The Curnamona Province: a Palaeo- to Mesoproterozoic time slice

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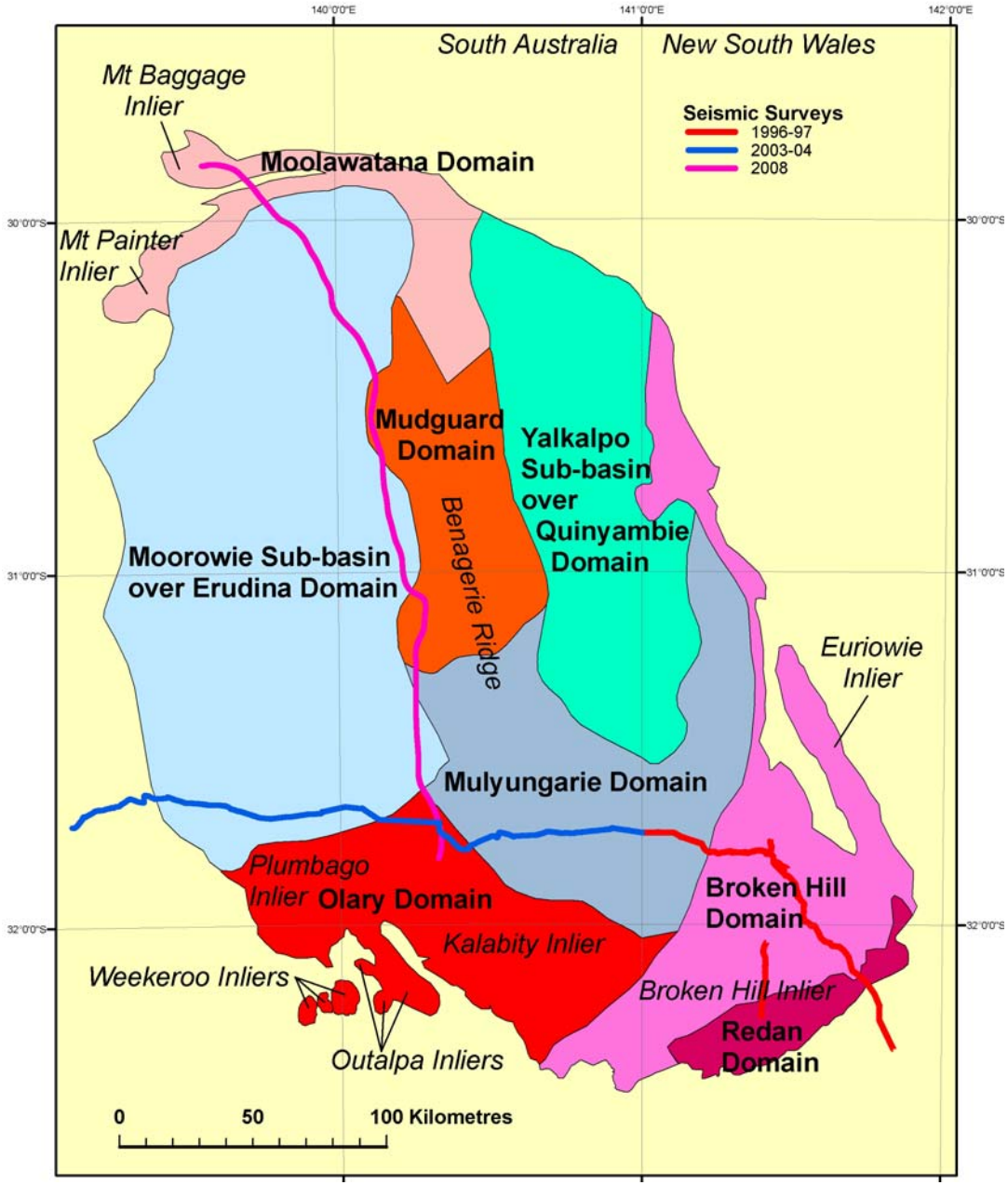
TIME-SPACE CHART

CURNAMONA AND OTHER PROTEROZOIC PROVINCES

Age Ma	Gawler Craton: Cleve Subdomain	Gawler Craton: Moonta Subdomain	Mt Lofty Ranges Inliers	Olary Domain	Curnamona Province: Broken Hill Domain	Moolawatana Domain	Mount Isa Inlier
0	*Neotectonic uplift*		*Neotectonic uplift*	*Neotectonic uplift*	*Neotectonic uplift*	*Neotectonic uplift*	
100	*Peneplanation* *Deep weathering*	*Peneplanation* *Deep weathering*	*Peneplanation* *Deep weathering*	*Peneplanation* *Deep weathering*	*Peneplanation* *Deep weathering*	*Peneplanation* *Deep weathering*	*Peneplanation* *Deep weathering*
200							
300						Mt Gee Sinter Radium Ridge Breccia	
400						British Empire Granite	
500			*Delamerian Orogeny*	*Delamerian Orogeny*	*Delamerian Orogeny*	*Delamerian Orogeny*	
600	Hawker Group Wilpena Group Umberatana Group	Normanville Group Wilpena Group Umberatana Group	Normanville Group Wilpena Group Umberatana Group	Hawker Group Wilpena Group Umberatana Group	Farnell Group Torrowangee Group	Wilpena Group Umberatana Group	
700		Burra Group	Burra Group	Burra Group		Burra Group	
800	Gairdner Dolerite				Poolamacca Group	Arkaroola Subgroup	
900							
1000							
1100							
1200							
1300							
1400	Pandurra Formation						Williams Batholith
1500						Moolawatana Suite	
1600	Hiltaba/GRV event	Hiltaba/GRV event	*Olarian Orogeny*	Ninnerie Supersuite *Olarian Orogeny*	Ninnerie Supersuite *Olarian Orogeny*	Radium Creek Metam ?	*Isan Orogeny*
1700	*Kimban Orogeny*	*?*	Barossa Complex orthogneiss	Willyama Supergroup	Willyama Supergroup		Isa Superbasin Calvert Superbasin
1800	Moonabie Fm Hutchison Group	Wallaroo Group Donington Suite	?	?	?		Leichhardt Superbasin Kalkadoon Batholith
1900							
2000	Miltalie Gneiss						



Domains of the Curnamona Province

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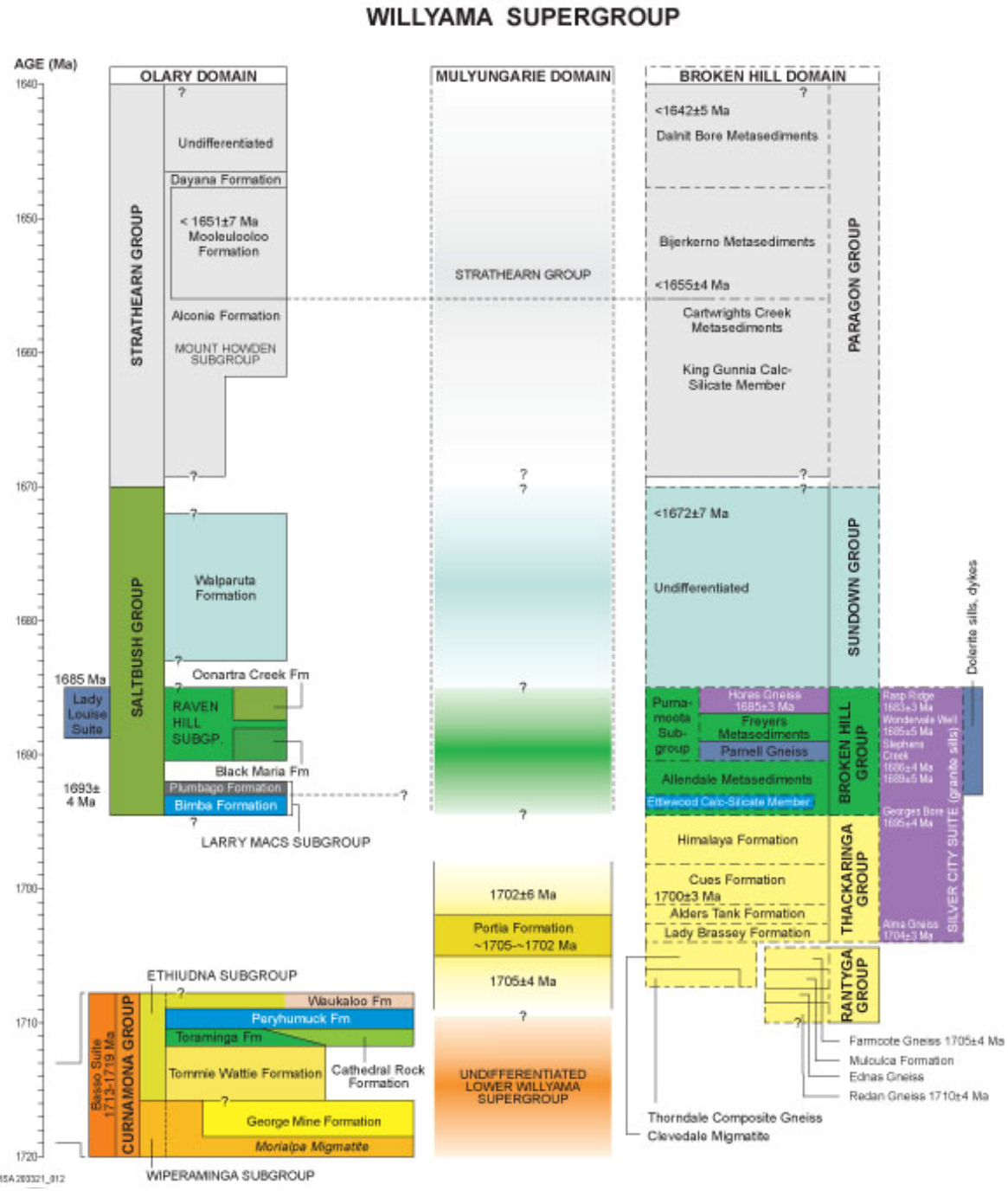
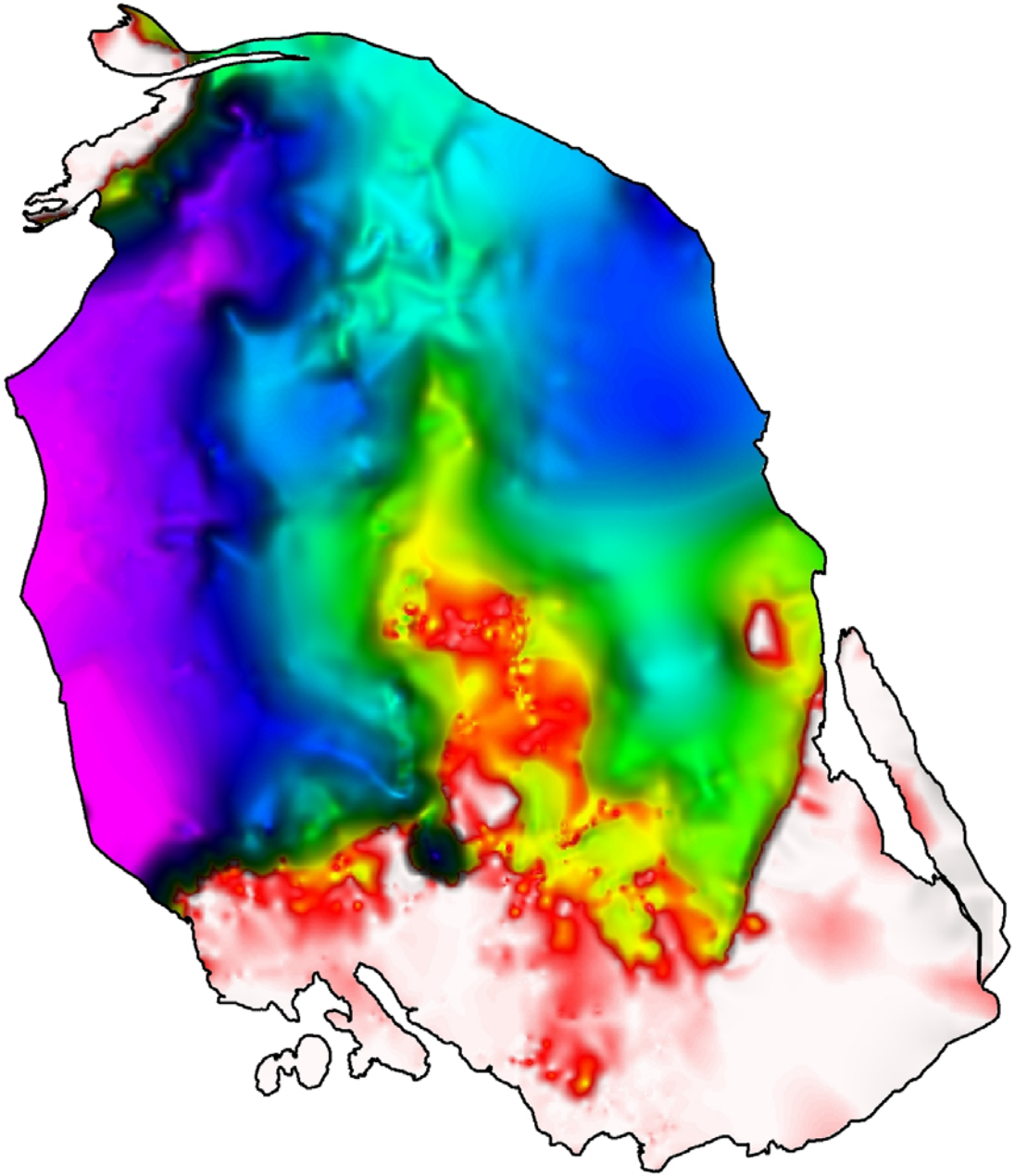
DOMAIN CHARACTERISTICS, CURNAMONA PROVINCE

	NW							*SE*
	Moolawatana Domain	Erudina Domain	Mudguard Domain	Quinyambie Domain	Olary Domain	Mulyungarie Domain	Broken Hill Domain	Redan Domain
Cover	largely exposed	Moorowie Sub-basin	Cainozoic, Mesozoic	Yalkalpo Sub-basin	patchy Quaternary	Quaternary Tertiary	patchy Quaternary	patchy Quaternary
Deformation	multiply deformed	unknown	flat-lying	unknown	multiply deformed	openly folded	multiply deformed	multiply deformed
Metamorphism	upper amphibolite	unknown	unmeta-morphosed	unknown	greenschist to upper amphibolite	greenschist	lower amphibolite to granulite	granulite
Stratigraphy	Early Mesoproterozoic metasediments; hot granites, felsic volcanics	unknown; presumed Willyama Supergroup and intrusives	Mesoproterozoic volcanic sheet unconformably overlies folded Willyama Supergroup	unknown; presumed Willyama Supergroup and intrusives	less complete Willyama S.G. locally developed Broken Hill Group Thackaringa Group absent Curnamona Group well developed	different Willyama Supergroup lithostratigraphy from Olary and Broken Hill Domains	more complete Willyama S.G. best developed Broken Hill Group Thackaringa Group well developed Curnamona Group not known but may be present at depth	Redan Gneiss, oldest unit of Willyama Supergroup in NSW
Geophysics		deep-seated magnetic ?granites		deep-seated magnetic ?granites	variable TMI prominent magnetic (redox) boundary	prominent magnetic (redox) boundary	low TMI	high TMI
Mineralisation	Cu, U	unknown	anomalous Cu, Au	unknown	Cu, Au, U; anomalous Pb, Zn, Co, Mo	Cu, Au, Mo anomalous Zn (Pb); U in cover	Cu, Au, Supergiant Pb-Zn-Ag	Unknown



Stratigraphy of the Willyama Supergroup



Depth to basement of the Curnamona Province

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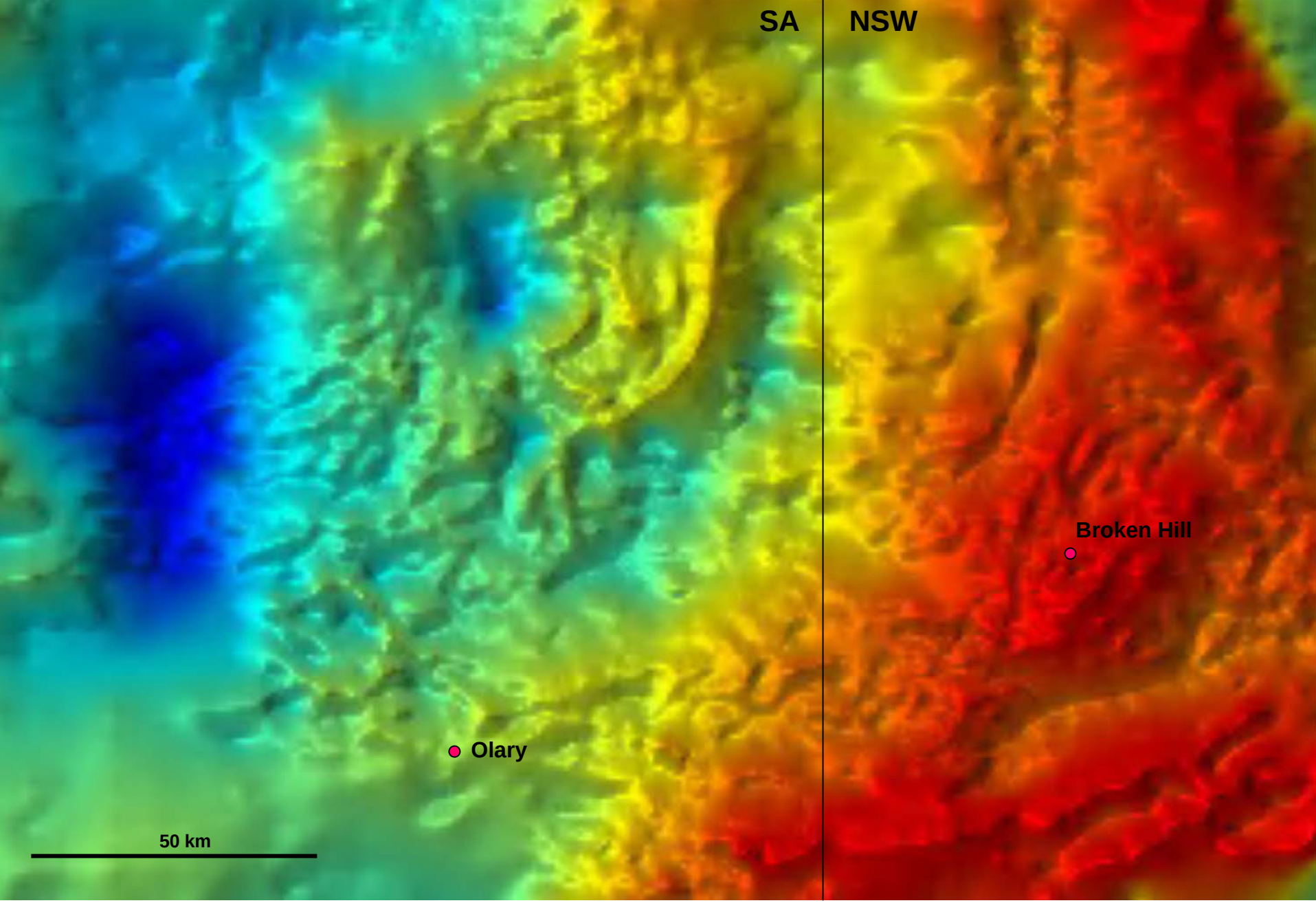
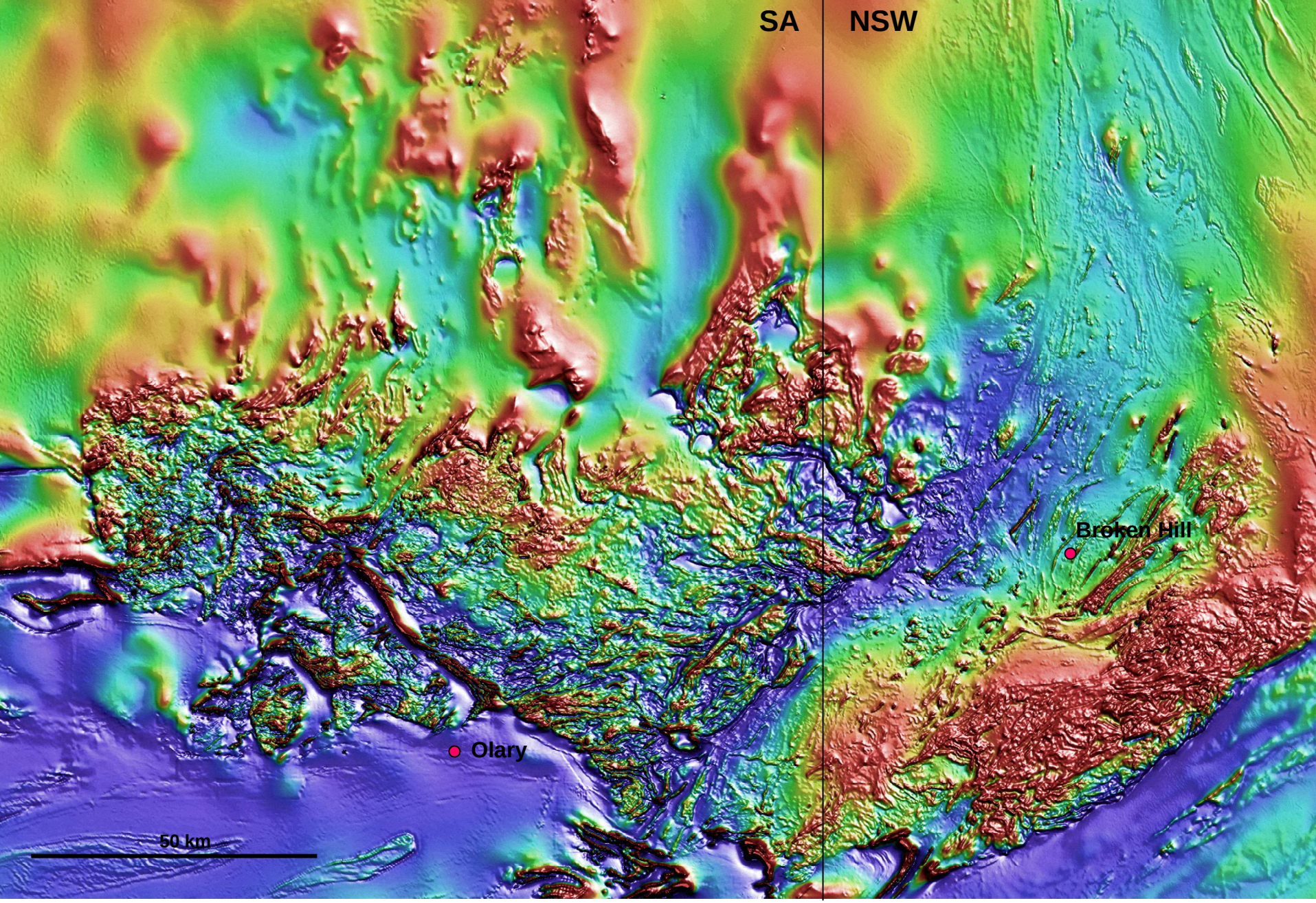
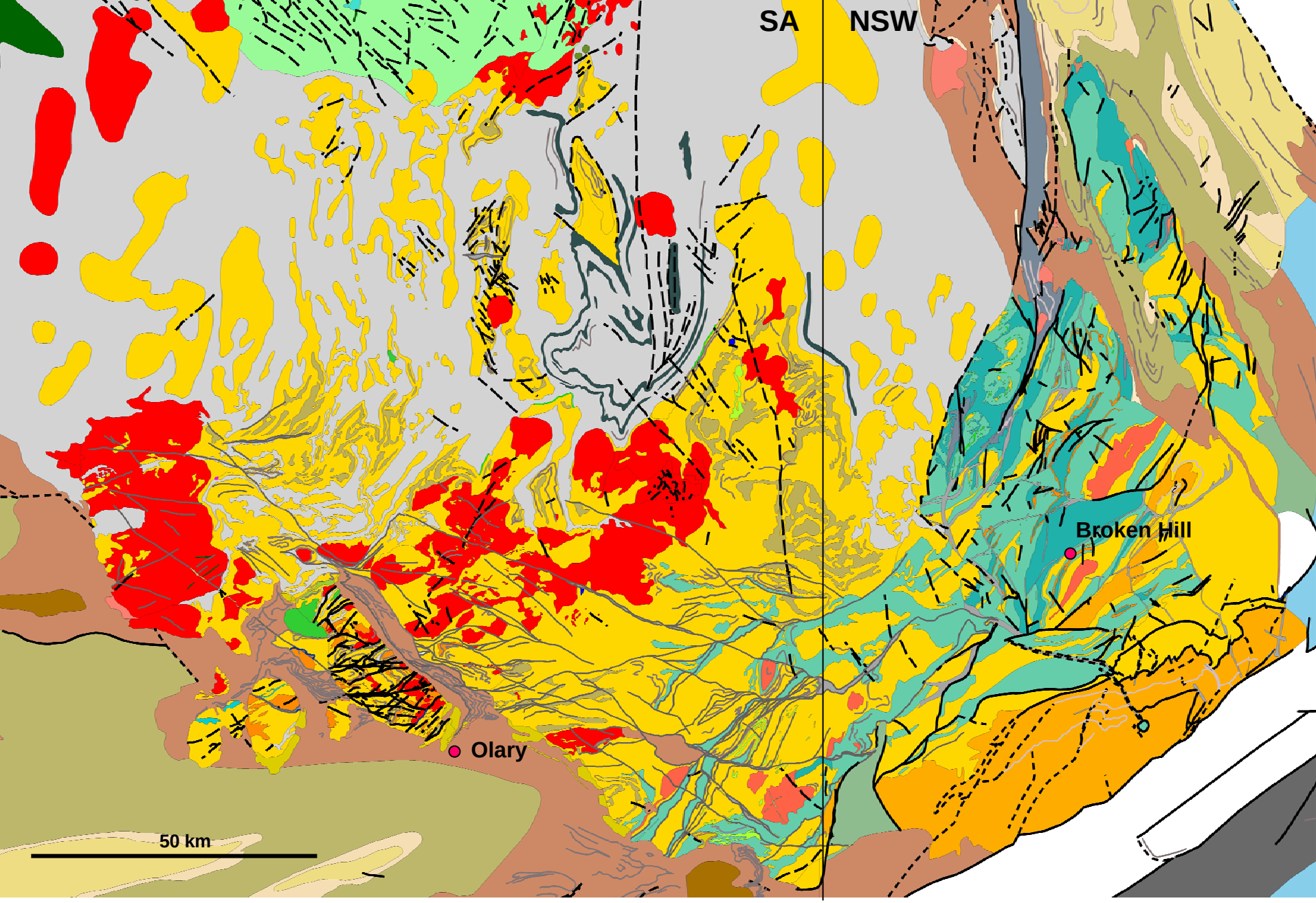
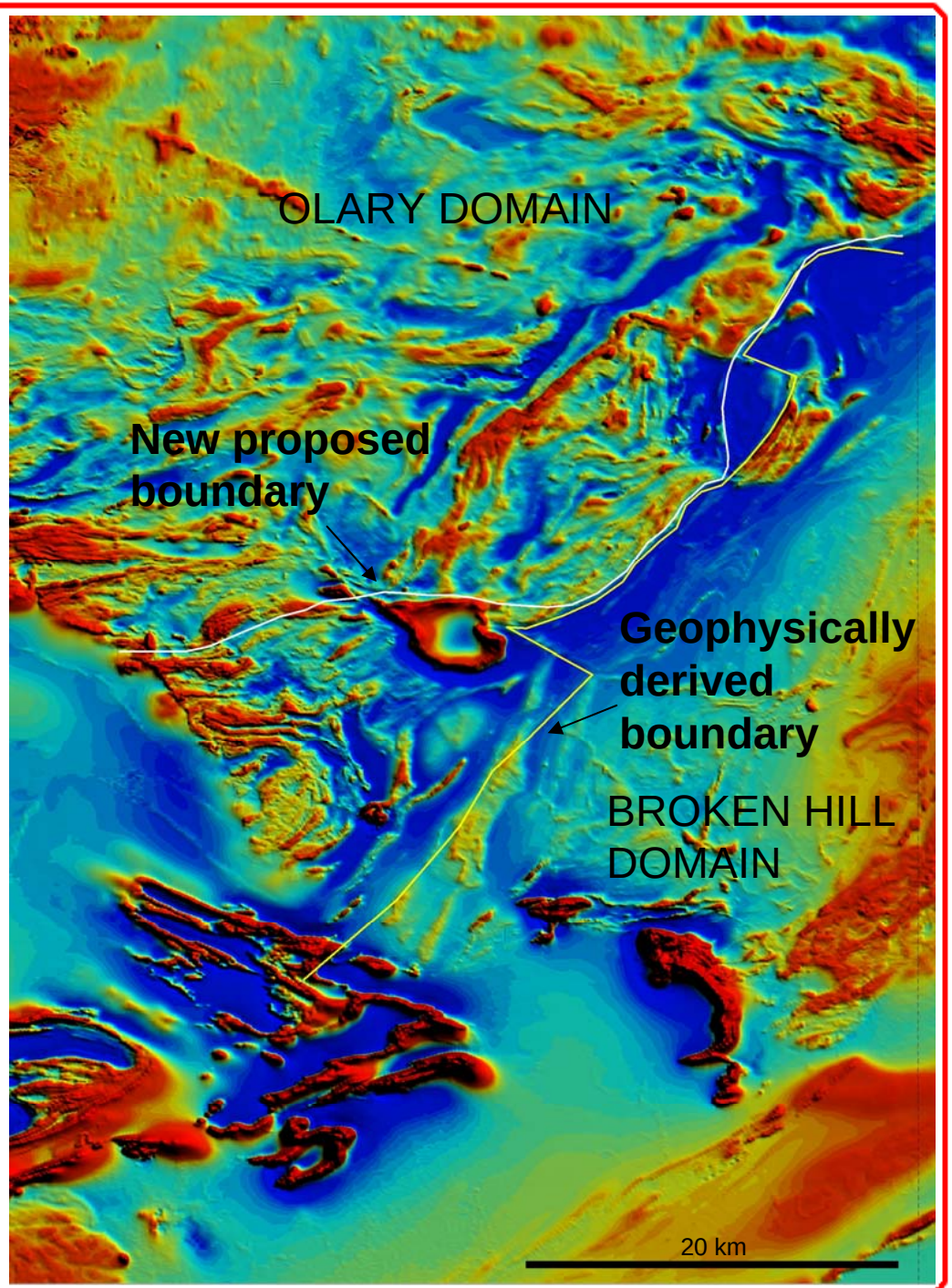

SA
NSW
Broken Hill
Olary
50 km

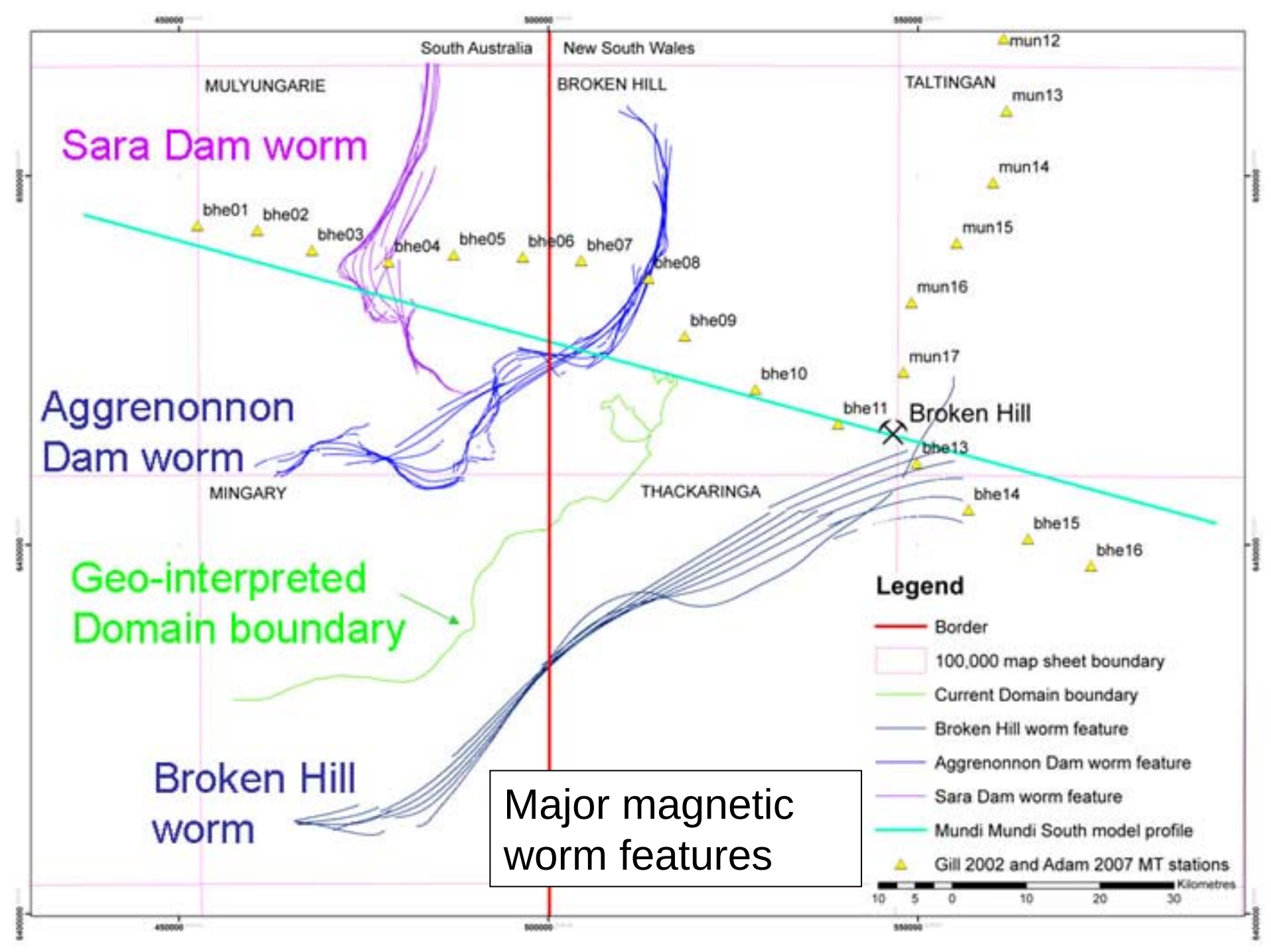

SA
NSW
Broken Hill
Olary
50 km


SA
NSW
Broken Hill
Olary
50 km
Curnamona Group
Thackaringa Group
Broken Hill Group
Sundown Group
Strathearn Group
Paragon Group
Ninnerie Supersuite

Olary – Broken Hill Domain Boundary

- **Prominent NE trending feature was recognised as boundary**
- **Detailed mapping discovered the lithologies used to define the domains are found on either side of the boundary**
- **SHRIMP geochronology has determined BH-type rocks are found in SA**




South Australia
New South Wales
MULYUNGARIE
BROKEN HILL
TALTINGAN
Sara Dam worm
Aggrenonnon Dam worm
Geo-interpreted Domain boundary
Broken Hill worm
Major magnetic worm features
MINGARY
THACKARINGA
Broken Hill
bhe01
bhe02
bhe03
bhe04
bhe05
bhe06
bhe07
bhe08
bhe09
bhe10
bhe11
bhe13
bhe14
bhe15
bhe16
mun12
mun13
mun14
mun15
mun16
mun17
Legend
Border
100,000 map sheet boundary
Current Domain boundary
Broken Hill worm feature
Aggrenonnon Dam worm feature
Sara Dam worm feature
Mundi Mundi South model profile
Gill 2002 and Adam 2007 MT stations
Kilometres
10 5 0 10 20 30

Magneto-telluric section & magnetic worms

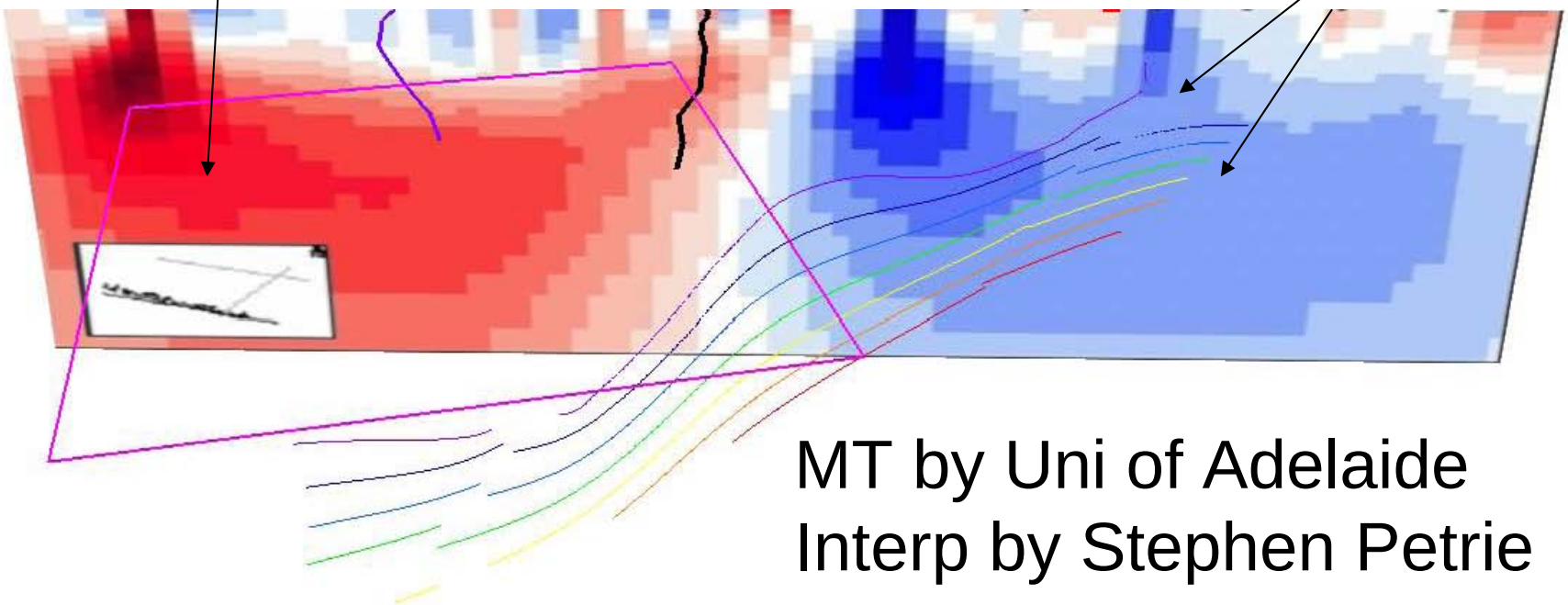
Olary Domain

Broken Hill Domain

? Curnamona Group

Aggrenonnon Dam mag-worm

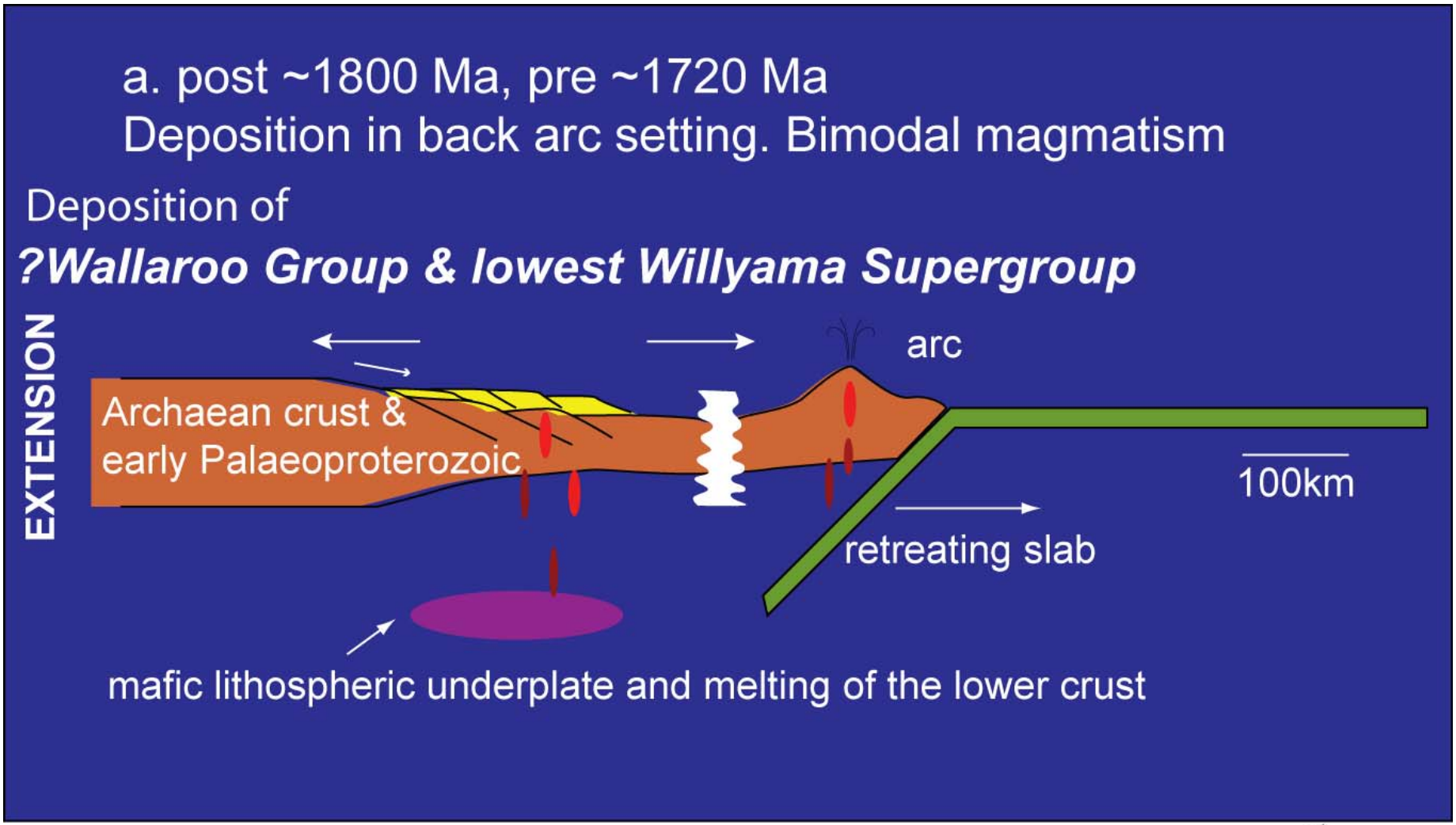
Broken Hill mag-worm



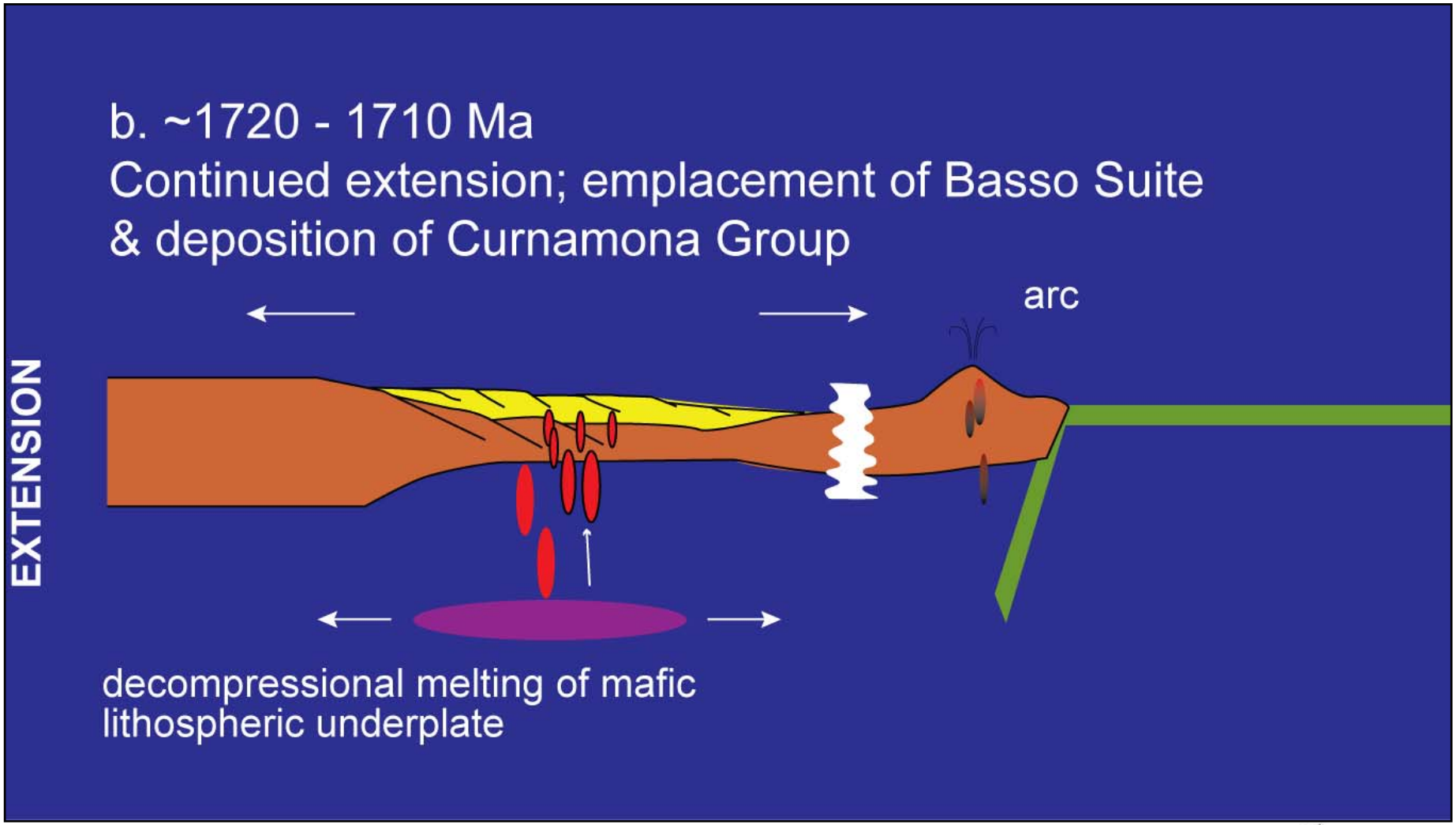
MT by Uni of Adelaide

Interp by Stephen Petrie

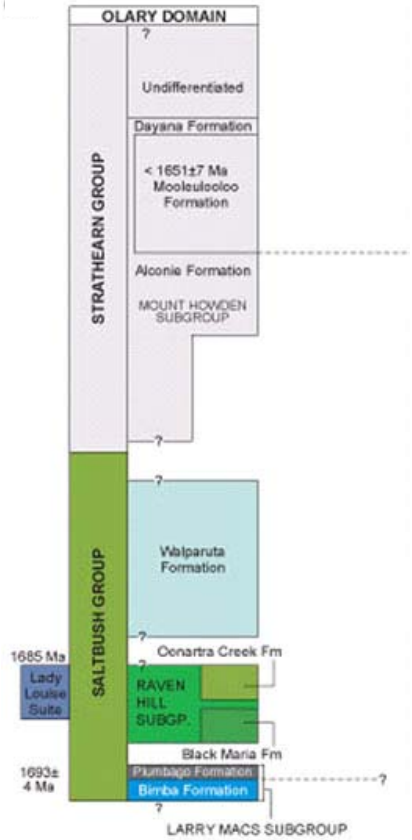
Tectonic evolution of the Willyama Supergroup Basin: Early crustal extension, pre ~1720 Ma



Early crustal extension
mafic and felsic magmatism, ~1720–1700 Ma

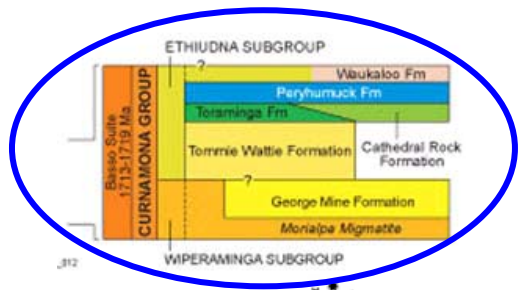


Early crustal extension mafic and felsic magmatism, 1720–1700 Ma



CURNAMONA GROUP (1720–1710 Ma)

- Wiperaminga and Ethiudna Subgroups
- Known from Olary Domain
- May be present beneath Mulyungarie Domain and ?Broken Hill Domain
- Oldest known rocks in Willyama Supergroup
- Syn-depositional bimodal magmatism

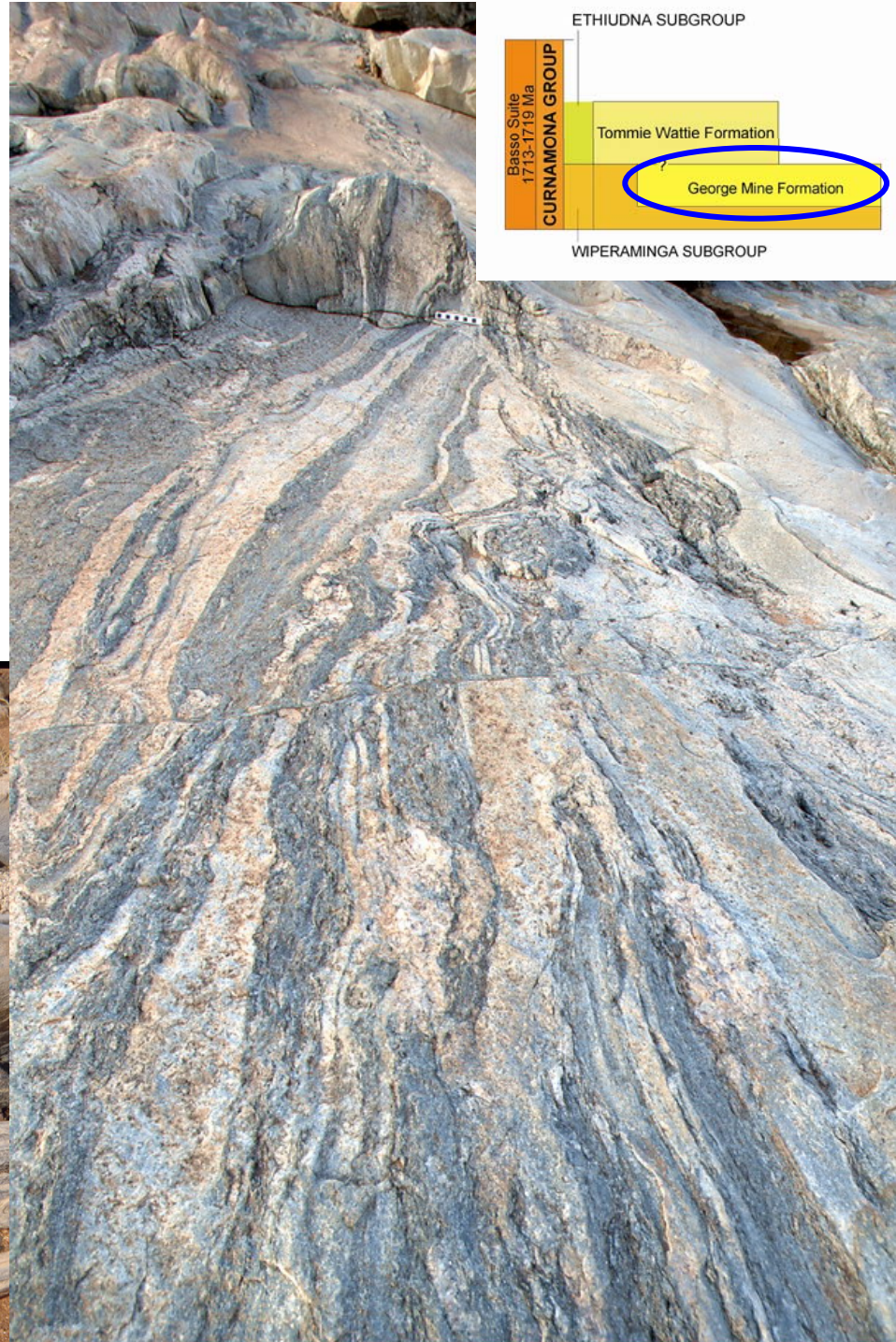


CURNAMONA GROUP

WIPERAMINGA SUBGROUP

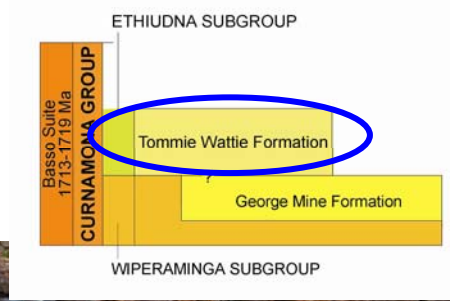
Variably albitised fine to medium-grained clastics deposited in rift basin

George Mine Formation
Interlayered psammopelite & albite-rich metasediments

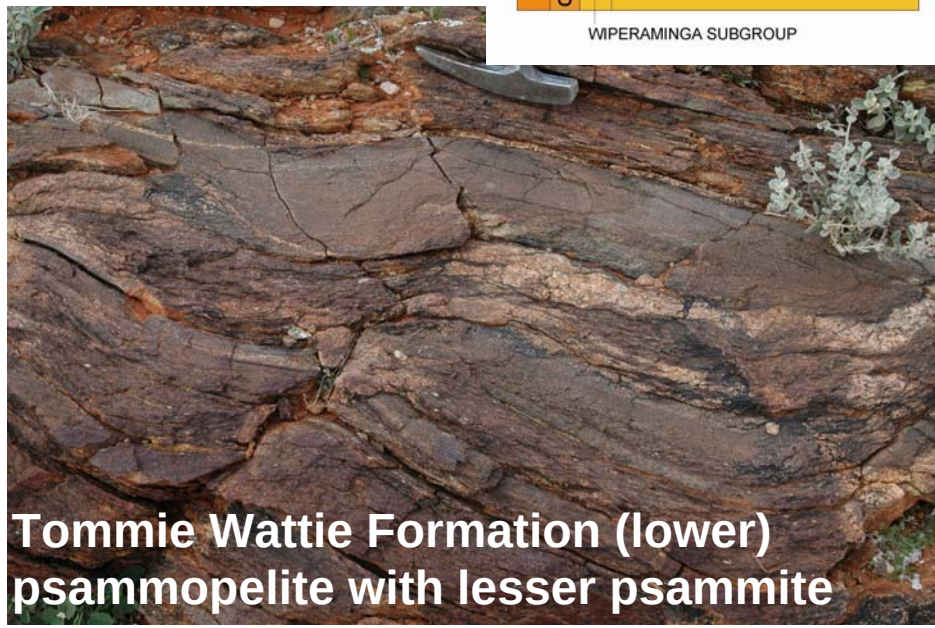


CURNAMONA GROUP

ETHIUDNA SUBGROUP



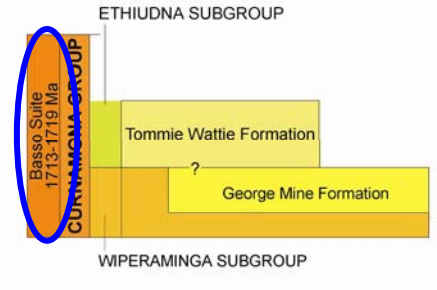
Tommie Wattie Formation
Psammopelite with lesser psammite, no albite.


Tommie Wattie Formation (lower)
psammopelite with lesser psammite

Tommie Wattie Formation (mid)
Psammite-rich, preserving sedimentary structures


Tommie Wattie Formation (upper)
Highly aluminous andalusite pelite

Felsic and mafic magmatism, ~1720–1700 Ma



BASSO SUITE

- Known only in Olary Domain
- A-type (locally I-, S-types) felsic
- Abminga Subsuite : rhyolite lavas, volcani-clastics, sub-volcanic intrusives
- Ameroo Subsuite: high-level granite

MONTSTEPHEN METABASALT

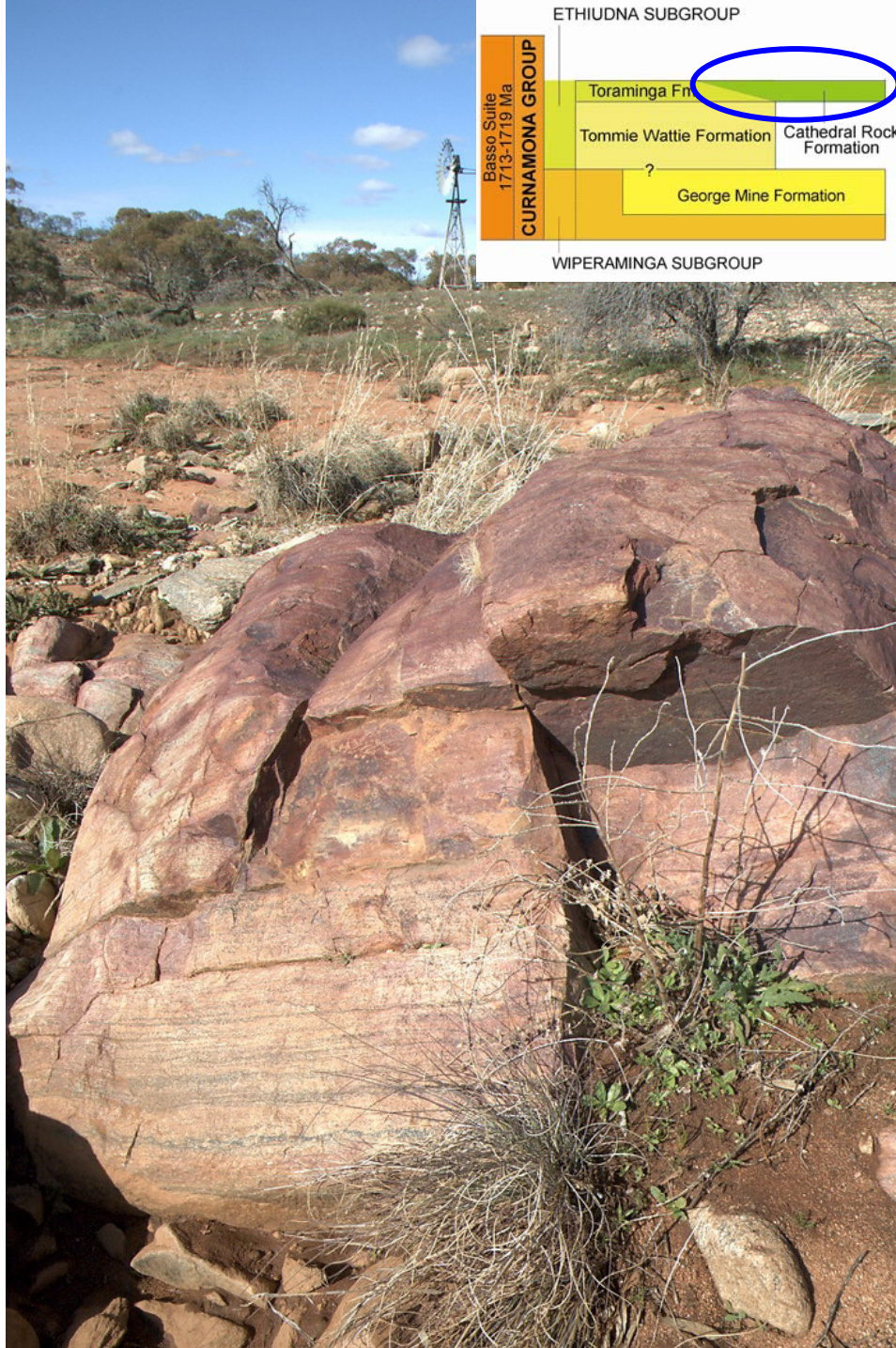
- Local mafic volcanism in the Olary Domain
- Pillow basalts
- Intercalated at the base of Ethiudna Subgroup

CURNAMONA GROUP

ETHIDUNA SUBGROUP

Fine to medium-grained shallow-water clastics, minor carbonates; possible evaporites

Cathedral Rock Formation
volcaniclastic basal unit

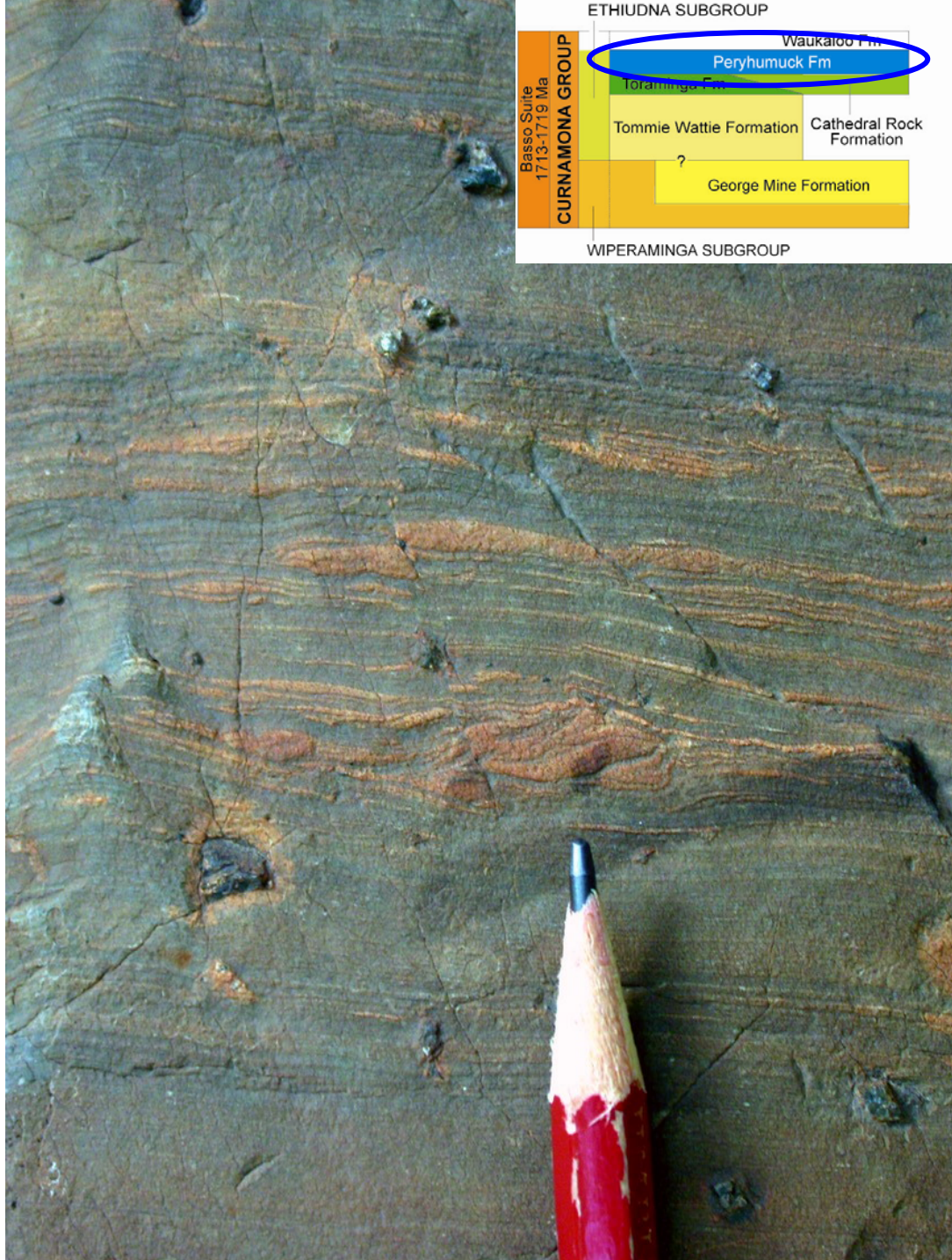


CURNAMONA GROUP

ETHIDUNA SUBGROUP

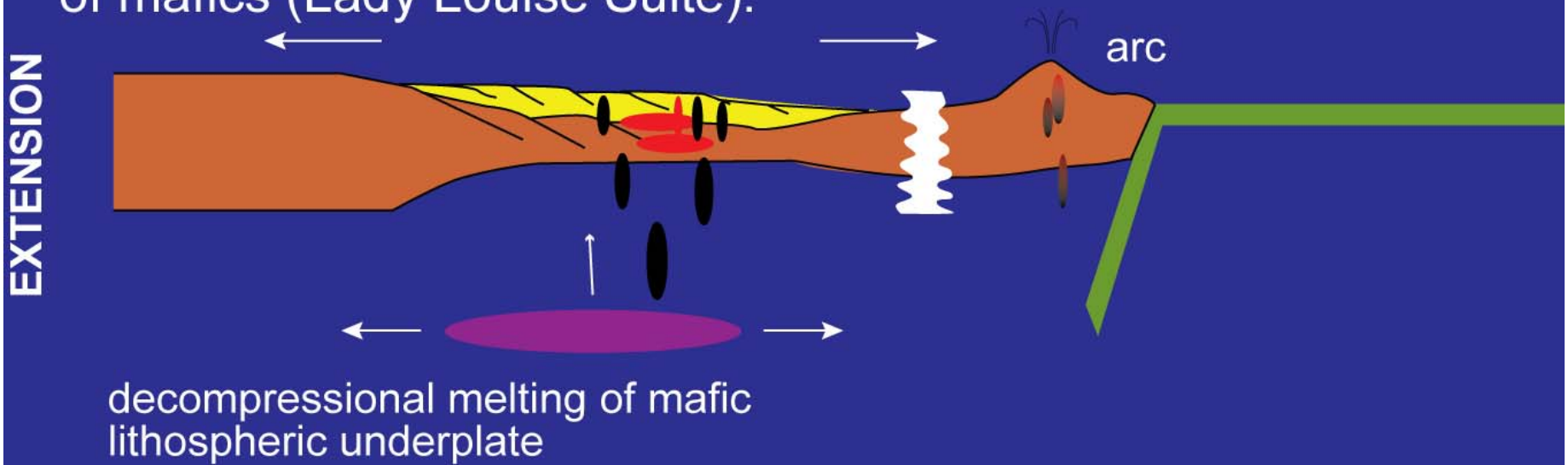
Peryhumuck Formation
Calc-albititic
Ripples, cross beds, fine-grained sandy-silty composition

shallow water – evaporitic



Early crustal extension and magmatism, 1710–1685 Ma

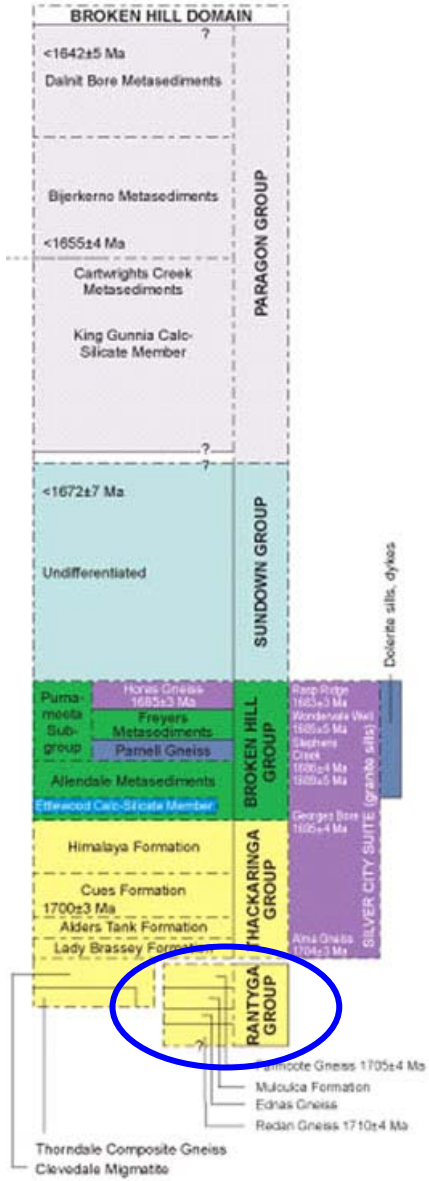
c. ~1710 - 1685 Ma
Focus of activity moves eastward.
Deposition of Rantyga, Thackaringa, Broken Hill Groups. Pb-Zn
Melting of crust & ?lower Willyama (Silver City Suite), Intrusion of mafics (Lady Louise Suite).



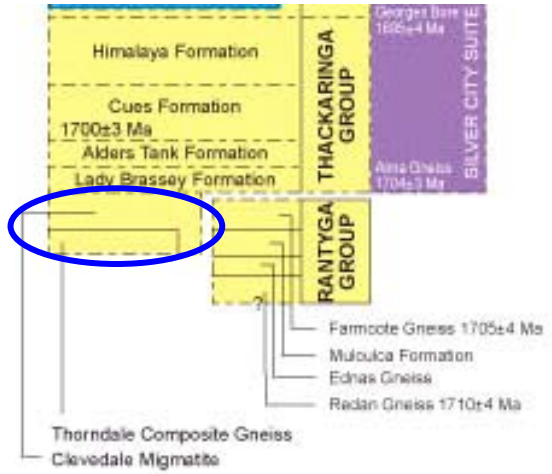
Early crustal extension, Broken Hill Domain, 1710–1700 Ma

- **RANTYGA GROUP (1710–1705 Ma)**

- Known from Redan Domain
- May overlap age of Ethiudna Subgroup in Olary Domain
- Oldest known rocks in Broken Hill Inlier
- Albite-quartz-magnetite ± amphibole



Early crustal extension, Broken Hill Domain, 1710–1700 Ma



THORNDALE COMPOSITE GNEISS, CLEVEDALE MIGMATITE (~1705 Ma)

- Known only from Broken Hill Domain
- Partially melted clastic metasediments ± albite

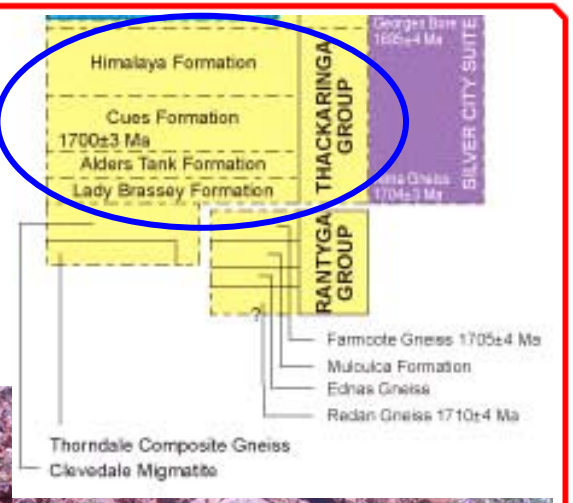
- **Thorndale Composite Gneiss**: was a relatively thinly bedded sandy sediment deposited in a shallow marine environment

- **Clevedale Migmatite**: distinguished by thin layers or laminae of albitised metasediment deposited in a hypersaline environment

Early crustal extension, Broken Hill Domain, 1710–1700 Ma

THACKARINGA GROUP (~1705–1700 Ma)

- Known only from Broken Hill Domain
- Possible equivalent in Mulyungarie Domain (Portia Formation)
- Absent in Olary Domain
- Thick albitised psammitic metasediment



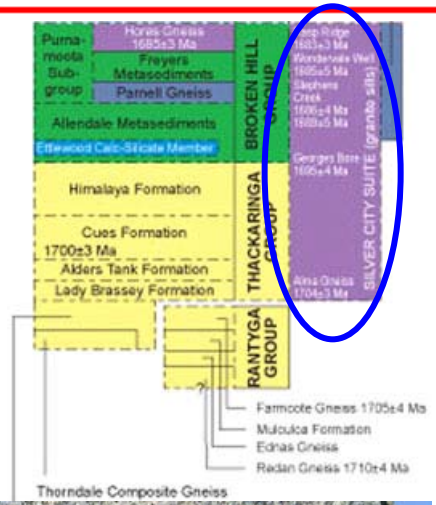

Thackaringa Group

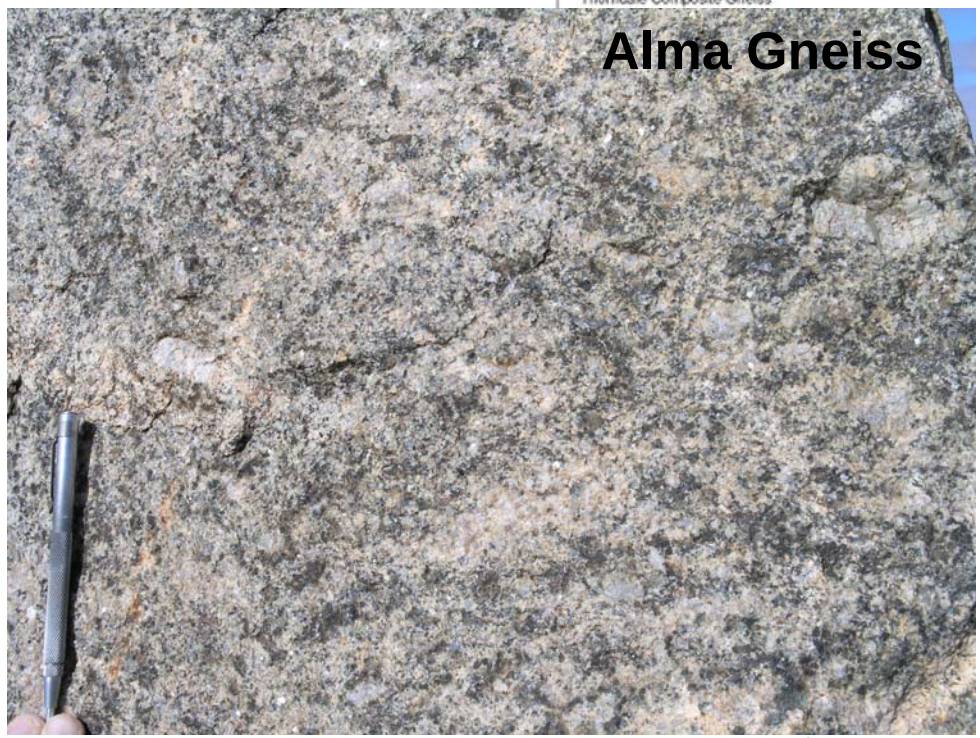

Himalaya Formation

Felsic S-type magmatism, Broken Hill Domain, 1700–1680 Ma

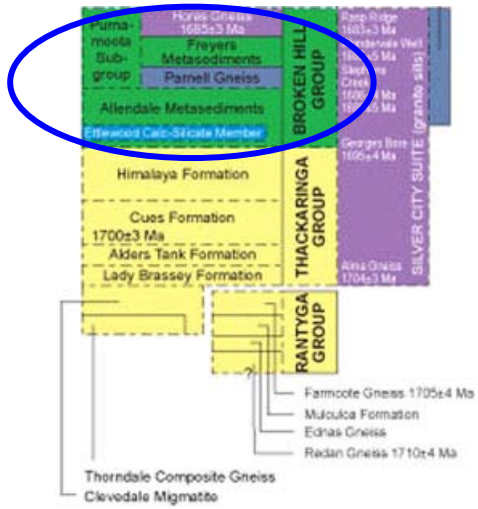
SILVER CITY SUITE

- **1704–1683 Ma**
- **Intruded as concordant sheets during sedimentation**
- **Quartz-feldspar-biotite ± garnet gneiss**
- **High level**
- **Derived from melting older sediments at depth (e.g. Curnamona Group)**





Upper rift packages, ~1700–1670 Ma



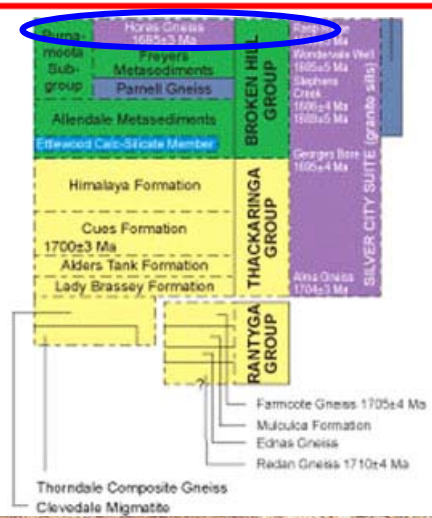
BROKEN HILL GROUP

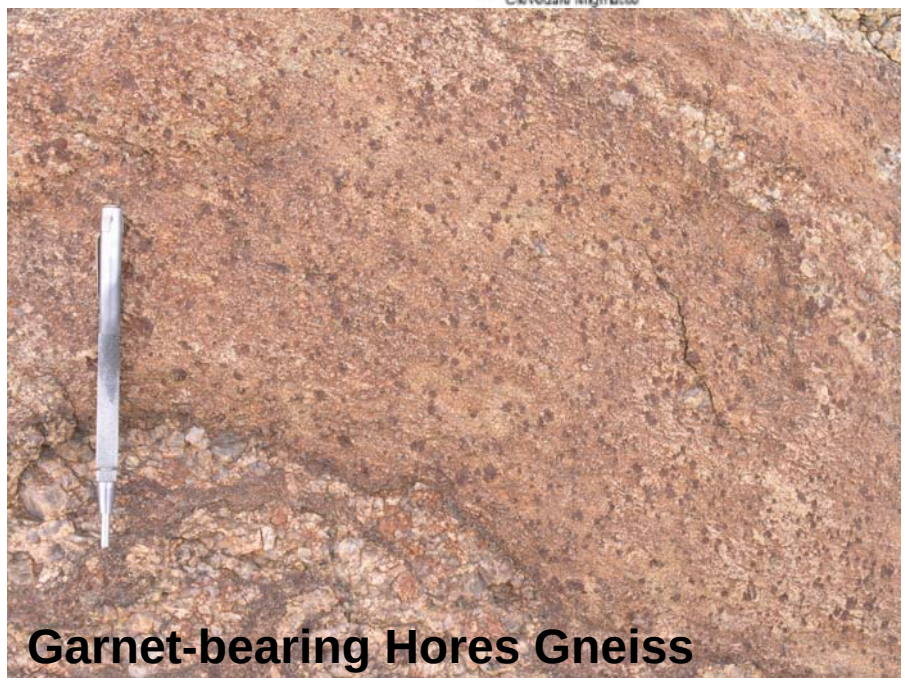
- Known mainly from Broken Hill Domain
- Raven Hill Subgroup (Saltbush Group) may be equivalent in Olary Domain
- Mainly fine to medium-grained clastics; exhalatives; chemical sediments
- Distinctive Potosi-type gneiss at two levels
- Calc-silicate and thin volcaniclastic siltstone marker units (~1693 Ma) in Olary and Broken Hill Domains

BROKEN HILL GROUP

POTOSI-TYPE GNEISS

- Medium-grained quartz-plagioclase-K-feldspar-biotite-garnet gneiss
  - **Hores Gneiss (~1685 Ma)**
  - Volcaniclastic
  - Known only from Broken Hill Domain
  - Broken Hill Pb-Zn-Ag lodes

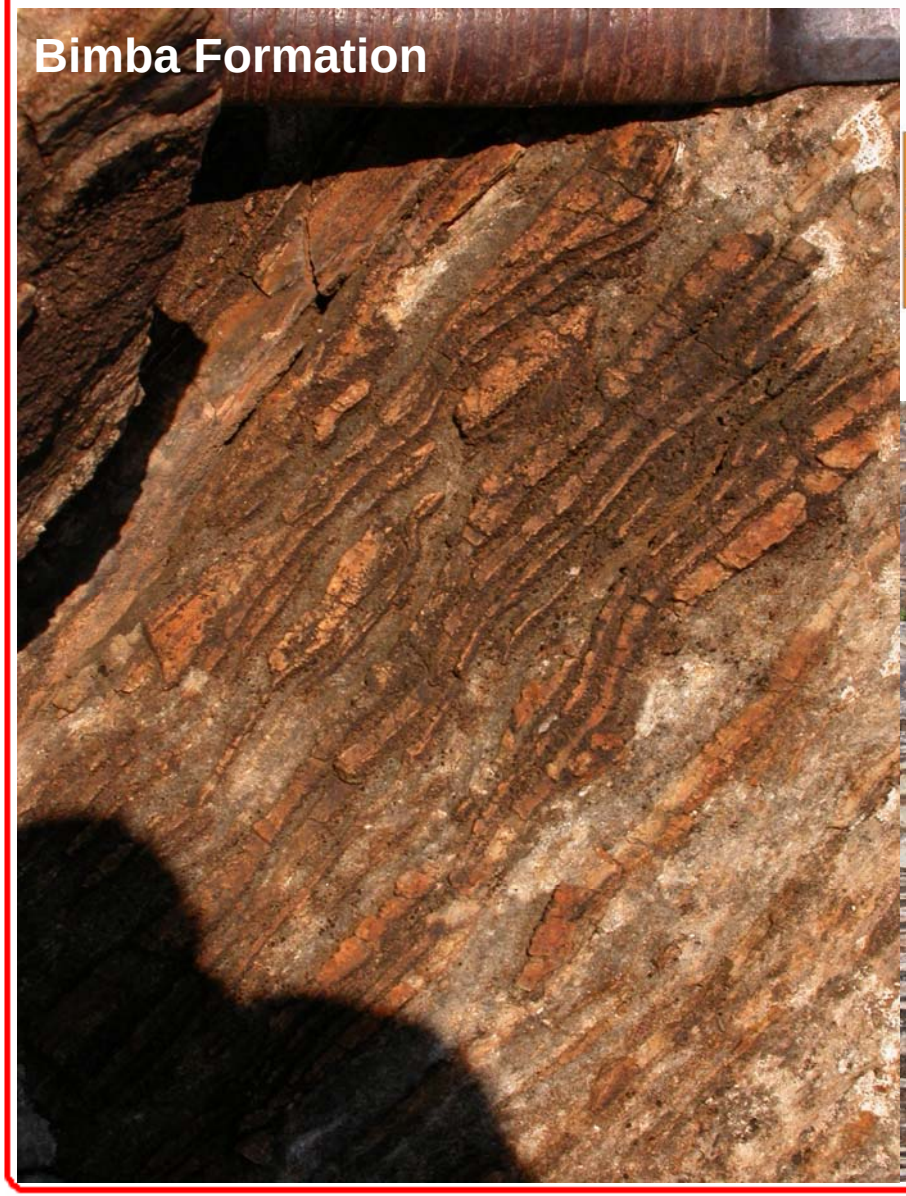


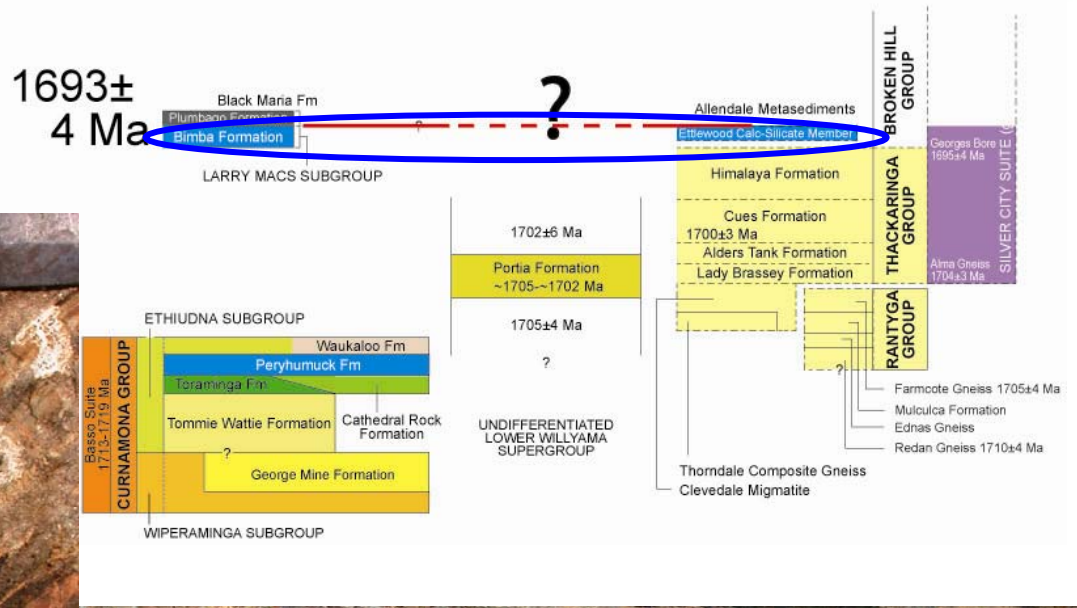


Garnet-bearing Hores Gneiss

Hores Gniess with rip-up clasts of unconsolidated metasediments

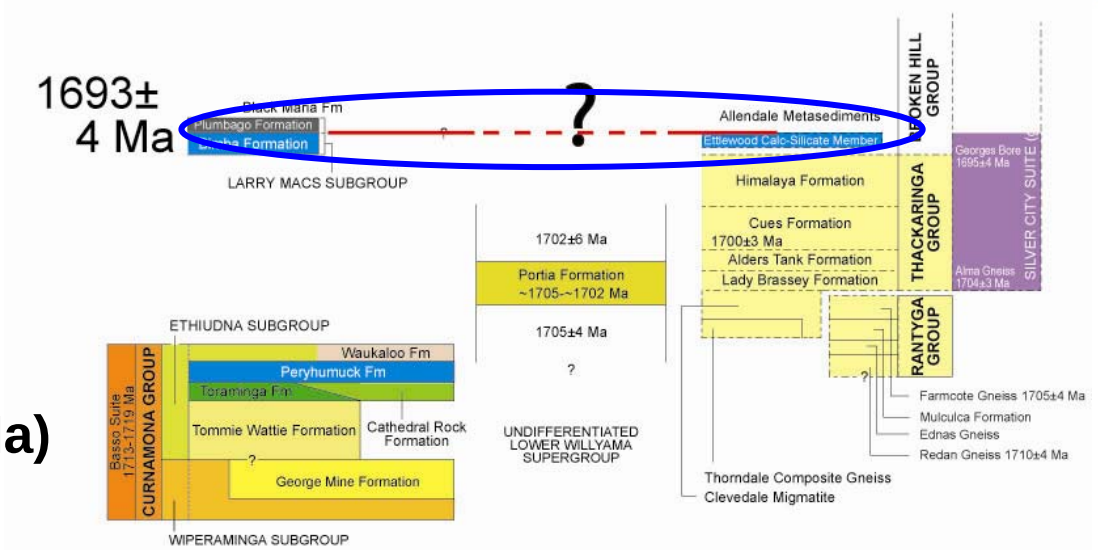
CALC SILICATE MARKER UNITS

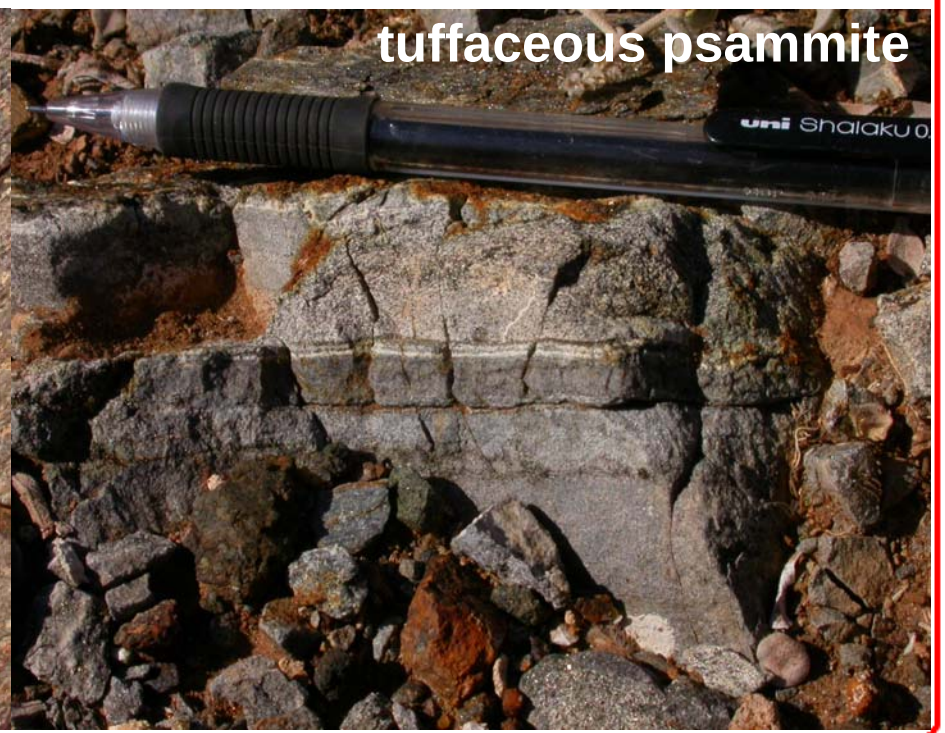




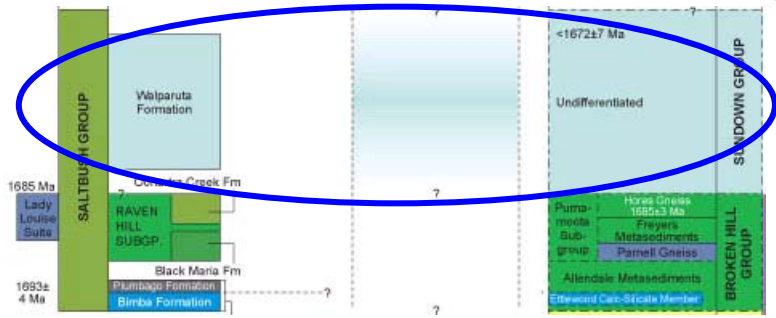
VOLCANICLASTIC MARKER UNIT

Plumbago Formation (1693 Ma)





Upper rift packages, ~1700–1670 Ma

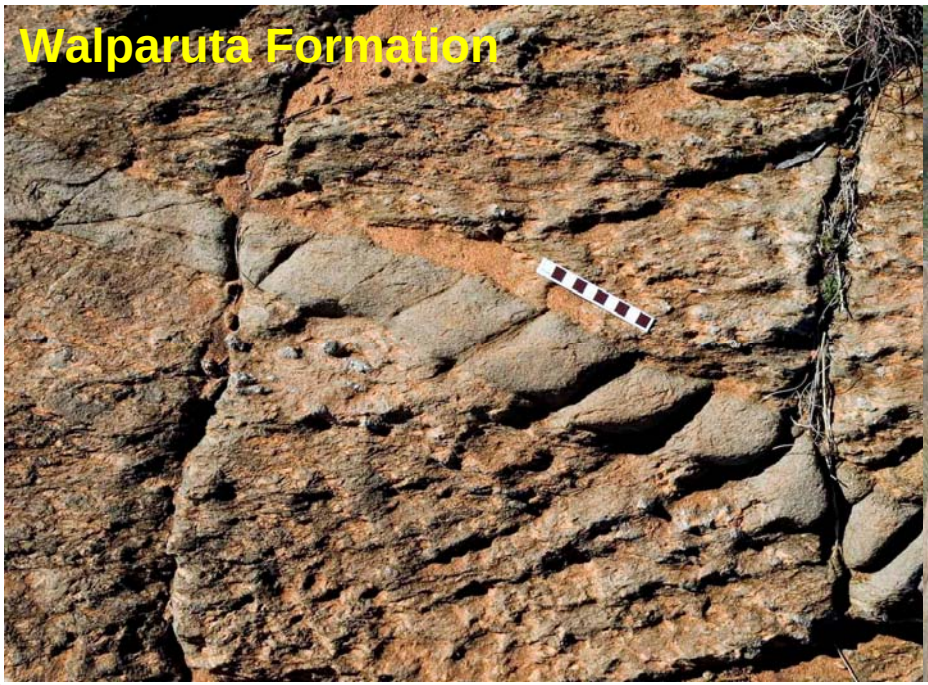


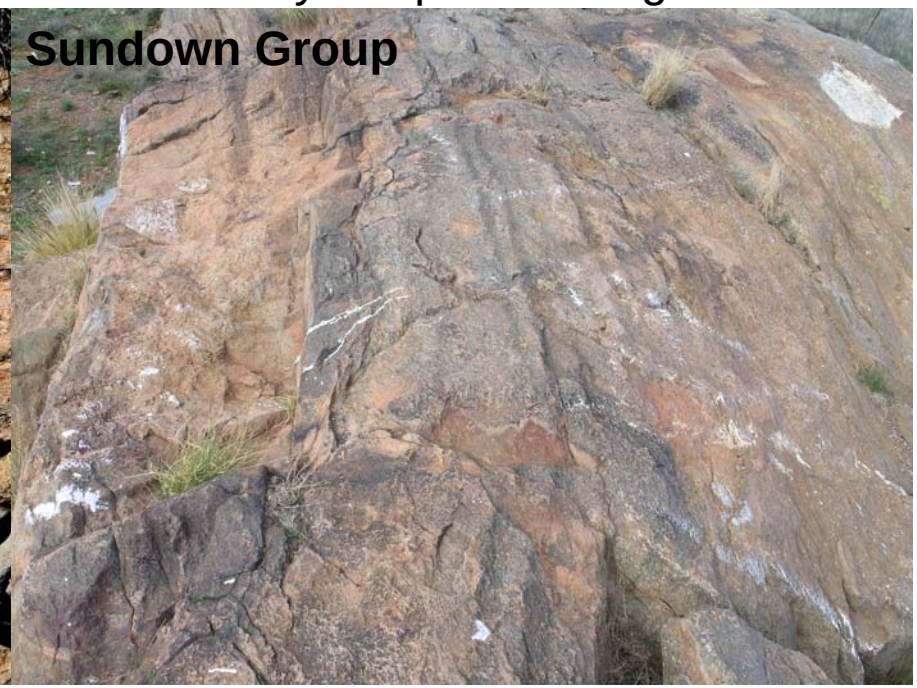
SALTBUSH GROUP

- Walparuta Formation stratigraphic equivalent of Sundown Group
- Restricted to synclinal cores in the Outalpa, Walpartua and Plumbago Inliers

SUNDOWN GROUP

- Known only from Broken Hill Domain
- Absent in Mulyungarie Domain and northern Olary Domain
- Siliclastic metaseds; distinguished by absence of syn-depositional igneous units

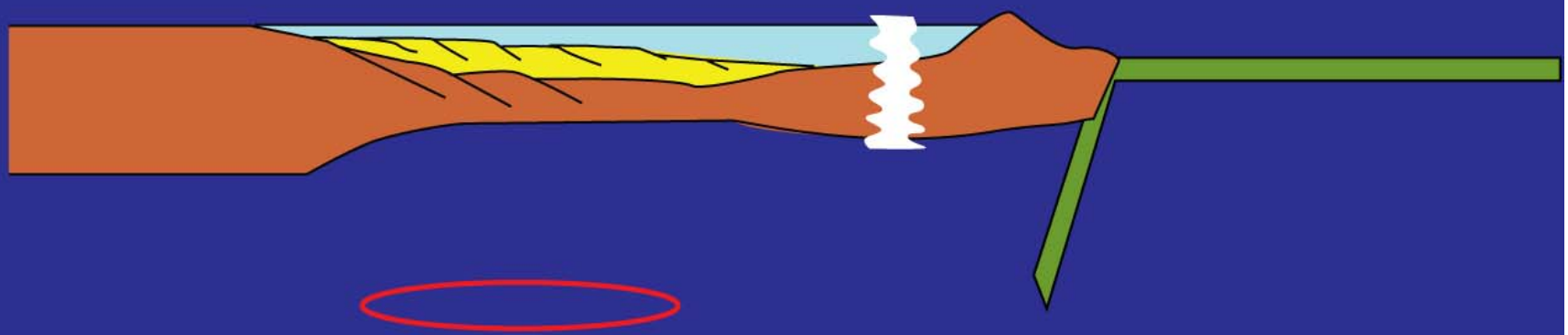




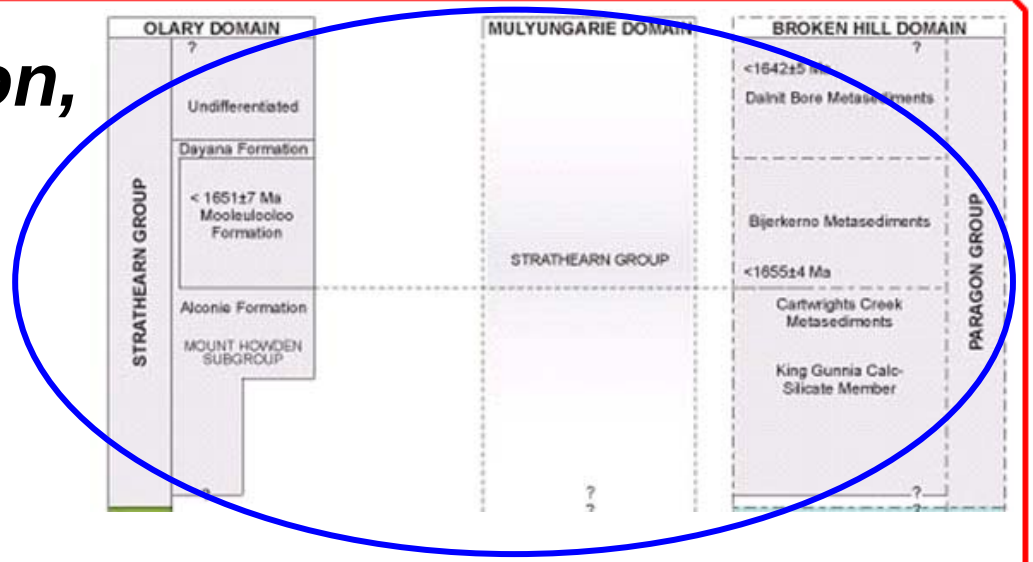
Sag-phase sedimentation, ~1660–1640 Ma

REDUCTION OF EXTENSION

d. ~1685 - 1640 Ma. Igneous activity ceases at start of Sundown Group, Strathearn-Paragon Groups deposited.



Sag-phase sedimentation, ~1660–1640 Ma

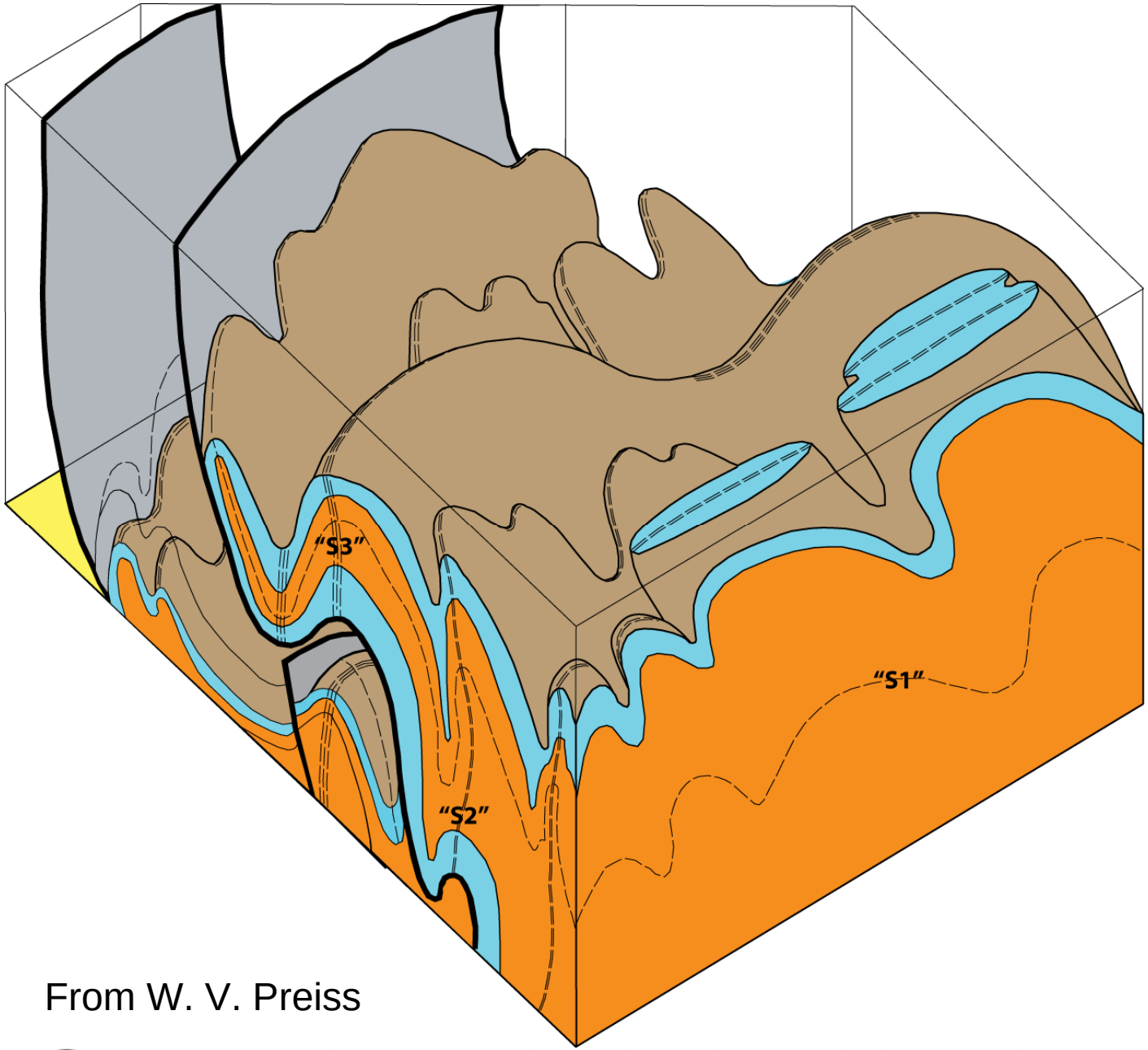


- **Pelite-dominated, graphitic sediments known from Broken Hill, Olary and Mulyungarie Domains (Paragon Group and Strathearn Group)**
- **Youngest known successions**
- **Change in sediment provenance to a more juvenile source, possibly from then adjacent Laurentia**
- **Infer a thick pelitic blanket over whole Curnamona Province**
- **Sedimentation may have continued to ~1620 Ma**

Tectonics of the Olarian Orogeny, ~?1620–1580 Ma

Many disparate interpretations, but some common themes:

- **Near ubiquitous layer-parallel foliation in southern Curnamona Province**
- **Evidence of very early heating**
- **Relatively early isoclinal recumbent folds involve already migmatised sediments**
- **Relatively later upright folds**
- **Granites (Ninnerie Supersuite) intrude late in structural sequence**
- **Retrograde shear zones cut late granites but truncated by Adelaidean unconformities**
- **Late upright folds, mostly E-W axes related to retrograde shear zones**



Complex Olarian refolded sheath folds formed by progressive and continuous deformation

From W. V. Preiss

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Tectonics of the Olarian Orogeny, ~?1620–1580 Ma

Exhumation history:

- **Metamorphic isograds only partly follow the dominant arcuate grain of Olarian folds**
- **Overall trend of Olarian metamorphic isograds is E-W**
- **Late Olarian retrograde shear zones dominated by E-W, ENE-WSW and WNW-ESE directions**
- **Higher-grade rocks preferentially exhumed in the south along these shears?**
- **Curnamona Province rocks re-buried by Neoproterozoic-Cambrian deposition, perhaps to deeper levels than at the end of Willyama deposition**

2 pyroxene granulite
Andalusite - Garnet
Andalusite - Sillimanite - Garnet
Sillimanite - Kfeldspar
Sillmanite - Muscovite

Tectonics of the Olarian Orogeny, ~?1620–1580 Ma

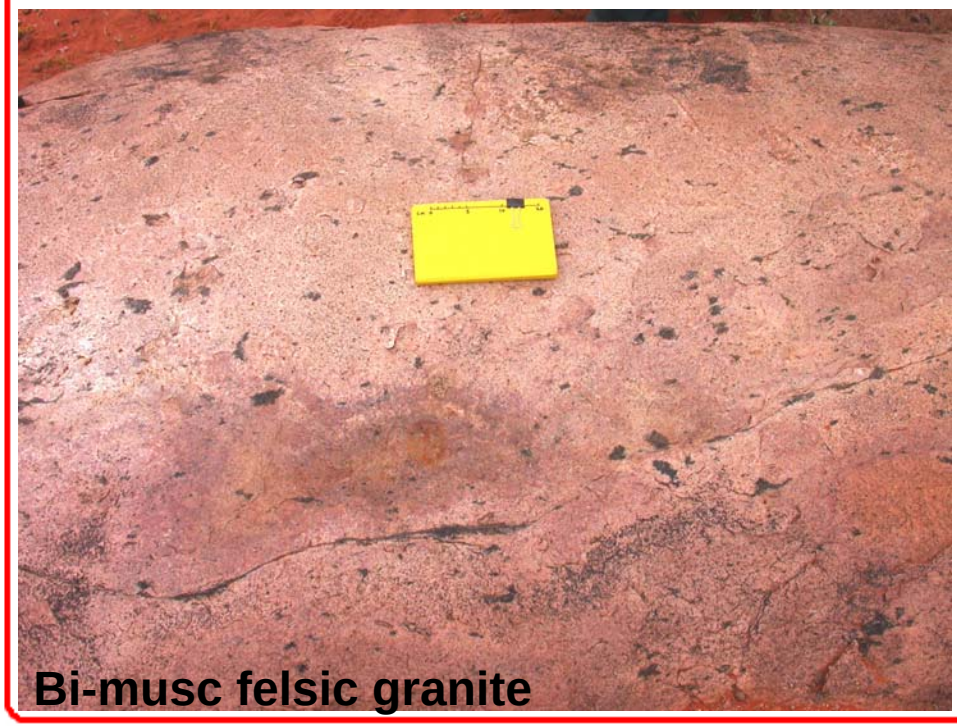
Preferred interpretation:

- **Early high-temperature metamorphism and migmatisation under an insulating pelitic blanket**
- **Early continuous and progressive ductile deformation in mid-crust by isoclinal, recumbent folding and thrusting, resulting in gradual crustal thickening**
- **Early folds with sheath morphology to explain diverse fold axis orientations and apparent vergences; overall tectonic transport to NW**
- **Later folds tend to be more upright but formed within the same overall stress regime**
- **Granites result from mid-crustal melting of sediments, perhaps induced by a regional deep crustal or mantle event ('Hiltaba Event') at 1590 Ma**
- **Granites may be incidental to Olarian Orogeny**

S-, I- and A-type Magmatism, Olary Domain, ~1580 Ma

NINNERIE SUPERSUITE

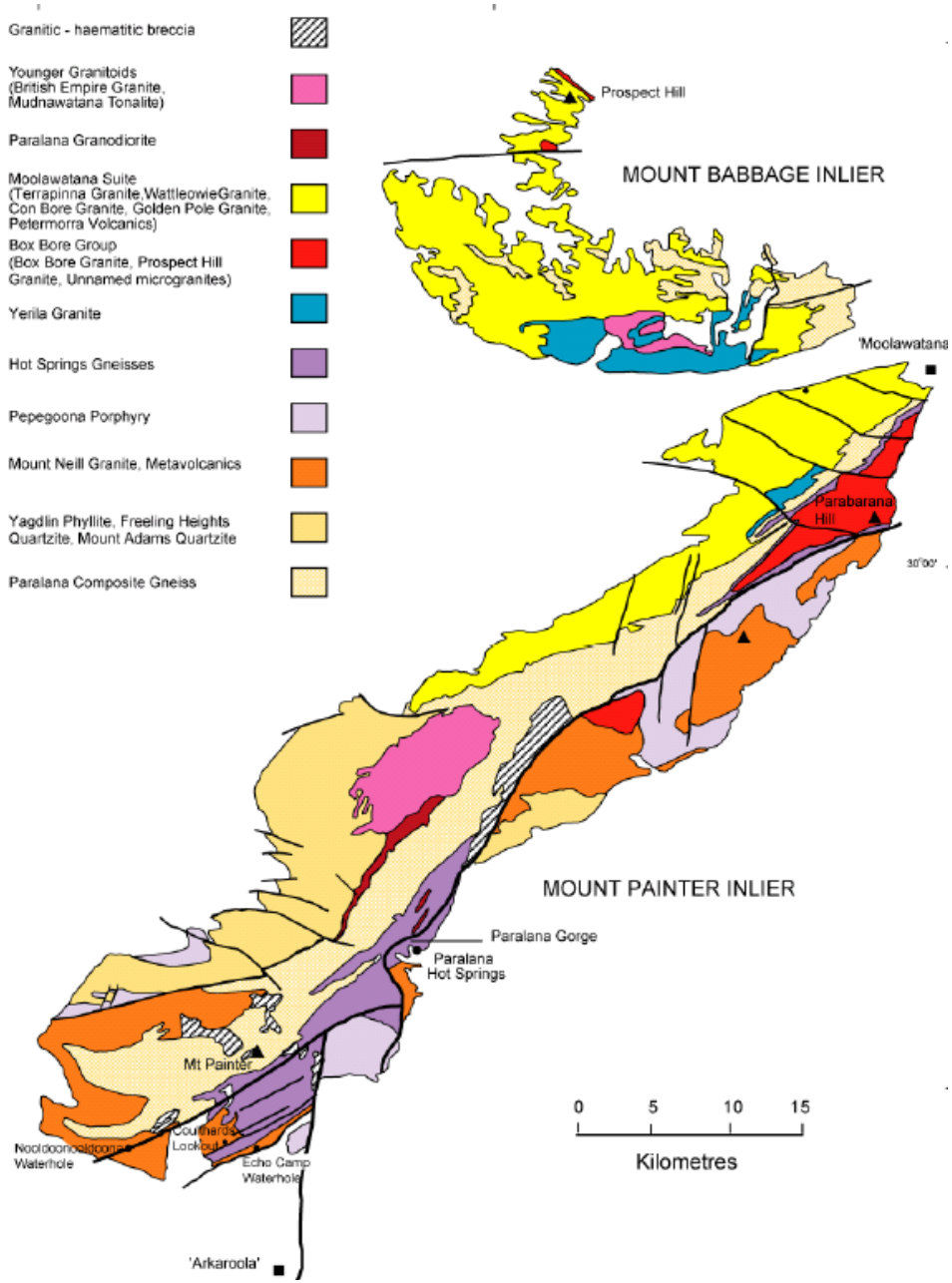
- Known in Olary, Mulyungarie and Mudguard Domains
- Equivalents in Broken Hill Domain (Mundi Mundi granites)
- Related to 1590 Ma Hiltaba-GRV event
- S-type magmas formed by partial melting of Willyama Supergroup
- More mafic I-type magmas derived from more juvelille, mantle source
- A-type volcanics different or mixed source from deep crust or mantle
- Such mantle-derived heating is consistent with concepts of a moving mantle hot-spot or plume



Bi-musc felsic granite

Mingled mafic and felsic granite

Mount Painter Province



- **Basal metasedimentary units deposited at/after 1590 Ma**
- **2 phases of felsic magmatism:**
  - **~1585–1575 Ma**
  - **~1565–1560 Ma**
- **~1550 Ma high-T metamoprhism and granodiorite magamtism**

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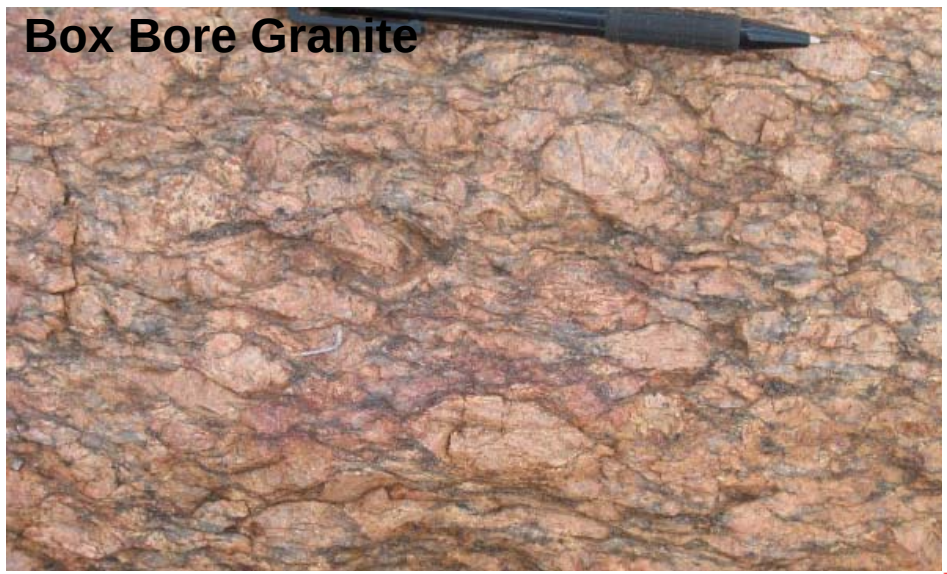
Magmatism, Mount Painter Province, ~1585–1575 Ma

Known only in southern Mt Painter Province

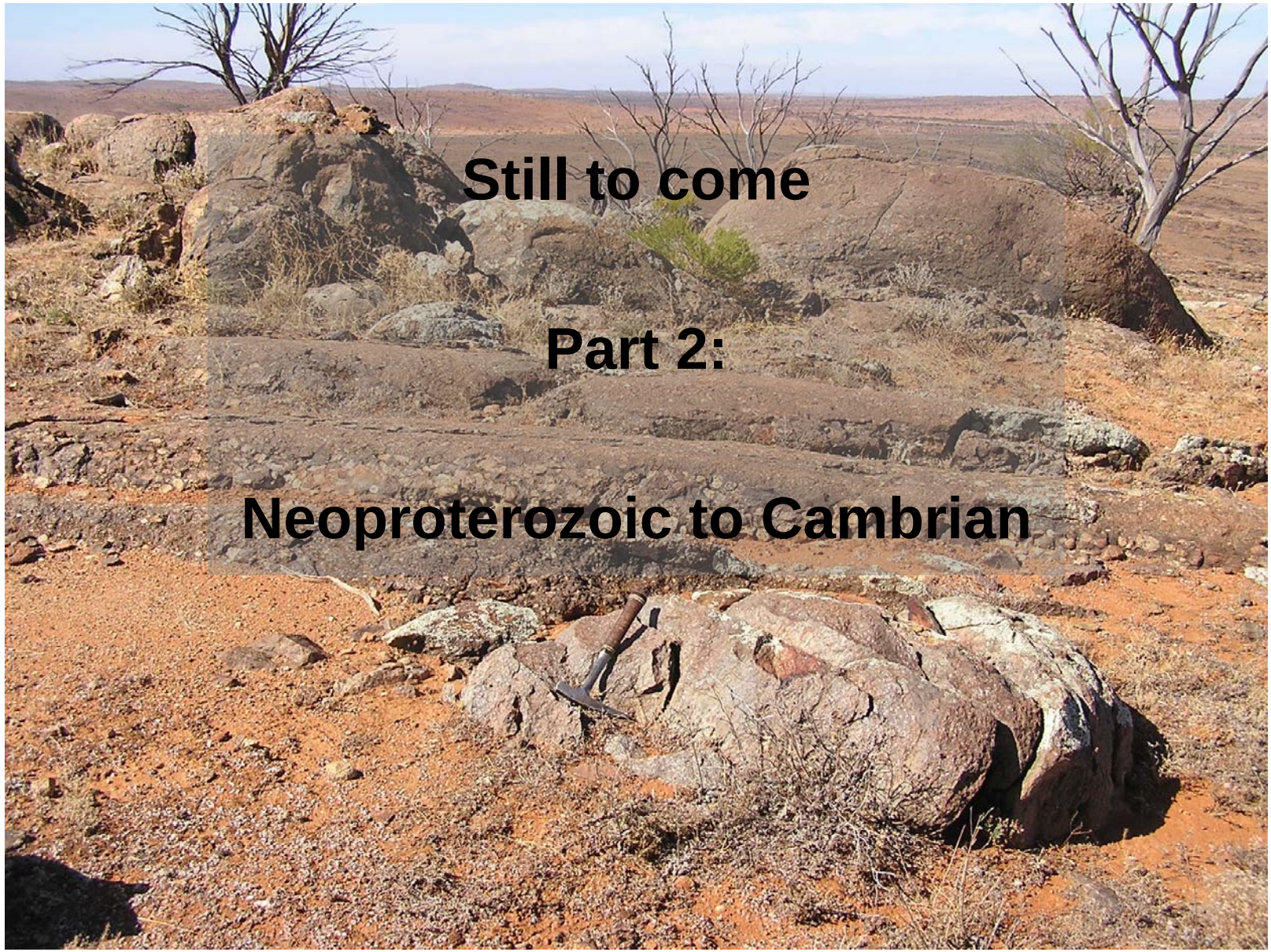
Mount Neill Granite, Pepegoona Porphyry, Box Bore Granite and gneisses from Paralana Hot Springs area



Magmatism, Mount Painter Province, ~1565–1555 Ma

Known only in northern Mount Painter Province

Followed by high-T metamorphism and granodiorite magmatism at ~1550 Ma


Still to come
Part 2:
Neoproterozoic to Cambrian