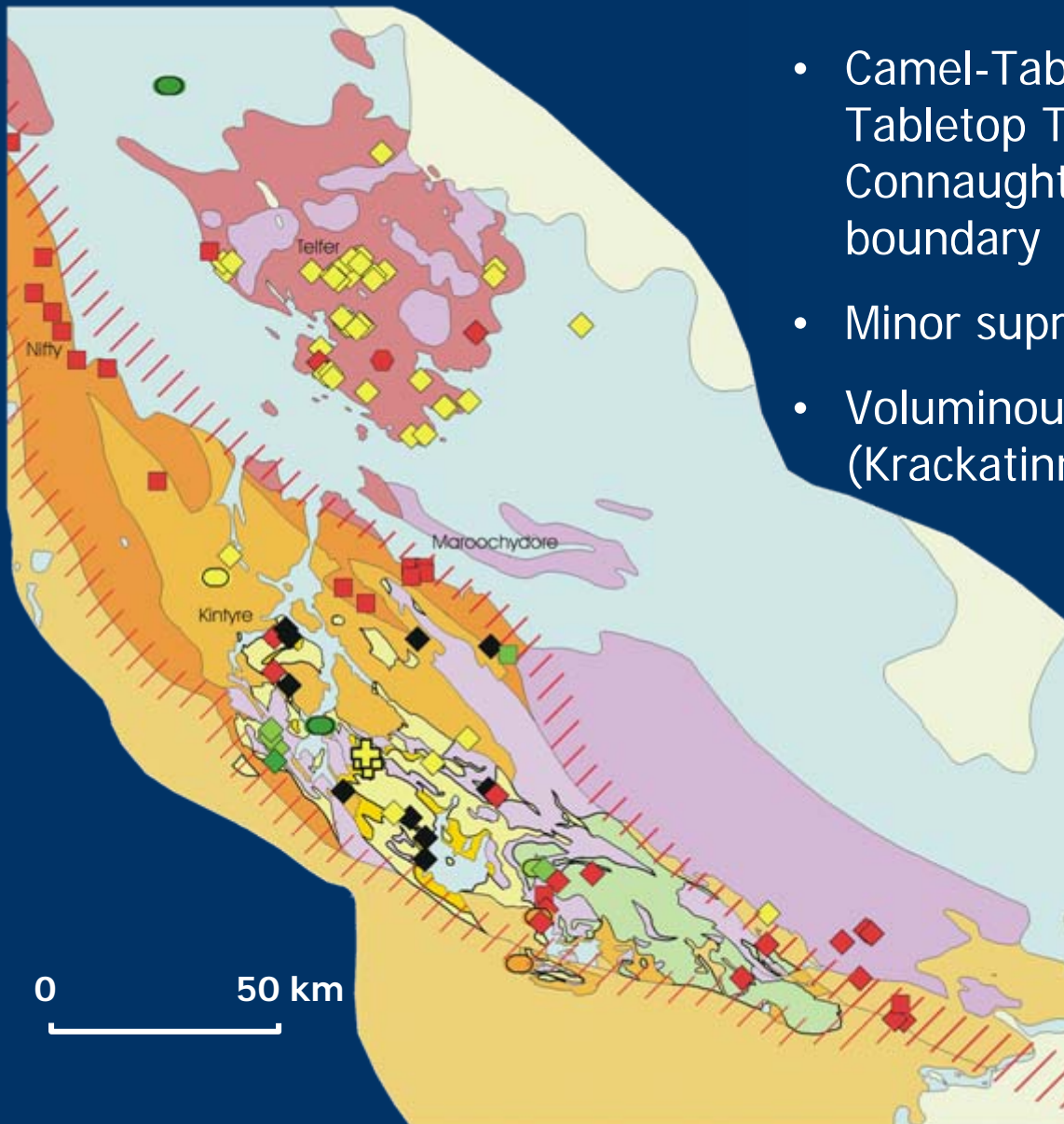
Gravity data



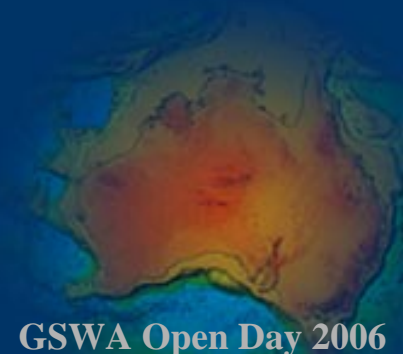
- clearly defines Warri-Anketell gravity high that extends from coast to central Australia – feature is likely belt of Mesoproterozoic rocks
- gravity delineates crustal components of the northwest Paterson Orogen
- Camel-Tabletop fault zone separates Tabletop Terrane (east) from Talbot/Connaughton Terrane (west)
- Tabletop Terrane extends north under Telfer and Anketell areas



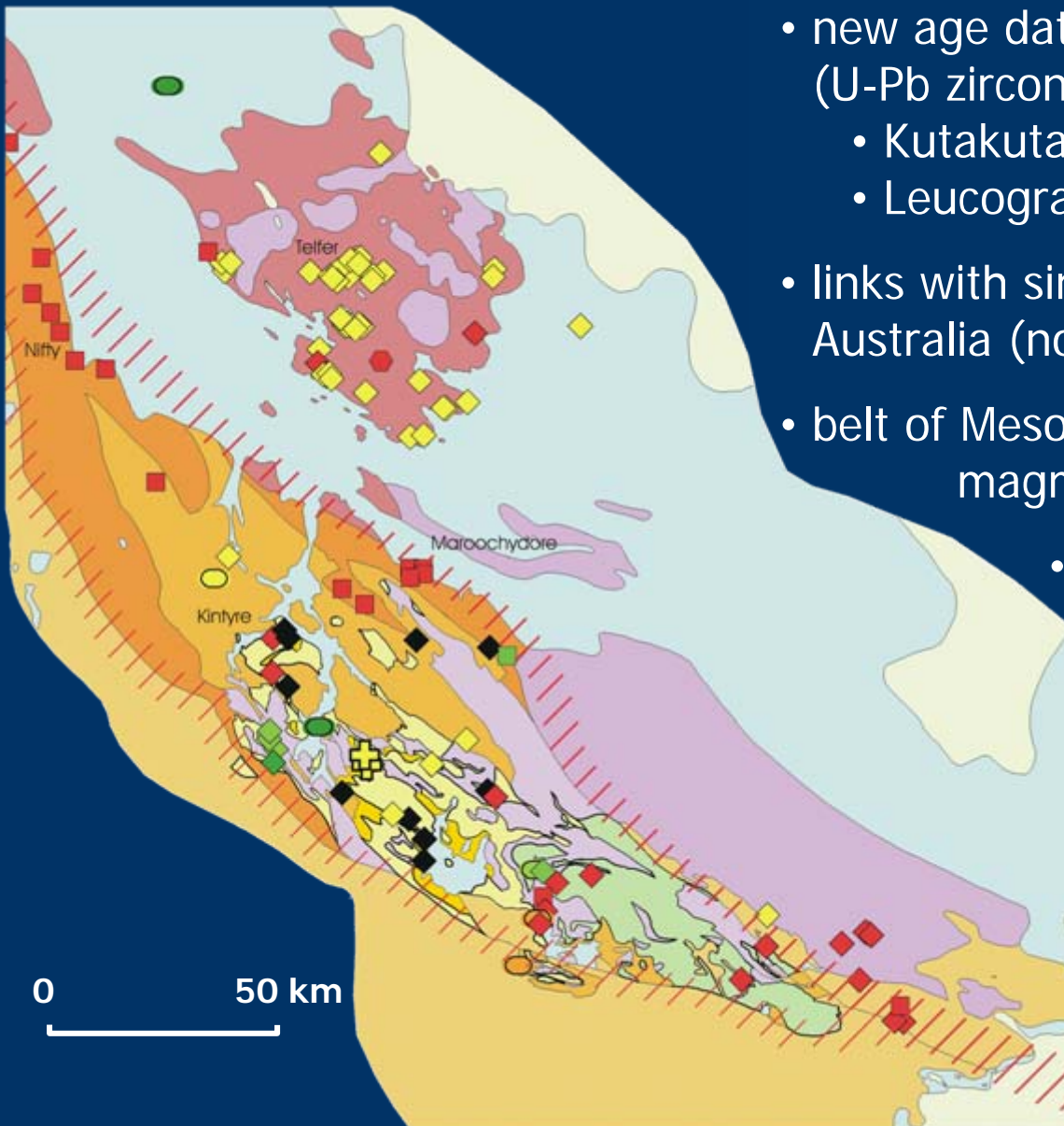
Rudall Complex: Tabletop Terrane



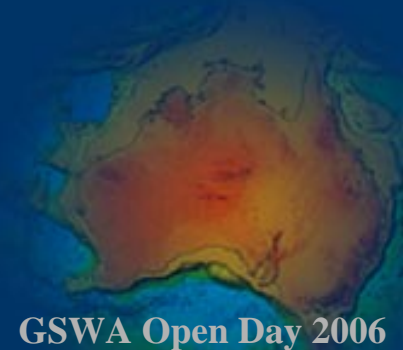
- Camel-Tabletop fault zone separates Tabletop Terrane from Talbot & Connaughton Terranes – a major crustal boundary
- Minor supracrustal rocks of unknown age
- Voluminous felsic magmatism (Krackatinny Suite: Smithies & Bagas, 1997) – calc-alkaline tonalites; geochemistry consistent with magmatic arc (subduction-related)



Tabletop Terrane

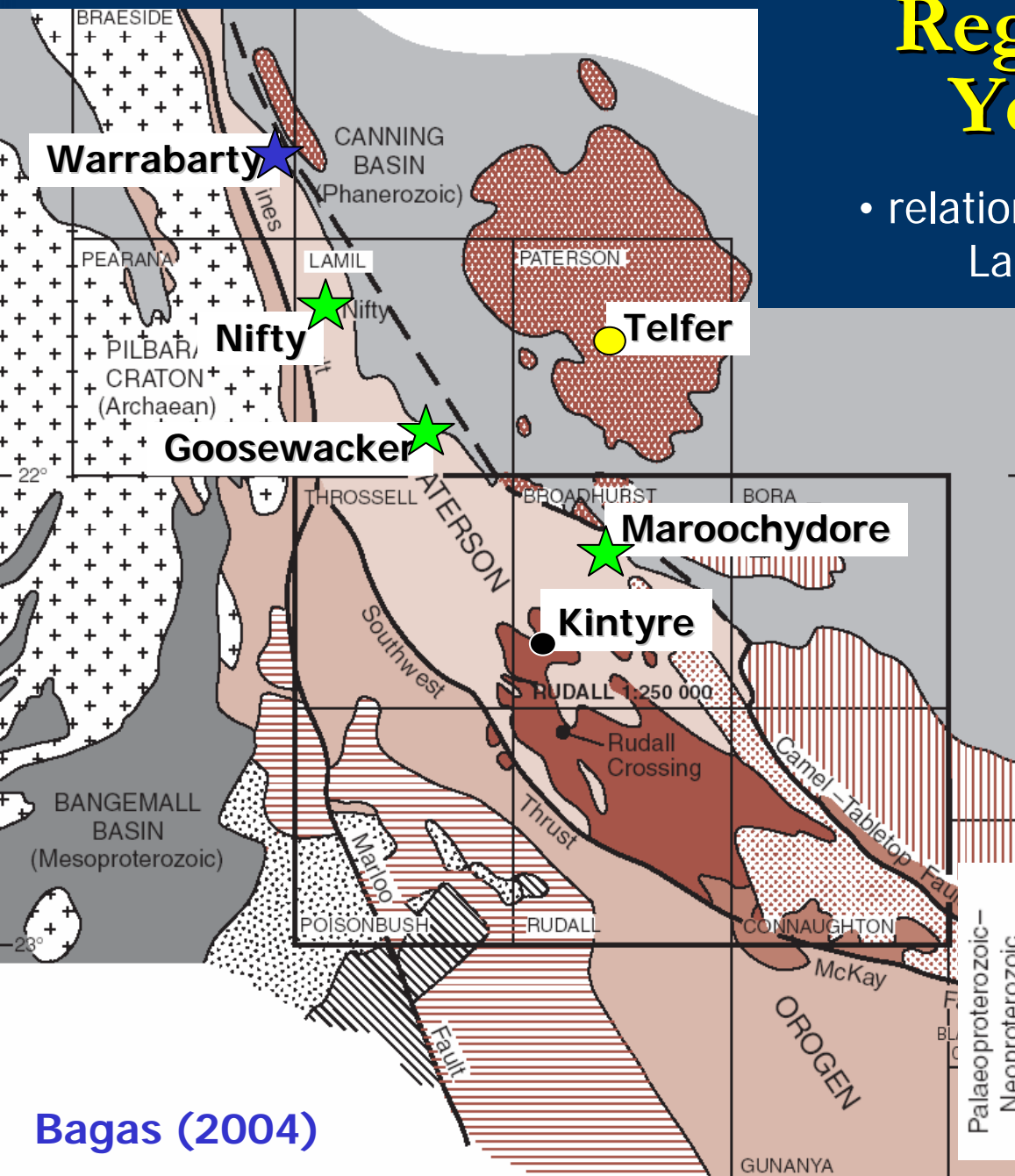


- new age dating indicates c. 1575-1550 Ma (U-Pb zircon)
 - Kutakuta Tonalite: 1577 \pm 2 Ma
 - Leucogranite: 1553 \pm 2 Ma
- links with similar aged rocks in central Australia (northern Musgrave; Gawler)
- belt of Mesoproterozoic subduction-related magmatism
- Tabletop Terrane likely:
 - exotic w.r.t. Talbot-Connaughton
 - enhanced prospectivity for gold-copper



Regional geology: Yeneena Basin

- relationship of Throssell Range and Lamil Groups to each other



Bagas (2004)

Throssell Range Group

(fining upwards succession = *transgression*)

Isdell Formation

- >3km thick
- deep water crystalline carbonate (>150 m)
- unclear relationship with underlying units



Nifty (Cu)



Maroochydore
(Cu, Pb, Zn)

Broadhurst Formation

- ~3km thick
- siltstones grade up into black shales
- turbidites in upper part underlying Nifty Member

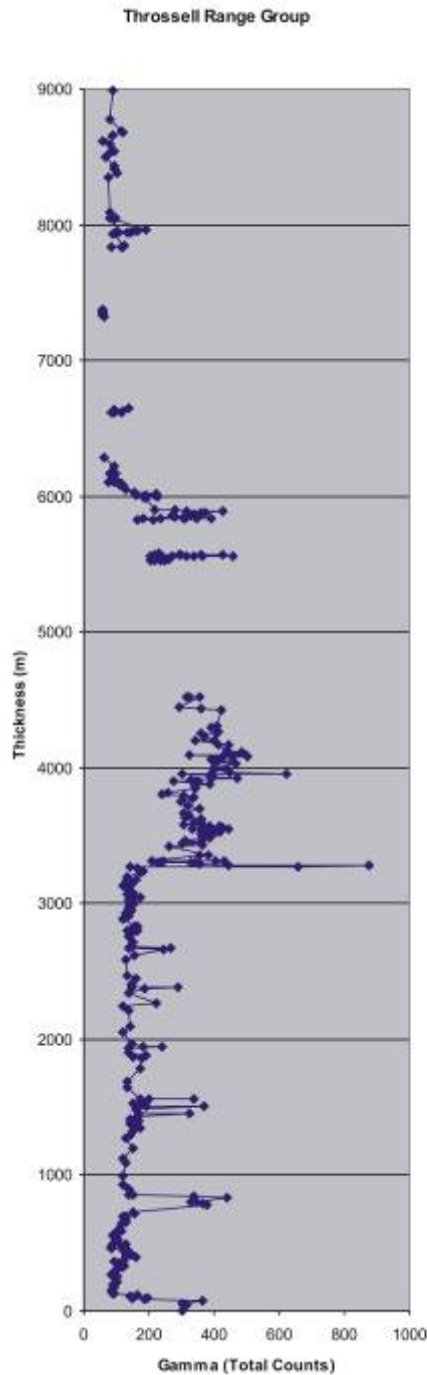
Coolbro Sandstone

- maximum 3.3km thick
- fluvial – shallow marine facies
- Kintyre U deposit in underlying basement
- U mineralization at upper contact



Kintyre
(U, Au)

Paleoproterozoic basement



Lamil Group

(coarsening upwards succession = *regression*)

Wilki Quartzite

- 1.5km thick
- well-sorted clean medium-grained quartzite
- shoreface facies

Puntapunta Formation

- 1.5 km thick
- ★ Fallows Field (Au, Sn) • sandy carbonate facies (inner shelf > 50m)

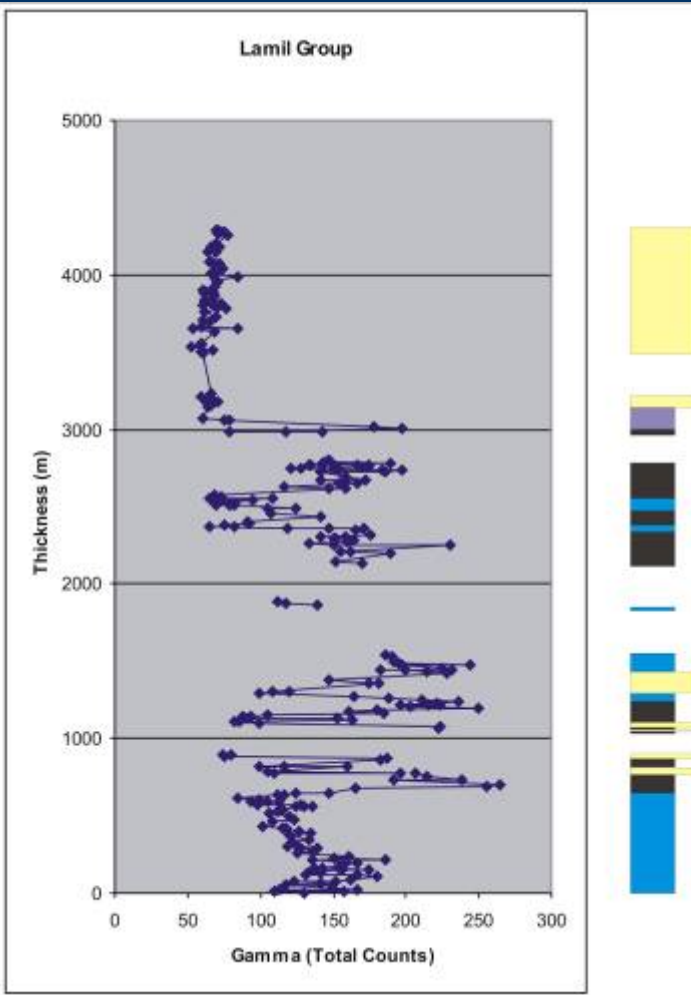
Malu Formation

- ★ Telfer (Au, Cu)

- 1 km thick
- 4 sandstone horizons (turbidites/tempestites)
- original Telfer ore at upper contact of #3
- interbedded with carbonate & calc. siltstone

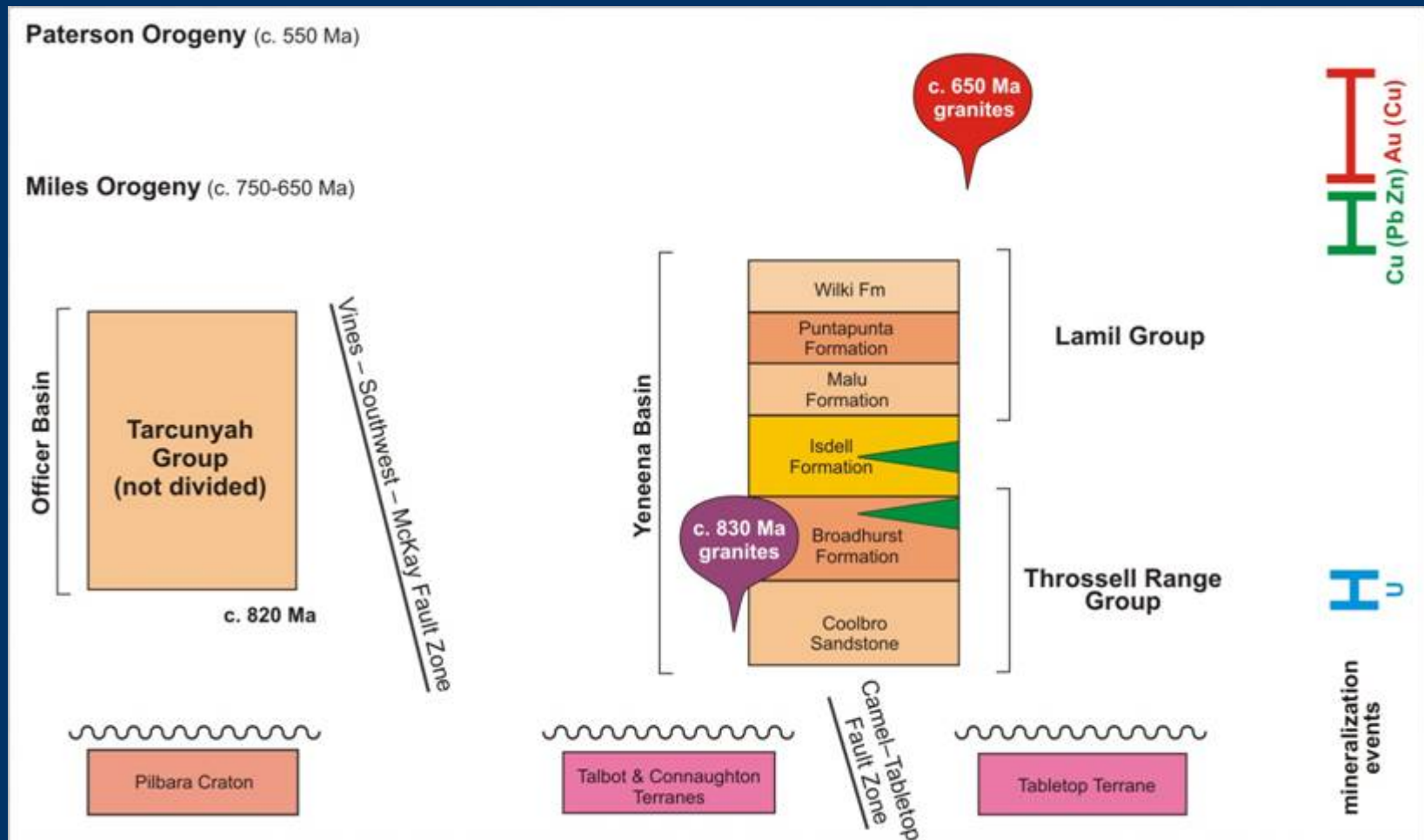
Isdell Formation

- intermediary facies; Isdell & Puntapunta Fms
- more typically Isdell Fm downsection,
& more typically Puntapunta Fm upsection



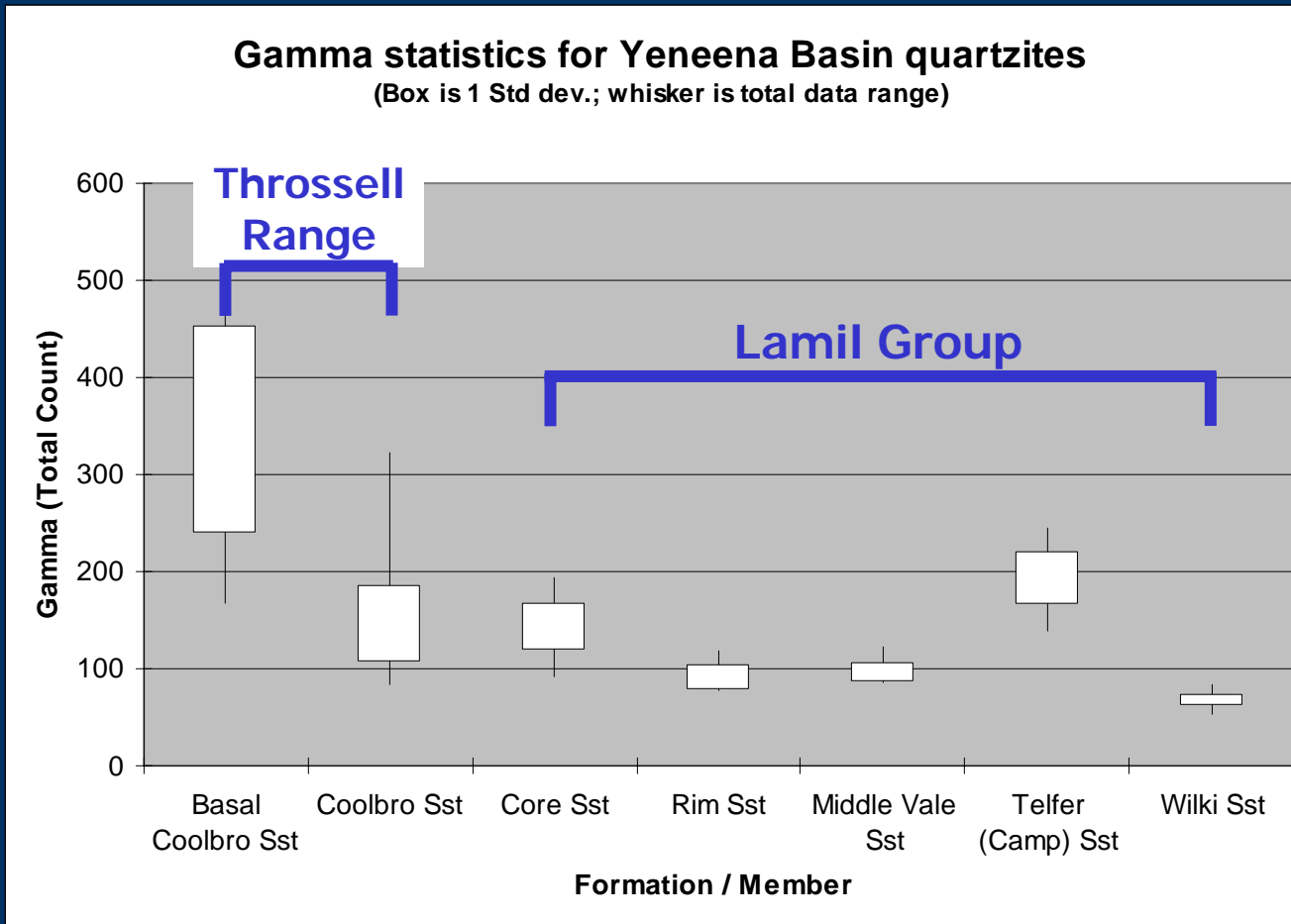
Yeneena Basin: Simplified stratigraphy?

- **Isdell Fm**: relationship to rest of stratigraphy unclear – facies change and at least two possible interpretations: single rock package or separate rock packages



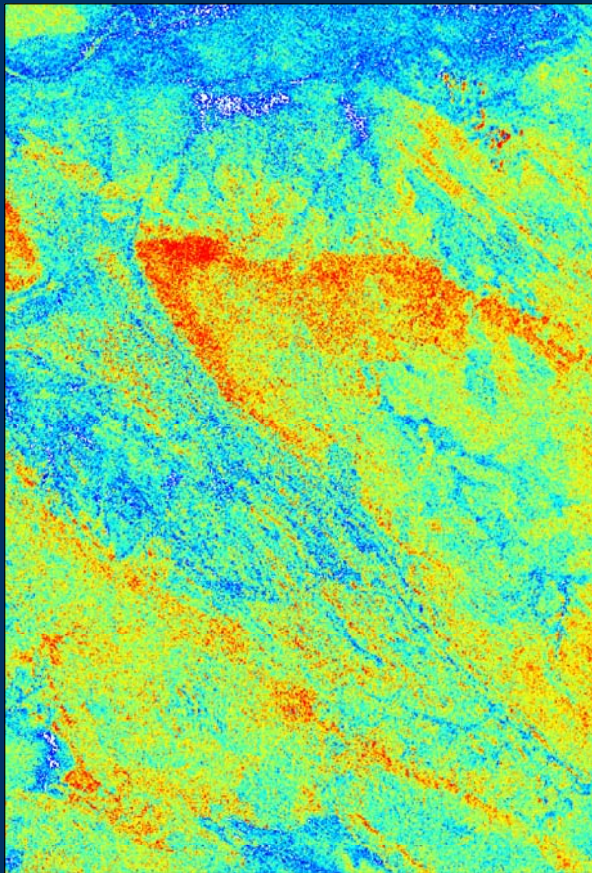
Yeneena Basin: Gamma ray counts

- Useful field tool to differentiate between units at outcrop-scale
- e.g., Telfer district stratigraphy – Camp Sst has distinct signature

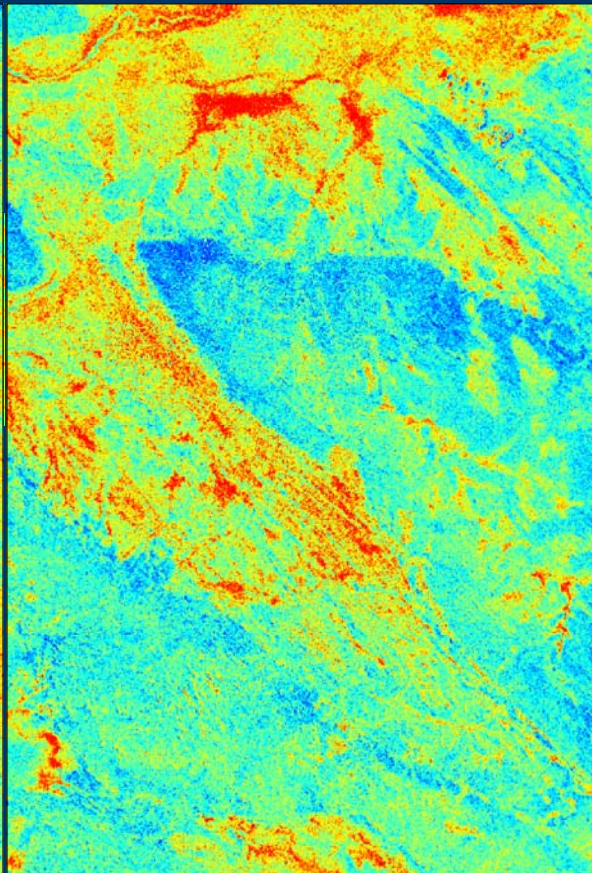


Yeneena Basin: ASTER satellite data

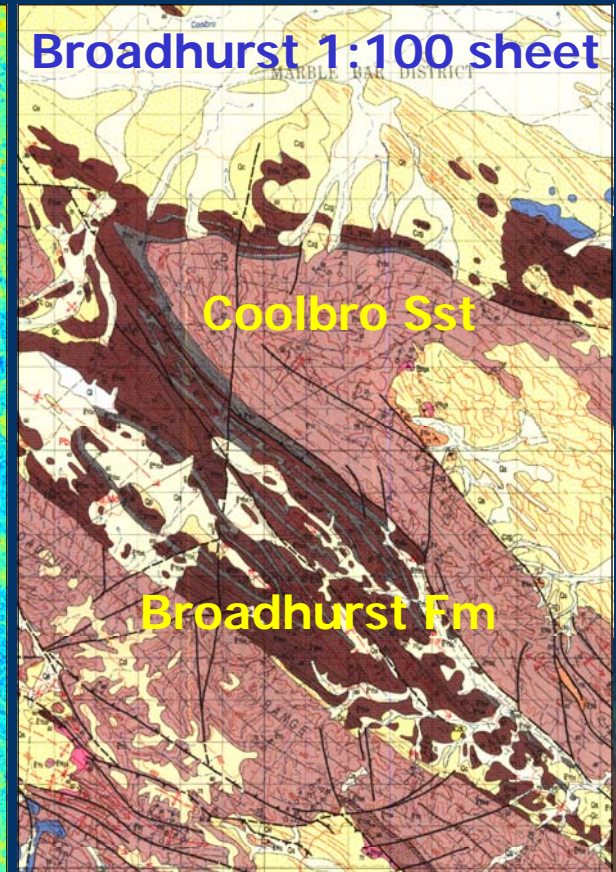
- Useful tool to differentiate between units & provides information on regional alteration
- Significant white mica alteration present along top of Coolbro Sandstone (Throssell Range Group)



Muscovite (red)



Epid_chl_amph (red)

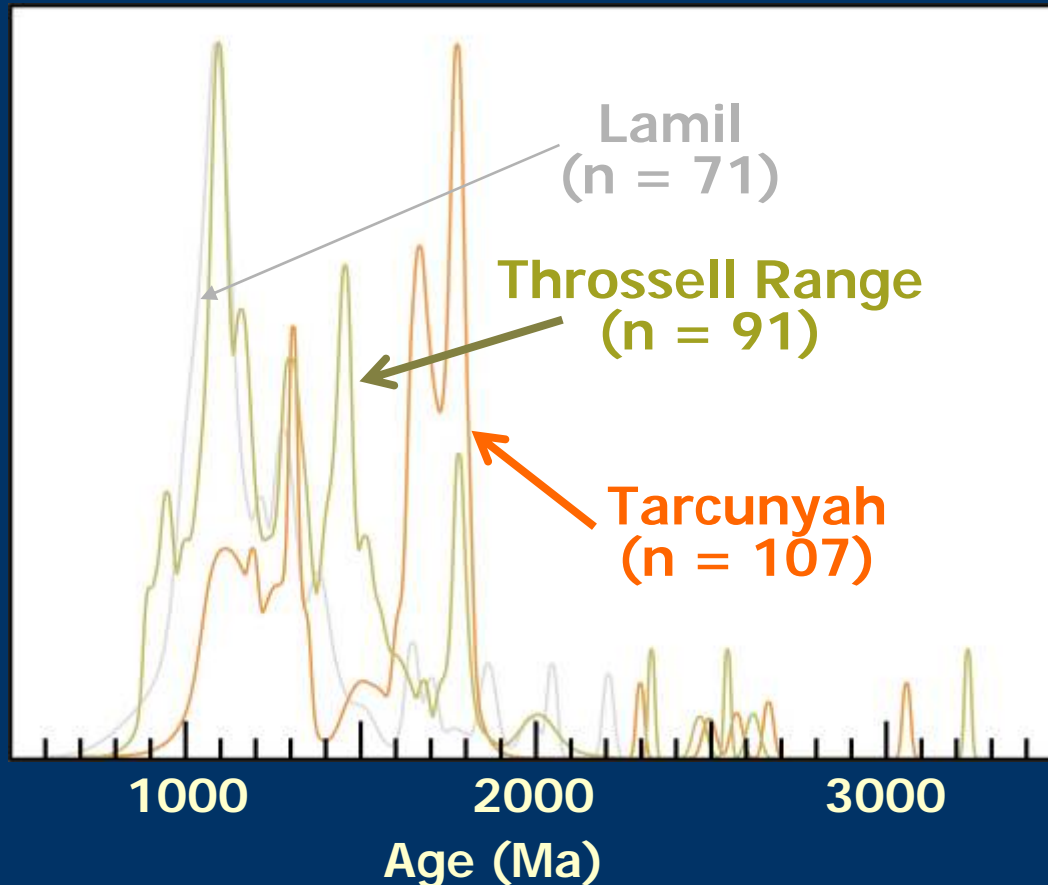


1:100,000 geology

Yeneena Basin: Age constraints

- Maximum depositional ages: c. 950 Ma – detrital zircons
- Minimum depositional ages: c. 830 Ma (Throssell Range Group); c. 650 Ma (Lamil Group) – felsic intrusions

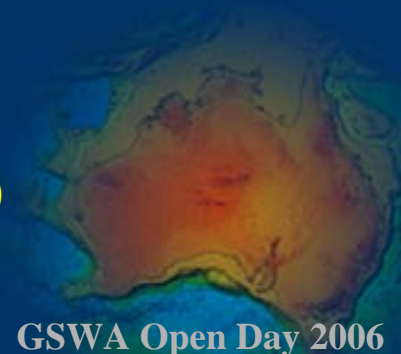
Relative cumulative probability



Detrital zircons:

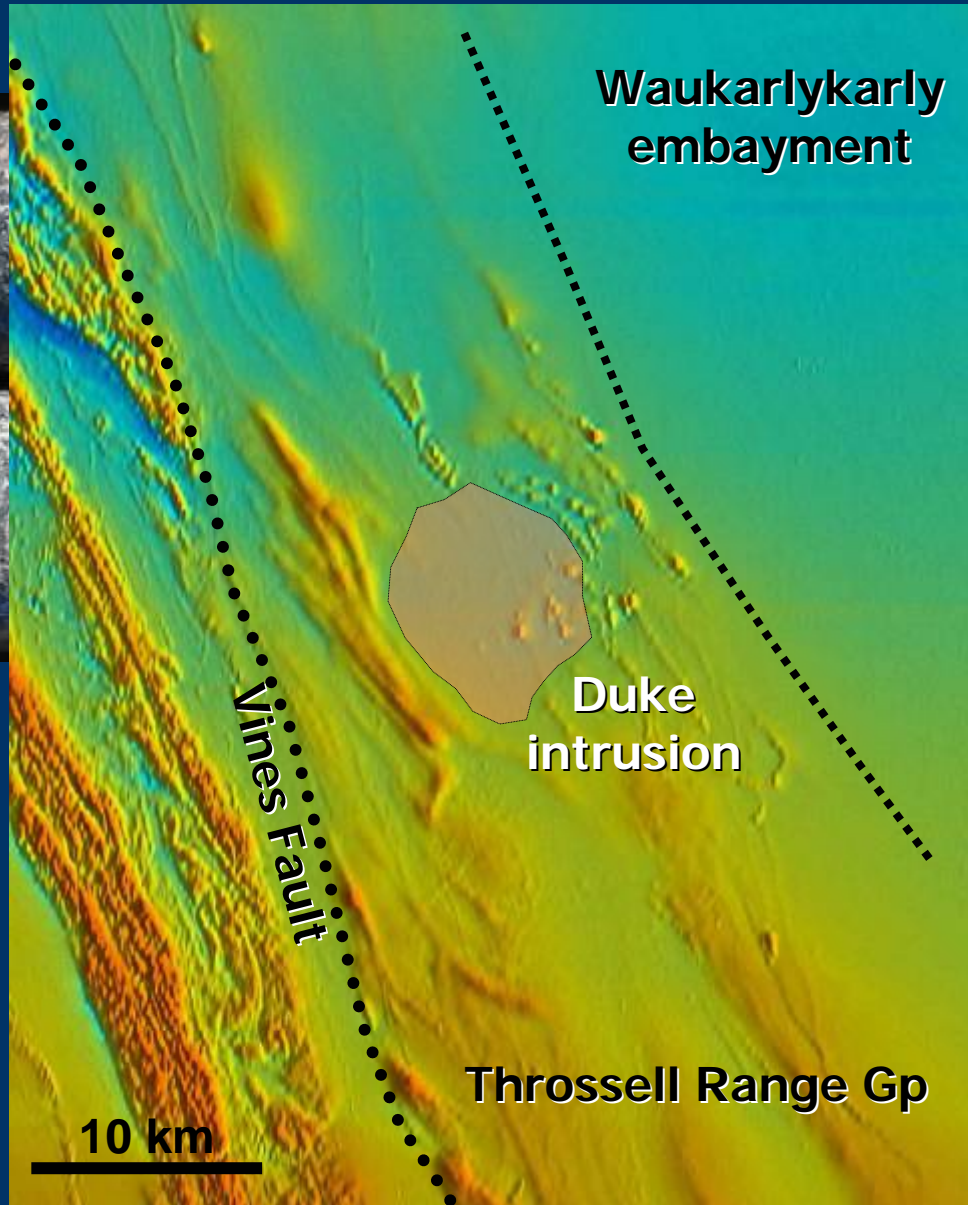
- mainly Proterozoic with minor Archean sources
- Eplison Nd data similar for Throssell Range and Lamil Groups; model ages of bulk detritus is 2.0-2.3 Ga

Bagas (2004)

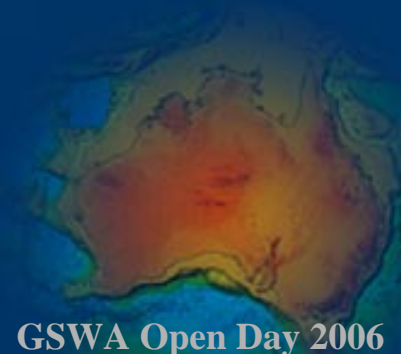


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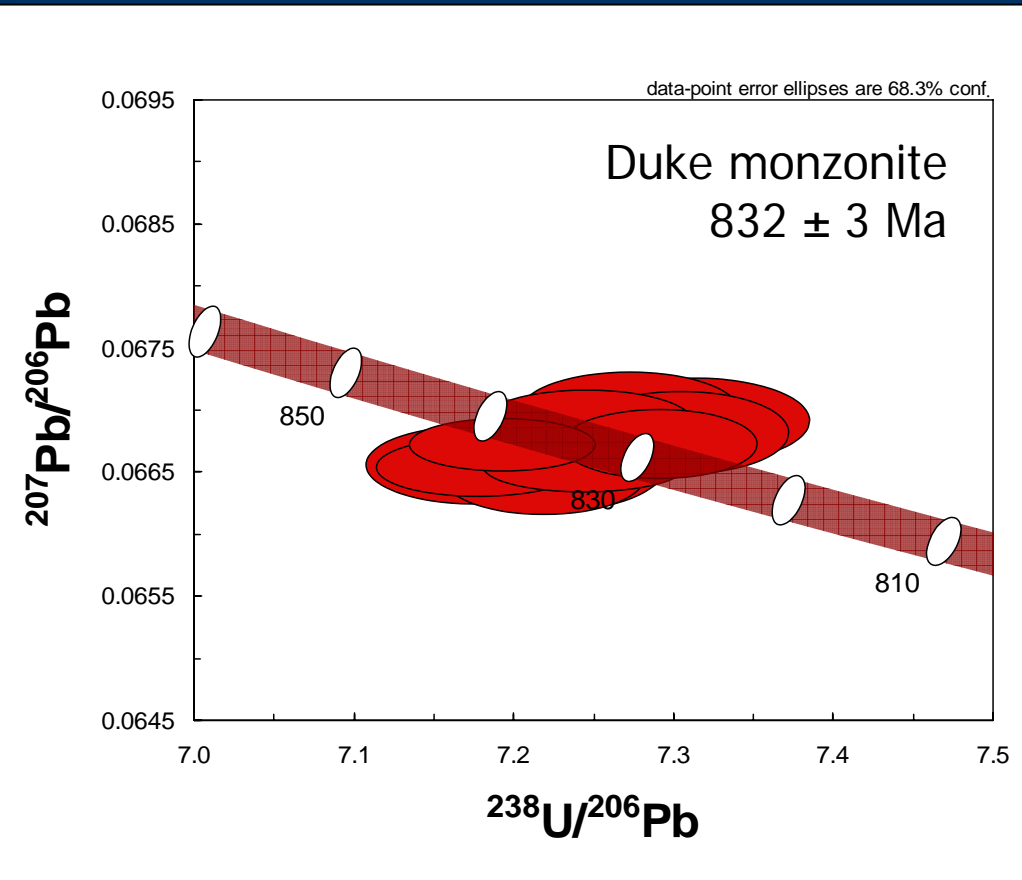
Neoproterozoic magmatism: Throssell Range Gp



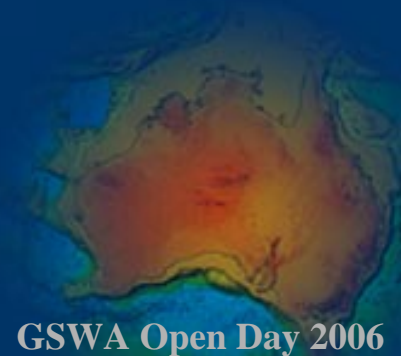
- dolerite sills & dykes (pre-folding) – c. 820 Ma Eva Well intrusion (Reed, 1996)
- monzonite intrusions – c. 830 Ma Duke intrusion (with associated Cu-Fe skarn)
- provide minimum age constraints for deposition of Throssell Range Group (950-830 Ma)



Neoproterozoic magmatism: Throssell Range Gp



- Duke monzonite intrusion: 832 ± 3 Ma (U-Pb zircon)
- provides minimum age for Throssell Range Group sedimentation (950-830 Ma)
- similar to Gairdner mafic dyke swarm age throughout central Australia
- related to break-up of Rodinia?

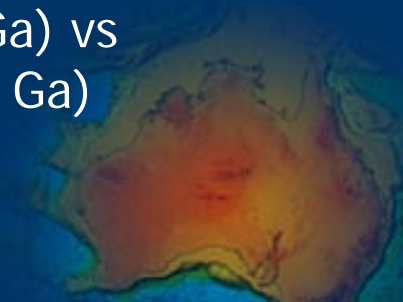


Neoproterozoic magmatism: Lamil Gp

Mount Crofton granite

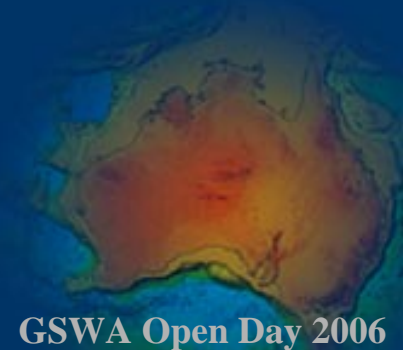
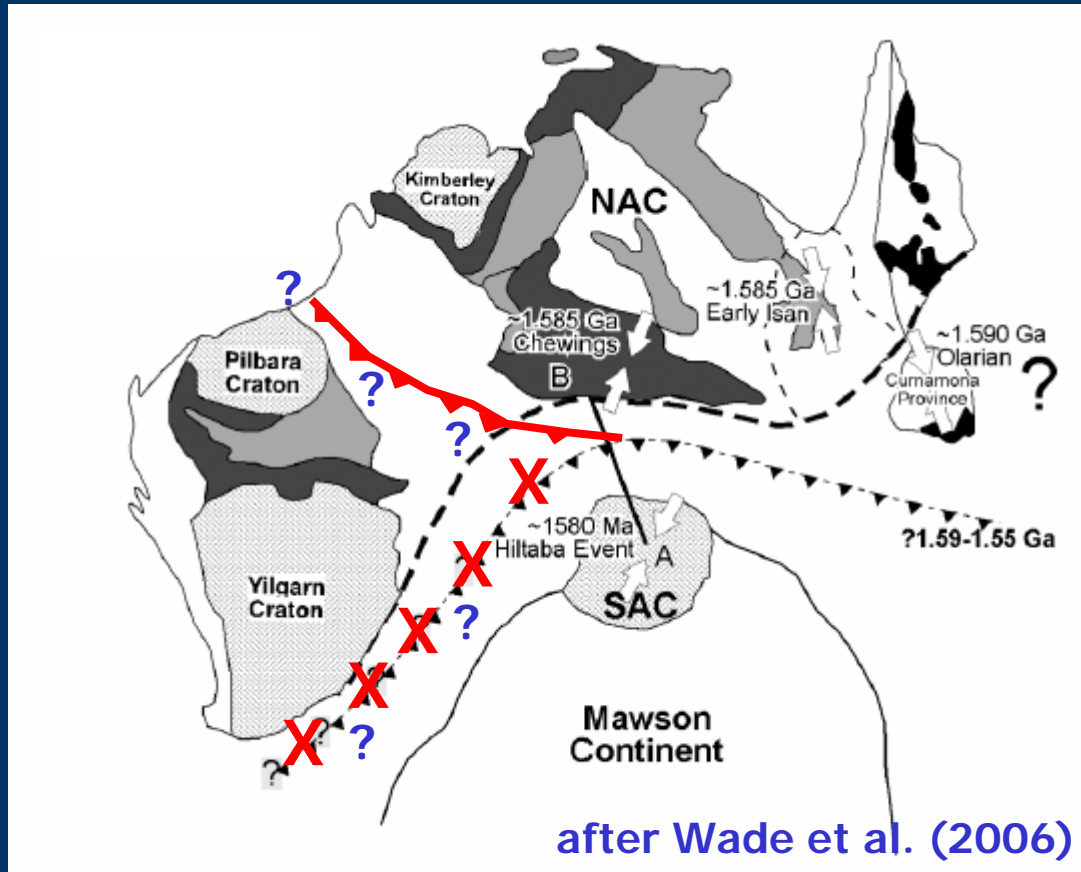


- fractionated I-type monzogranite intrusions:
 - Mt Crofton (magnetite)
 - Minyari (ilmenite)
 - O'Callaghans
- geochemistry consistent with melting of older felsic crust
- c. 650-640 Ma (Dunphy & McNaughton, 1998)
- Mt Crofton/Minyari and O'Callaghans have distinct ϵ_{Nd} values implying different age of source rocks – Mt Crofton & Minyari (1.6-1.7 Ga) vs O'Callaghans (2.3 Ga)



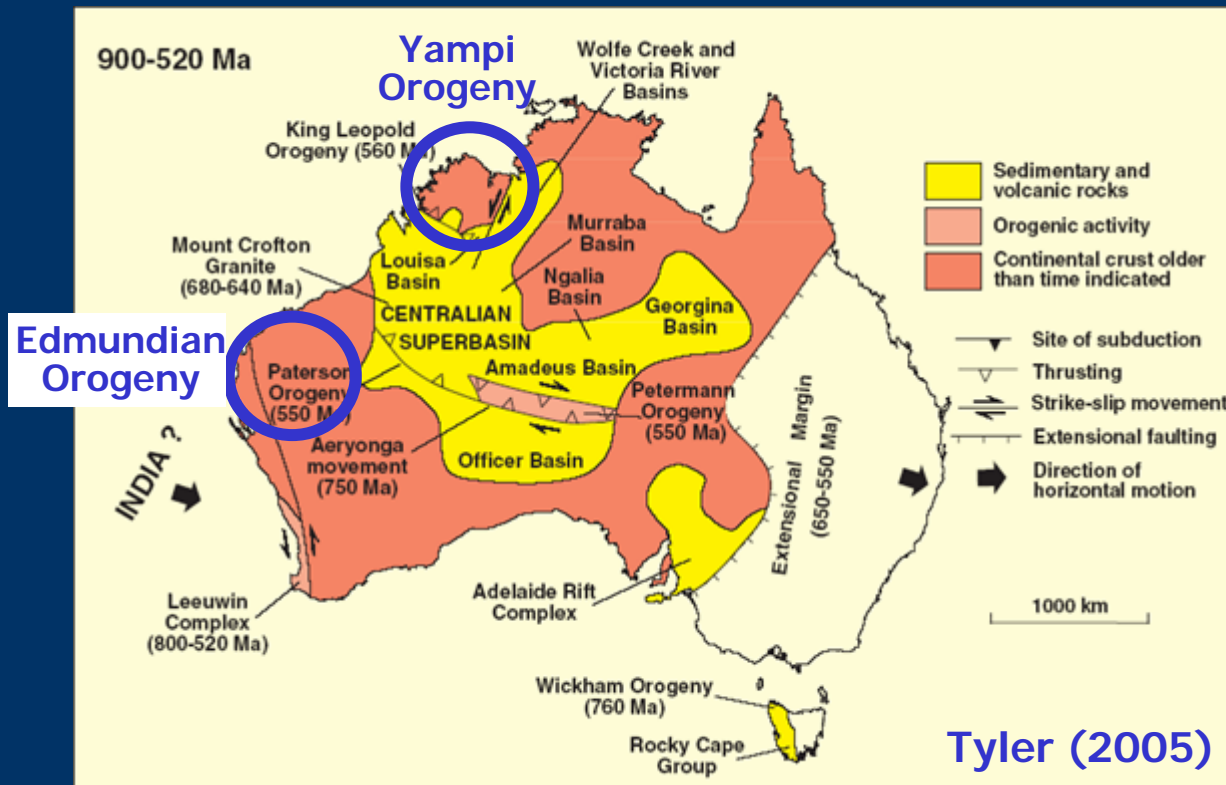
Final comments 1: Tabletop Terrane

- terrane likely extends under Telfer and Anketell areas; area is copper-gold prospective (and under shallow cover)
- 1575-1550 Ma calc-alkaline magmatism provides links to arc-related magmatism in northern Musgrave/southern Arunta as well as Isan/Late Kararan orogenies



Final comments 2: Yeneena Basin

- Throssell Range (& ?Lamil) Group deposited c. 950-840 Ma
- not correlated with Supersequence 2 (Centralian Superbasin) (cf. Bagas, 2004); possibly pre-basal Officer Basin (Supersequence 1)
- ?related to uplift/exhumation in west and north Australia during c. 0.95-0.85 Ga Edmondian/Yampi orogenies



Acknowledgements

- Martu people for land access
- Minerals exploration companies for field logistic support, access to core, datasets
- GSWA for field logistic support



Distribution of mineralization

