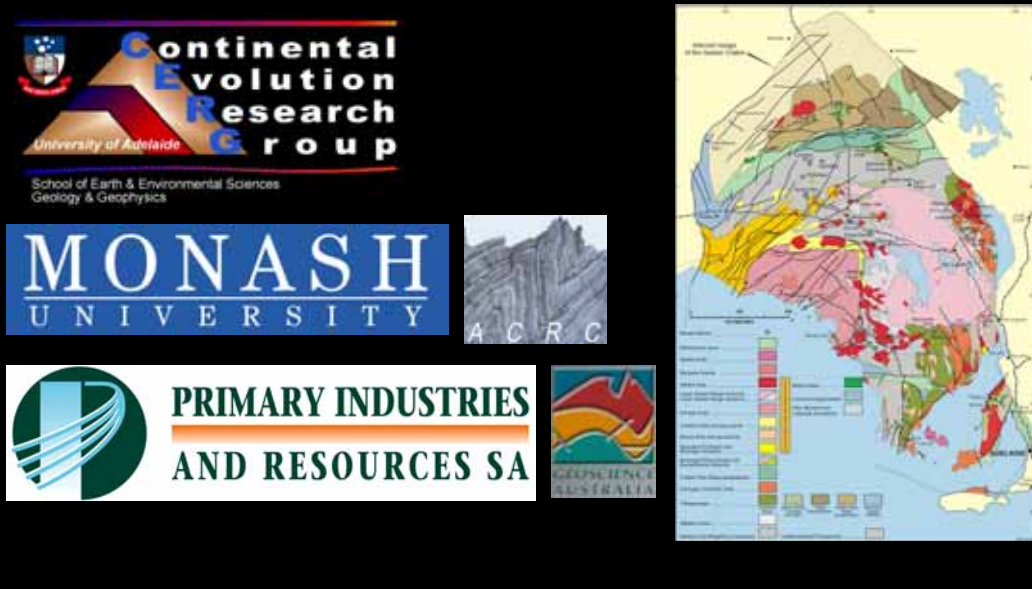


Developing a tectonic framework for the Gawler Craton: a collaborative 5 year project



Developing a tectonic framework for the Gawler Craton: a collaborative 5 year Australian Research Council funded project

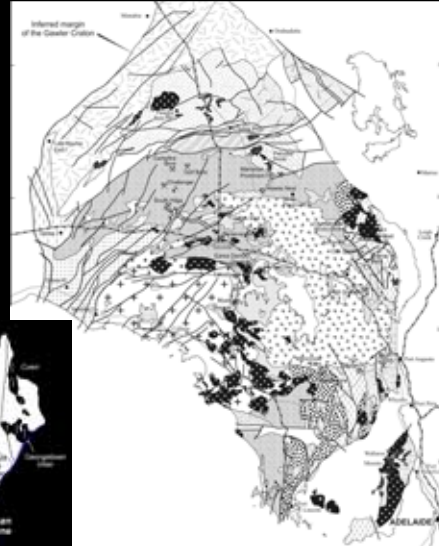
 <p>School of Earth & Environmental Sciences Geology & Geophysics</p>	<p>Martin Hand Graham Heinson Nick Direen Karin Barovich</p>	<p>Greg Swain Rian Dutch Justin Payne Rob Gill Stephan Thiel</p>
		 <p>Peter Betts Bruce Schaefer Steve Beresford</p>
	<p>Michael Schwarz Gawler Craton Team</p>	

Towards a tectonic framework for the Gawler Craton



The tectonic evolution of the Gawler Craton is defined by two tectonic megacycles both of which lead to apparent cratonisation....

It is also defined by a lot of unknowns.....

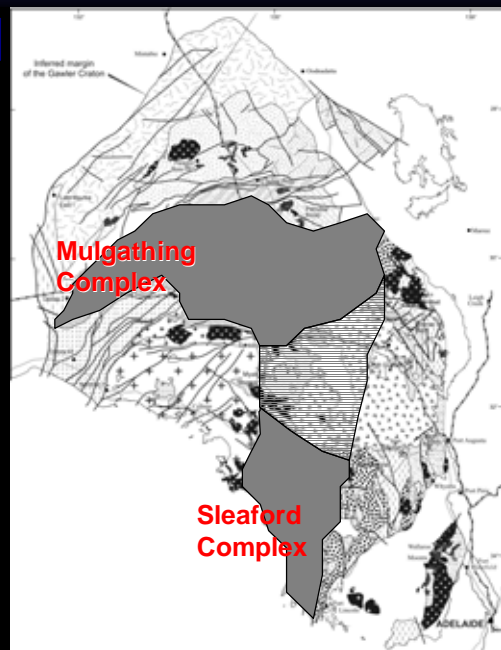


Towards a tectonic framework for the Gawler Craton



Megacycle 1: (2.6-2.4 Ga)

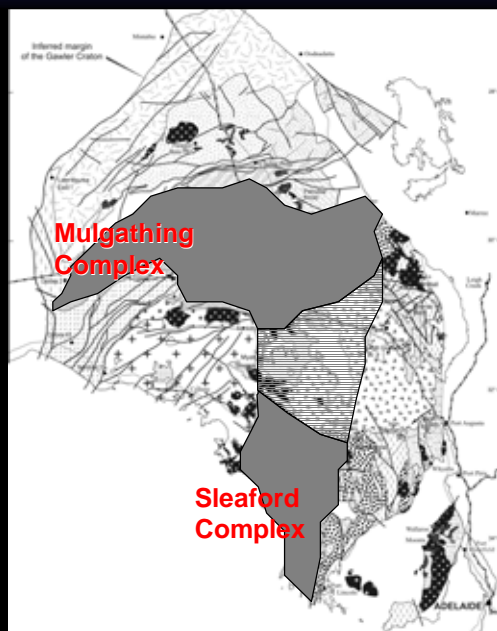
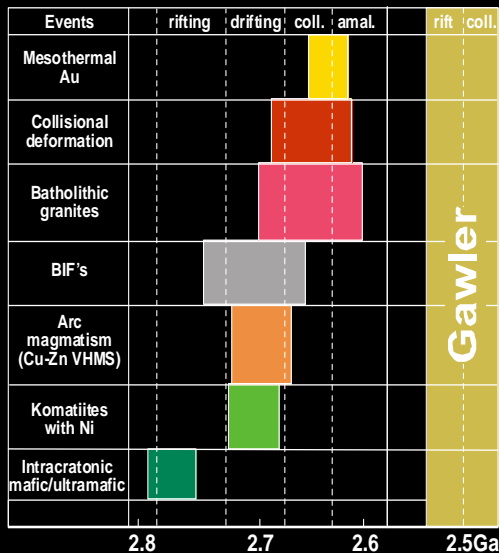
- 2.55-2.51 Ga: Rift-related sequences derived from late Archaean crust and mafic-ultramafic packages.
- 2.55-2.50 Ga: Arc-like felsic rocks.
- 2.48-2.42 Ga: Regional high heat flow tectonism (Sleafordian Orogeny).
- 2.4-2.0 Ga: Cratonisation.



Towards a tectonic framework for the Gawler Craton



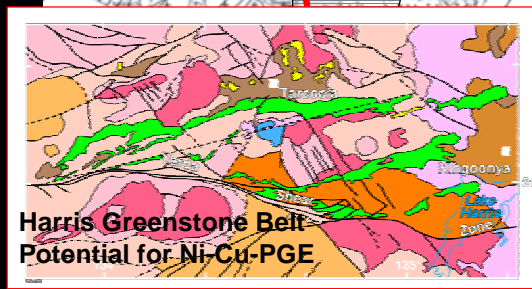
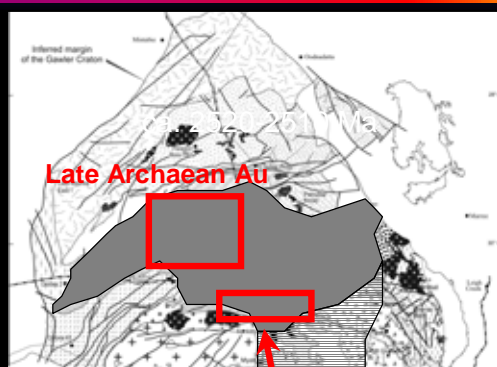
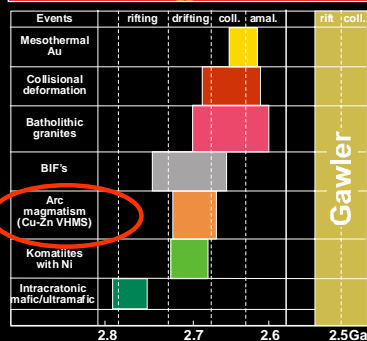
Cycle 1: Late Archaean-Early Palaeoproterozoic (2.55-2.4 Ga)



Towards a tectonic framework for the Gawler Craton



Cycle 1: Late Archaean-Early Palaeoproterozoic (2.55-2.4 Ga)

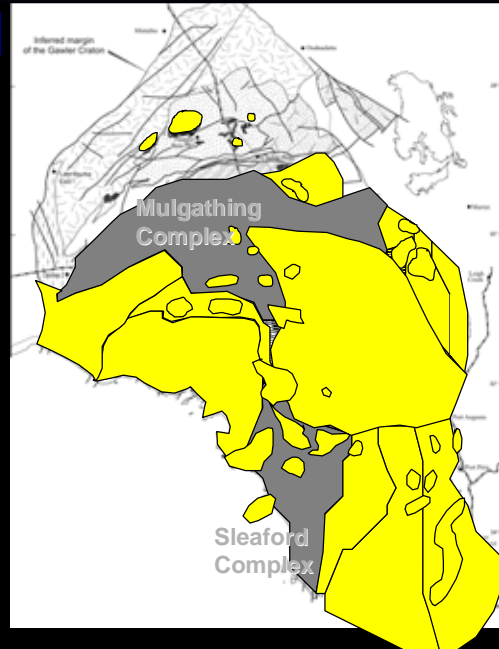


Towards a tectonic framework for the Gawler Craton



Megacycle 2: (1.9-1.55 Ga)

- Rift basin development.
- Regional high heat flow deformation and metamorphism.
- Regional magmatic systems.
- IOCG and Au mineral systems.



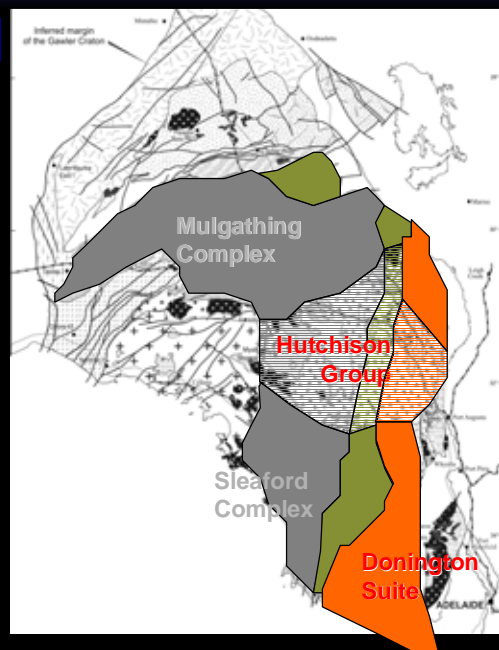
Towards a tectonic framework for the Gawler Craton



Megacycle 2

1.9-1.85 Ga

- Initiated by basin development on rifted late Archaean basement.
- Terminated by regional high-T compressional deformation magmatism and crustal extension (1.85 Ga).



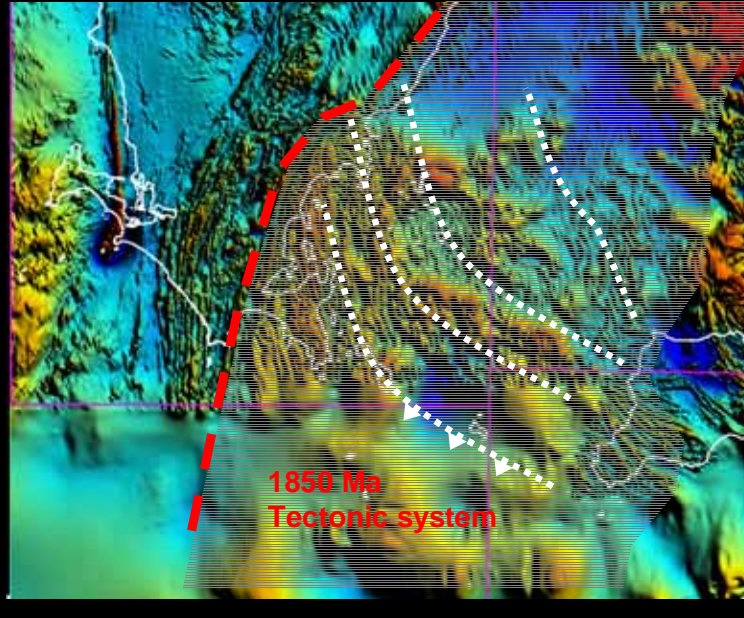
Towards a tectonic framework for the Gawler Craton



Megacycle 2

1.9-1.85 Ga

- Initiated by basin development on rifted late Archaean basement.
- Regional high-T transpressional north-directed transport and extensional crustal thinning.
- Voluminous syn-deformational magmatism.



Towards a tectonic framework for the Gawler Craton



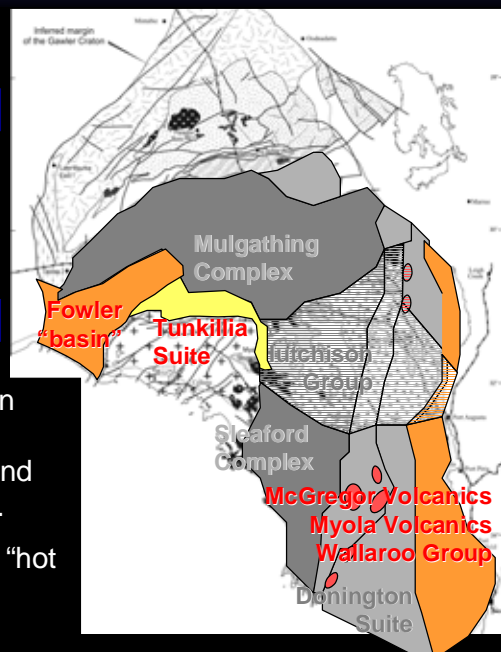
Megacycle 2

1.8-1.75 Ga

- Basin development on rifted and volcanised late Archaean and Palaeoproterozoic basement.

1.75-1.68 Ga: Kimban Orogeny

- An apparently Gawler wide event, terrain scale strike-slip deformation systems (Kalinjala and Tallacoutra shear zones) and magmatism (Moody and Tunkillia Suites).
- High-T system foot prints are primed by "hot basins".



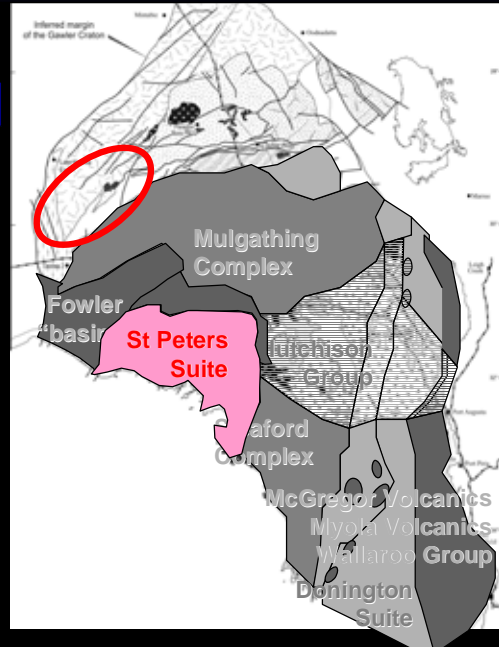
Towards a tectonic framework for the Gawler Craton



Megacycle 2

1.65-1.62 Ga

- Localised rift basin development.
- Regional ultrahigh-T metamorphism in NW Gawler.
- Development of St Peters Magmatic Suite: felsic and mafic syn-deformational system.
- Apparent arc related geochemistry of the St Peters Suite suggest a convergent margin system.



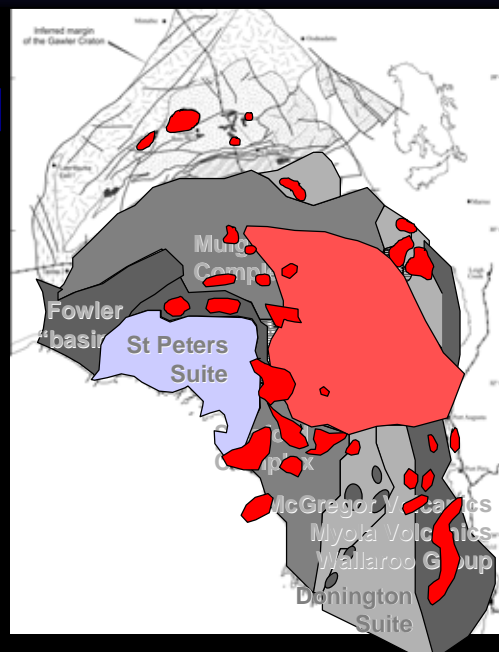
Towards a tectonic framework for the Gawler Craton



Megacycle 2

1.59-1.57 Ga: Hiltaba

- Localised rift basin development and voluminous felsic magmatism (1.59 Ga).
- Terrain-scale I-type felsic magmatism with a significant crustal component and mafic subordinates.



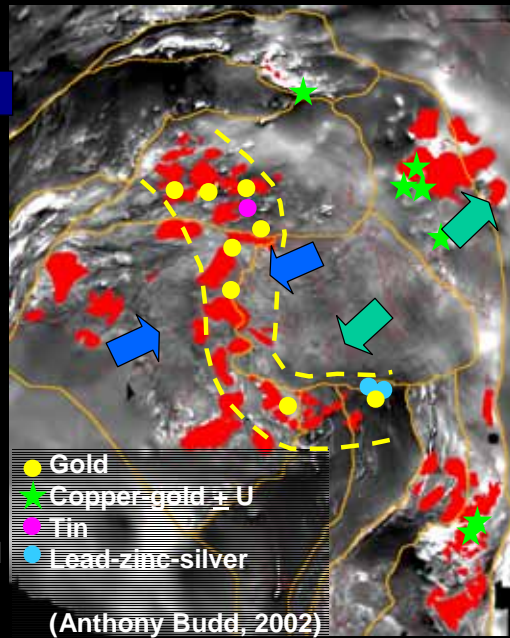
Towards a tectonic framework for the Gawler Craton



Megacycle 2

1.59-1.57 Ga: Hiltaba

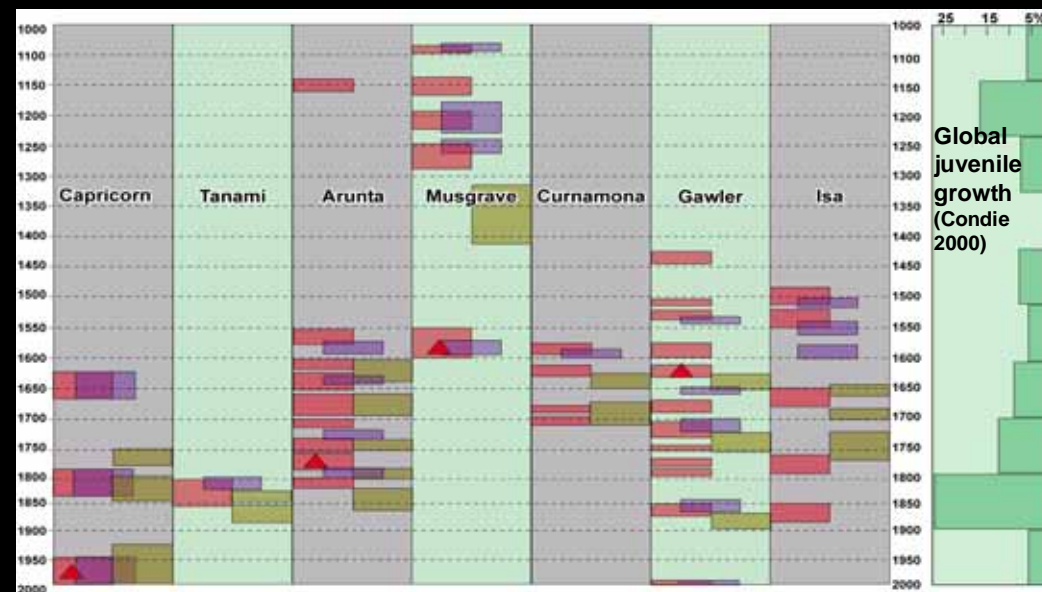
- Localised rift basin development and voluminous felsic magmatism (1.59 Ga).
- Terrain-scale I-type felsic magmatism with a significant crustal component and mafic subordinates.
- Development of IOCG systems in rift related settings in the eastern Gawler.
- Regional compressive deformation (1.58 Ga).
- Development of Au systems associated with compressional structures in the central Gawler.



Towards a tectonic framework for the Gawler Craton



What does it all mean, and why and how did it happen?



Towards a tectonic framework for the Gawler Craton



What does it all mean and why and how did it happen?

Cycle 1: 2.55-2.4 Ga

Rifting followed by shortening.



Towards a tectonic framework for the Gawler Craton



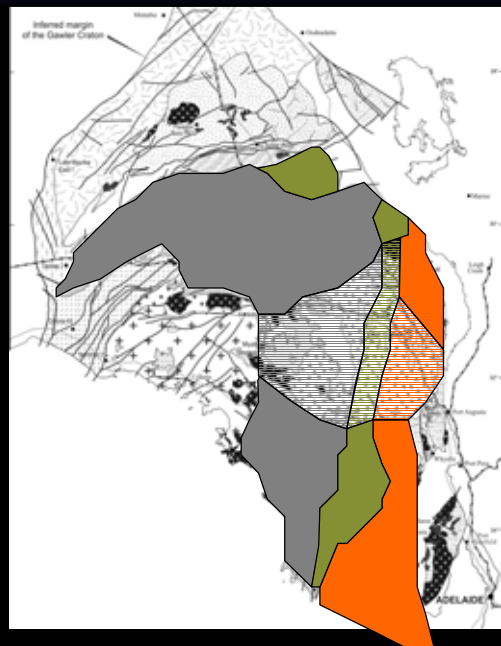
What does it mean and why and how did it happen?

Cycle 1: 2.55-2.4 Ga

Rifting followed by shortening.

Cycle 2: 1.9 to 1.57 Ga

1900-1850 Ma – Rifting followed by shortening and regional magmatism.



Towards a tectonic framework for the Gawler Craton



What does it mean and why and how did it happen?

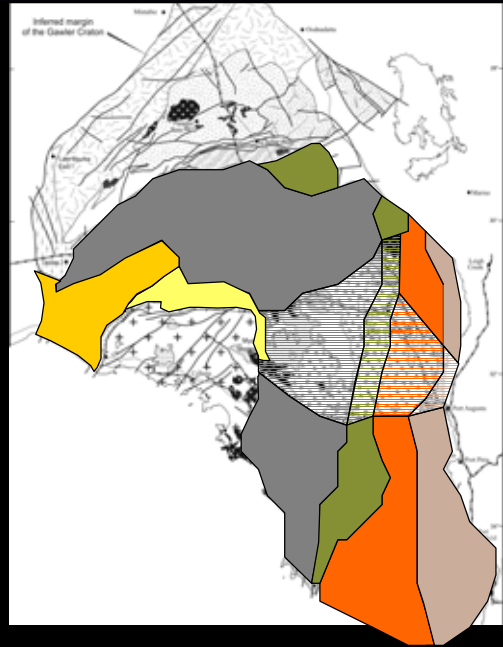
Cycle 1: 2.55-2.4 Ga

Rifting followed by shortening.

Cycle 2: 1.9 to 1.57 Ga

1900-1850 Ma – Rifting followed by shortening and regional magmatism.

1790-1700 Ma – Rifting followed by shortening and regional magmatism.



Towards a tectonic framework for the Gawler Craton



What does it mean and why and how did it happen?

Cycle 1: 2.55-2.4 Ga

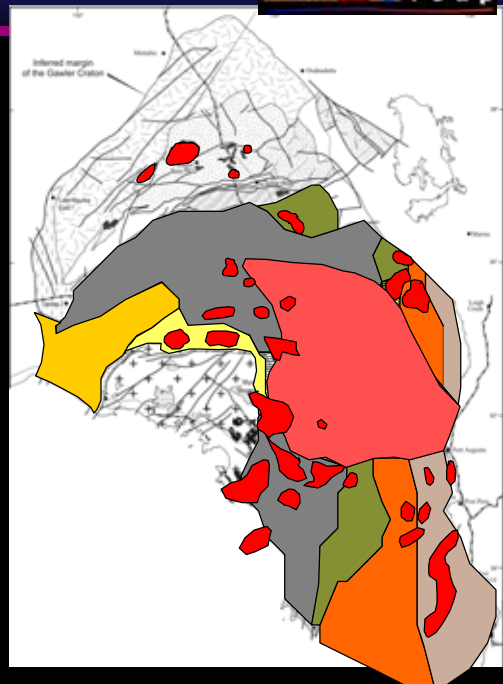
Rifting followed by shortening.

Cycle 2: 1.9 to 1.57 Ga

1900-1850 Ma – Rifting followed by shortening and regional magmatism.

1790-1700 Ma – Rifting followed by shortening and regional magmatism.

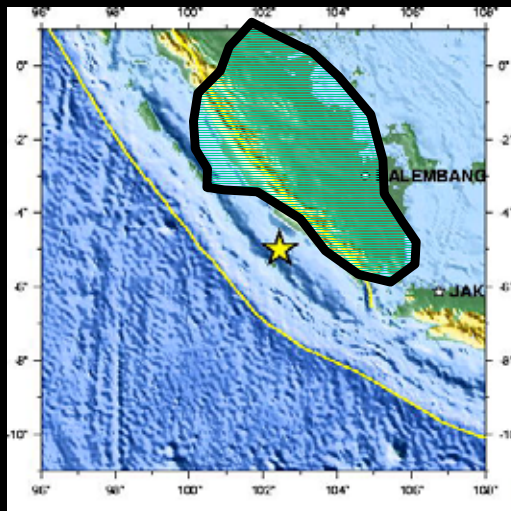
1600-1570 Ma – Rifting followed by shortening.



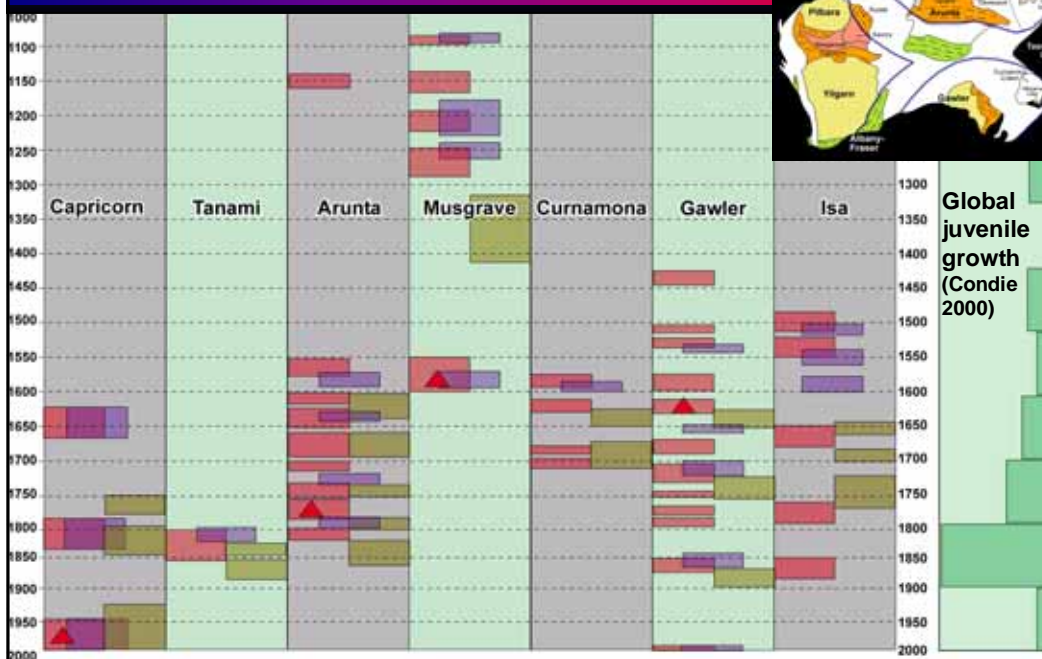
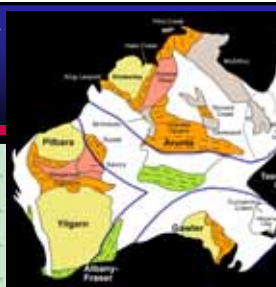
Towards a tectonic framework for the Gawler Craton



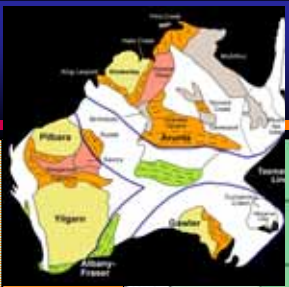
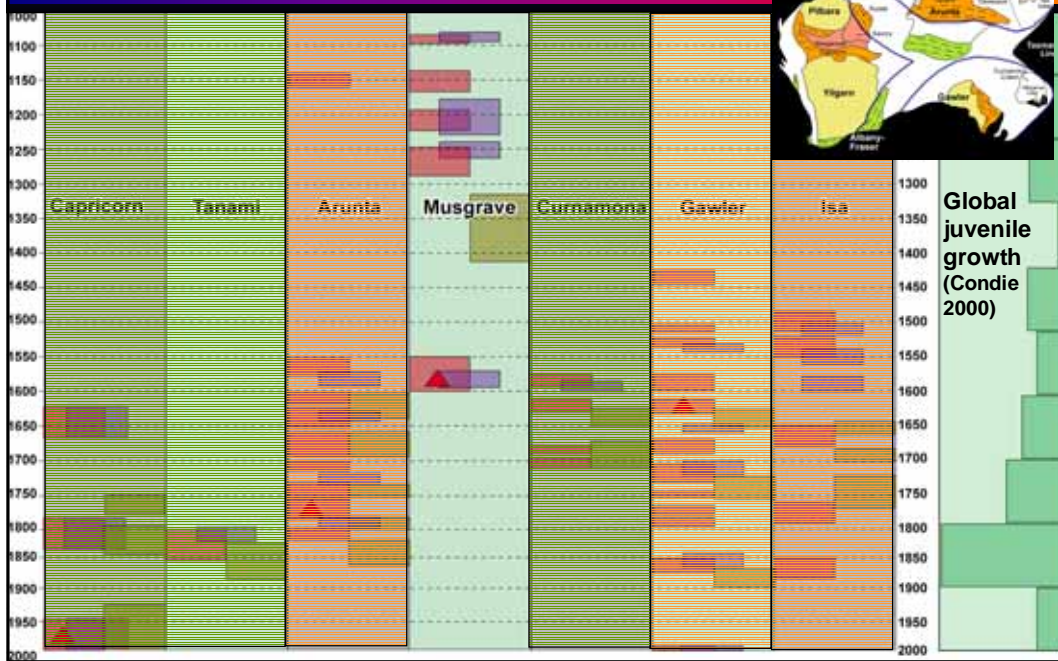
In the context of Gawler are the scales appropriate for accretionary systems to have played a central role?



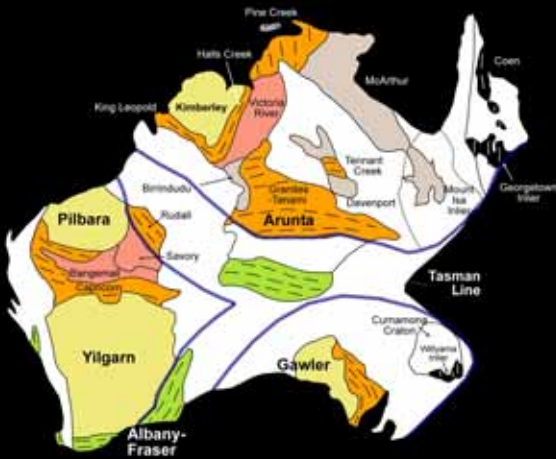
Towards a tectonic framework for the Gawler Craton



Towards a tectonic framework for the Gawler Craton



Selected Proterozoic regions



“Short” history systems

Capricorn
Kimberly
Tanami

“Long” history systems

Gawler (high T low P)
Arunta (high T low P)
Isa (high T low P)

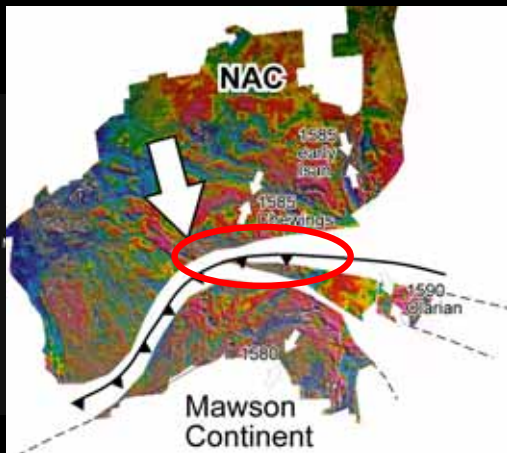
Do systems with short histories predominantly define collisional belts?

Are systems with long histories predominantly located in continental interior settings? If so:

- (1) Why are the interiors so hot and responsive?
- (2) Why is there arc-like magmatism in those terrains as well?

What happened at 1600-1550 Ma: In the Gawler it was the Hiltaba Event, but elsewhere...

Voluminous juvenile subduction-related crust formation along the northern margin of the presently located Gawler Craton.



Does this mean that the Hiltaba event was dynamically linked to an adjacent evolving margin?

Is there a danger of looking internally for the solutions when the drivers are external?

Towards a tectonic framework for the Gawler Craton: Ad-Mon-MRG

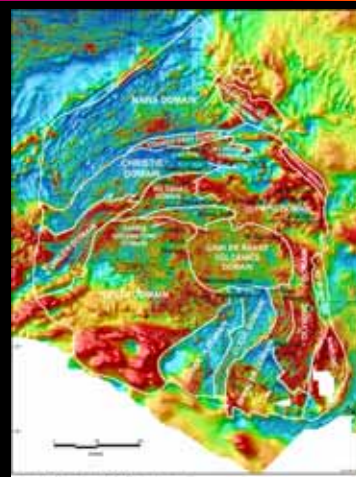


Impediments to developing a tectonic framework for the Gawler Craton:

- (1) Lack of outcrop.
- (2) Scale of the craton.
- (3) Protracted tectonic history.

Solution:

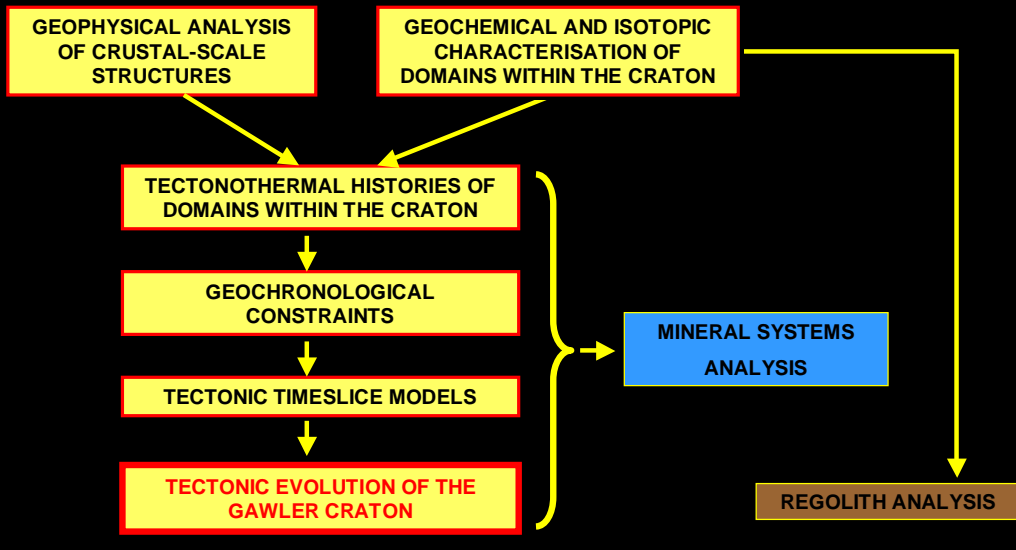
Develop a "remote sensing" approach to tectonic analysis that is effective at large scales.



Towards a tectonic framework for the Gawler Craton: Ad-Mon-MRG



Generalised flow chart for the development of the Gawler Craton tectonic framework and links to parallel programs in the overall GCSP



Towards a tectonic framework for the Gawler Craton: Ad-Mon-MRG



METHODOLGIES APPLICABLE TO THE TECTONIC ANALYSIS OF POORLY EXPOSED TERRAINS

GOAL	TOOLS	OUTCOMES
GEOPHYSICAL ANALYSIS OF CRUSTAL-SCALE STRUCTURE	Magneto telluric profiling Potential field modelling Seismic line profiles	Constrained 3D crustal architecture
GEOCHEMICAL AND ISOTOPIC CHARACTERISATION OF DOMAINS	Sm/Nd and Re/Os isotopic modelling Major, Trace and Rare Earth Element analysis Geochemical and isotopic tectonic discrimination	Constrained lithospheric evolution of tectonic domains Geochemical and isotopic datasets
TECTONOTHERMAL HISTORIES OF DOMAINS	Modelling of metamorphic phase relationships Pressure temperature calculations	Constrained thermal regimes and event styles Depth-temperature datasets
GEOCHRONOLOGY	SHRIMP U/Pb analysis Th-U-Pb electron microprobe dating of monazite Sm/Nd dating Ar/Ar analysis	Constrained thermal histories and event time lines across the craton Age constraints on crustal-scale structural boundaries

Towards a tectonic framework for the Gawler Craton: Ad-Mon-MRG



TARGET AREAS IN THE GAWLER CRATON

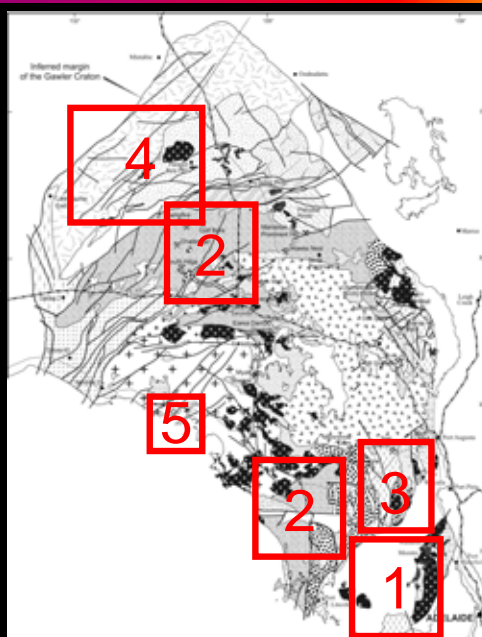
TARGET AREA	RATIONALE
Olympic Cu-Au province	Recognised Fe-oxide Cu-Au mineral province. Tectonic drivers not yet established. Focus of current mineral systems analysis.
Central Gawler Craton Au-only province	Becoming an important Au mineral province. Tectonic drivers not yet established. Spatial pattern of Au verses Cu-Au not yet explained. Focus of current mineral systems analysis.
Fowler Domain	Dominates the geological and geophysical expression of the western Gawler Craton. Strong potential for Ni systems.
Northwestern Tectonic Domains	Dominates the geophysical expression of the northern Gawler Craton. Geological affinities to the rest of the Gawler Craton are unknown. These poorly known terrains link the Gawler and Musgrave provinces.
Domain Boundaries	History of craton-scale domain boundaries and domain assemblage is largely unknown. Likely locations for mineralisation and fluid flow.

Towards a tectonic framework for the Gawler Craton: Ad-Mon-MRG



Current projects

- 1: Tectonic setting of the Donington Suite.
- 2: Late Archaean terrain development: sediment sources, geochemical and isotopic characterisation of rock systems.
- 3: Thermal history of the Kimban Orogeny in the eastern Gawler Craton.
- 4: Isotopic terrain mapping in the northern Gawler Craton exploring the boundaries with the broader Proterozoic.
- 5: Defining the St Peter Suite-Hiltaba transition.



Towards a tectonic framework for the Gawler Craton: Ad-Mon-MRG



Current projects

6: Isotopic characterisation of IOCG and Au mineralisation and related alteration.

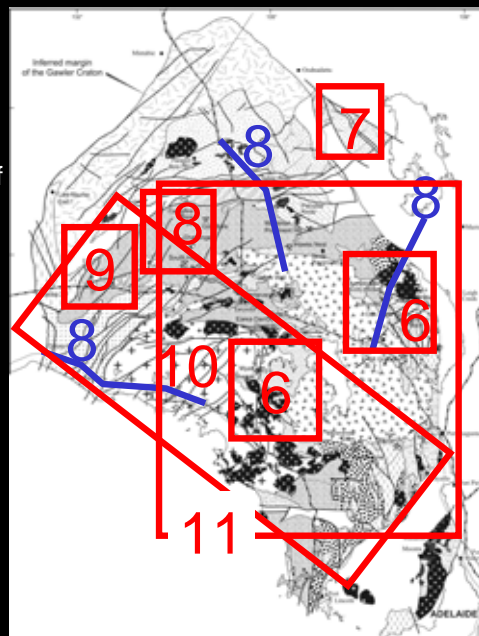
7: Peake and Denisons, looking for the edge of the Gawler Craton and components of the Isan system.

8: Large scale crustal architecture, magneto-telluric imaging of the deep crust and potential field constraints.

9: Timing of events and architecture in the Fowler Domain.

10: Timing of deformation in regional-scale shear systems.

11: Hiltaba-aged mafic magmatism.



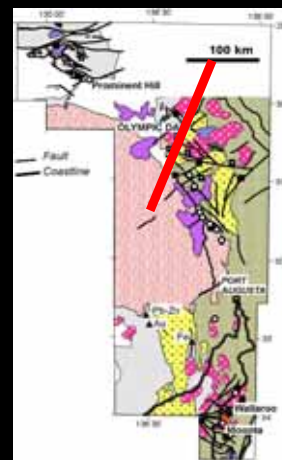
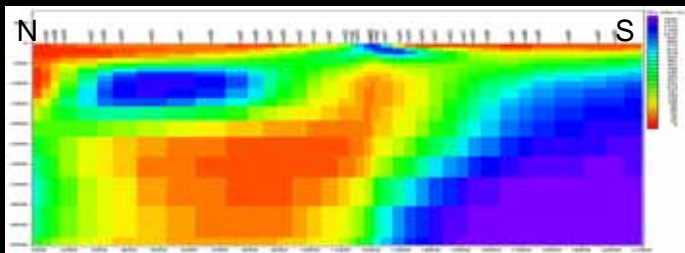
Towards a tectonic framework for the Gawler Craton: Ad-Mon-MRG



Outputs of the Gawler Tectonic project

- Timing of terrain scale shear zones not unique, but pointing to tectonic reactivation over a 250 Ma interval.

- Magneto-telluric constraints on crustal architecture on the OD region.



- Archaean crust in the Nawa Domain.

- Age and structural constraints on cycle 2 evolution of the eastern Gawler

Towards a tectonic framework for the Gawler Craton: Ad-Mon-MRG



Outputs of the Gawler Tectonic project

- (1) Extensive geochemical, isotopic and geochronological datasets for the Gawler Craton.
- (2) Constrained 3-dimensional lithospheric architecture of tectonic domains in the Gawler Craton.
- (3) Constrained tectonothermal evolution of tectonic domains and the crustal-scale structural boundaries within the Gawler Craton.
- (4) Constrained models for the evolution of the crust and lithospheric mantle in the Gawler Craton.
- (5) Inputs into the Gawler Craton Strategic Plan aimed at developing effective mineral exploration strategies for the region.