

EVOLUTION OF THE SOUTHERN THOMSON OROGEN (STO): Update of the ARC-Linkage Project

10/11/17

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Aim of Presentation

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- Characterise the Cobar basin and place it in tectonic setting
- Characterise the Louth region of the STO
- Characterise the Bourke region and determine the relation of the Warraweena volcanics to the Macquarie arc
- Characterise the Yancannia region south of Tibooburra

- Assess regional correlations of major stratigraphic units
- Present a regional structural evolution model

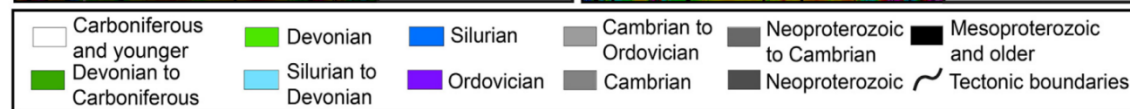
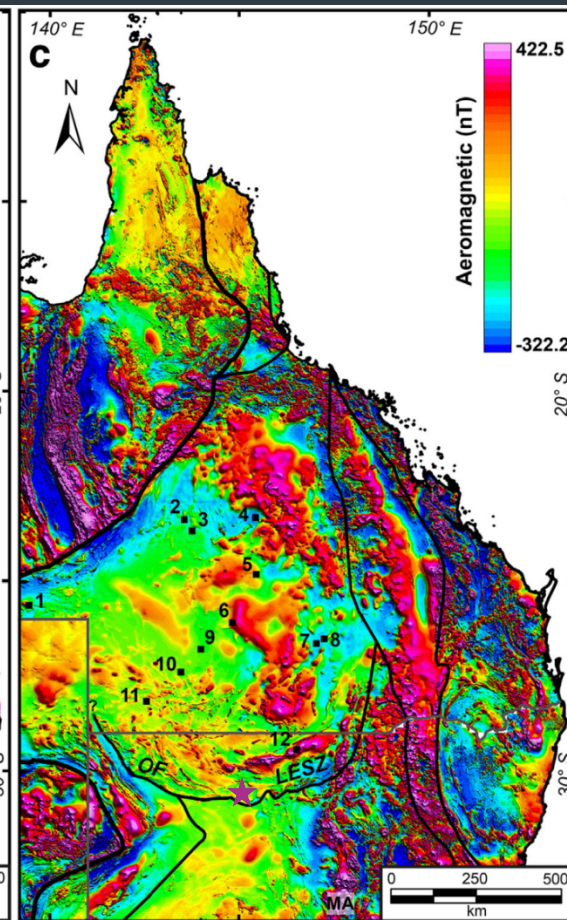
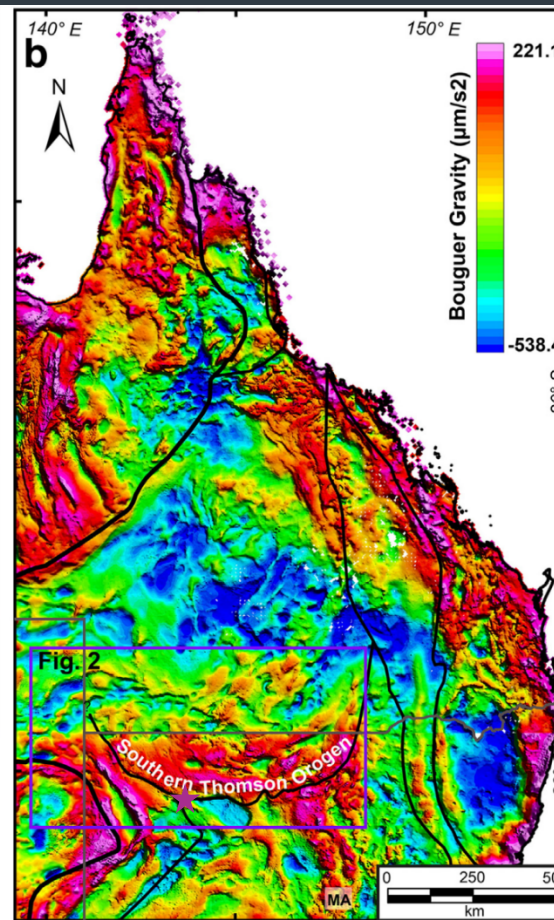
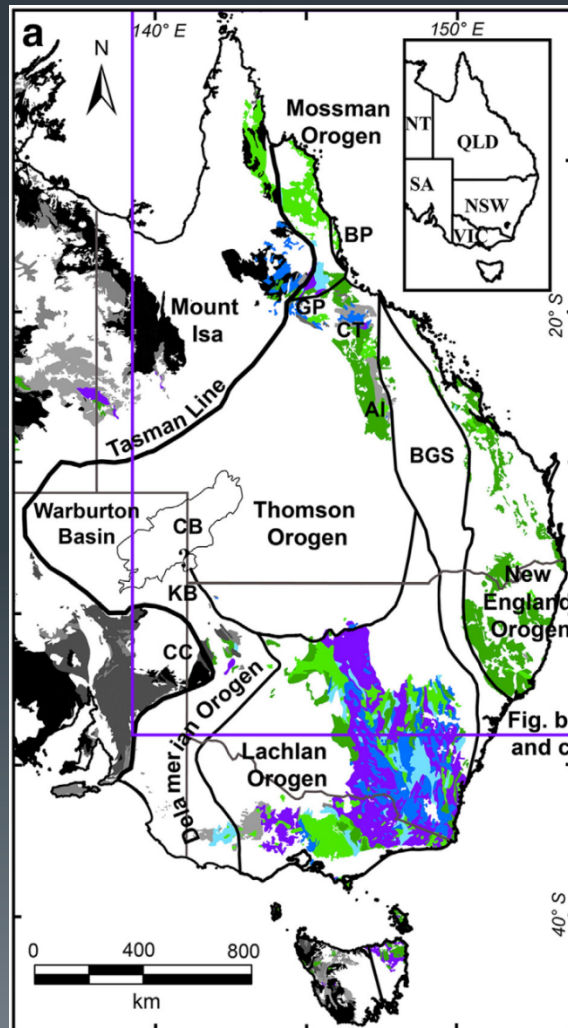
- Re-assess the links between the Delamerian, Lachlan and Thomson orogens

LOCATION of the Southern Thomson Orogen

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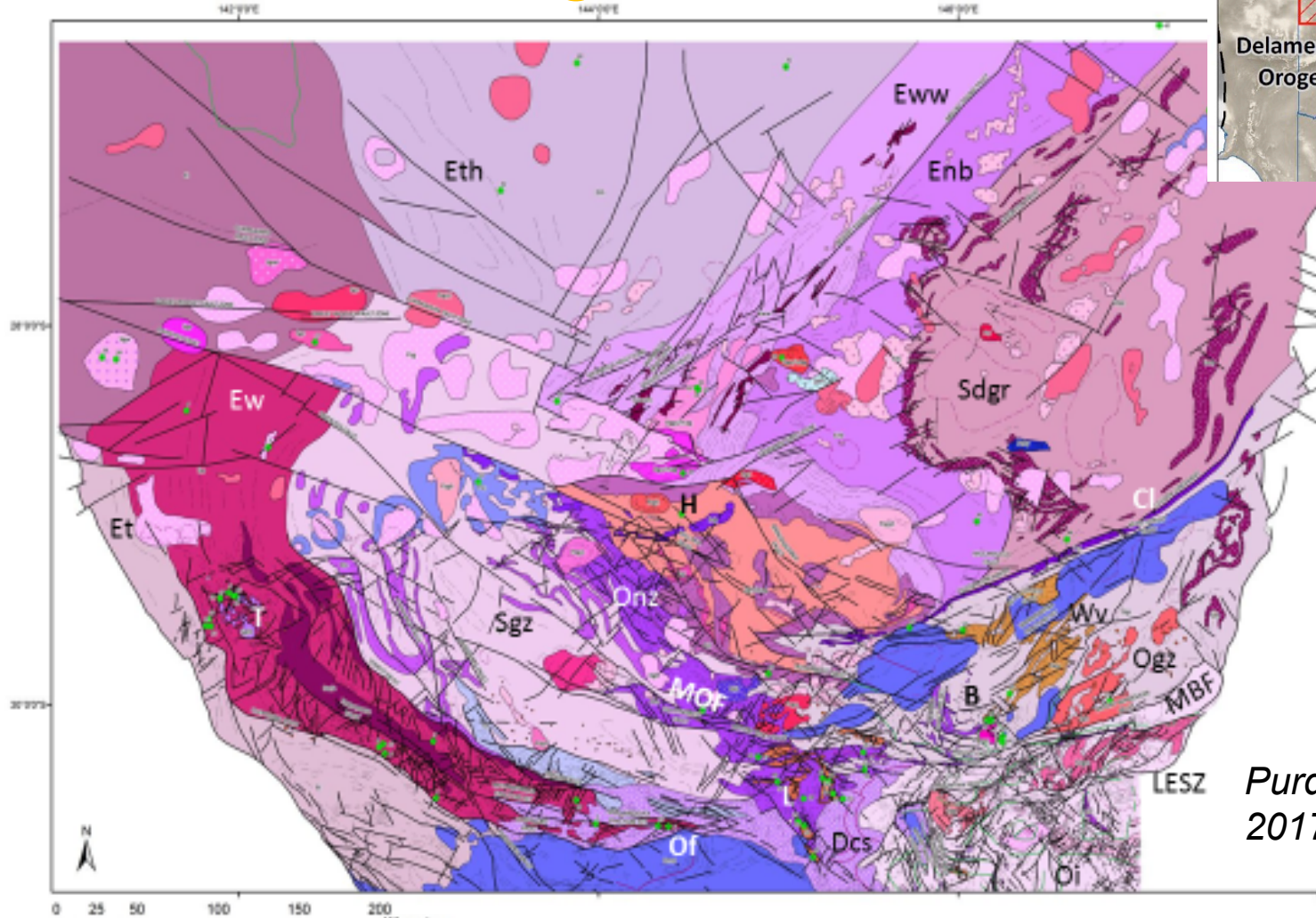
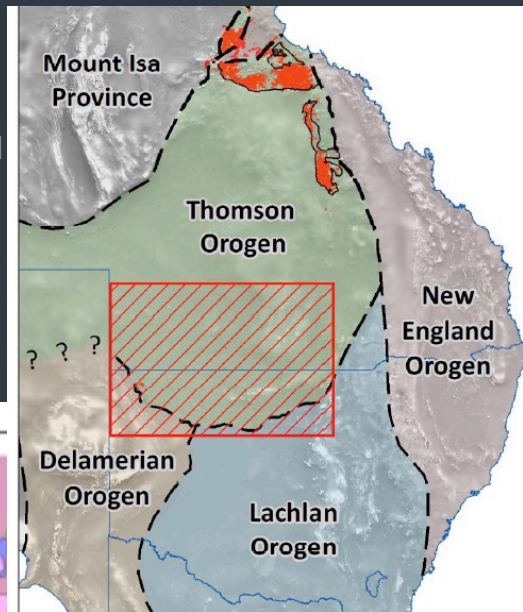
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Abdullah & Rosenbaum, 2016



LOCATION and basement structure of the Southern Thomson Orogen

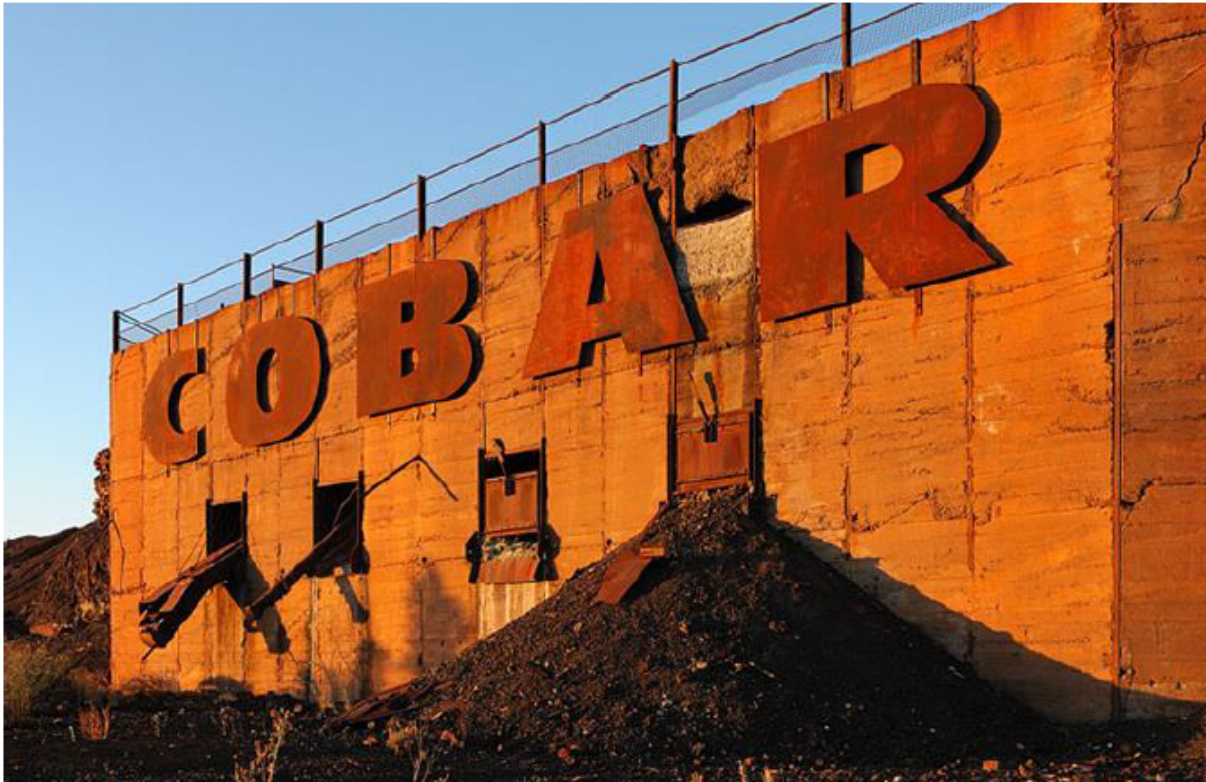
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*Purdy et al.,
2017*

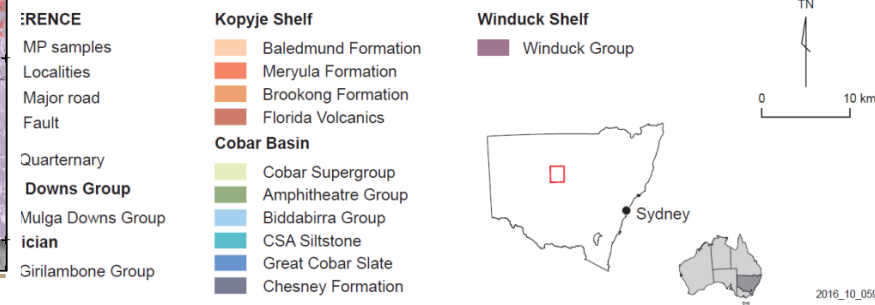
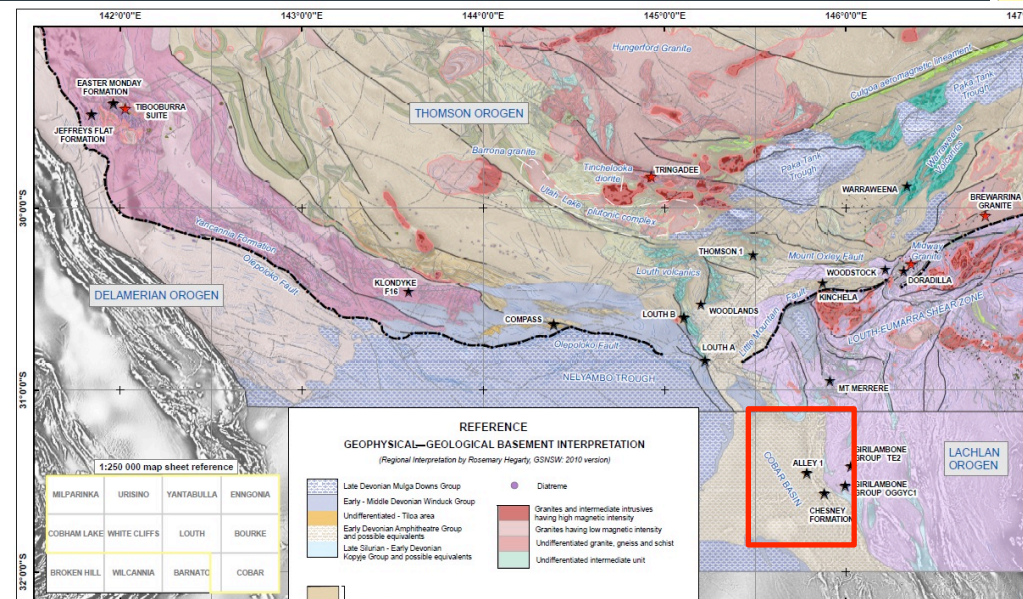
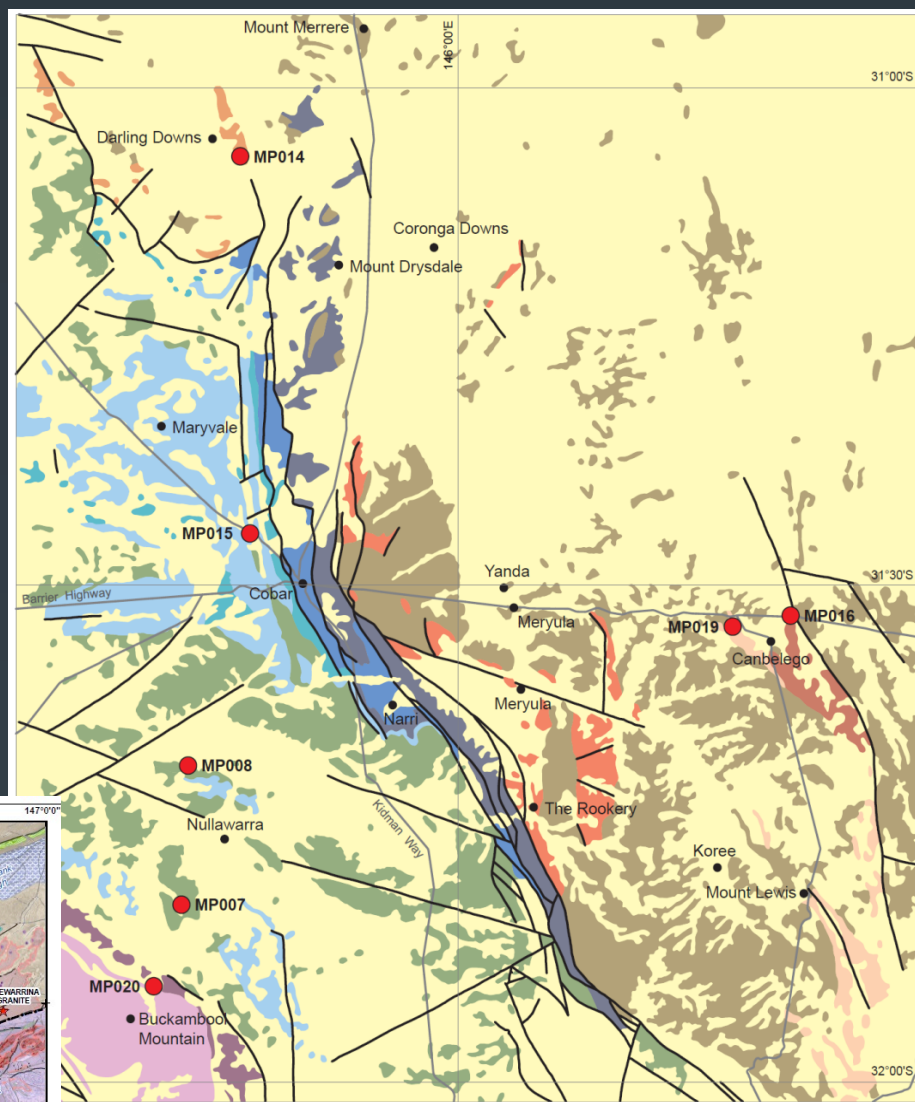
Age and provenance of the Cobar Supergroup

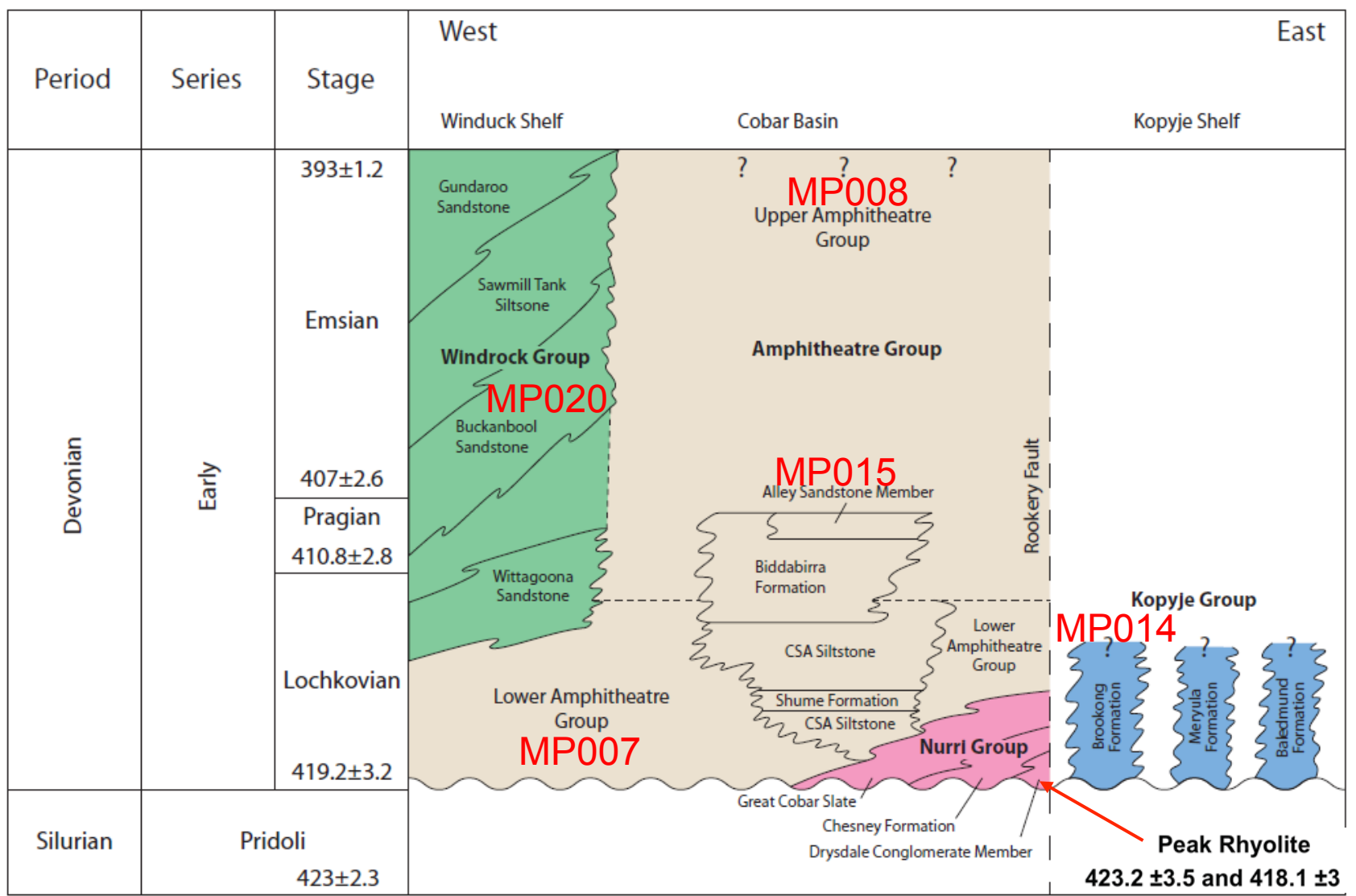
Matt Parrish Hons Thesis (2014)



Matthew Douglas Parrish

Sample location & local geology: Cobar region





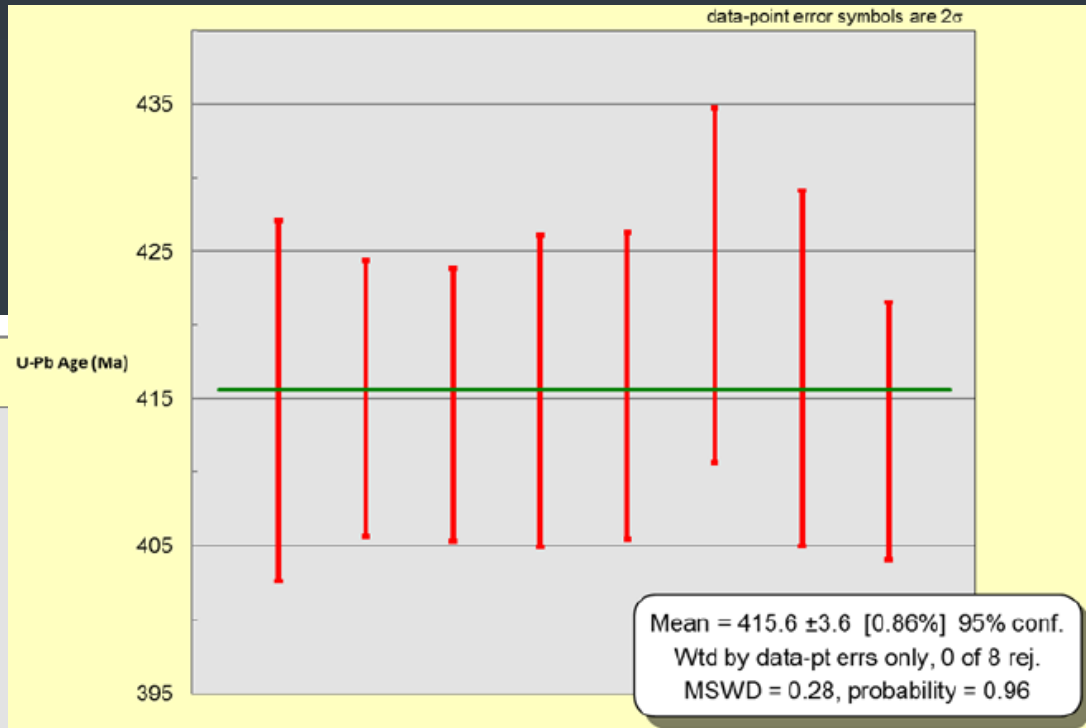
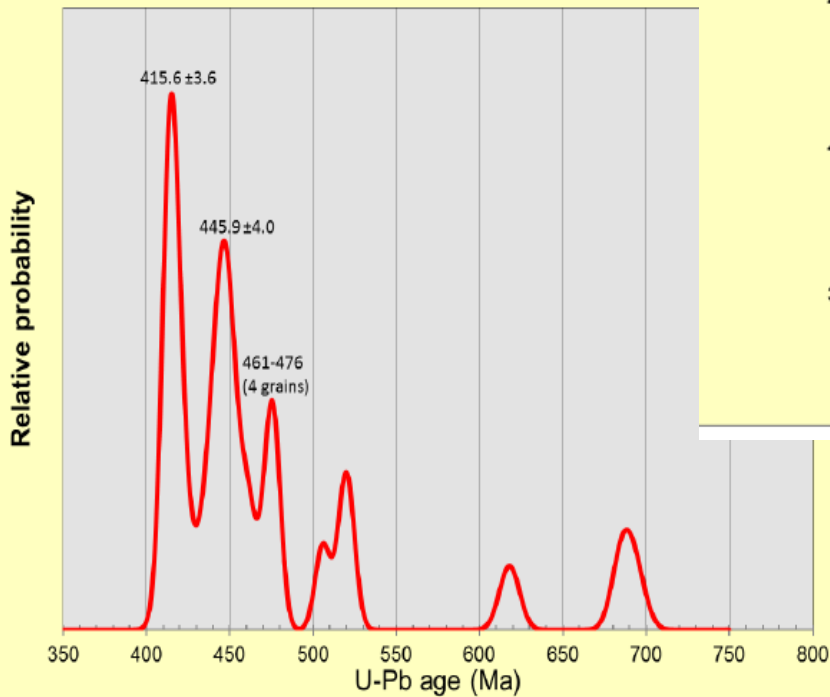
Florida Volcanics

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415 ± 6 Ma
Early Devonian

MP016 - Florida Volcanics

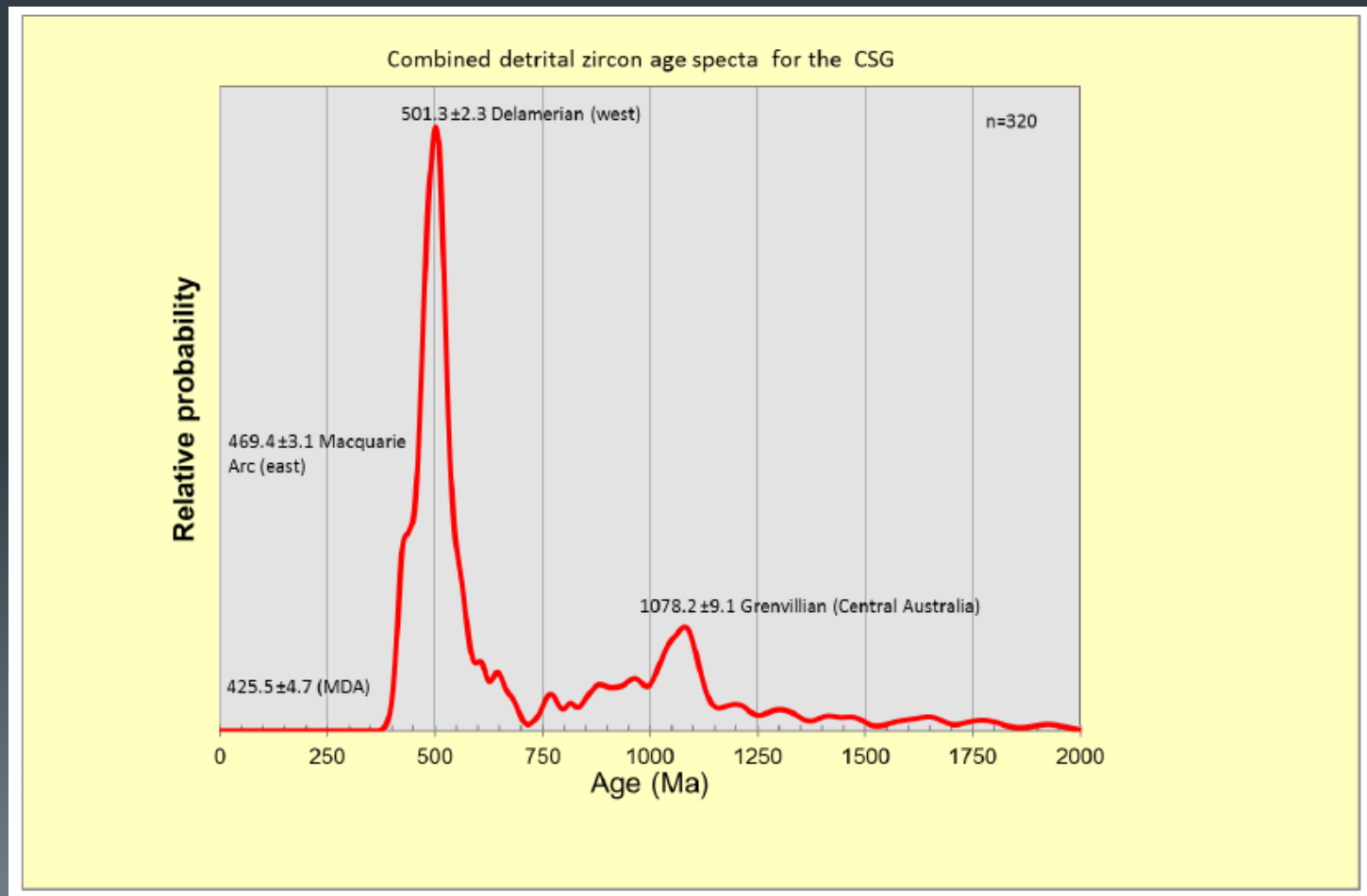


Combined detrital data: Cobar Supergroup

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470 Ma subpeak on 500 Ma peak
425 Ma Maximum Depositional Age (MDA)



Depositional age constrained by Florida
Volcanics and other Early Devonian
volcanic rocks

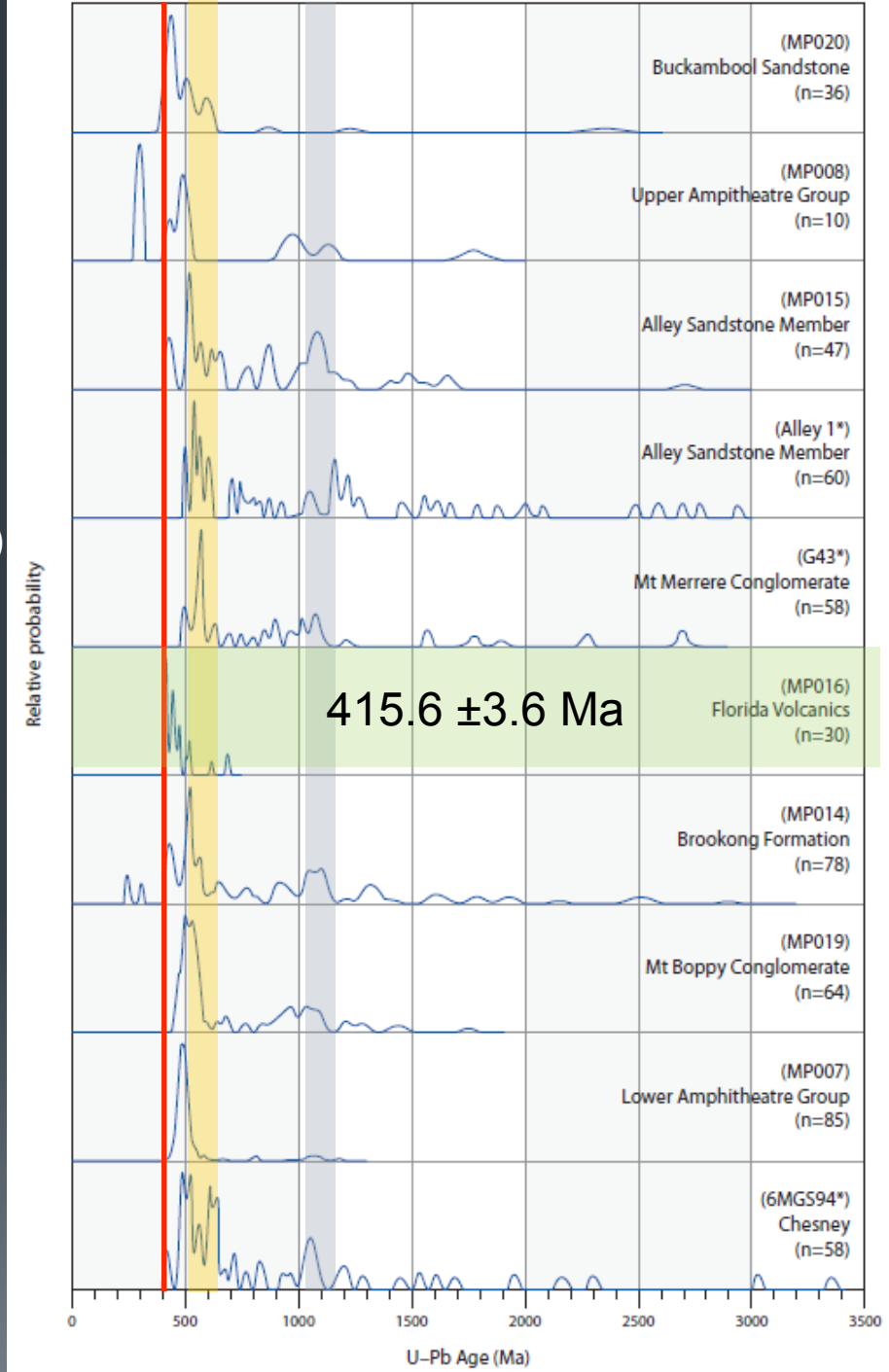
Peak rhyolite @ 415 or 423 Ma

Subdued Grenvillian signature (1.15-1.0 Ga)

Significant “Gondwanan” signature (650-500
Ma), but largely focussed on 500 Ma peak

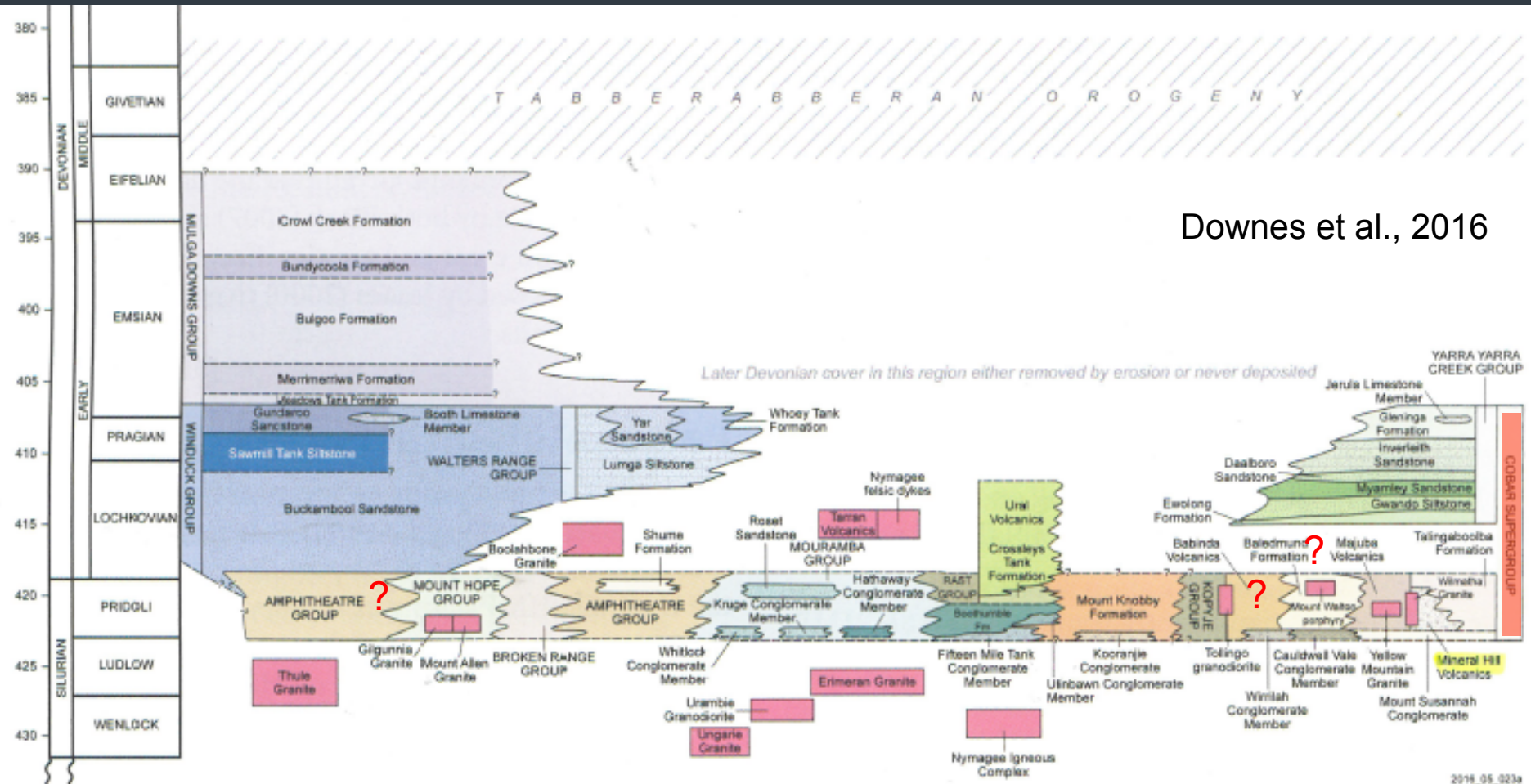
Upper strata and lowermost strata have
MDA = depositional age.

Implication is that (most of)
the Cobar Basin is Early Devonian ?



Age of the Cobar Basin?

Downes et al., 2016

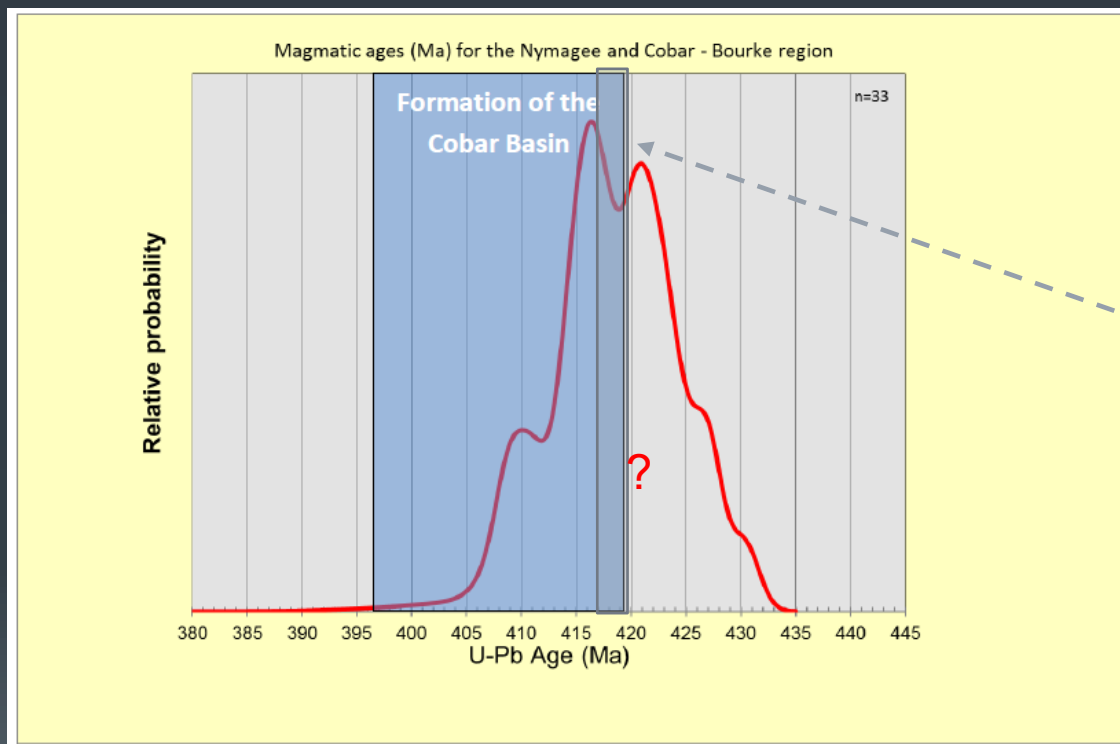


A backarc origin for the Cobar Basin

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Magmatism was already occurring before rifting began



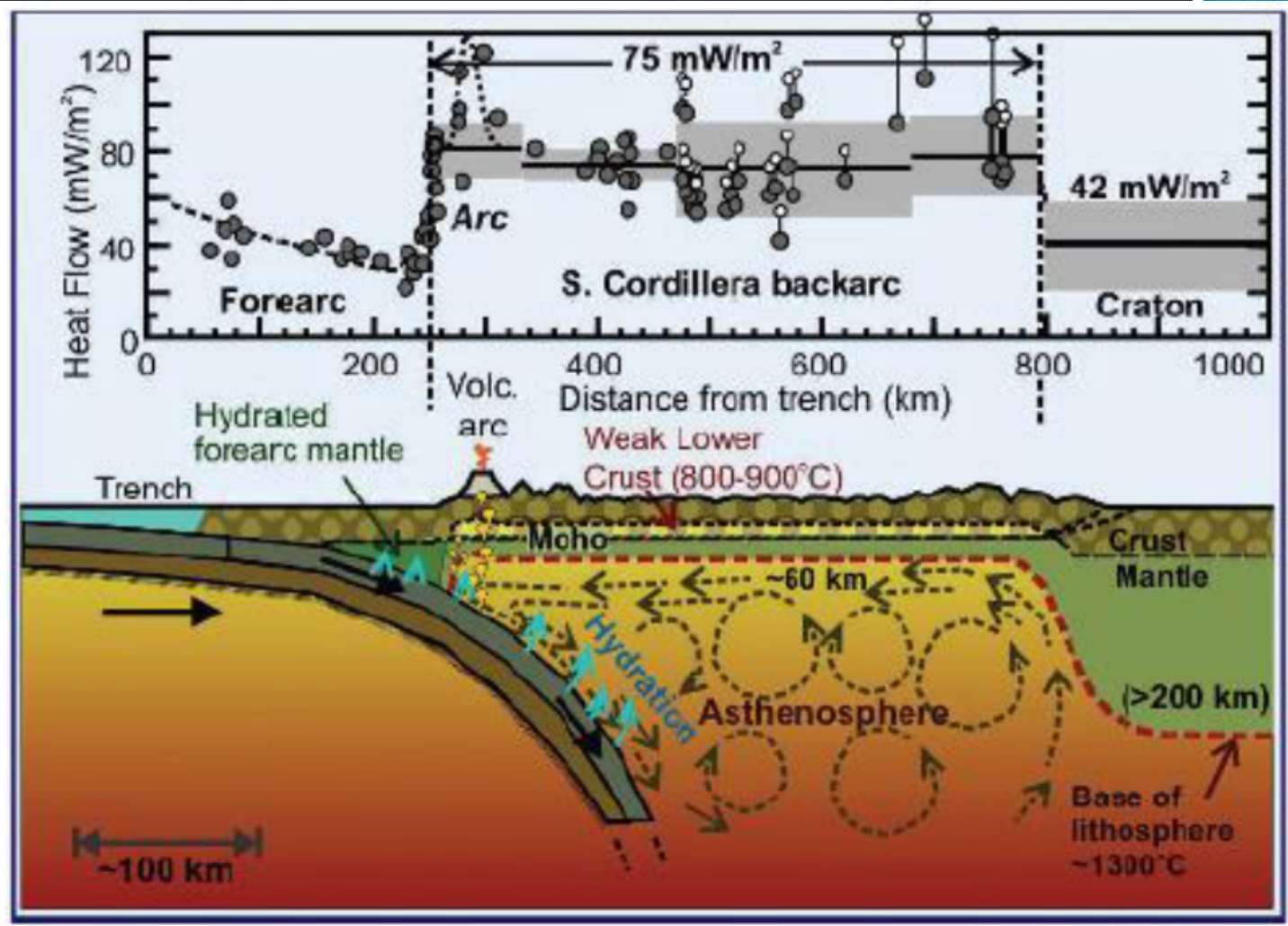
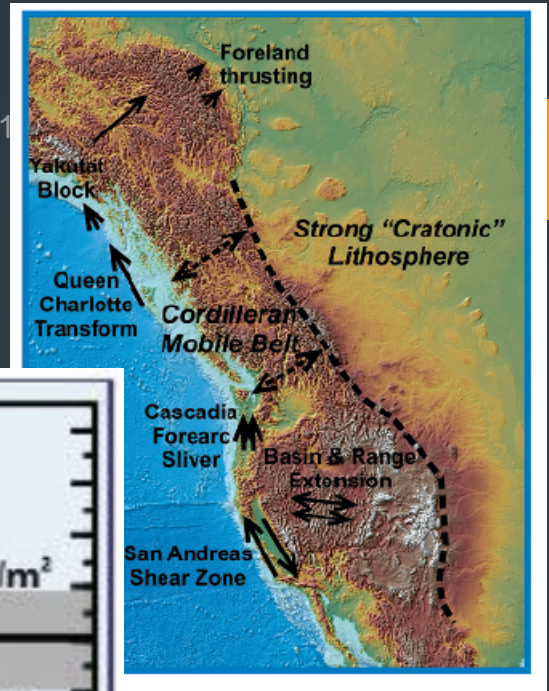
Probability distribution for magmatic ages in the Nymagee, Cobar and Bourke regions, NSW.

From: Downes (2013), Campbell et al. (2013) and Parrish (2014)

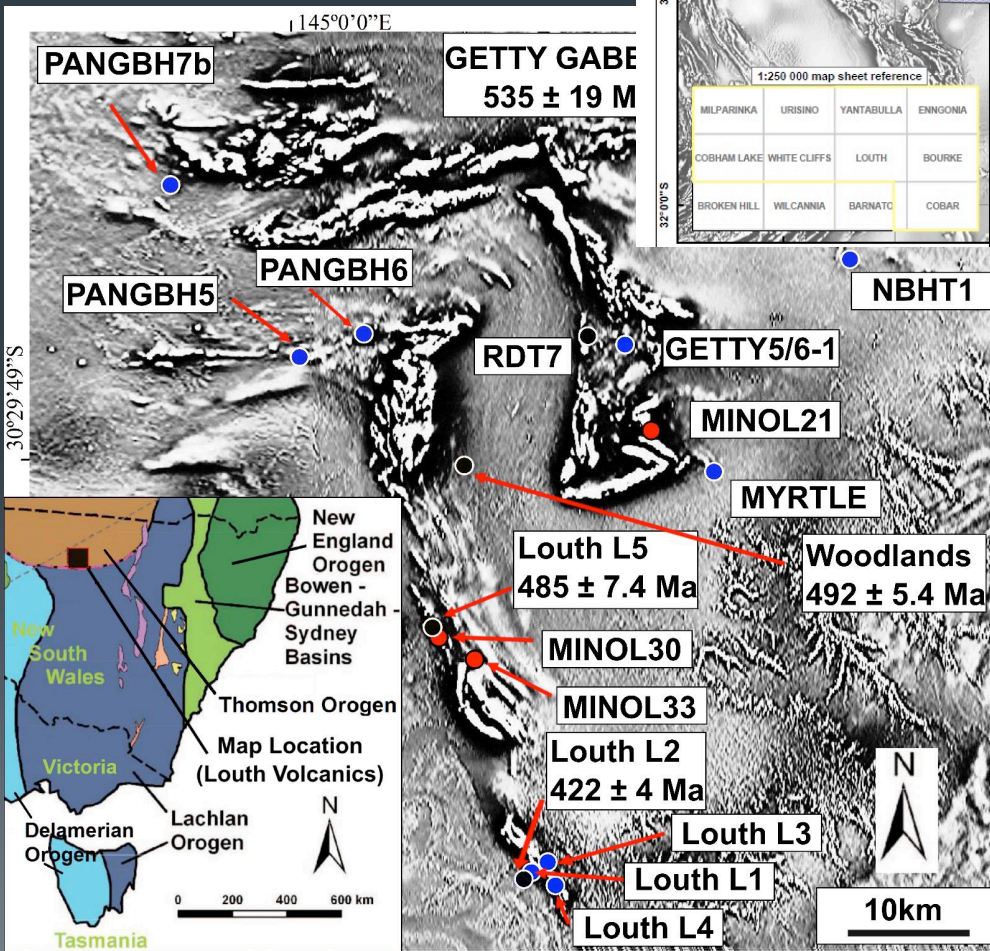
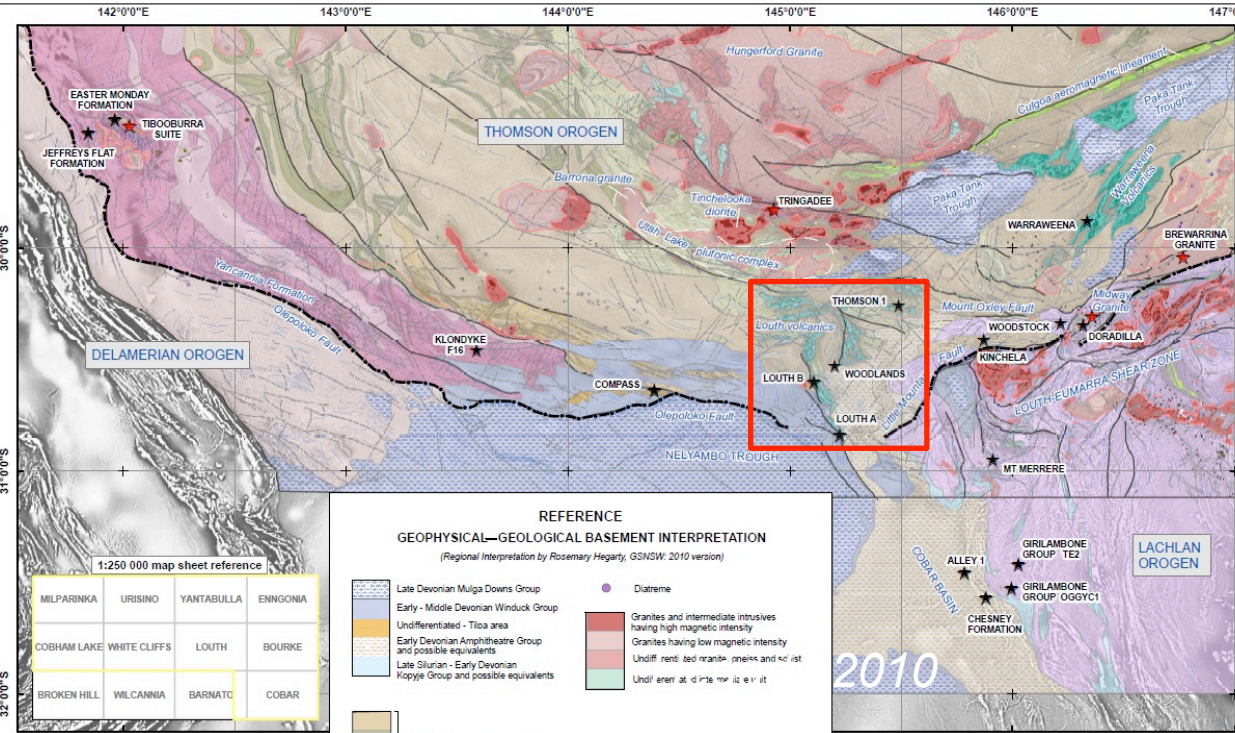
North American Cordillera: orogenic heat flow

Typical of accretionary orogens like LFB

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The Louth region



The Louth region is the northern extension of the Cobar Basin?

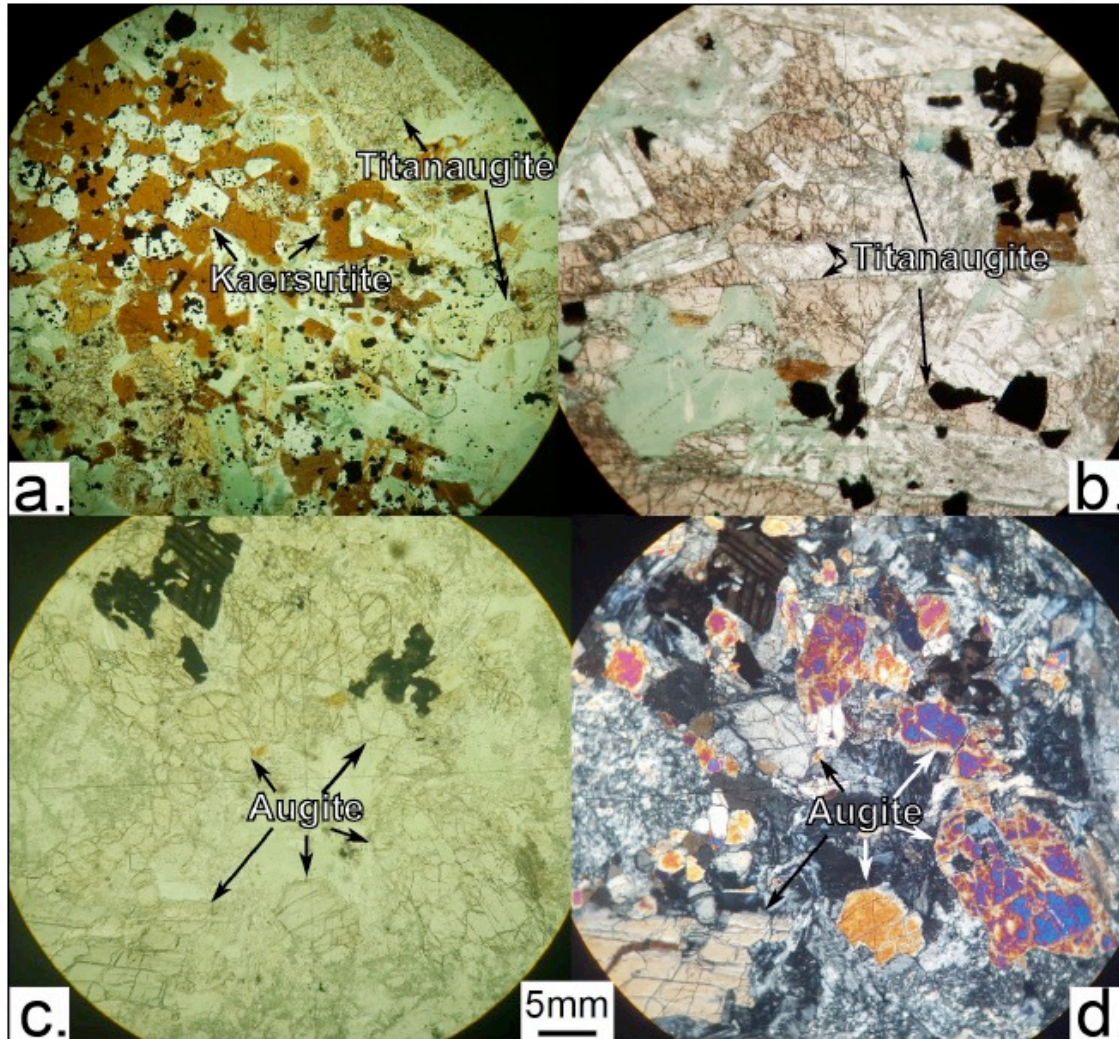
Note the Olepoloko Fault cannot be traced across the Cobar basin

A pre-Cobar structure or Lachlan and STO are connected

2 distinct petrographic types of volcanics in the Louth region

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ALKALINE
(Getty Gabbro)

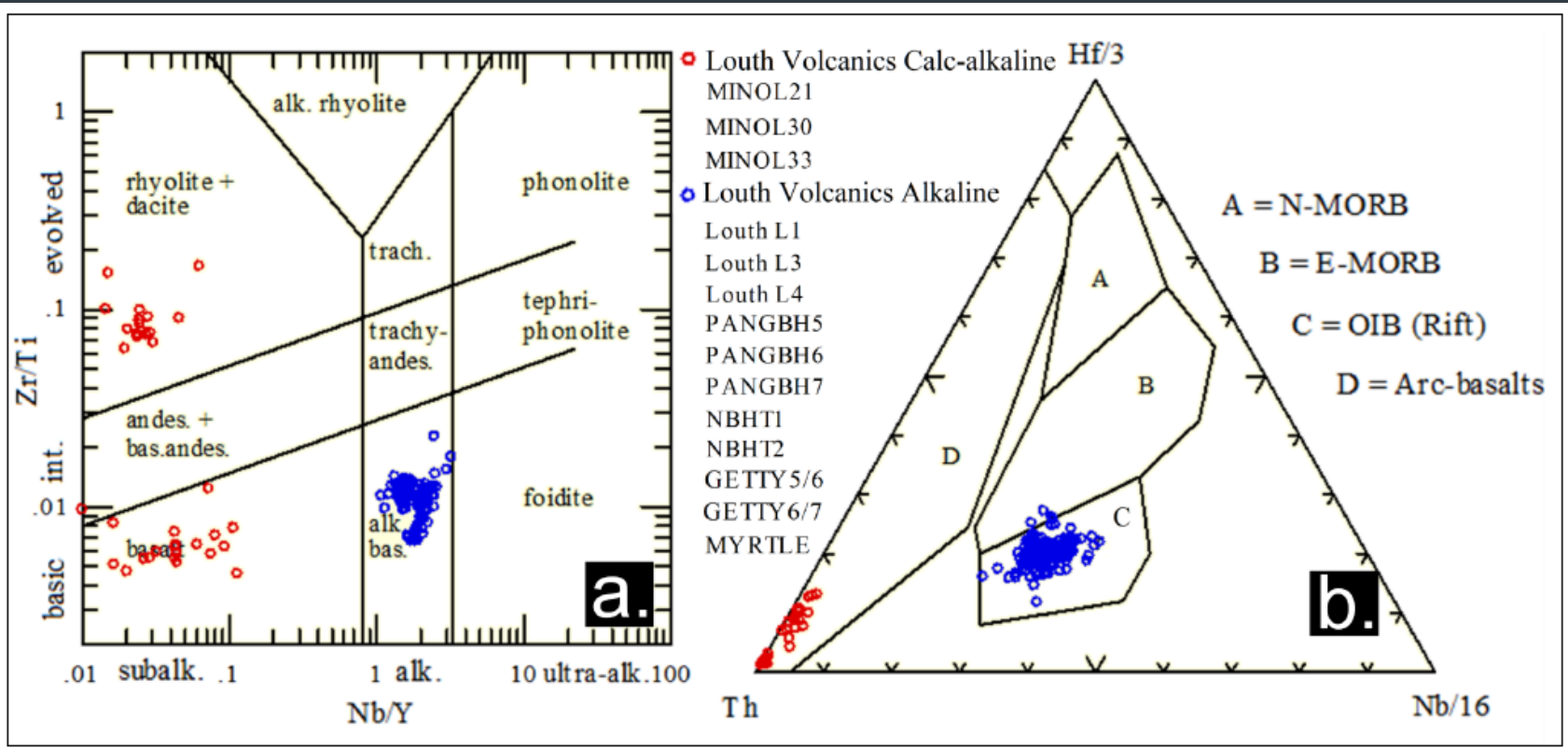
CALC-ALKALINE

Dwyer, 2016

2 distinct geochemical types of volcanics in the Louth region

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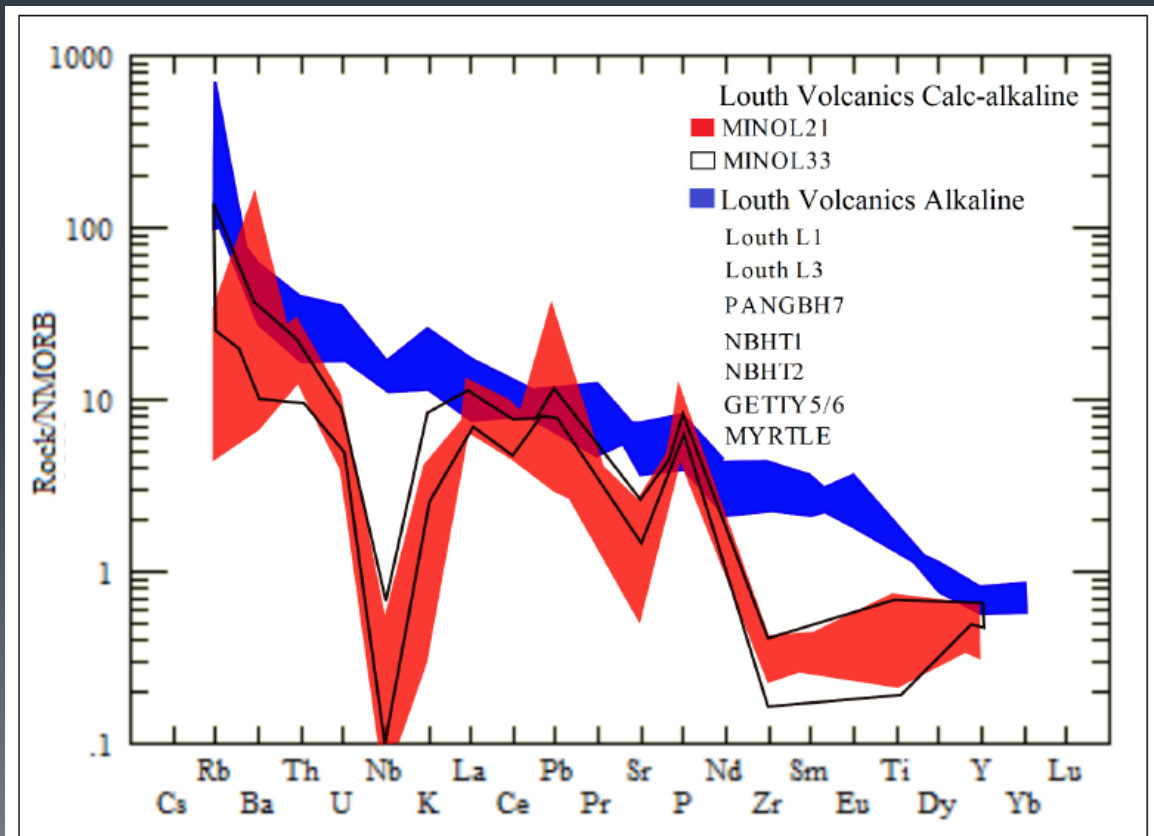


Calc-alkaline - Volcanic arc type (subducton-related)

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Alkaline - Intraplate type



Dwyer, 2016

U-Pb isotopic analysis: calc-alkaline volcanics

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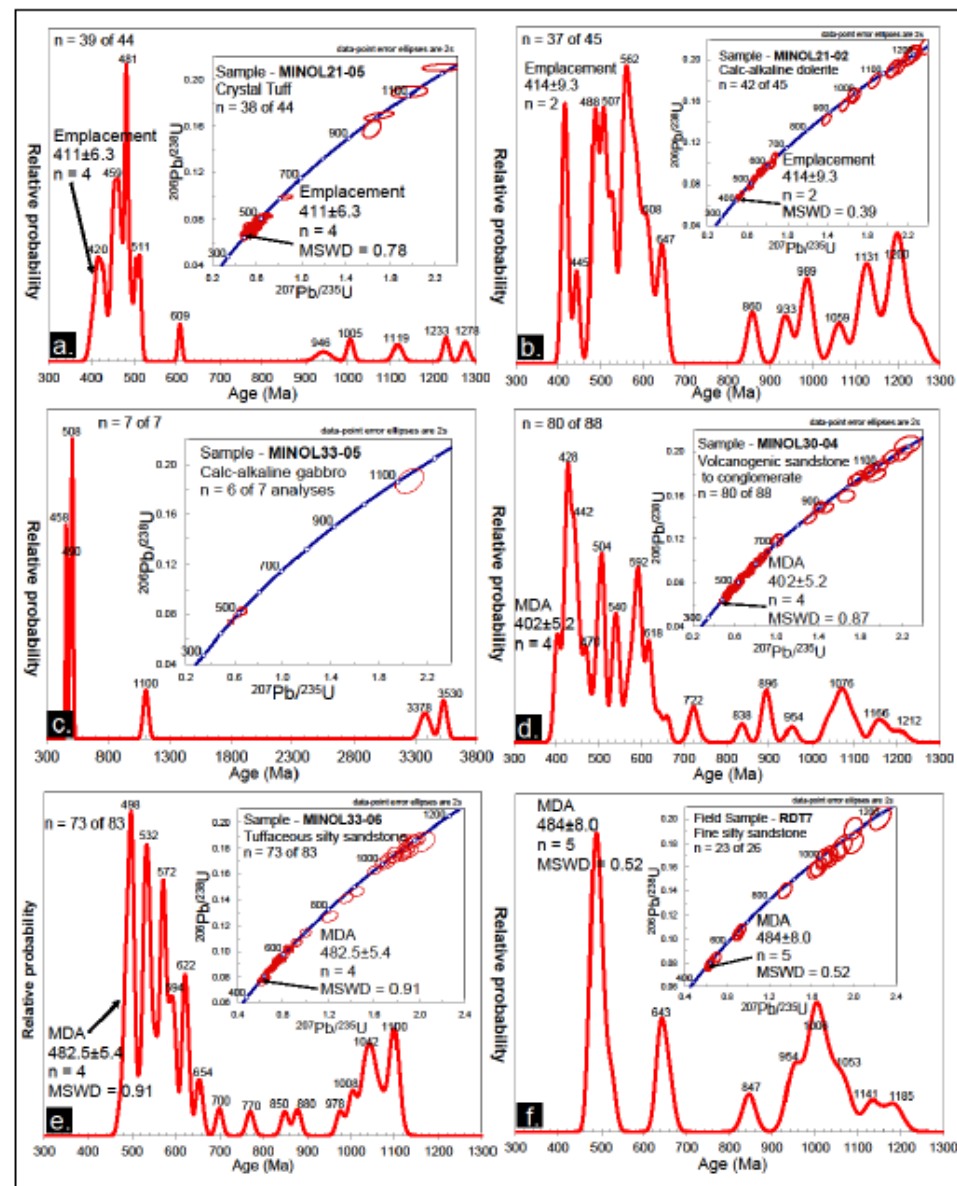
Emplacement ages for volcanic arc rocks are Early Devonian (415-410 Ma)

Similar to Mineral Hill volcanics adjacent to Cobar Basin

One volcanogenic sandstone is ~400 Ma

Other interlayered sandstones do not record the Devonian magmatism: may be Early Ordovician (both have moderate 1100-1000 Ma clusters)

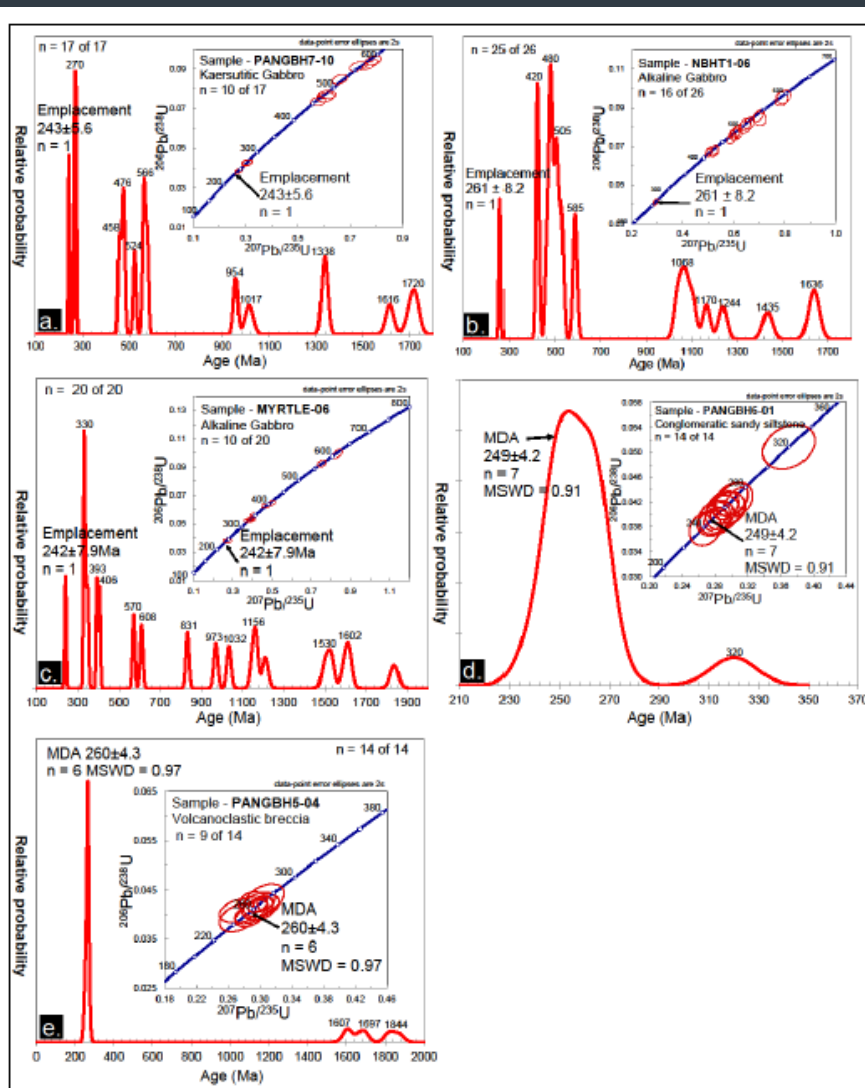
Dwyer, 2016



U-Pb isotopic analysis: alkaline volcanics

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Alkaline rocks contain many partially reset zircons: crustally contaminated

The youngest distinct populations are 260-240 Ma (Permian-Triassic)

Getty Gabbro is Triassic, not Neoproterozoic

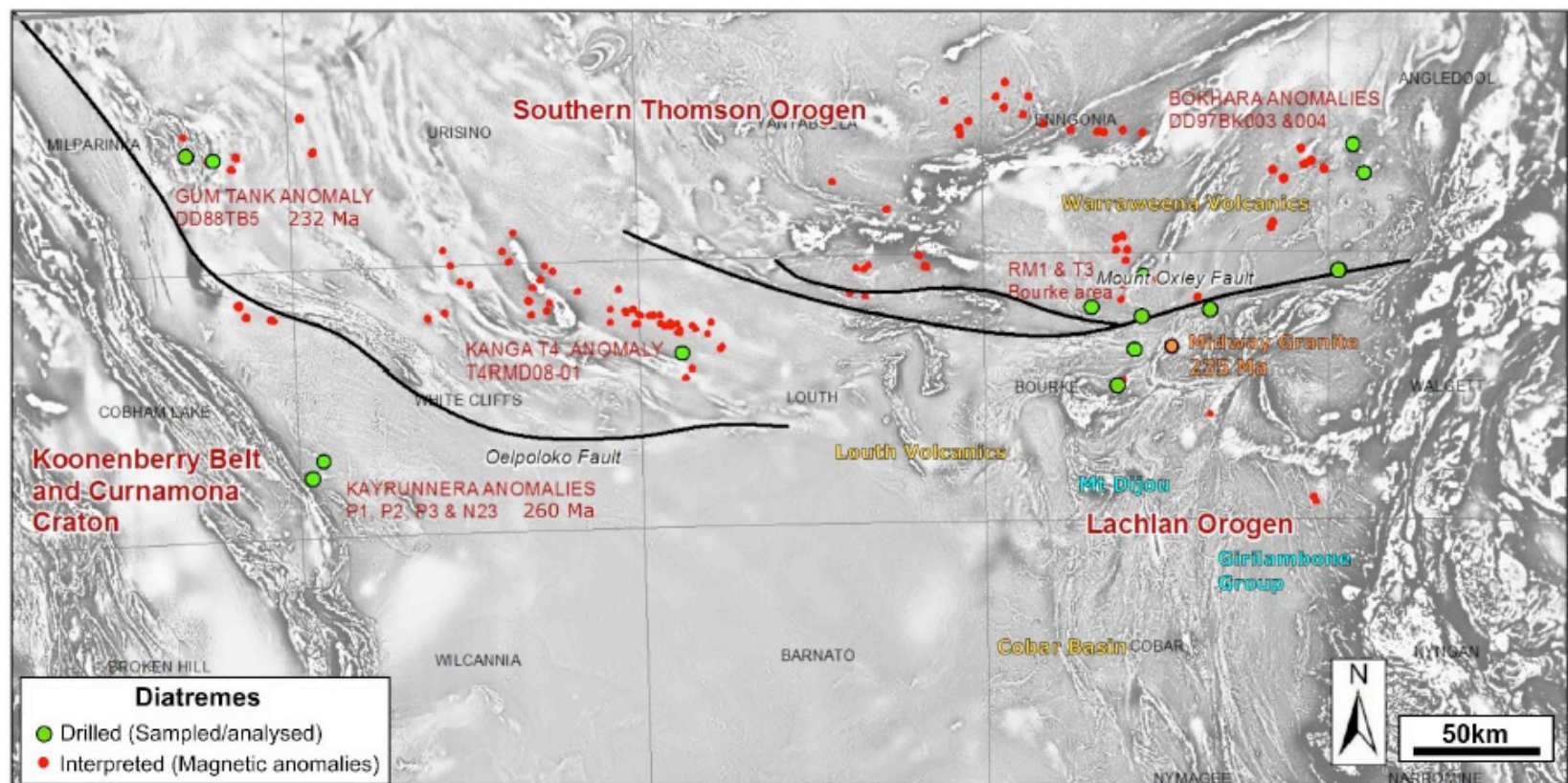
Dwyer, 2016

The alkaline rocks belong to a suite of Permo-Triassic diatremes extending E-W for ~400 km across NW-New South Wales

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Dwyer, 2016

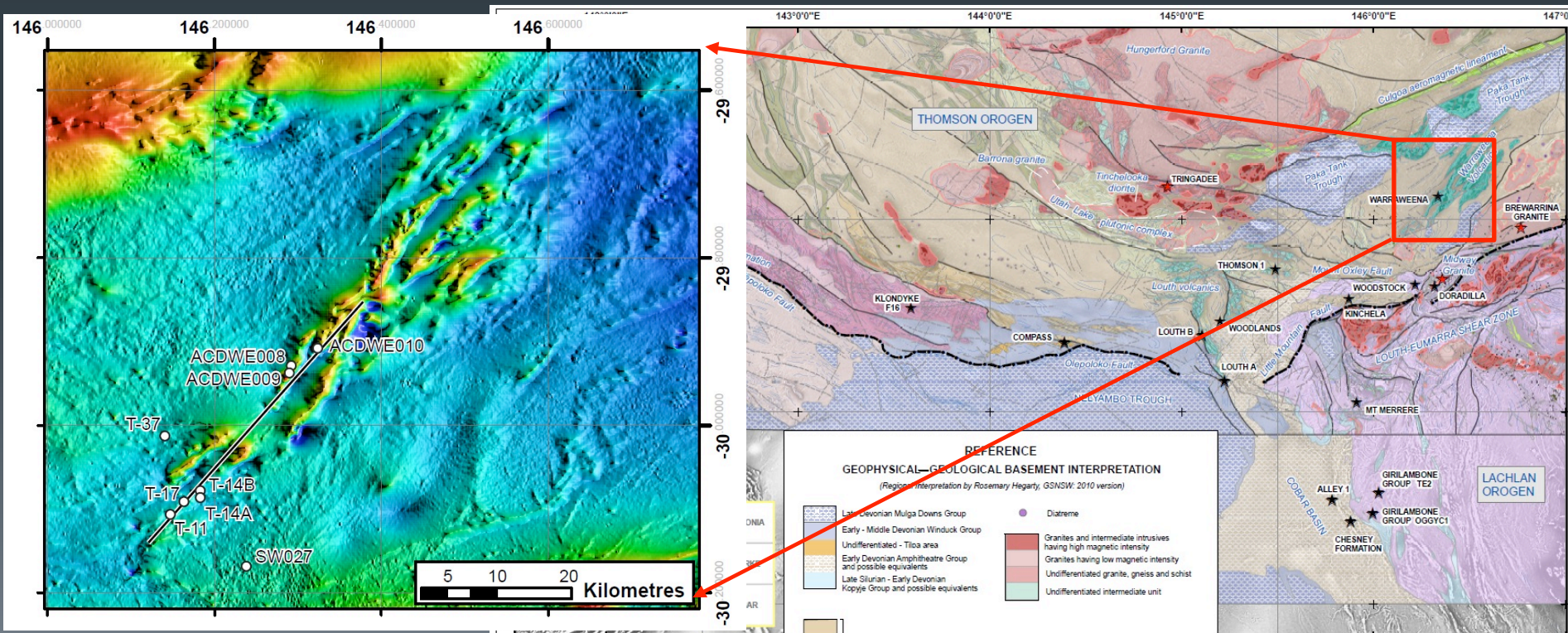


The Warraweena region (near Bourke)

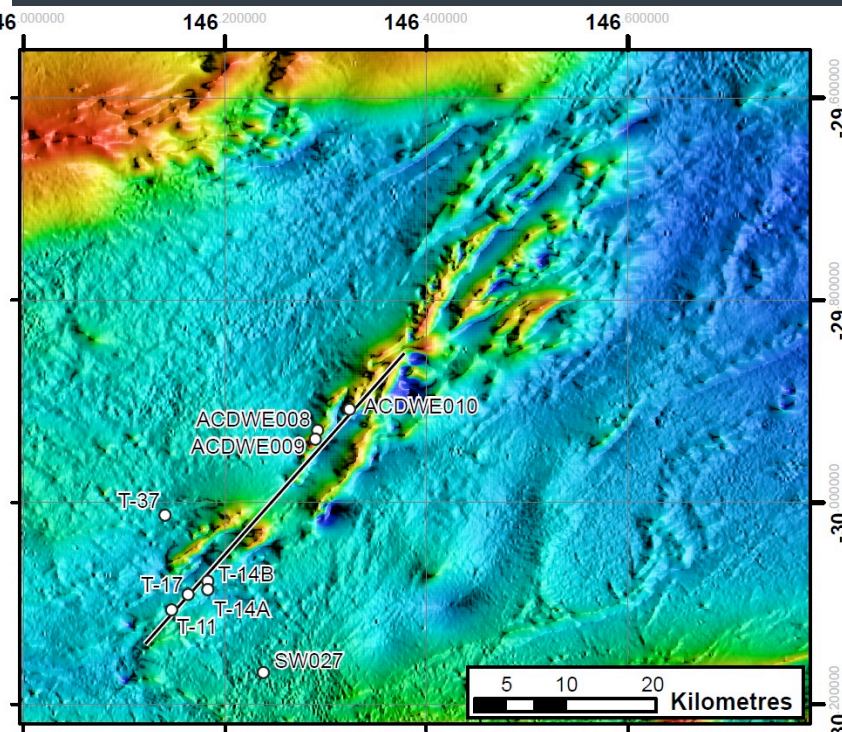
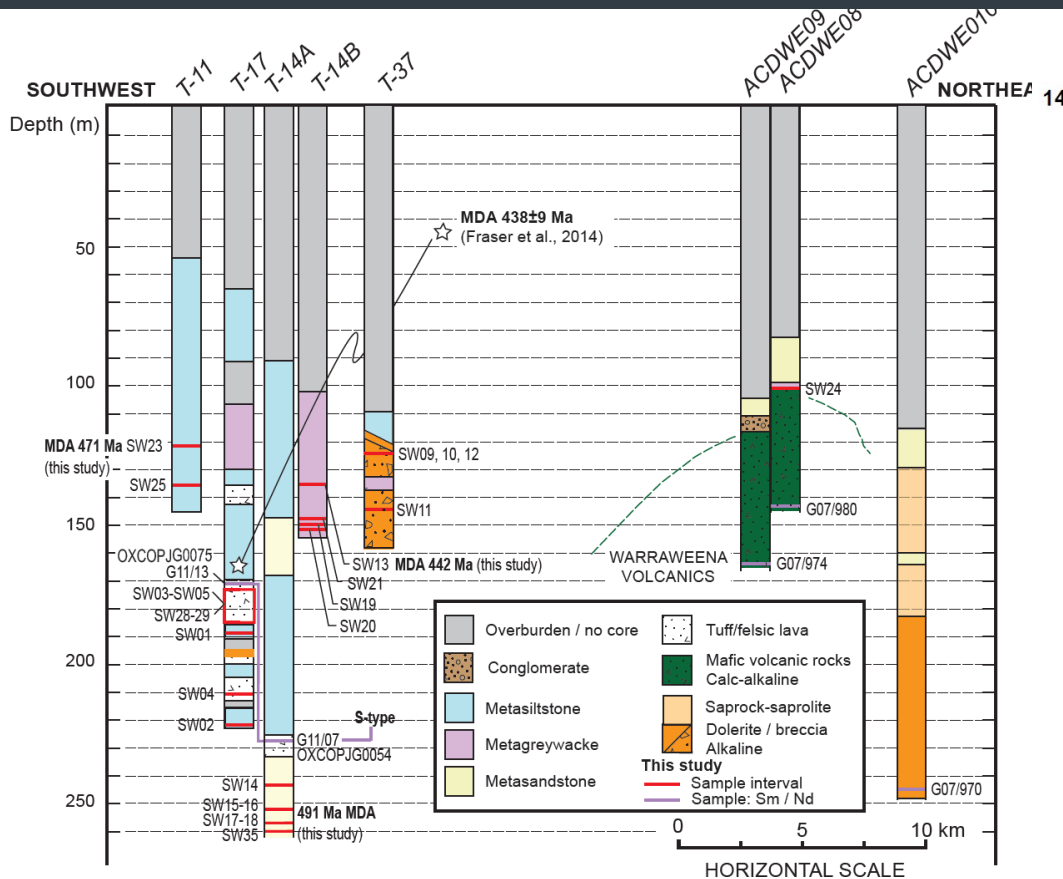
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Linear magnetic anomalies are mafic volcanics



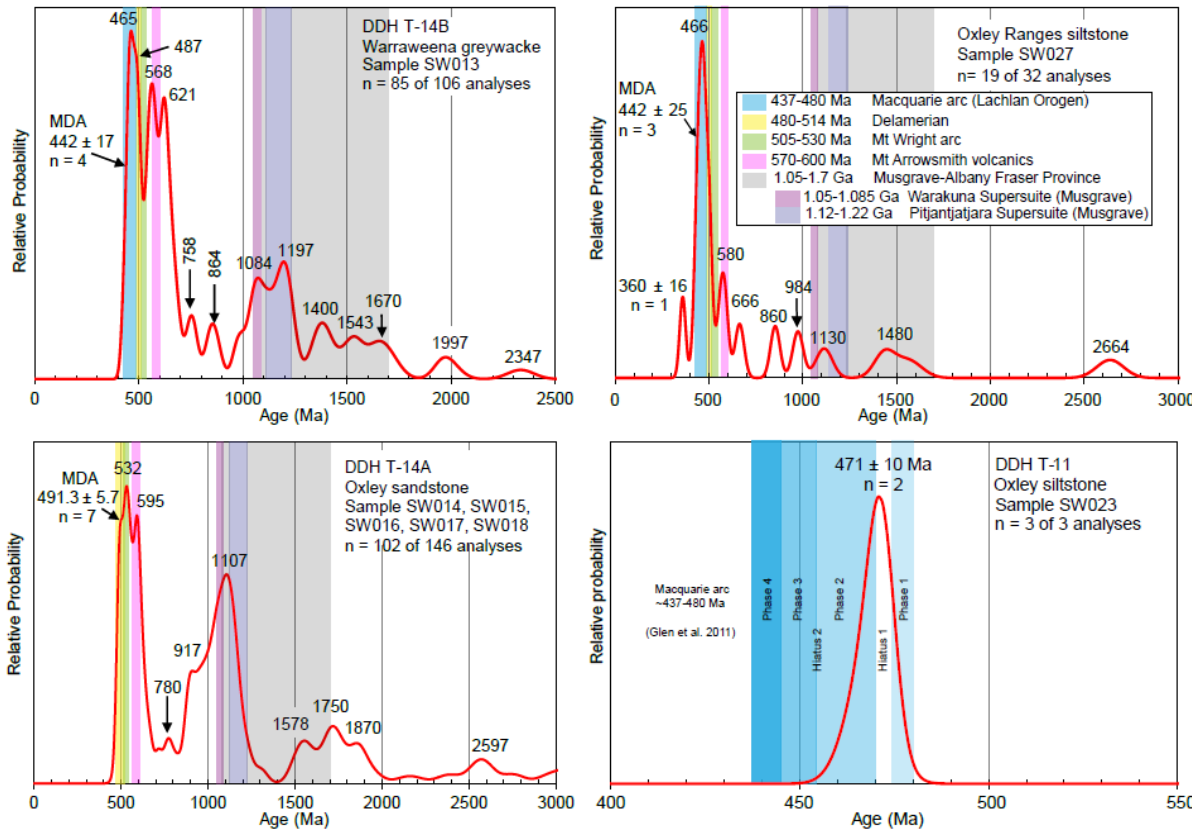
Location of drillcore



Most interbedded sediments have a Macquarie Arc PEAK age signature, with a subordinate ~500 Ma peak and a 1100-1000 Ma cluster

The 470-460 Ma age peak and lithic character of the sediments imply direct derivation from the Macquarie Arc (contain cpx grains)

Sedimentation was Early Silurian or later (MDA of ~440 Ma)



BOODA FORMATION

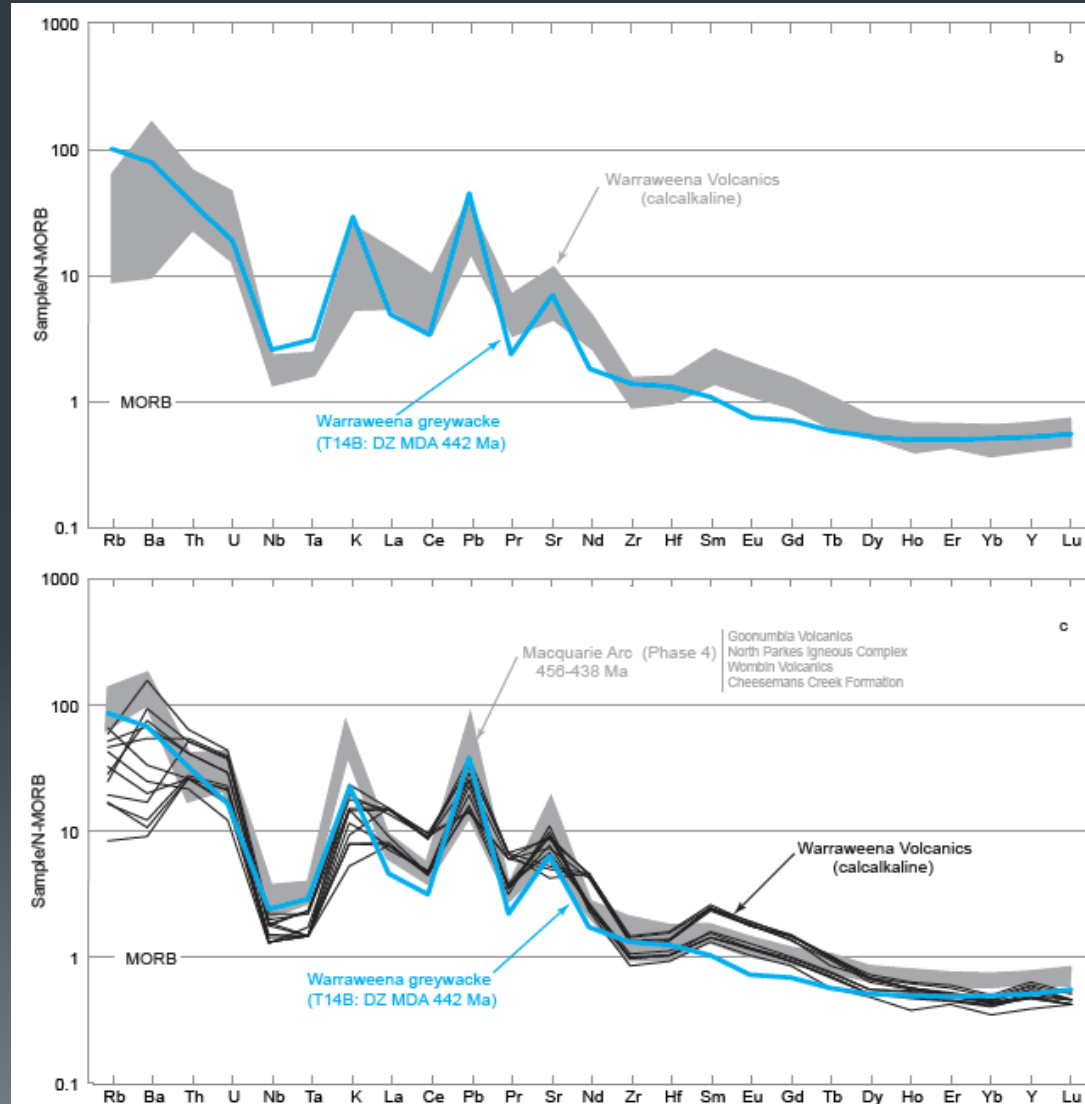
Comparisons with the Macquarie Arc

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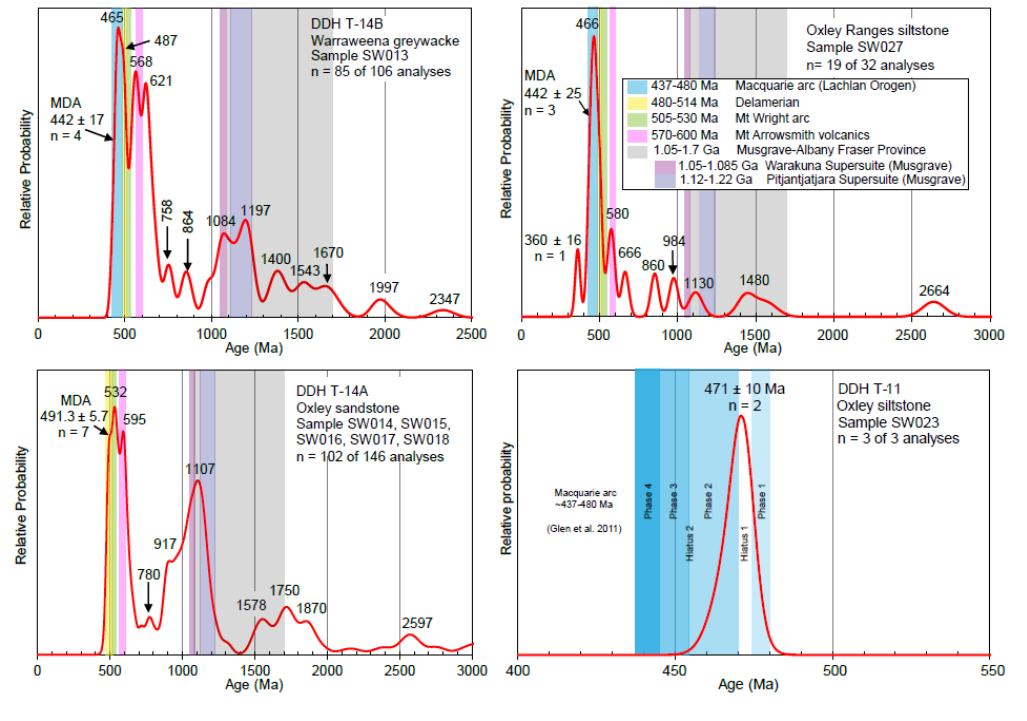
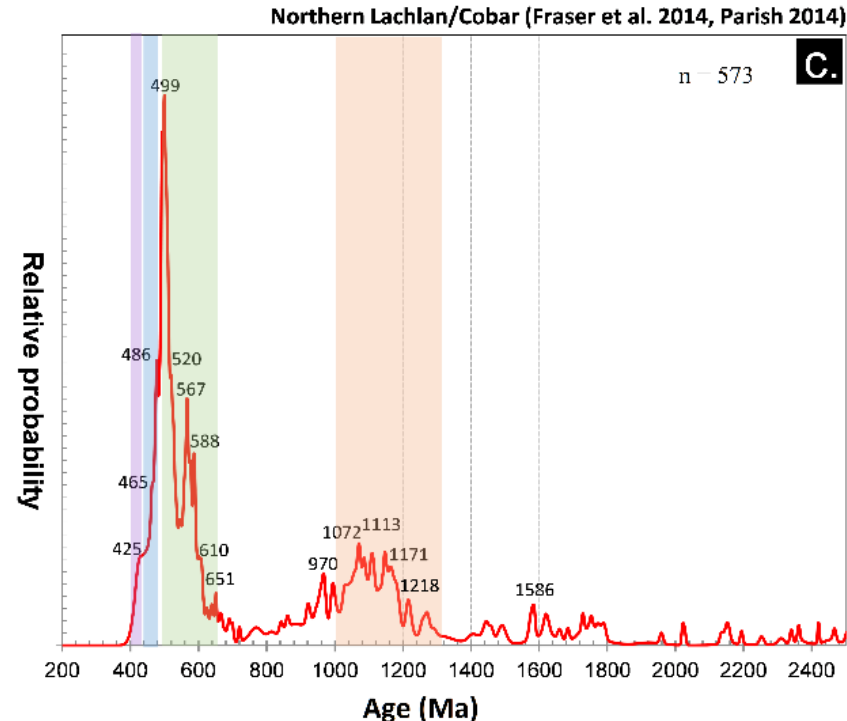
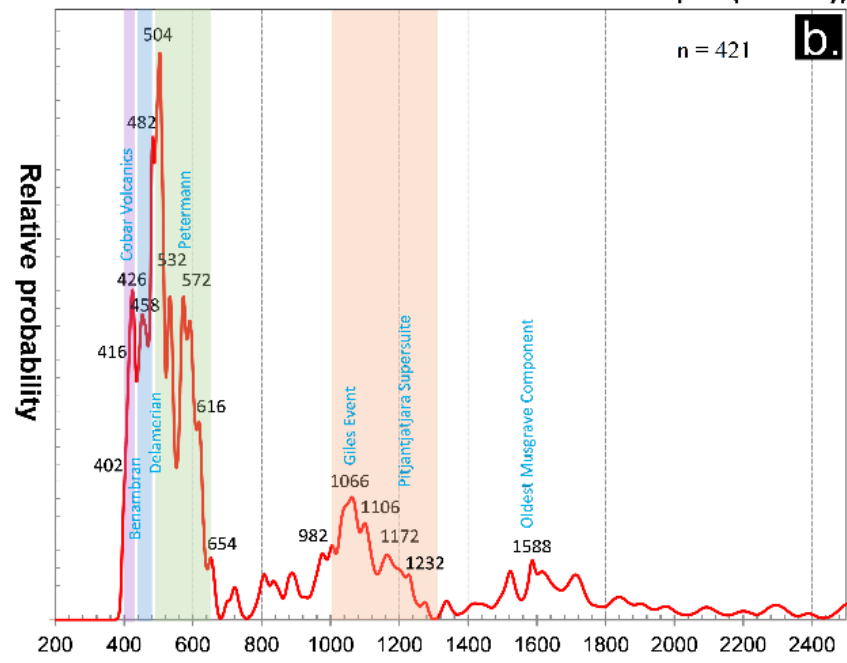
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Note the similarity between the Booda greywacke and the Warraweena volcanics

Note the similarity between the Warraweena volcanics and phase 4 of the Macquarie Arc (excluding the mobile elements K, Ba, Rb)



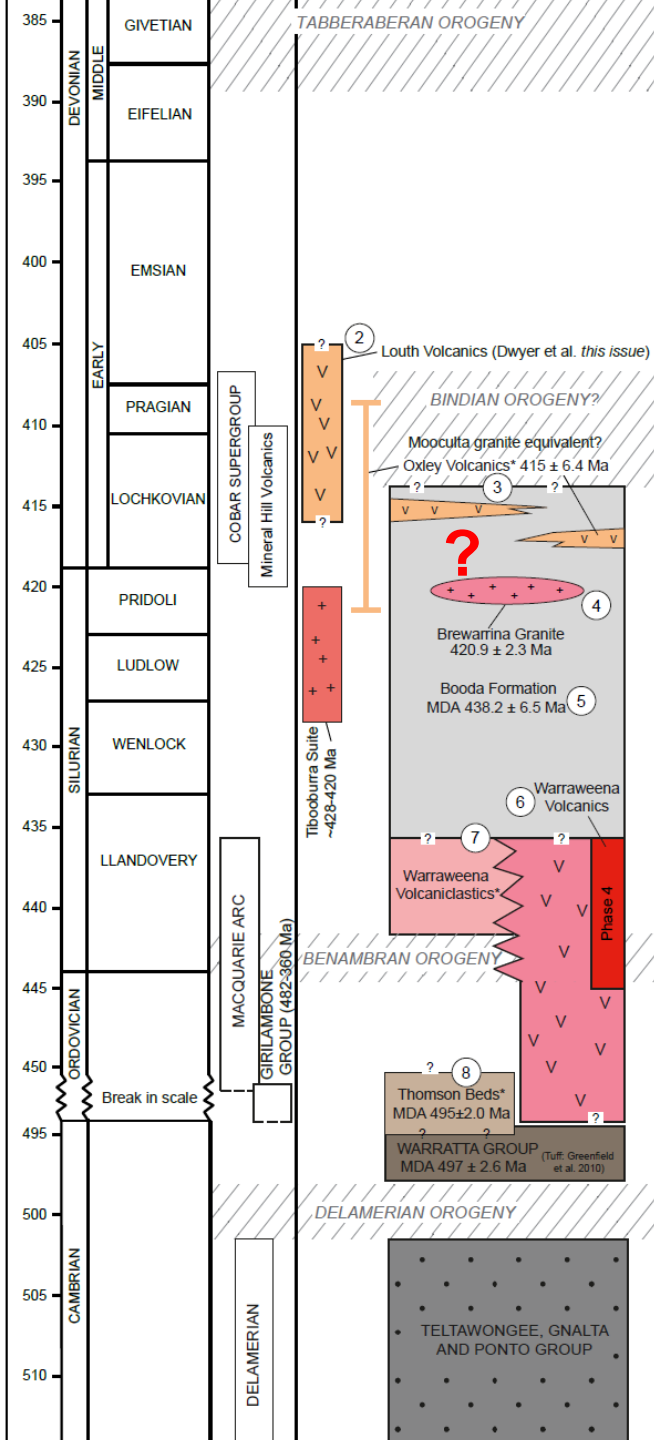
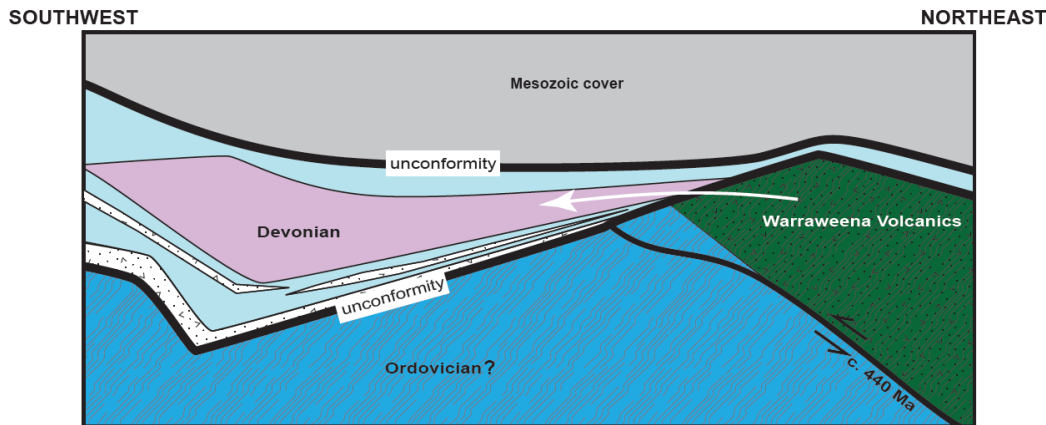
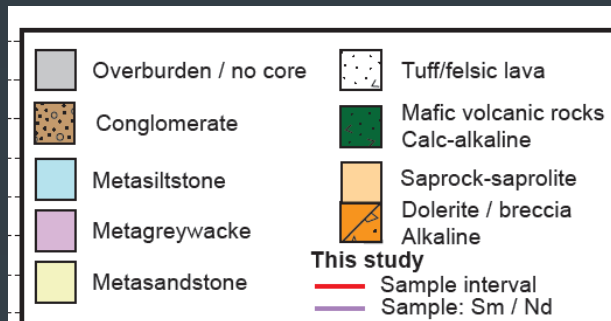
The age spectra lacks the 425 Ma “shoulder” that typifies the Cobar Supergroup and Louth sedimentary rocks, but the 465 Ma peak implies an older age (Silurian?) Tumut Trough?



Stratigraphic relations in the Bourke region

Is the Booda formation equivalent to the Cobar Supergroup, or older? (Silurian or Early Devonian)?

Hack et al., 2017



Sm-Nd isotopic relations

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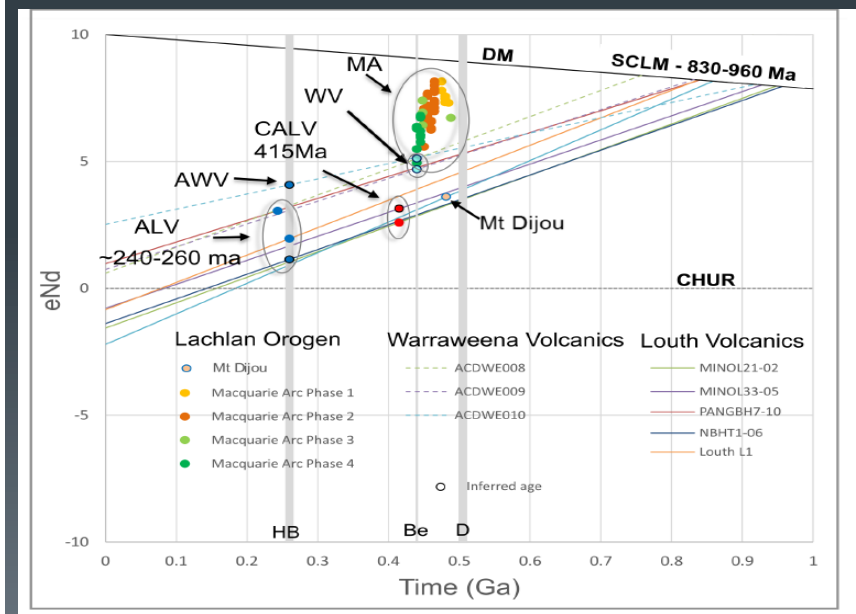
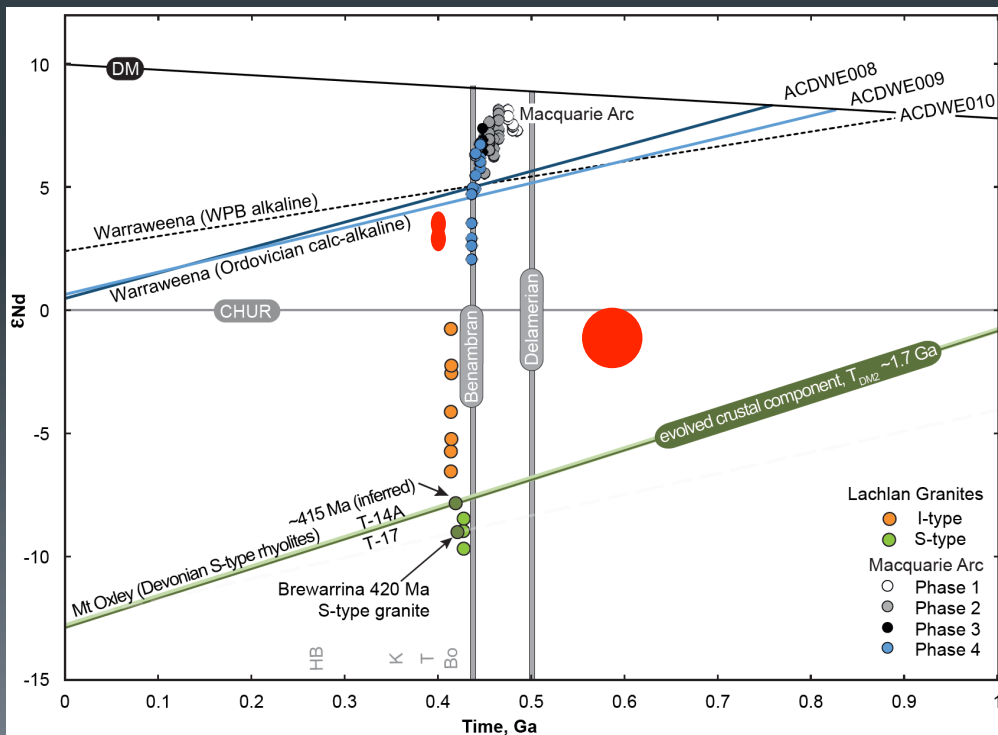
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Warraweena volcanics lies on “Late” Macquarie arc trend (Phase 4)

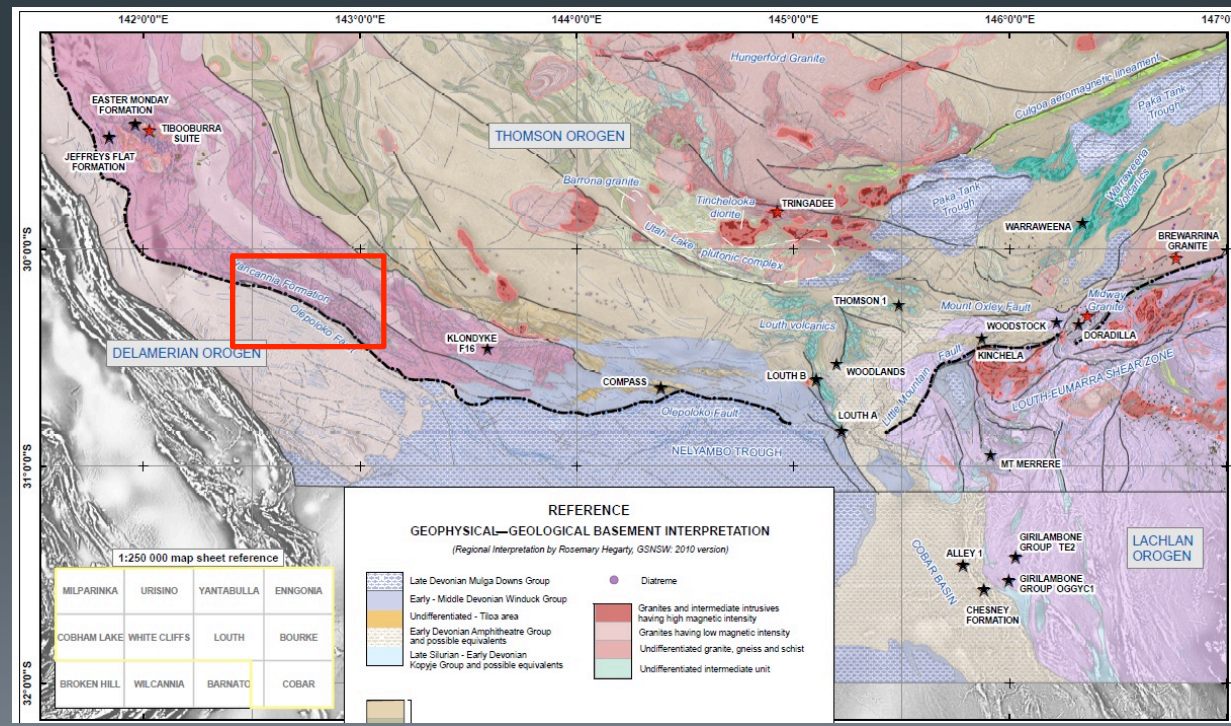
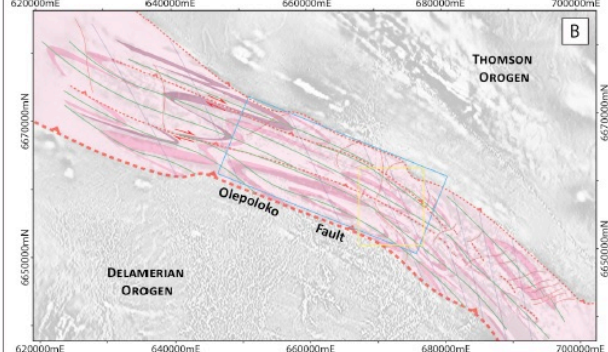
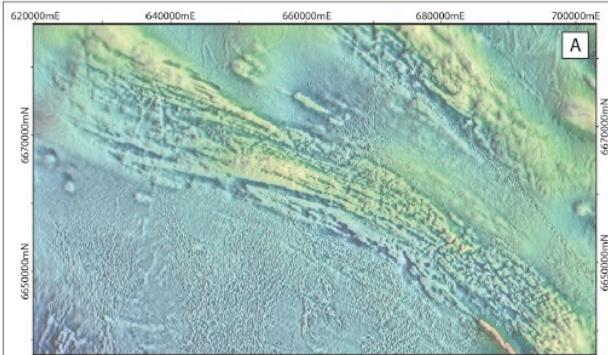
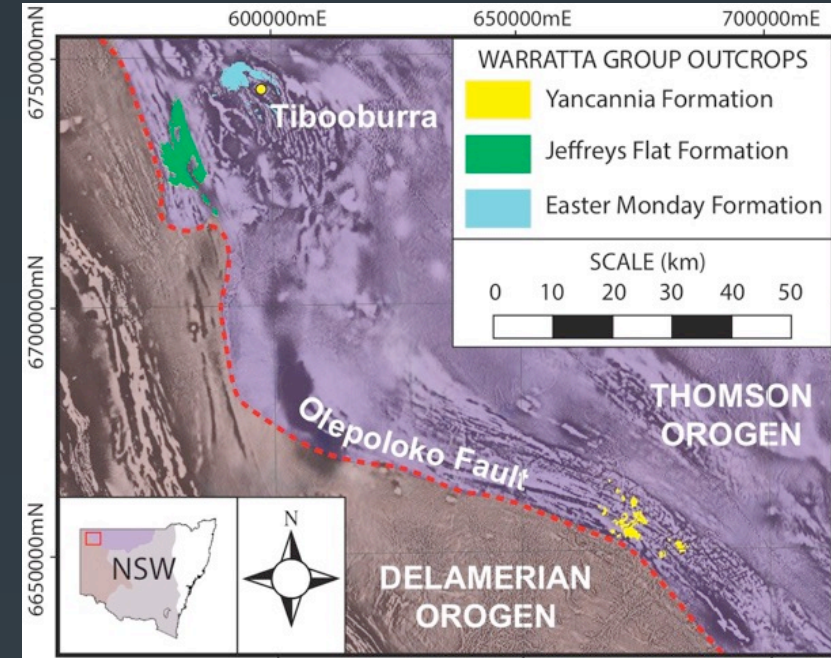
Calc-alkaline Louth volcanics (415 Ma) are similar to Lachlan I-type granites

Mt Oxley volcanics (Bourke) are similar to Lachlan S-type granites (Brewarrina)

Perm-Triassic alkaline volcanics lie on same evolutionary line as Mt Dijou volcanics!
(same SCLM source?)



The Yancannia region

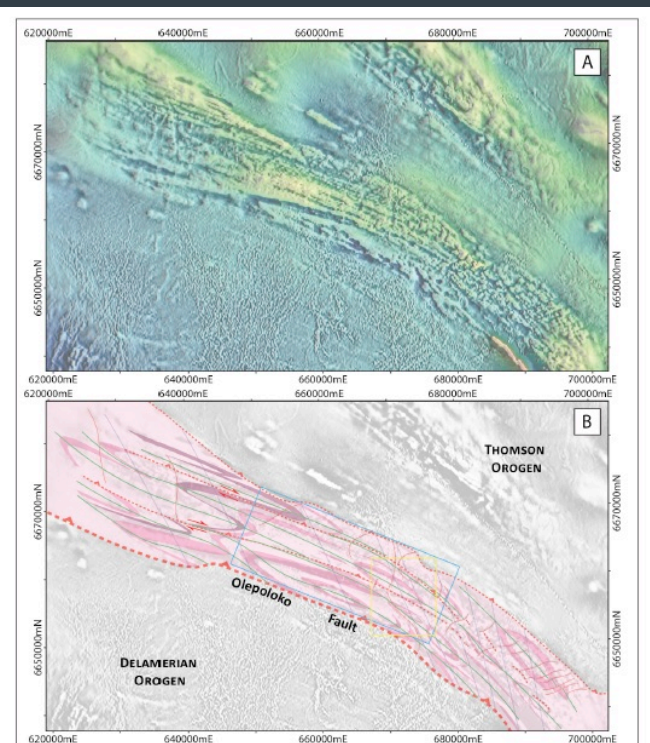
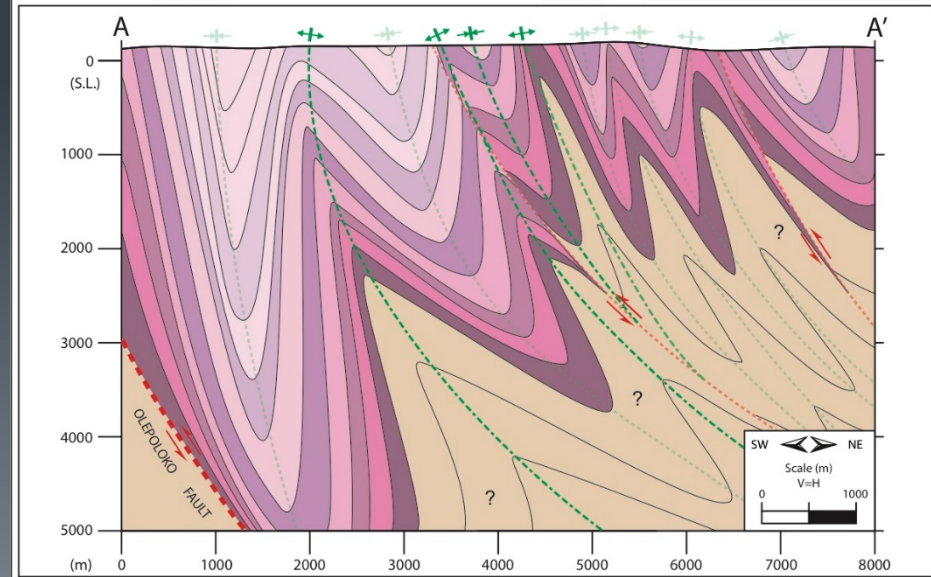
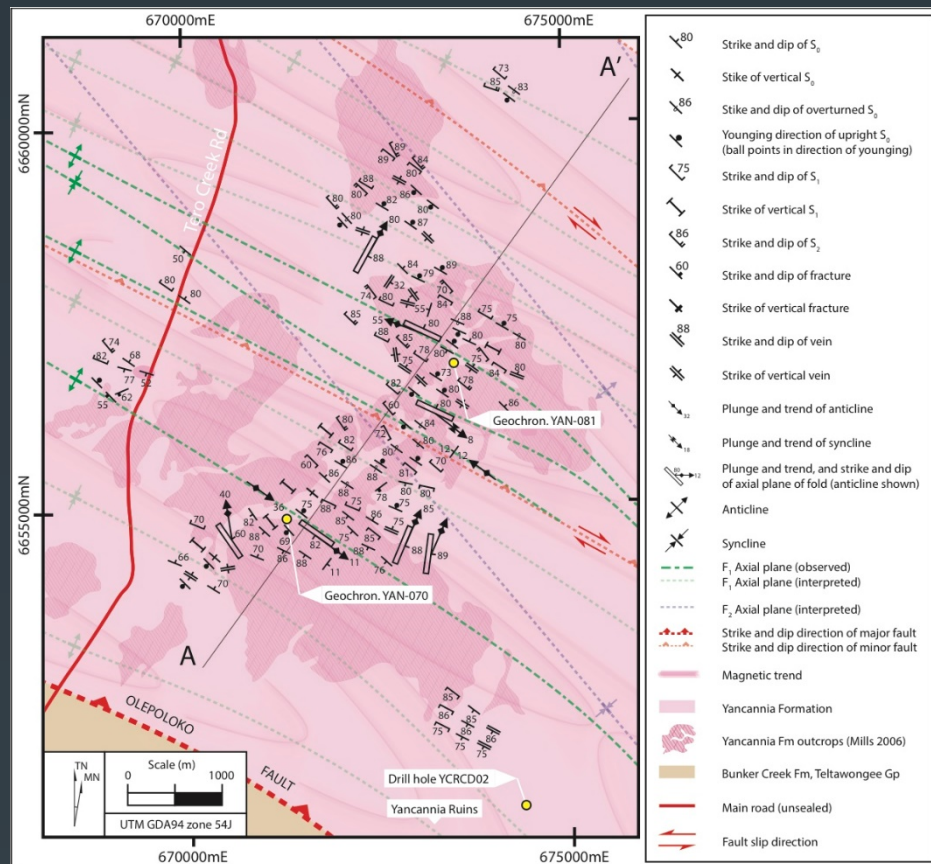


Yancannia structure

First generation folds are upright, inclined doubly plunging
Fits the 1VD imagery

A general weak SE-NW overprint

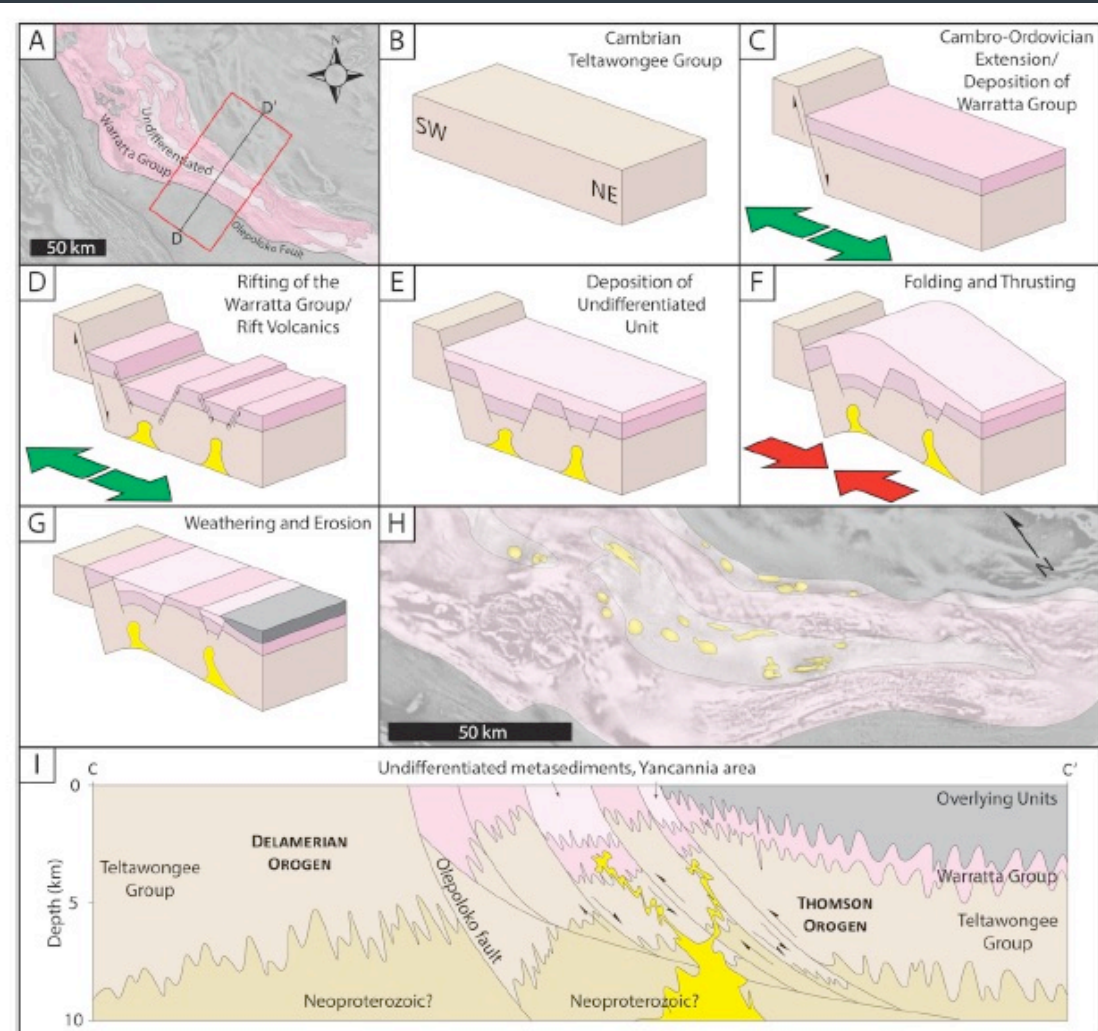
Benambran deformation (cut by 428-422 Ma Tibooburra granite)



Difficult to escape the conclusion that the Warratta Group (STO) conformably overlies Teltawongee (Delamerian)

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Focussing on the detrital zircon age spectra for the Yancannia Formation

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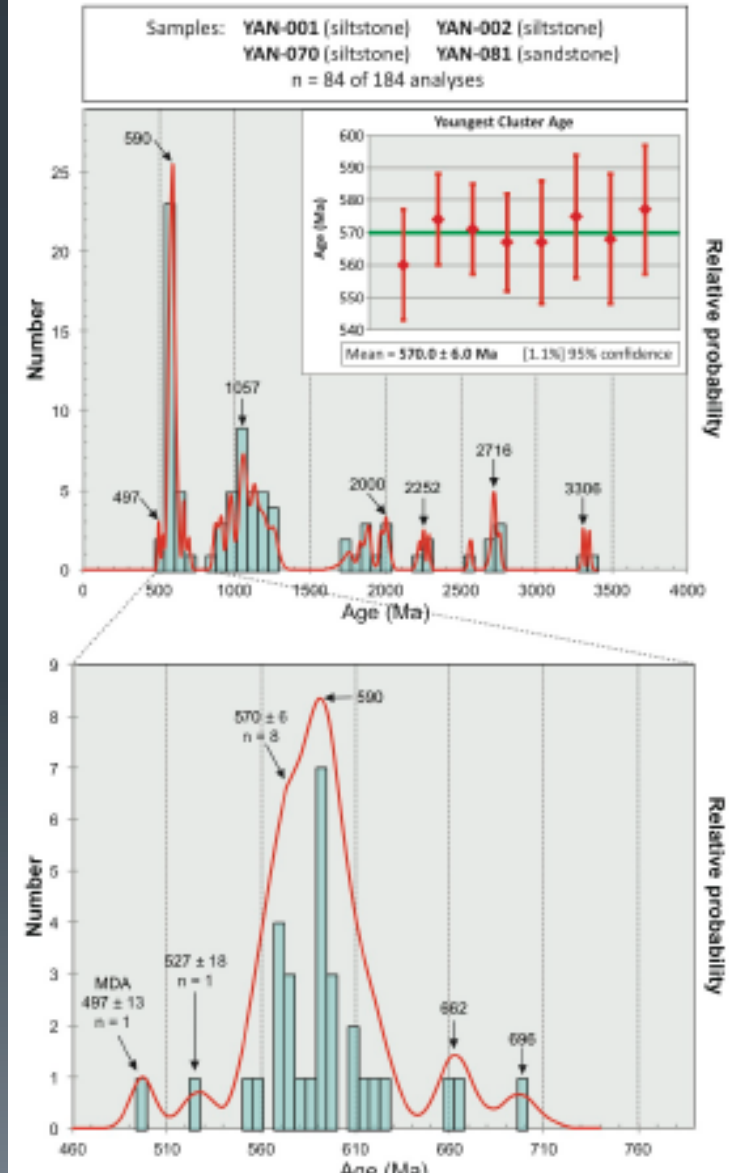
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Youngest grain is 497 ± 13 Ma

Interbedded tuff in Warratta Group is 497 ± 3 Ma
(Late Cambrian age)

Youngest major age cluster is 570 ± 6 Ma;
Peak at 590 Ma

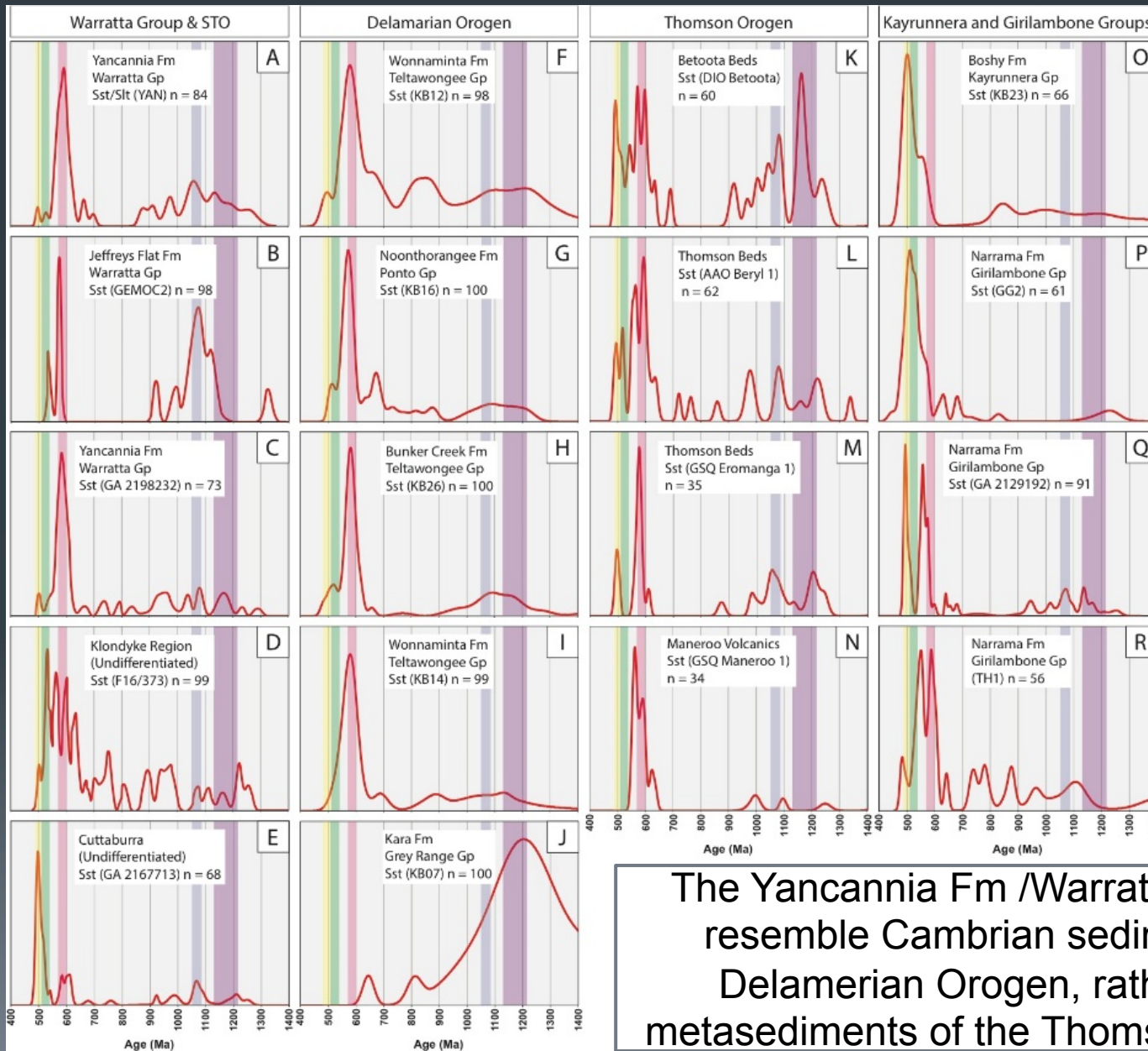
Distinct age cluster at 1100-1000 Ma (Musgravian)



Regional comparisons

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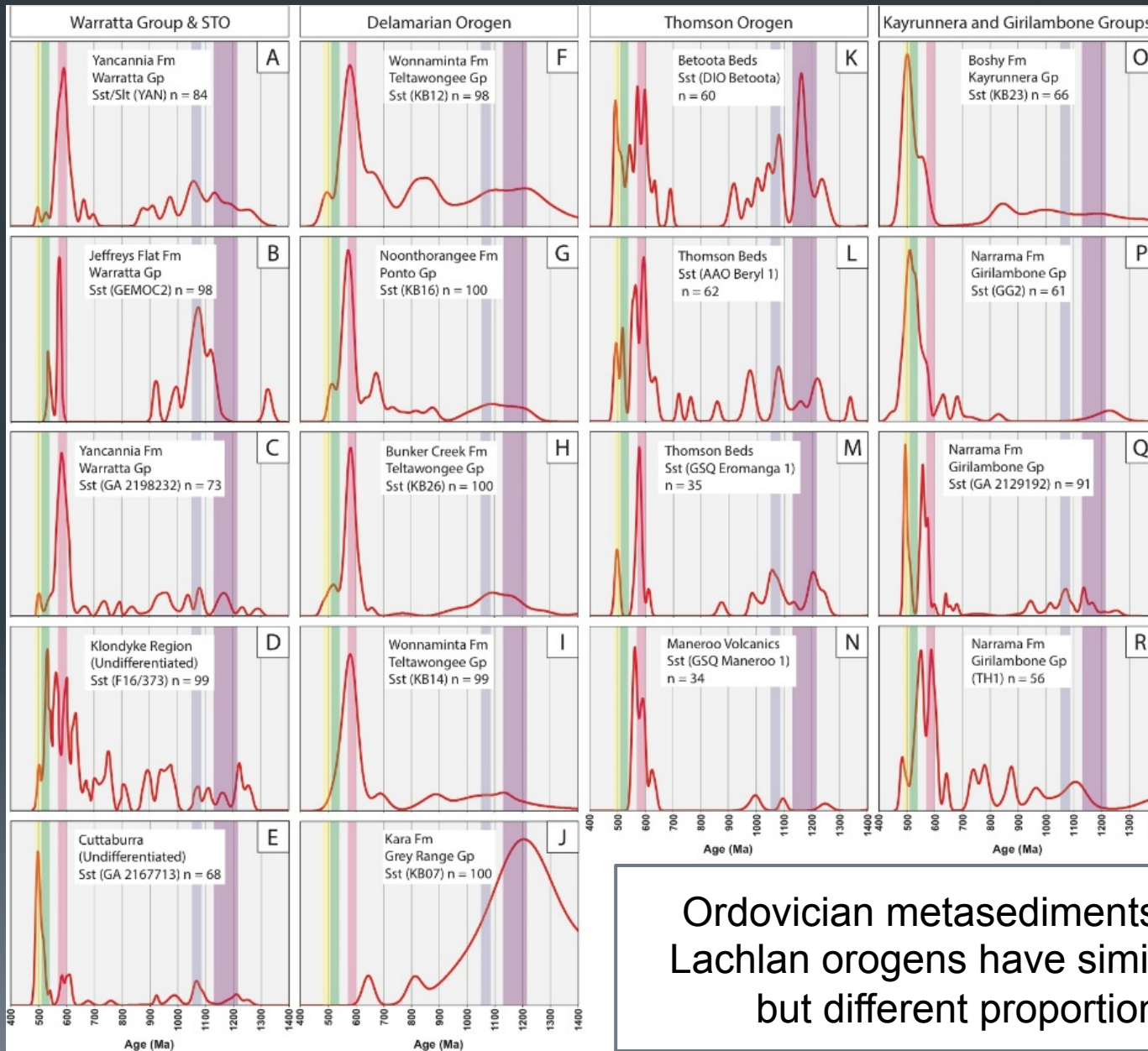


The Yancannia Fm /Warratta Group most closely resemble Cambrian sedimentary rocks of the Delamerian Orogen, rather than Ordovician metasediments of the Thomson or Lachlan orogens

Regional comparisons

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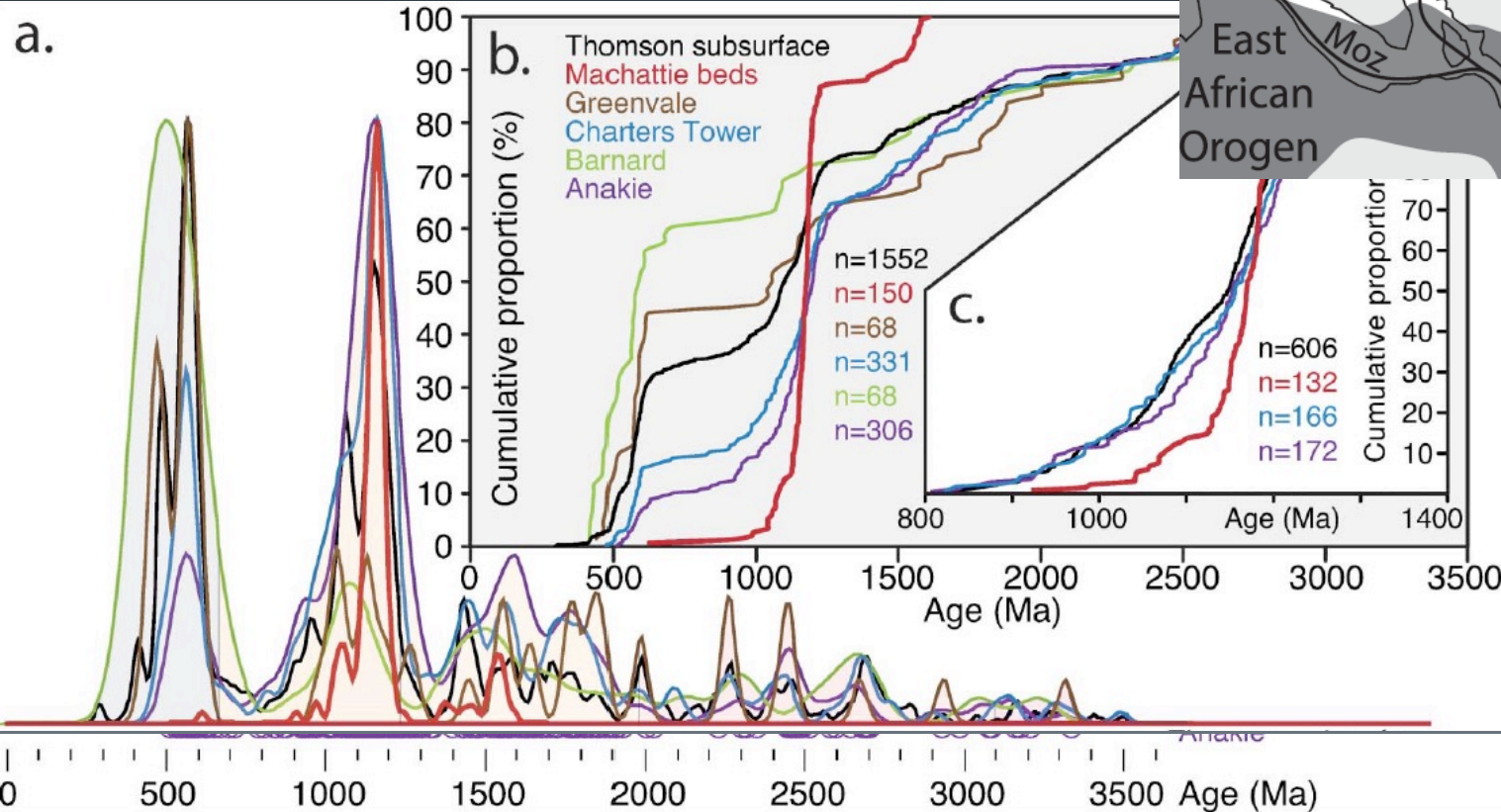
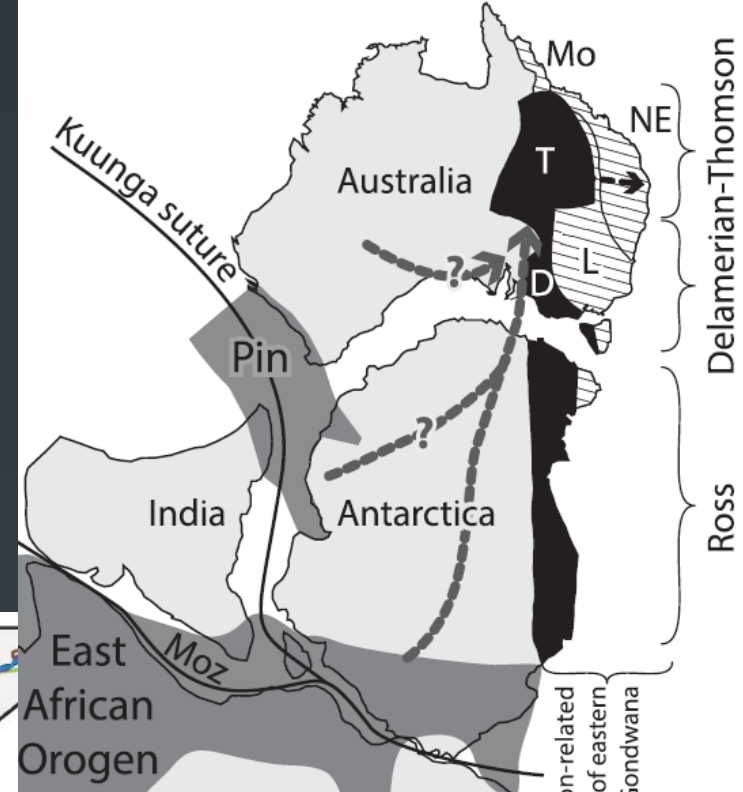
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Ordovician metasediments of the Thomson and Lachlan orogens have similar MDAs (same age), but different proportions of age clusters

The large 1200-1000 Ma peak from the Thomson Orogen

Shaanan et al, 2017



Regional correlations

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- The Warratta Group is likely to be part of the Delamerian Orogen
- The Warraweena Volcanics are likely to be Phase 4 of Macquarie Arc
- The Thomson Beds and Girilambone group are age equivalents
- The Louth volcanics are probable equivalents of the Mineral Hill volcanics
- Cobar Basin strata is apparent in the STO (Louth region)
- Booda Formation (Bourke region) is either Silurian or Early Devonian

- The Southern Thomson Orogen has equal affinities to the Thomson and Lachlan orogens

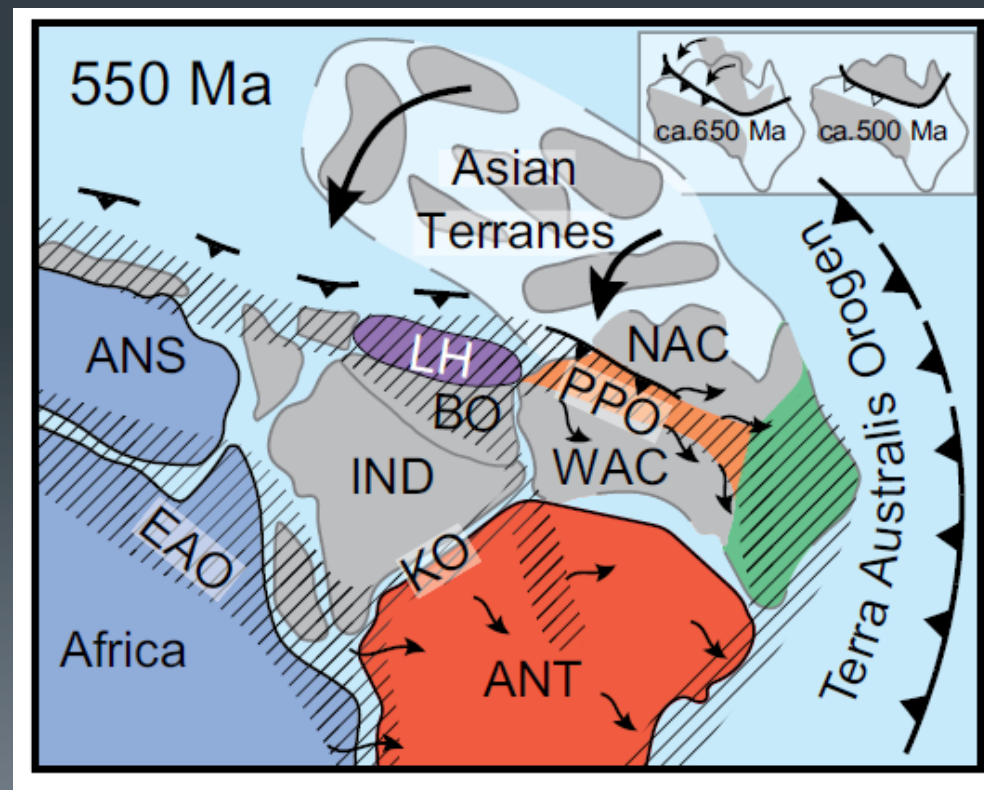
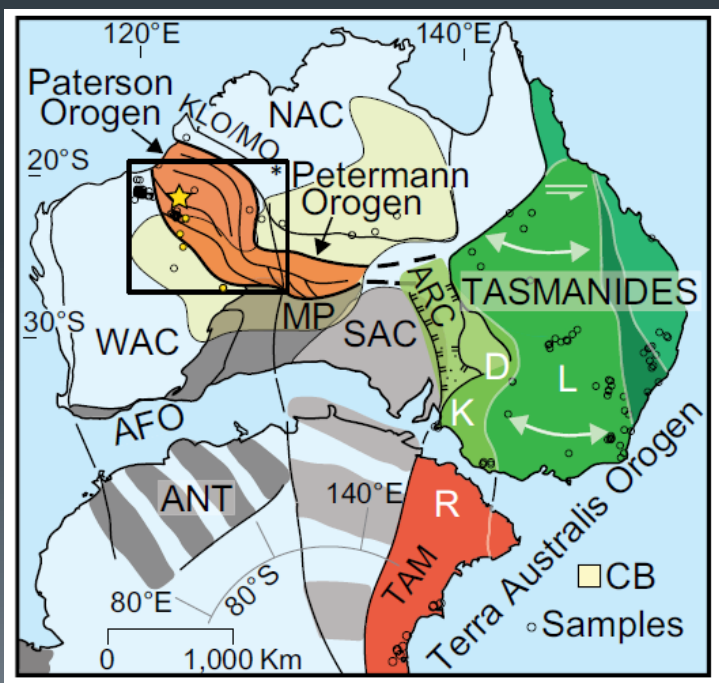
- **The Thomson and Lachlan orogens are tectono-stratigraphic equivalents**

So why do they look different?

The 570-590 Ma zircon populations come from the **Petermann-Paterson Orogen**, not Antarctica, as the Macquarie Arc-Nebine Ridge retreated eastward away from Australia during the Ordovician (hence the 1100-1000 Ma cluster in the Thomson, but not Lachlan orogen)

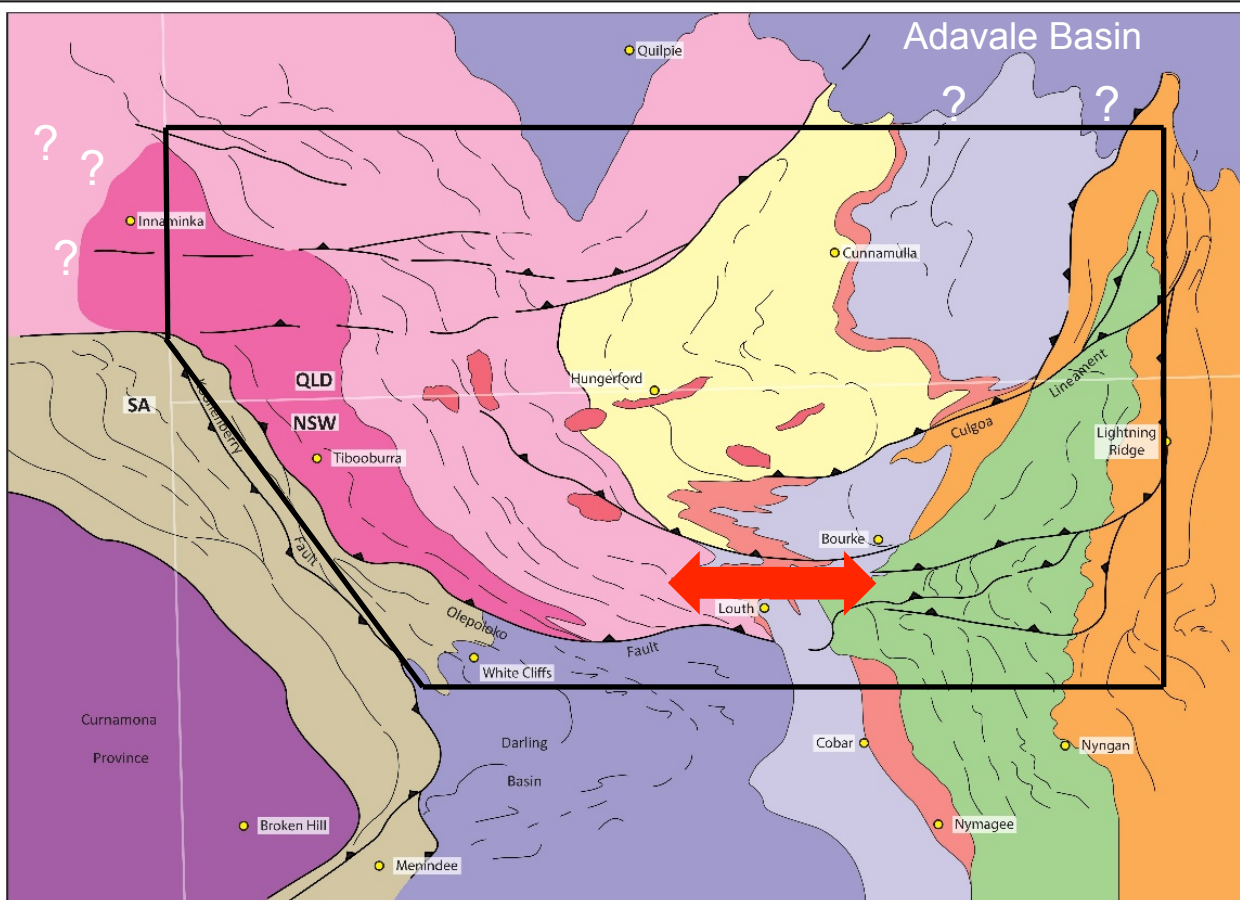
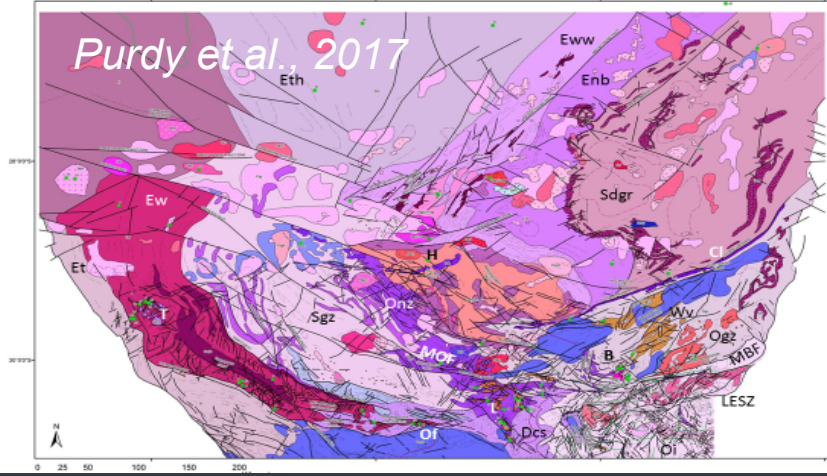
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Martin et al., 2017



Stratigraphic/structural relations between the Lachlan, Thomson and Delamerian orogens

Late Devonian basins in the STO are removed
Cobar Basin underlain by Delamerian/Warratta



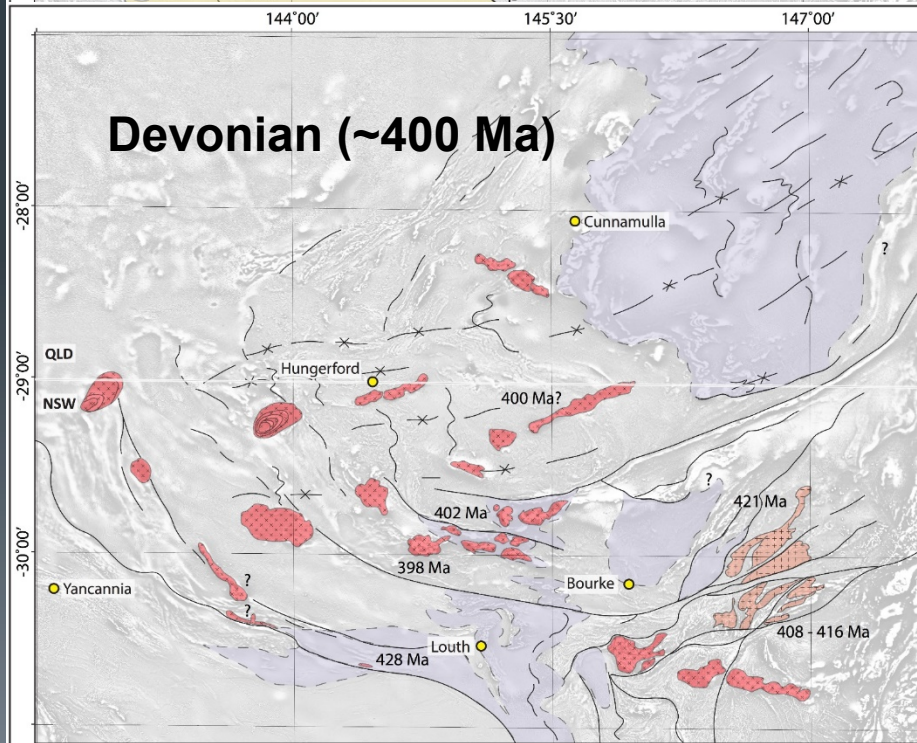
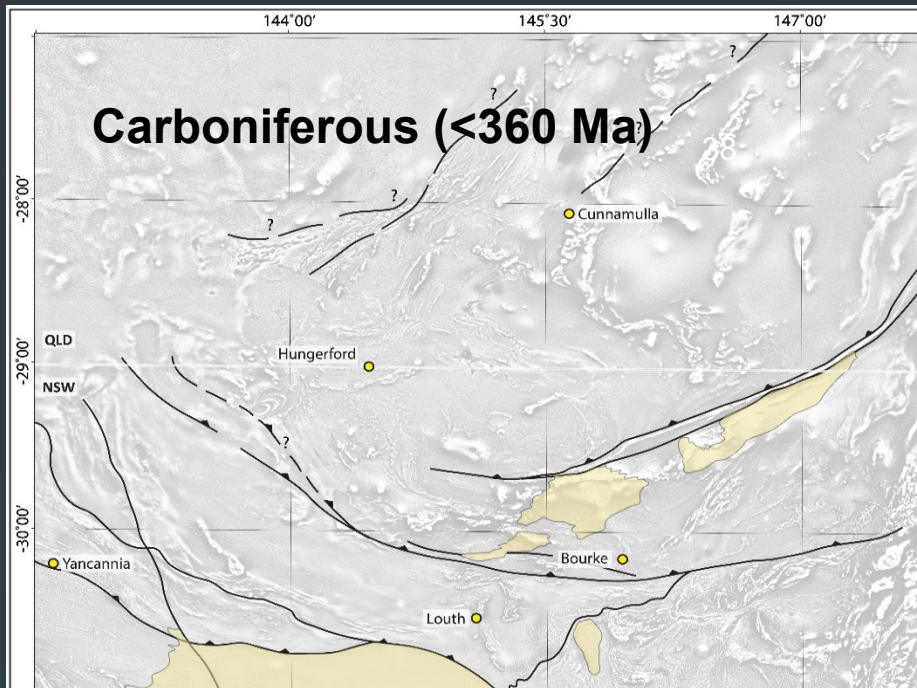
Age Equivalent Units of the Central Tasmanides

- ▲ Major fault
- Fault
- Magnetic trend
- Locality
- Upper Devonian basins
- Late Silurian - Early Devonian basins
- Late Silurian - Early Devonian volcanics
- Girilambone Group
- Thomson beds
- Warratta Group
- Macquarie Arc
- Nebine Metamorphics / Werwilka Fm
- Delamerian Orogen
- Curnamona Province
- Granite plutons

Structural Evolution of the STO

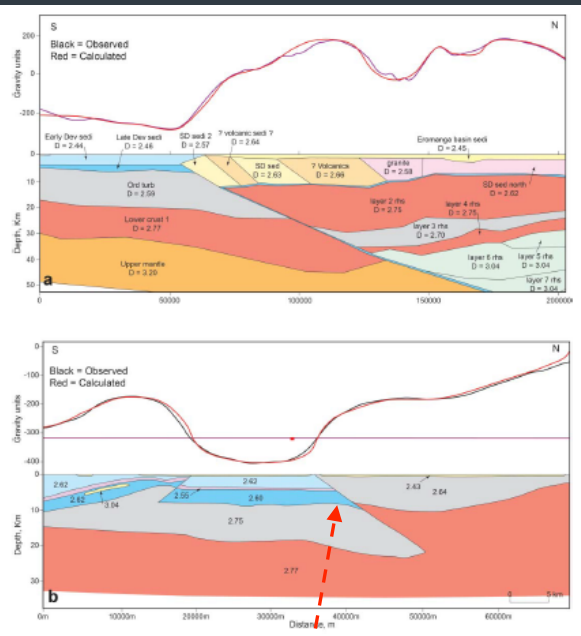
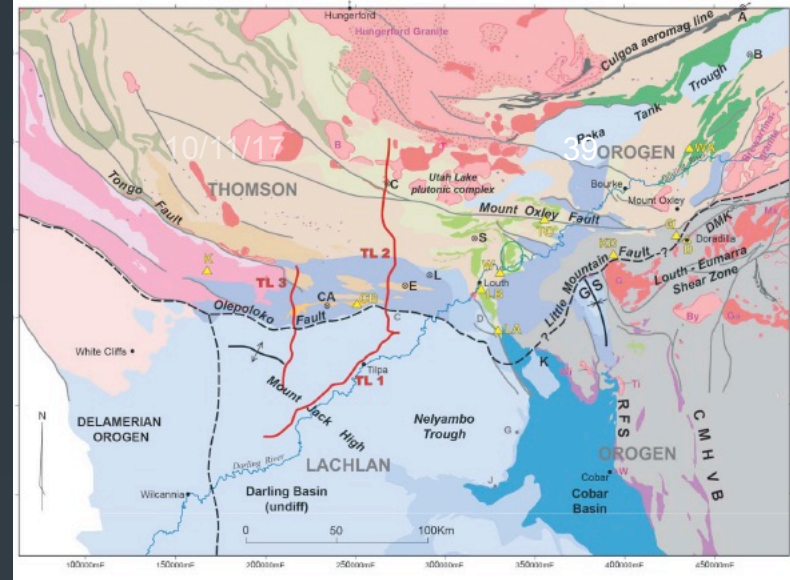
The impact of Late Paleozoic deformation on producing the E-W structural trends

Note the ~400 Ma ages for the ENE-trending granitic plutons, axial planar to the NE-trending folds



Deep seismic imaging of the Oleopoloko Fault

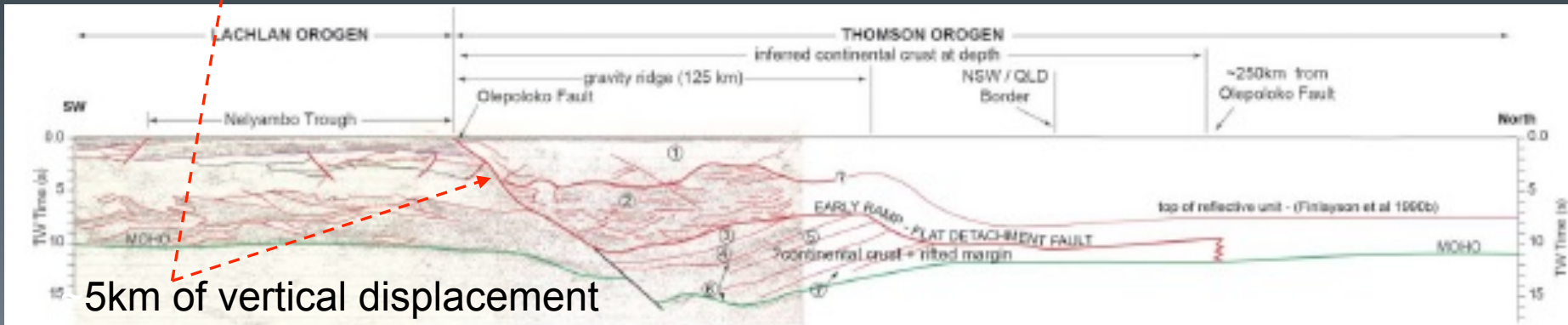
Glen et al., 2013)



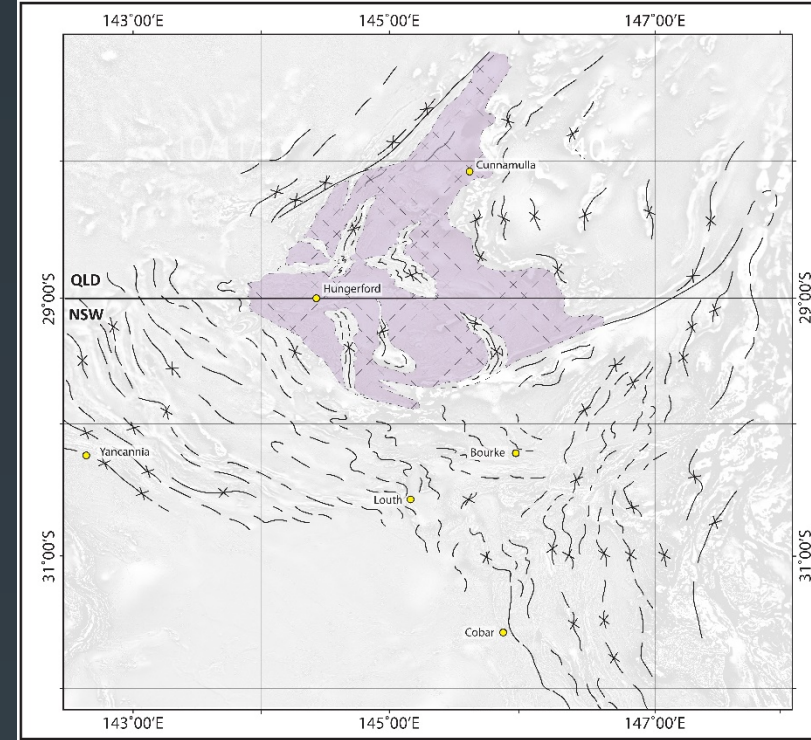
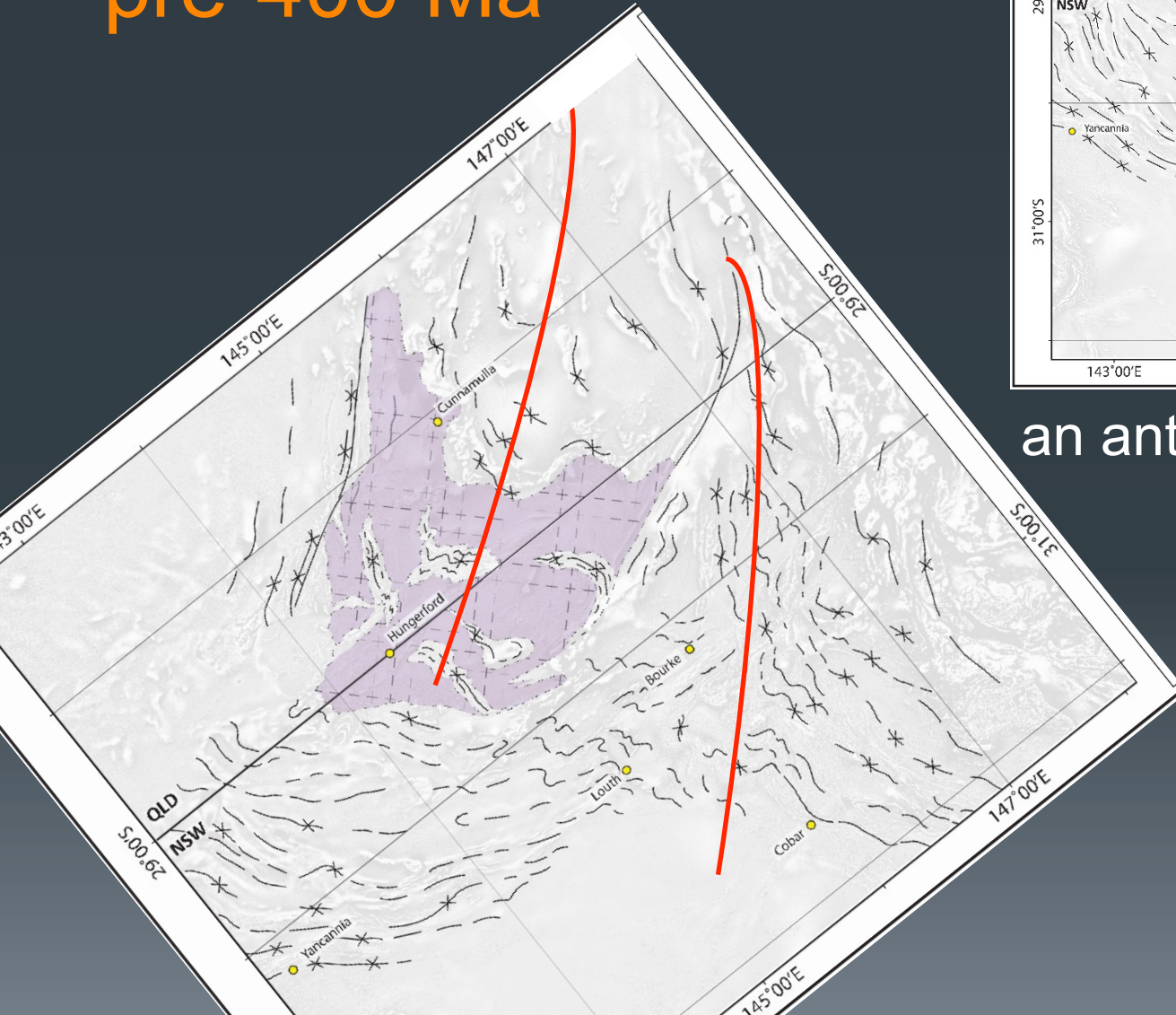
Forward modelling of gravity data along both lines

Major Carboniferous deformation

Interpreted combined deep seismic reflection data



Structural Evolution of the STO: pre-400 Ma

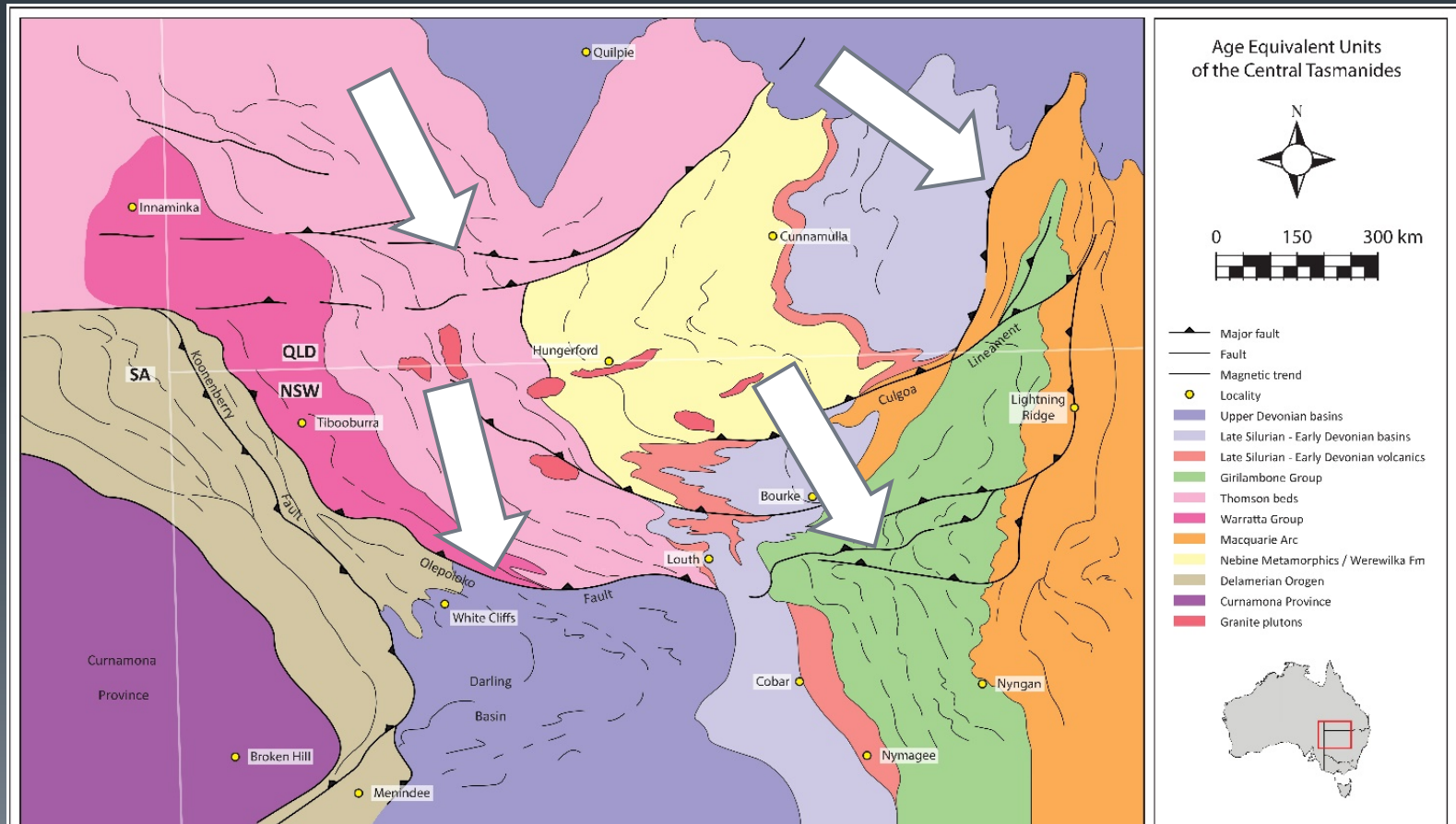


an anticlinorial-synclinorial
fold structure

The present arrangement of crustal structure in the STO is largely a result of continental-scale, Devonian-Carboniferous transpressive deformation (Alice Springs orogeny)

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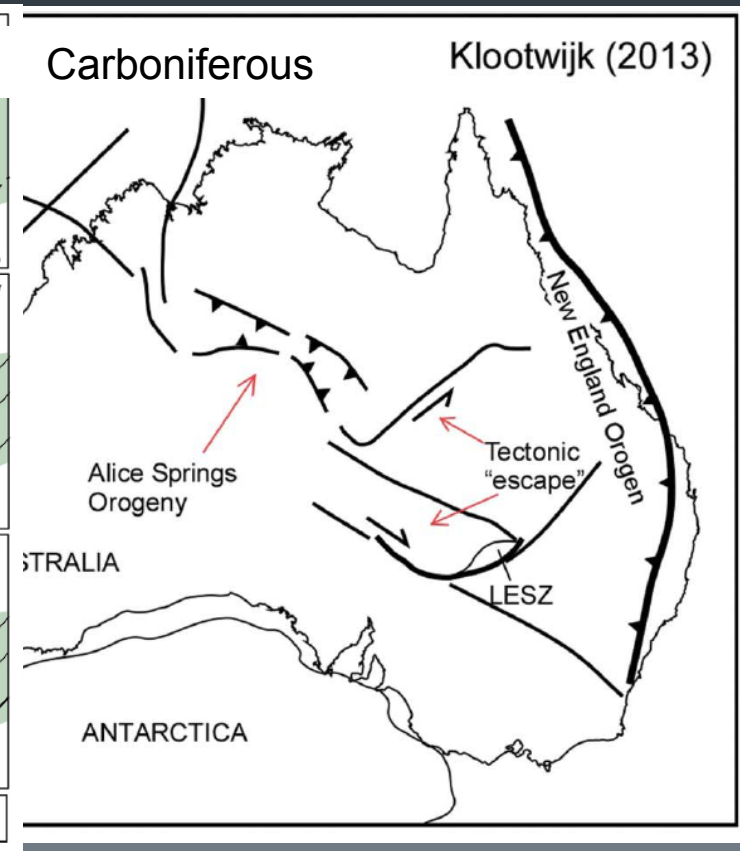
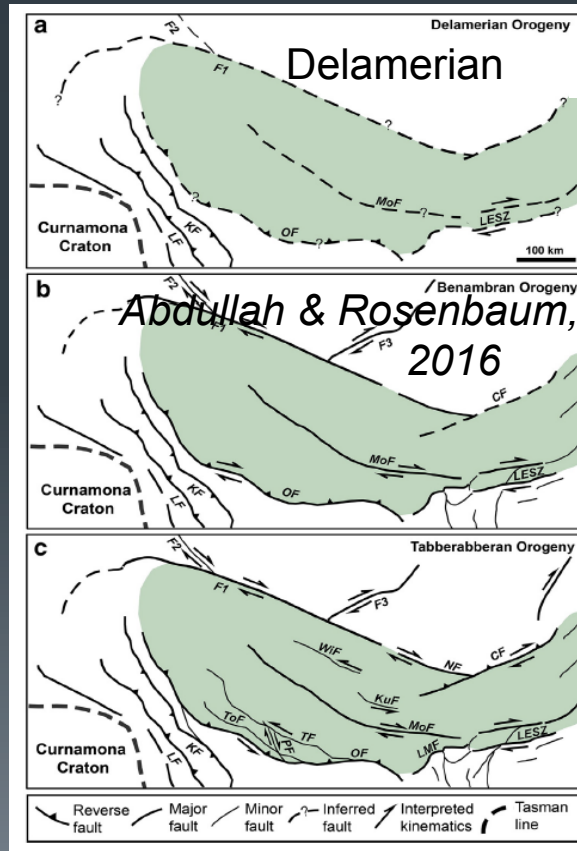
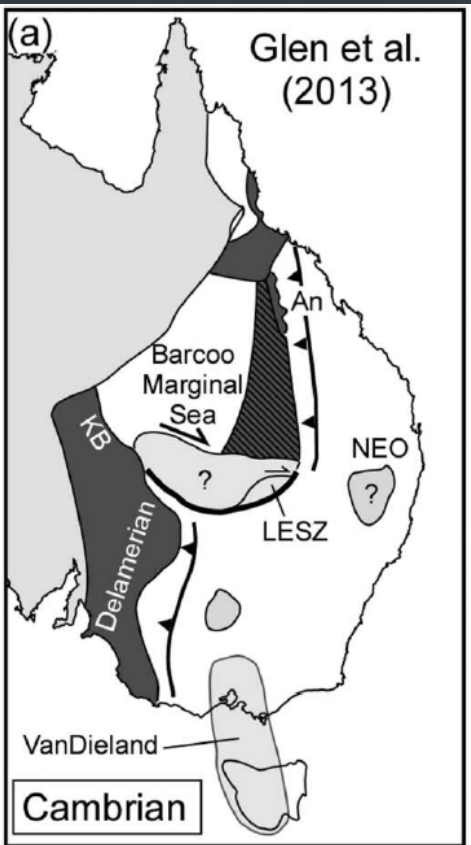


Opposed tectonic models for the STO

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- (a) No evidence of a Neoproterozoic arc (Nebine Ridge may be Neoproterozoic continental ribbon – N extension of Macquarie arc?)
- (b) No evidence of a reactivated Delamerian orocline
- (c) Compelling evidence for major Devonian-Carboniferous deformation



Reverse fault Major fault Minor fault Inferred fault Interpreted kinematics Tasman line

Broader implications

10/11/17

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- Macquarie arc (Phase 4) probably exists in the STO (N & S of the Conlea lineament)
- Thomson beds and Girilambone Group probable equivalents
- Cobar Basin most likely exists in the STO (interbedded with Mineral Hill volcanic equivalents)
- Booda Fm (near Bourke) could be Tumut Trough equivalent
- Don't drill magnetic "pin-anomalies" (Permo-Triassic diatremes)