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Mineral systems and tectonic evolution of the North Australian Craton

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Northern Territory Geological Survey

Geological Survey of Western Australia

NAP-wrap 2006

Acknowledgments

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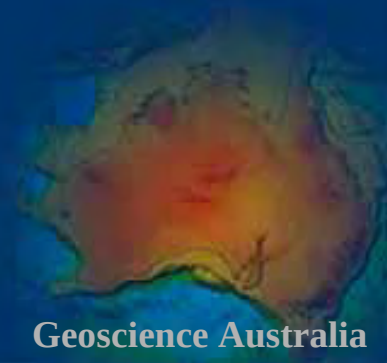
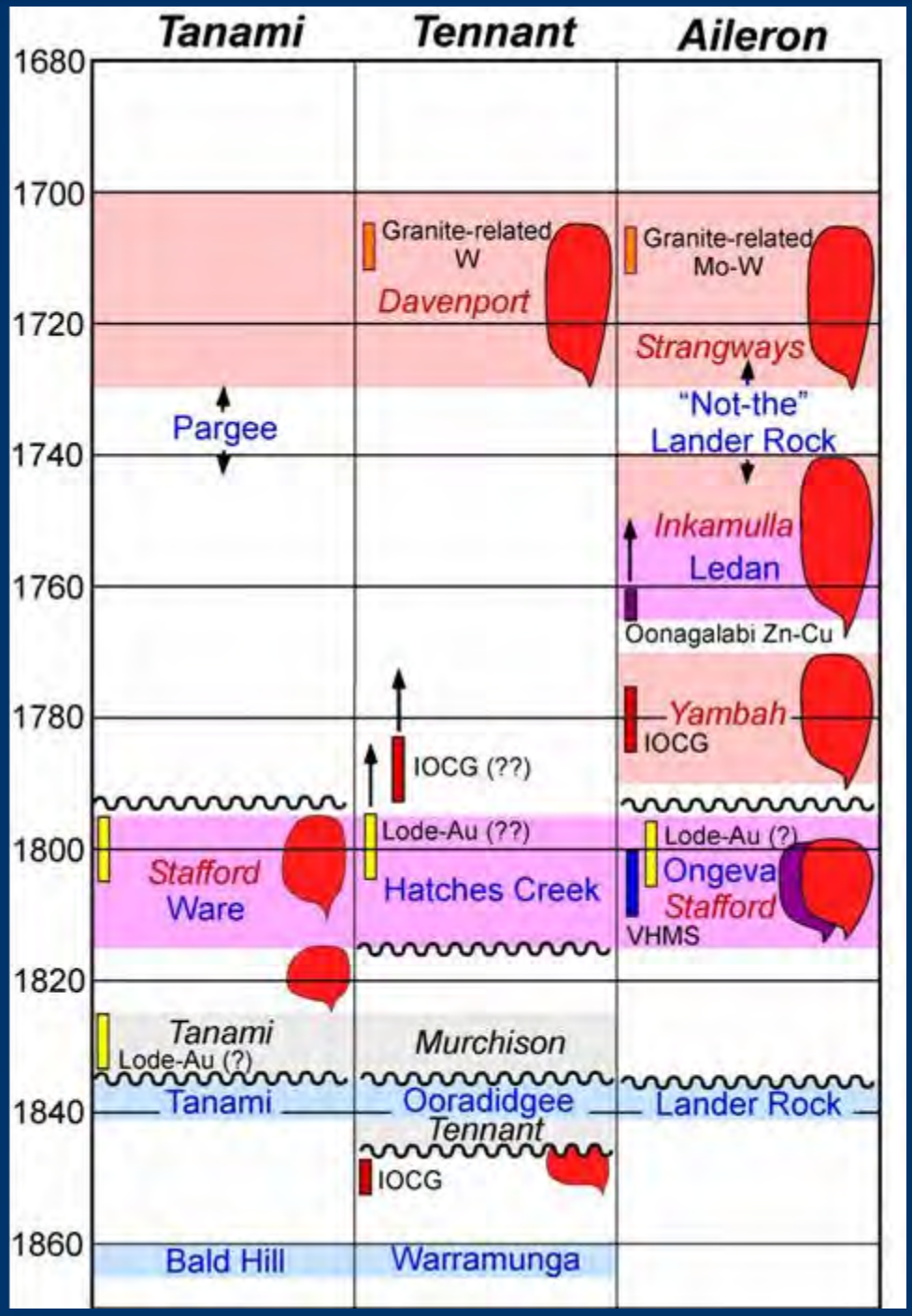
Colleagues at NTGS and GSWA





Purposes of this talk

To extend outward new knowledge from the Tanami, Tennant, Aileron and Warumpi Provinces

To relate mineral systems to the evolution of the North Australia Craton

To predict possible new mineral systems

To identify new directions for future research

North Australian Craton – event systems

2680-1920 Ma: Basement growth

1920-1840 Ma: ESE-dipping subduction

1840-1835 Ma: Kimberley-NAC collision

1835-1825 Ma: deformation of foreland (?) basin

1825-1790 Ma; transition from activity on NW margin to S margin

1790-1745 Ma: N-dipping subduction

1790-1745 Ma: Calvert basin

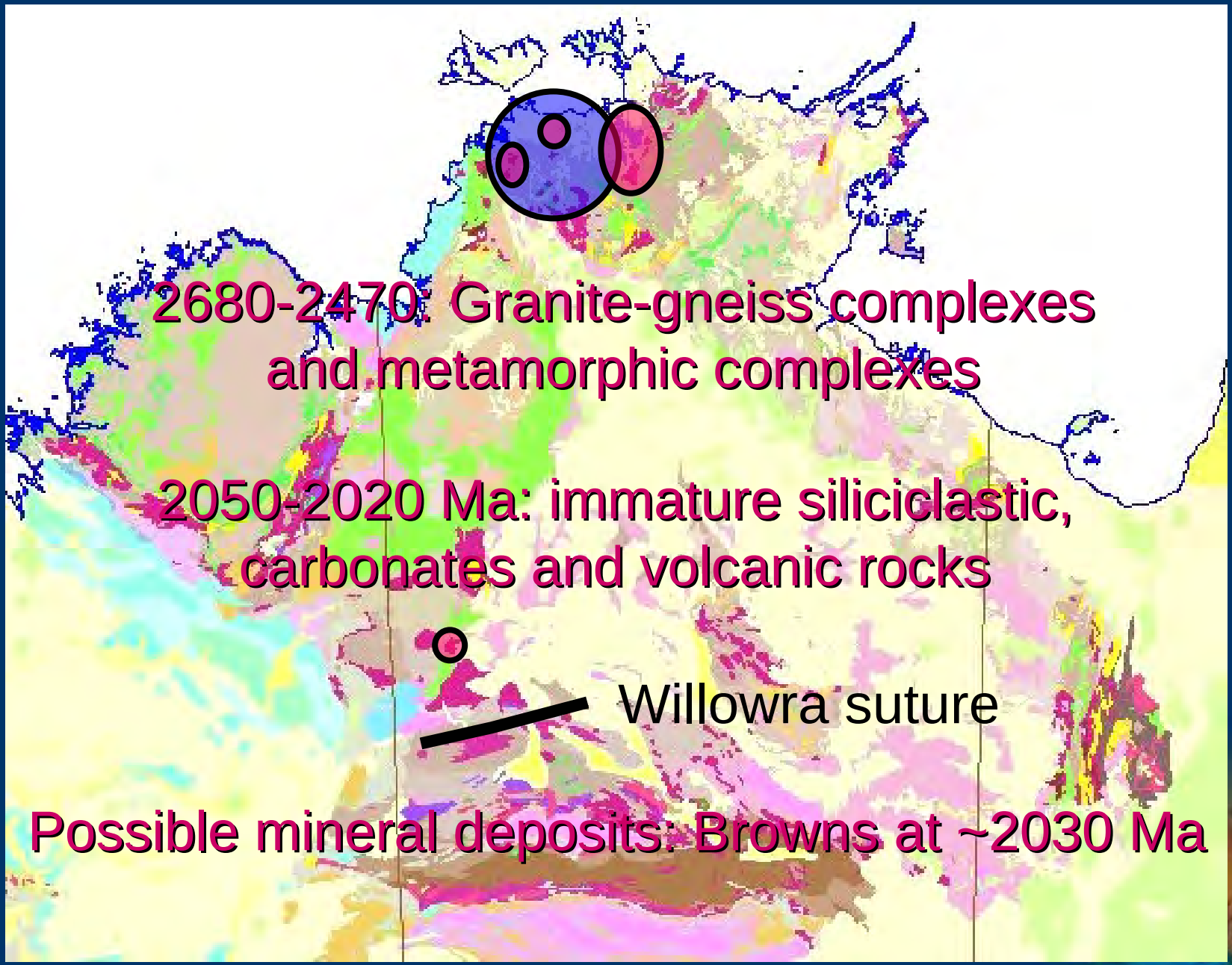
1730-1690 Ma: Basement growth

1690-1640 Ma: Growth of Warumpi Province

1640-1610 Ma: Collision and exhumation of Warumpi Province

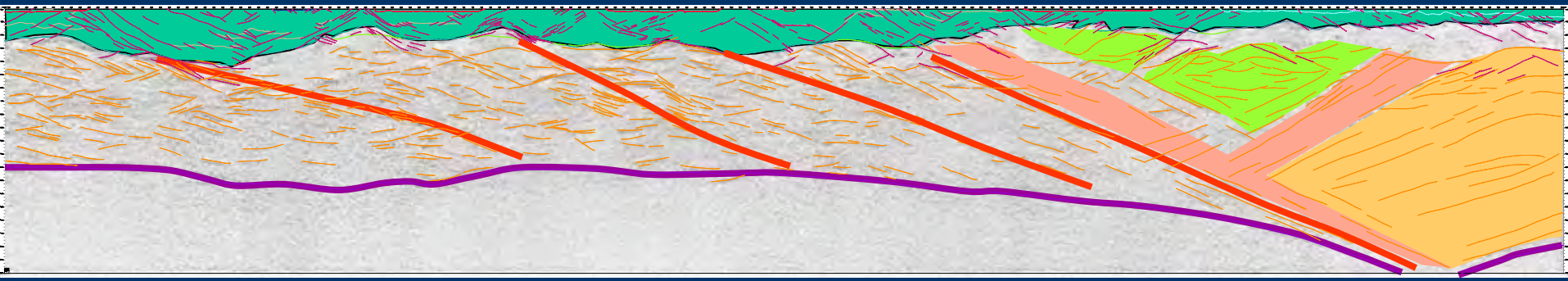
1640-1575 Ma: Rift-related and passive margin sedimentation in east and north

2680-1920 Ma – basement

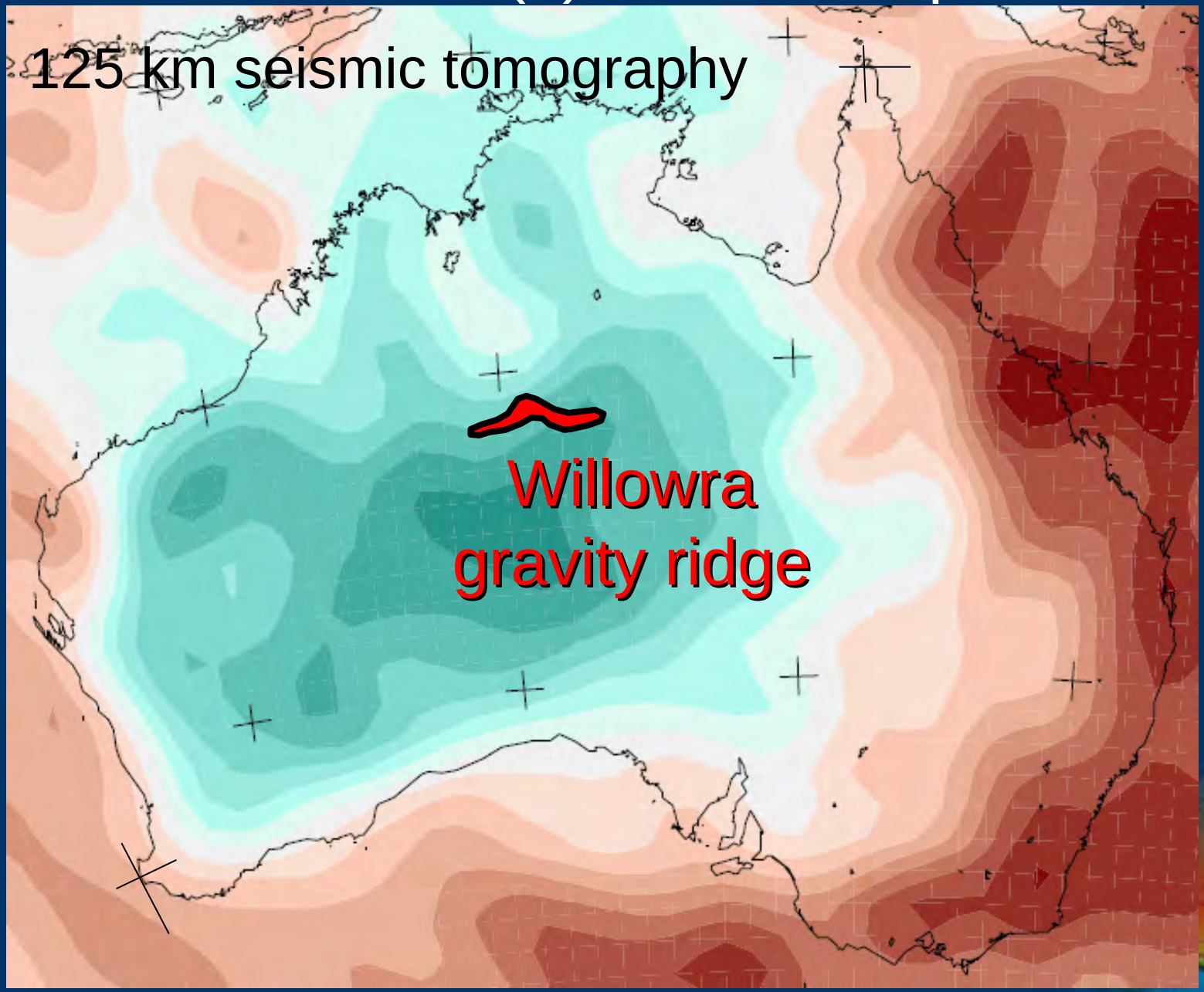


Willowra suture (?) – seismic evidence

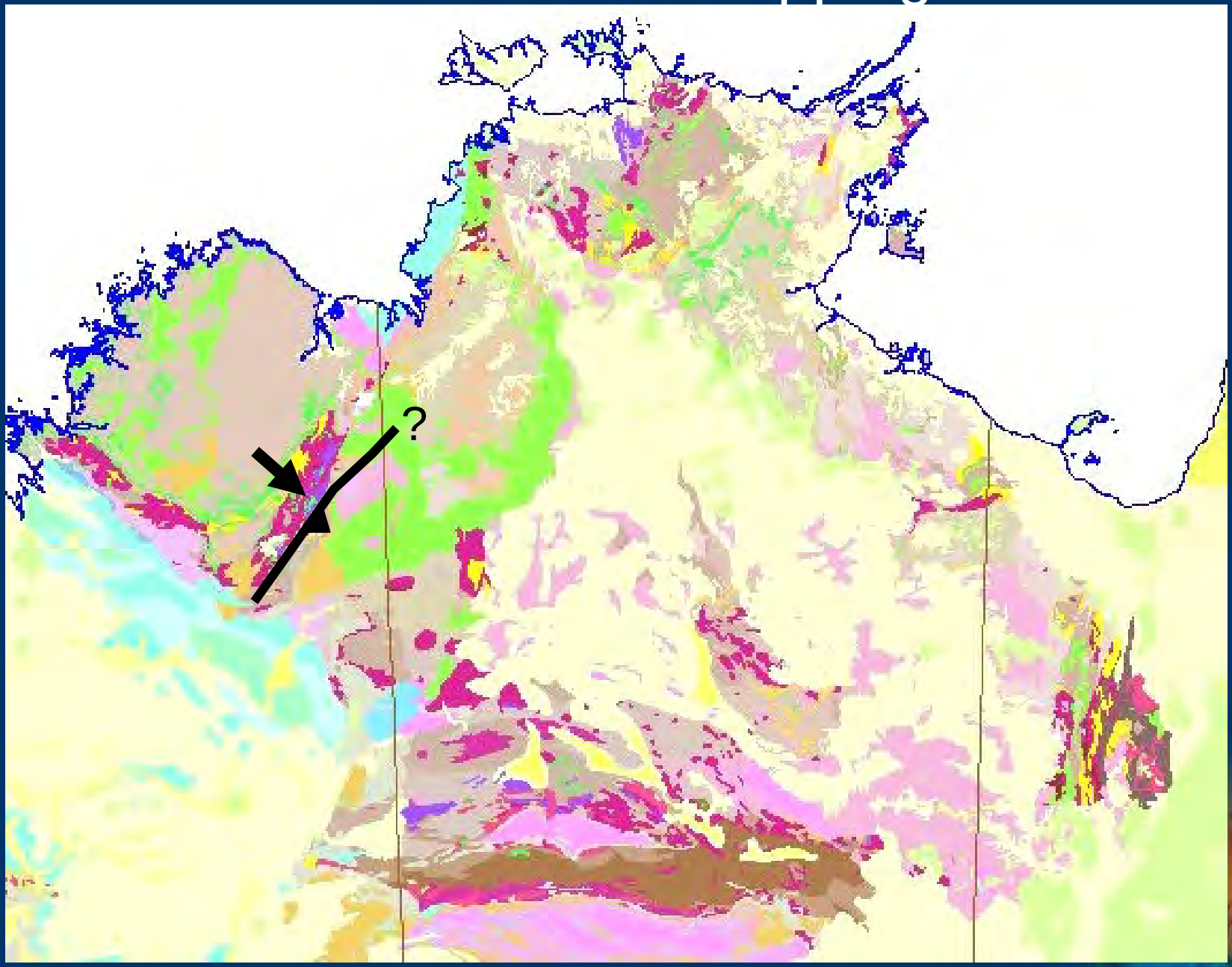
NW SE



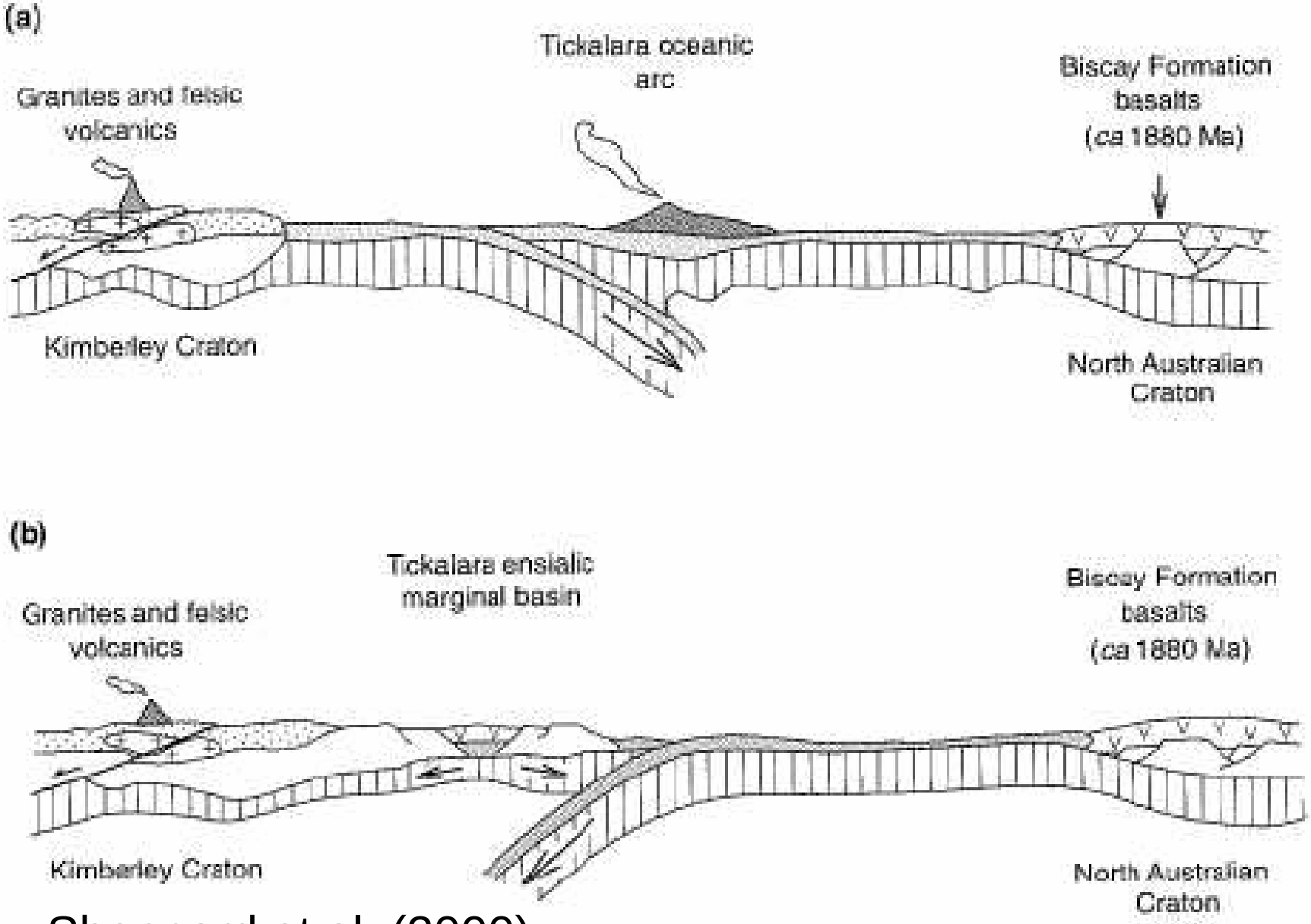
Willowra suture (?) – diamond potential



1920-1840 Ma – southeast dipping subduction

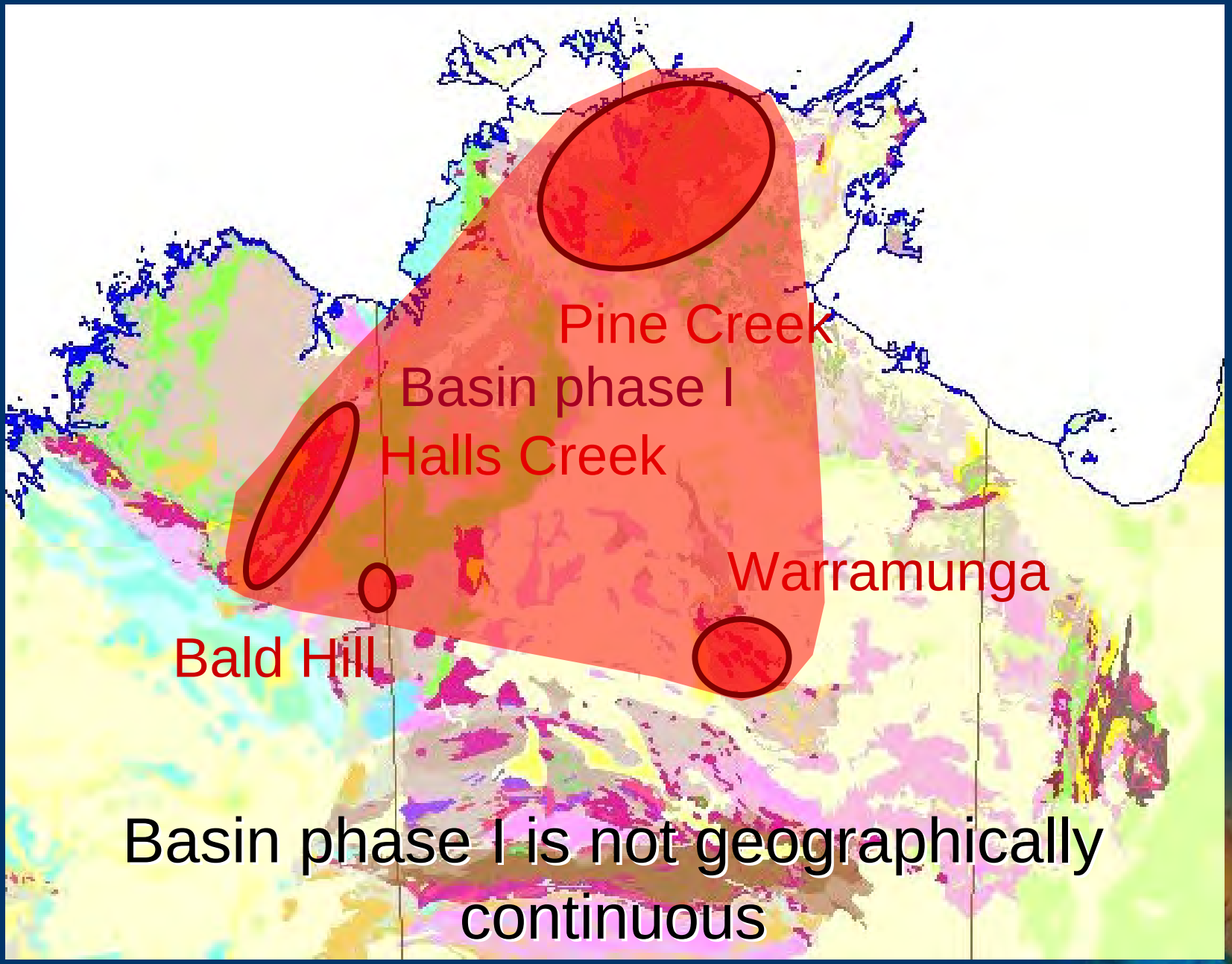


1920-1840 Ma – southeast dipping subduction



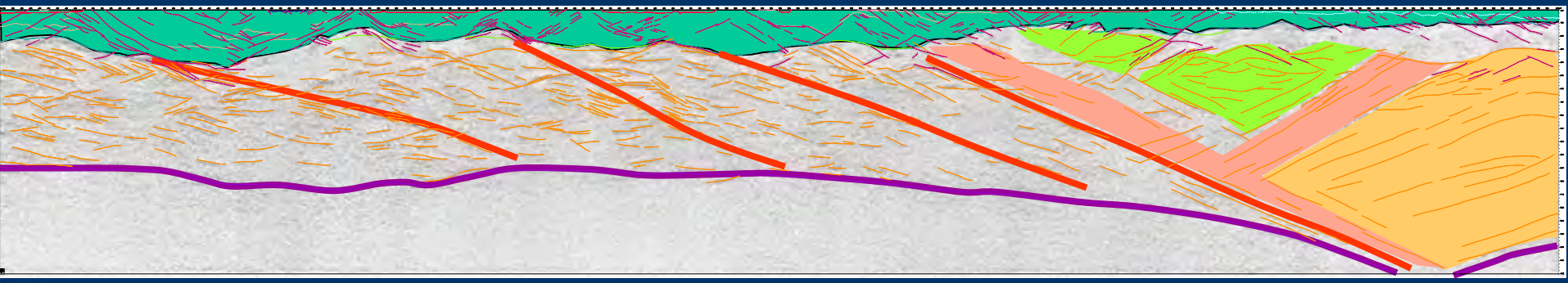
Sheppard et al. (2000)

Extent of 1865-1860 Ma basins



Basin phase I is not geographically continuous

NW SE

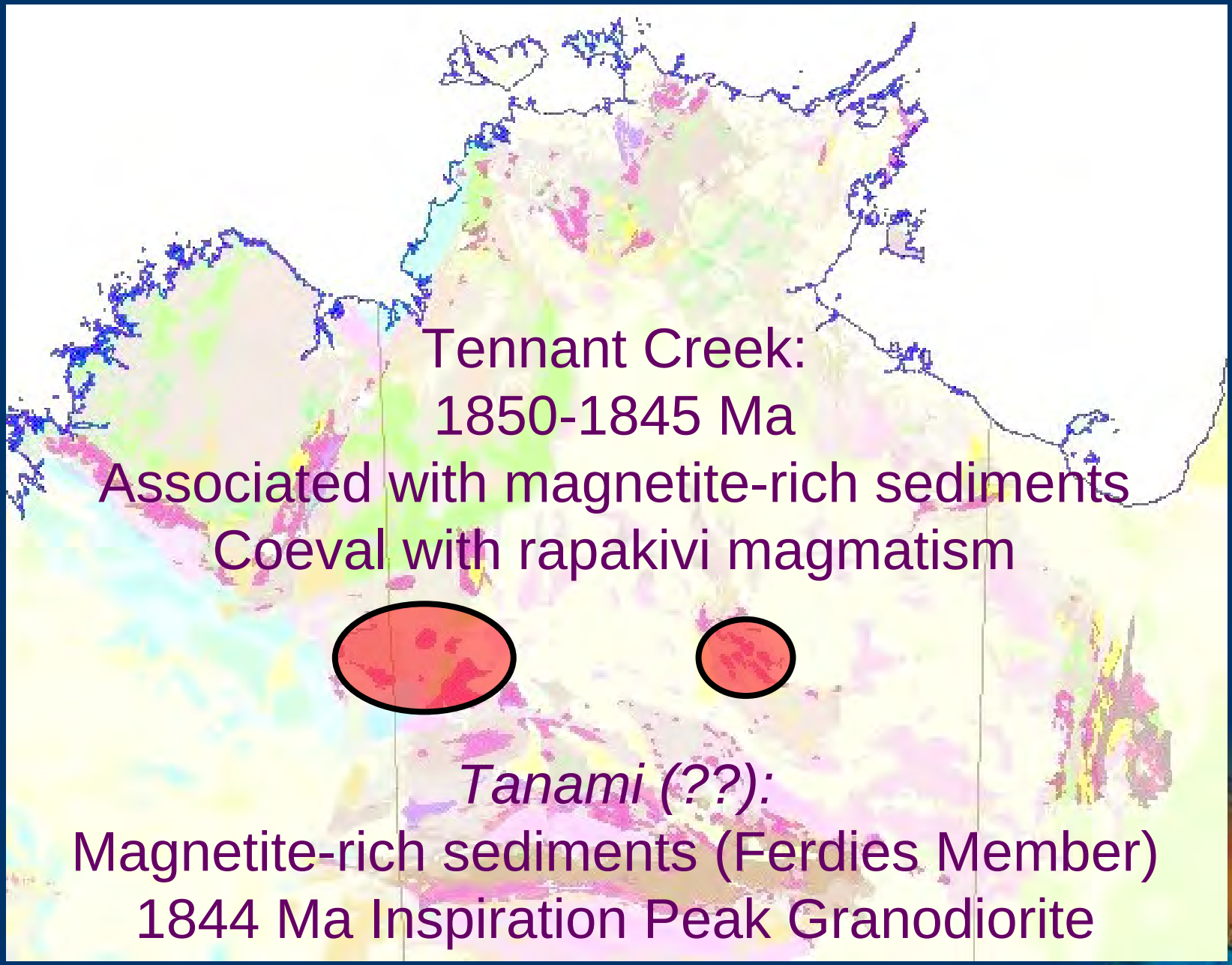


Does lack of continuity for basin phase I indicate segmented basin system?

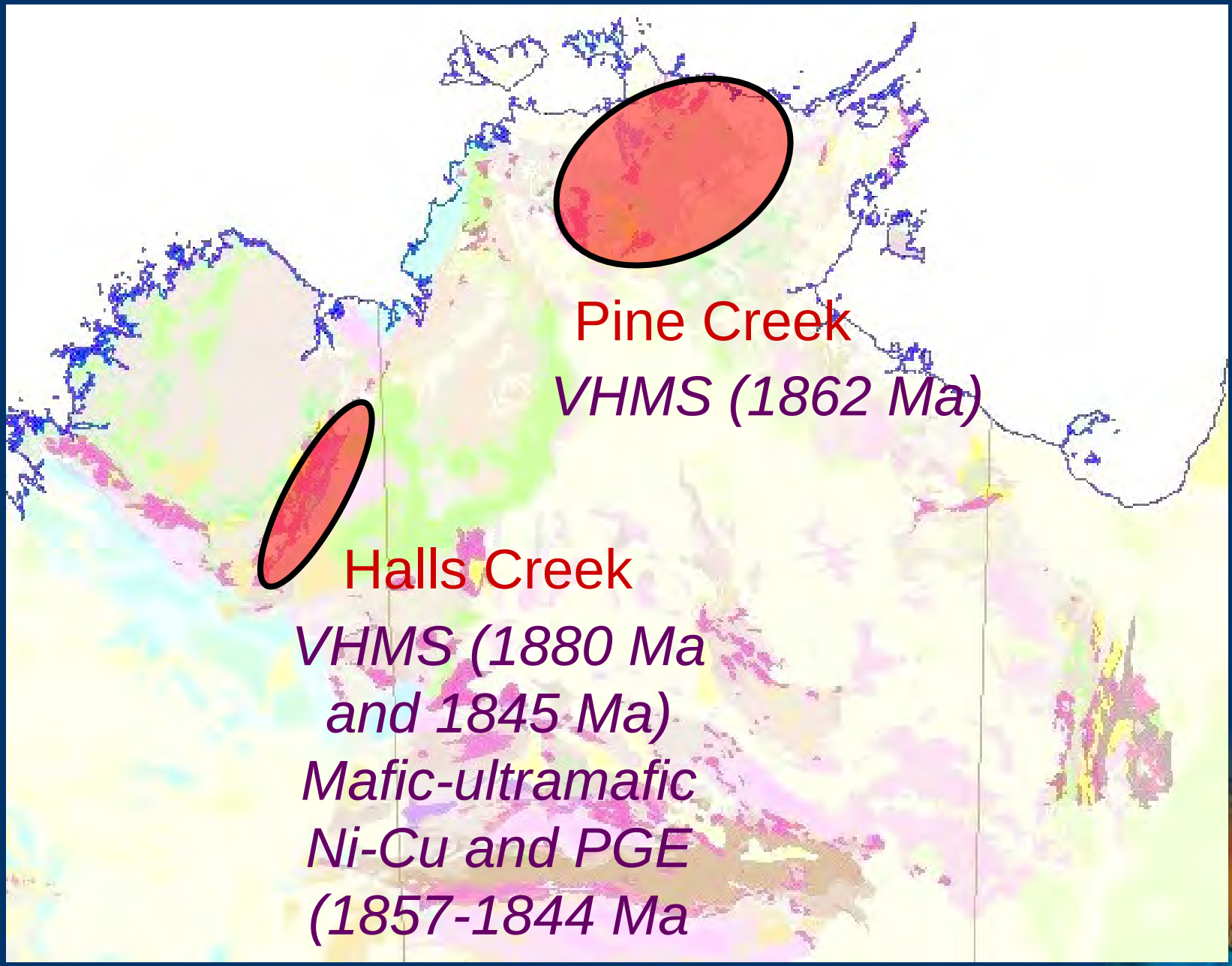
Possibly filling bottom of half grabens?

Related to back-arc extension on continental crust?

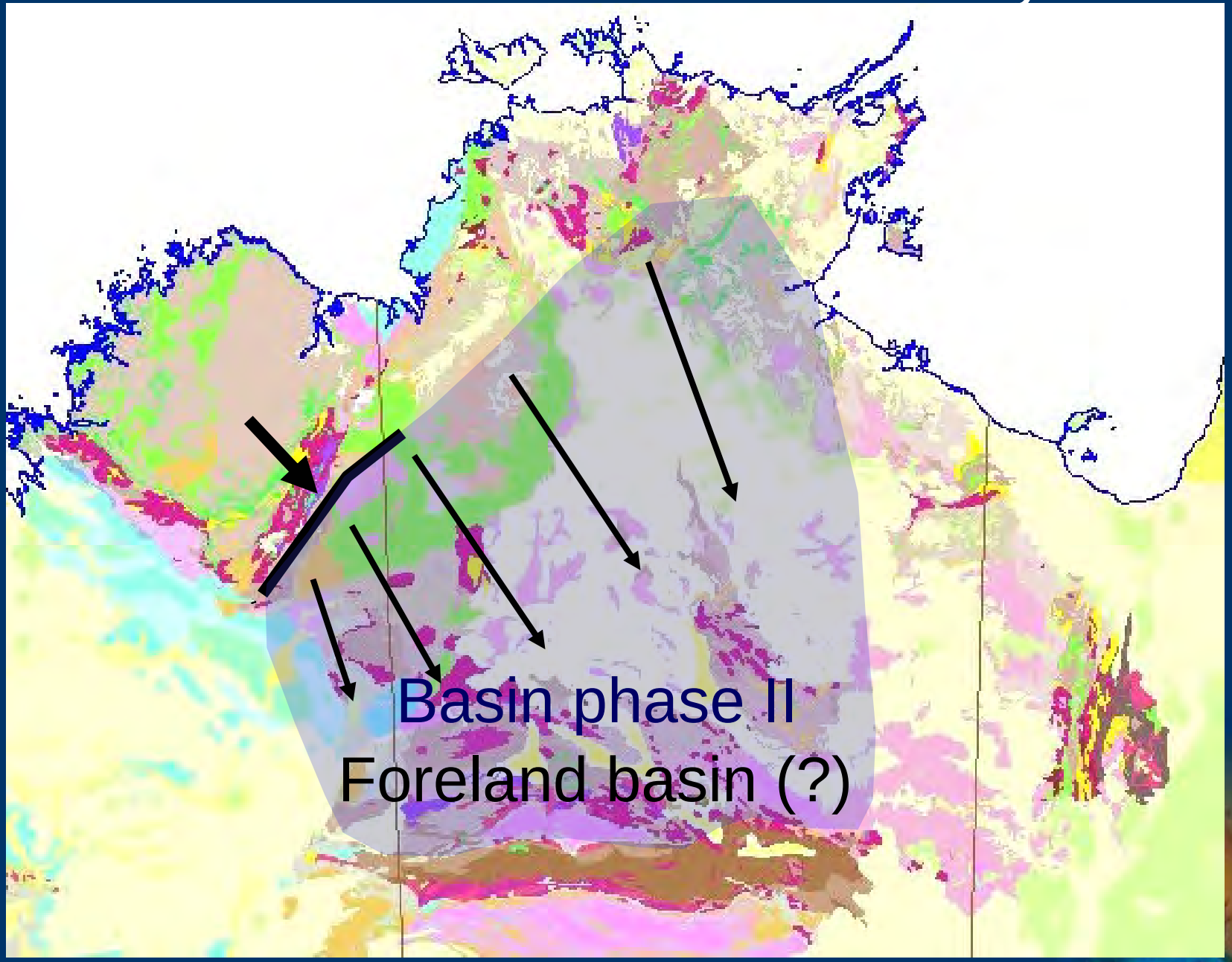
1850-1845 Ma – IOCG mineralisation



1920-1840 Ma – other mineralisation

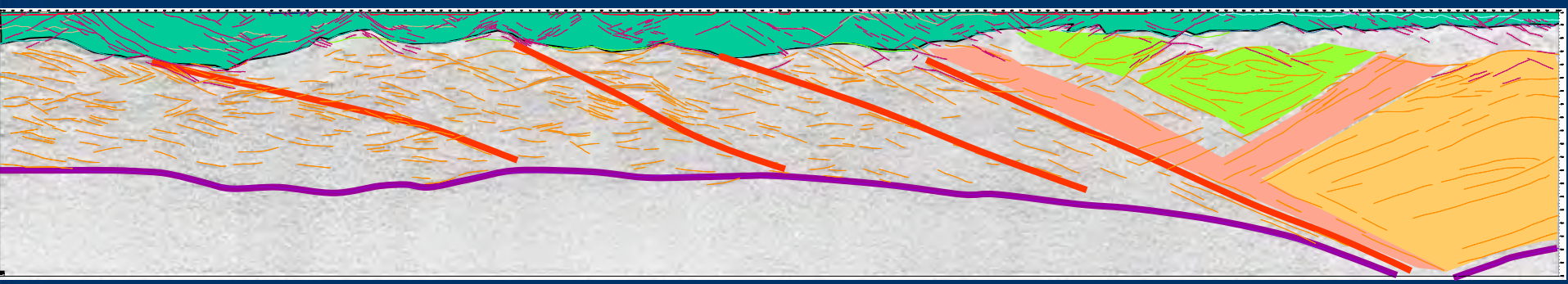


1840-1835 Ma – Collision of Kimberley Craton



Thinning of Tanami-Lander Package to southeast

NW SE



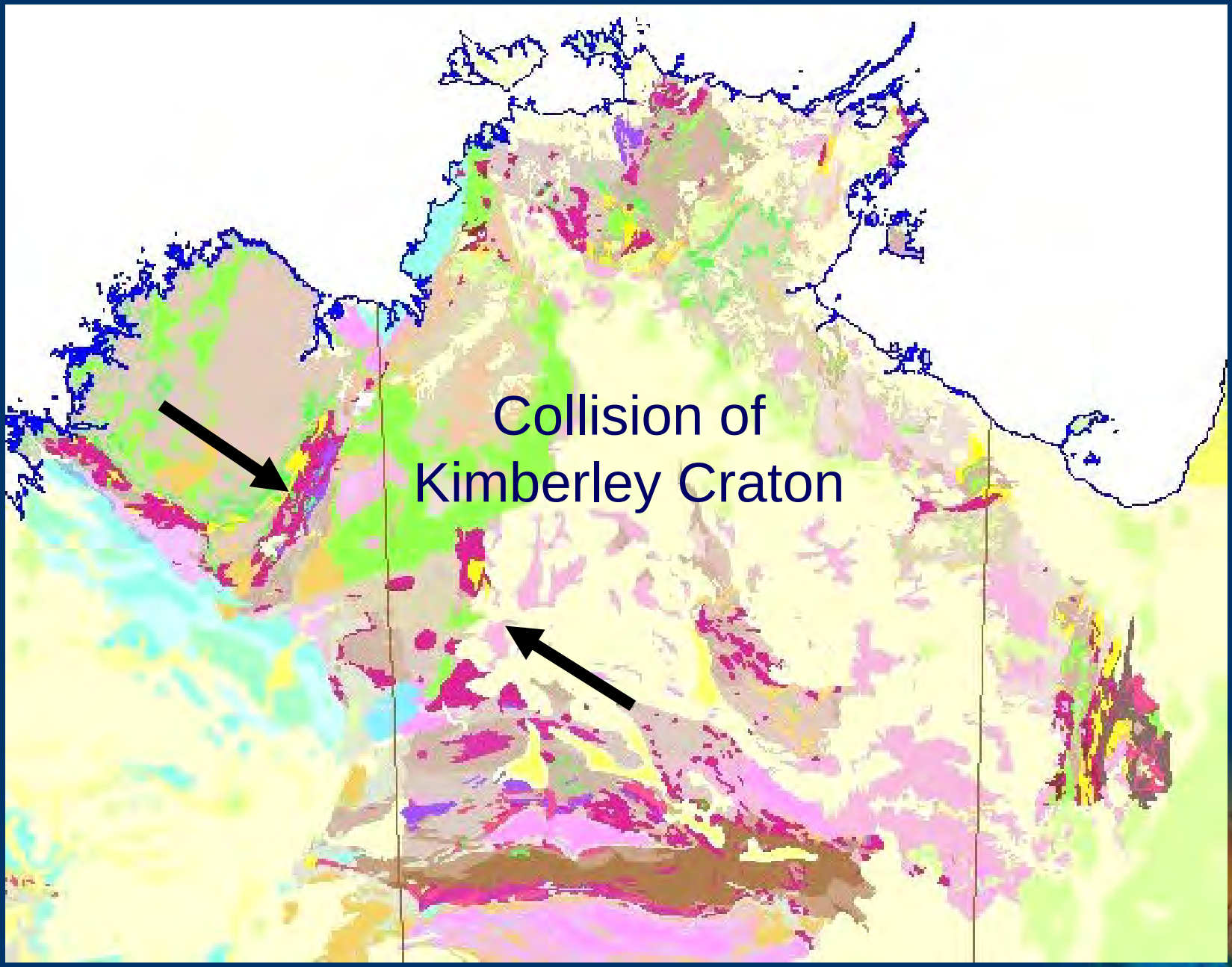
Basin developed on continental crust (Nd and Pb isotopes)

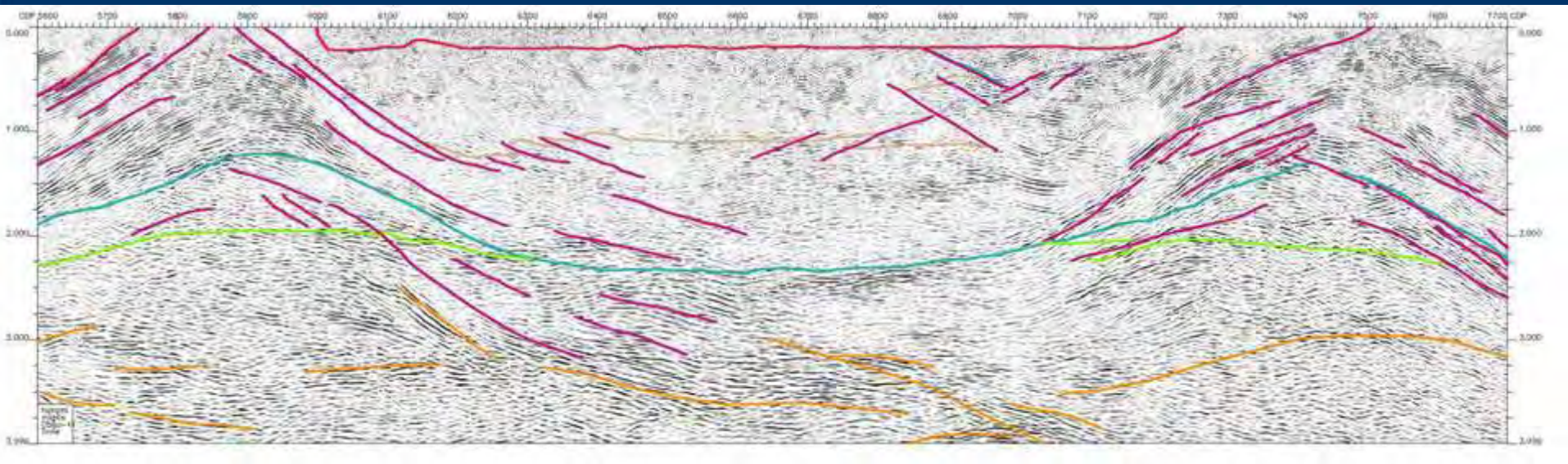
Sediments sourced from north and west

Basin system appears to be continuous

Mineral potential: Sullivan-type Zn-Pb (?)

1835-1825 Ma – Deformation of foreland basin



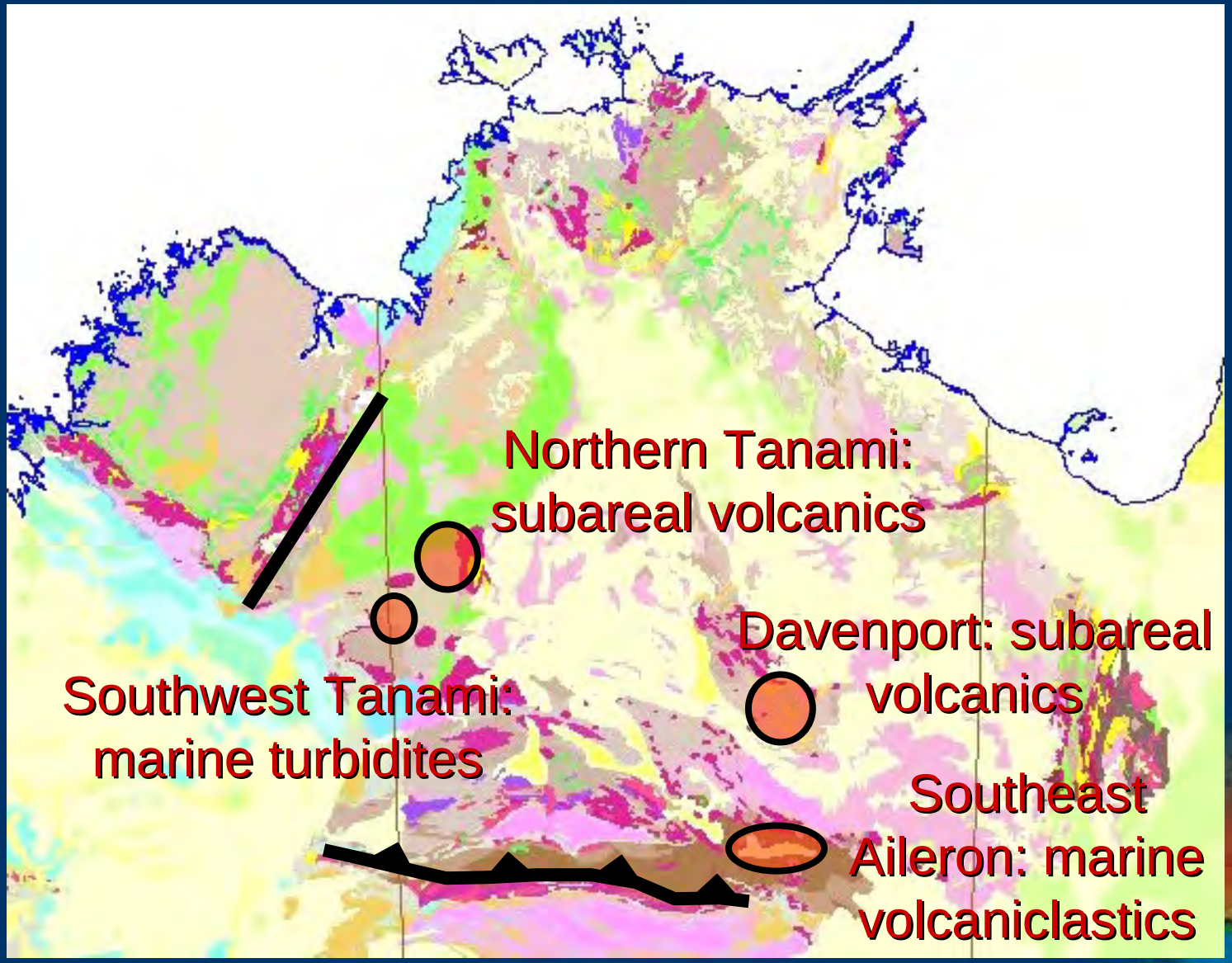


NNE-SSW trending anticlines—earliest deformation?

Some evidence for early (~1830 Ma) lode gold

Prepares architecture for later gold mineralisation

1825-1790 Ma; transition from activity on NW margin to S margin



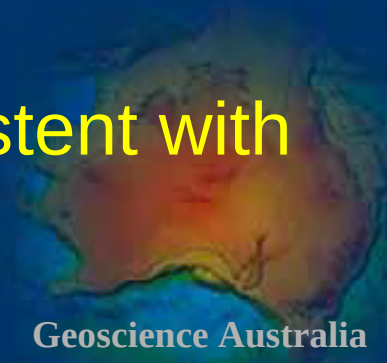
1820-1800 Ma – Basin phase III

Segmented basin system

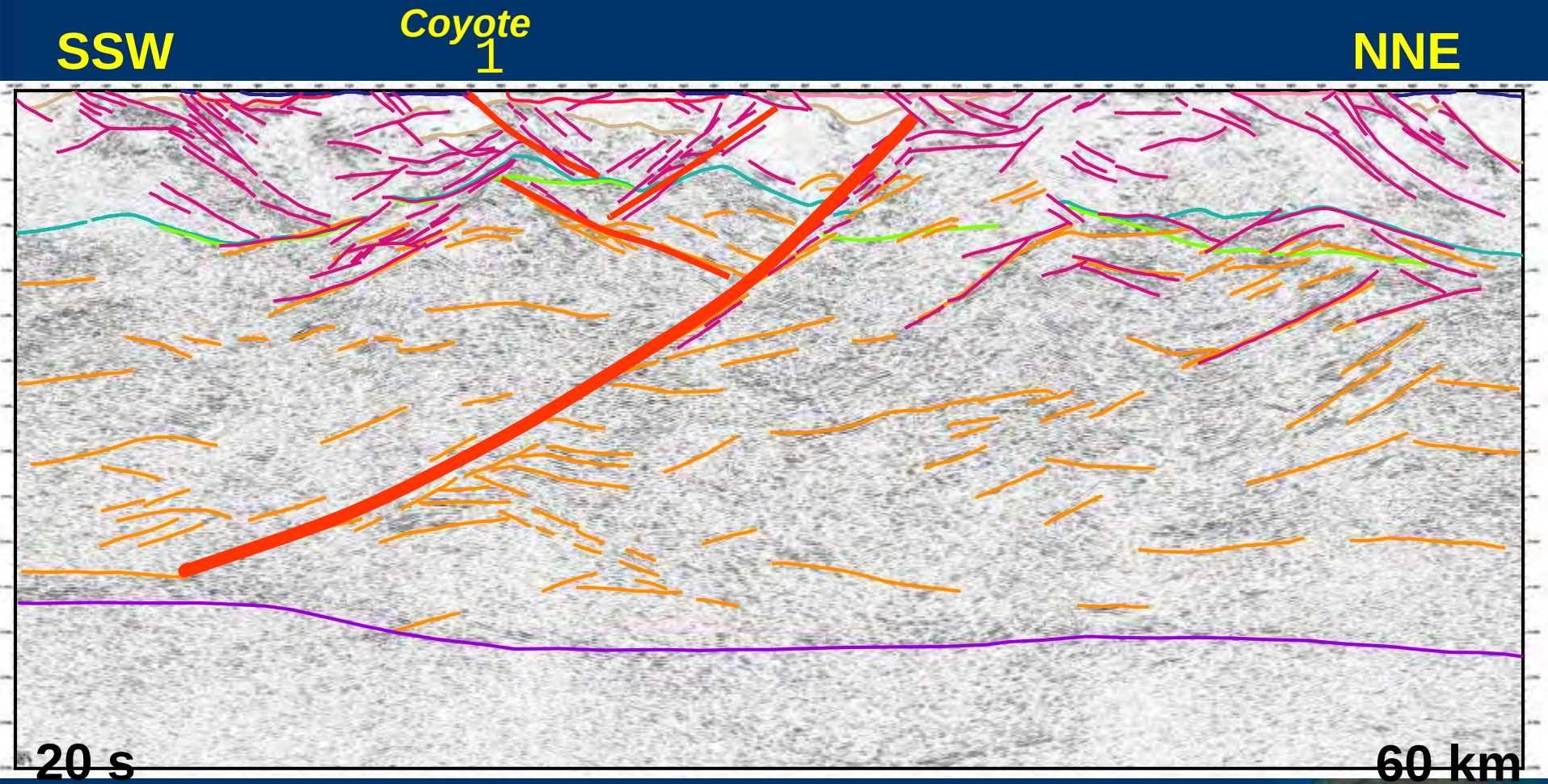
Basins have quite different fill – subareal and marine; volcanic and siliciclastic

Local extensional or transpressive basins?

Ongeva (southeast Aileron) package consistent with back-arc basin



East-west structuring



Consistent with stress from south

Mineral potential – 1825-1790 Ma

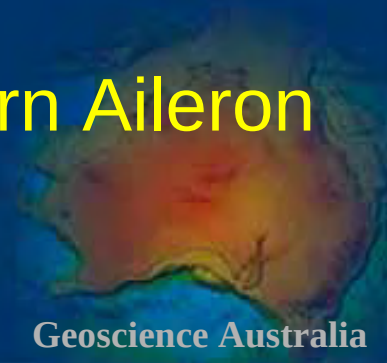
Volcanic-hosted massive sulphide deposits — Ongeva package

Low sulpidation Au-Ag and high sulphidation Au-Cu epithermal systems – northern Tanami and Davenport

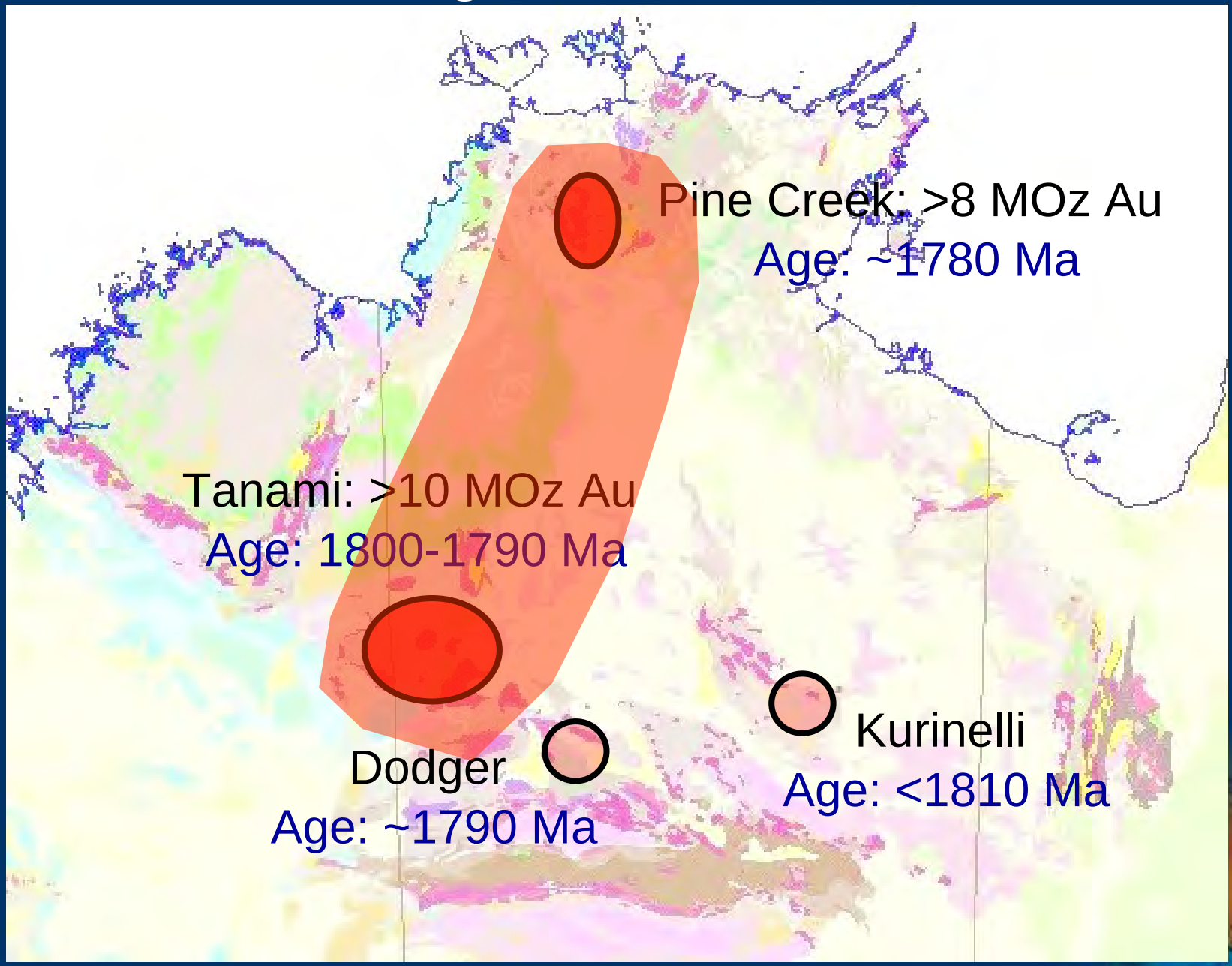
Advanced argillic alteration assemblages reported by D Blake

Vein silver deposits in Davenport region

Lode gold – Pine Creek, Tanami and northern Aileron



~1790 Ma lode gold, North Australia Craton



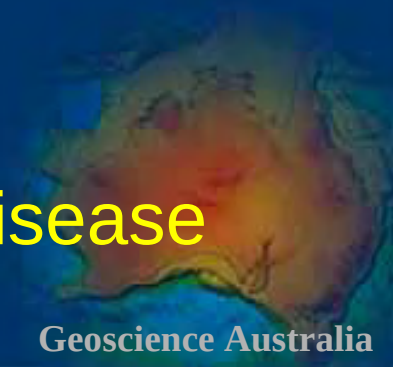
Controls on ~1790 Ma lode gold

Pre-structuring of Tanami Group, Pine Creek: collision of Kimberley from northwest; stress from south

Existence of favourable host units – BIFs and carbonaceous sediments in condensed sections of deep water basins

Coeval tectonothermal disturbance at ~1790 Ma (granites and deformation)

Gold and granites: symptoms of same disease



1790-1690 Ma – contrast between east and south

Mt Isa Inlier

1790-1745 Ma: Initiation and closure of Leichhardt Superbasin

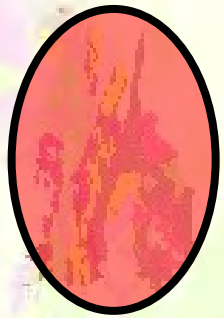
ENE-WSW extension produced N-S basins

Mafic volcanic rocks and siliciclastics; minor carbonates

1730-1690 Ma: Initiation and closure of Calvert Superbasin

NE-SW extension – linked to Strangways event

Bimodal volcanism cumlinating with Sybella Granite



1790-1690 Ma – contrast between east and south

Southern Margin of Aileron Province

1790-1745 Ma: North-dipping subduction

Yambah thermal event: 1790-1770 Ma granites

Supracrustal rocks very restricted (Reynolds package?)

Inkamulla thermal event: 1770-1745 Ma granites

1765-1745 siliciclastic and volcaniclastic rocks

1730-1690 Ma: Strangways Event

High T-low P metamorphism in south

Granite emplacement towards north

1790-1690 Ma – (potential) mineral systems

Leichhardt Superbasin

No known mineralising system

Source rock for Mt Isa-type mineral systems

Potential for Sullivan-type Zn-Pb deposits

Calvert Superbasin

No known mineralising system

Potential for Sullivan-type Zn-Pb deposits

Yambah Event

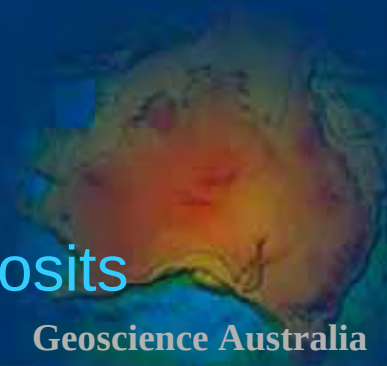
IOCG deposits

Inkamulla Event

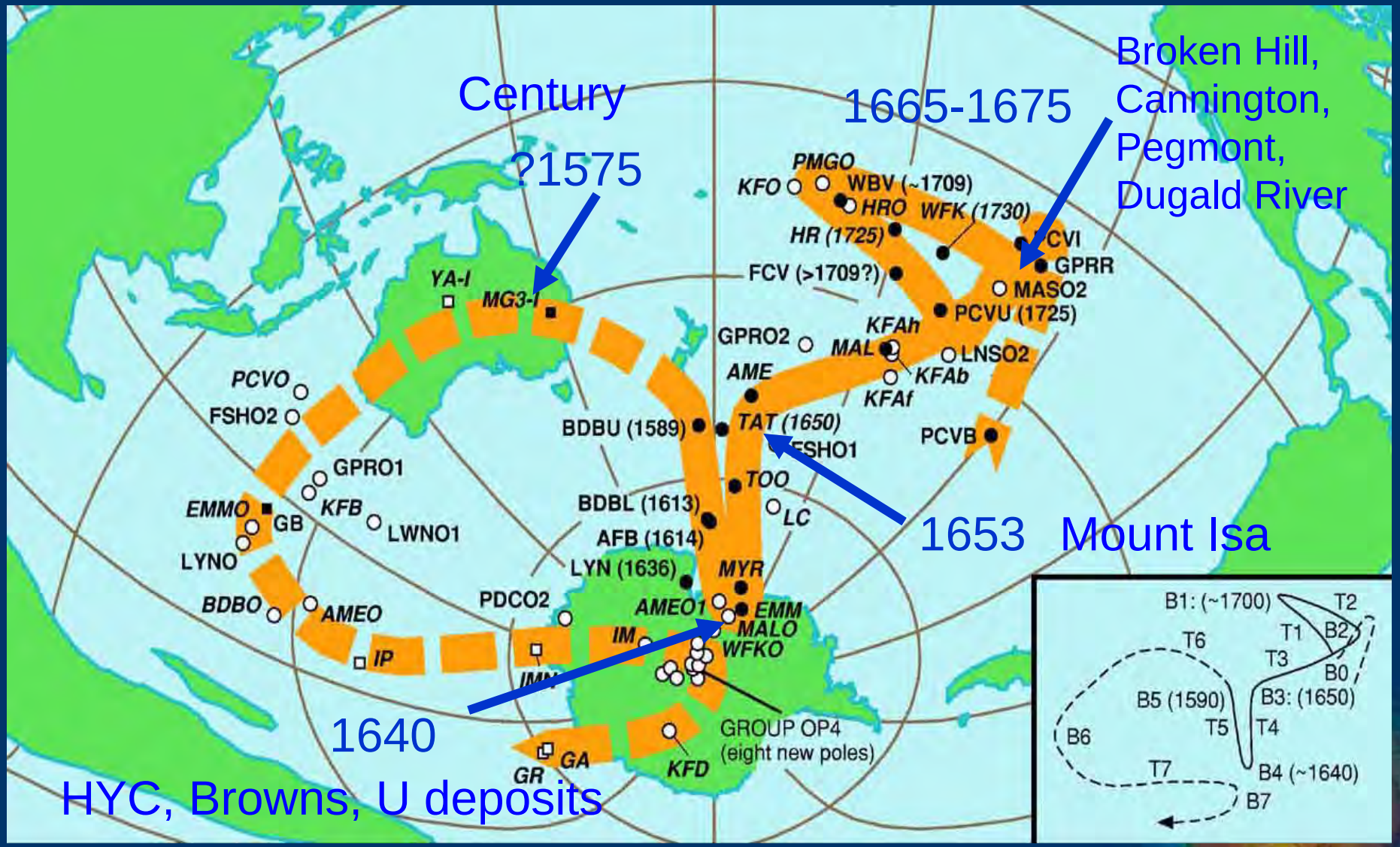
Carbonate replacement Zn-Cu deposits

Strangways Event

Skarn, carbonate replacement Sn-W-Mo deposits



Australian Proterozoic apparent polar wander path



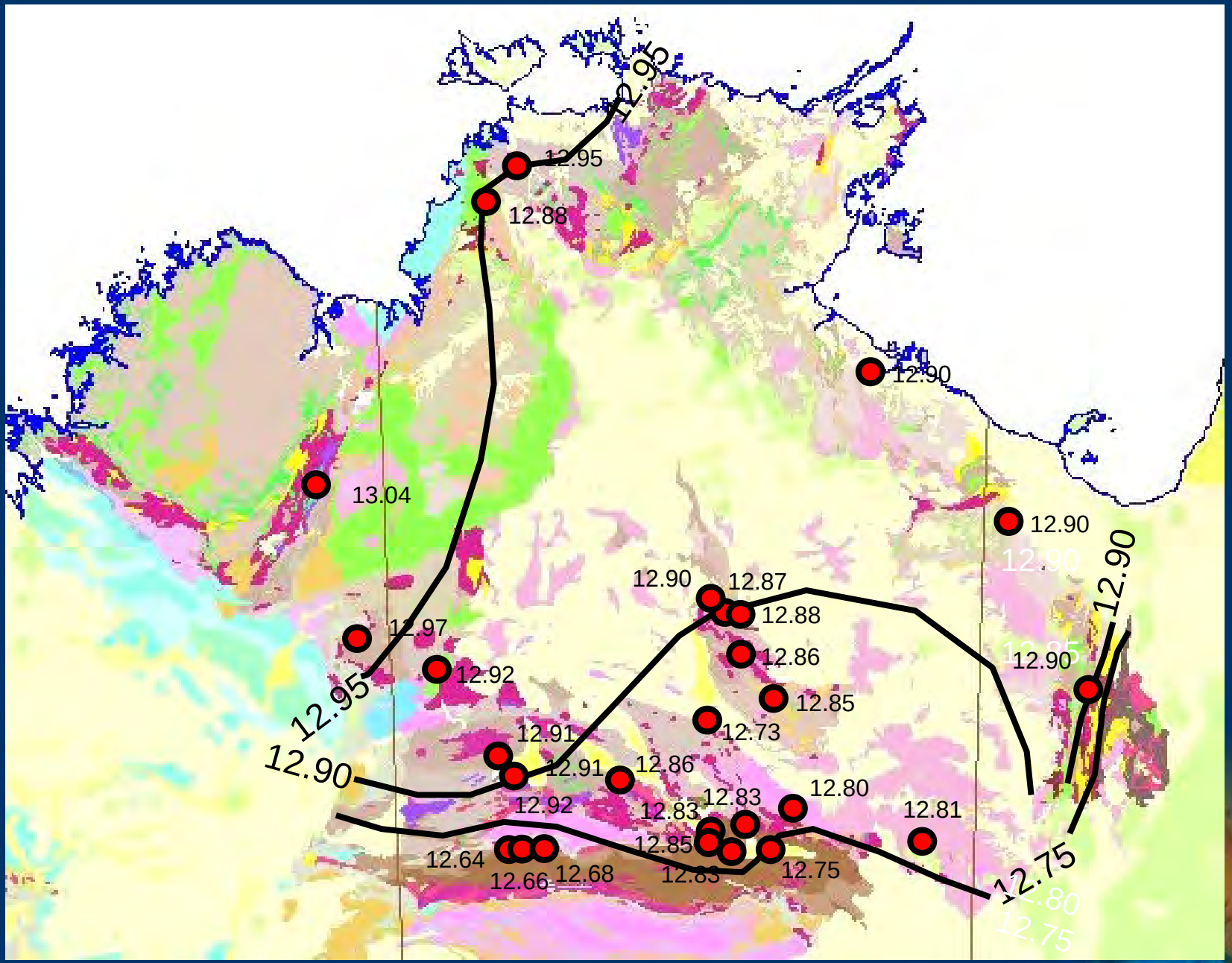
Idnurm (2000)

Broken Hill-type versus Mt Isa-type Zn-Pb-Ag deposits

	Broken Hill-type	Mt Isa-type
Basin	Ensialic rift: siliciclastic dominated; minimal carbonates; bimodal magmatism	Sag phase: carbonate-dominated; no coeval magmatism
Metal assemblage	Pb-Zn-Ag(Cu-Au)	Zn-Pb-Ag
Regional alteration	Albitic; oxidised (high Fe_2O_3/FeO)	K-spar-bearing; oxidised (high Fe_2O_3/FeO)
Fluids	High T (200-300°C), reduced	Low T (<200°C), oxidised
Depositon	(Near) syngenetic	Diagenetic, epigenetic
Pb isotopes	Relatively primitive	Evolved

Cooke et al., 2000; Huston et al., 2006

Pb isotope data – variations in μ (CSIRO-AGSO model)



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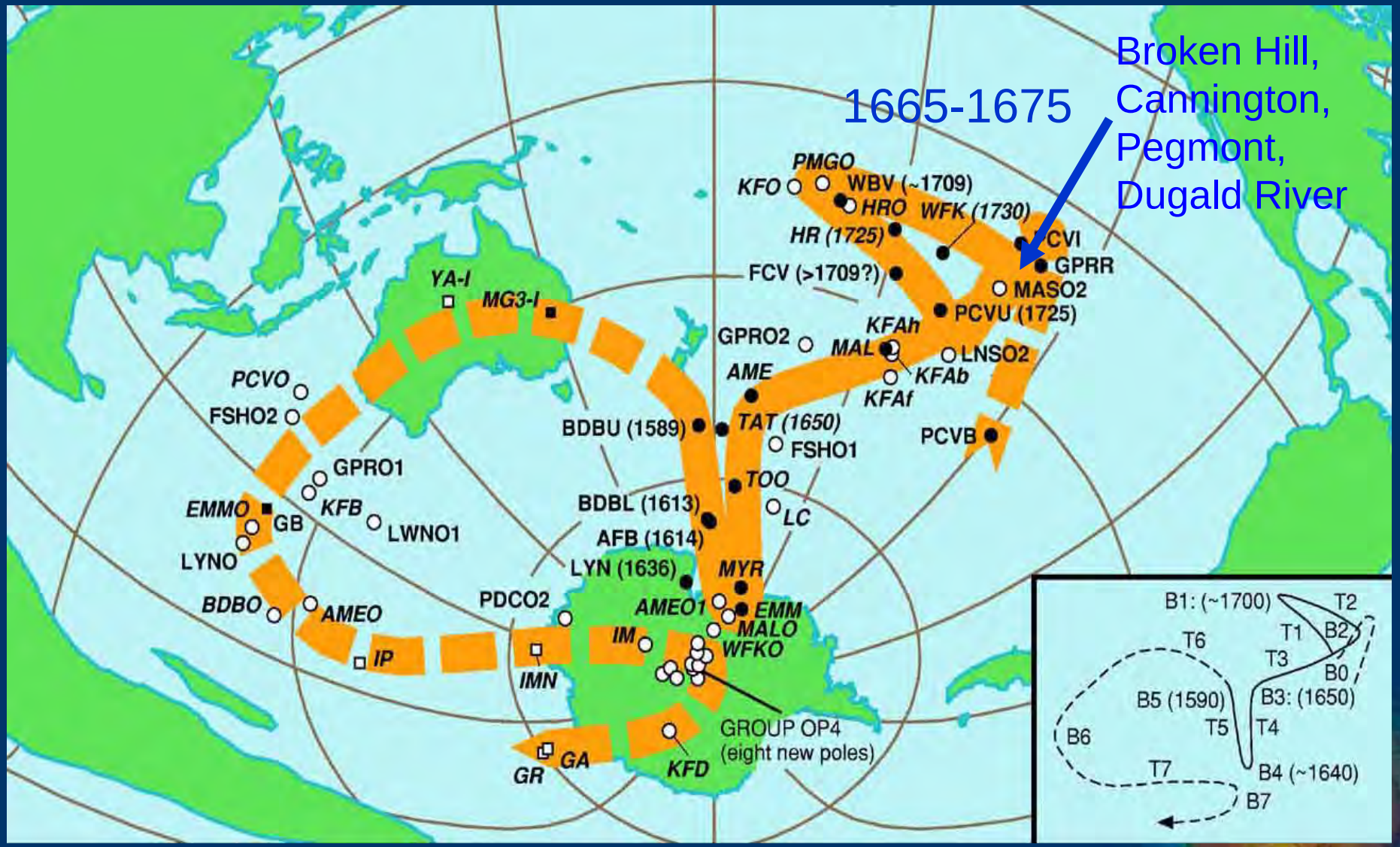


Idnurm (2000)

Mt Isa eastern succession

1680-1670 Ma Maronan Group

Rift-related turbidites

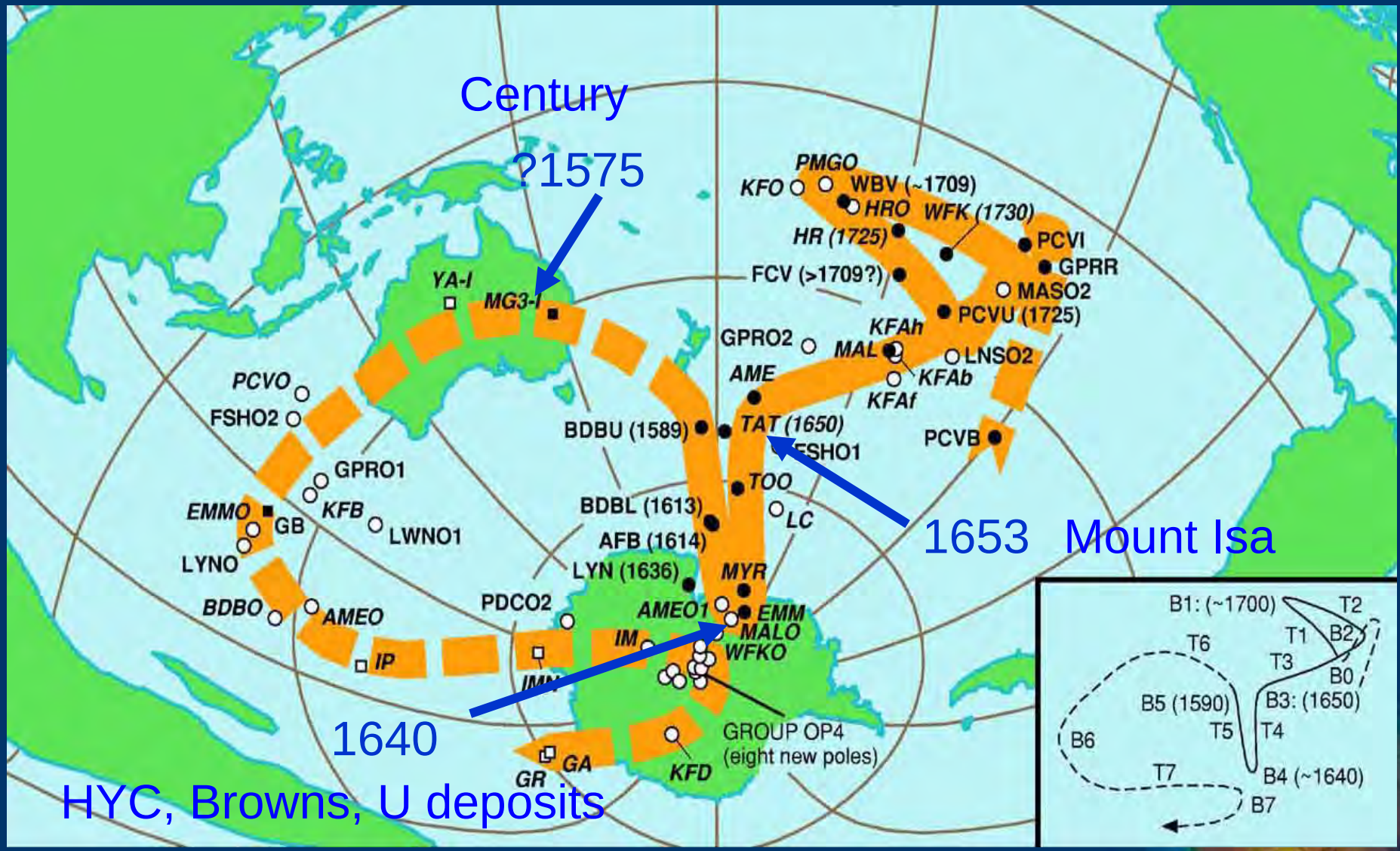
Amphibolite and metabasalt; minor felsic volcanic rocks

Coeval with emplacement of Sybella Granite in western succession

Regional albitic alteration

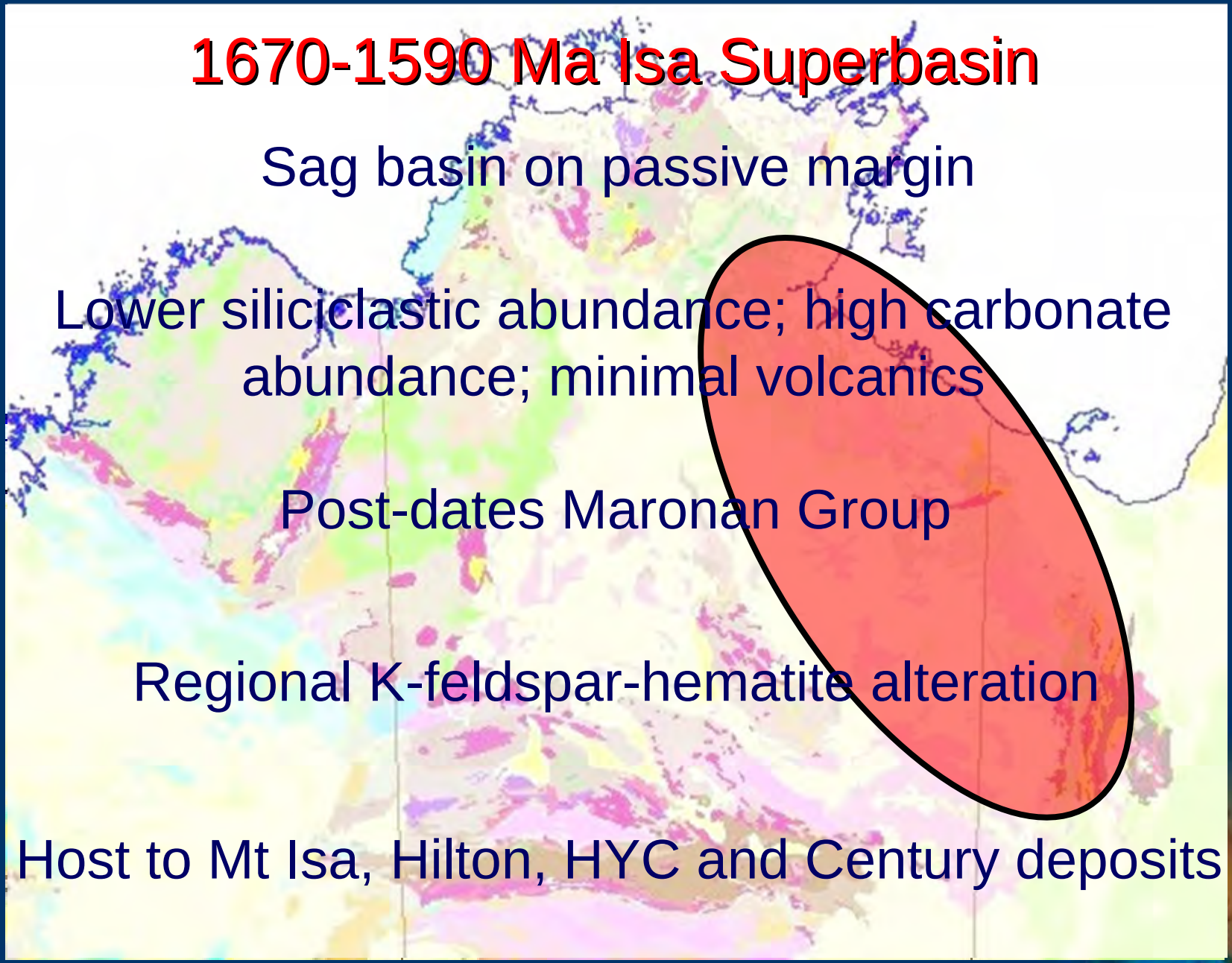
Host to Cannington and Pegmont BHT deposits

Australian Proterozoic apparent polar wander path



Idnurm (2000)

Mt Isa western succession



1670-1590 Ma Isa Superbasin

Sag basin on passive margin

Lower siliciclastic abundance; high carbonate abundance; minimal volcanics

Post-dates Maronan Group

Regional K-feldspar-hematite alteration

Host to Mt Isa, Hilton, HYC and Century deposits

Australian Proterozoic polar wander path bends

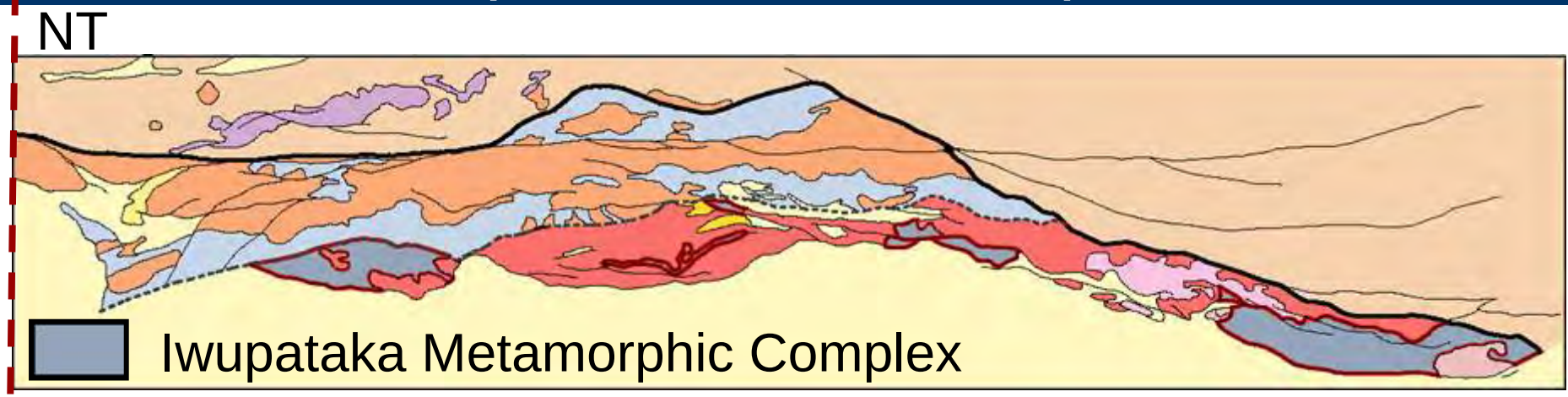
1653 Ma: Mt Isa and Hilton deposits
No apparent trigger in present North Australia Craton

1640 Ma: HYC Zn-Pb deposits; U-Th deposits (Westmoreland and Killi Killi Hills)
Triggered by accretion of Warumpi Province

1575 Ma: Century Zn-Pb deposit
Triggered by Chewings Event

Mt Isa-type and U deposits require circulation of oxidised fluids → Coeval evolution of mineral systems?

Zn-Pb-Cu potential – Warumpi Province



Known deposits: epigenetic deposits in 1620-1610 Iwupataka Metamorphics

Potential: 1690-1660 Ma Haasts Bluff domain; felsic volcanism in arc outboard of NAC (VHMS)

Potential: ~1660 Ma Yaya Domain; Fore-arc basin with contemporaneous mafic volcanism (BHT)

Potential: ~1640 Ma Webb region; oxidised granites and associated alteration (IOCG)

Potential: ~1635 Ma Mafic intrusion-hosted Ni-Cu

Potential: Lode Au on NAC

Post-1610 Ma “intracratonic” events

1590-1560 Ma Chewings/Early Isan Event

IOCG deposits, Mt Isa Eastern Succession

IOCG deposits, Gawler Craton

~1130 Ma Teapot Event

Alaska-type PGE

~730 Ma carbonatites

Neoproterozoic-Palaeozoic basins

Mississippi Valley-type deposits

Broken Hill-type deposits: Harts Range Group

450-300 Ma Alice Springs Orogeny

Lode gold deposit

REE-U deposits

Future work – Tanami region

Quantitative structural chronology

Chronology and relationships in bottom Tanami stratigraphy

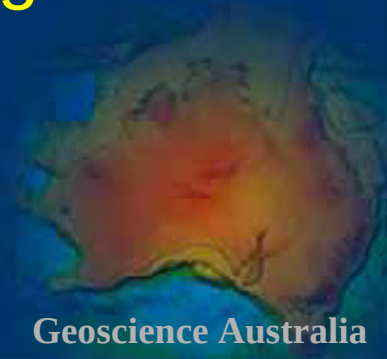
Stratigraphic drilling

Extension of seismic line across Hall Creek

Future work – North Australia Craton

Correlation of event systems through regions

Future work – exploration



Thanks

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