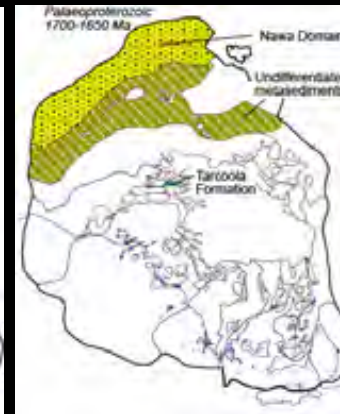


Towards a tectonic framework for the Gawler Craton



Martin Hand Justin
Payne, Greg Swain,
Karin Barovich, Rian
Dutch, Anthony Reid,
Mike Schwarz

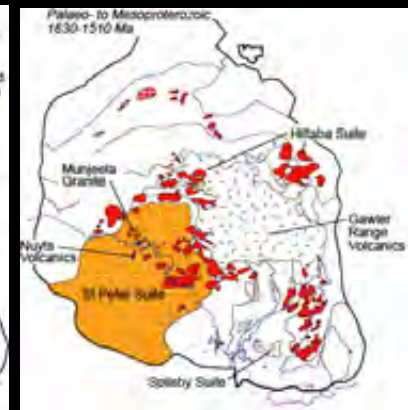
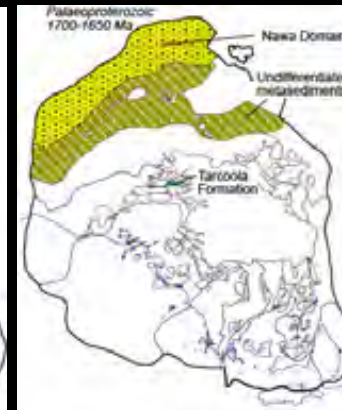


Towards a tectonic framework for the Gawler Craton

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



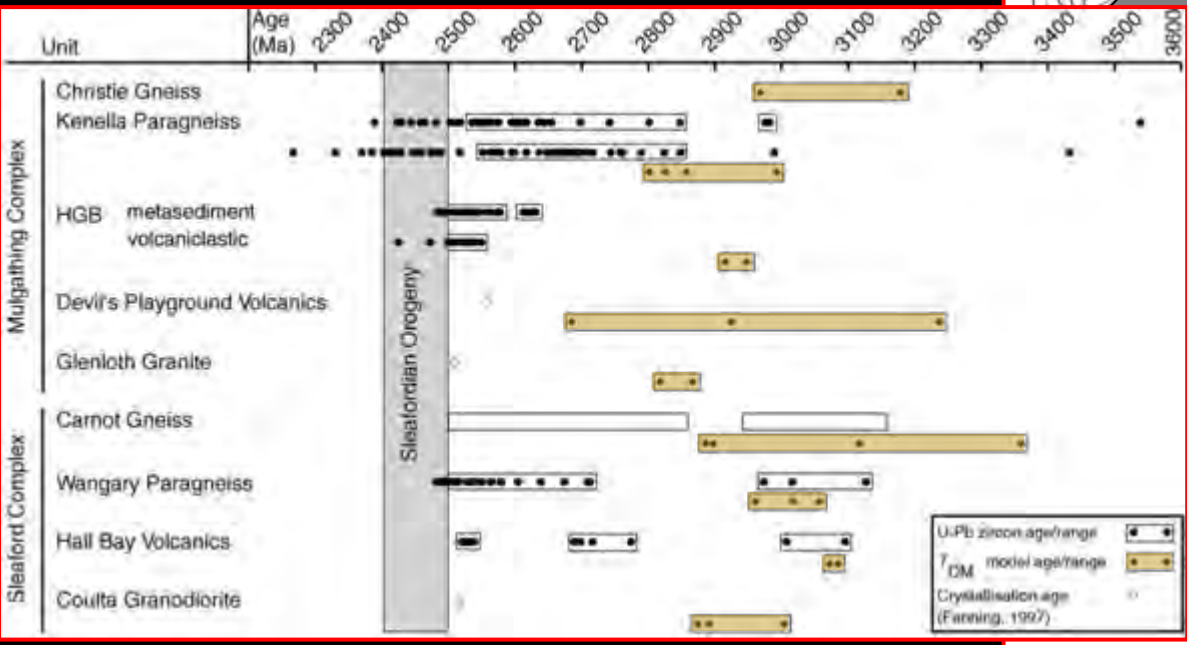
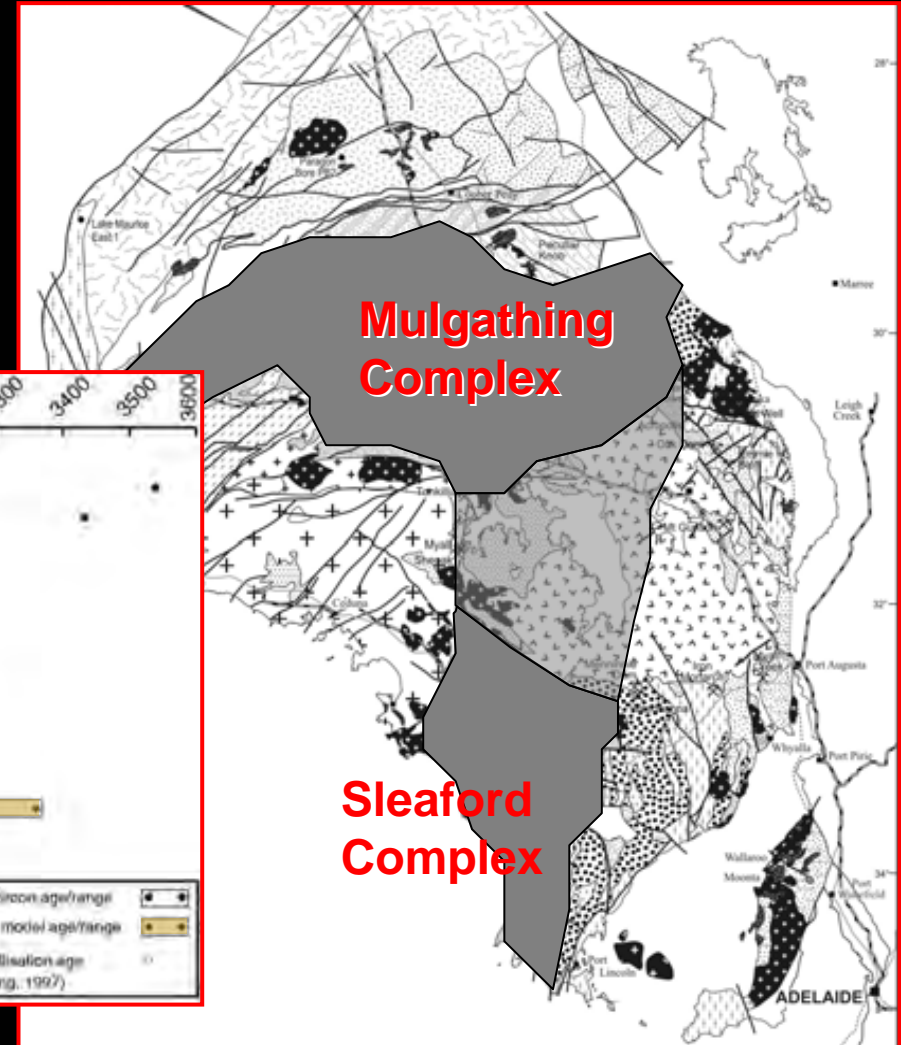
Do the lithostratigraphic components in the Gawler represent “insitu” craton building, or are there major, or even plate-scale boundaries within the craton?



Towards a tectonic framework for the Gawler Craton

Late Archaean-Early Palaeoproterozoic: 2550-2400 Ma

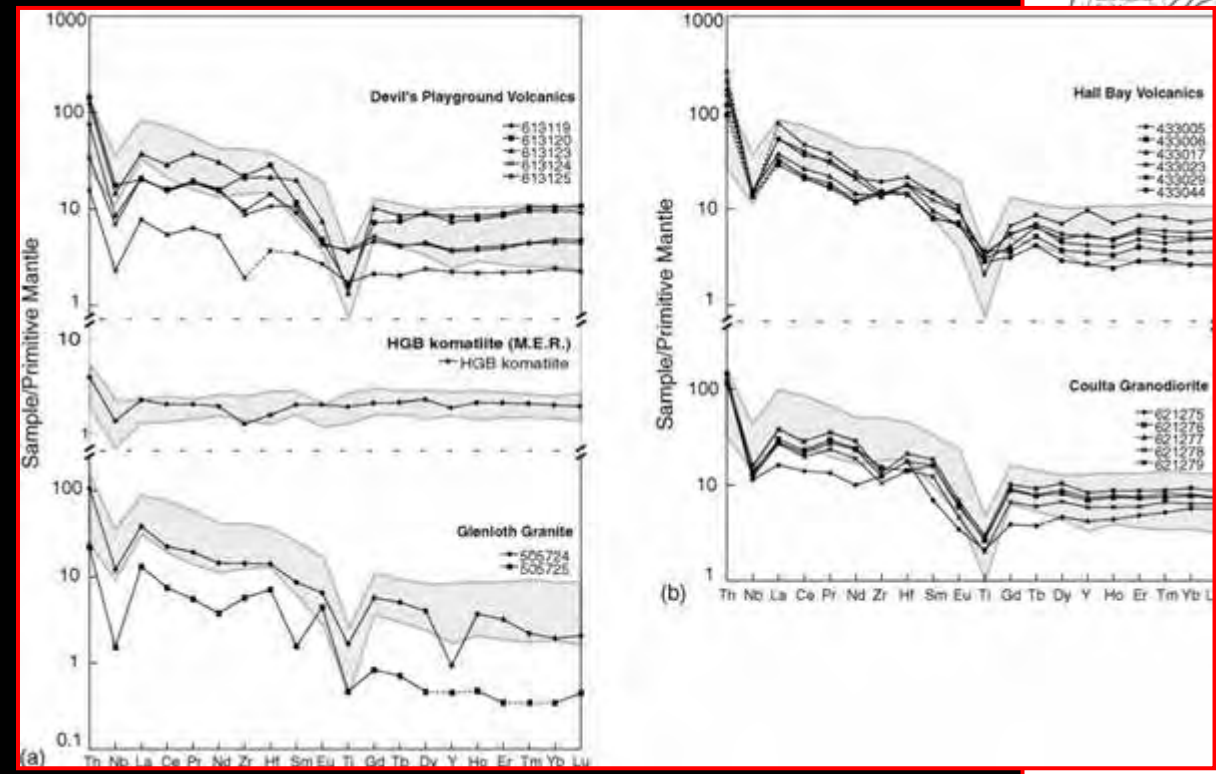
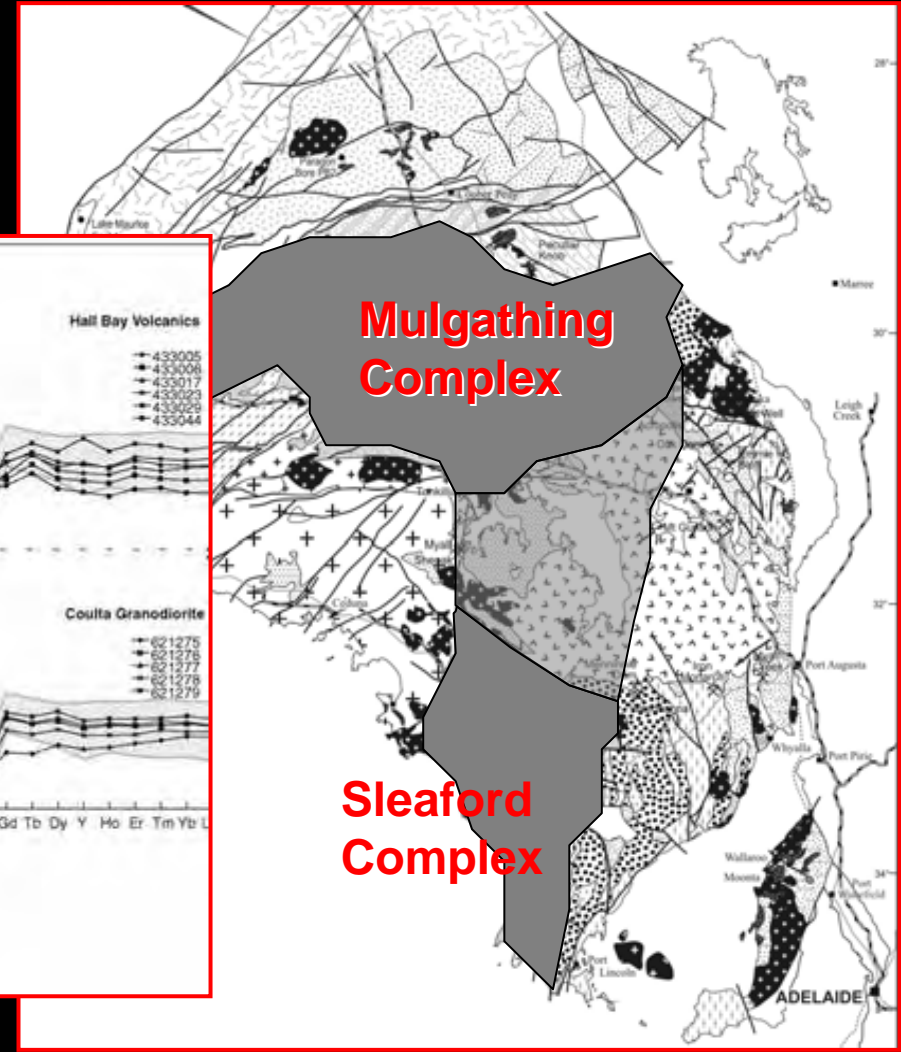
- 2.55-2.51 Ga: Rift-related sequences derived from late Archaean crust, minor BIF's.



Towards a tectonic framework for the Gawler Craton

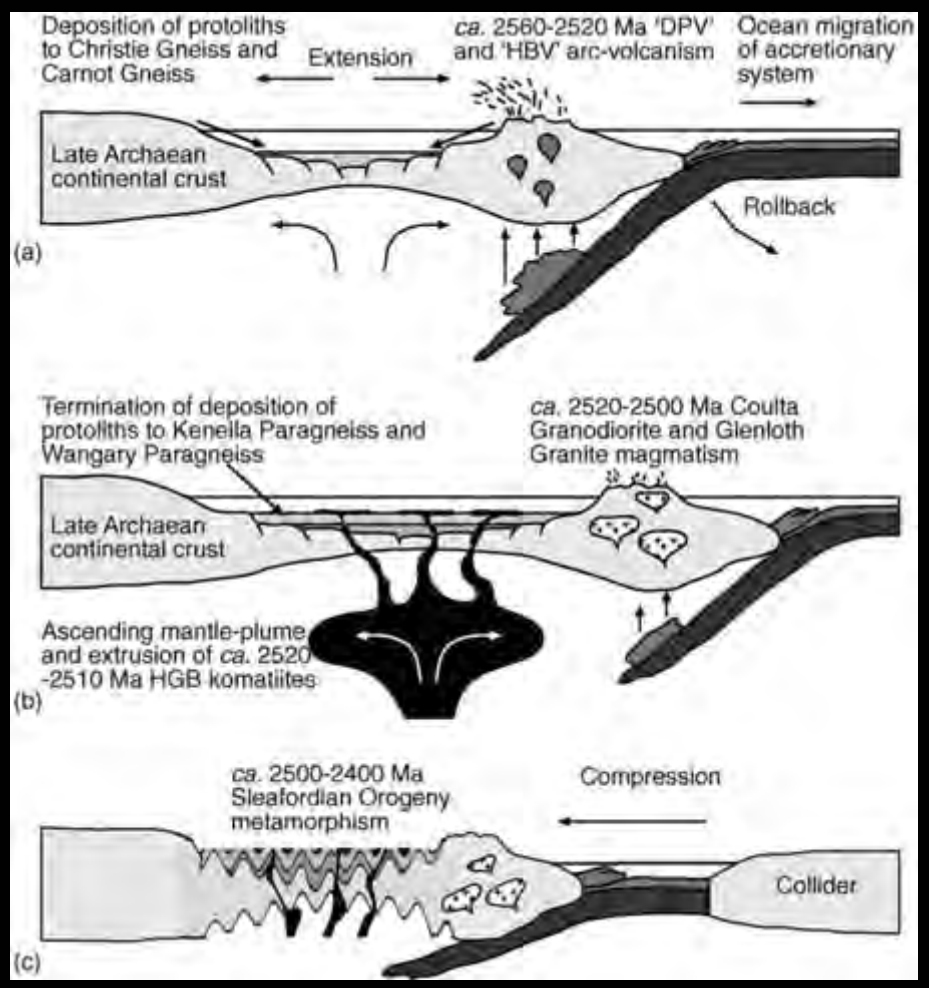
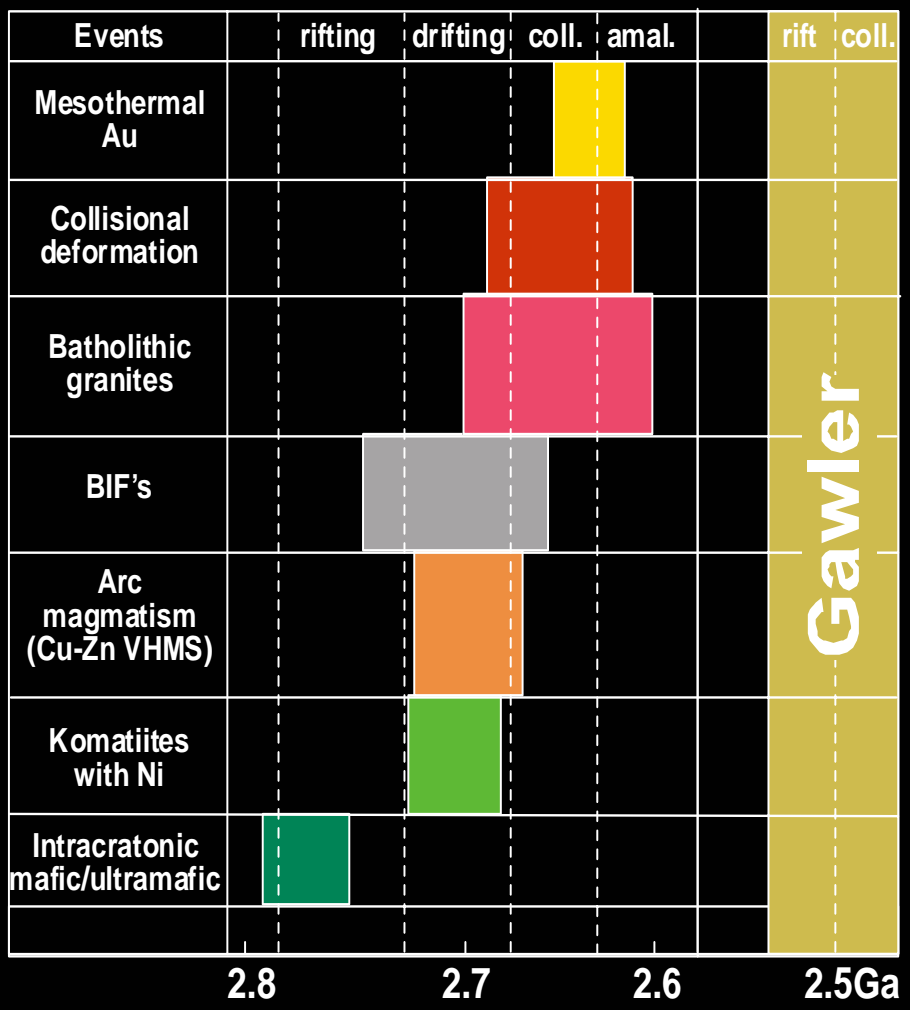
Late Archaean-Early Palaeoproterozoic: 2550-2400 Ma

2.55-2.51 Ga: Arc-related and arc-rift magmatism.



Towards a tectonic framework for the Gawler Craton

Late Archaean-Early Palaeoproterozoic (2.55-2.4 Ga)

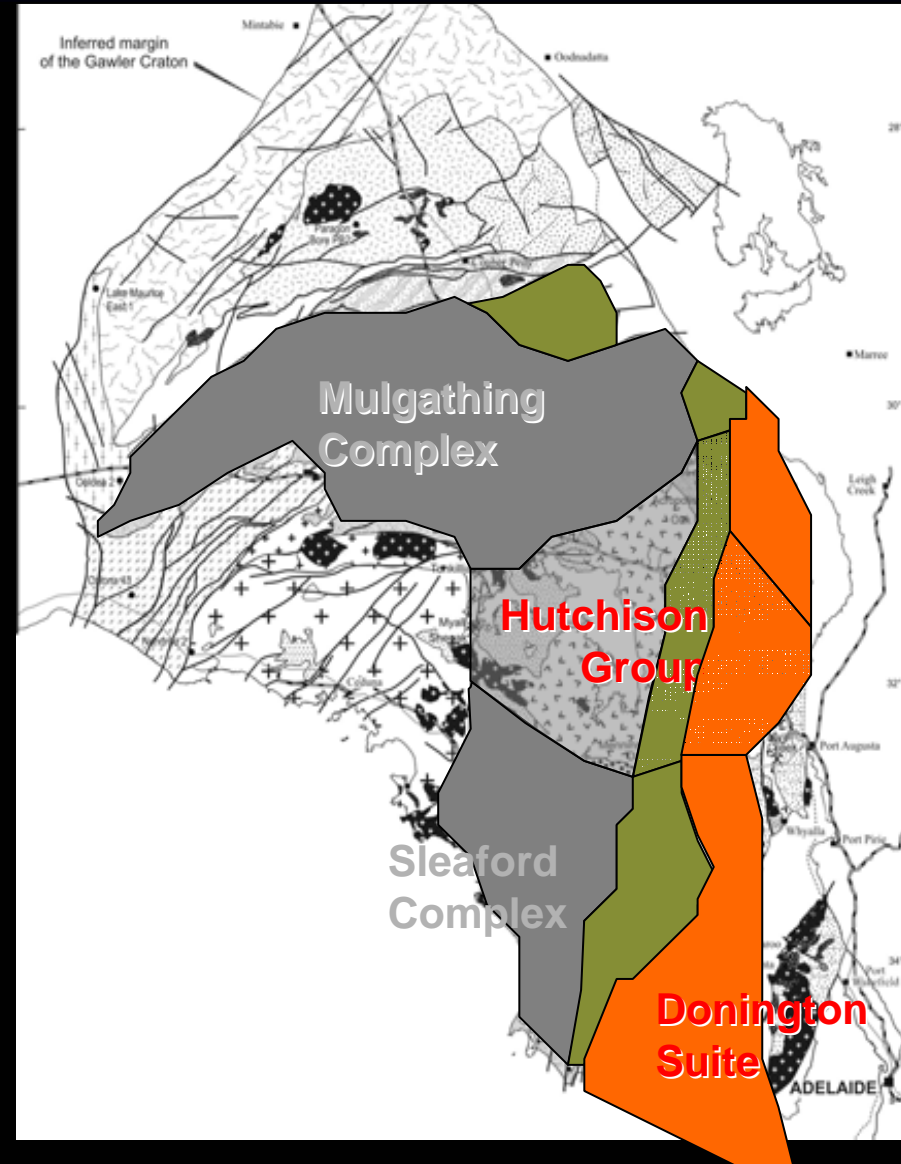


Towards a tectonic framework for the Gawler Craton

Megacycle 2

1.9-1.85 Ga

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



Towards a tectonic framework for the Gawler Craton

Megacycle 2

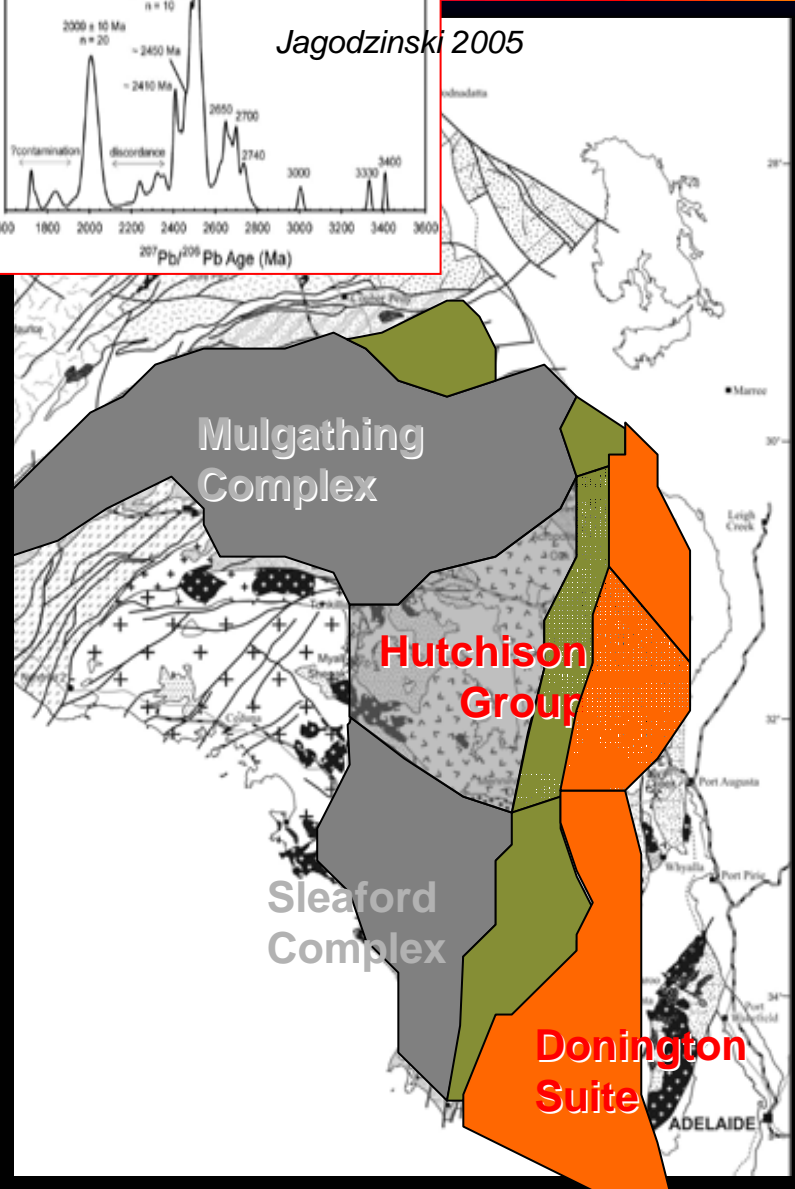
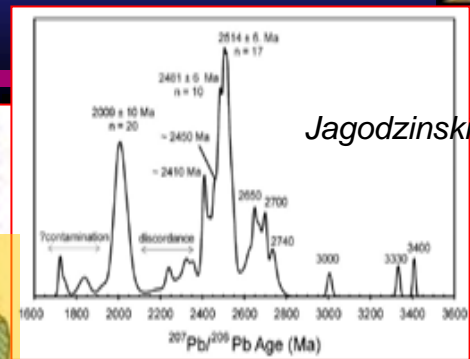
1.9-1.85 Ga:
Hutchison Group

Is there a major stratigraphic break?

Initial ϵ_{Nd} values range between -3.8 to +2.7

Initial ϵ_{Nd} values range between -9.4 to -8.4

2000, 2440, 2520 and 2720 Ma

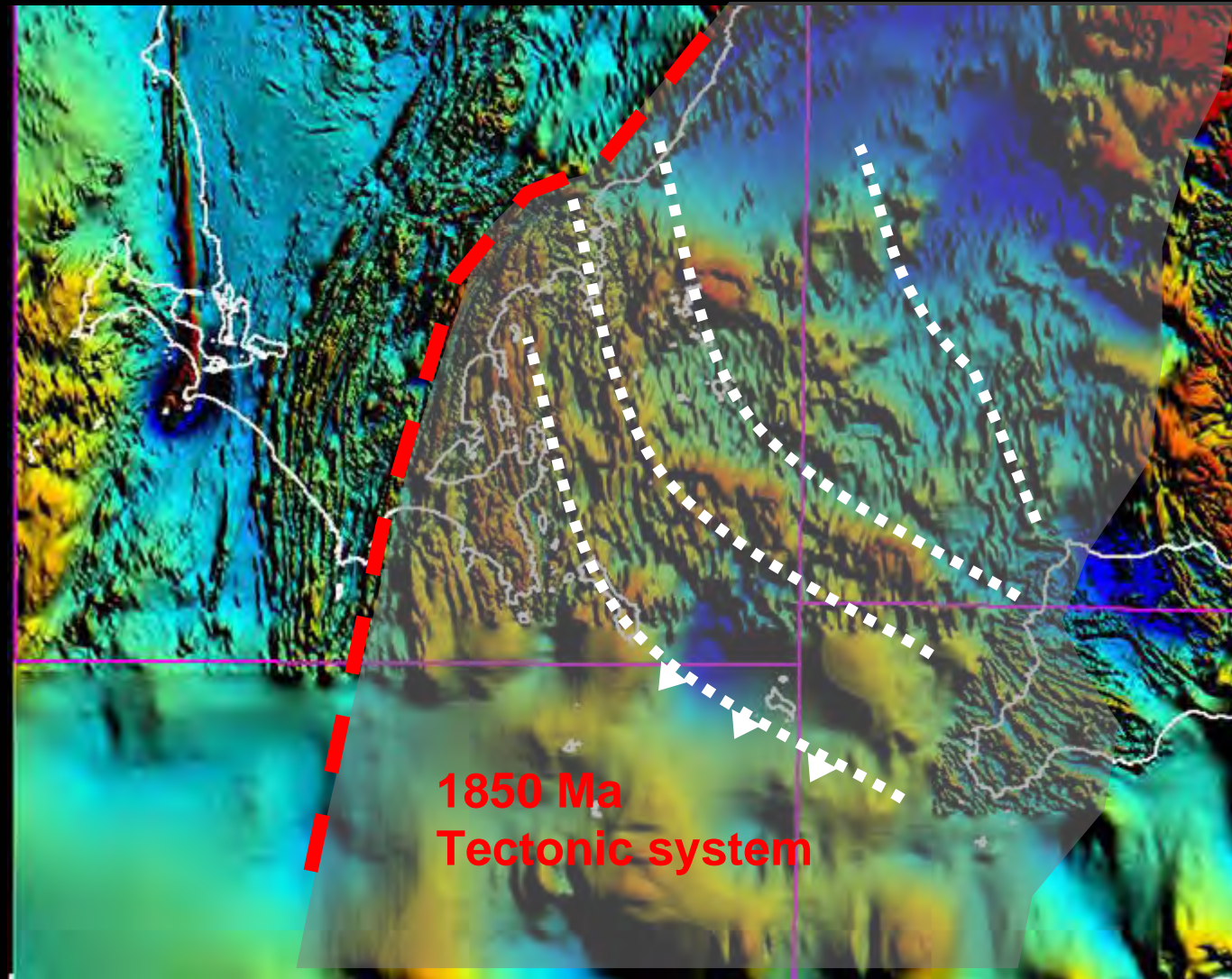


Towards a tectonic framework for the Gawler Craton

Megacycle 2

1.9-1.85 Ga

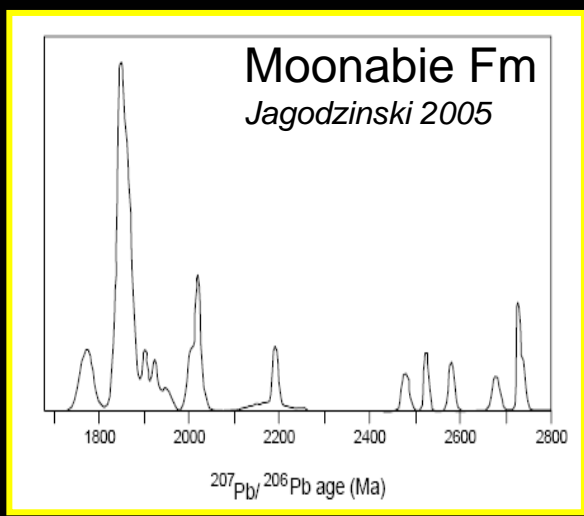
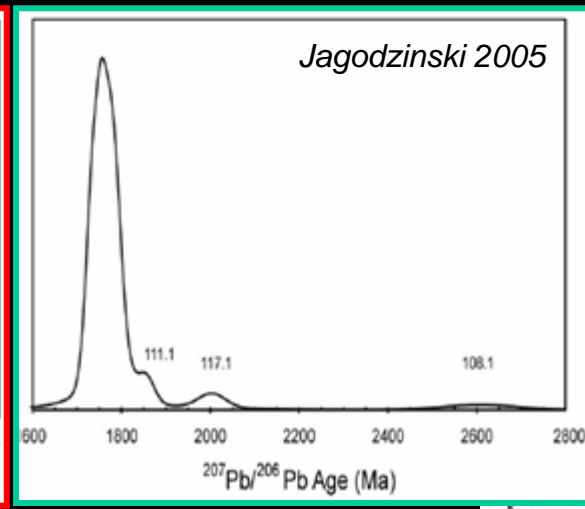
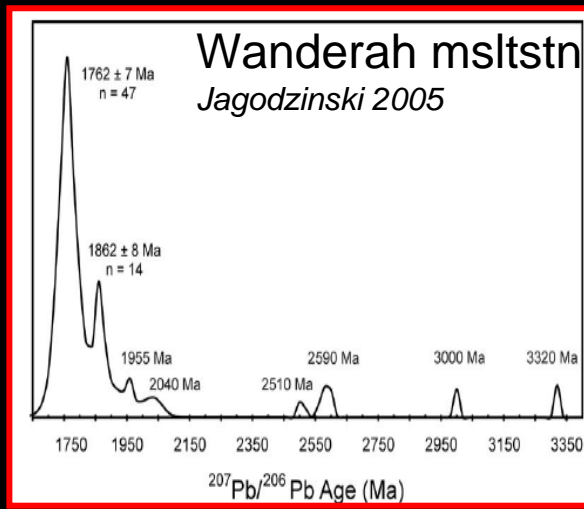
- Initiated by basin development on rifted late Archaean basement.
- Regional high-T transpressional north-directed transport and extensional crustal thinning.
- Voluminous syn-deformational magmatism.



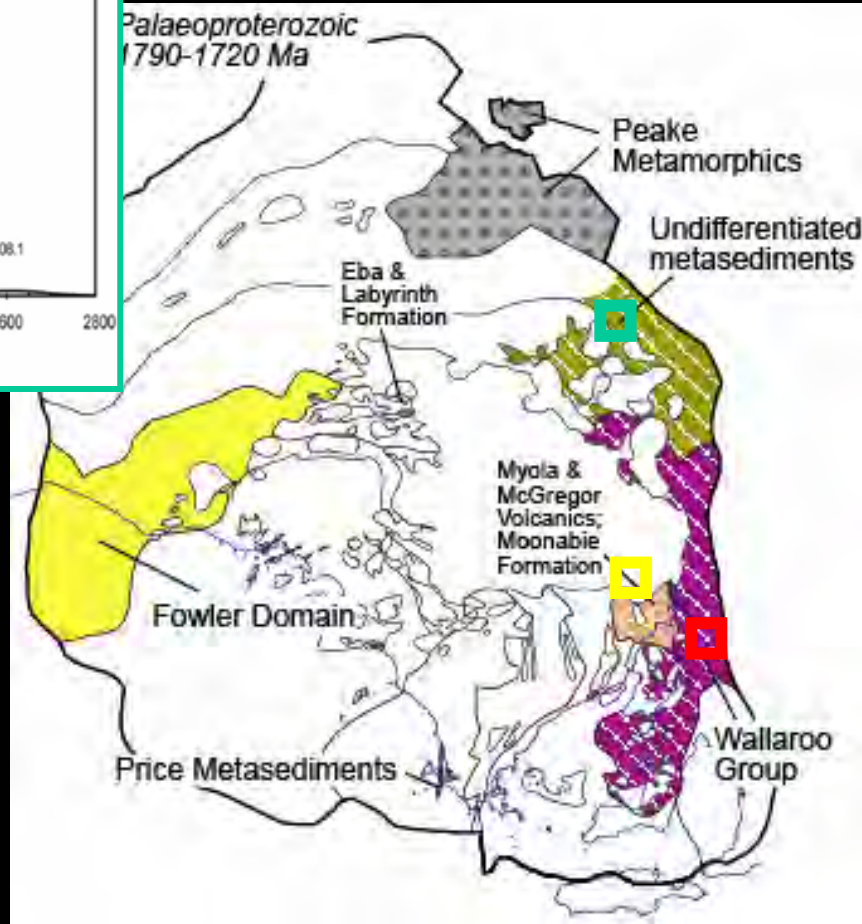
Towards a tectonic framework for the Gawler Craton

Younger rift packages (1.8-1.75)

- Basin development on rifted late Archaean and Palaeoproterozoic basement.



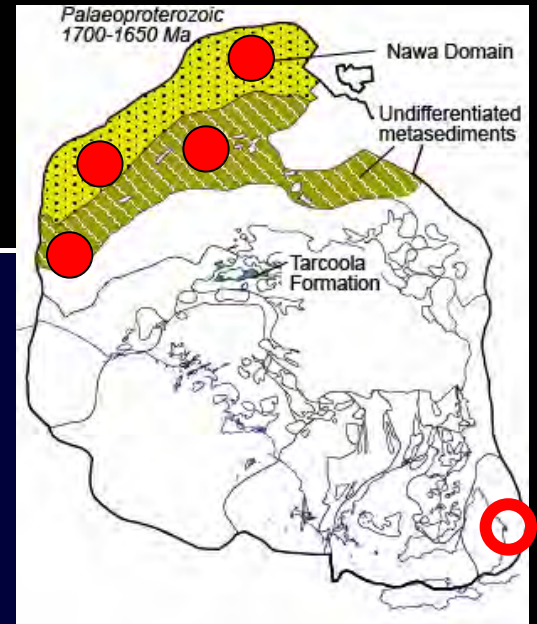
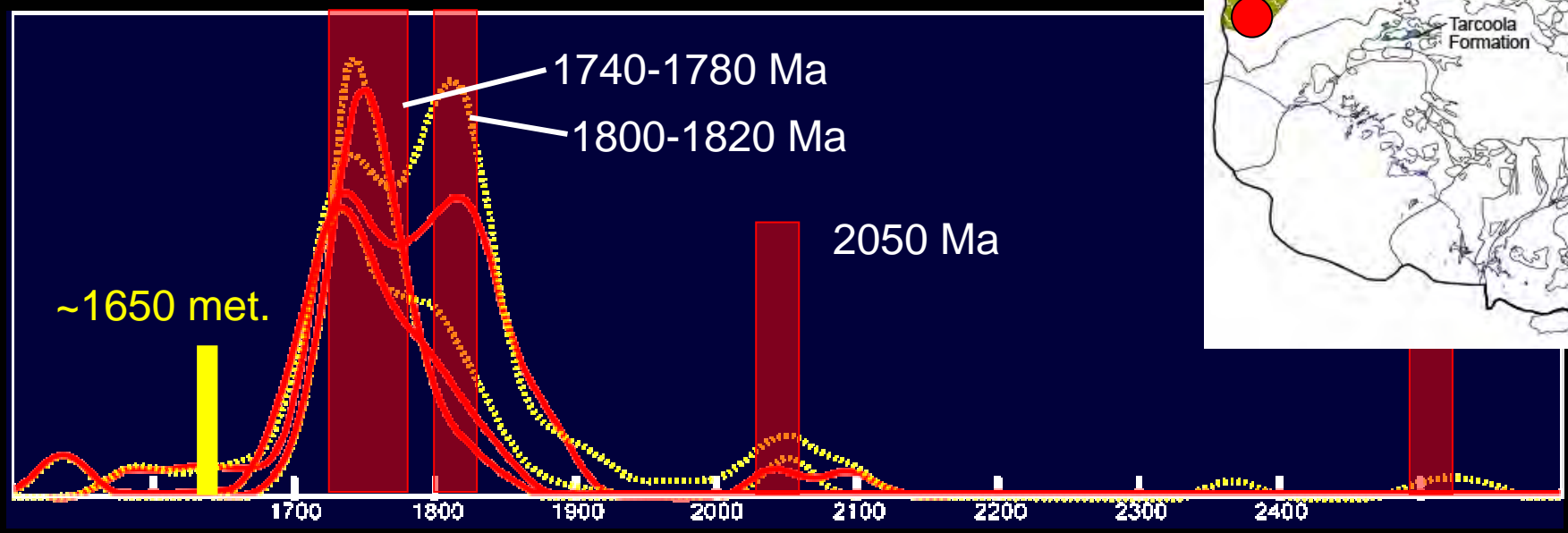
- Fowler Belt: Nd-isotopic data suggests deposition on early Palaeoproterozoic-late Archaean basement. Mx dep age ~ 1730 Ma.



Towards a tectonic framework for the Gawler Craton

Nawa packages

Combined NAWA Detrital Zircons



LA ICPMS monazite ages from the Nawa Domain

- 1715 ± 22 Ma
- 1726 ± 3 Ma
- 1717 ± 5 Ma
- 1690 ± 10 Ma

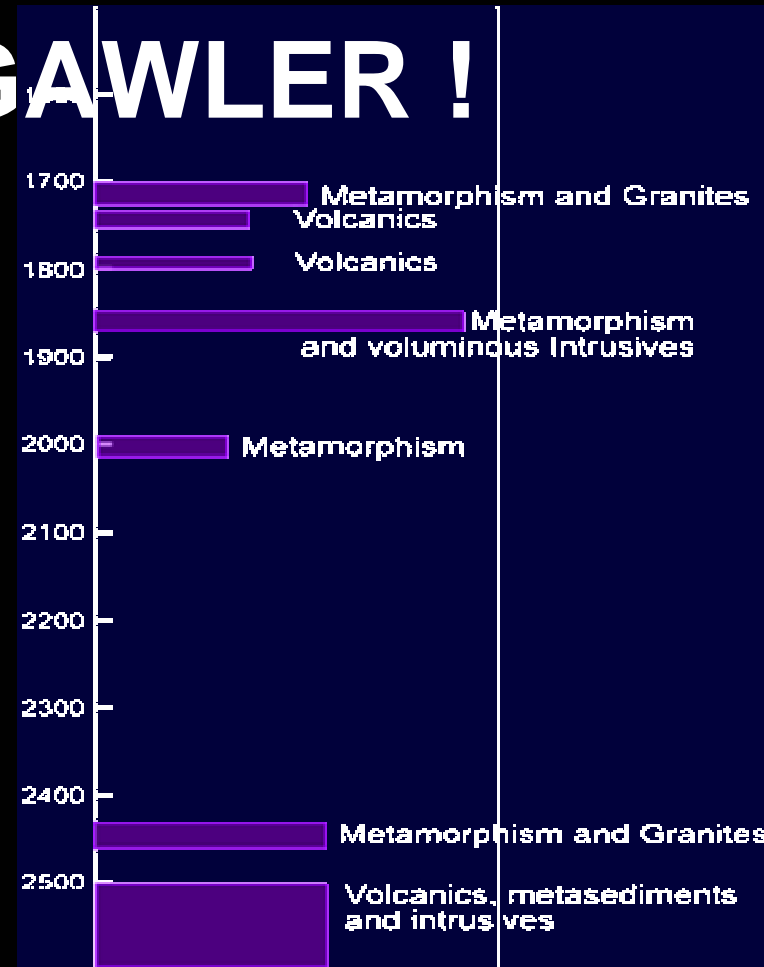
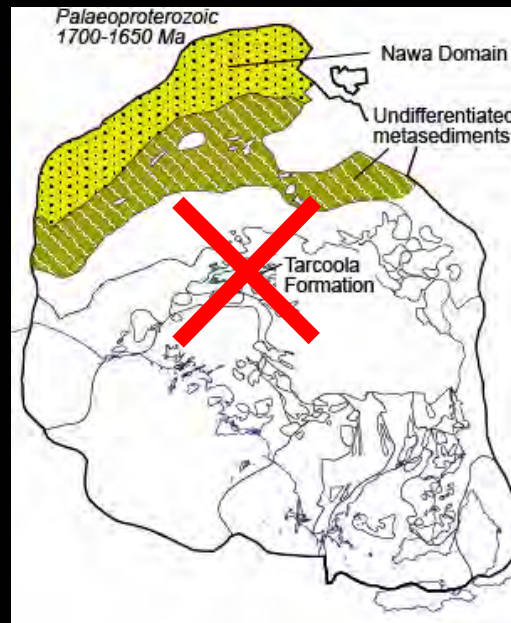
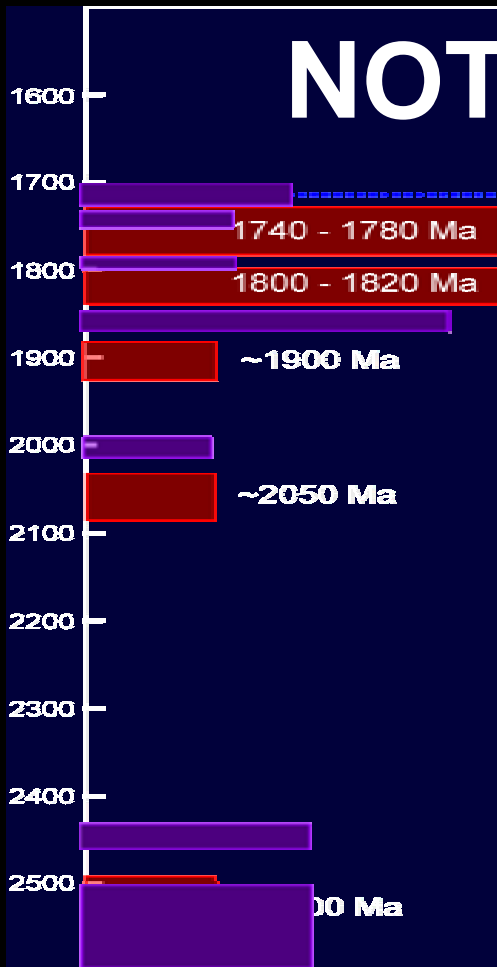
Nawa packages deposited between
1740-1720 Ma

Towards a tectonic framework for the Gawler Craton

Nawa packages (1.74-1.72)

GAWLER AT ~1740 Ma

NOT THE OLD GAWLER !



Towards a tectonic framework for the Gawler Craton

Nawa packages (1.74-1.72)

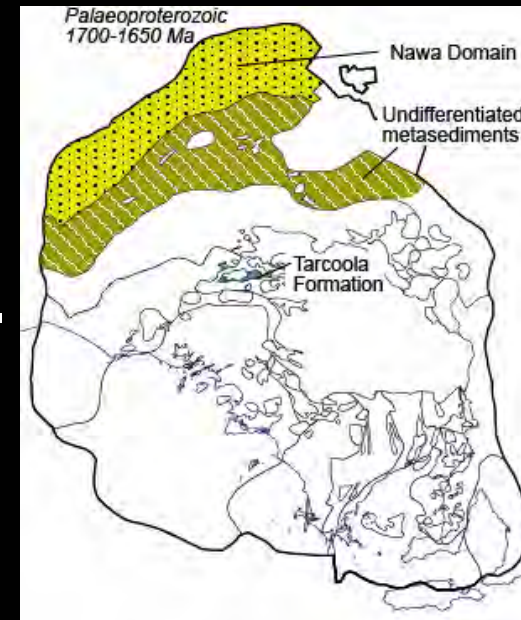
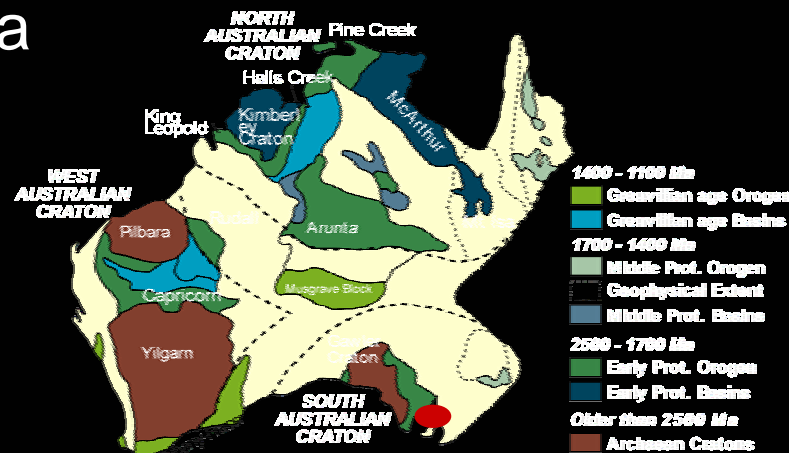
Comparative meta-sedimentary succession

Lower Willyama of the Curnamona region

Similar depositional age 1715 through to 1650 Ma

Detrital populations – 1730, 1750, 1780, 1790, 1800, 1810-1820, 1850, 1900, 1980-1990, 1980 & 2700 Ma

Not Forgetting Mt Isa

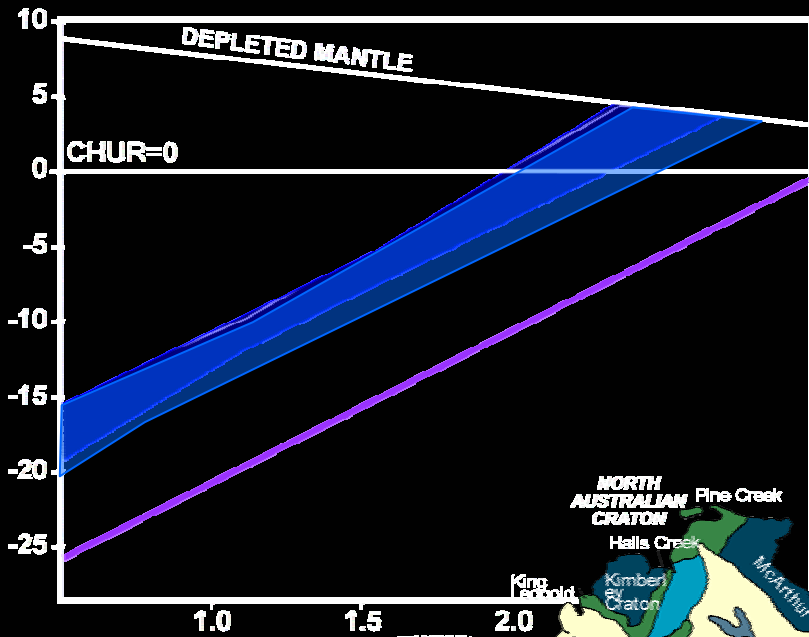


Towards a tectonic framework for the Gawler Craton

Younger rift packages (1.74-1.72)

NAWA

Similar shapes in the Lower Willyama

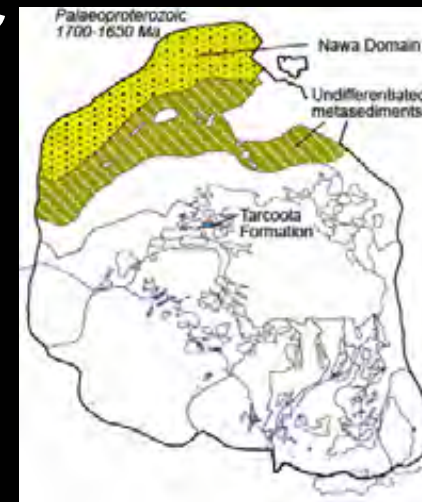
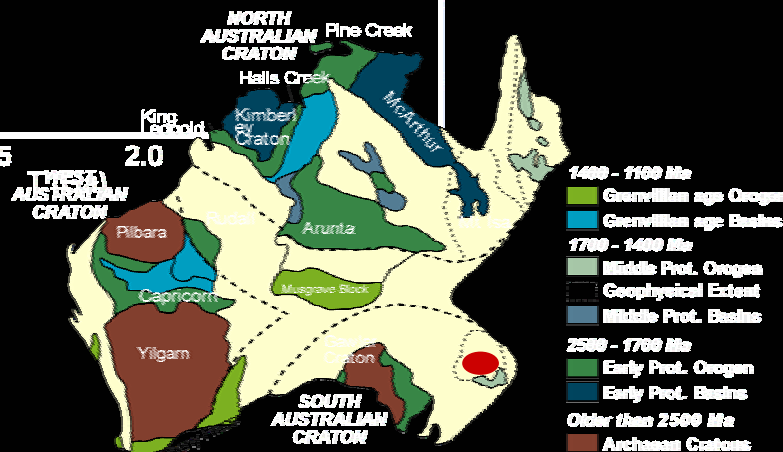


Similar - isotope values

- REE

- Detrital Zircons

Sourced from NAC

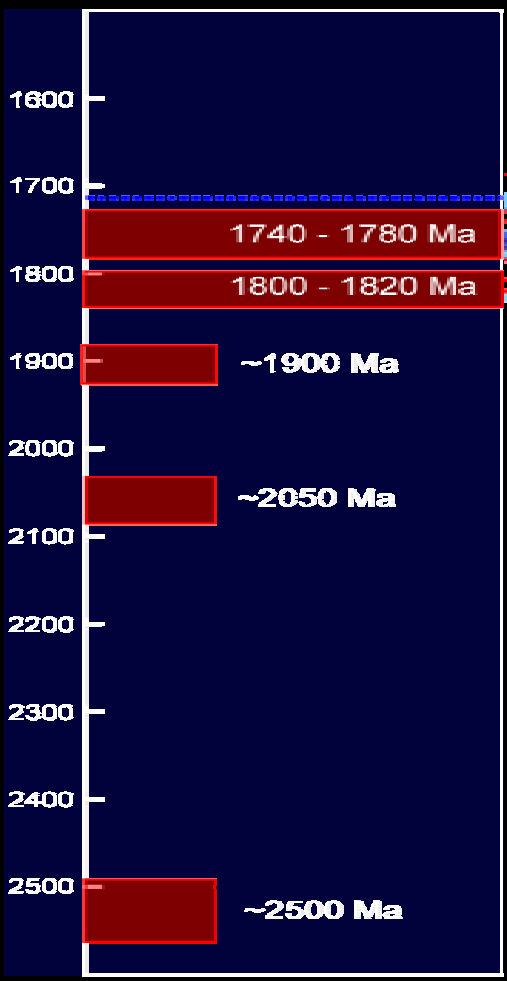


Towards a tectonic framework for the Gawler Craton

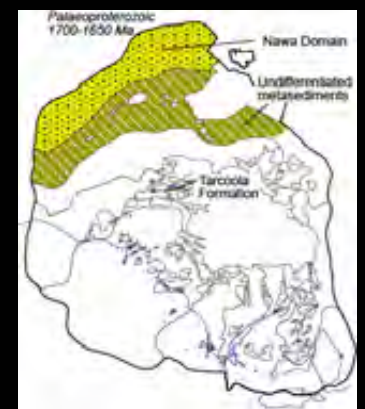
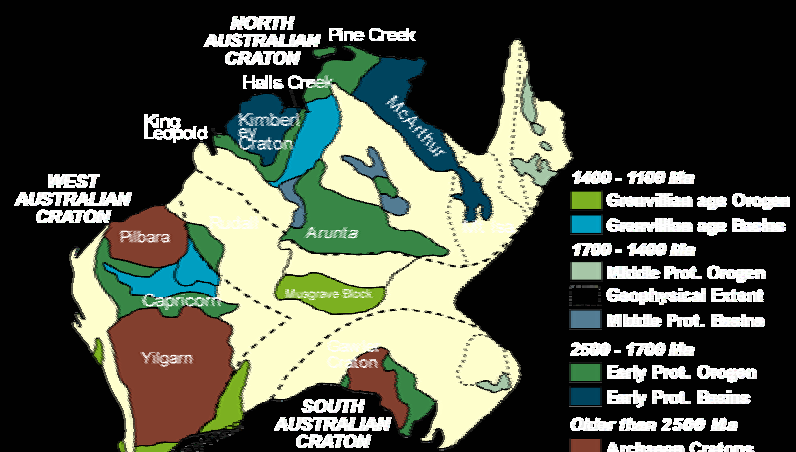
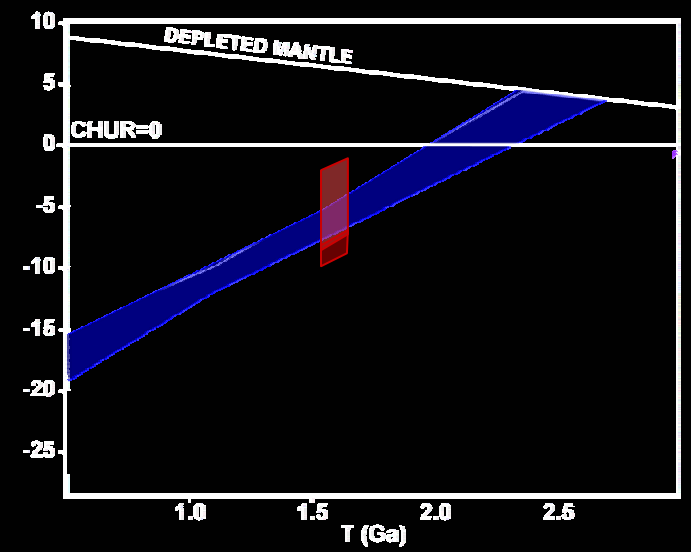
Younger rift packages (1.74-1.72)

NAWA

North Australia Craton – Arunta Region

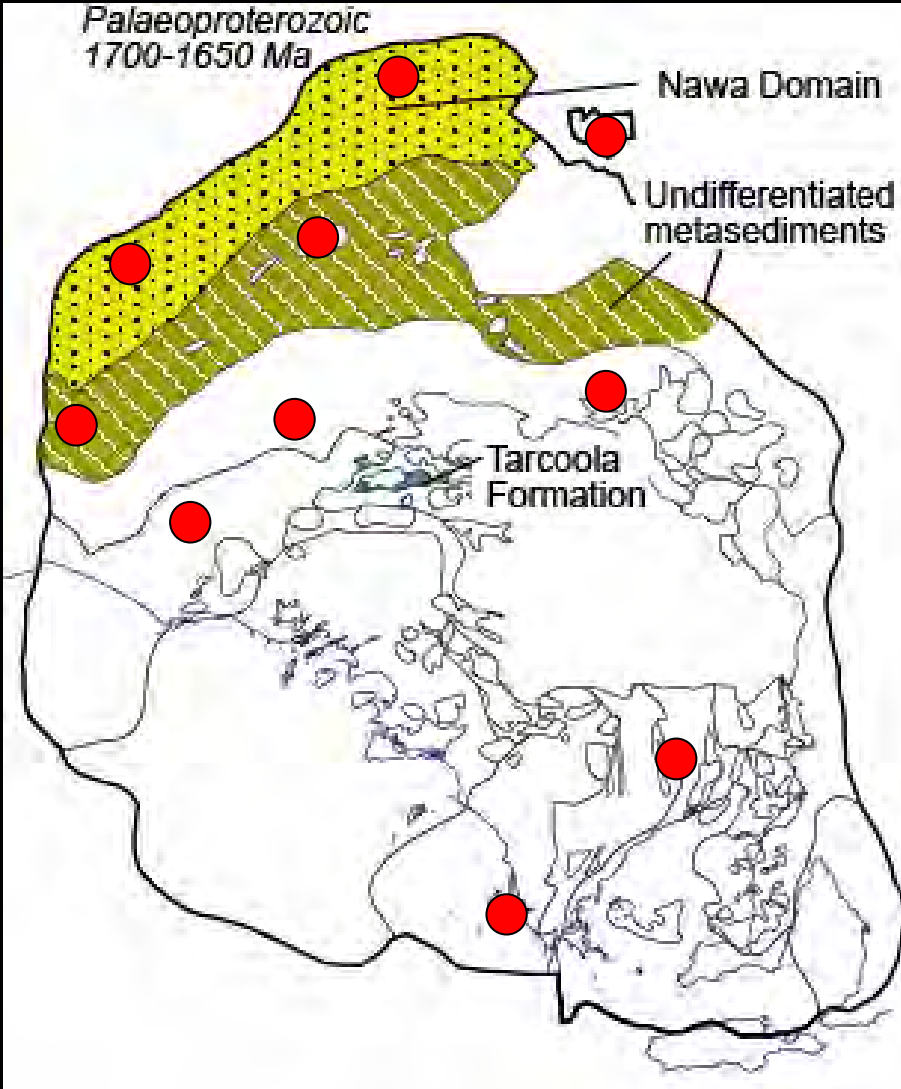


Arunta thermal event
 Arunta magmatic suite

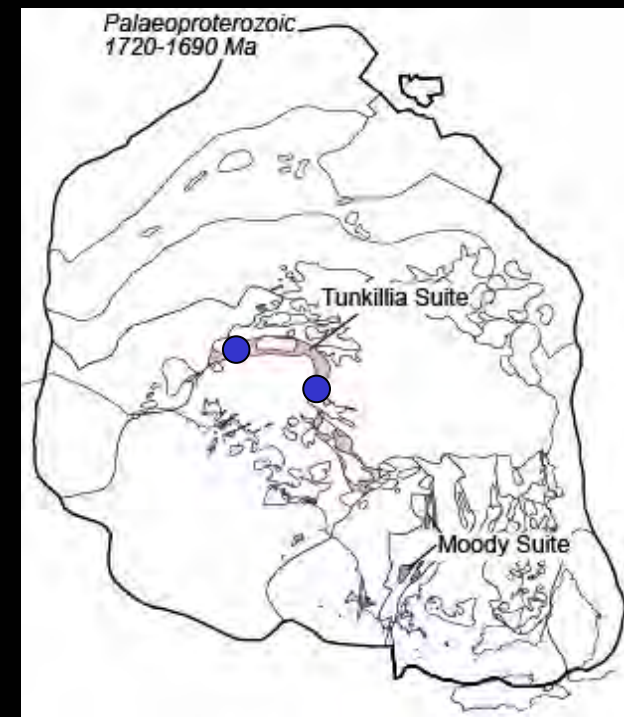


Towards a tectonic framework for the Gawler Craton

Kimban Orogeny (1.73-1.68)



- Affected the entire pre-1740 Ma Gawler system. Pre-Kimban basins -> highest grade regions.
- Tunkillia Suite - mixture of crustal and mantle sources.

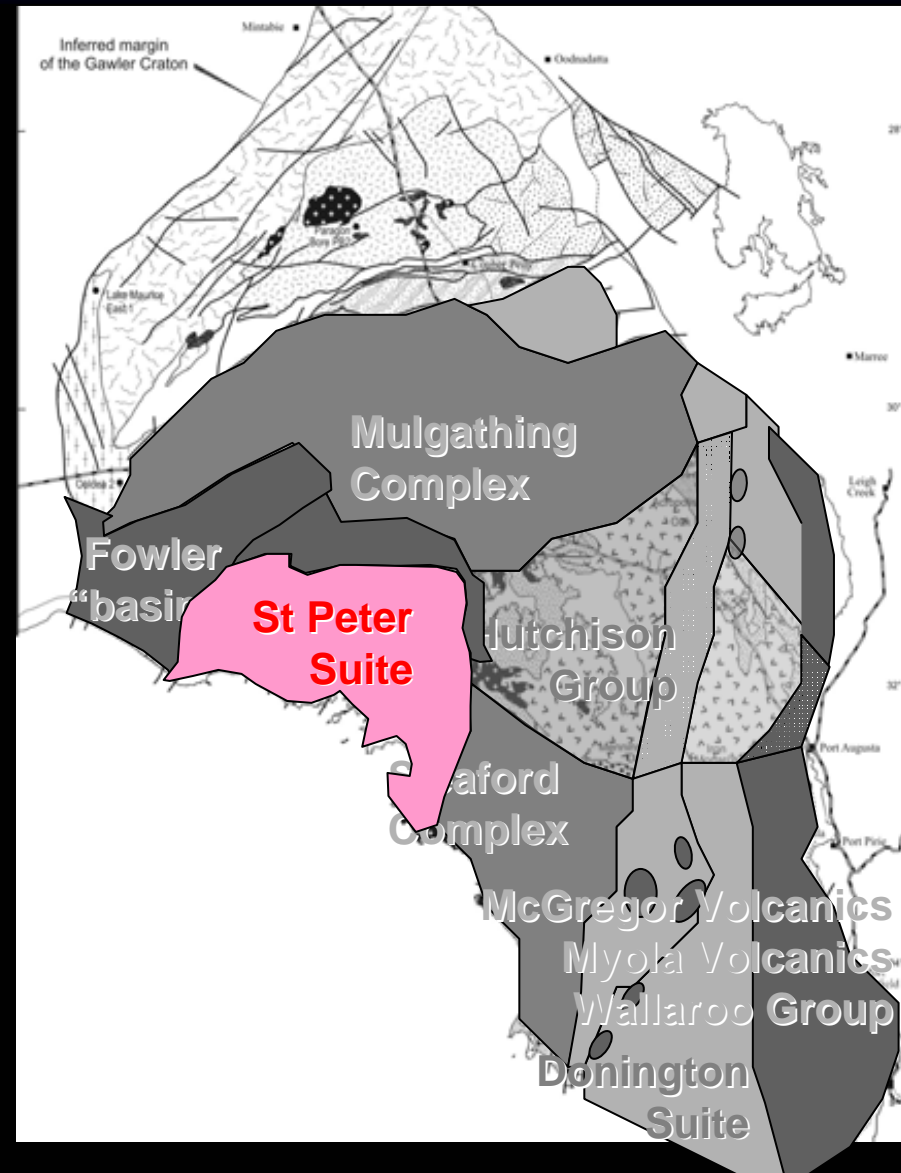


Towards a tectonic framework for the Gawler Craton

Megacycle 2

1.65-1.62 Ga

- Localised rift basin development (Tarcoola Fm).
- Regional high-T metamorphism in NW Gawler.
- Development of St Peter Magmatic Suite (1620-1608 Ma): felsic and mafic syn-deformational system.
- Apparent arc related geochemistry of the St Peters Suite suggests the development of a convergent margin system.

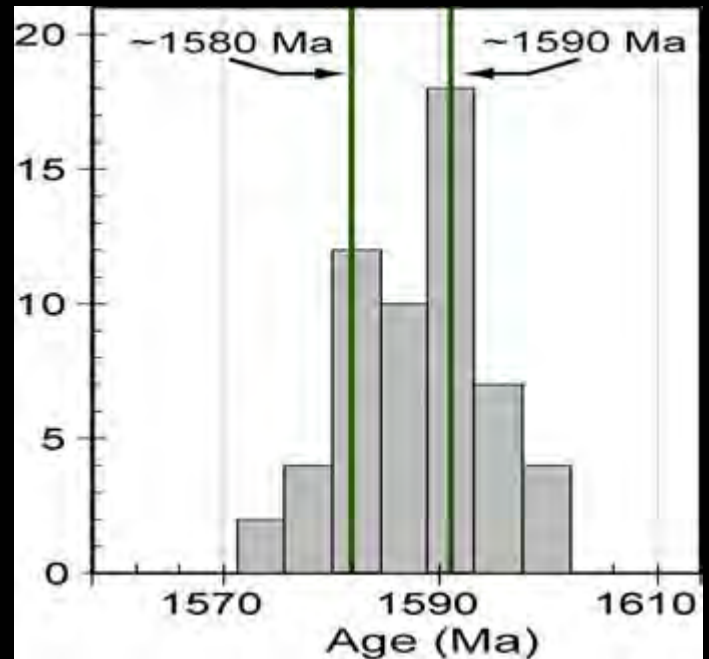
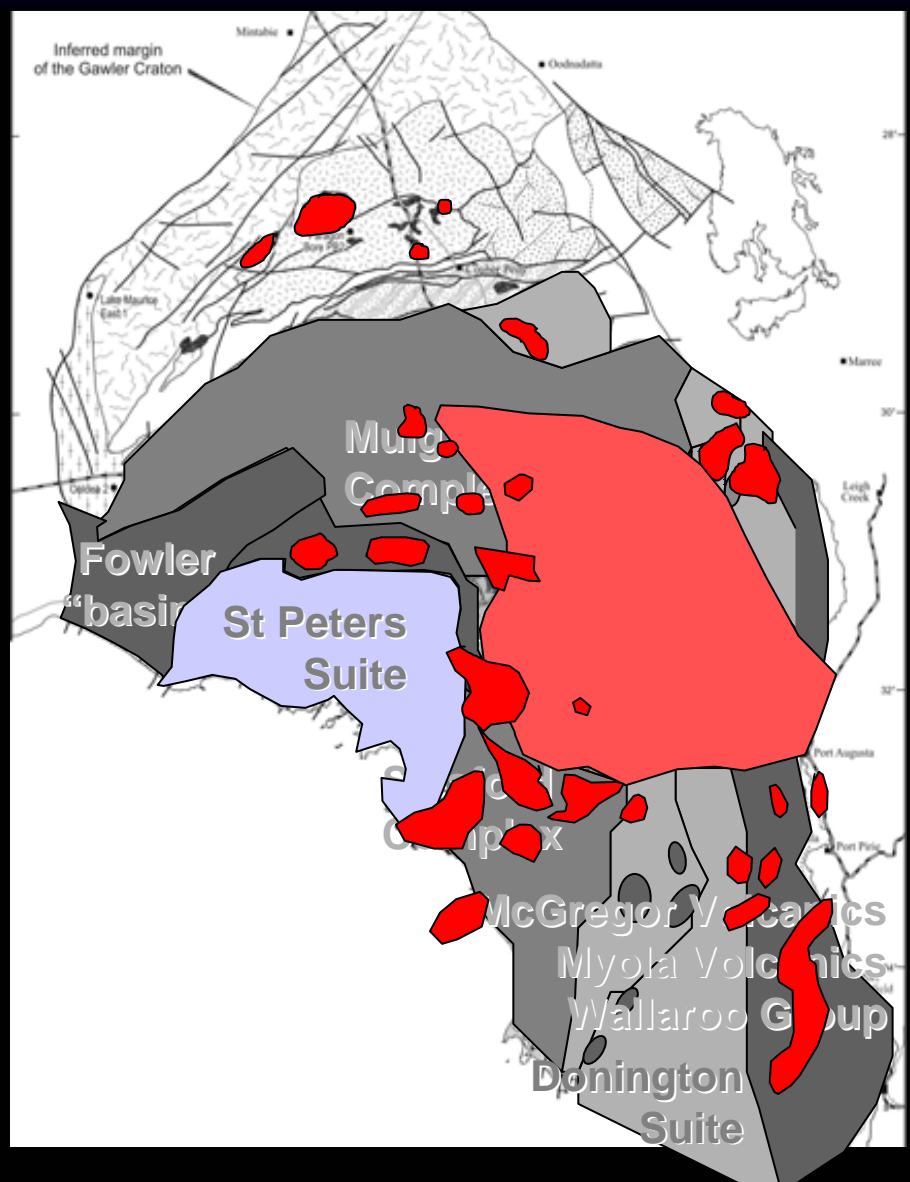


Towards a tectonic framework for the Gawler Craton

Megacycle 2

1.595-1.57 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.

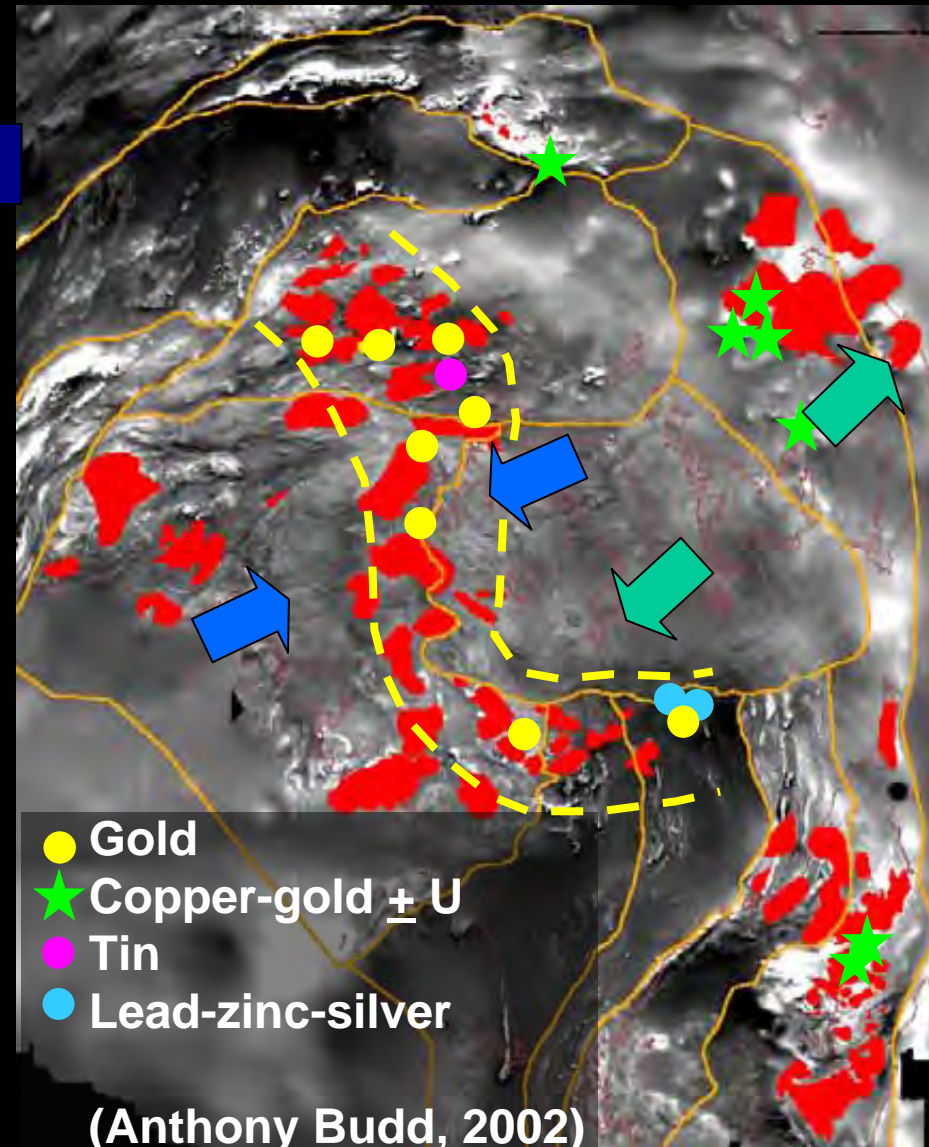


Towards a tectonic framework for the Gawler Craton

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.

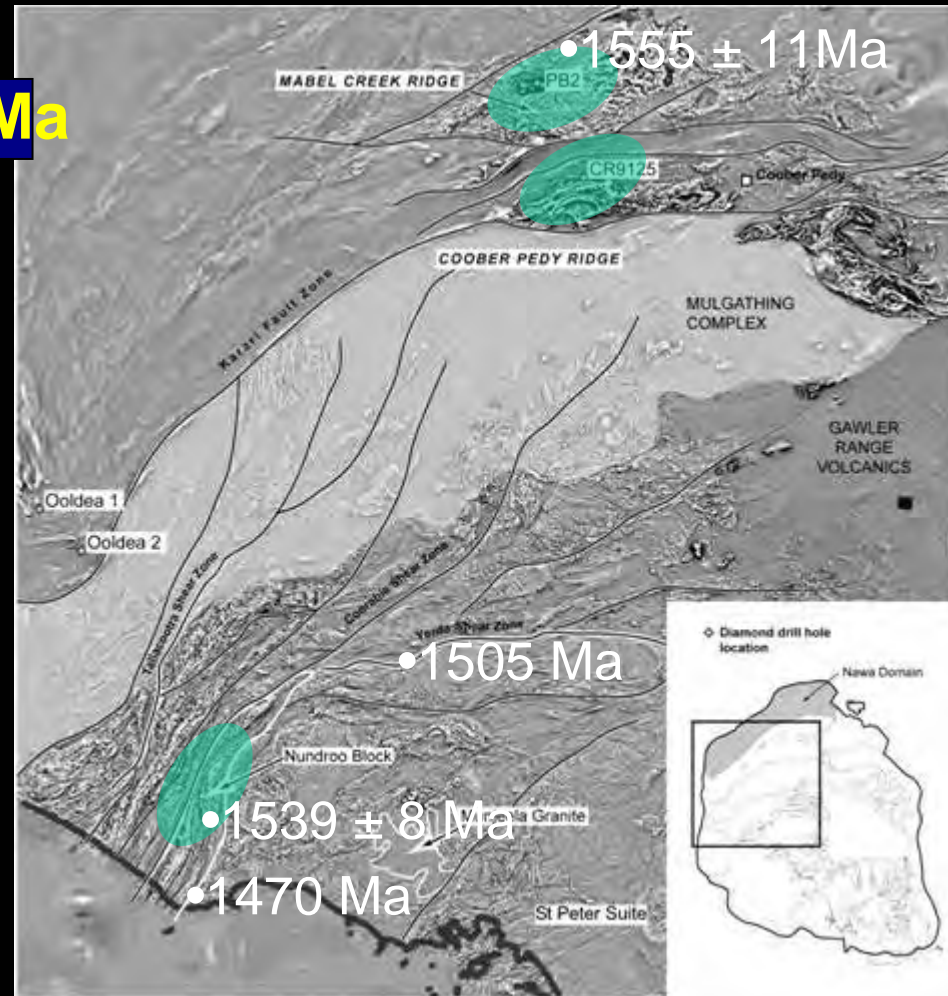


Towards a tectonic framework for the Gawler Craton

Megacycle 2

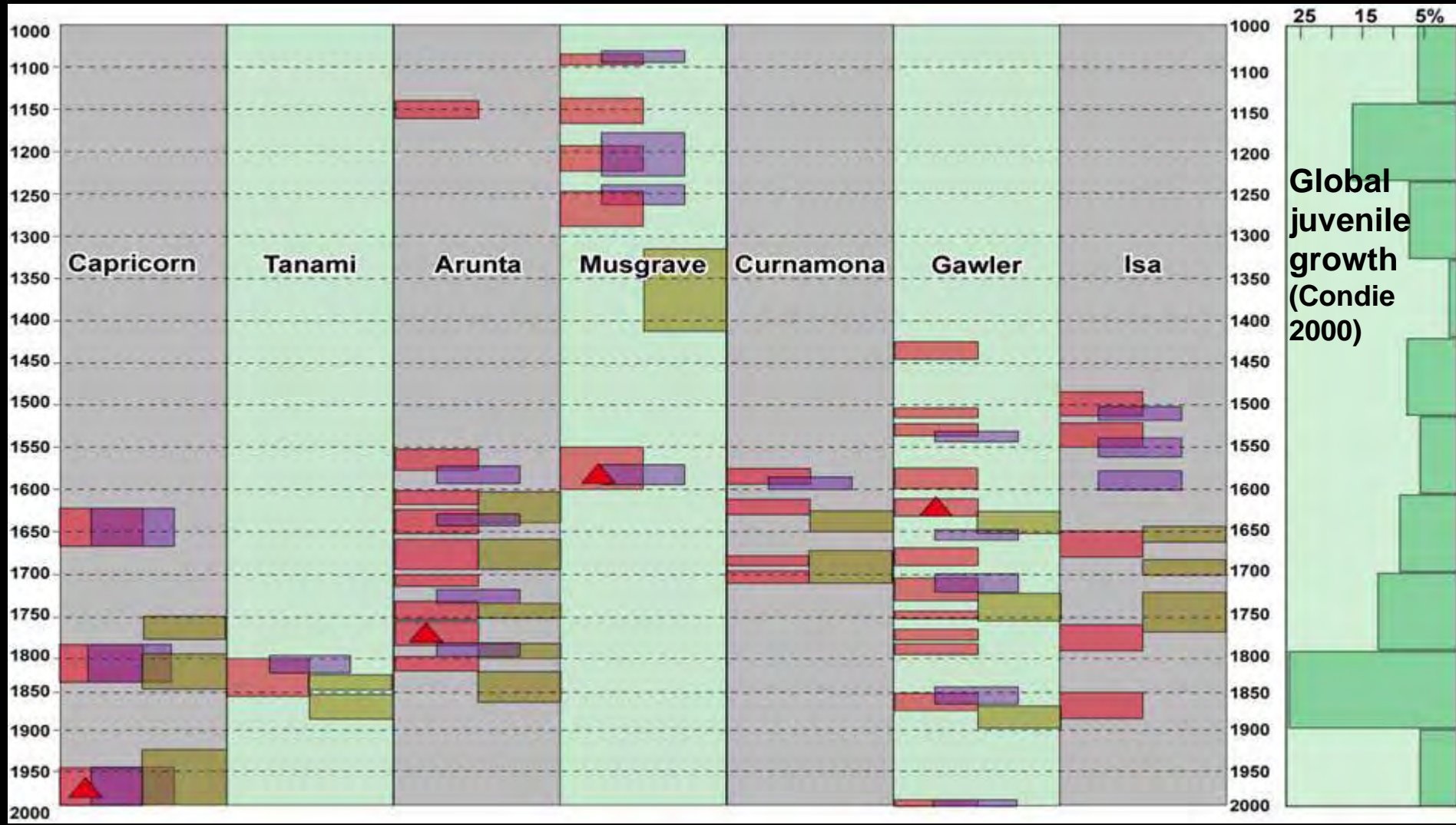
Post Hiltaba tectonism – 1550 Ma

- Regional high-grade tectonism in the northern Gawler. Reworks rocks 1.74-1.72 Nawan packages affected by the Kimban.
- High-grade metamorphism in the Fowler Belt.
- Regional-scale transpressional zone systems driving deep exhumation of crustal rocks.



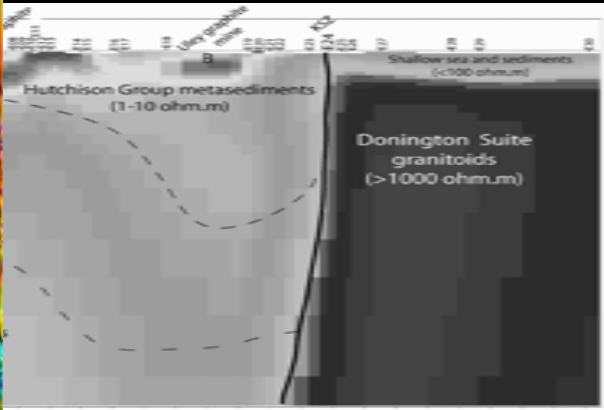
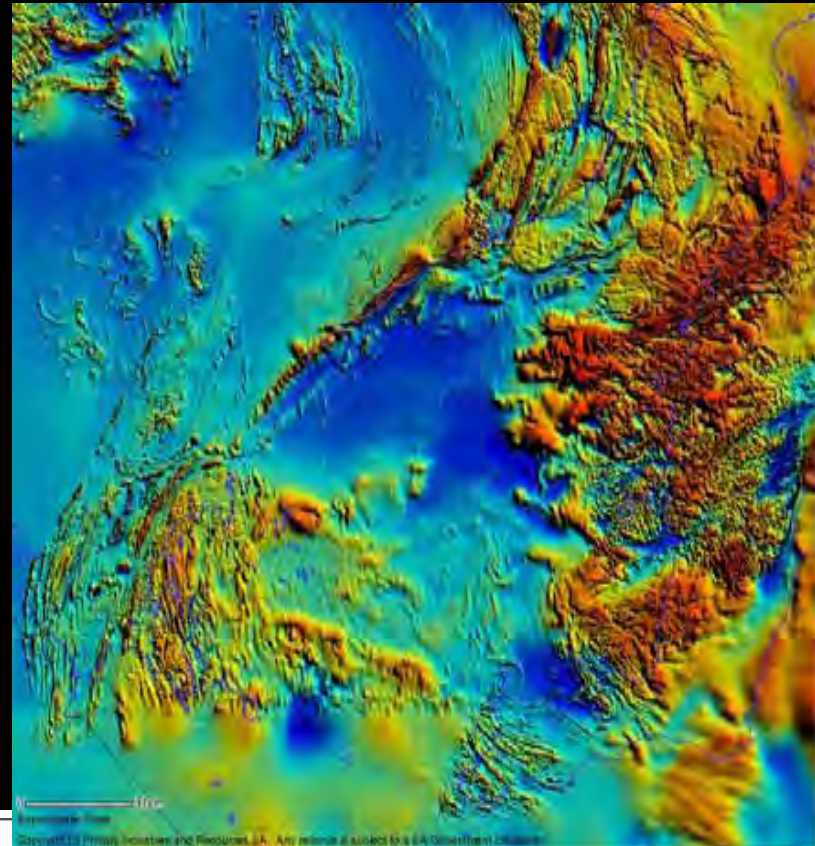
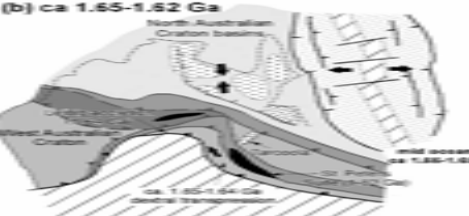
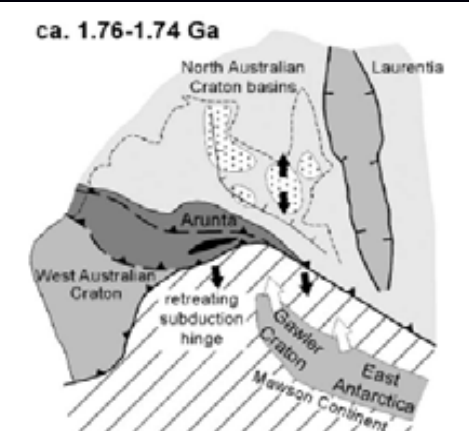
Towards a tectonic framework for the Gawler Craton

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

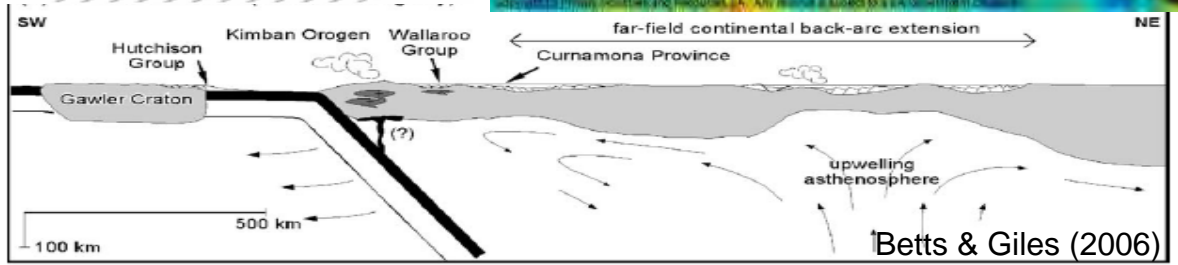


Towards a tectonic framework for the Gawler Craton

Sutures and Plates....fact or wishful thinking?



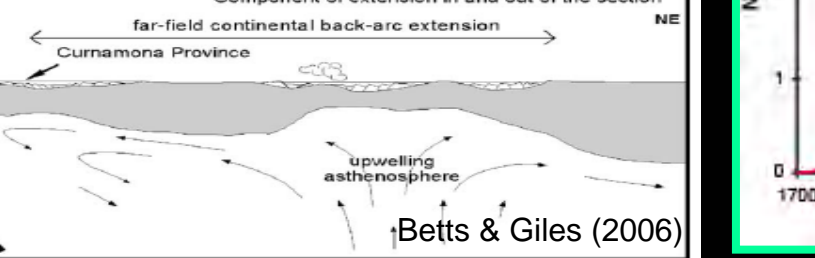
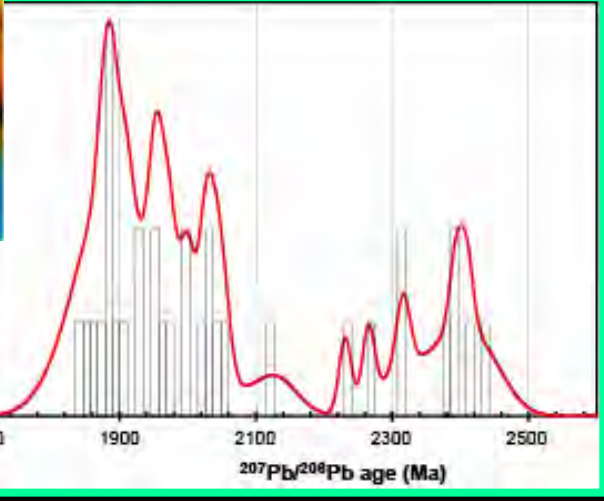
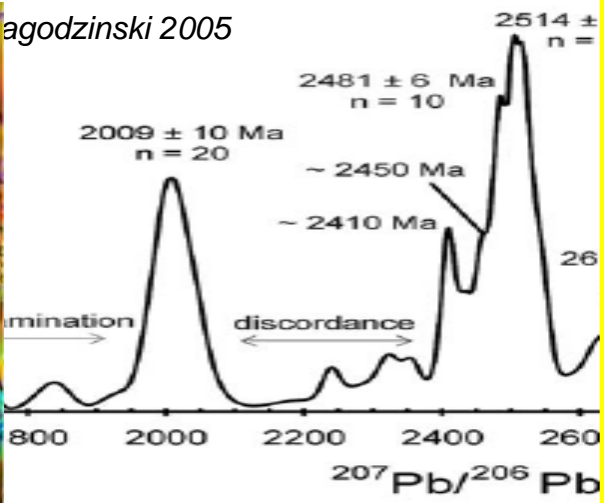
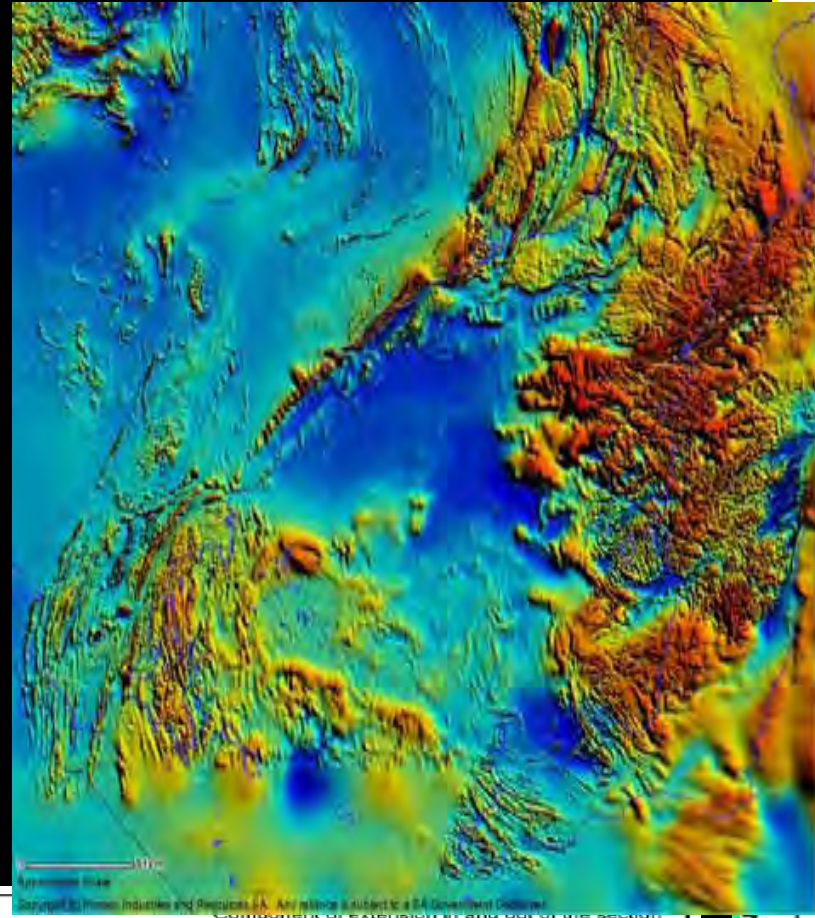
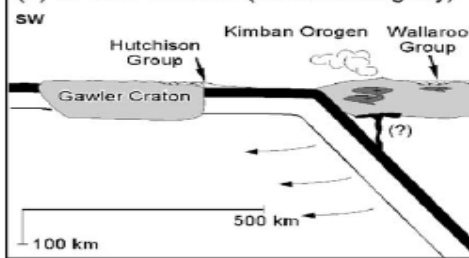
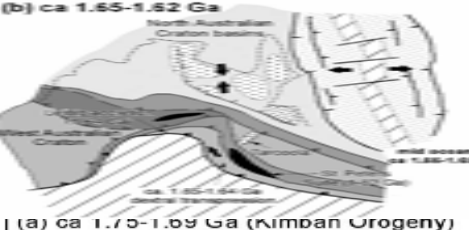
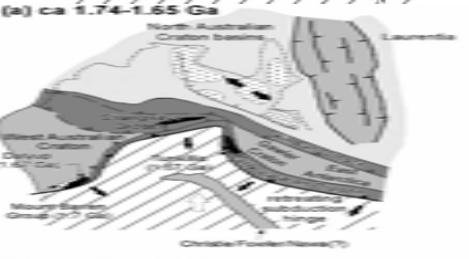
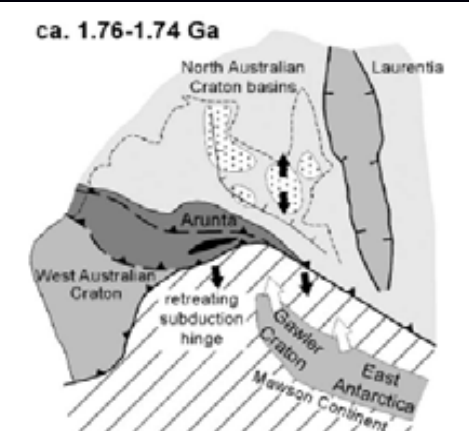
Theil et al., (2005)



Betts & Giles (2006)

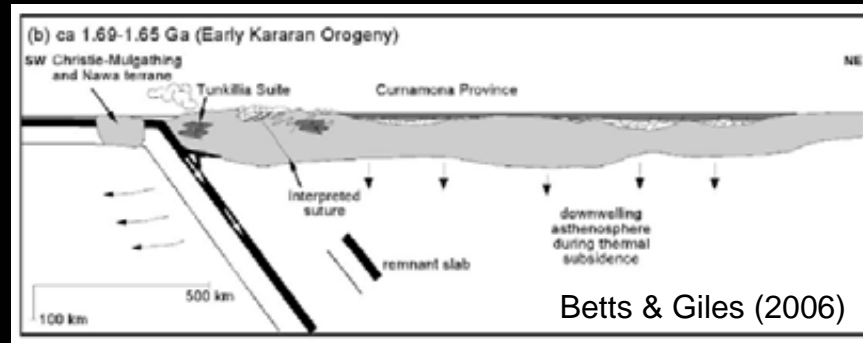
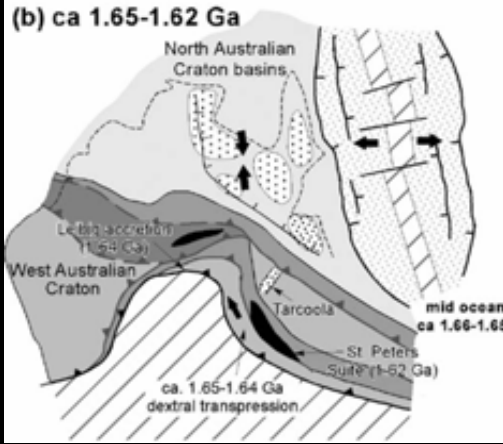
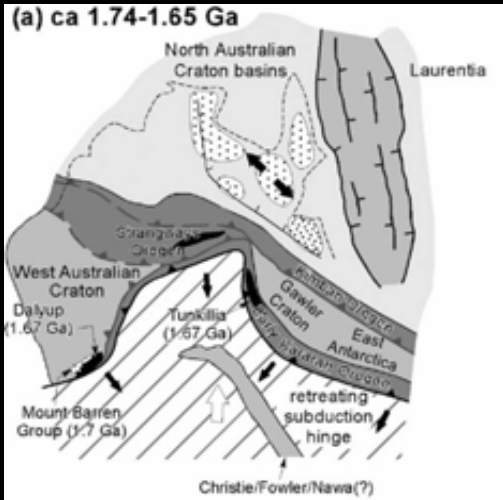
- Rock systems east of the “Kimban front” belong to the north Australia Craton.
- Olympic Cu-Au province affinities with the NAC
- Central Gawler Au...

Towards a tectonic framework for the Gawler Craton

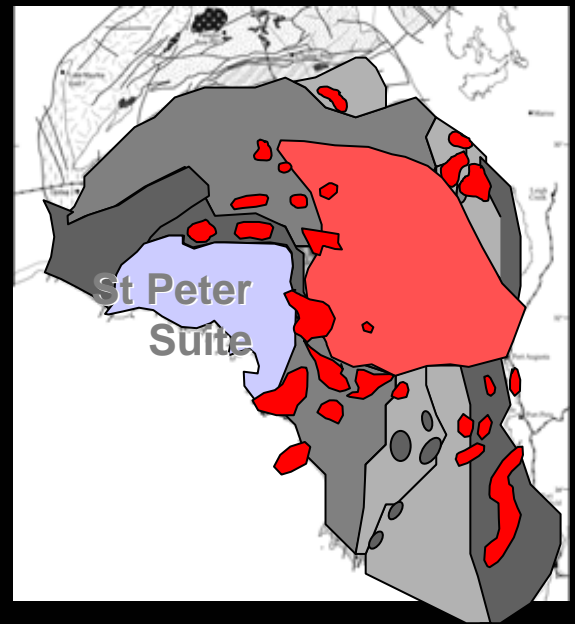
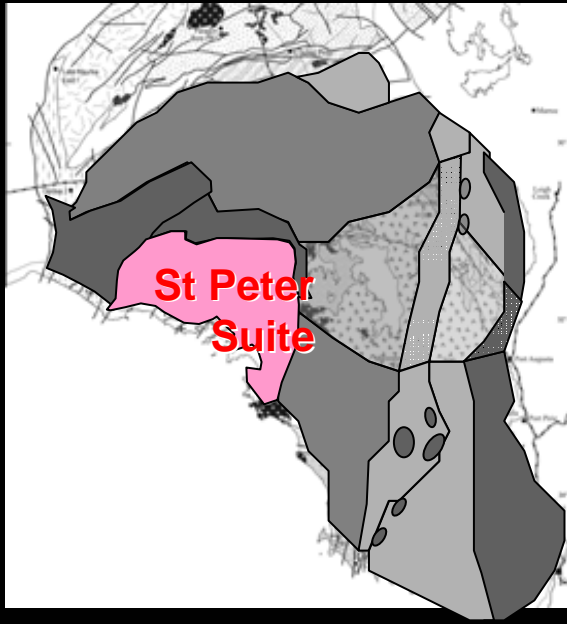


Towards a tectonic framework for the Gawler Craton

Sutures and Plates...fact or wishful thinking?

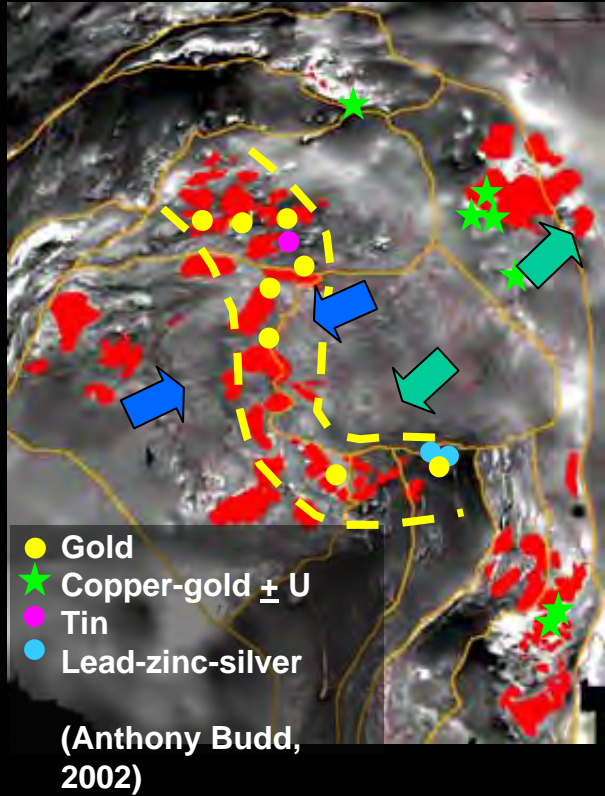
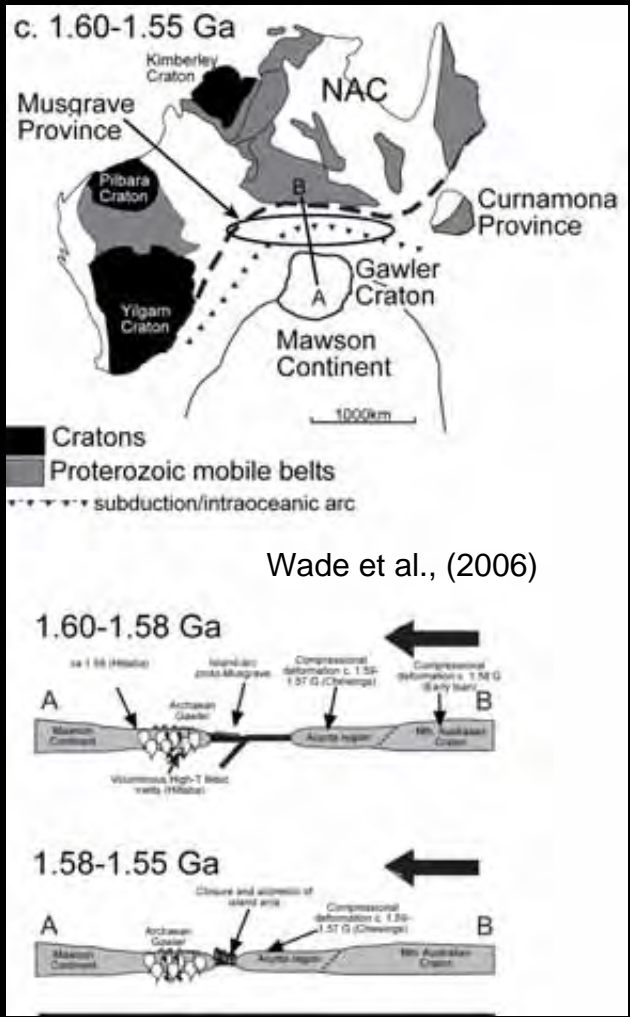


Betts & Giles (2006)



Towards a tectonic framework for the Gawler Craton

Sutures and Plates...fact or wishful thinking?



Is there a Hiltaba Suite subduction link?

Is there a mantle connection?

Are there large-scale fluid systems?

Towards a tectonic framework for the Gawler Craton

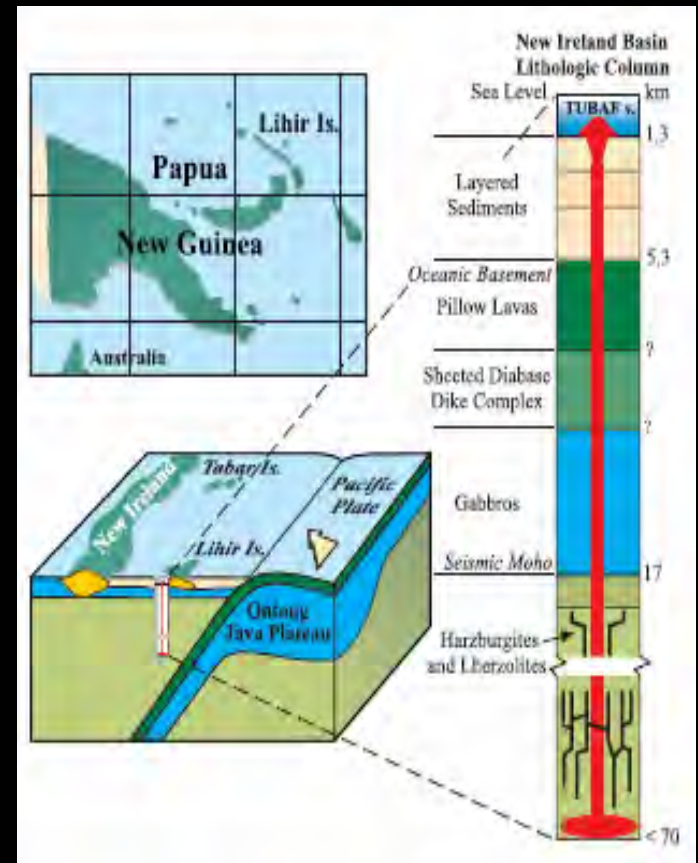
Where does the metal come from in big deposits?

Ladolm Au deposit: 45 million ounces

Metasomatised (from slab fluids) mantle xenoliths beneath the deposit are 2 to 800 times more enriched in Cu, Au, Pt and Pd compared to the surrounding depleted arc mantle.

Au ores from Ladolm have similar Os isotope compositions to the metasomatised Au-rich mantle.

The Au et al comes from the Mantle and is transported in fluids.



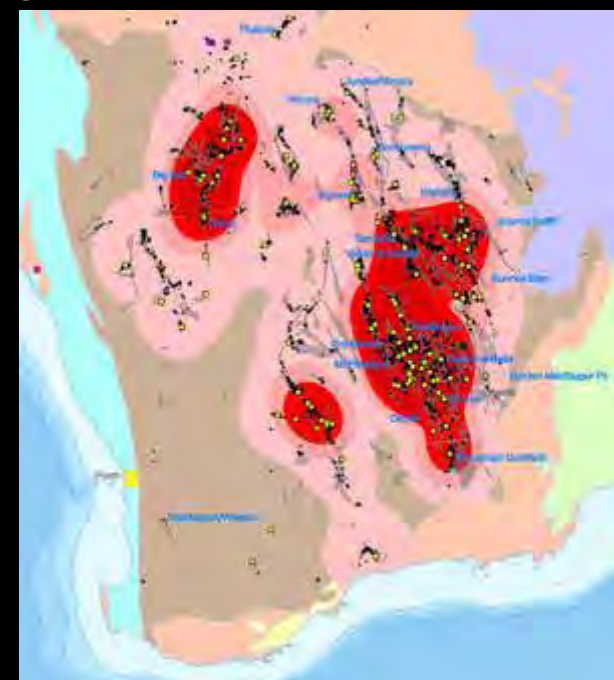
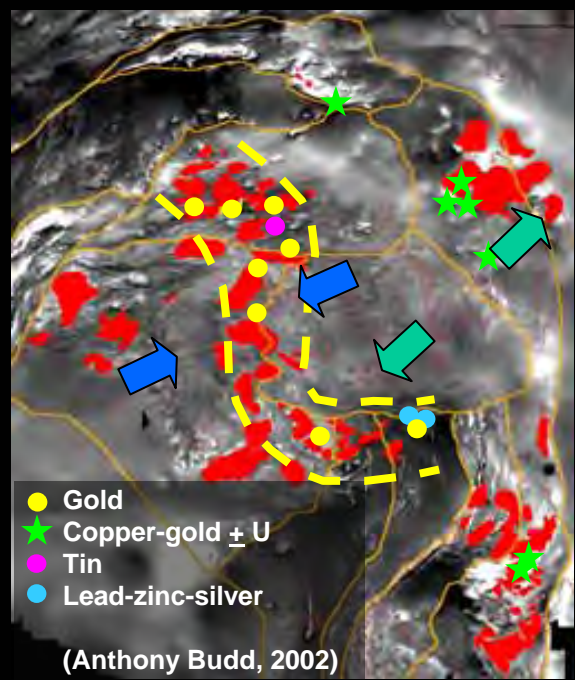
Towards a tectonic framework for the Gawler Craton

Where does the metal come from in big deposits?

Ladolm Au deposit: 45 million ounces

The Au-Cu etc comes from the Mantle.

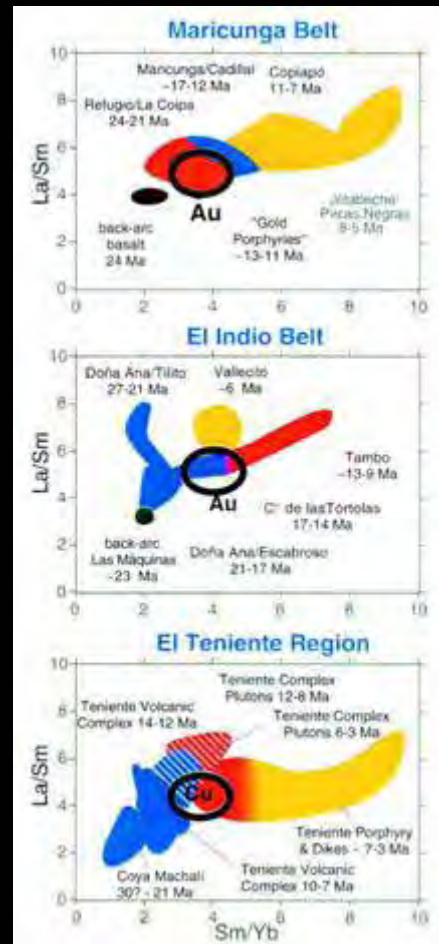
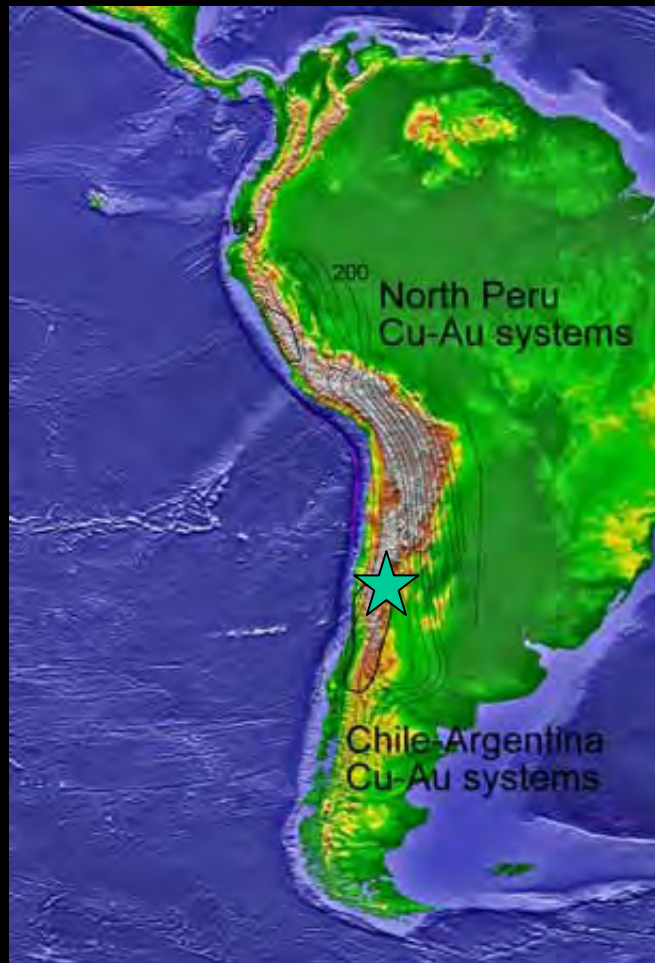
Yes.....that's stating the obvious, but....



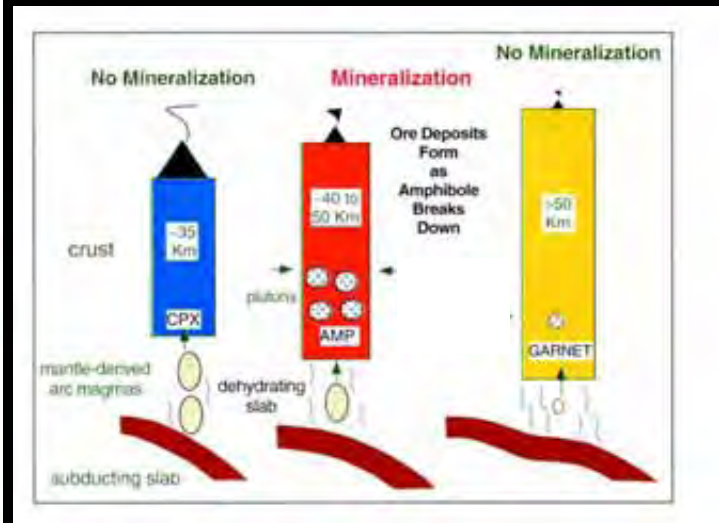
In both the Yilgarn and the Gawler Au (+Cu) post date major fluid/tectonic systems.

Towards a tectonic framework for the Gawler Craton

If the mantle is the key player how might crustal fluid systems get involved?



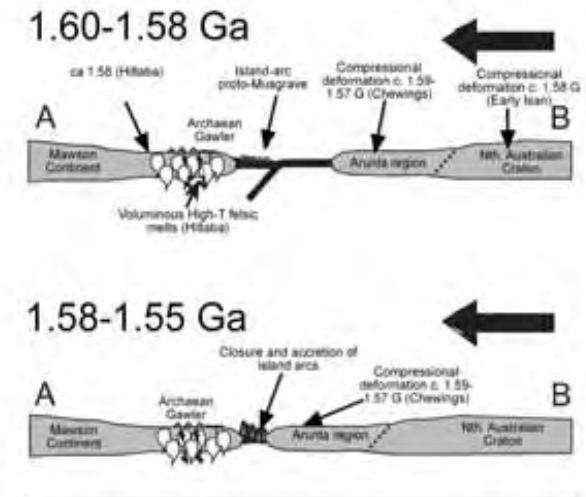
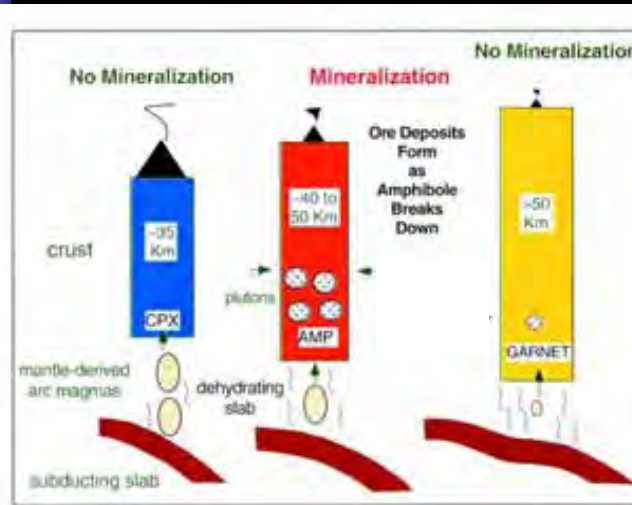
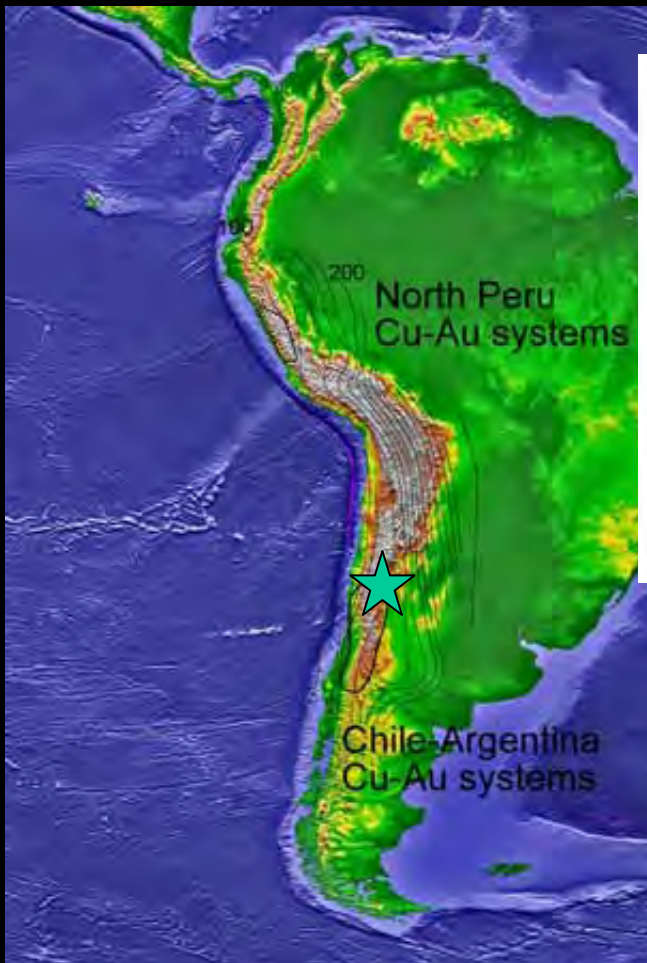
Granitic melts that bracket the mineralising events show a smooth evolution in REE composition, reflecting involvement of dehydrating lower crust.



Towards a tectonic framework for the Gawler Craton

If the mantle is the key player how might crustal fluid systems get involved?

Forget South America: think Gawler

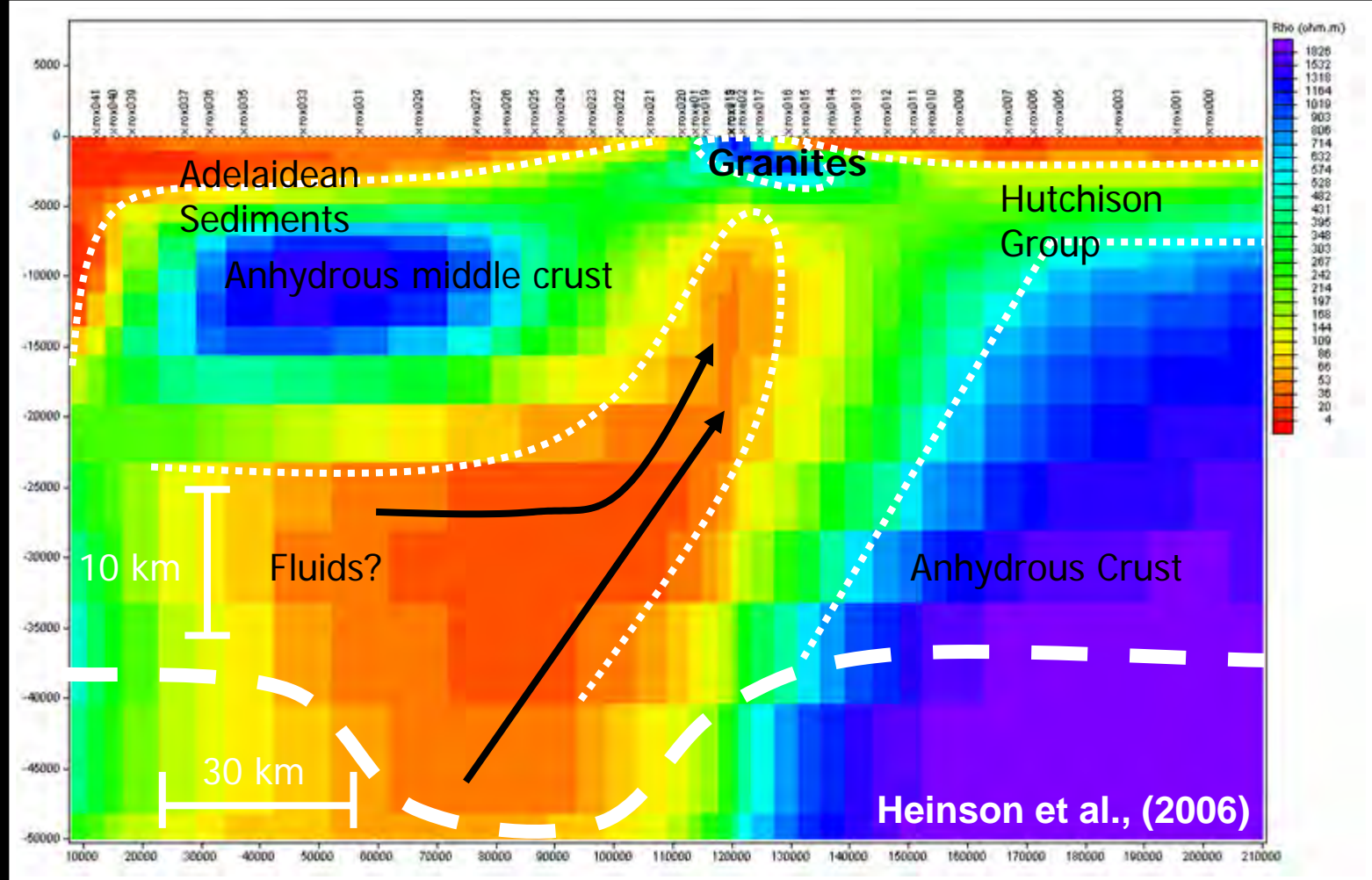


The key ingredients are:

- (1) Hydrated mantle.
- (2) Hydrated minerals in the lower crust.
- (3) Metals in the bottom of the system.
- (4) A process that dehydrates the lower crust.

Towards a tectonic framework for the Gawler Craton

Crustal-scale electrical anomaly under Olympic Dam: Was it caused by a lower crustal derived metal-bearing fluid – driven by the Hiltaba mafic underplate?



Towards a tectonic framework for the Gawler Craton



1. Major basin(s) system 1760-1720 Ma in the eastern and northern Gawler, in part derived from a source region that has affinities with lower Willyama sources -> Northern Australian Craton?
2. The role of plate margin processes.....? Well the St Peter Suite looks like an arc system, however sutures and even polarity remain unclear.

For mineralisation

Fertile regions: tectonics that lead to hydration of lower crust and upper mantle.

Need a tectonic regime that leads to large-scale deeply-derived fluid systems.

Understand which structures were active during dehydration events and where major boundaries exist in terrains.

Image those systems geophysically, and look for crust-mantle connections where rehydration processes are likely to have occurred.