



Australian Government

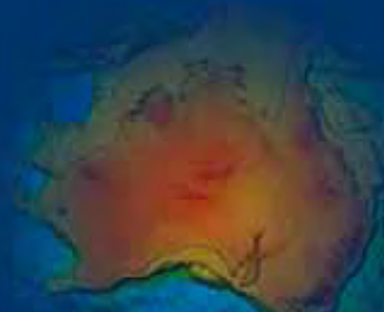
Geoscience Australia

Geodynamic framework for contemporaneous Proterozoic terranes in the Mt Isa, Curnamona and sthrn NAC

George Gibson



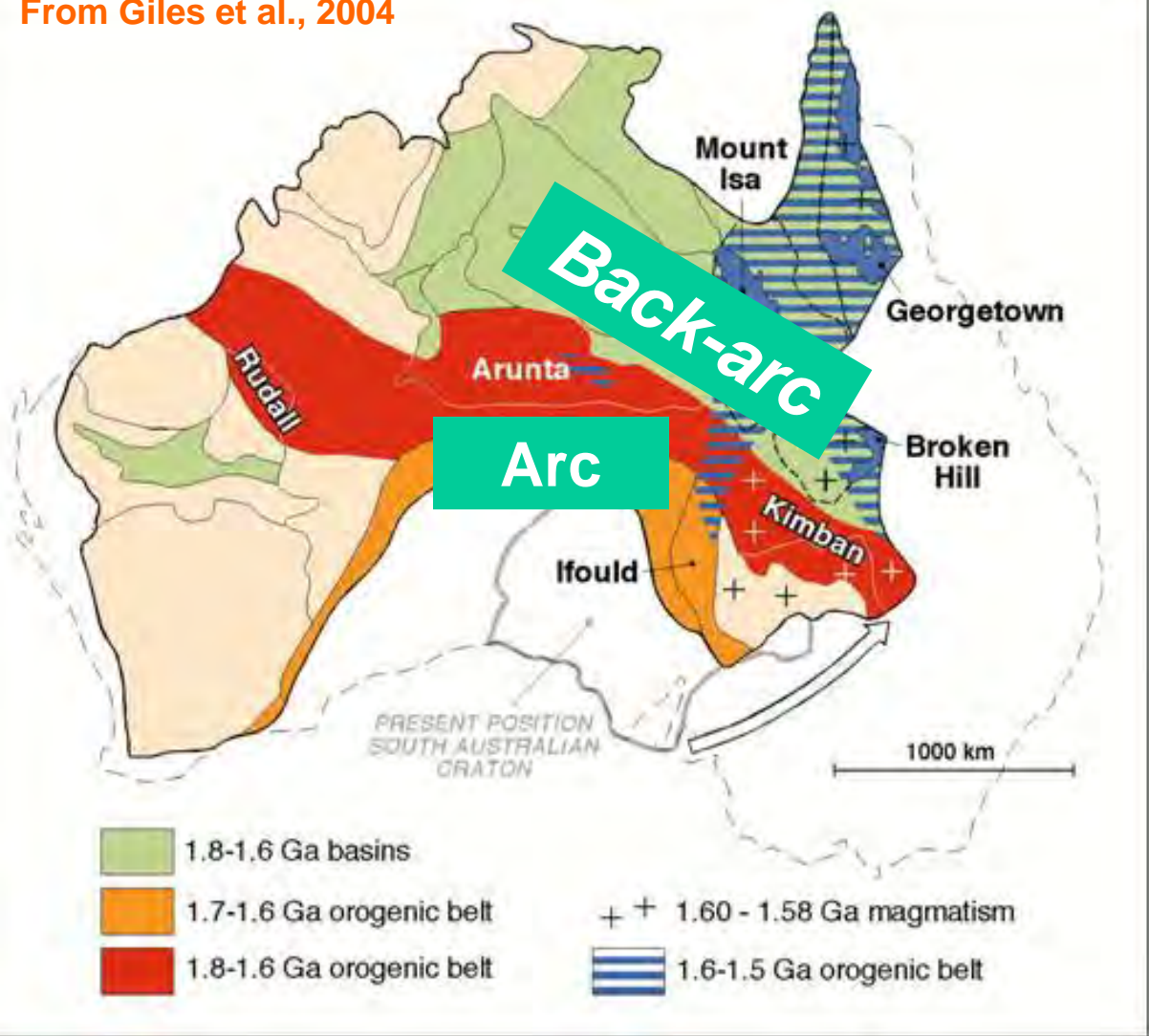
NAP Wrap-up Conference, June 2006



Geoscience Australia

Australian Precambrian configuration

From Giles et al., 2004

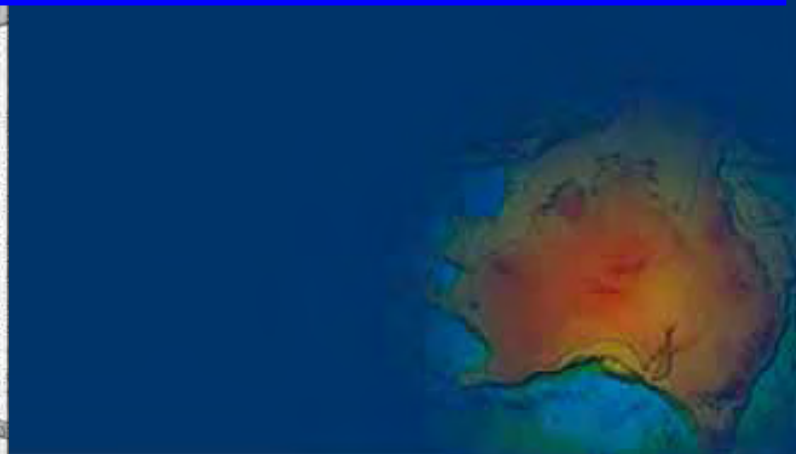
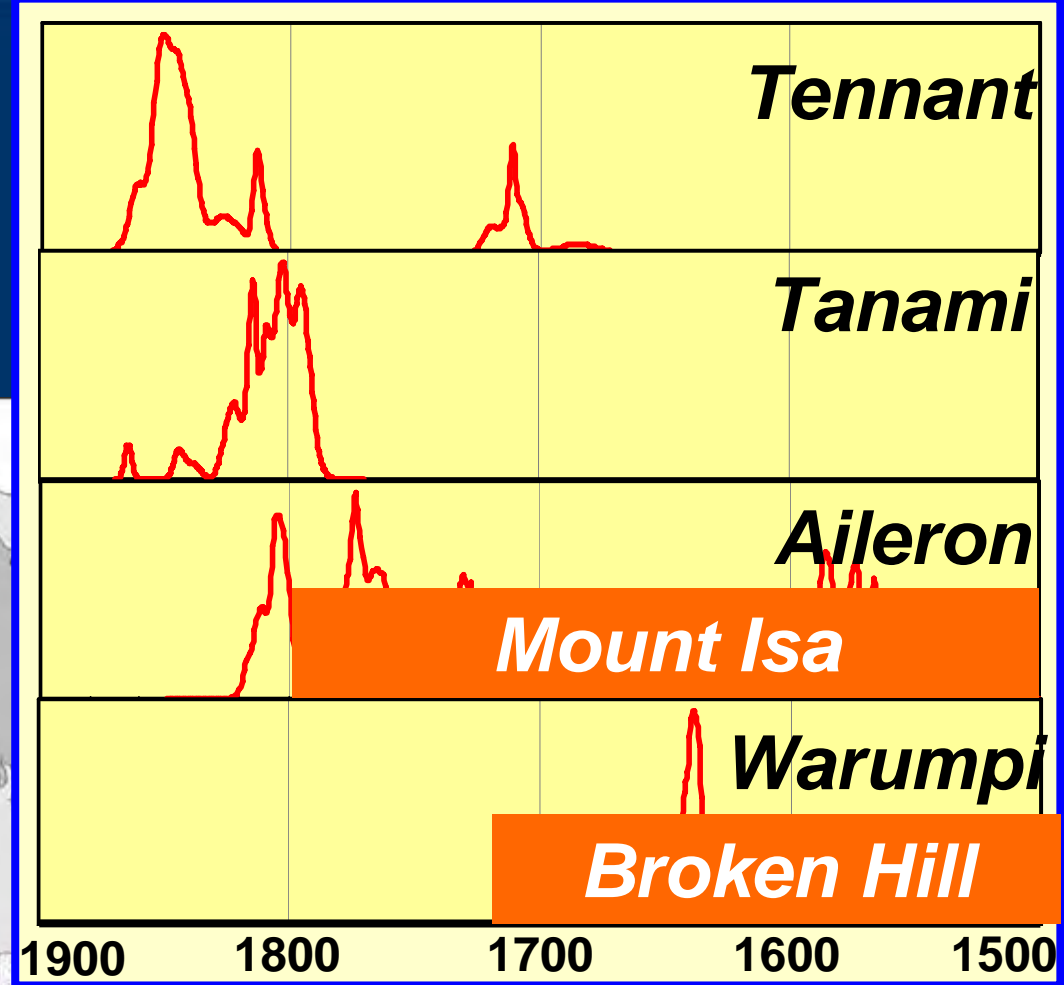
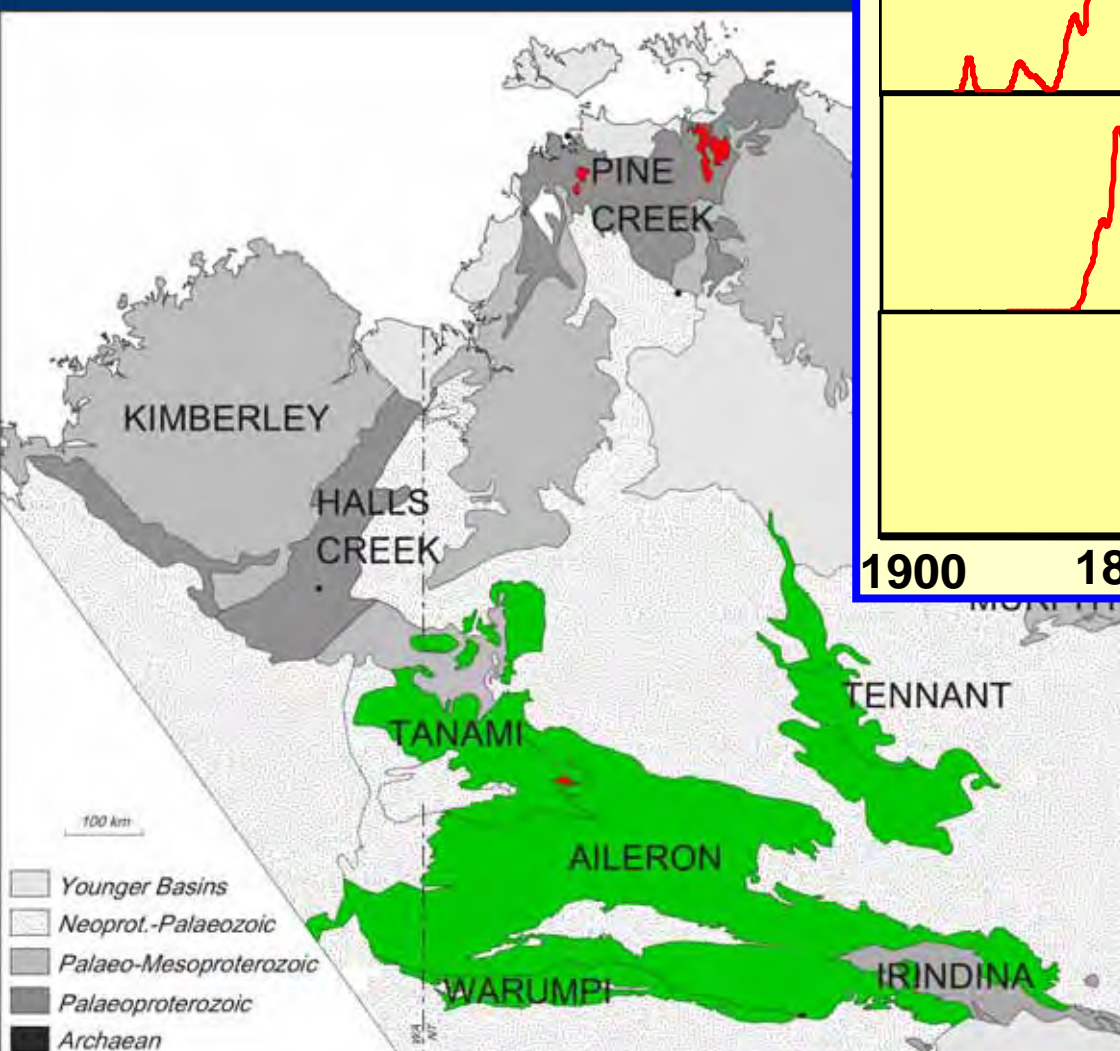


Reconstruction of North and South Australian cratons through 52° rotation of the SAC

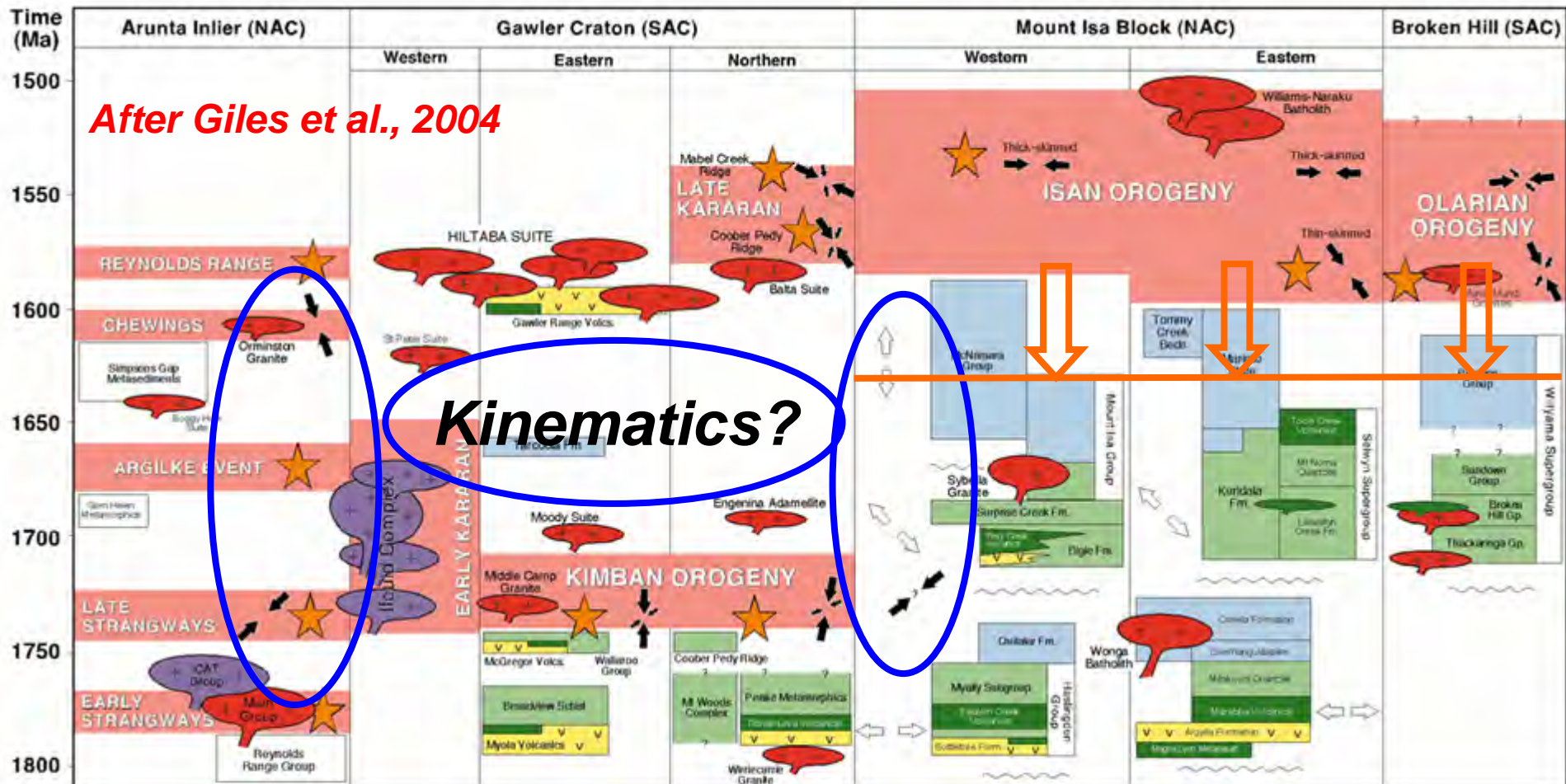
1. NAC, Isa & BHill all contiguous
2. Magmatic arc to south of NAC
3. North- or south-directed subduction
4. Common back-arc position for Arunta, Isa & BHill
5. NAC & SAC collide at 1730 Ma (Kimban)














Contiguous terranes & test of concept:

1. Common age
2. Shared tectonic history

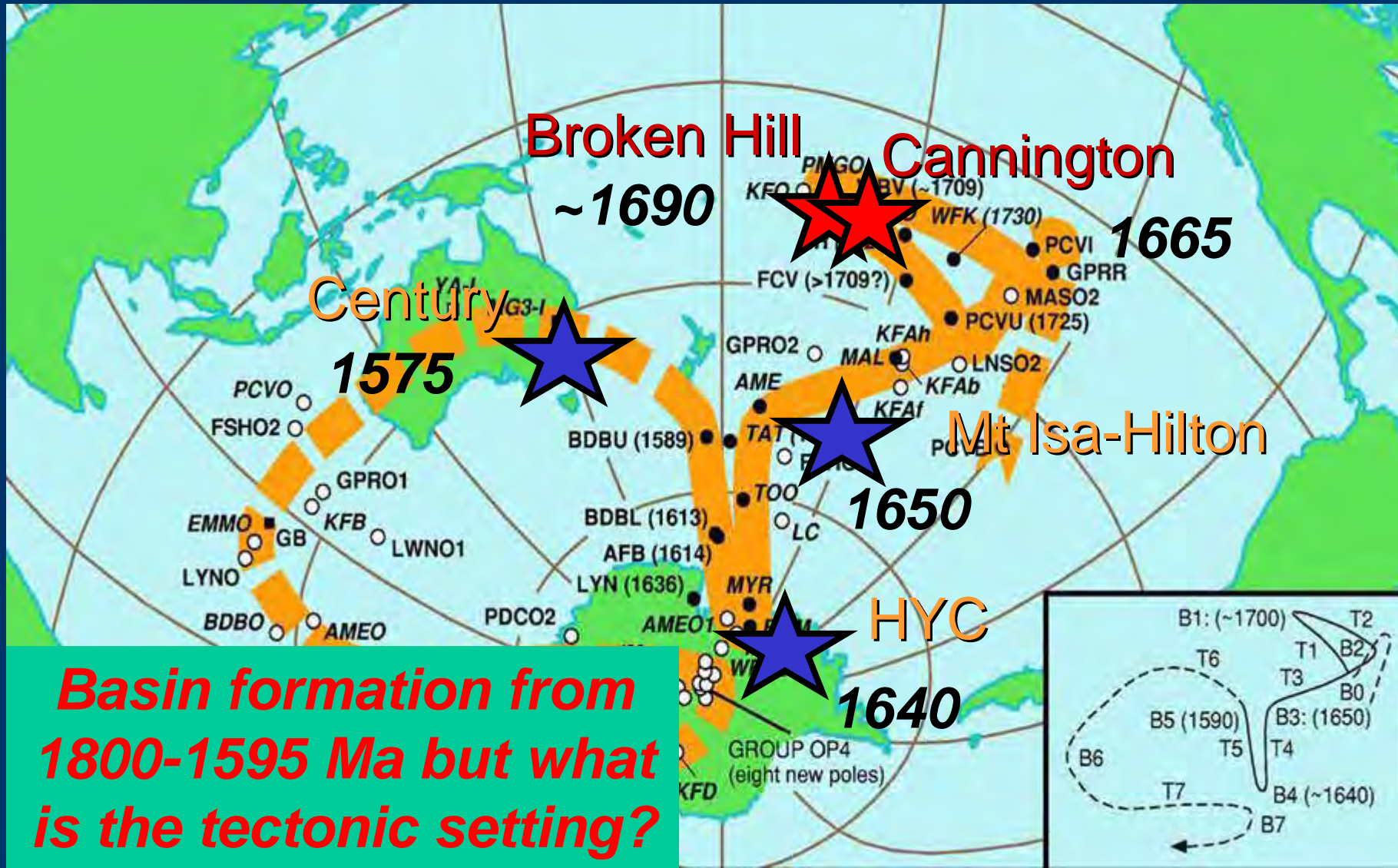


Proterozoic kinematics & space-time plot



- | | | | | | |
|---|---------------------------|---|---------------------|---|--|
|  | Other sediments |  | "Arc-type" granites |  | Inferred regional extension direction |
|  | Post rift-phase sediments |  | Other granites |  | Inferred regional shortening direction |
|  | Rift-phase sediments |  | Mafic intrusion |  | Inferred regional shortening direction (present-day) |
|  | Mafic volcanics |  | Metamorphic event |  | Unconformity or depositional hiatus |
|  | Felsic volcanics | | | | |

Proterozoic Australian polar wander path



Basin formation from 1800-1595 Ma but what is the tectonic setting?

Sediment Hosted Massive Sulfides

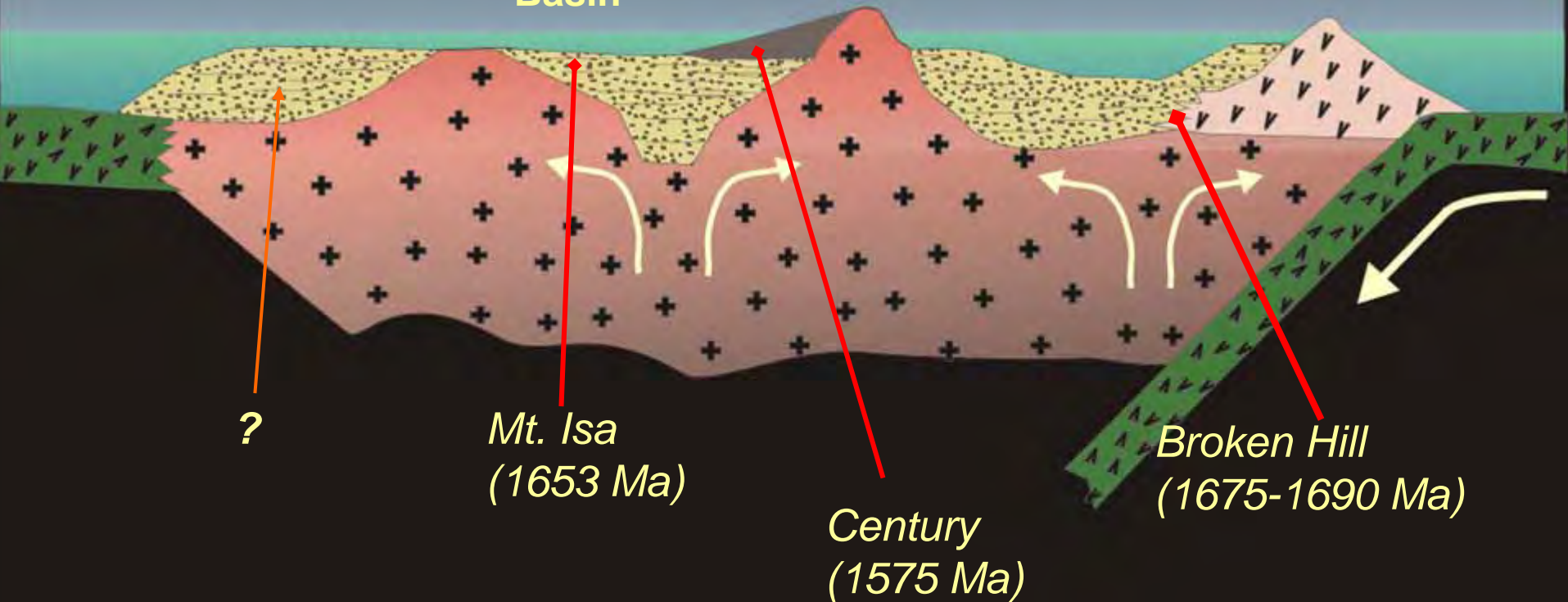
Tectonic Settings

Divergent

Intraplate

Convergent

Ocean Basin Passive Margin Intracratonic Basin Foreland Basin Back Arc Basin Volcanic Arc



?

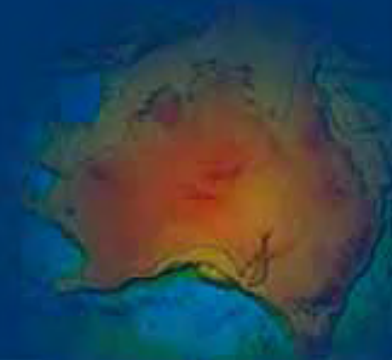
Mt. Isa
(1653 Ma)

Century
(1575 Ma)

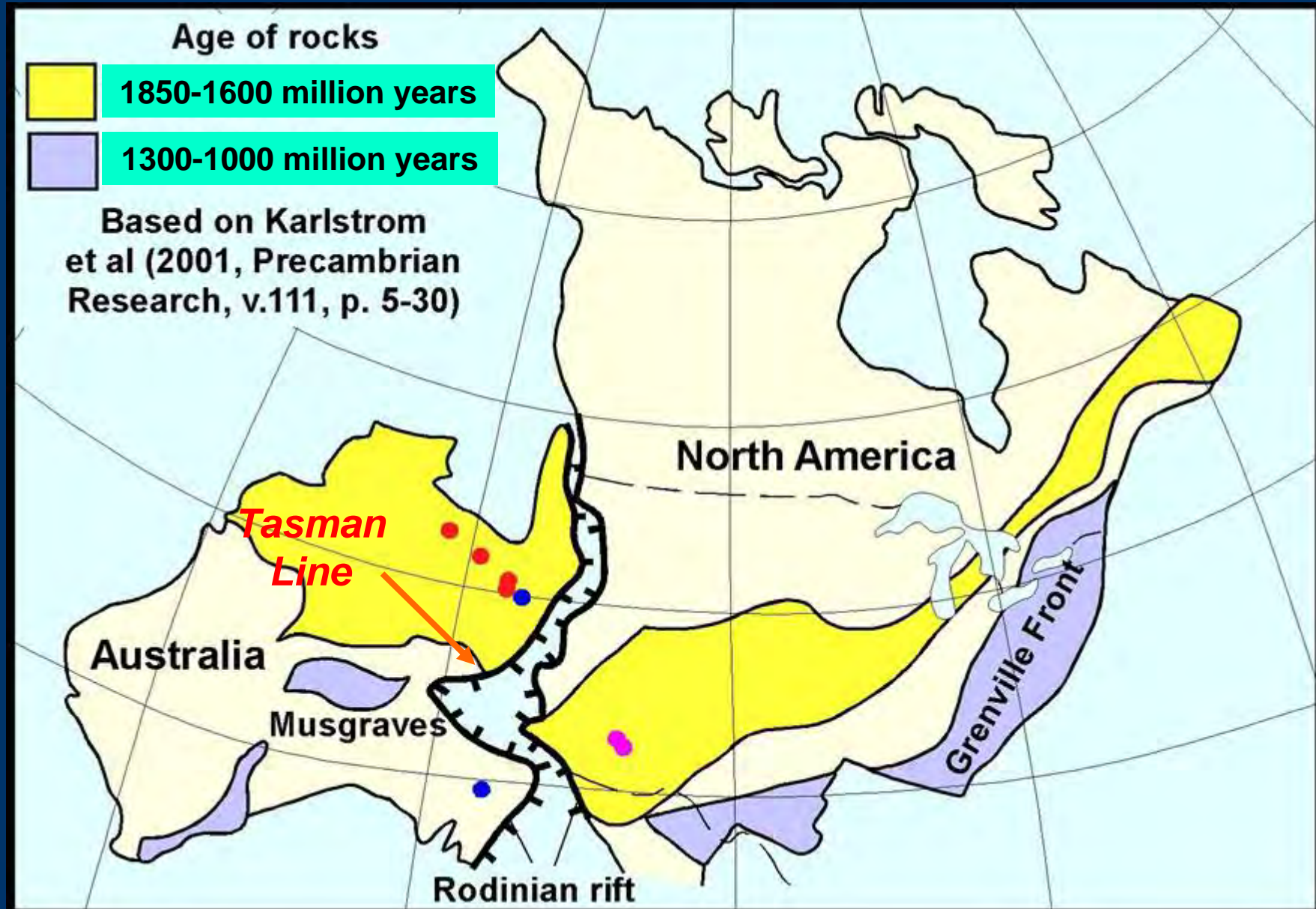
Broken Hill
(1675-1690 Ma)

Questions & Issues

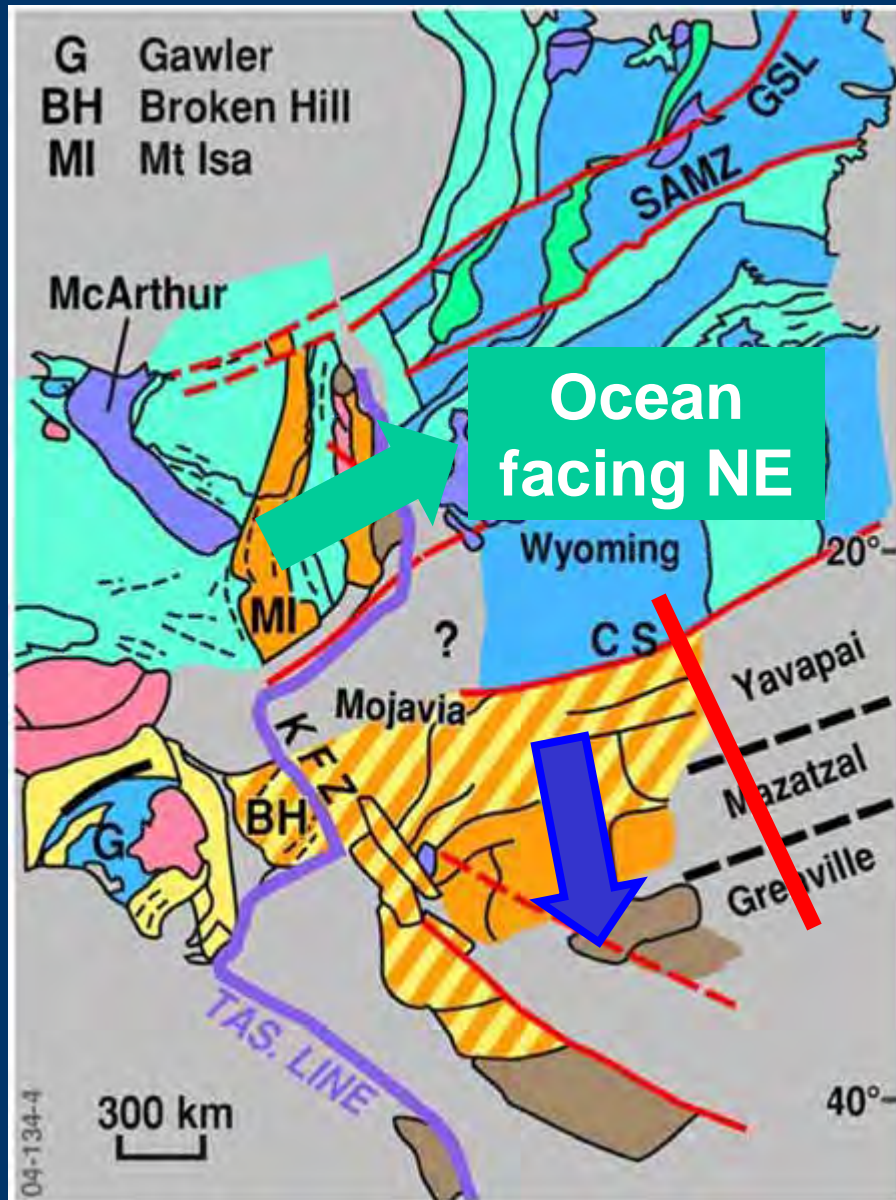
- Geodynamic setting of Isa & BHill terranes as proxy for NAC?
 - Initially intracontinental rift
 - Progression towards passive margin
 - Parallels in Rodinia reconstructions
- Commonalities between NAC, Isa & BHill
 - **Basin & Magmatic histories**
 - **Tectonic & kinematic evolution**
- Implications for fluid flow & mineral potential
 - Oxidised vs Reduced fluid cells
 - Redox boundary



Rodinia (AUSWUS)—ties to North America?



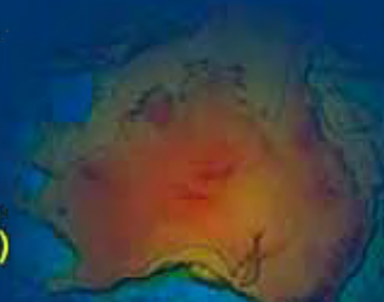
Australia – Laurentia Crustal elements



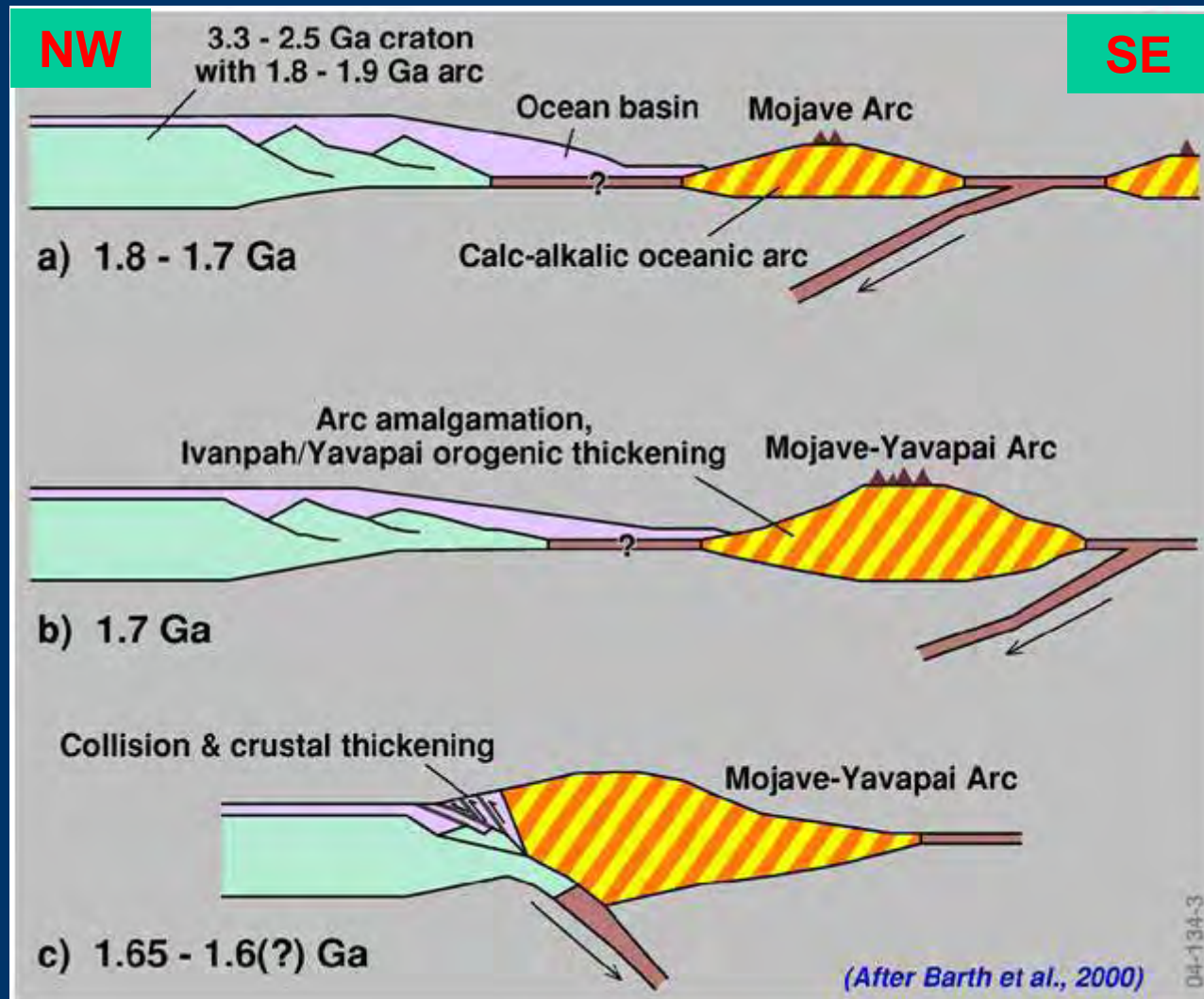
**Willyama
Supergroup**

K F Z Kooneberry
Fault Zone

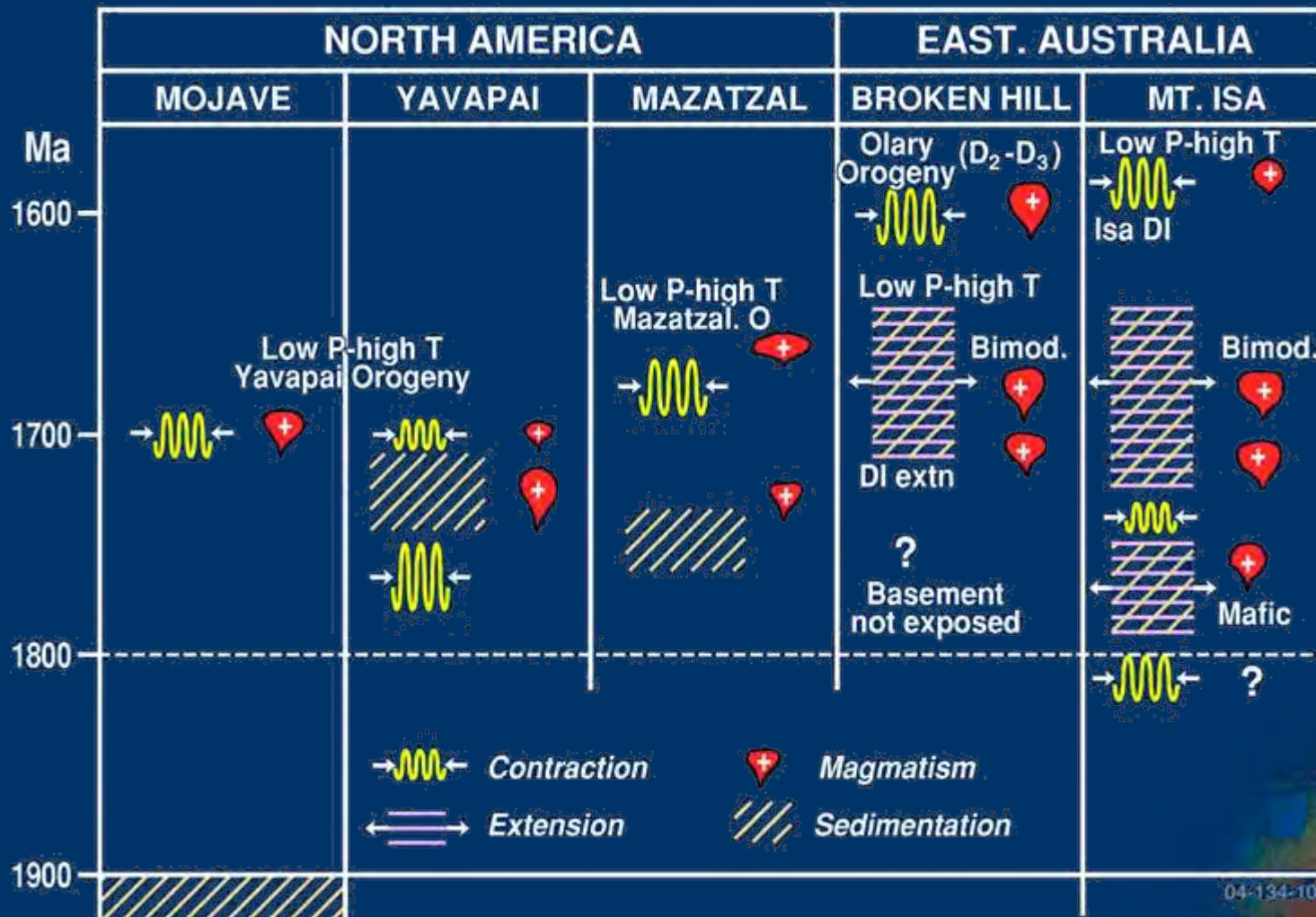
AUSWUS
(Burrett & Berry, 2000)



SW Laurentia: orogenic drivers & tectonic setting

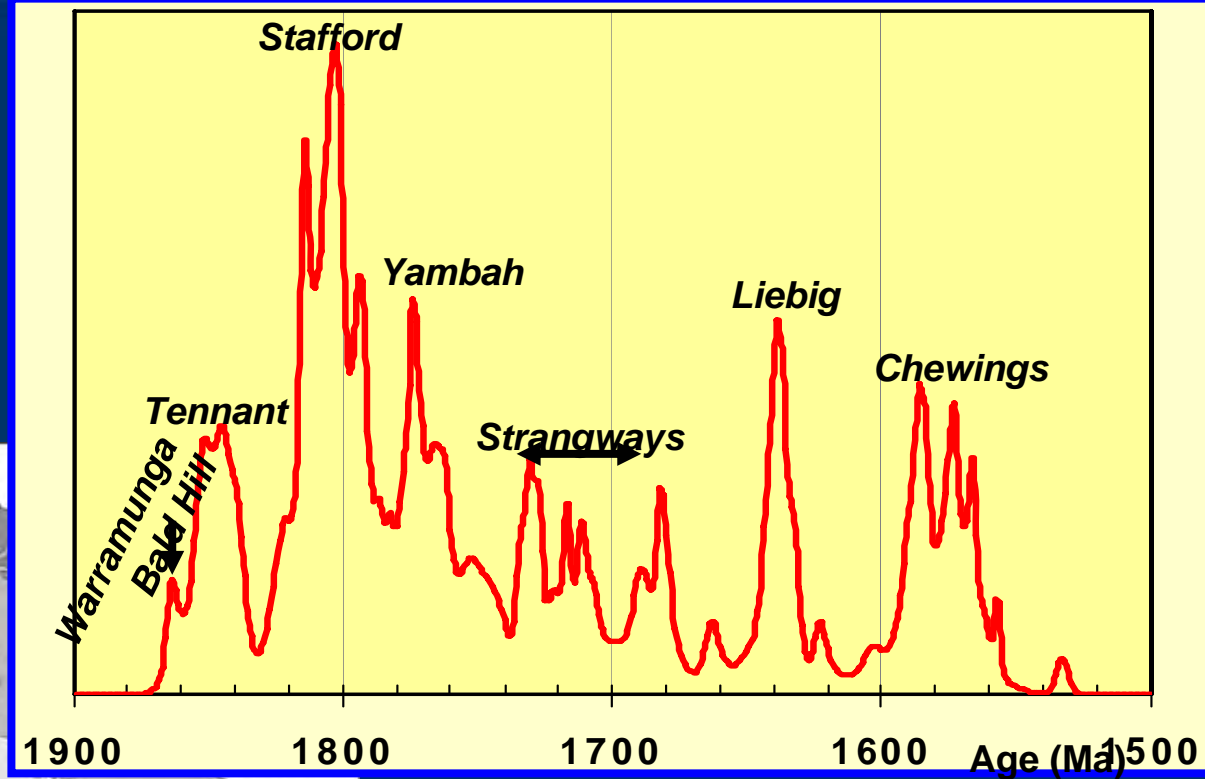
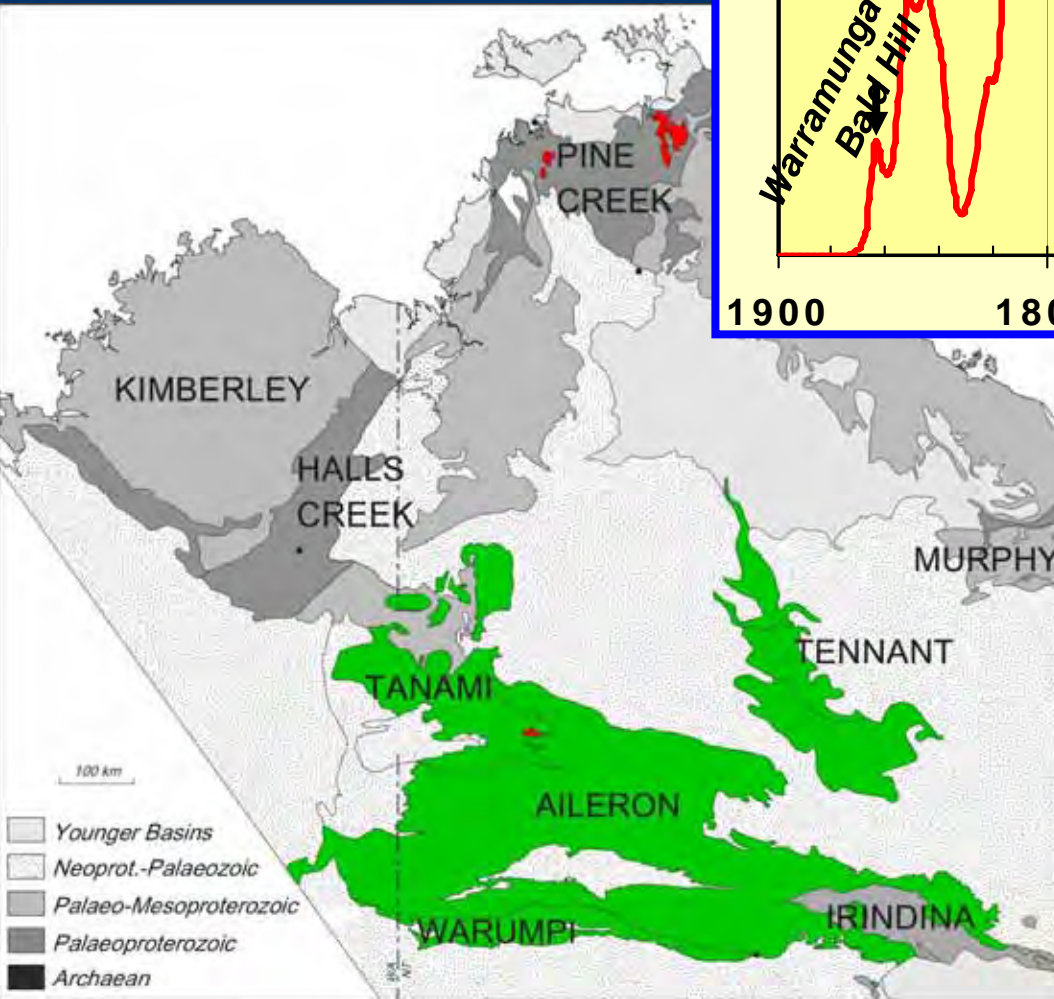


SW Laurentia- East Australia Space-Time plot



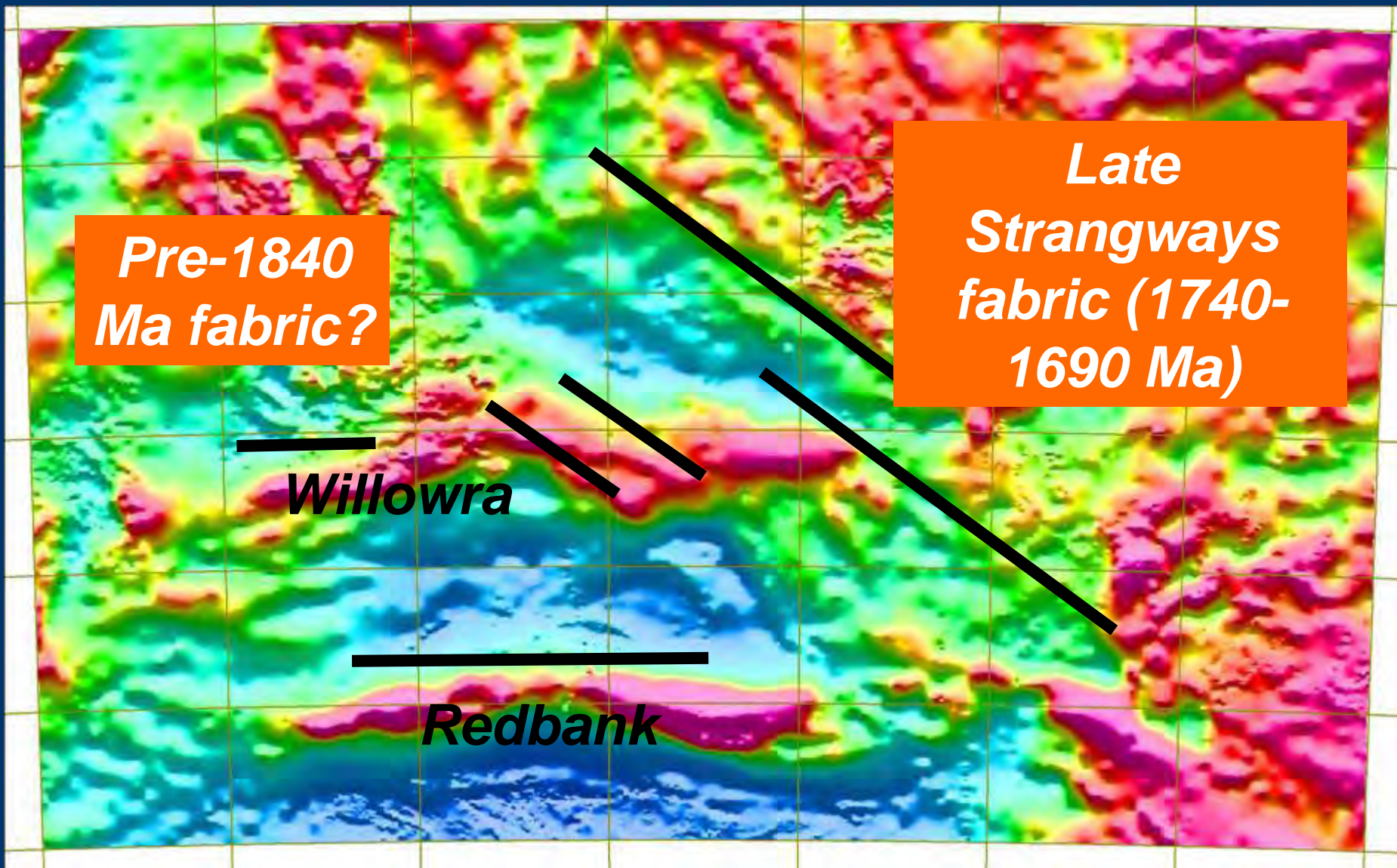
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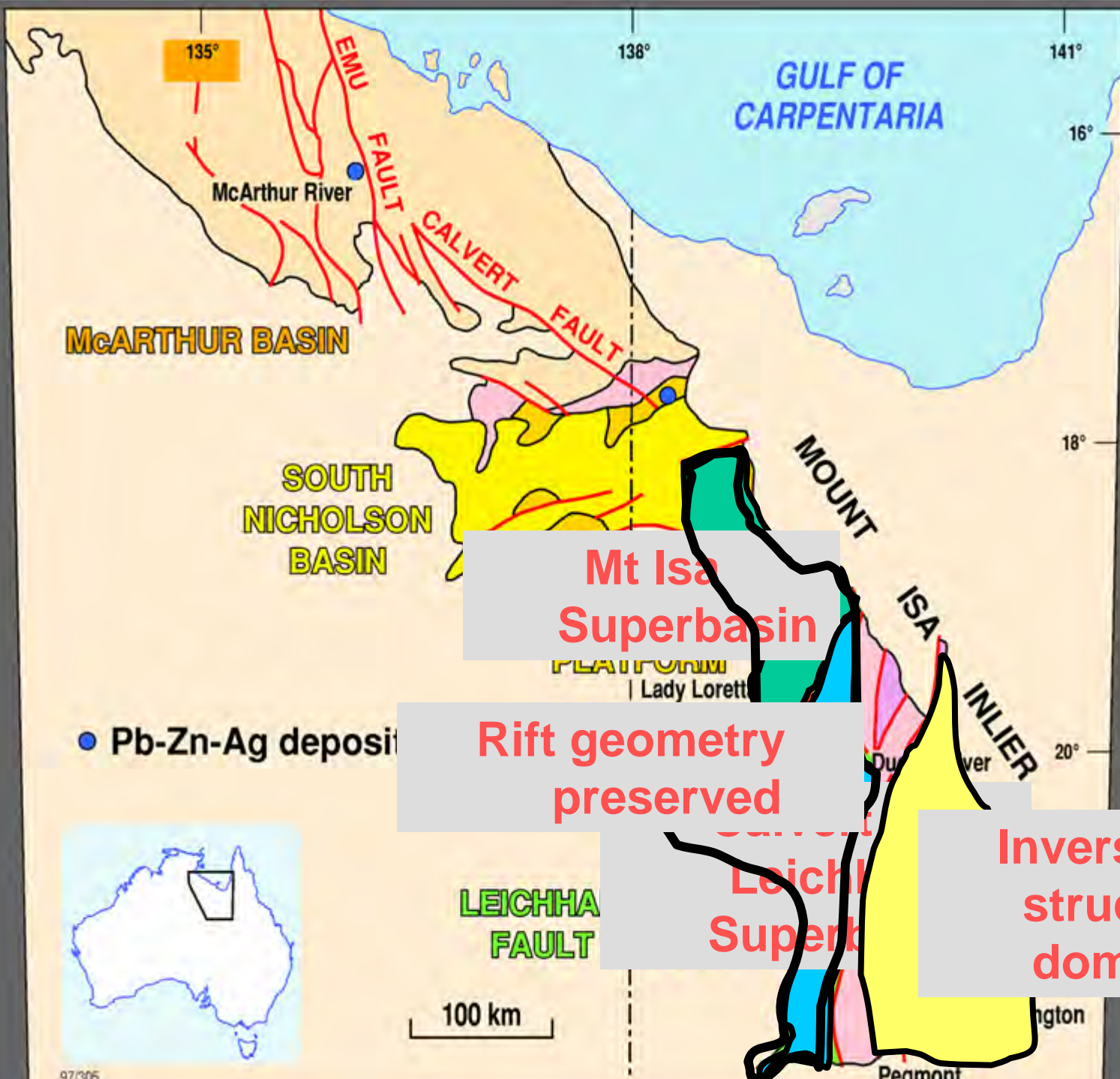
NAC events - contractional or extensional?



1. 1730-1700 Ma Strangways Event = Calvert extension
2. 1640 Ma Liebig (Warumpi accretion) = nappe formation & basin inversion (B Hill D2 + ? Isa D1)
3. 1590 Ma Chewings = D3 transpression (Isa + B Hill)

Crustal-scale fabrics preserved in gravity image





Mt Isa Superbasin

Rift geometry preserved

Inversion structures dominant

LEICHTHA FAULT

Leicht Superk

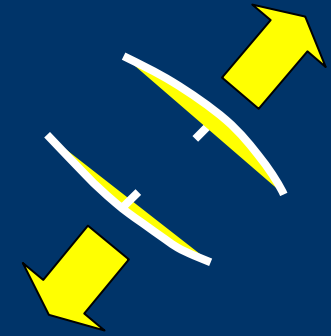
● Pb-Zn-Ag deposits



100 km

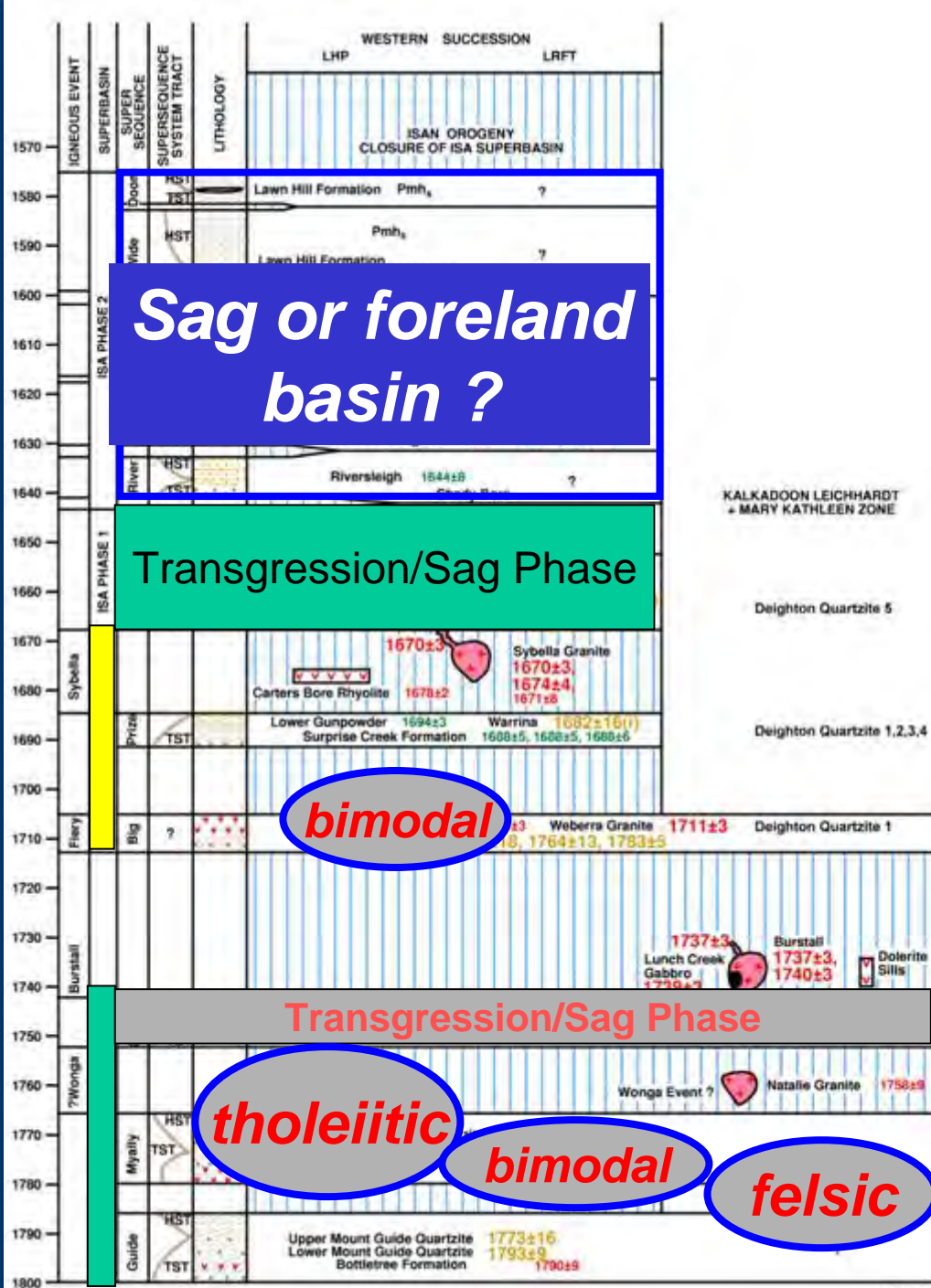
Calvert Superbasin 1730 -1670 Ma

Rift -
Drift



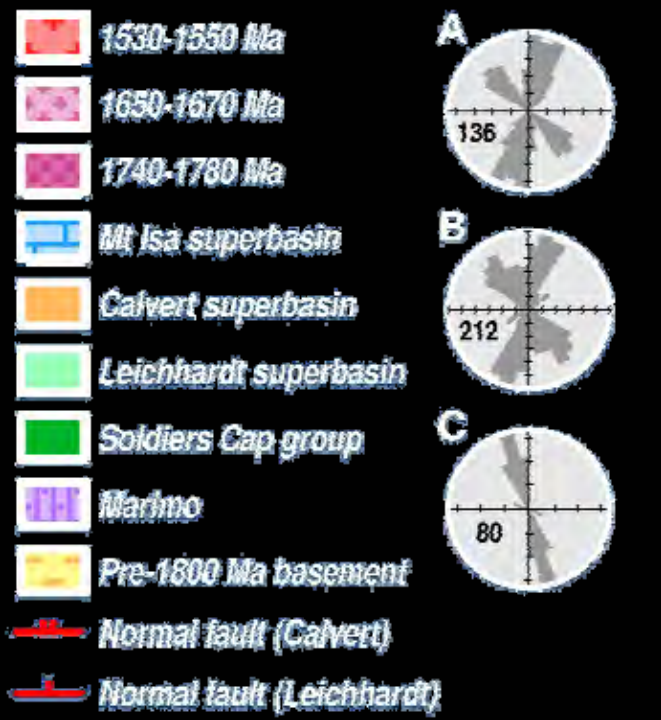
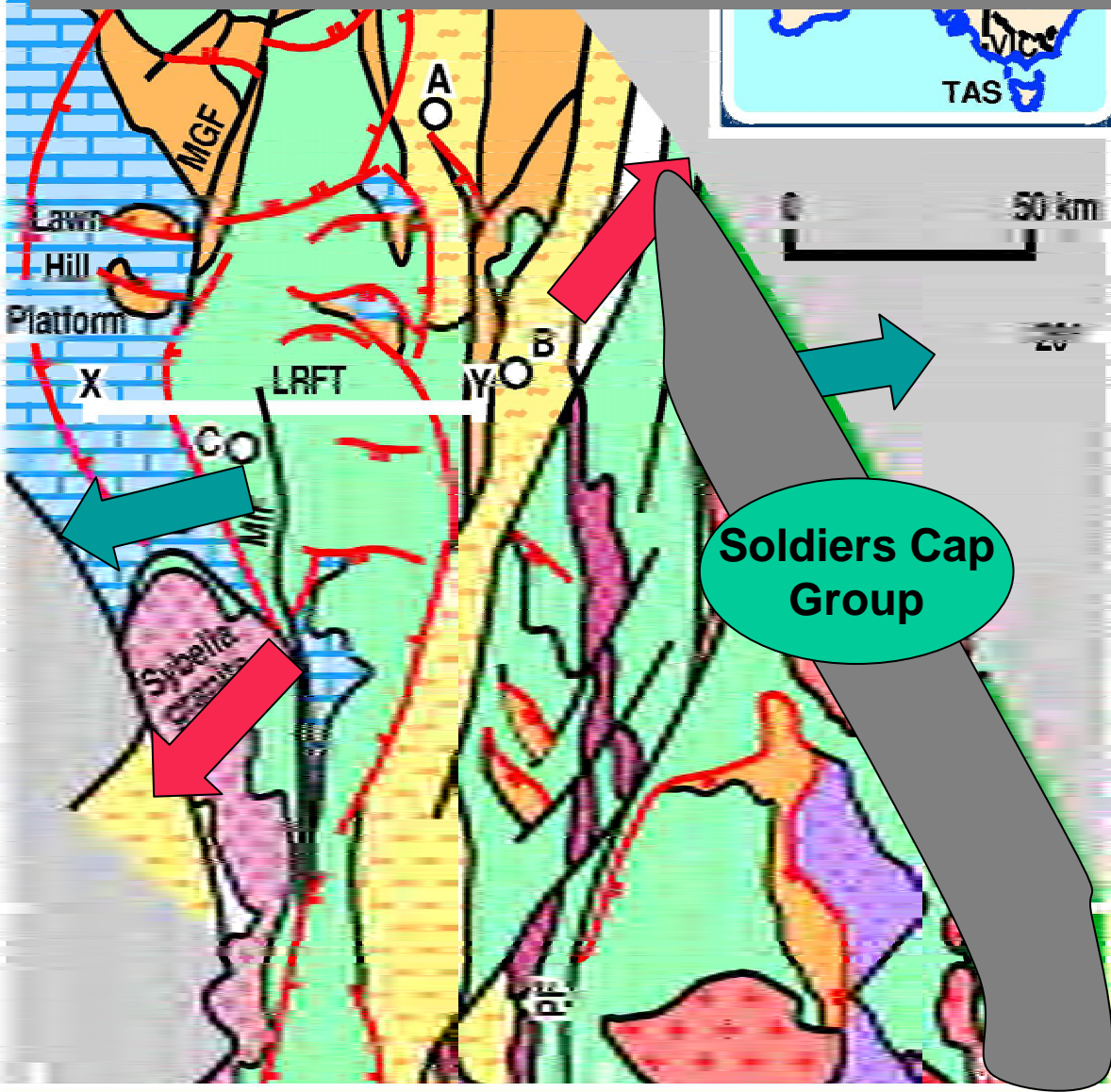
Leichhardt Superbasin (1800-1740 Ma)

Rift



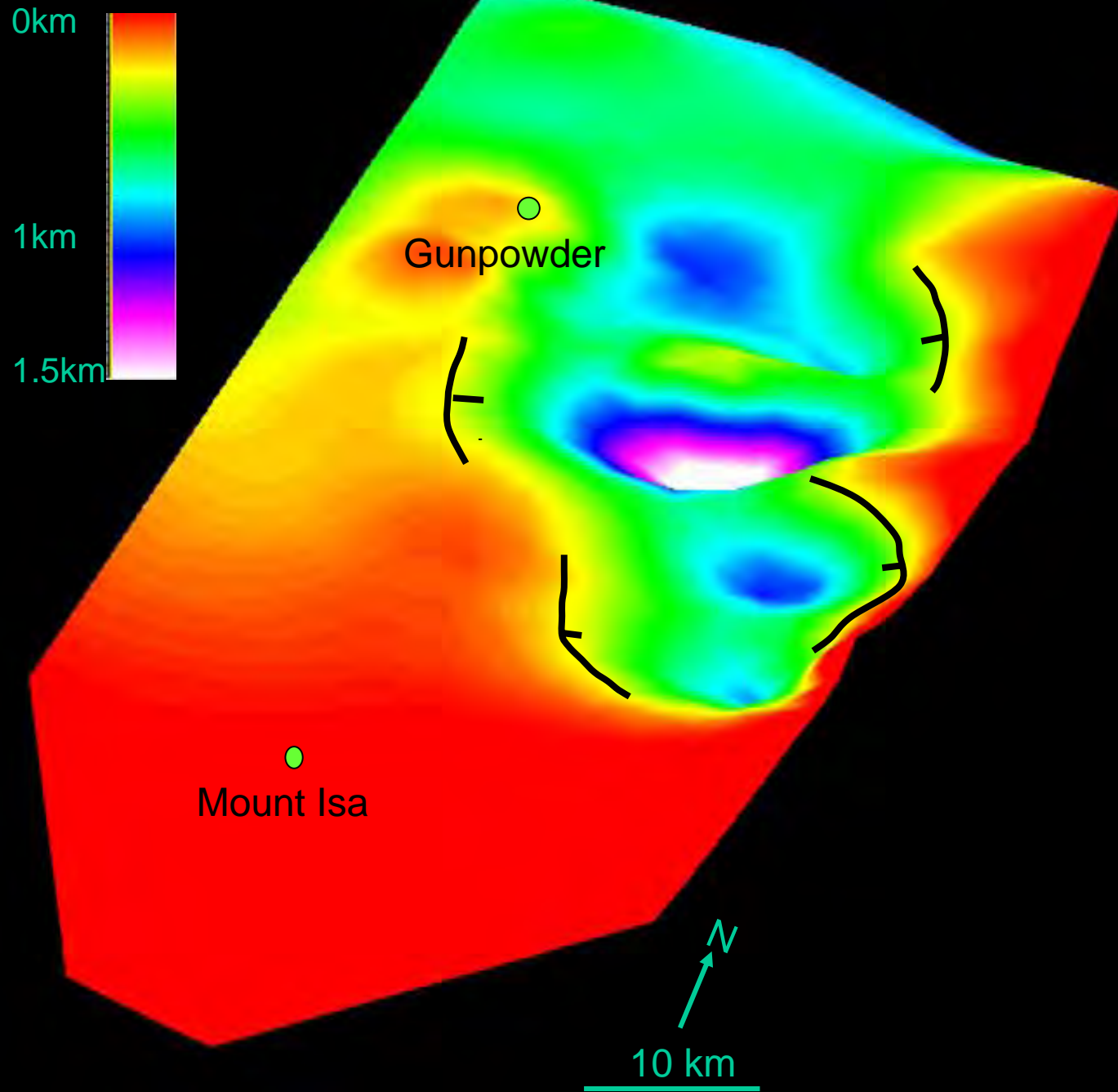
139° 140° 19°

Mount Isa – basin evolution & structural elements



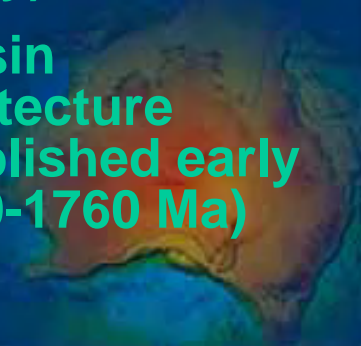
- Extension/rifting
- Growth faults
- Platform deposits
- Reduced shale package
- Deep tapping fluid conduits (detach.)

Myally Subgroup 3D Isopach Map

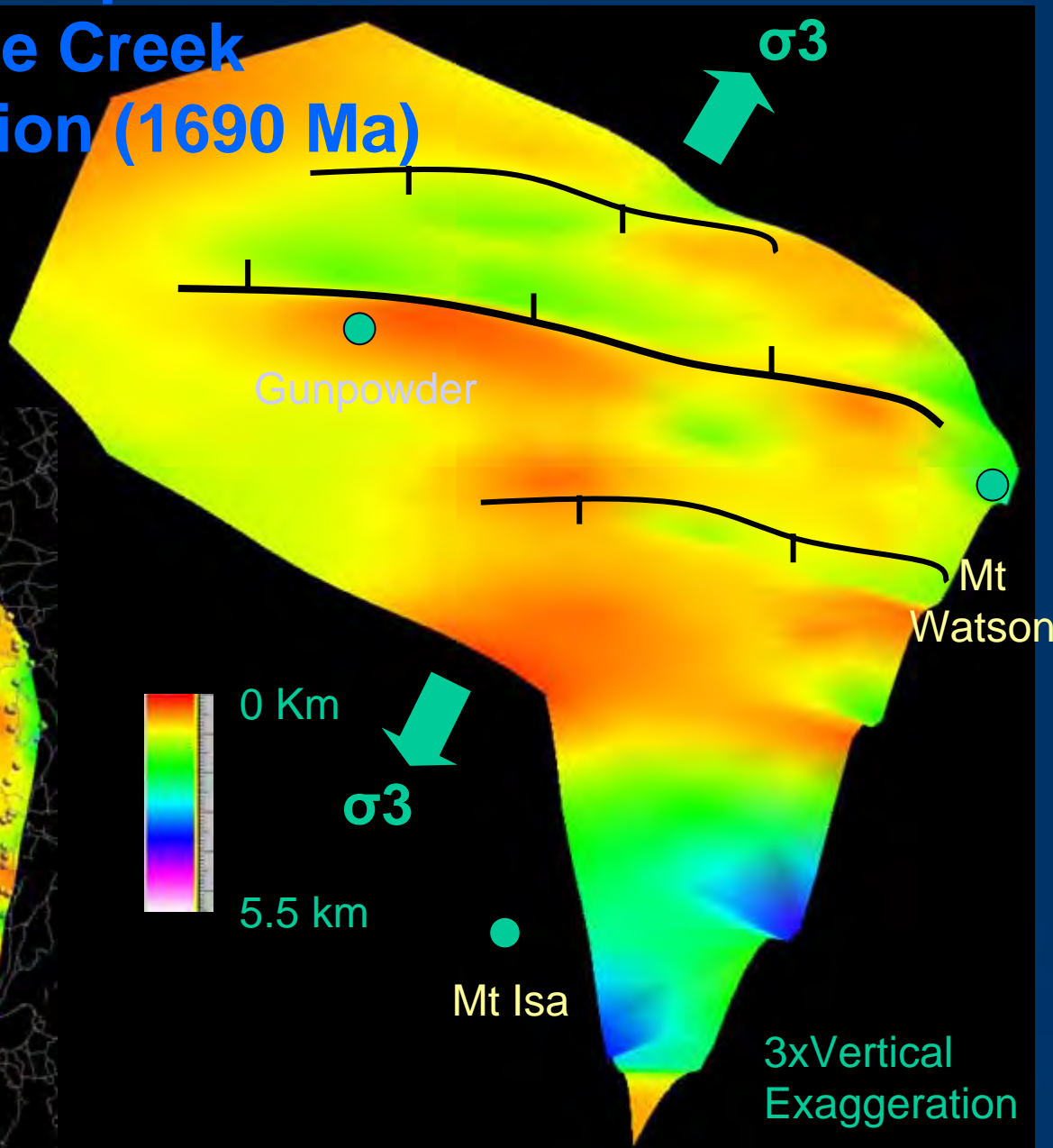
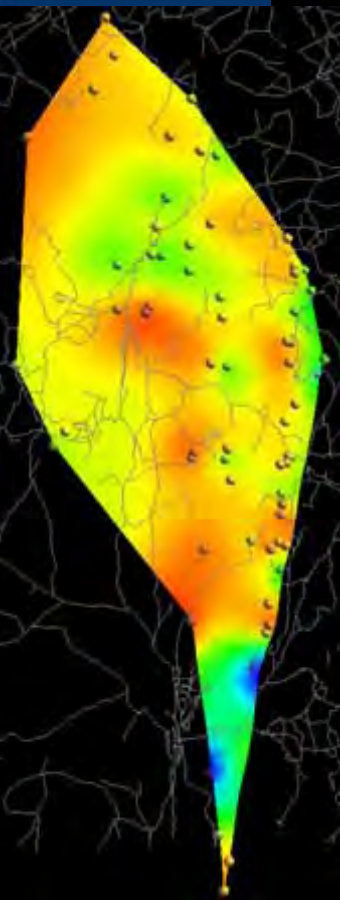


Leichhardt Rift

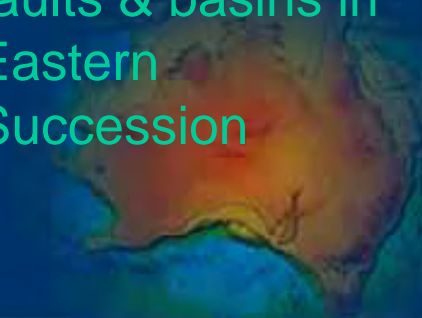
- NNW trend
- Narrow intracontinental basin
- Individual depocentres
- Secondary basins bounded by overlapping normal faults
- Basins strongly asymmetric (eastward-thickening Myally)
- Basin architecture established early (1780-1760 Ma)



Calvert Superbasin: Surprise Creek Formation (1690 Ma)



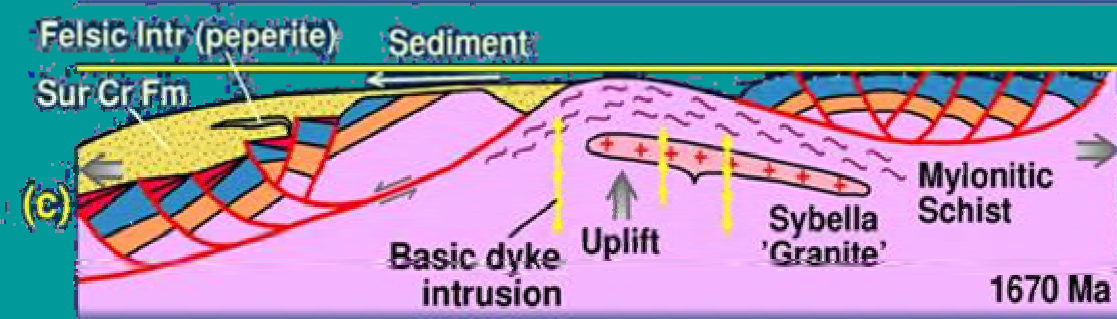
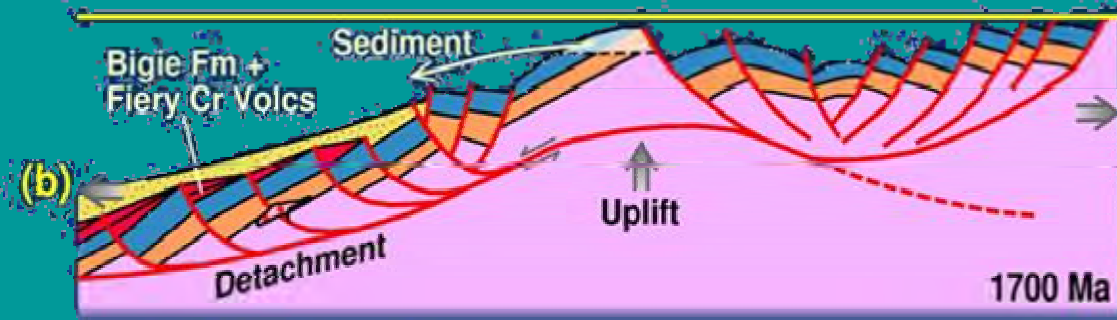
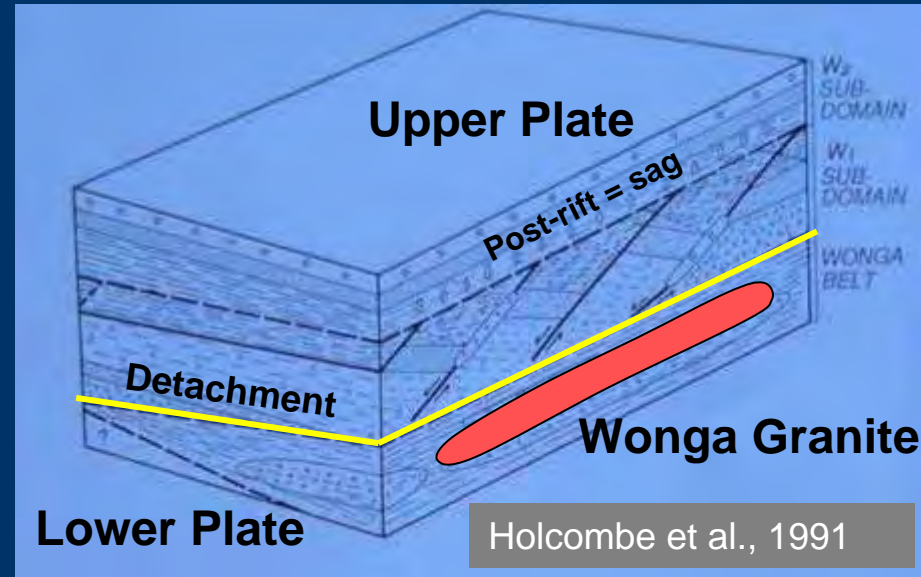
- No obvious basin corridor
- NW-SE oriented growth faults, reactivation of N-S faults
- Basin generally deepens to NE
- Basin margin not preserved
- Similarly oriented growth faults & basins in Eastern Succession



Mid-crustal response to superbasin formation

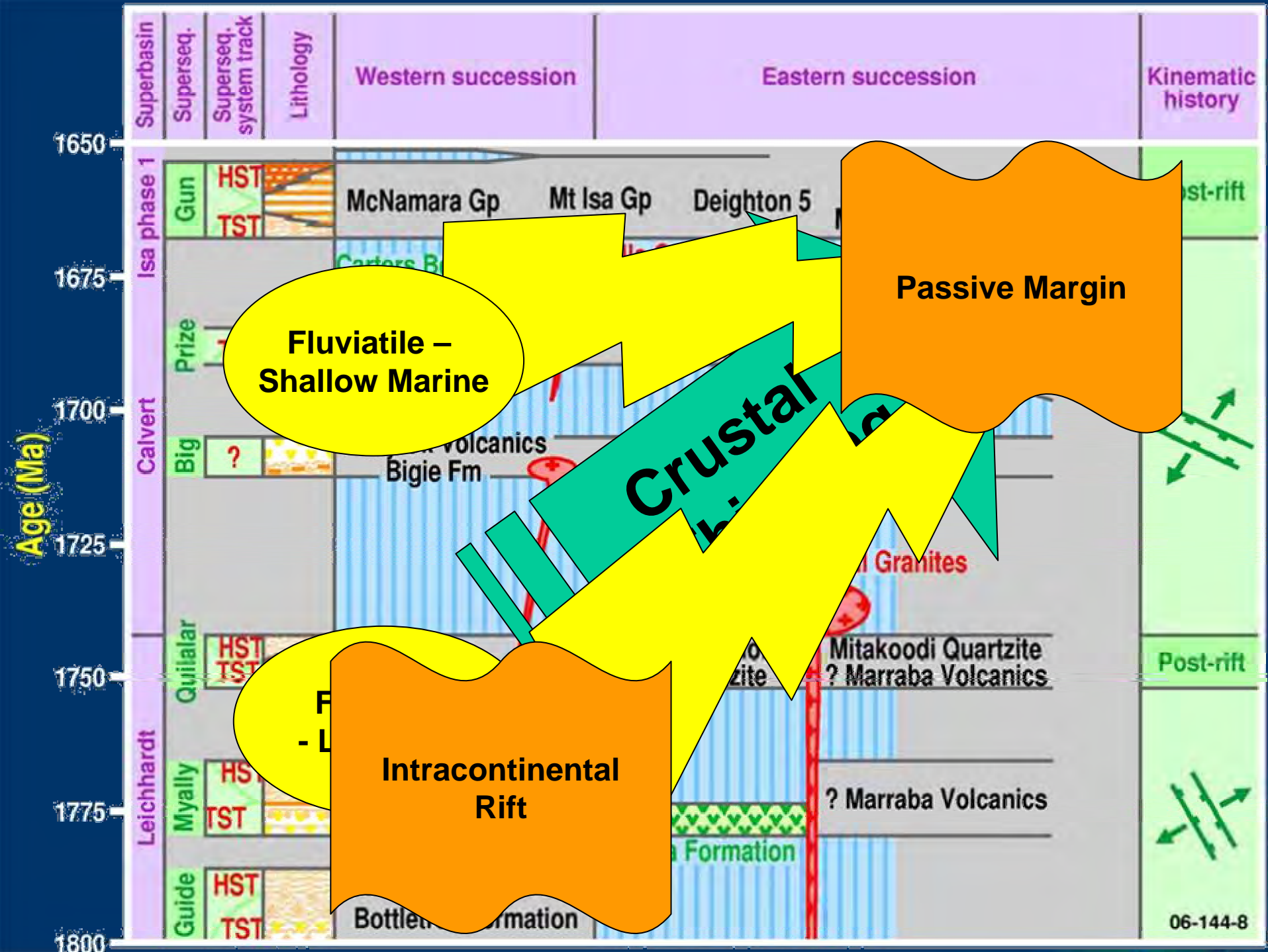
Leichhardt Superbasin:

- 1790-1750 Ma
- Bimodal magmatism (including flood basalts)
- Half-graben formation
- Mid-crustal detachment faulting (Eastern Succession)

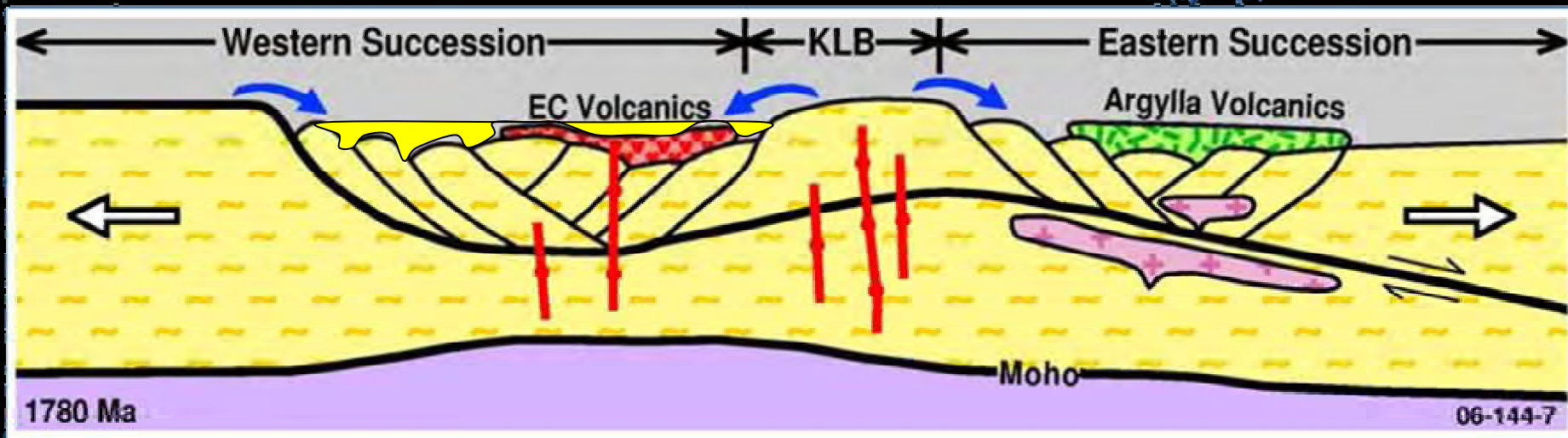
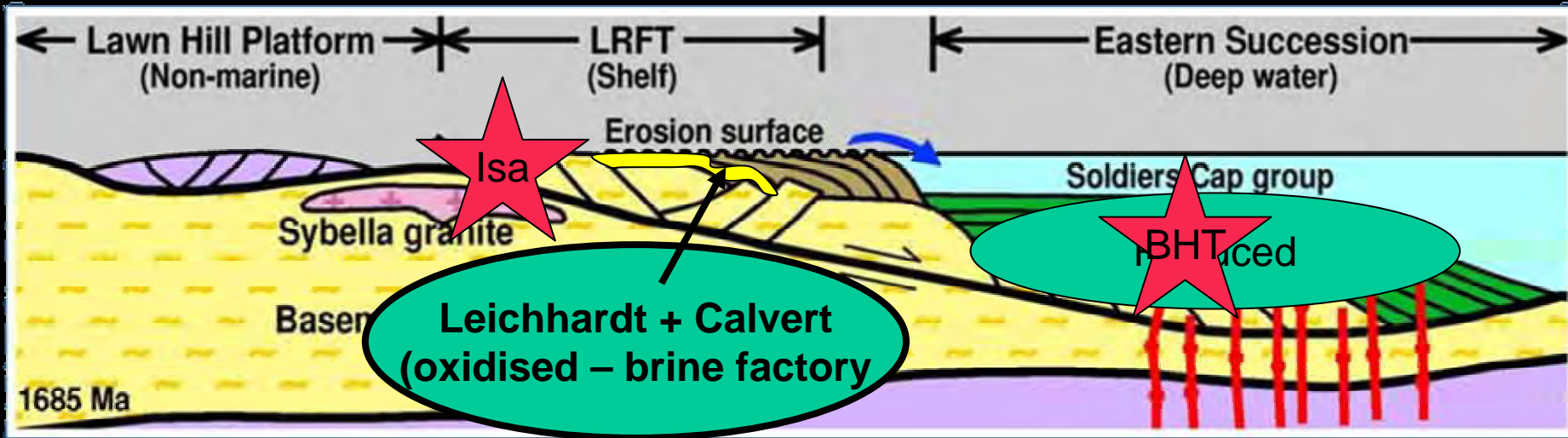


Calvert Superbasin:

- 1740-1670 Ma
- Bimodal magmatism (including oceanic tholeiites)
- Magmatic inflation & doming
- Uplift & erosion
- Extensional unroofing of mid-crustal rocks & 1670 Ma granite



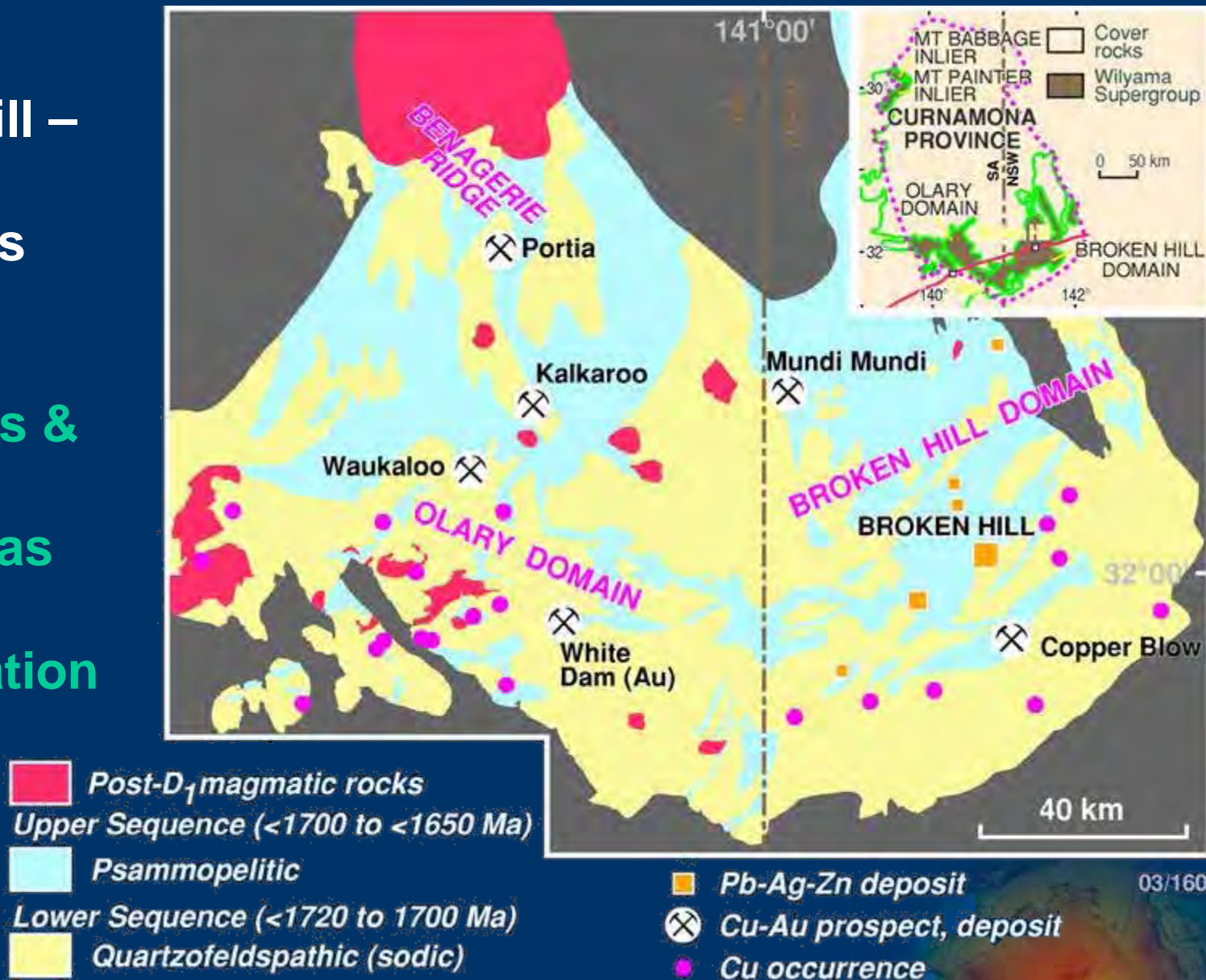
Syn-rift Depositional Environment through time



06-144-7

Broken Hill – Olary domains

Redox
boundaries &
magnetic
gradients as
vector to
mineralisation



OLARY DOMAIN

BROKEN HILL

Mt Howard Subgroup (≤1651 Ma)

Saltburn Subgroup

Bimba Fm

Ethiudna Sub-Group

Wipera Subgroup

Migmatites

Broken Hill Group

Thorndale Gneiss and Clevedale Migmatite

No D1 Fabric

D1 Fabric

Mylonite

Intensity of D1 Fabric

Change in provenance

Post-rift (Sag): amagmatic

Syn-rift with magmatism

Detachment

Sequence

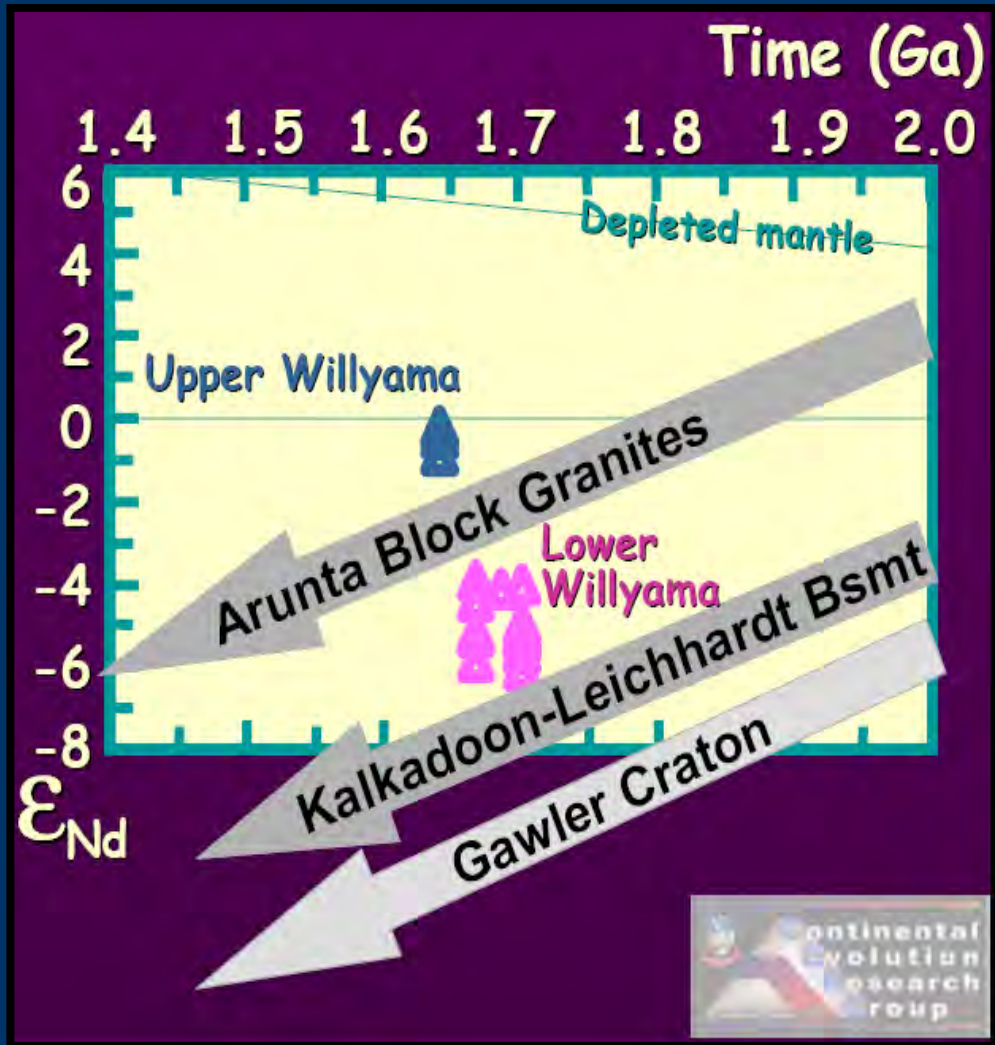
Increasing

Mafic magmatic rocks

Silicic magmatic rocks

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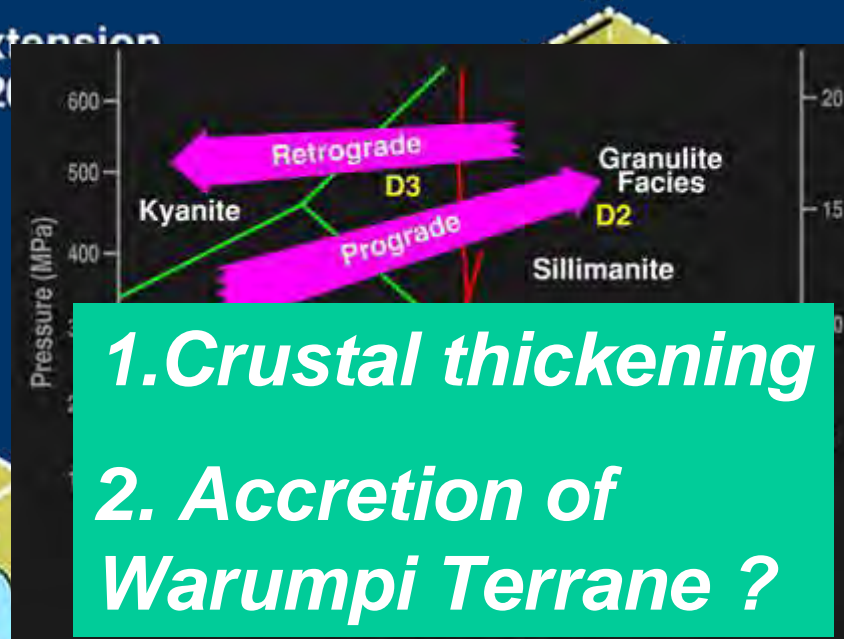
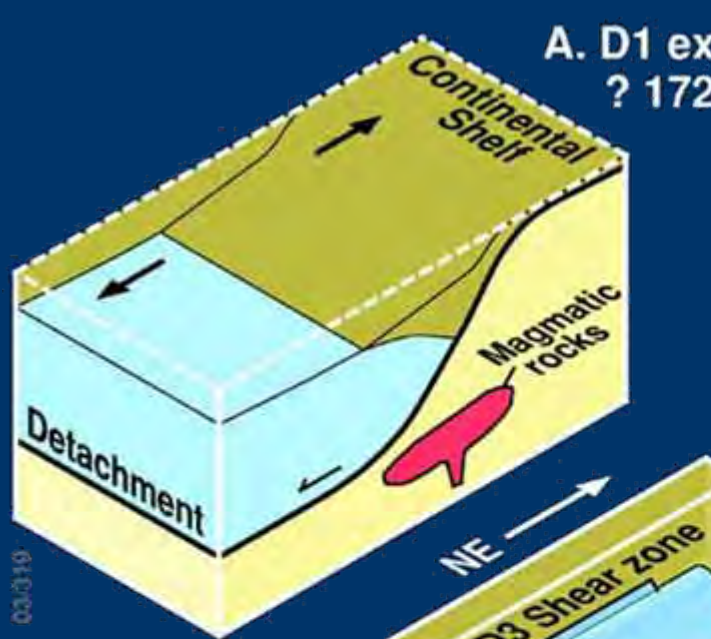
Provenance for BHill rocks?



Barovich et al., 2004

1. Not Gawler
2. More juvenile & felsic terrane for Upper Willyama Supergroup
3. Central \pm north Australian source for Lower Willyama Supergroup
4. Arunta source after 1650-1640 Ma (Upper Willyama Supergroup)
5. Change in provenance result of uplift following accretion of Warumpi terrane (Liebig event) ?

BHill Tectonic history: 1720-1590 Ma



1. Crustal thickening
2. Accretion of Warumpi Terrane ?

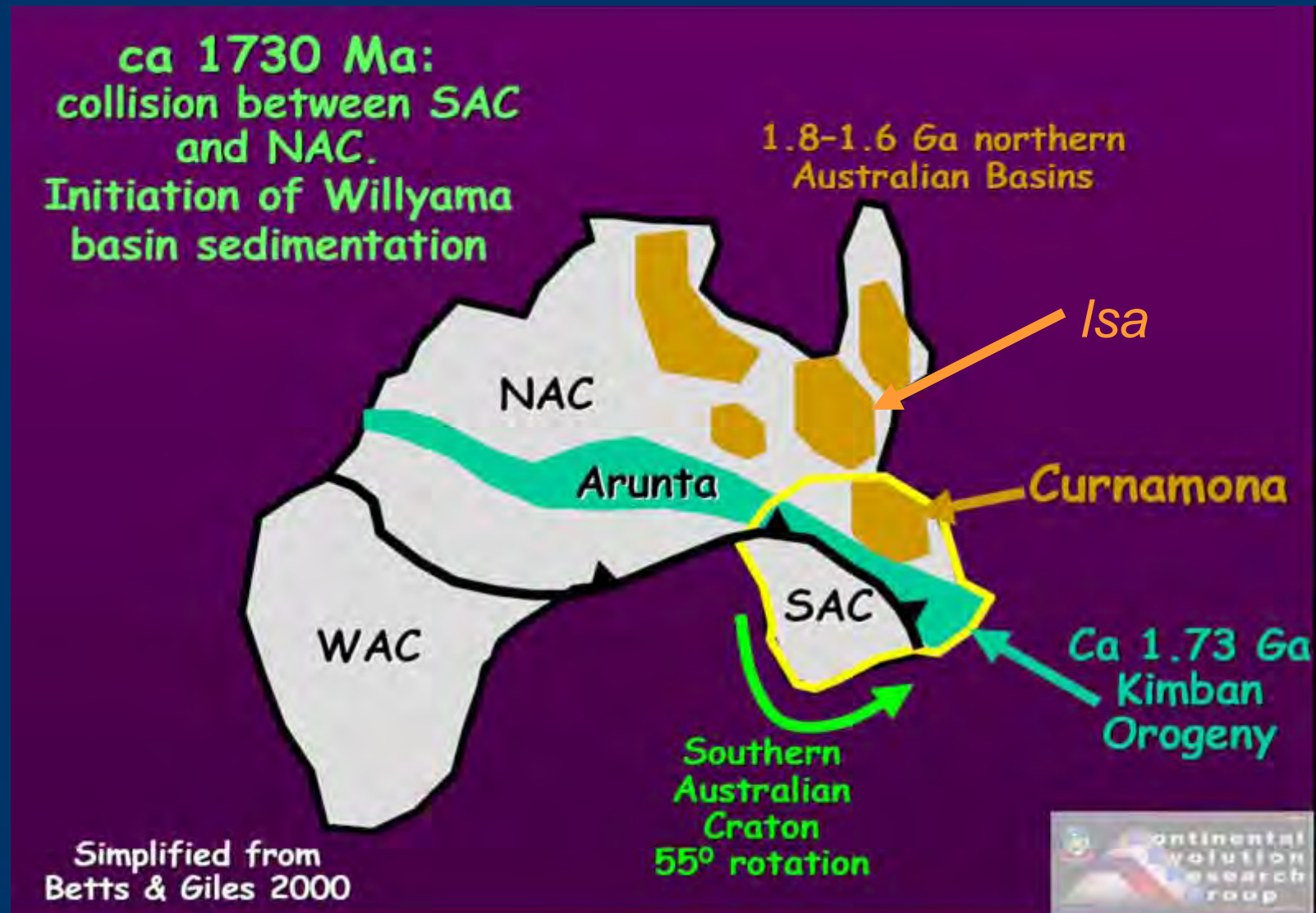


Chewings Event

C. D3 Thrust faulting
1585-1590 Ma



Full circle: 1730 Ma event – collision between NAC & SAC or intracontinental rifting?



Conclusions

- Similar but not identical geological records from 1730-1690 Ma (NAC, Isa & BHill)
- Late Proterozoic tectonism in central Australia (Strangways event) linked to basin formation in eastern Australia (Isa + BHill)
- Crustal/lithospheric thinning towards East or NE from NAC through Isa (BHill) terrane
- Passive margin formation in Isa & BHill regions not easily reconciled with subduction to south of NAC
- Collision between NAC and SAC at 1730 Ma inconsistent with record of ongoing crustal extension at Isa from 1800-1670 Ma

