Crustal boundaries of the marginal terranes of the Northern Gawler Craton

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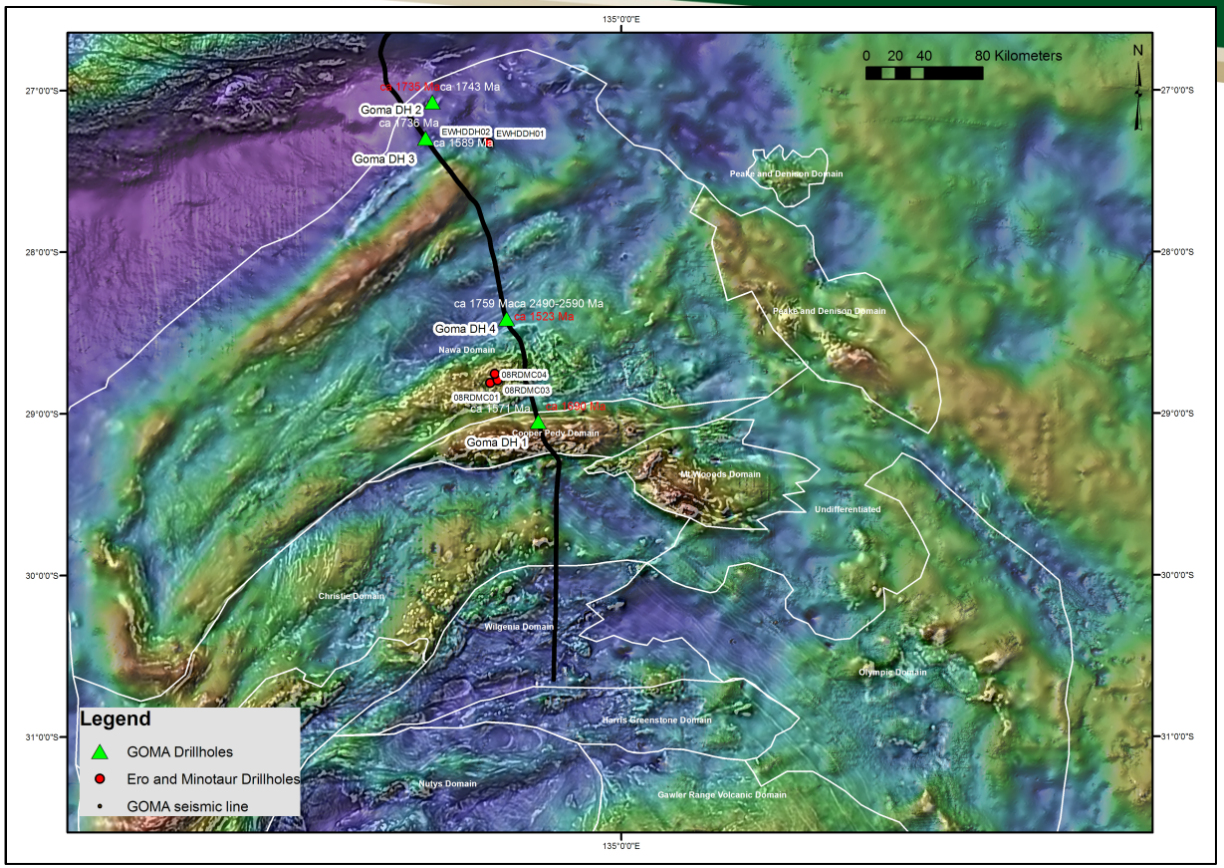
Marginal terranes of Northern Gawler Craton

- **The Nawa terrane**
- **Coober Pedy Ridge**
- **Mabel Creek Ridge**
- **Peake and Denison Inlier**
- **Mount Painter Inlier**

Important because they are located between the:

- **Archaean-Mesoproterozoic SAC, WAC and NAC.**

- **Meso- to Neoproterozoic rocks of central Australia and**
- **Phanerozoic accretionary belts of eastern Australia.**



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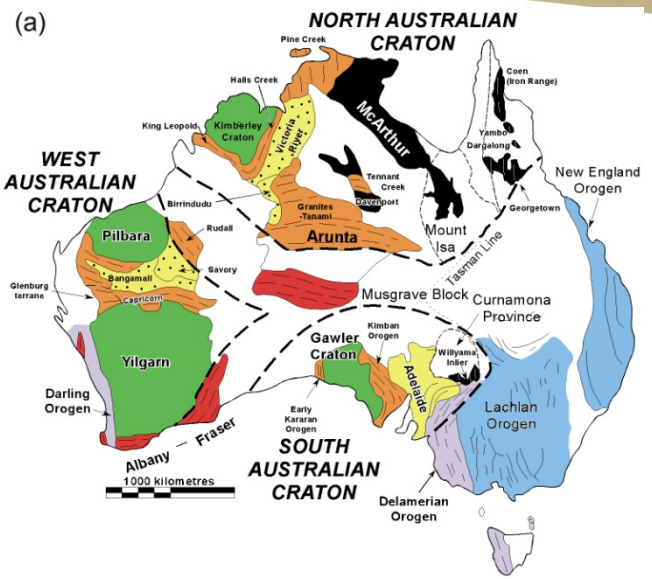
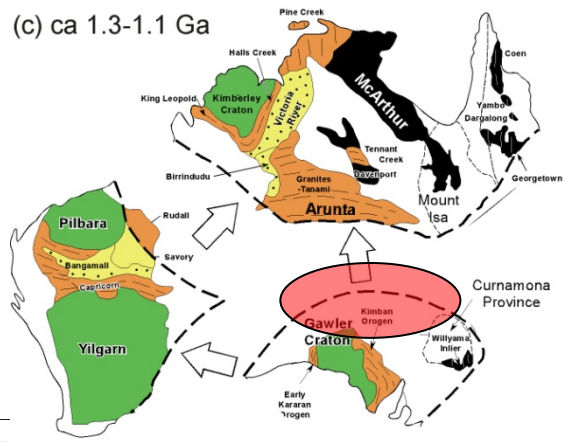
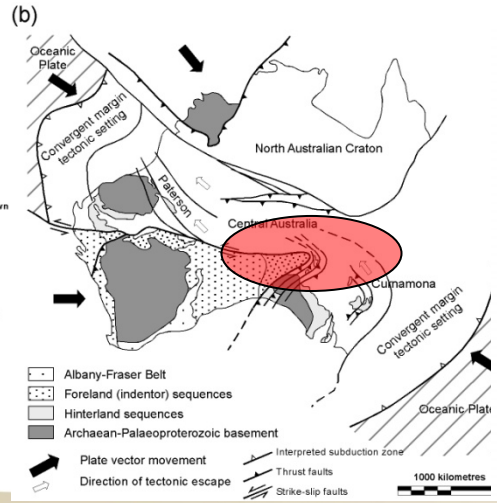
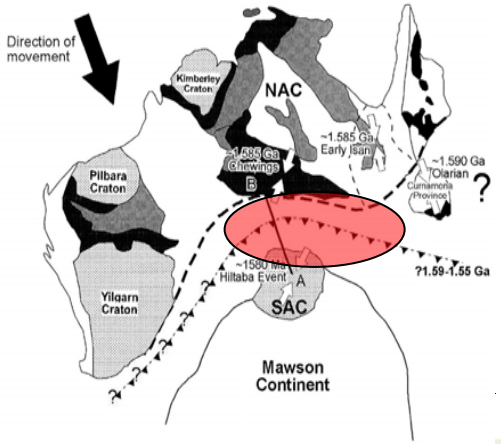
Marginal terranes of Northern Gawler Craton

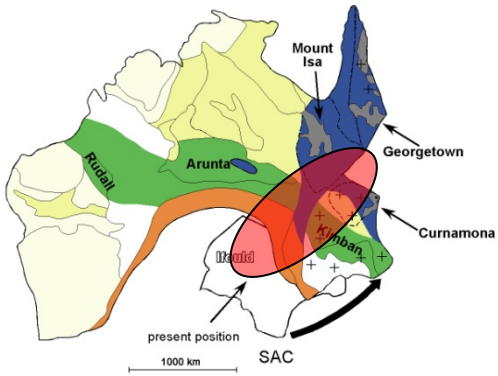
Reconstructions the Australian continent it is the marginal terranes of the Gawler Craton that are the most speculative.











Questions

However, a number of important questions concerning Australian Proterozoic geology remain matters of speculation:

(1) what was the relative importance of crustal growth versus crustal reworking through time?;

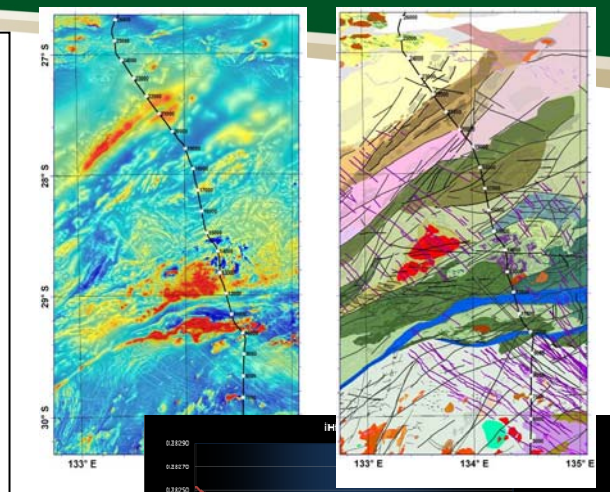
(2) when did the various Precambrian component terranes amalgamate?; and

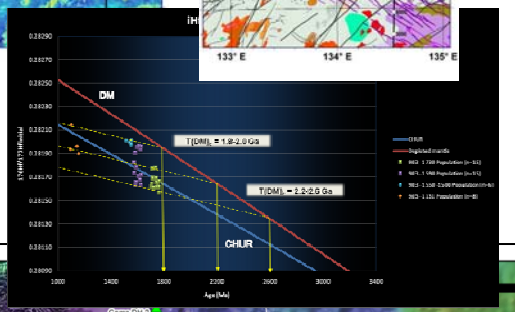
(3) to what extent can ‘modern’ plate tectonic processes be implicated, where are the convergent margin mobile belts and fossil subduction zones?

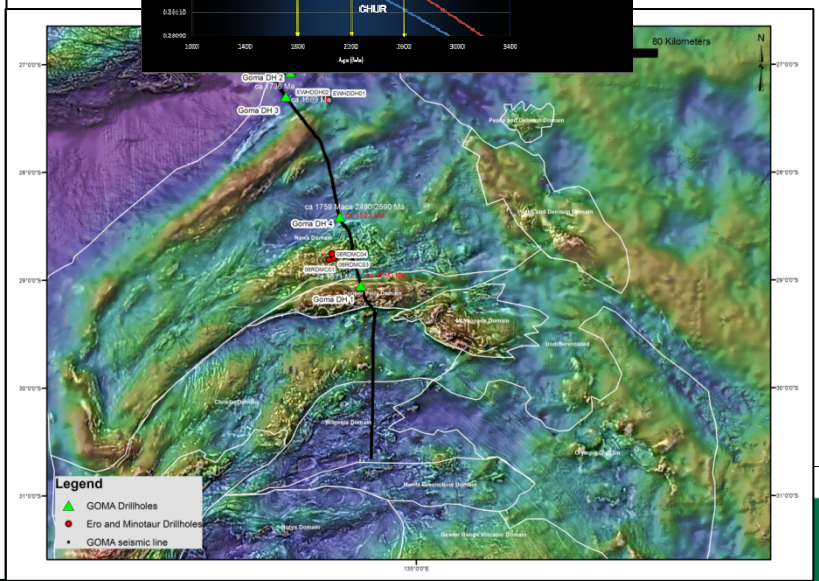
(4) How does this relate to mineral systems if at all?

Northern margins project

- Collaboration between PIRSA, Monash University and University of Adelaide (ARC Linkage scheme).
    - Integrated program of research that included:
    - **Interpretation and modelling of regional gravity and aeromagnetic data** to constrain the 3D architecture of the northern Gawler Craton
    - **Drilling program** into buried terranes of the northern Gawler Craton to intersect basement
    - **Geochronological and Hf isotope geochemistry** to characterise the crustal evolution of different packages collected from drill-holes - Sample rocks along the GOMA seismic line.
    - The project also focussed research in the exposed marginal terranes including the Peake and Denison Inlier and the Mount Painter Inlier (Fig. 1)
    - Intersected during drilling programs conducted by Minotaur Exploration Ltd (Mabel Creek Ridge) and Eromanga Uranium Ltd (45 km east of GOMA DH3).



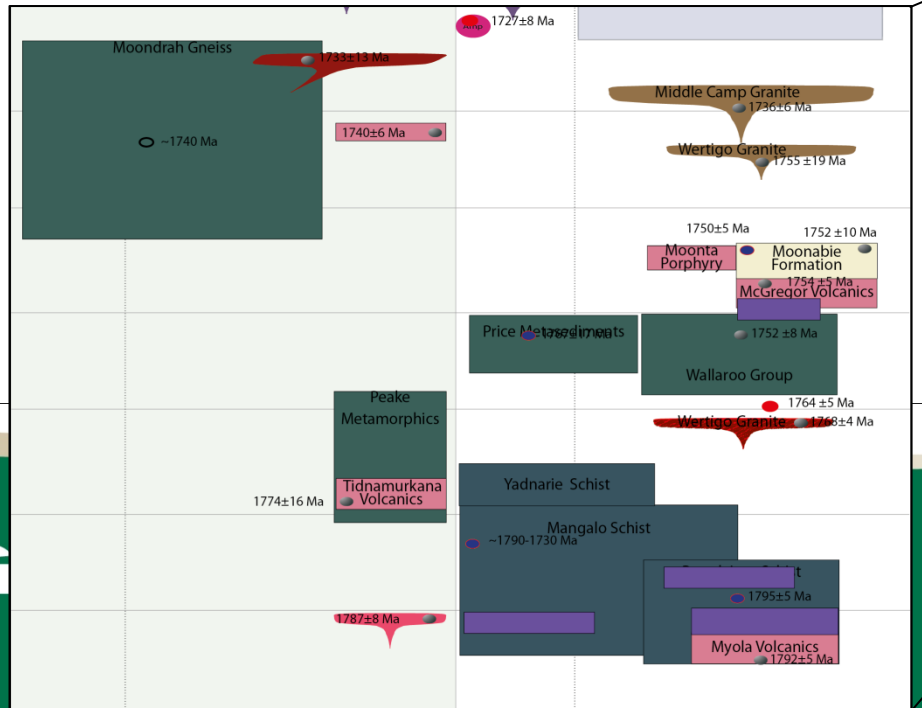


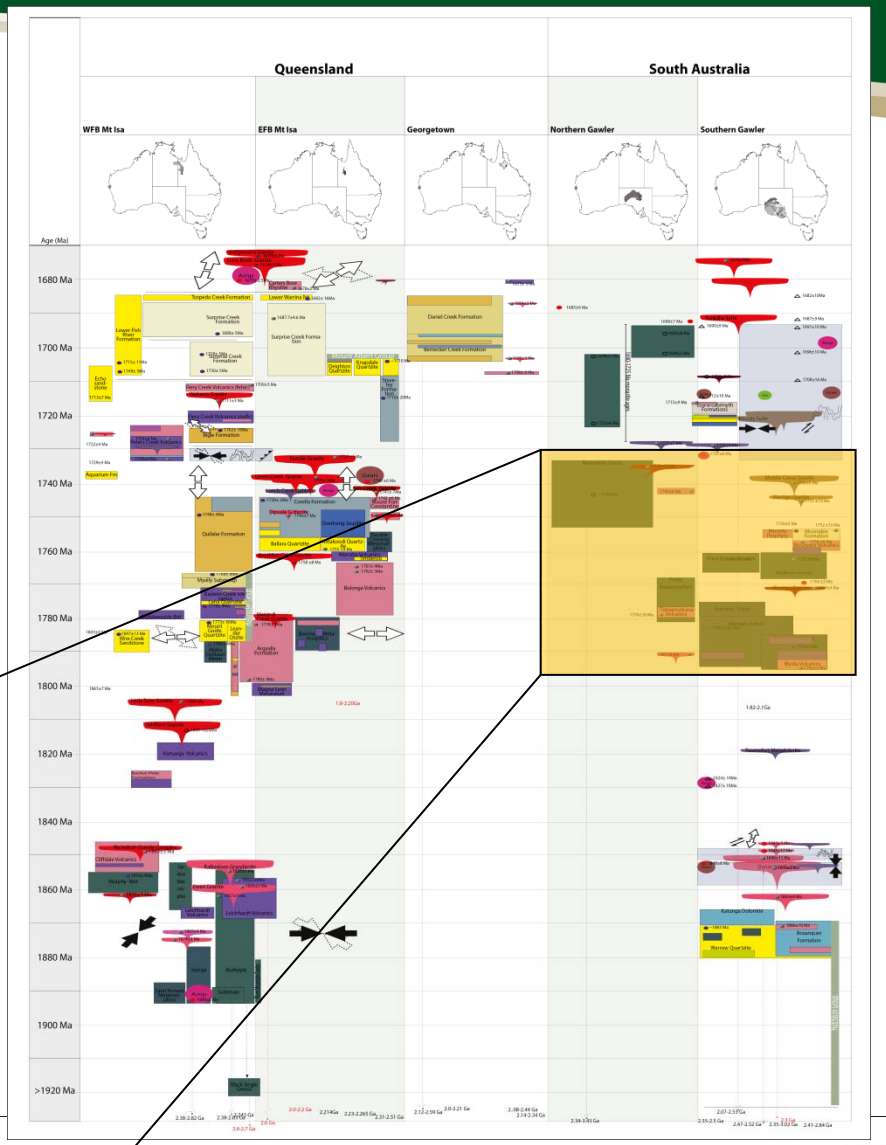


Event Chronology

Gawler Craton records several major Palaeo- to Mesoproterzoic continental growth events (Cawood and Korsch, 2008; Betts and Giles, 2006).

Pre-Kimban Orogeny (ca 1790-1750 Ma) sedimentary successions extending from the Nawa terrane to the Yorke Peninsula (North Australian Craton) suggesting that the Archaean nucleus of the Gawler Craton had amalgamated with the rest of the Australian continent before the Kimban Orogeny.





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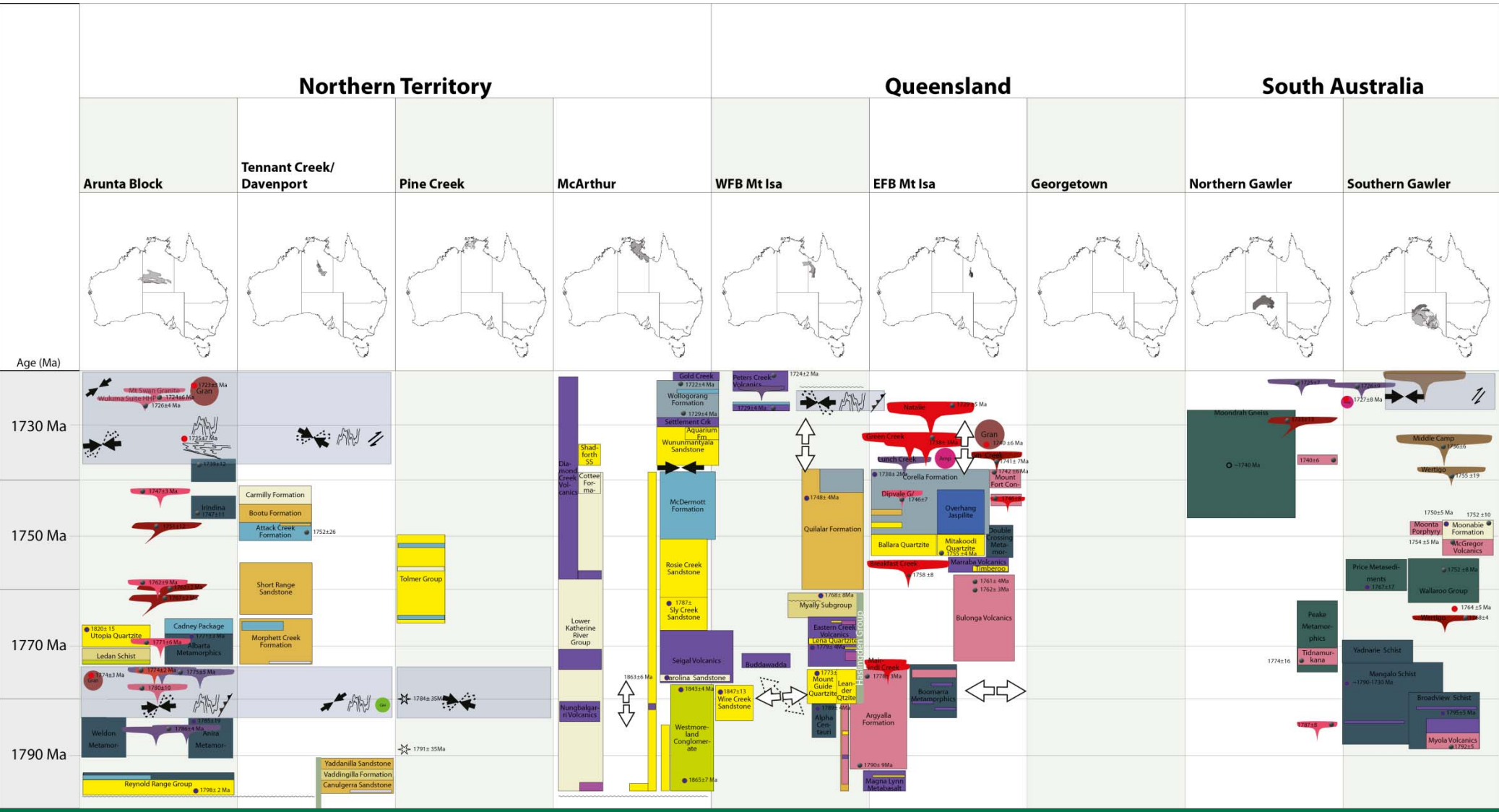
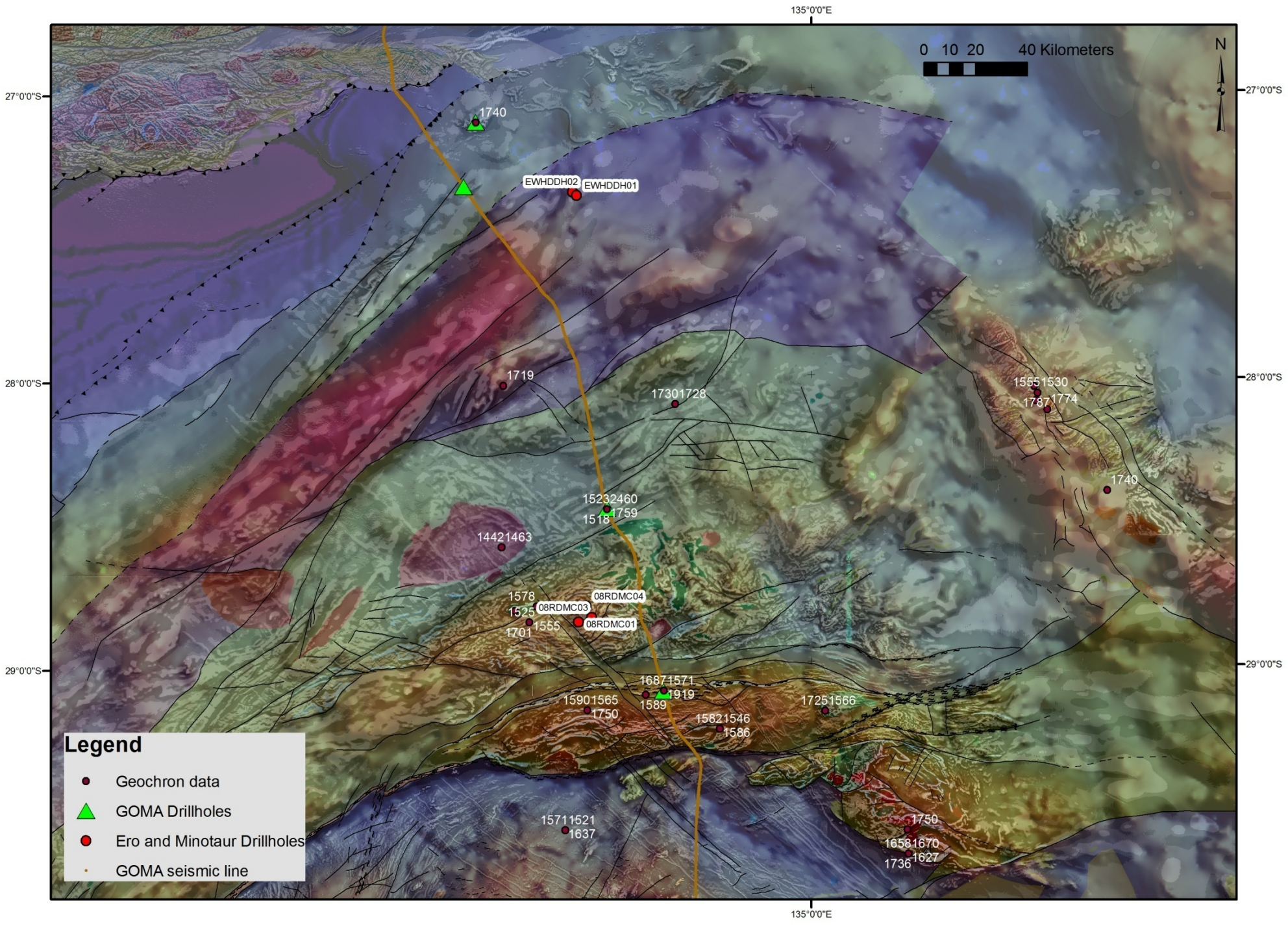
Event Chronology

These basins correlate with similarly aged basins across large tracts of Northern Australia.




135°0'0"E
27°0'0"S
28°0'0"S
29°0'0"S
0 10 20 40 Kilometers
N
1740
EWHDDH02
EWHDDH01
1719
17301728
15551530
17871774
1740
15232460
1759
1518
14421463
1578
08RDMC04
1525
08RDMC03
08RDMC01
1555
1701
16871571
1919
1589
15901565
1750
17251566
15821546
1586
15711521
1637
1750
16581670
1736
1627
Legend
Geochron data
GOMA Drillholes
Ero and Minotaur Drillholes
GOMA seismic line

Event Chronology

Need to consider the tectonic evolution of the northern Gawler Craton

Important orogenic event that may have influenced the marginal terranes include:

•***ca 1850-1845 Ma Cornian Orogeny*** (Reid et al., 2008):

- amalgamation between the Archaean nucleus of the craton and the NAC occurred.

•*ca 1740-1690 Ma Kimban Orogeny:*

- **Craton-scale orogenic event**
- **major thermal event**
- **movement along major crustal structures such as the Kalinjala Shear Zone and the Tallacootra Shear Zone.**
- **The drivers for the Kimban Orogeny are uncertain.**

•***ca 1610-1590 Ma Wartaken Orogeny*** (Hand et al., 2007; Stewart and Betts, 2010):

- correlates with the Olarian Orogeny in the Curnamona Province.
- short-lived event constrained by the St Peter Suite (arc) and the Hiltaba Granites
- expressed in the southern Gawler Craton as movement along major shear zones (Stewart and Betts, 2010).

•*ca 1580-1540 Ma Kararan Orogeny* (Hand et al., 2007):

- **post-dates the ca 1600-1580 Ma Hiltaba Event.**
- **ultra-high temperature granulite facies metamorphism**
- **•southward translations of the marginal terranes of the northern Gawler Craton.**

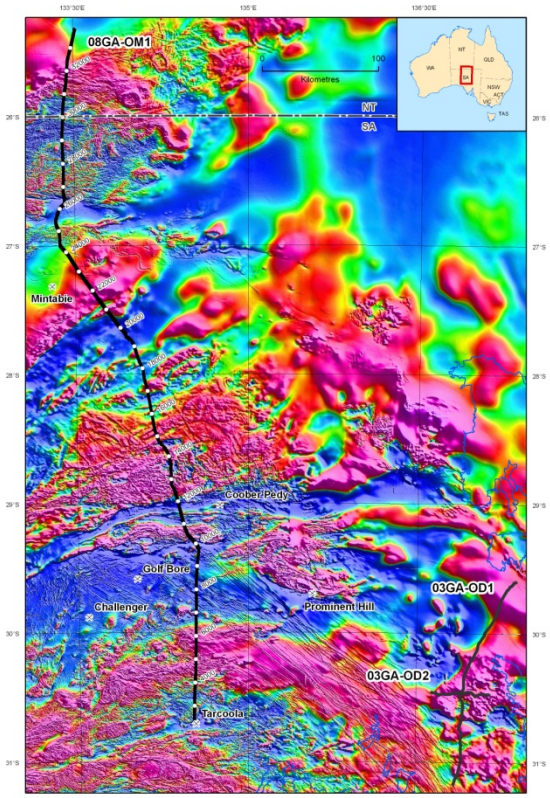
•***ca 1450 Ma Coorabie Orogeny*** (Fraser and Lyons, 2006):

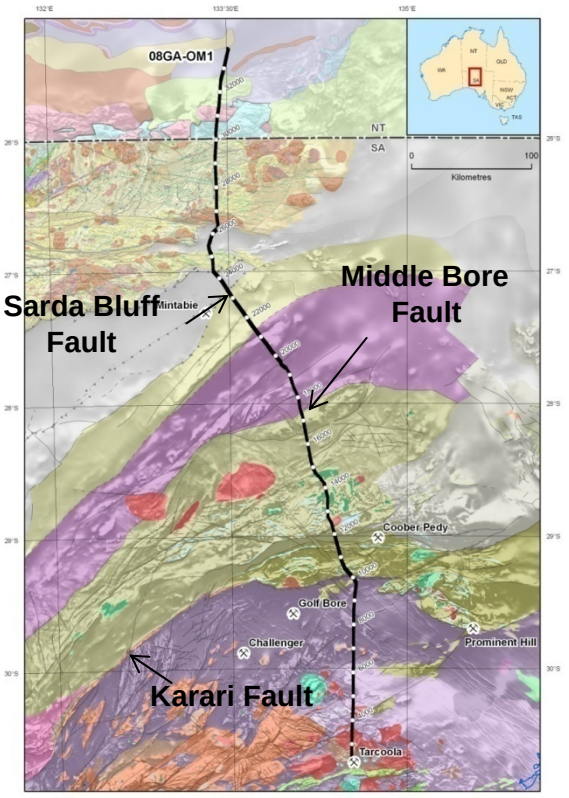
- •sinistral reactivation of NNE-trending shear zones in the western Gawler Craton.

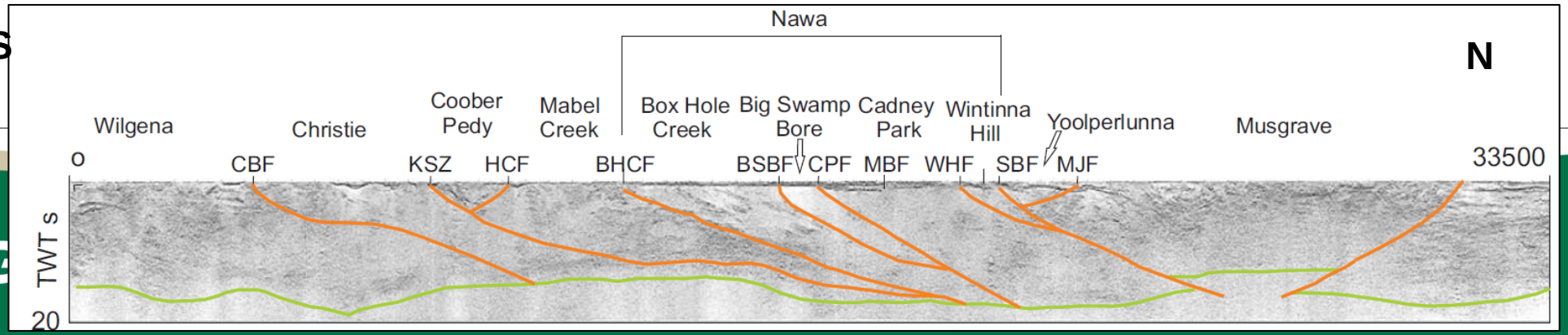
Major fault zones

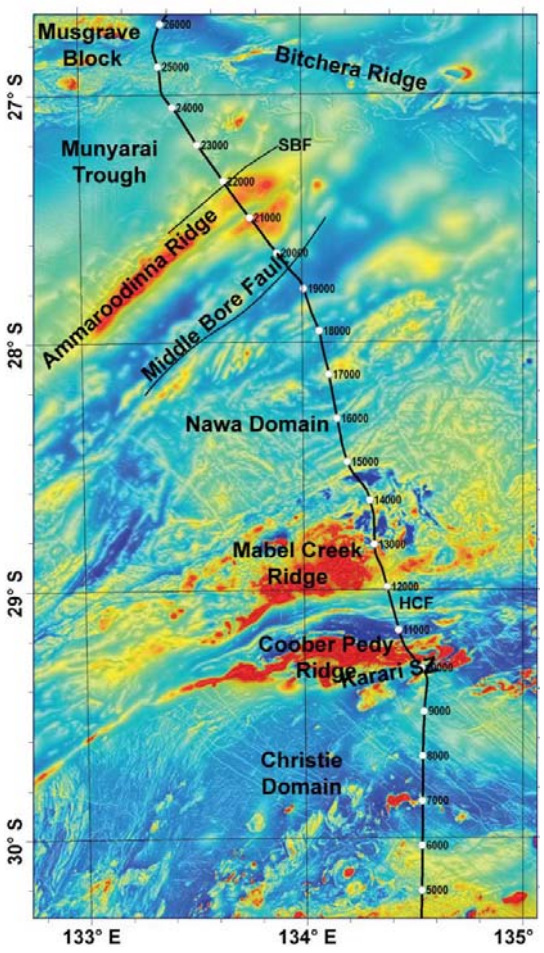
Focus on two structures:

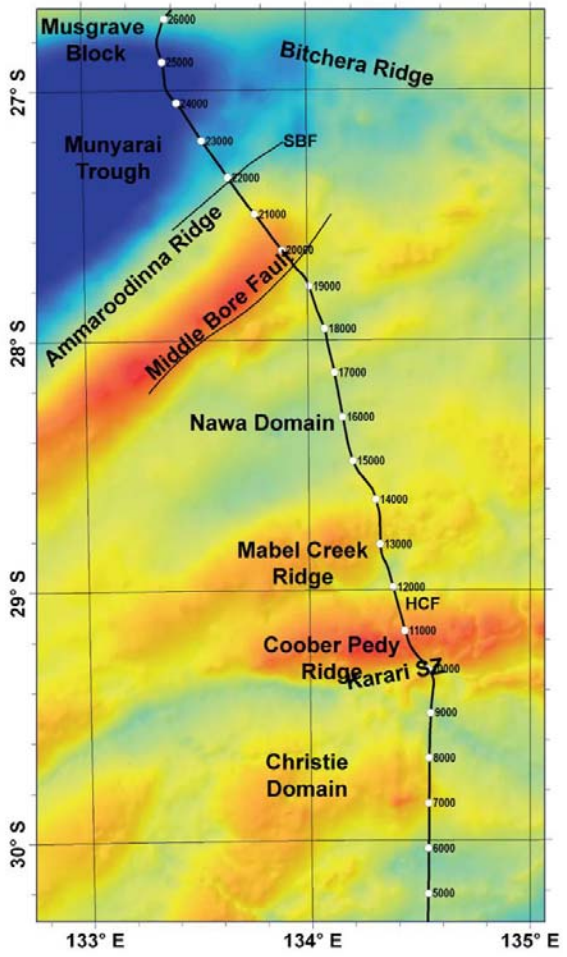
1.Karari Shear Zone:
2.Middle Bore Fault Zone
3.Sarda Bluff Fault Zone








Musgrave Block
Bitchera Ridge
Munyarai Trough
SBF
Ammaroodinna Ridge
Middle Bore Fault
Nawa Domain
Mabel Creek Ridge
HCF
Coober Pedy Ridge
Karari SZ
Christie Domain
27° S
28° S
29° S
30° S
133° E
134° E
135°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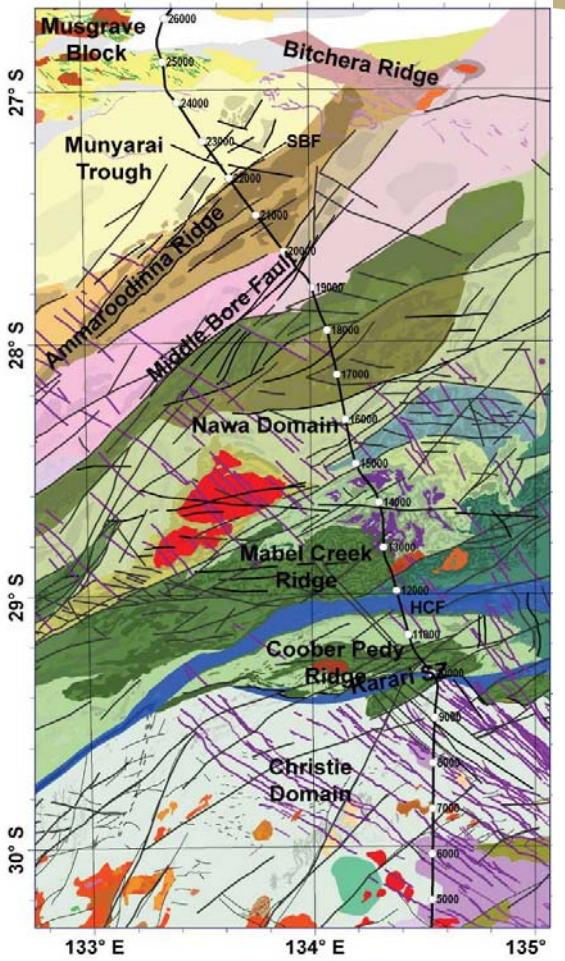
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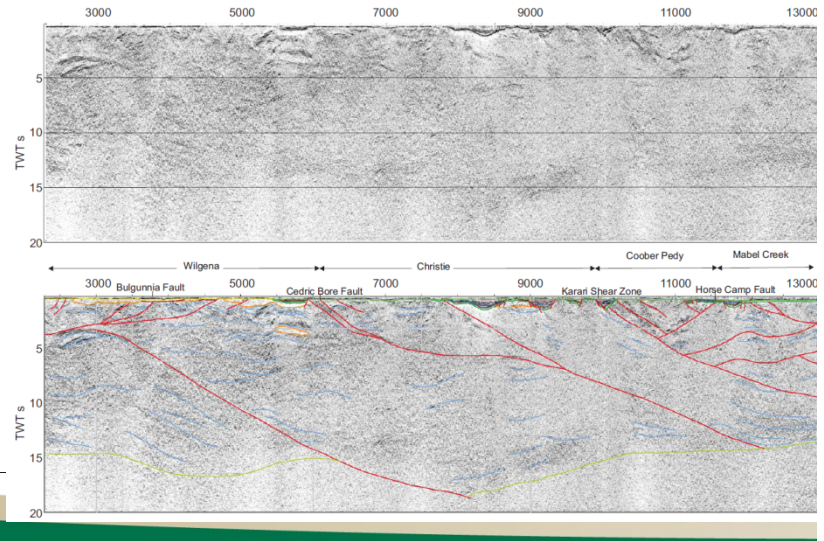
Coober Pedy Ridge
Karari SZ
Christie Domain
27° S
28° S
29° S
30° S
133° E
134° E
135°

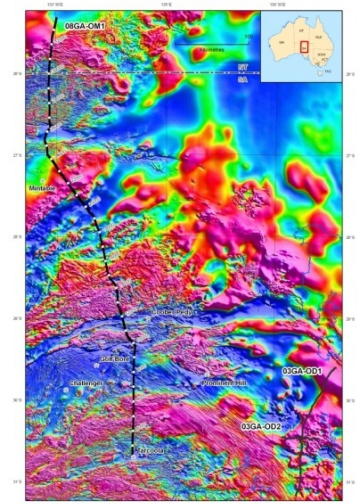
Major structures

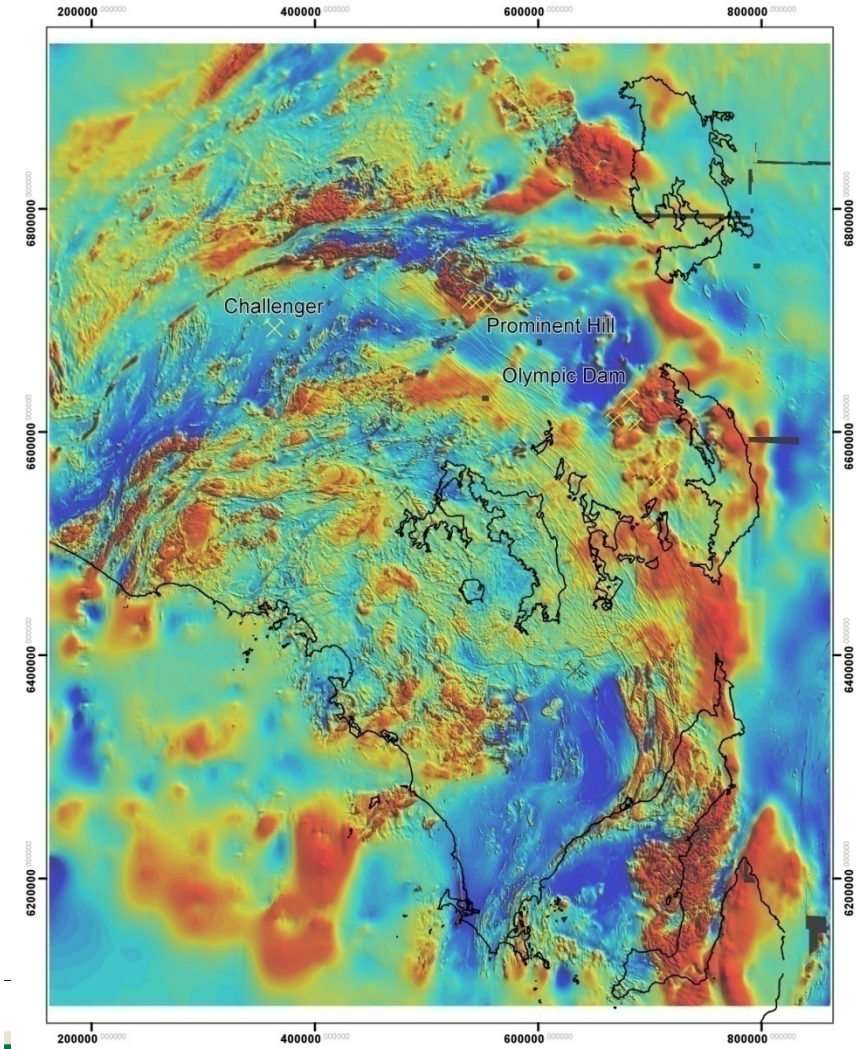
1.Karari Fault Zone:

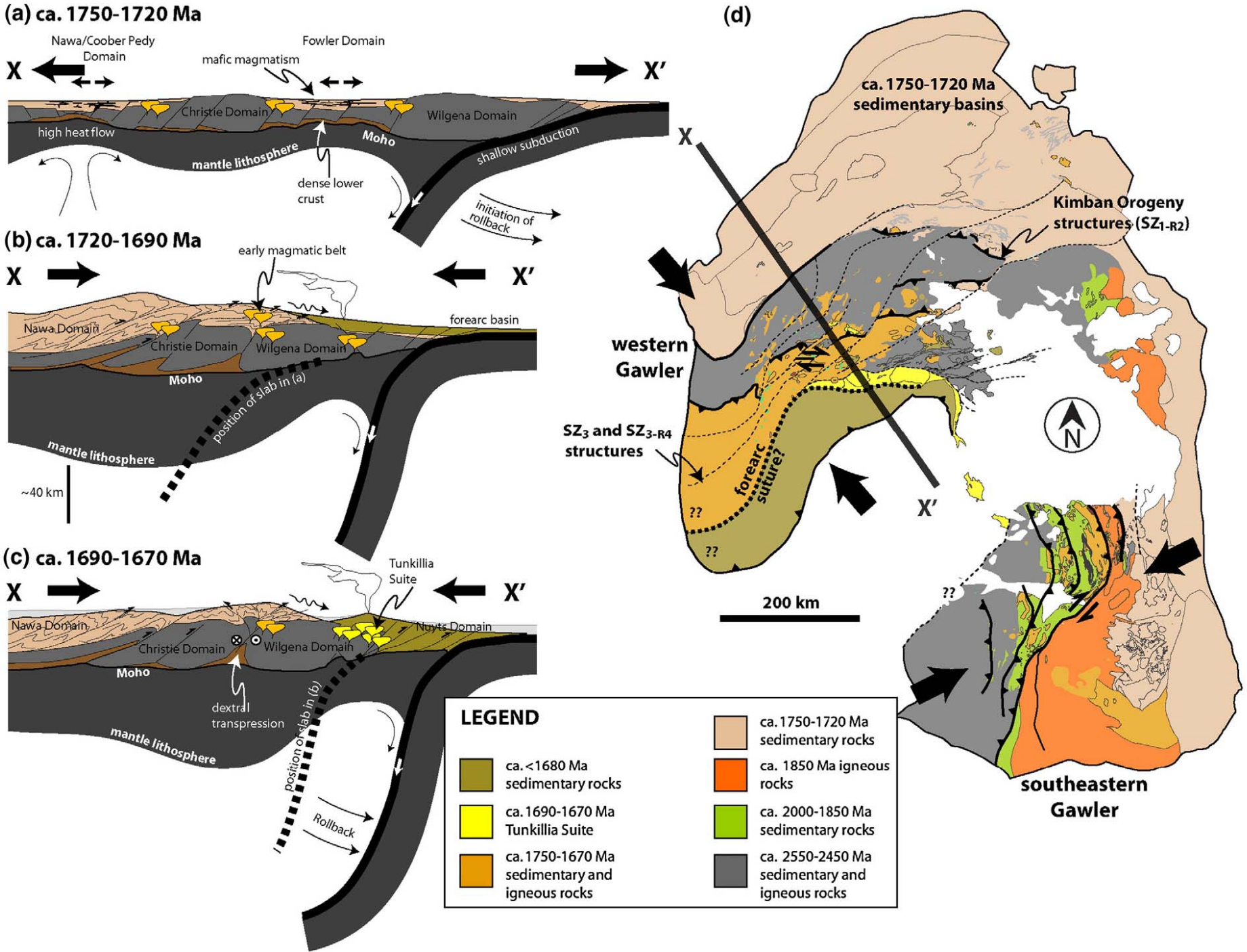
• Boundary between the Archaean nucleus of the Gawler Craton and the Palaeoproterozoic terranes of the northern marginal terranes (CPR, Nawa terrane).

• 500 km long and is a major crustal discontinuity







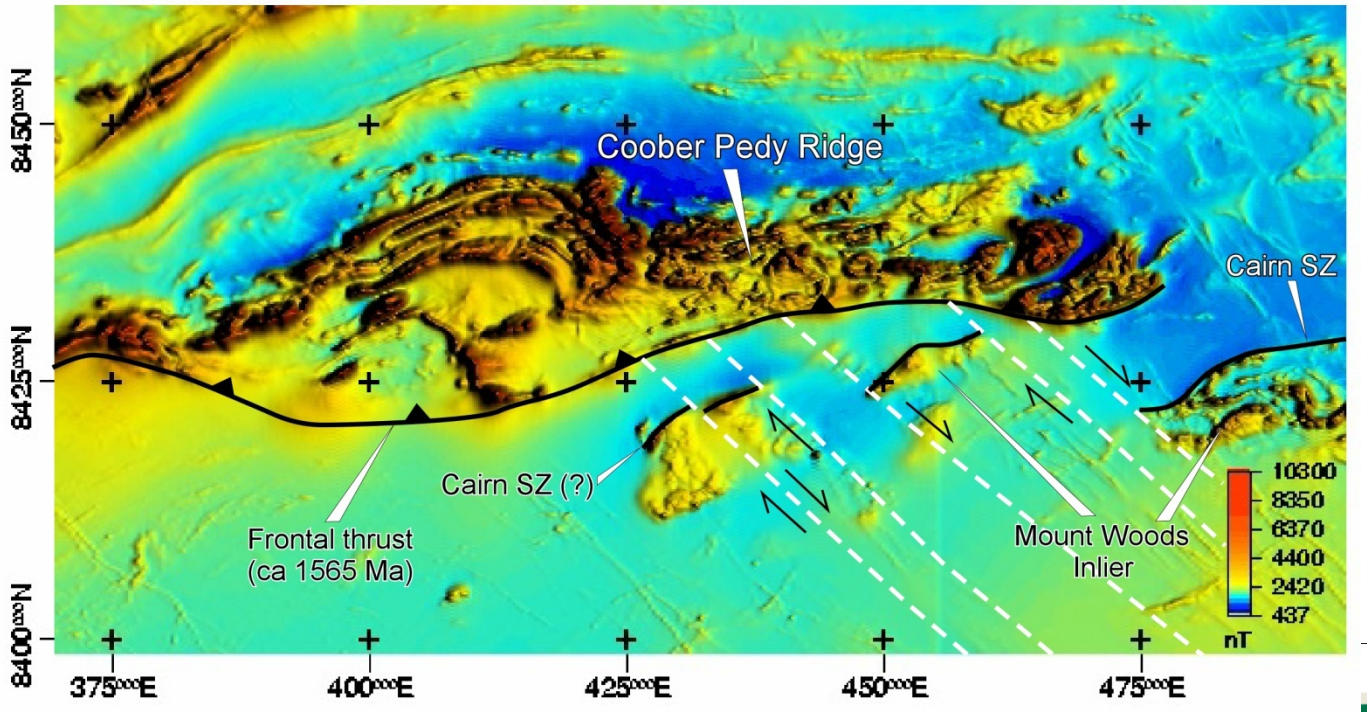

(a) ca. 1750-1720 Ma
Nawa/Coober Pedy Domain
Fowler Domain
mafic magmatism
X
X′
Christie Domain
Wilgena Domain
high heat flow
mantle lithosphere
Moho
shallow subduction
dense lower crust
Initiation of rollback
(b) ca. 1720-1690 Ma
early magmatic belt
X
X′
forearc basin
Nawa Domain
Christie Domain
Wilgena Domain
Moho
position of slab in (a)
mantle lithosphere
~40 km
(c) ca. 1690-1670 Ma
Tunkillia Suite
X
X′
Nawa Domain
Nuyts Domain
Christie Domain
Wilgena Domain
Moho
dextral transpression
position of slab in (b)
mantle lithosphere
Rollback
(d)
ca. 1750-1720 Ma sedimentary basins
X
Kimban Orogeny structures (SZ1-R2)
western Gawler
SZ3 and SZ3-R4 structures
forearc suture?
??
??
X′
N
??
200 km
southeastern Gawler
LEGEND
ca. <1680 Ma sedimentary rocks
ca. 1690-1670 Ma Tunkillia Suite
ca. 1750-1670 Ma sedimentary and igneous rocks
ca. 1750-1720 Ma sedimentary rocks
ca. 1850 Ma igneous rocks
ca. 2000-1850 Ma sedimentary rocks
ca. 2550-2450 Ma sedimentary and igneous rocks

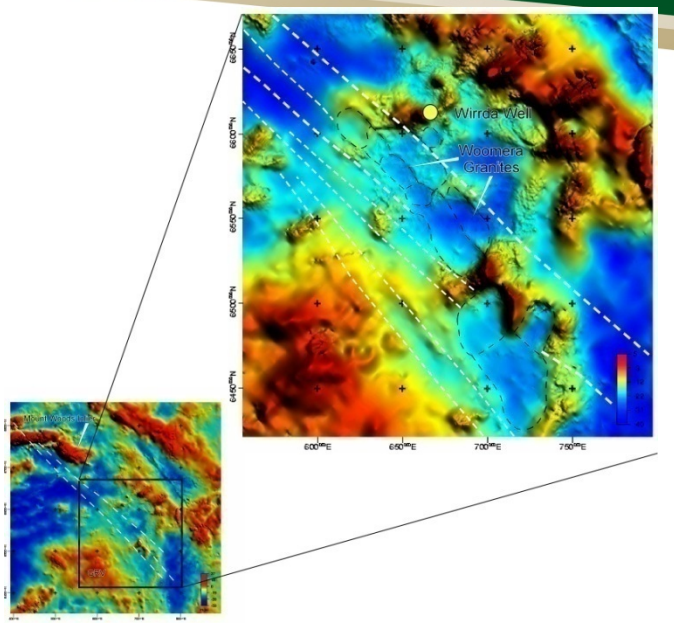
Major structures

1.Karari Fault Zone:

• Timing of the latest movement along the Karari Fault Zone post-dates the Hiltaba Event .

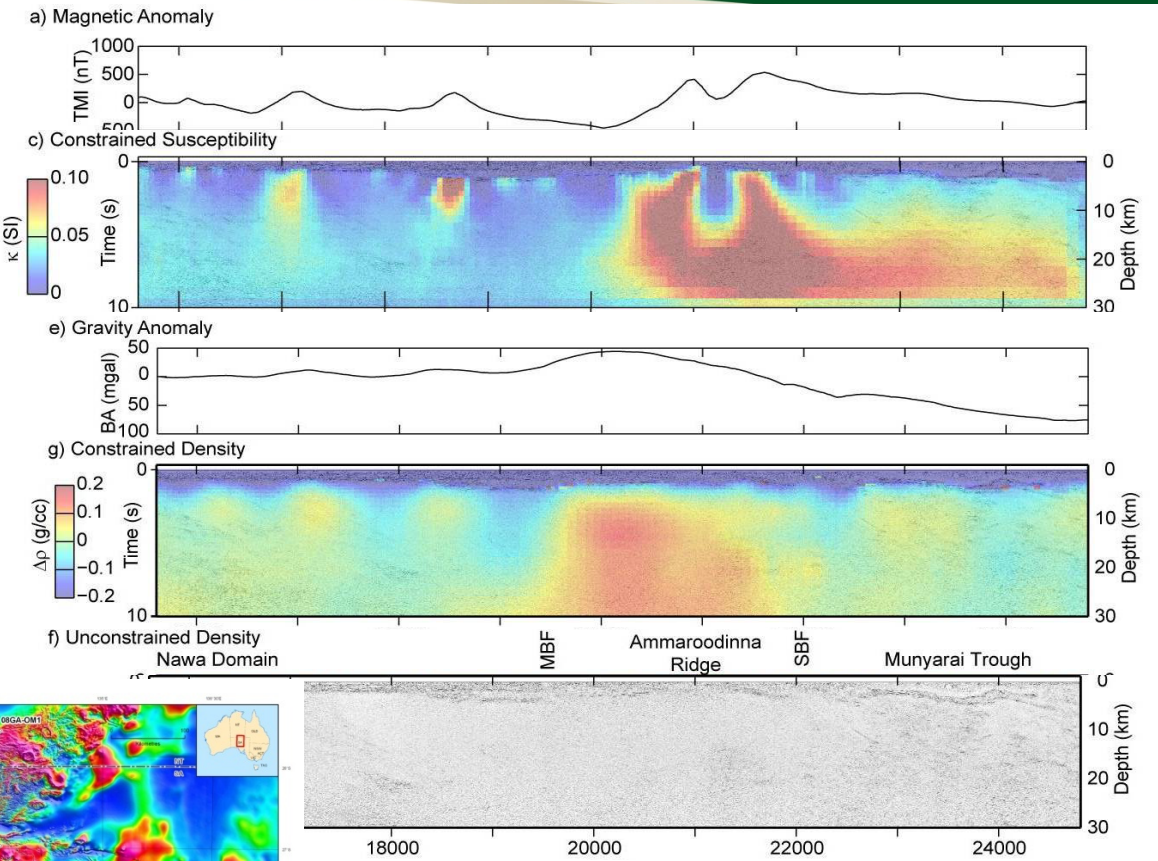
• Kararan Orogeny (as defined by Hand et al., 2007).

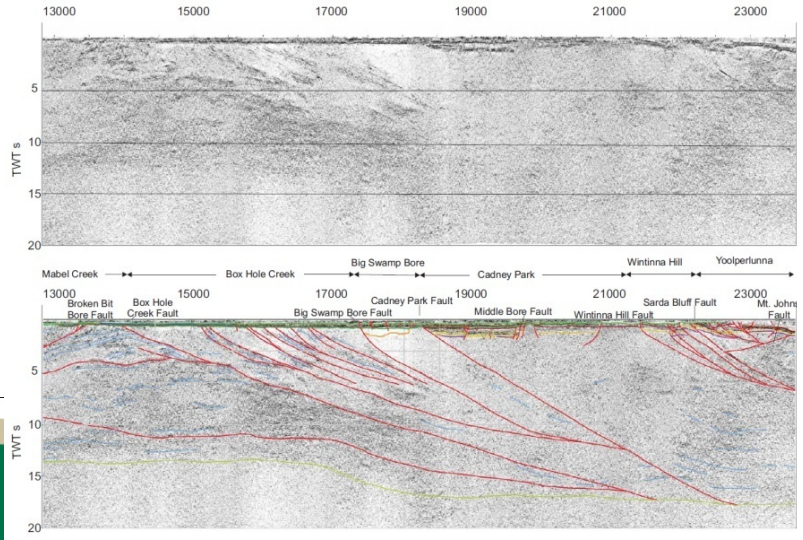


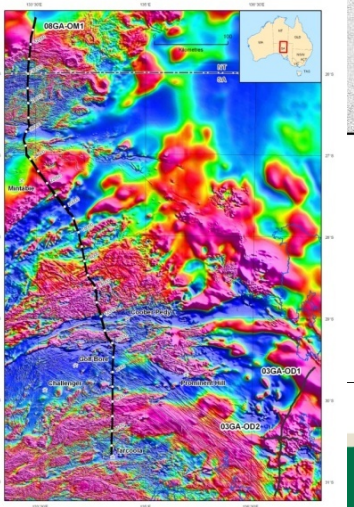


Middle Bore Fault

- MBF: imaged particularly well in gravity and magnetic datasets (Baines et al., in review, this volume).
- ca 1740 Ma Kimban Orogeny - transpressional deformation.
- The Middle Bore Fault Zone is poorly imaged in the GOMA seismic line







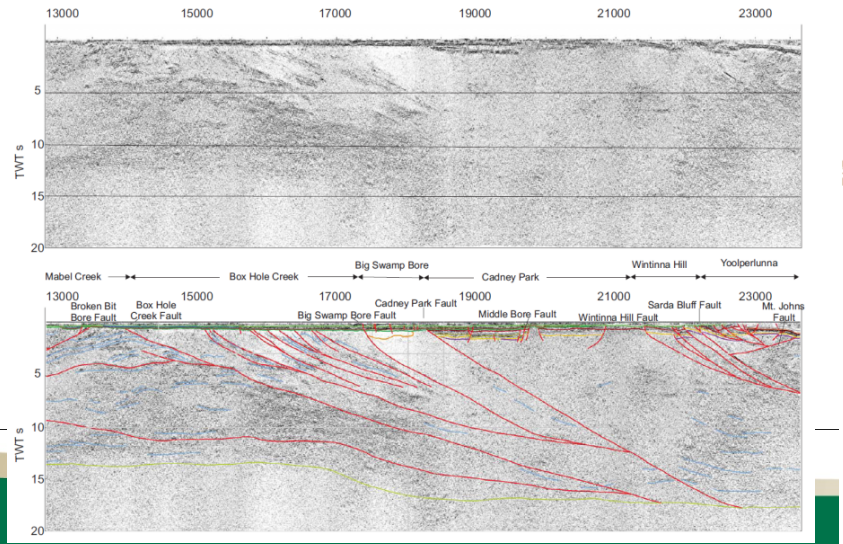
Sarda Bluff Fault

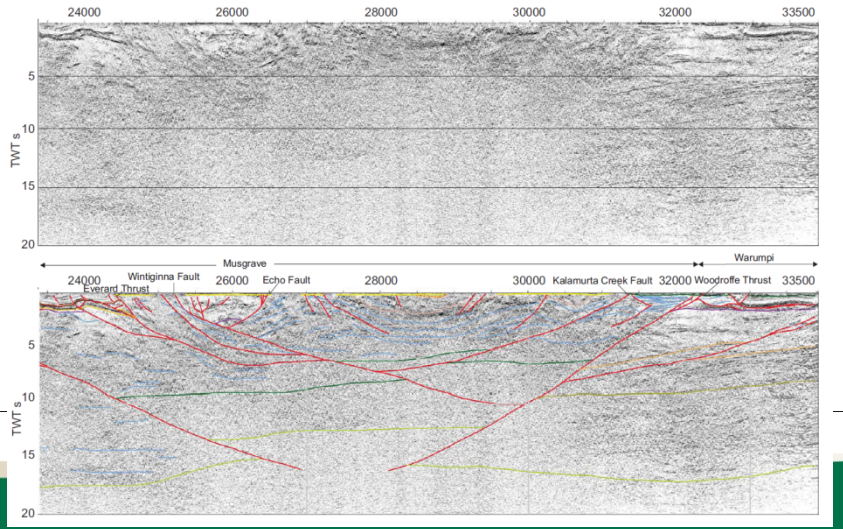
Sarda Bluff Fault:

•SBF is located to the north of the Ammaroodinna Ridge.

•Suture between the Gawler Craton the proto-Musgrave Block at ca 1740 Ma???????

•Region between the Sarda Bluff Fault and the Middle Bore Fault maybe a mosiac crustal blocks within the collision zone.

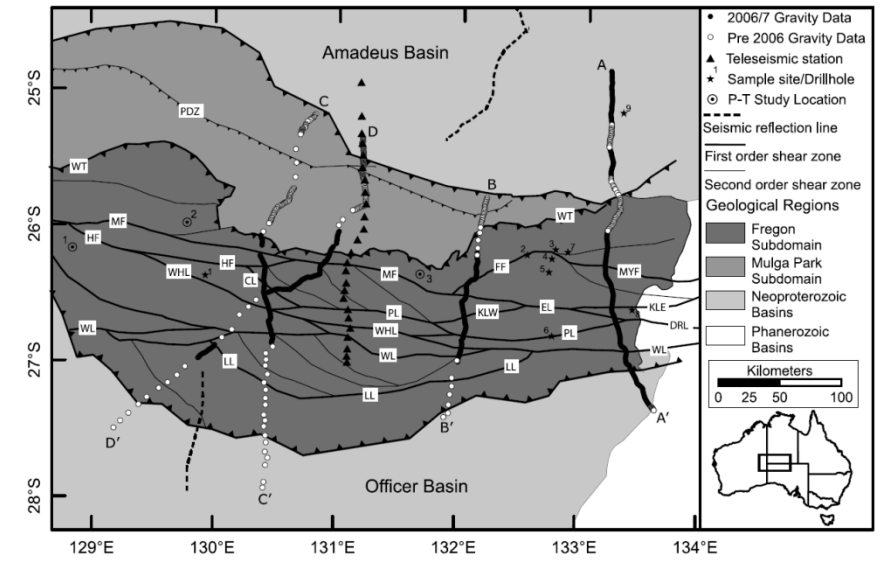


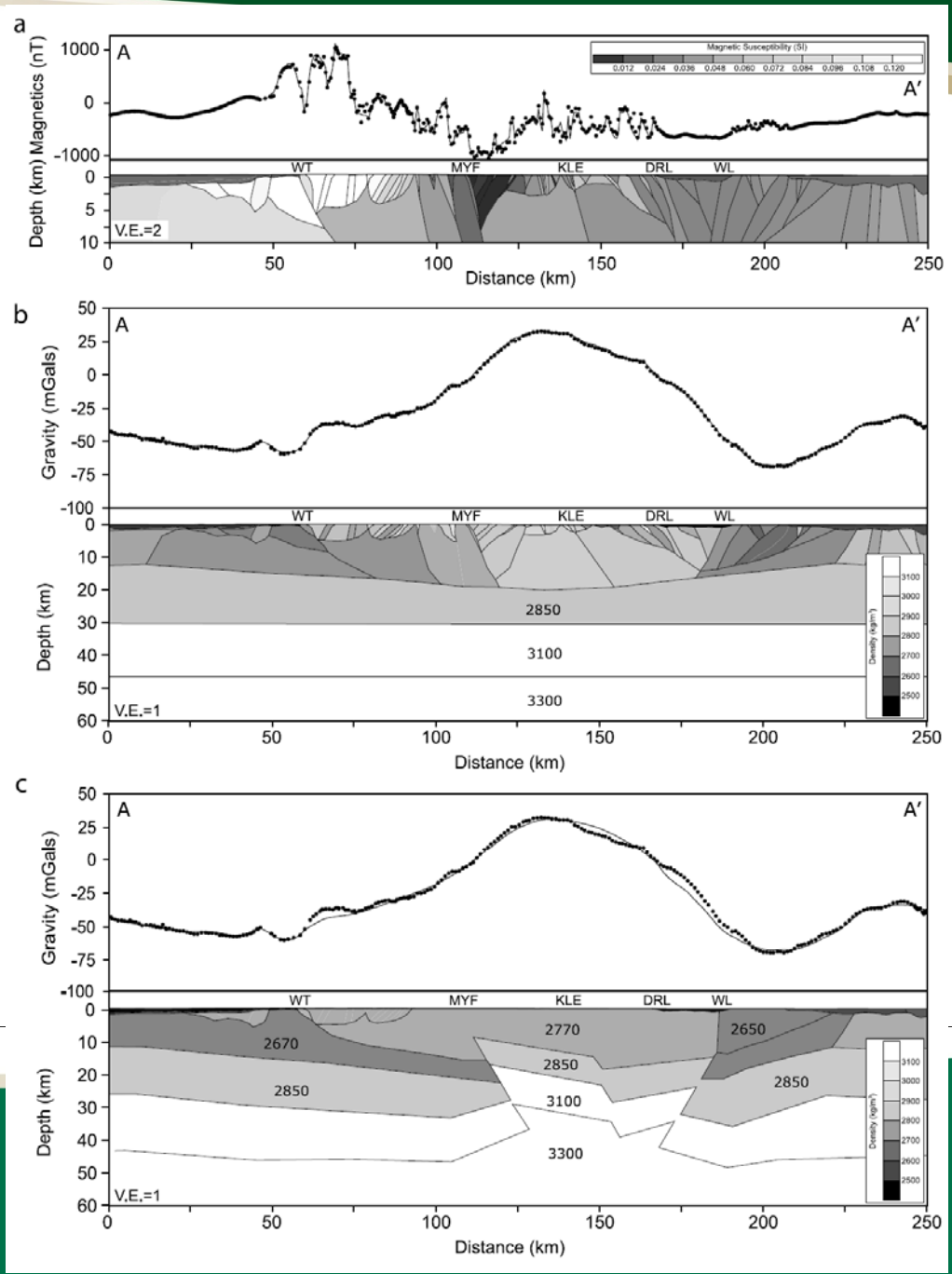


Sarda Bluff Fault

Sarda Bluff Fault:

•Alternatively could represent a zone of Moho uplift associated with the Late Neoproterozoic Petermann Orogeny (Aitken et al., 2009).





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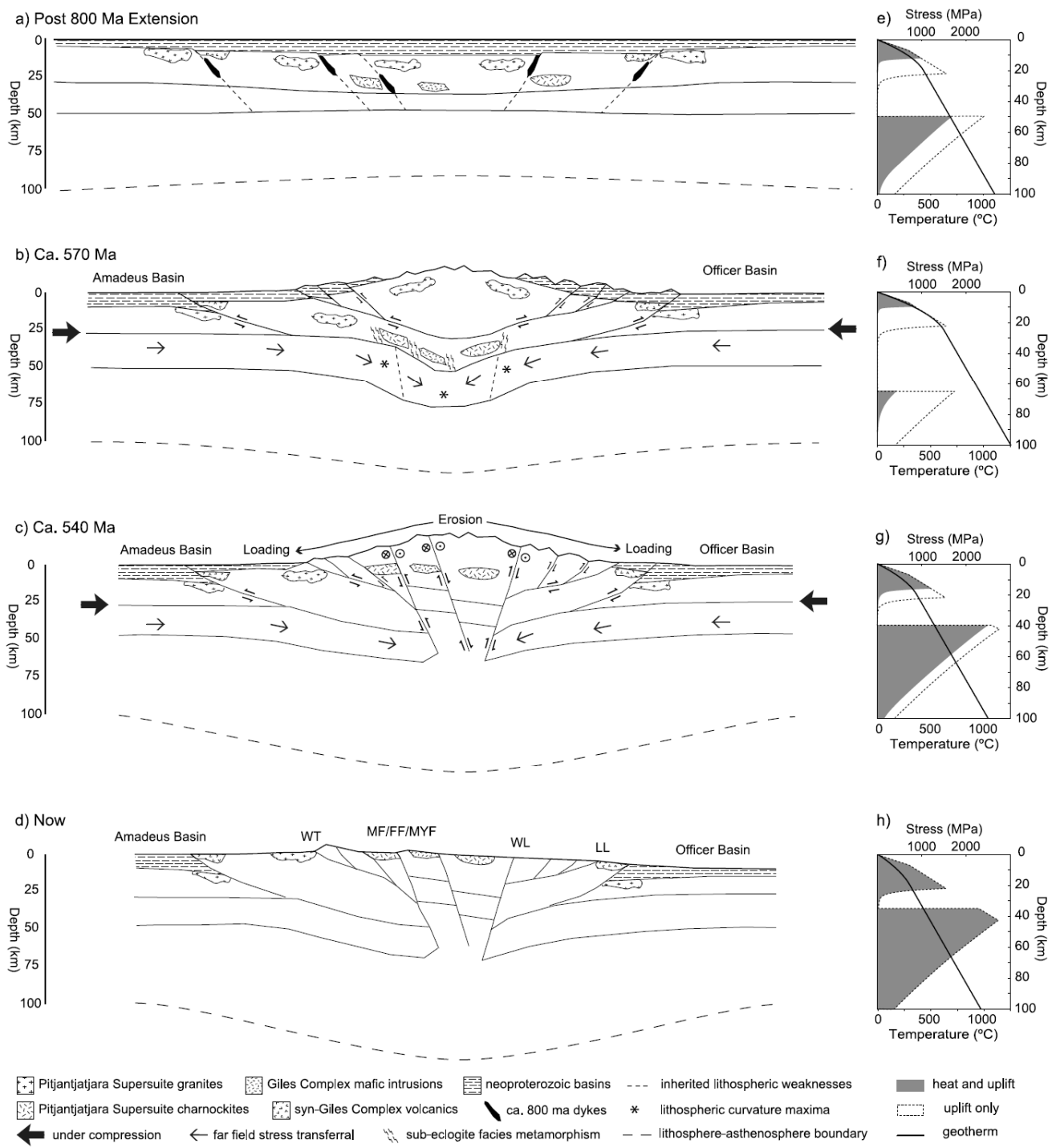

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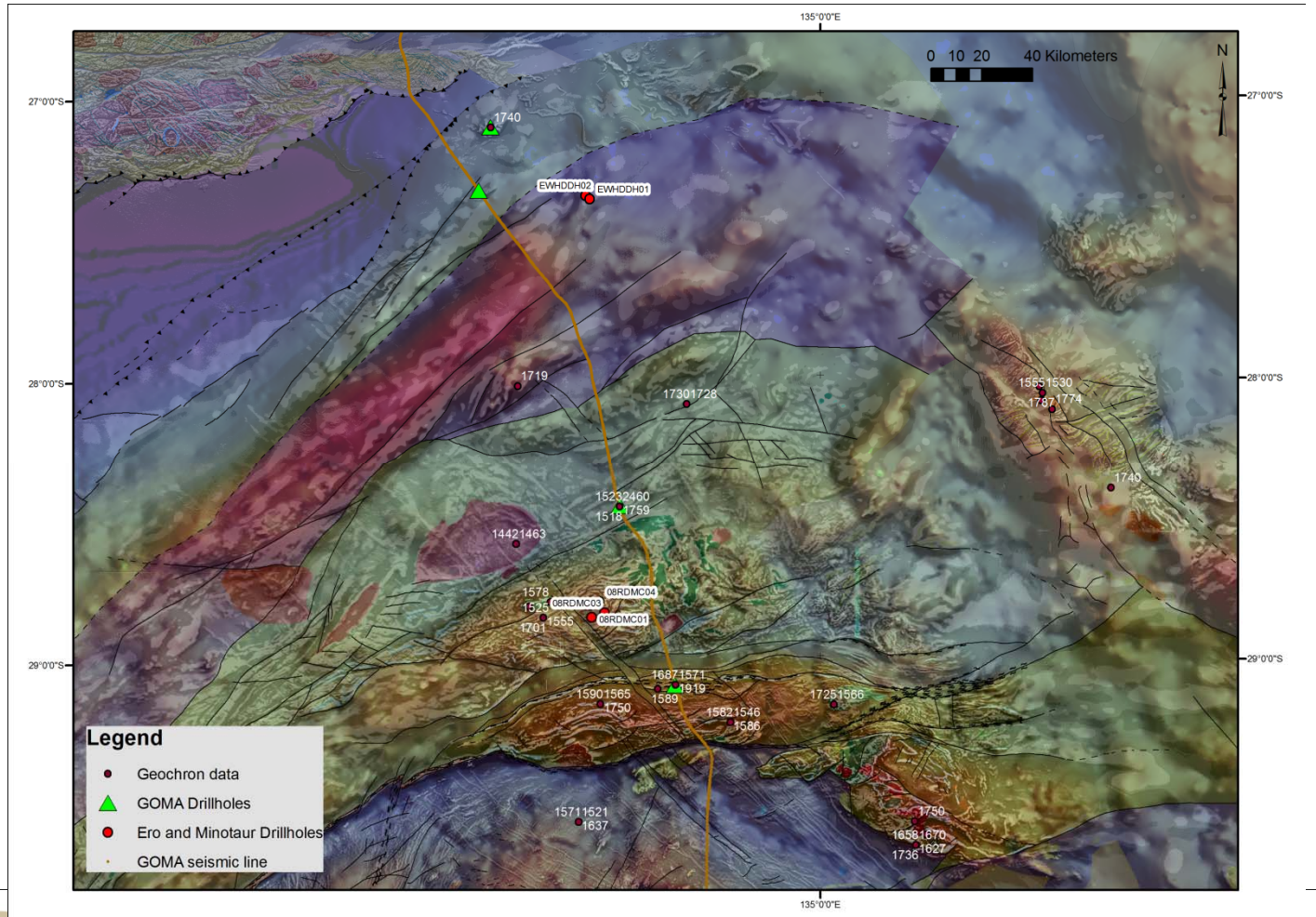
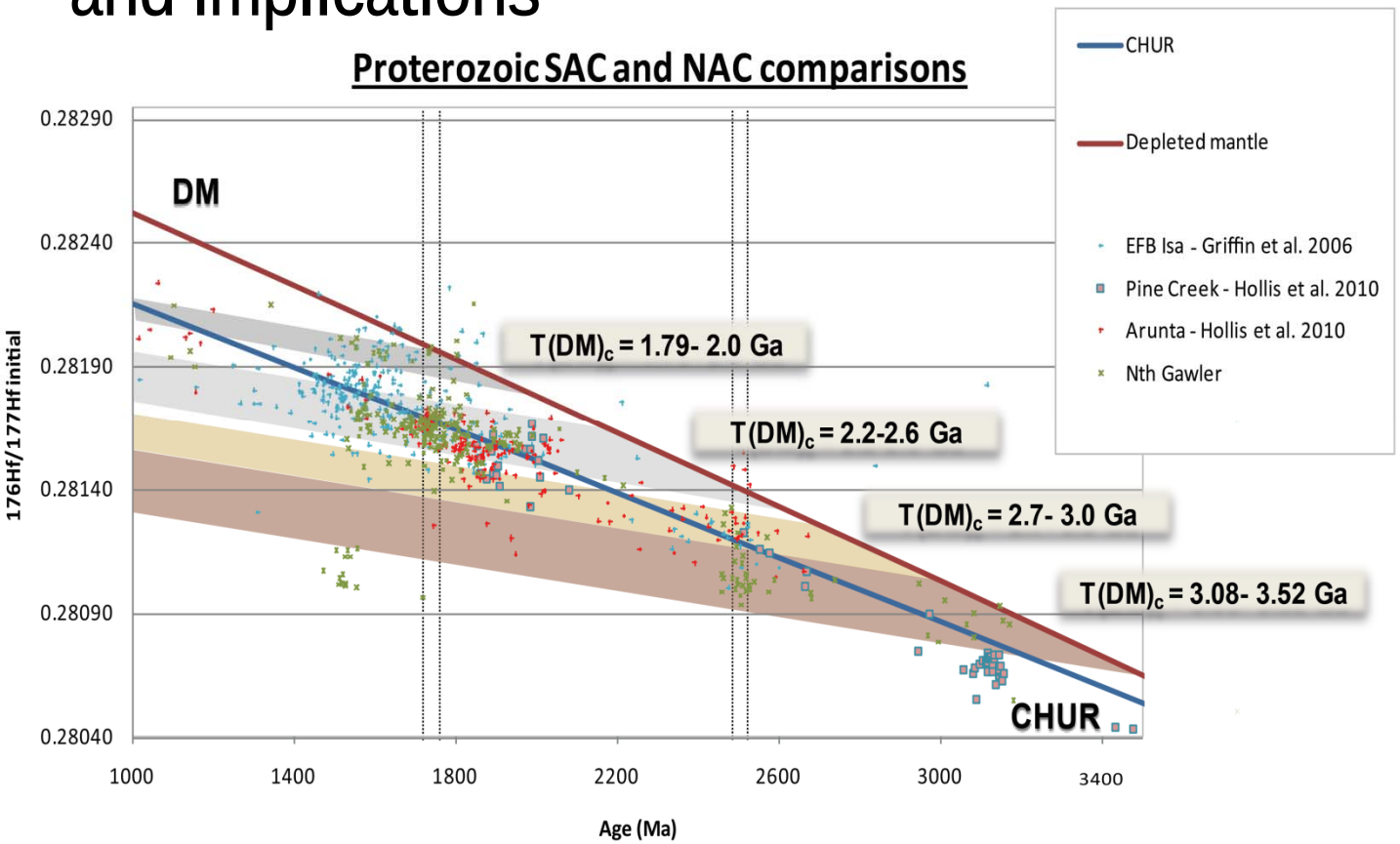
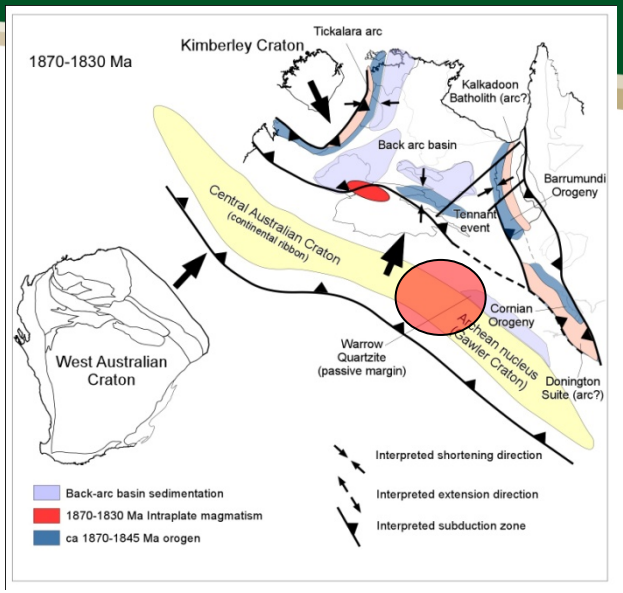
Geochronology and Hf-isotope constraints and implications

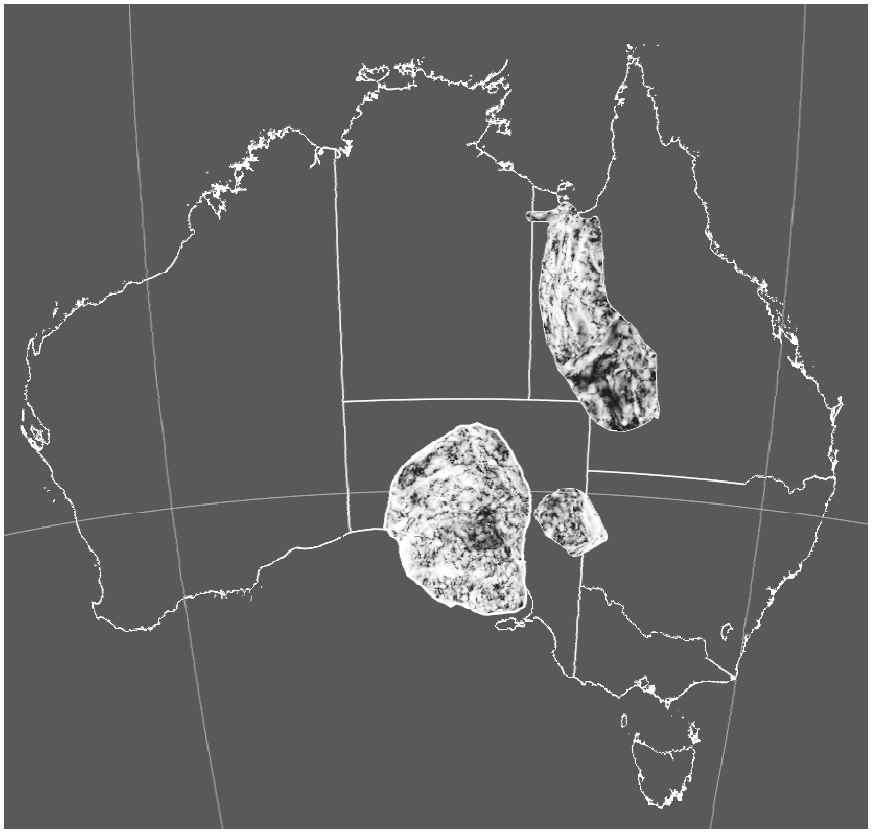


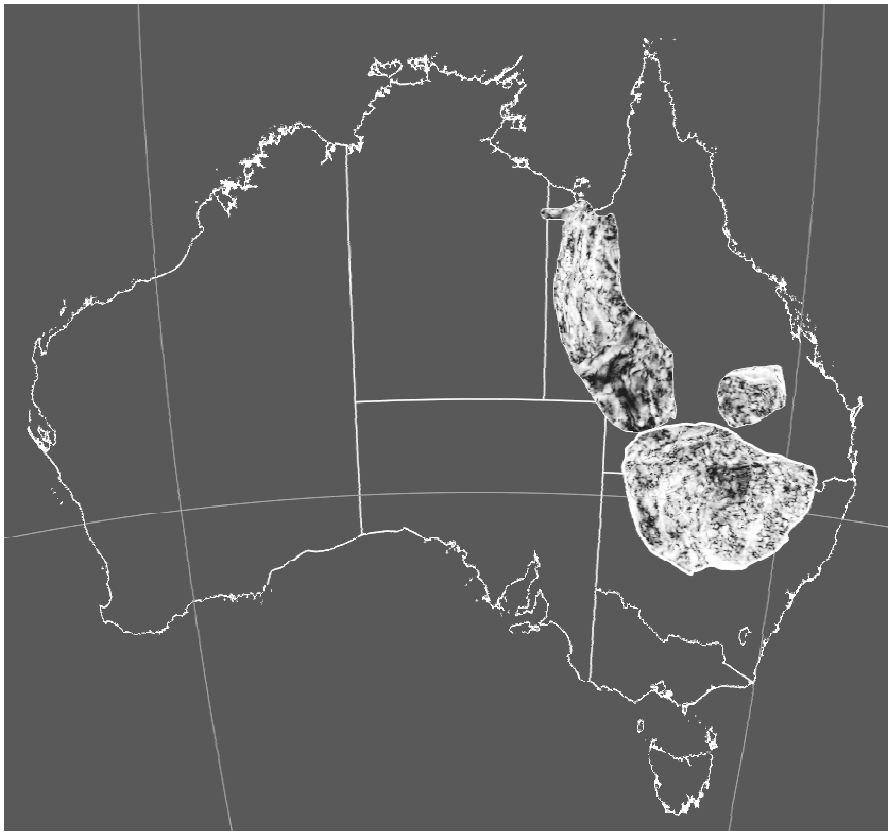
Geochronology and Hf-isotope constraints and implications



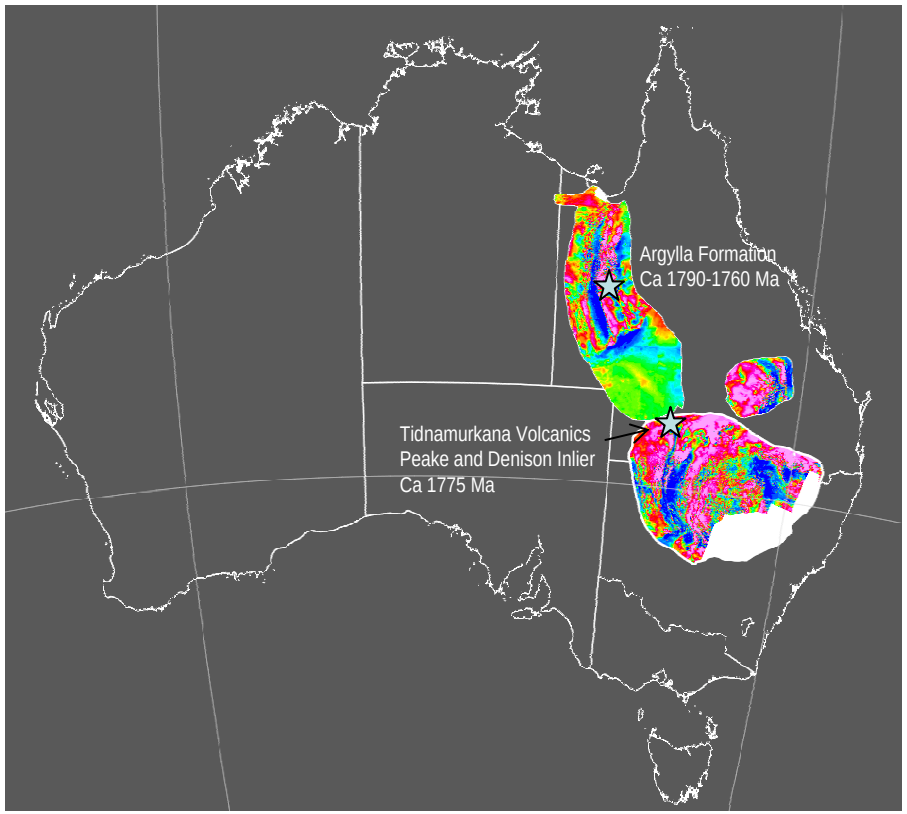


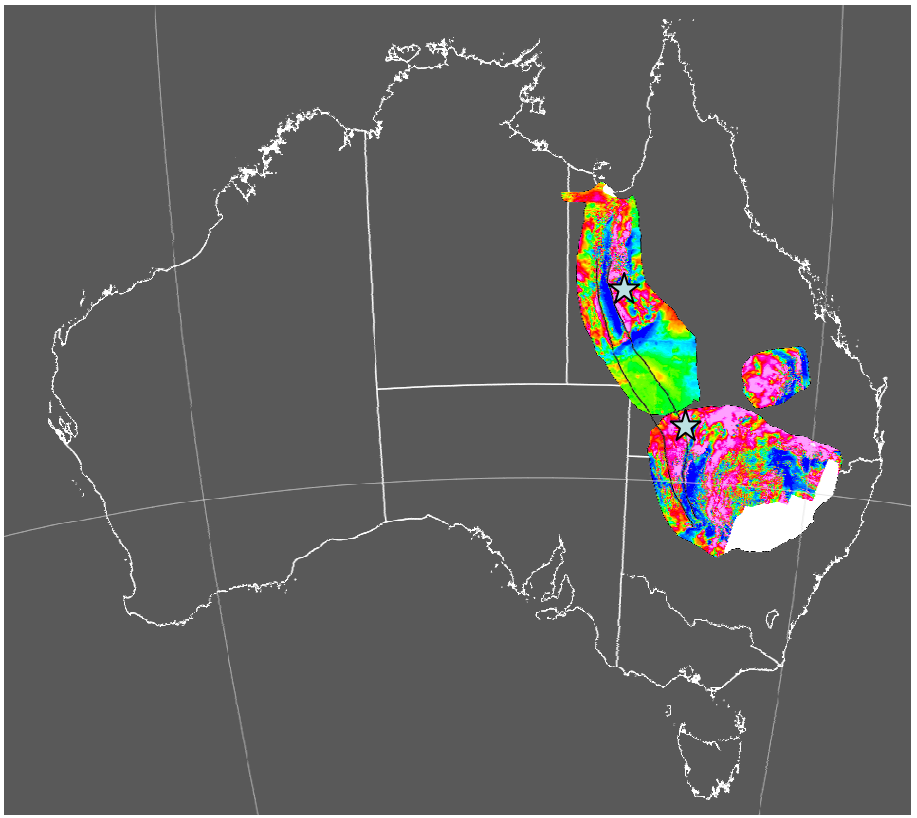
Reconstruction



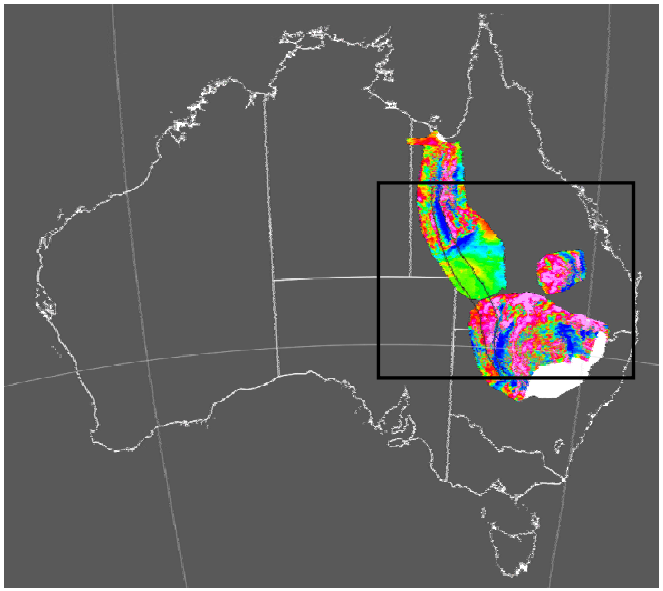


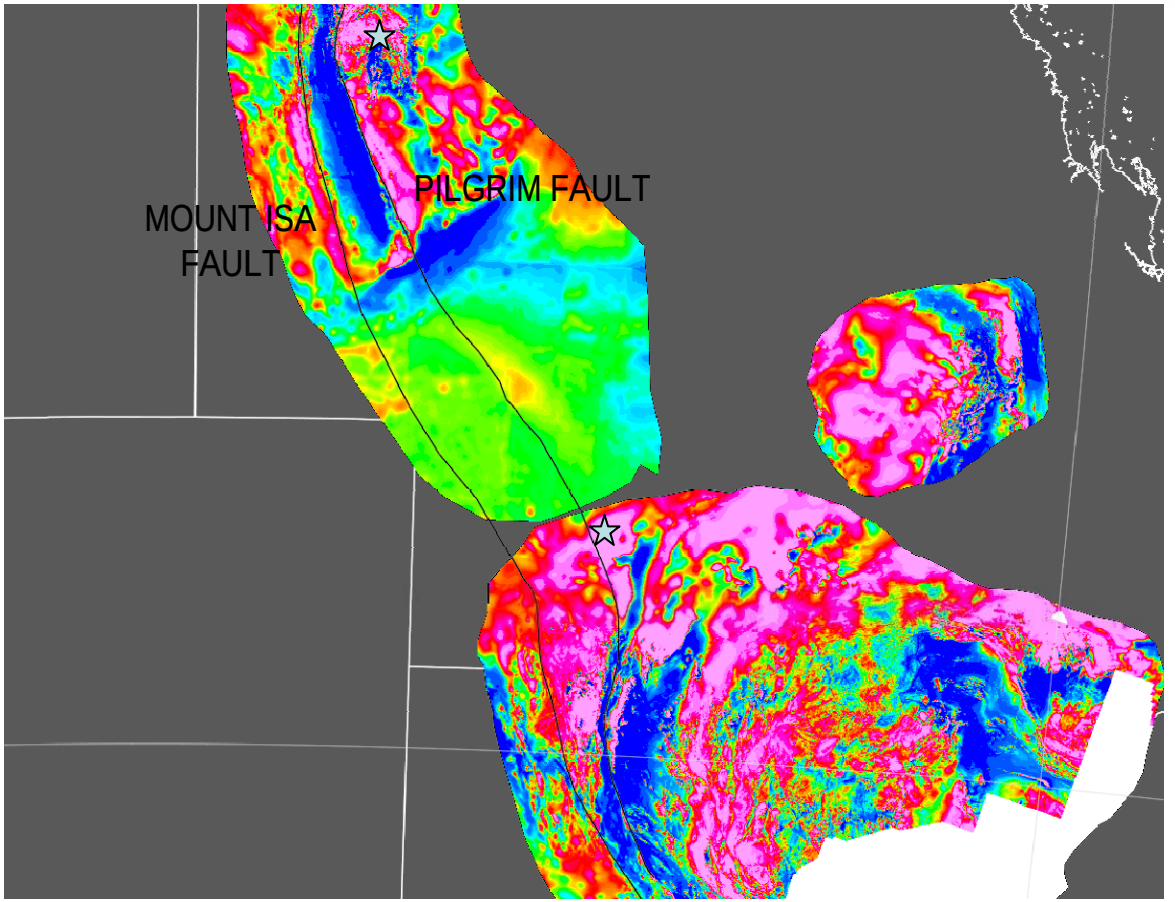
Reconstruction





Reconstruction



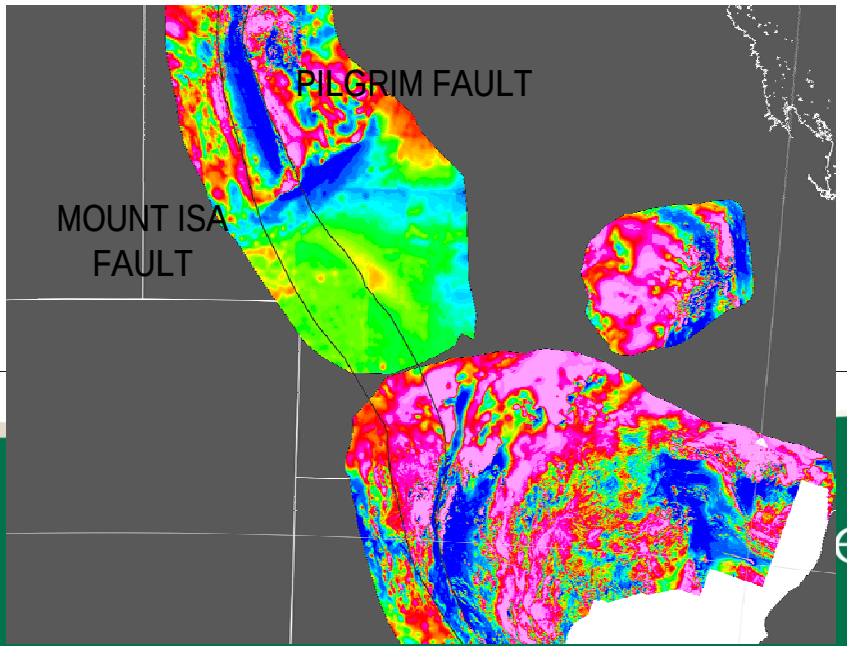


Lessons from Mt Isa

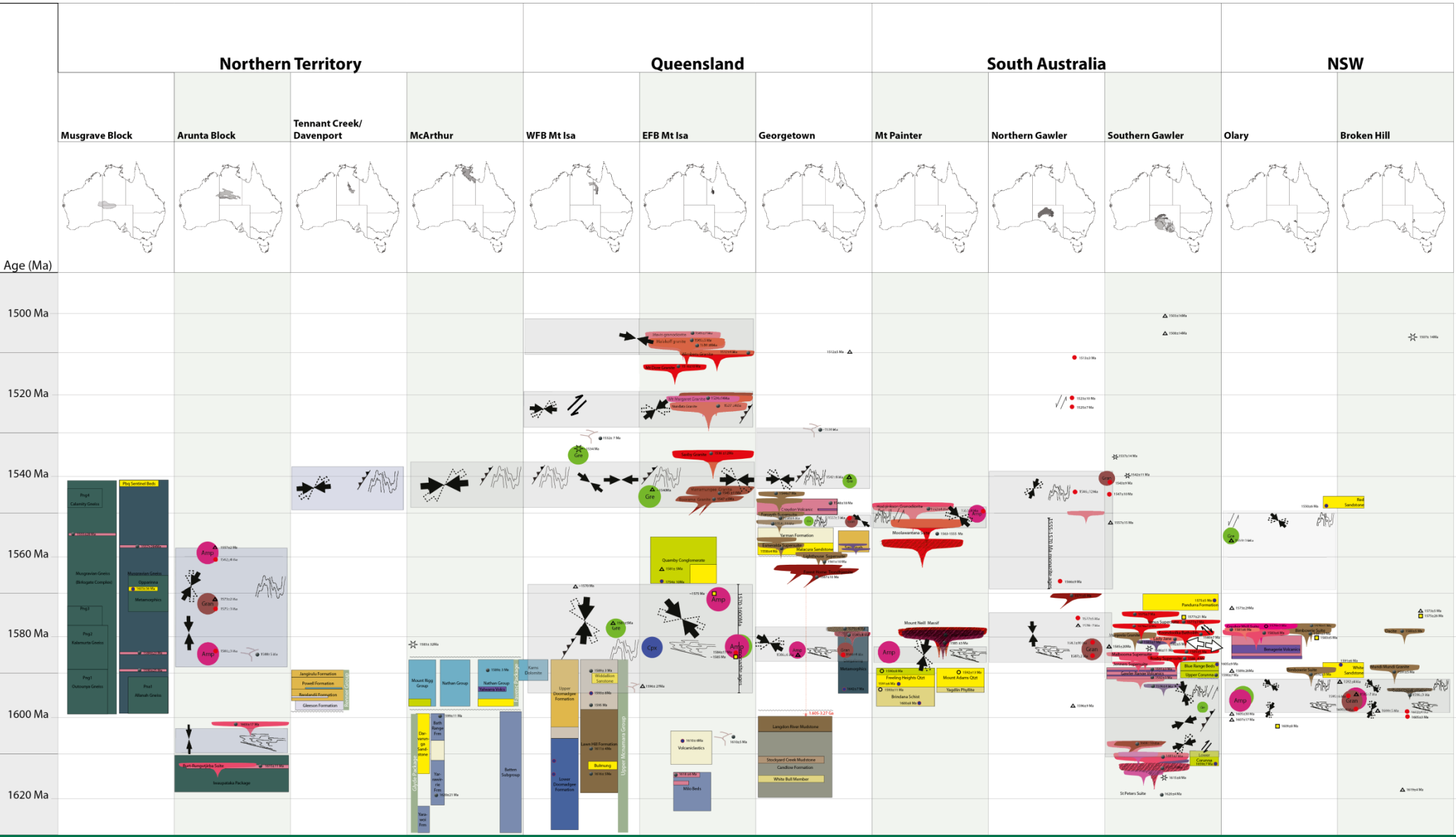
Pilgrim Fault – Long lived
Extensional fault during deposition of ca 1790-1760 Ma Leichhardt Superbasin

Reactivated during the ca 1580-1540 Ma Isan Orogeny as a reverse fault

Late Isa dextral strike-slip movement between 1530-1500 Ma



Lessons from Mt Isa



Reconstructions at two critical times

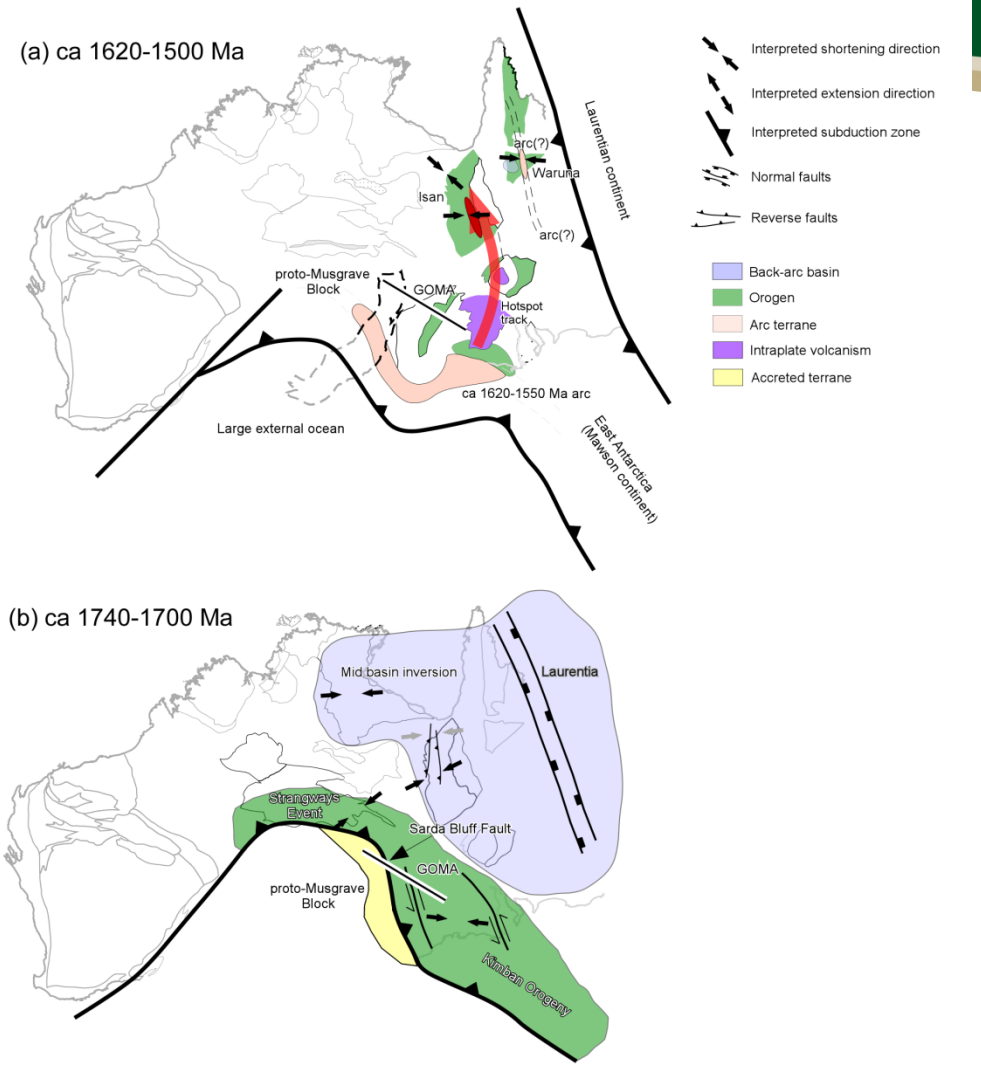
c. 1730-1720 Ma – what drove the Kimban Orogeny?

Collision of the Musgravian Crust (which is slightly more juvenile) onto the southern margin of the continent?

c. 1620-1500 Ma – bloody complicated with competing margins.

Arc magmatism along the southern margin (1620-1550 Ma)

Collision of Laurentia to the east controlling basin inversion during the Kararan Orogeny – and beyond!



Some things to think about.

1.Crustal evolution suggest that the NGC has similar evolution to the Arunta and parts of the North Australian Craton – so I think its part of the same crustal ribbon as the Arunta that was accreted to the North Australian Craton at ca 1845 Ma.

2.The structural architecture (at the scale of the continent) might be comparable to the Mount Isa Inlier (basin development followed by complex Mesoproterozoic inversion).

3.Many of the big structures accommodate basin inversion – twice

4.Basins correlate with the NAC – this might have implications for mineral systems – particularly SHMS-Pb-Zn.

5.Are all the big faults imaged in the seismic reflection data?

6.Still have some big questions - what is driving orogenesis in the Gawler Craton (are we close but not that close to a margin?)