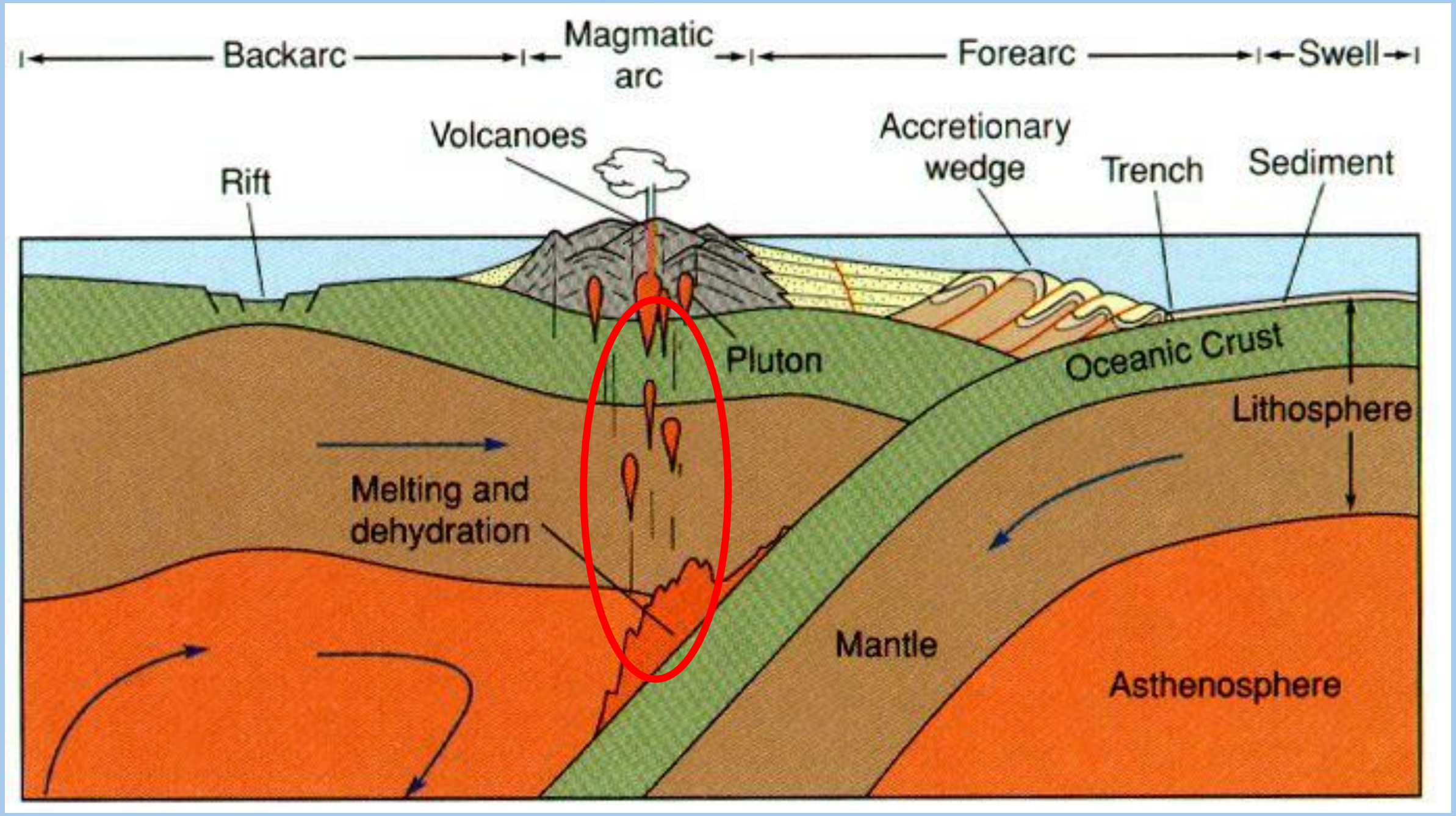
A plate tectonic approach to high-tech metals in NSW

Keynote Presentation
Exploration in the House
May 9th 2025

Dick Glen

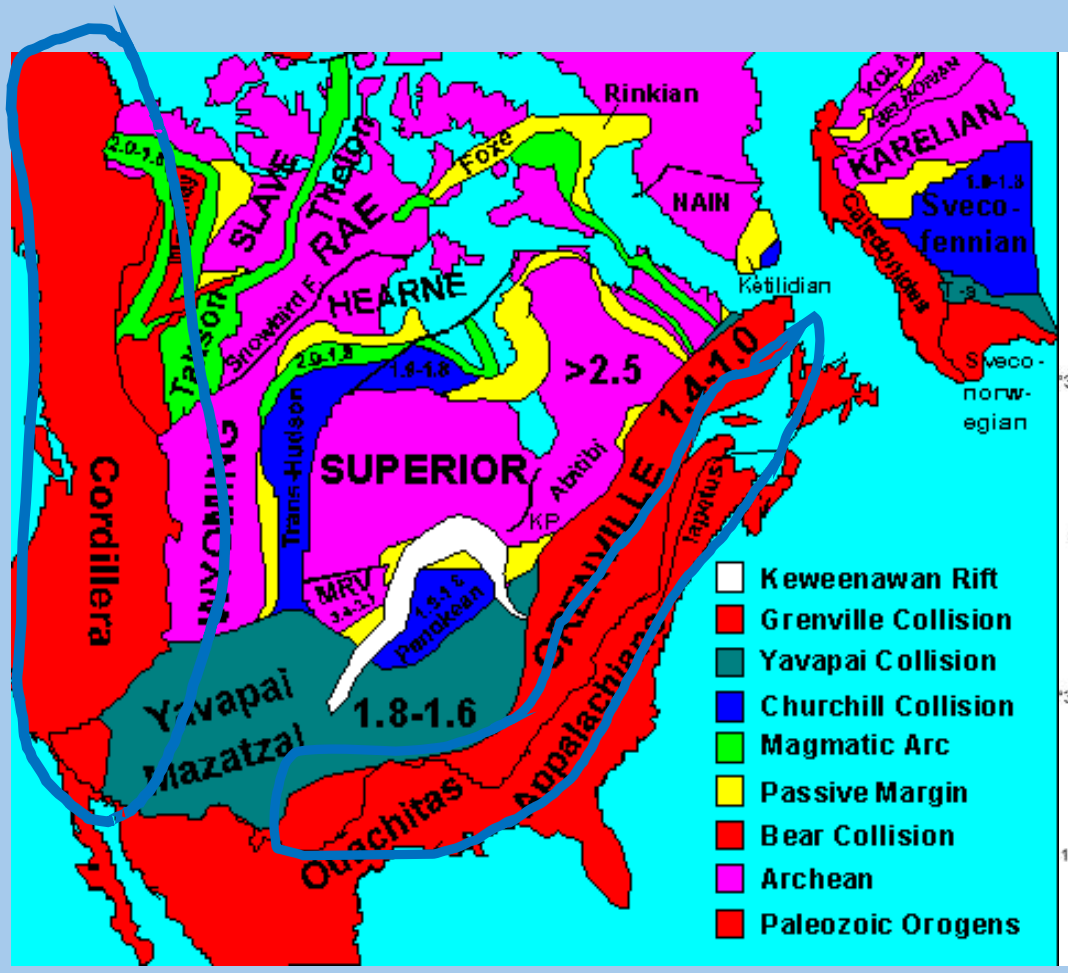
Macquarie University

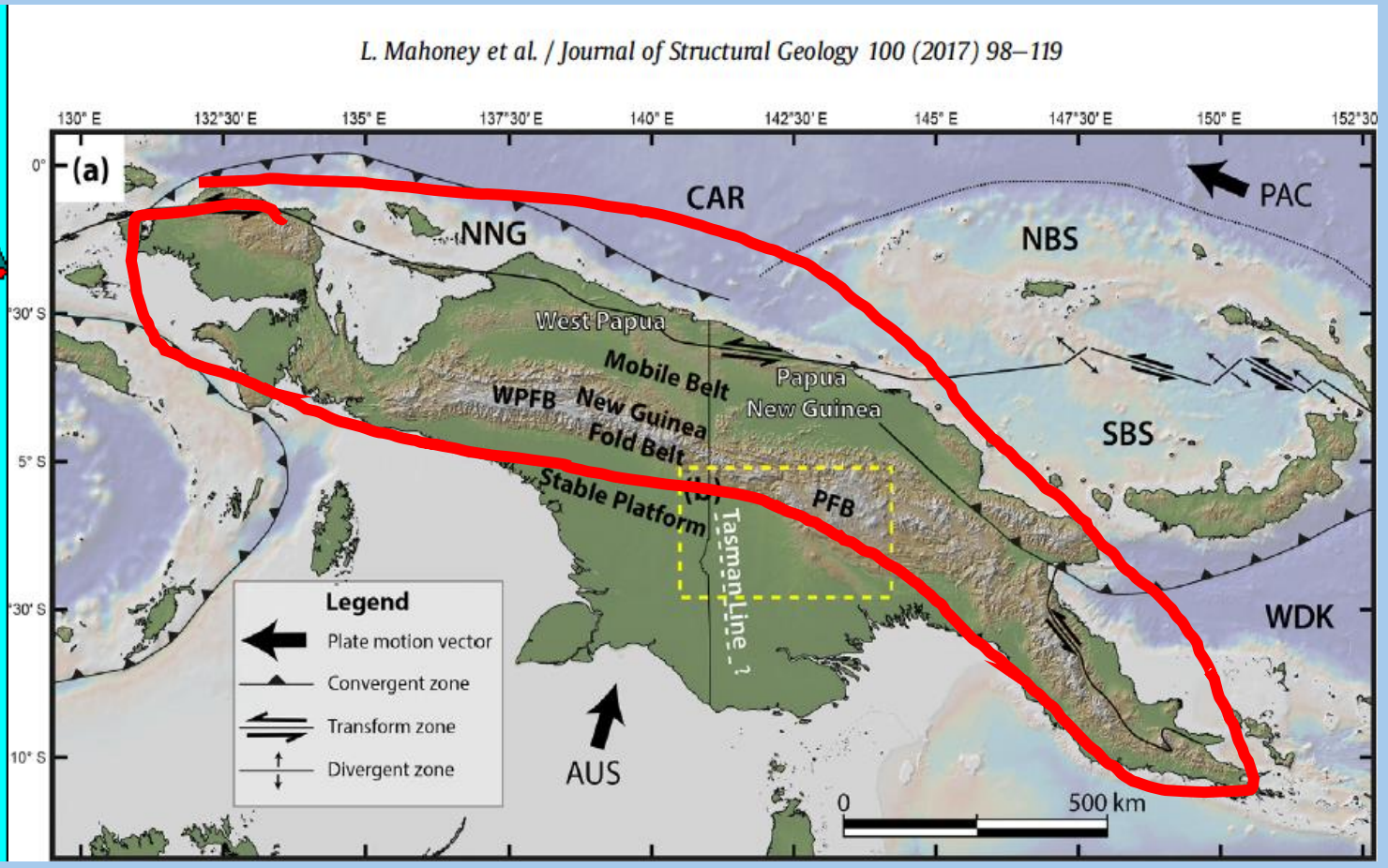
Sydney



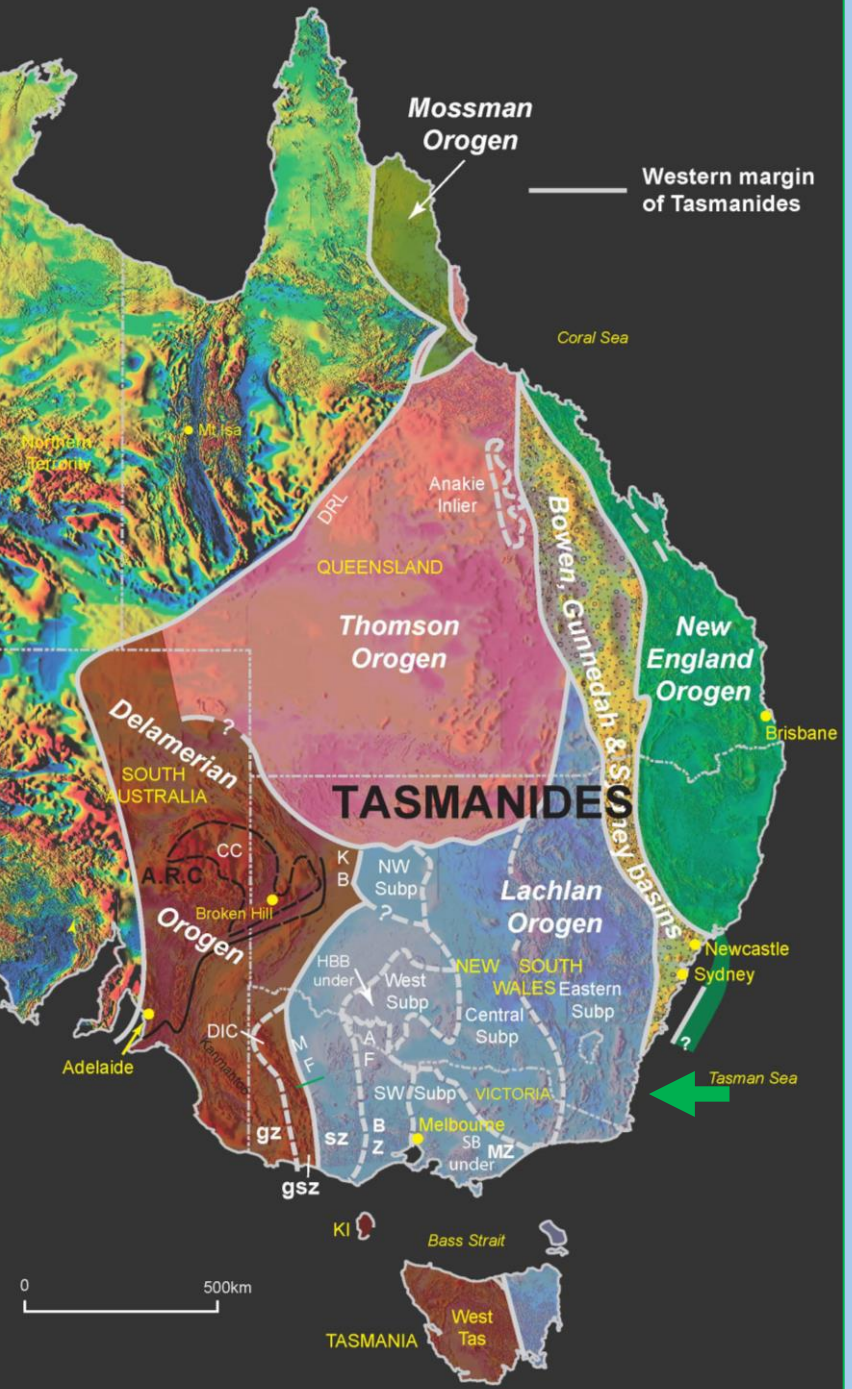
eol.umd.edu/~piccoli/100/Image200.jpg

Rj Stern





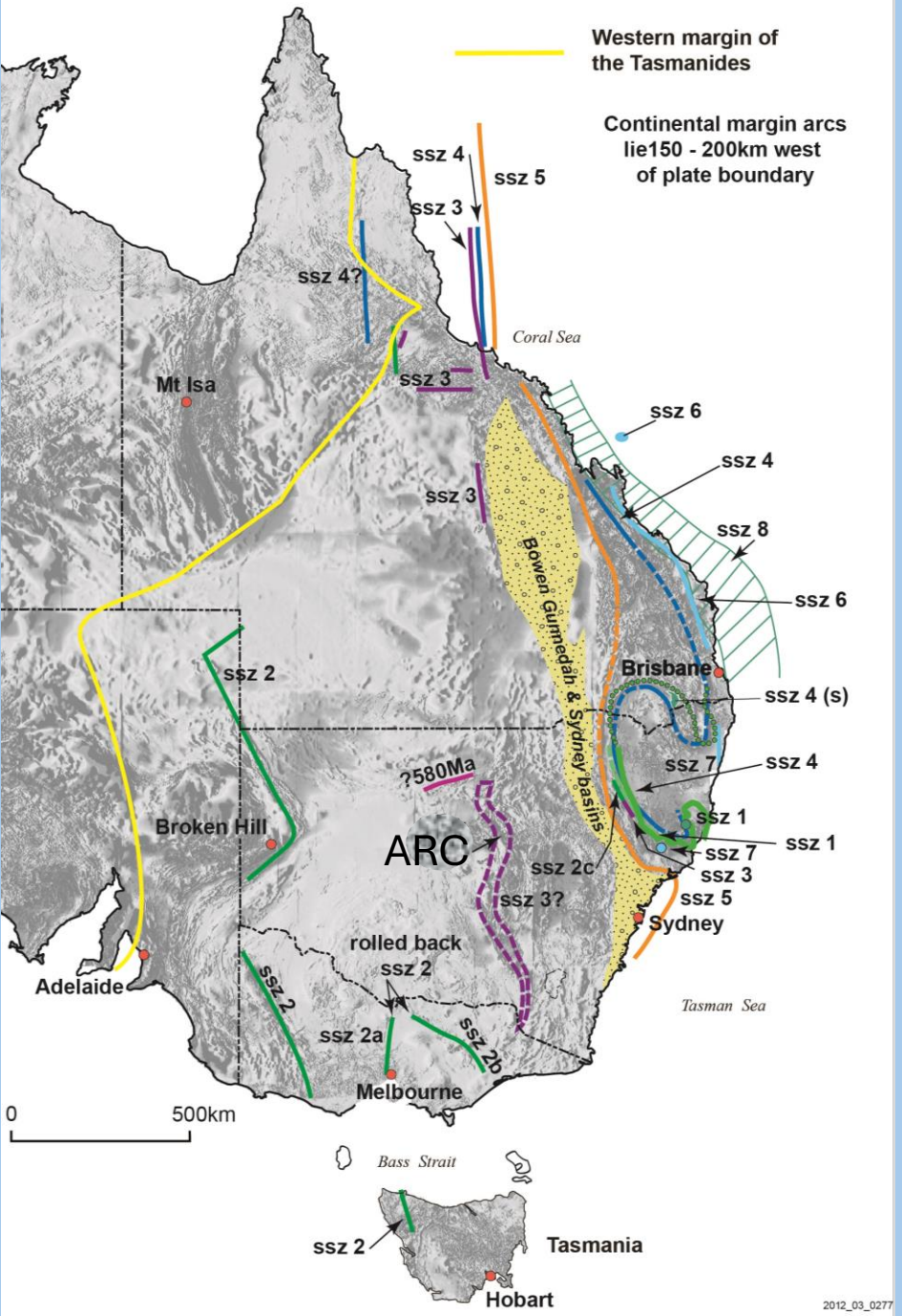
https://instruct.uwo.ca/earth-sci/200a-001/09hist.htm

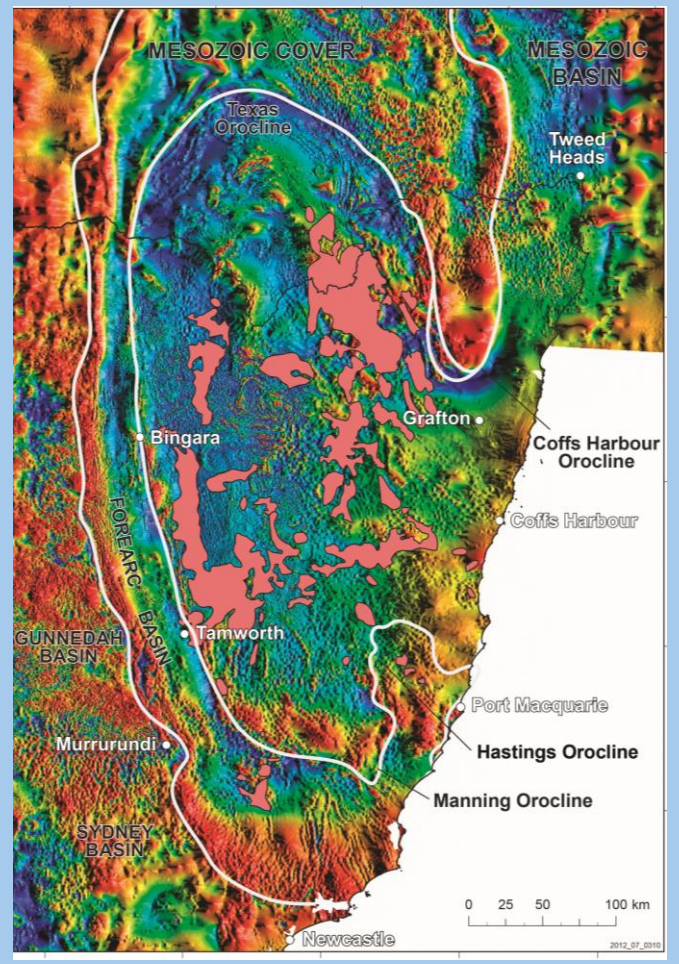


Why are the Tasmanides so wide?

Modified from Glen (2013, AJES volume 60)

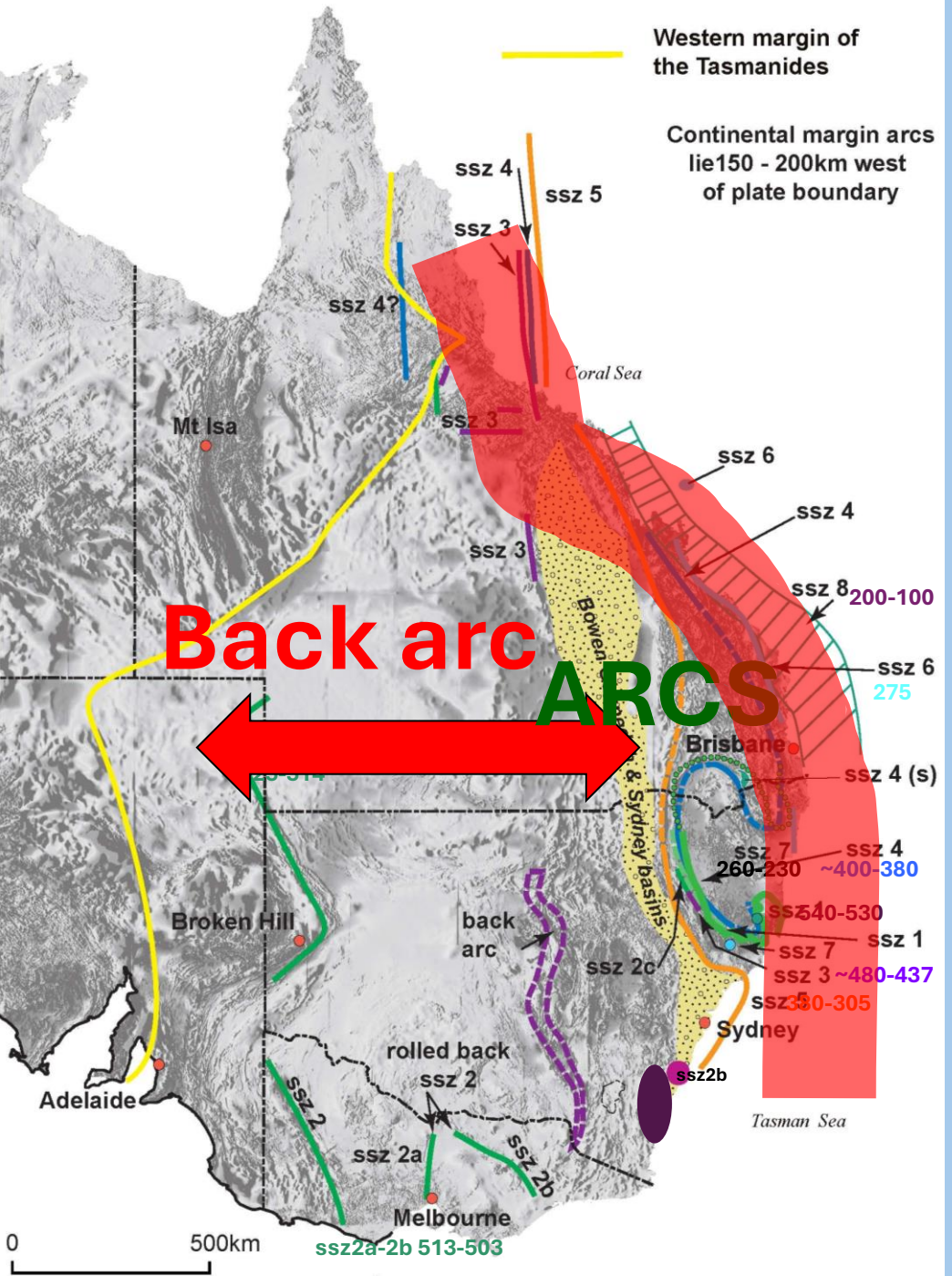
Answer 1: OROCLINES





Modified from Glen (2013, AJES)

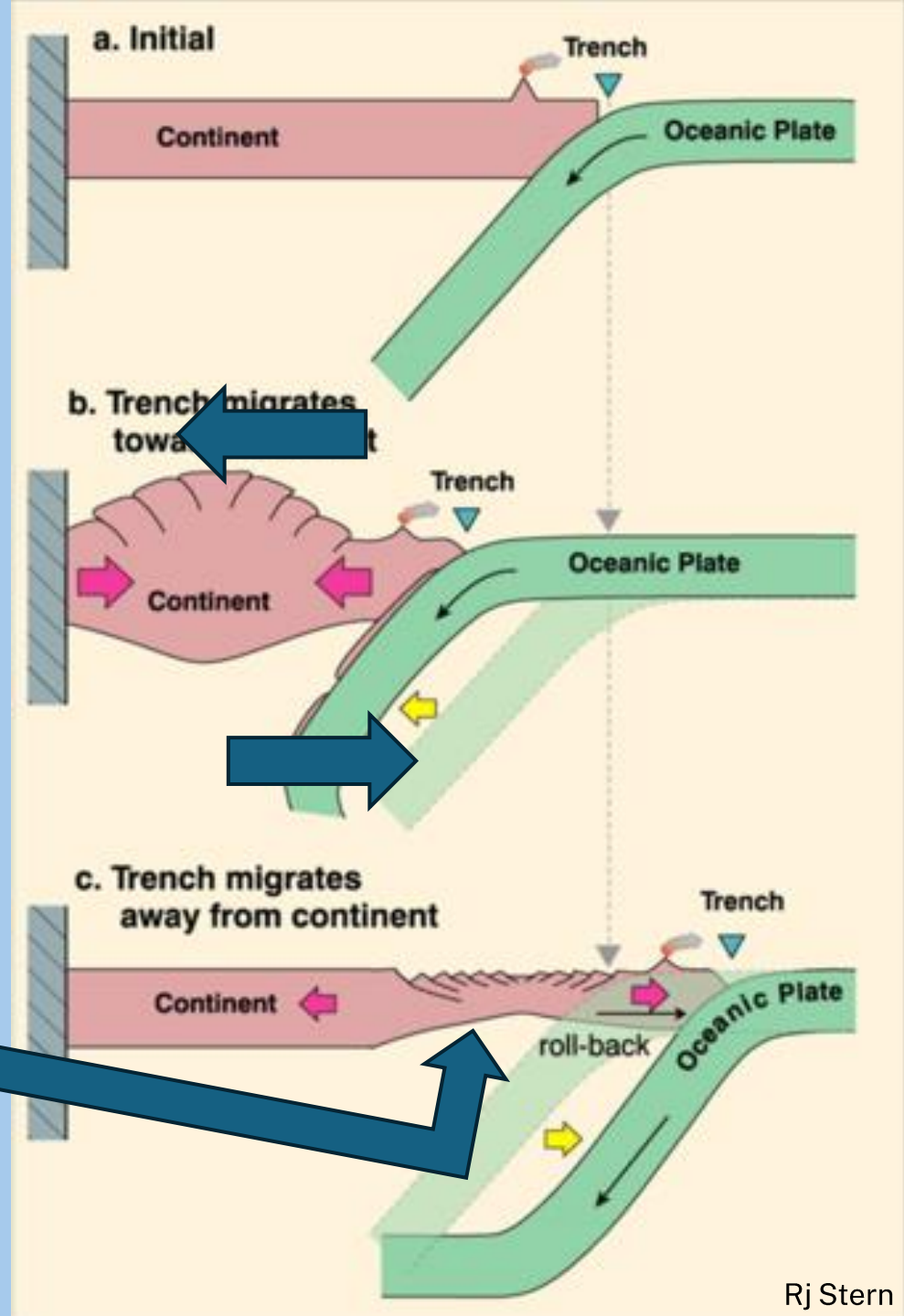
Glen & Roberts 2012 & unpubl



Answer 2: opening BACKARC BASINS

Behind end-Ordovician to end-Cretaceous arcs

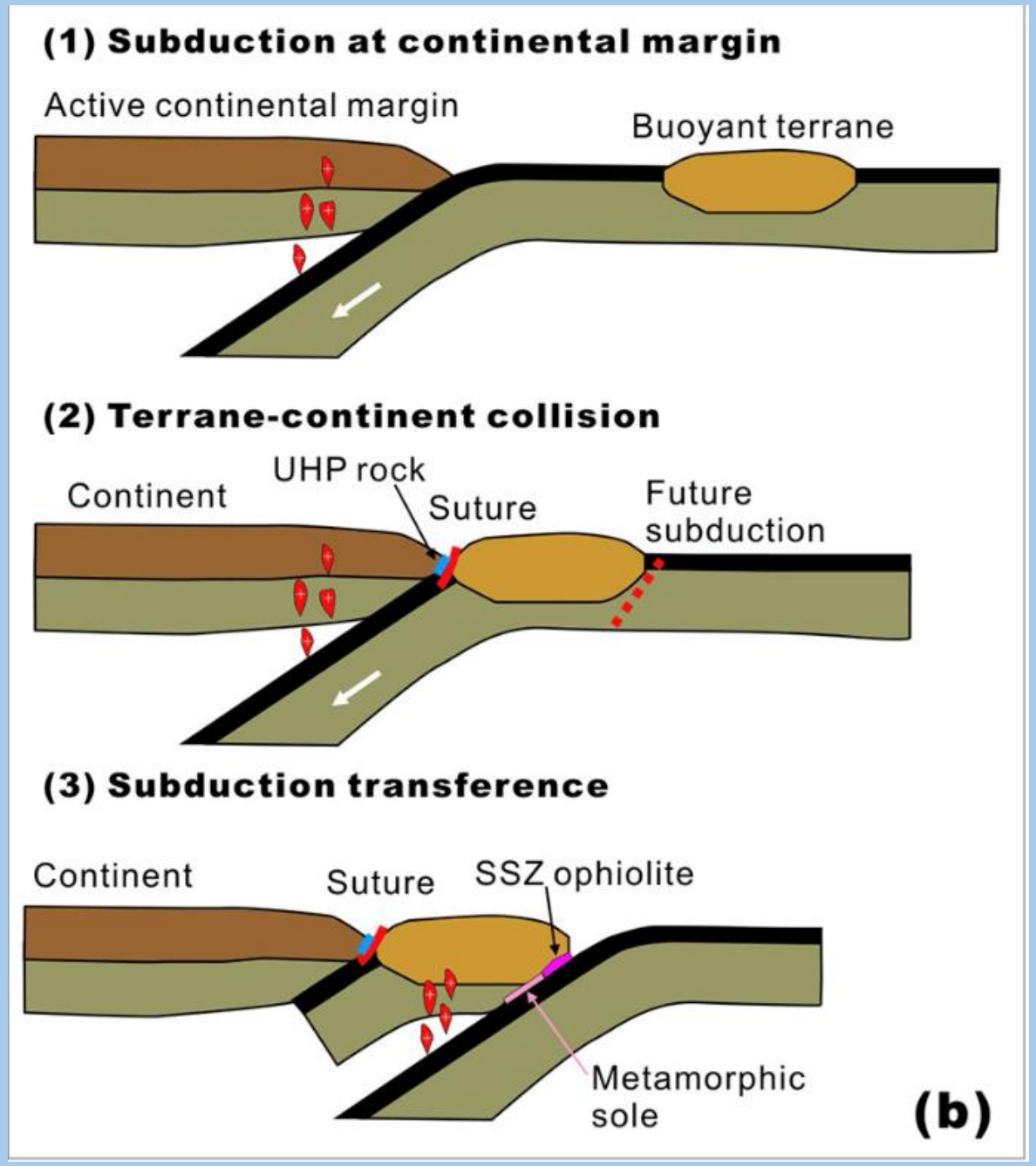
Location of subduction zone is not fixed in position or dip-reflects ....



Wide back arc

https://quizlet.com/ca/tal-crust-flash-cards/

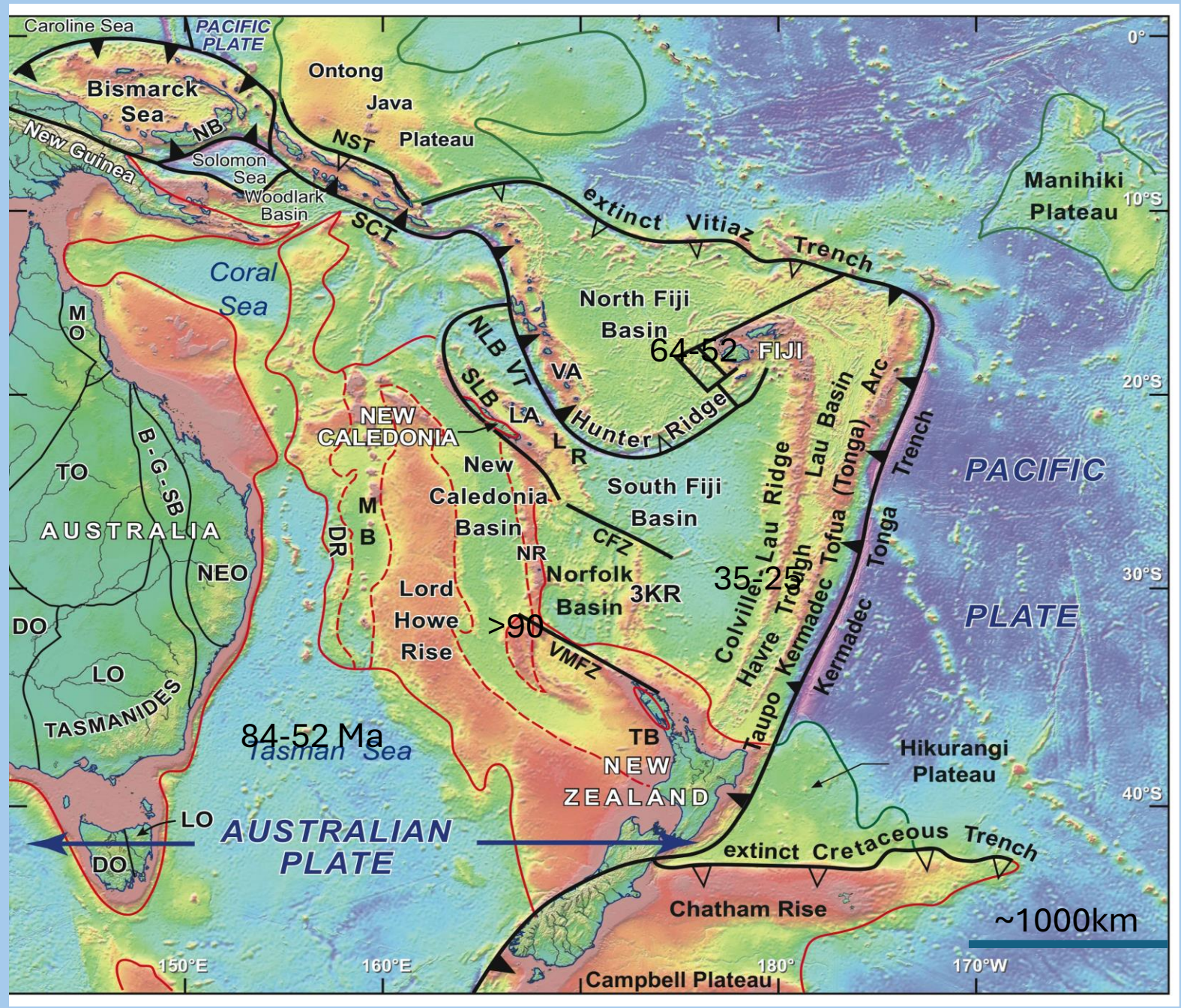
Rj Stern



Yang 2022

Rj Stern

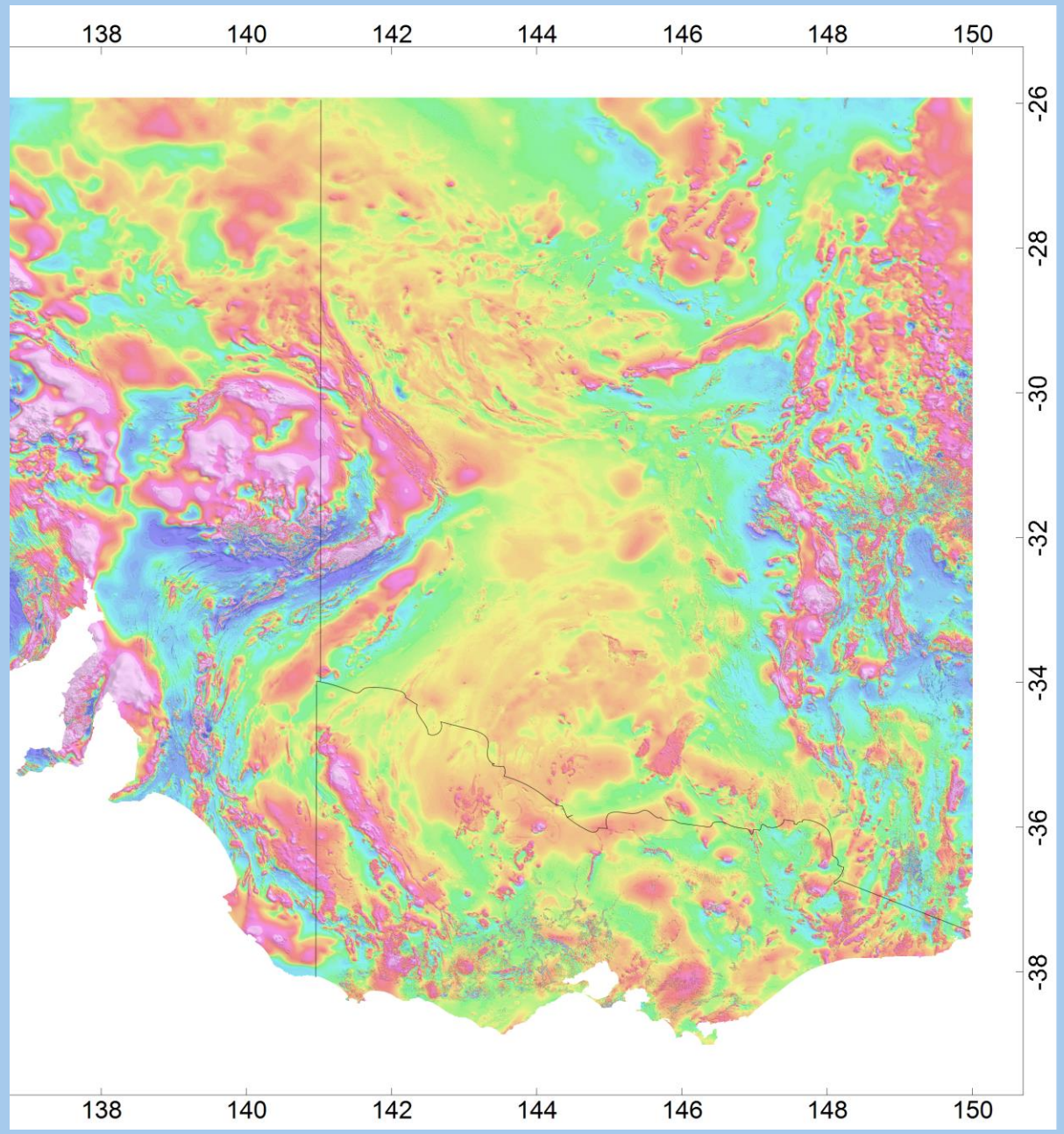
Mod after Mortimer et al. 2008, Glen & Roberts 2012, and interpreted from Packham & Hubble 2016



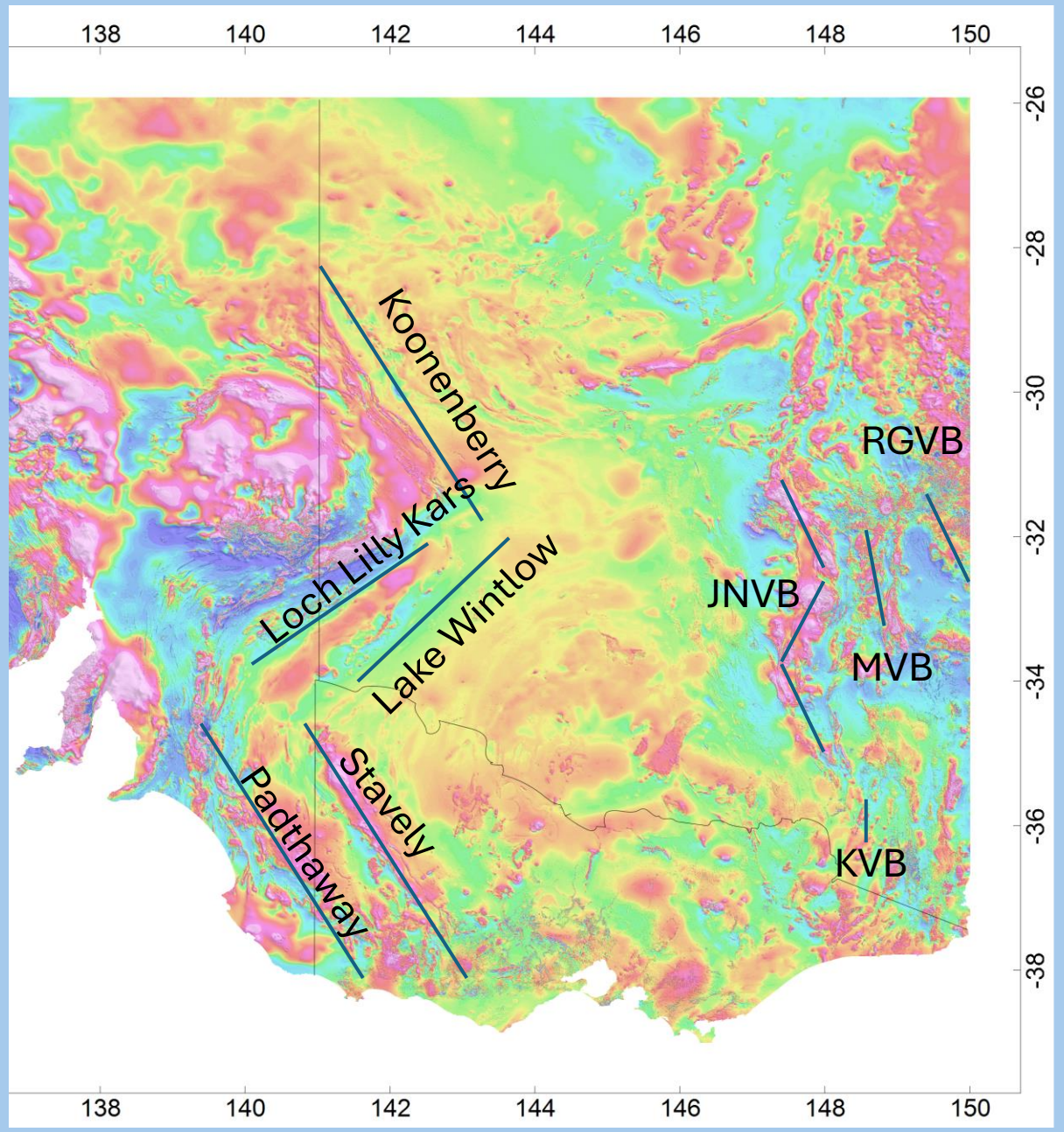
After Crawford et al. 2003

Mortimer et al.

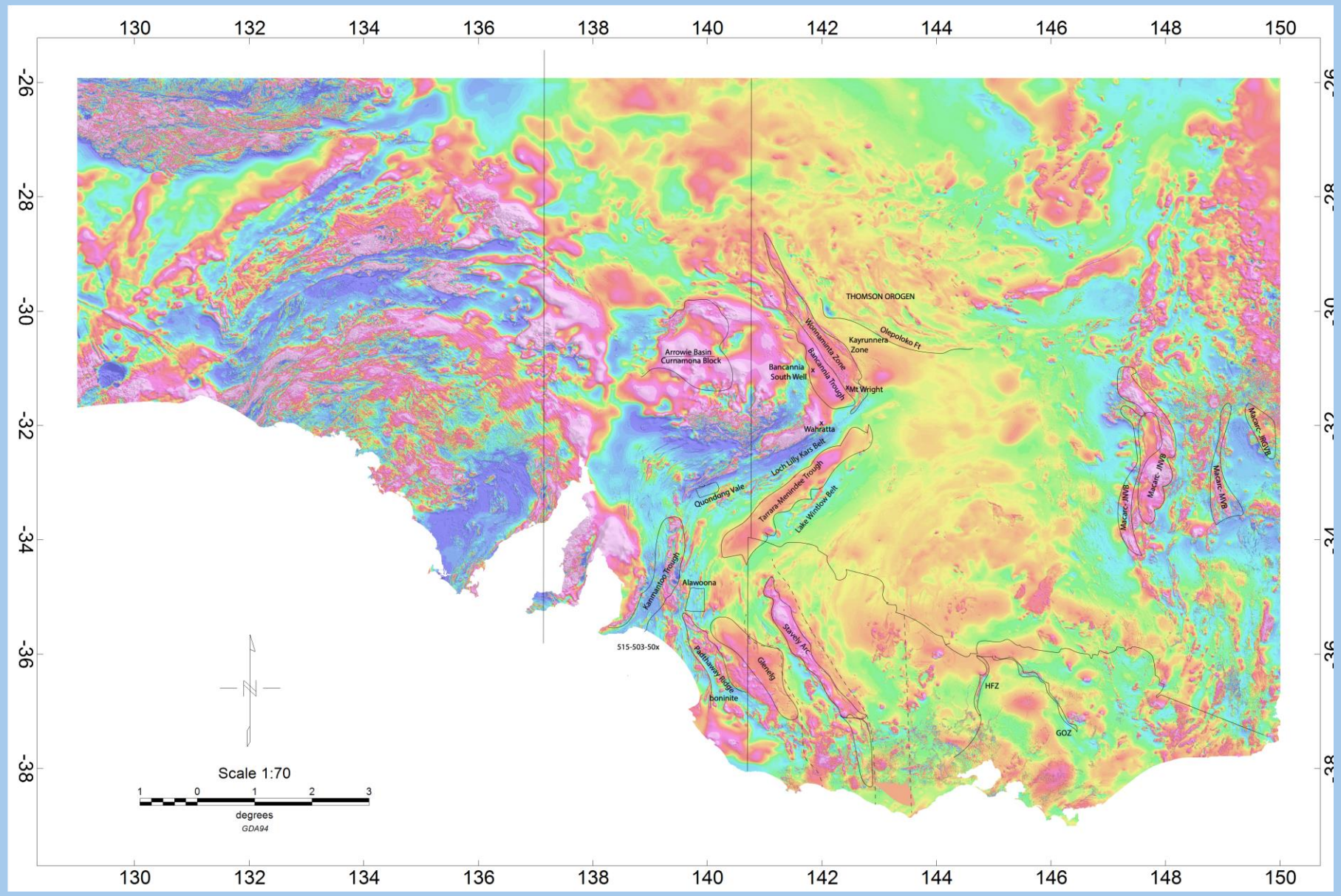
1. So lets look at rifting starting from the Cambrian Arc



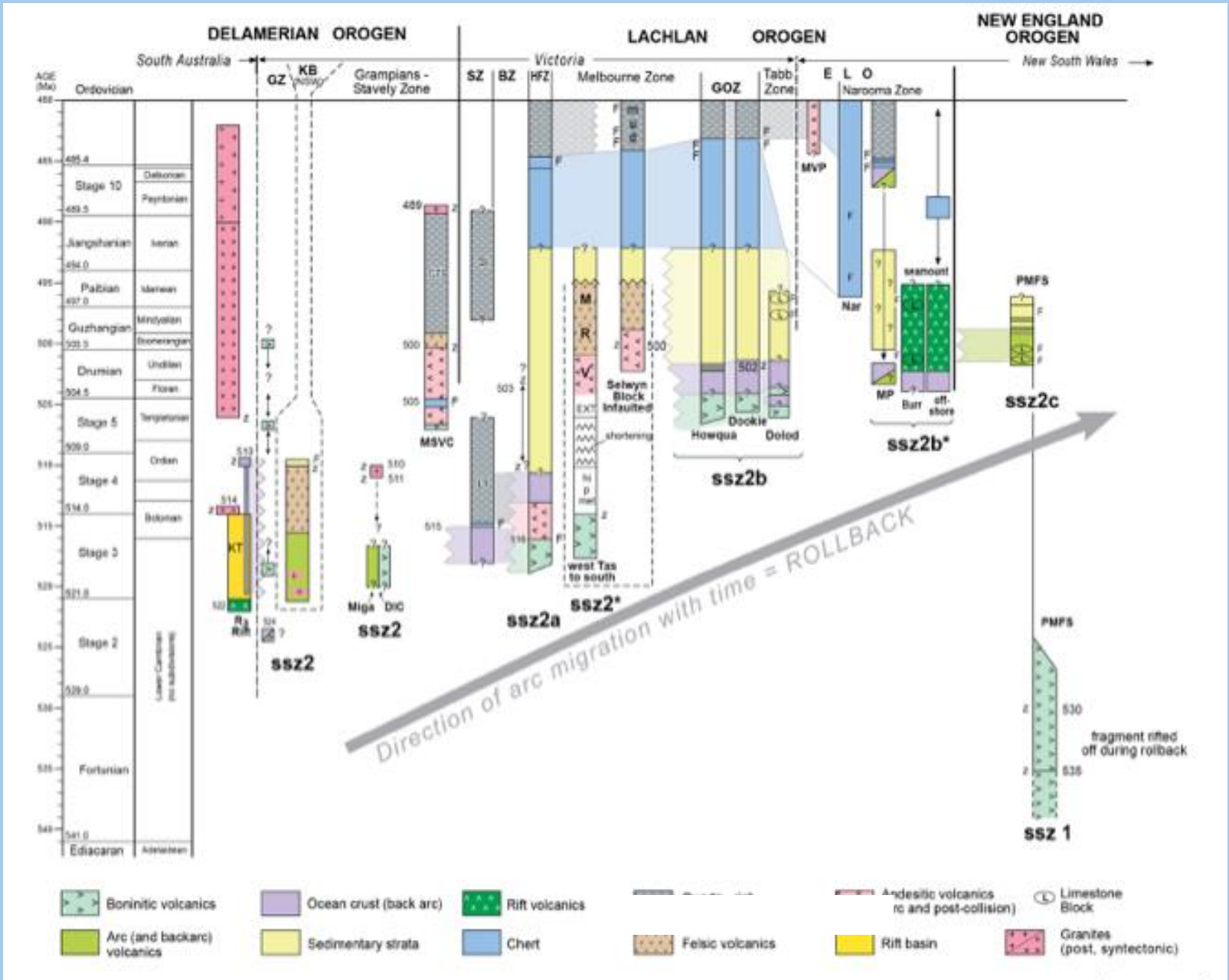
Gravity image courtesy of Yvette Poudjom-Djomani



Simplified version RG 05/2025



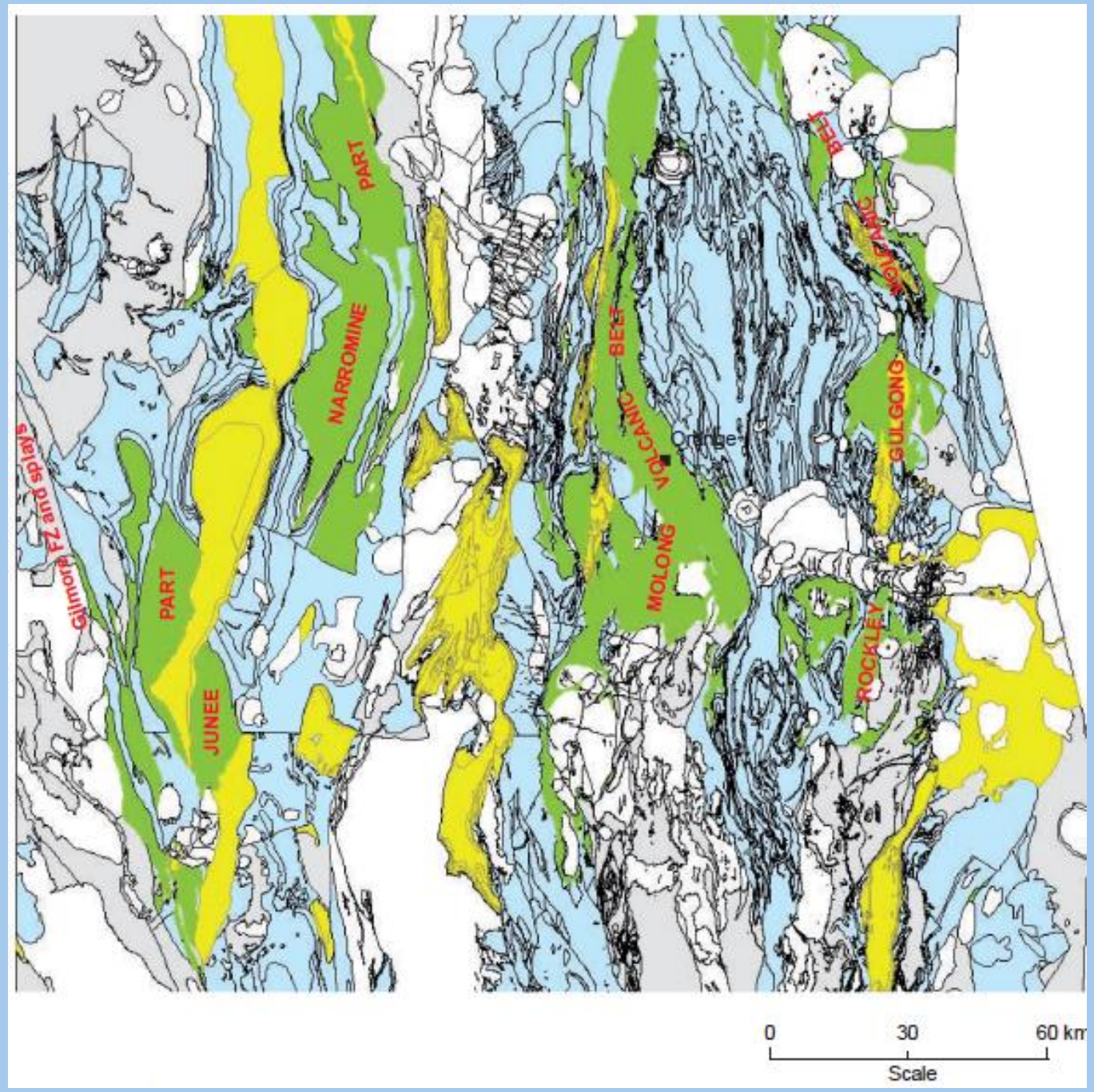
Simplified version RG 05/2025



Simplified version of figure used in presentation Glen et al., 2016 Canadian JES

2. Next arc: Ordovician Macquarie Arc

2a. Age of Cadia deposits

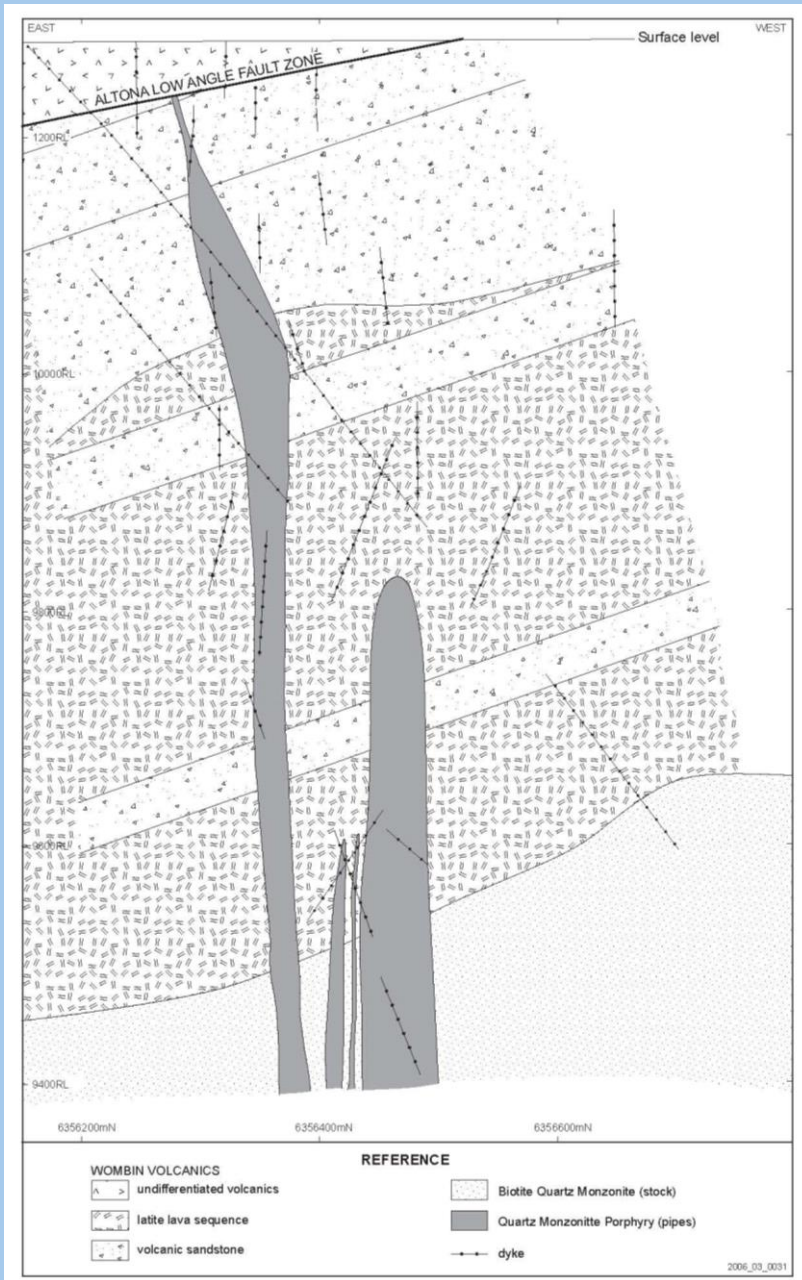


Macquarie Volcanic Belt

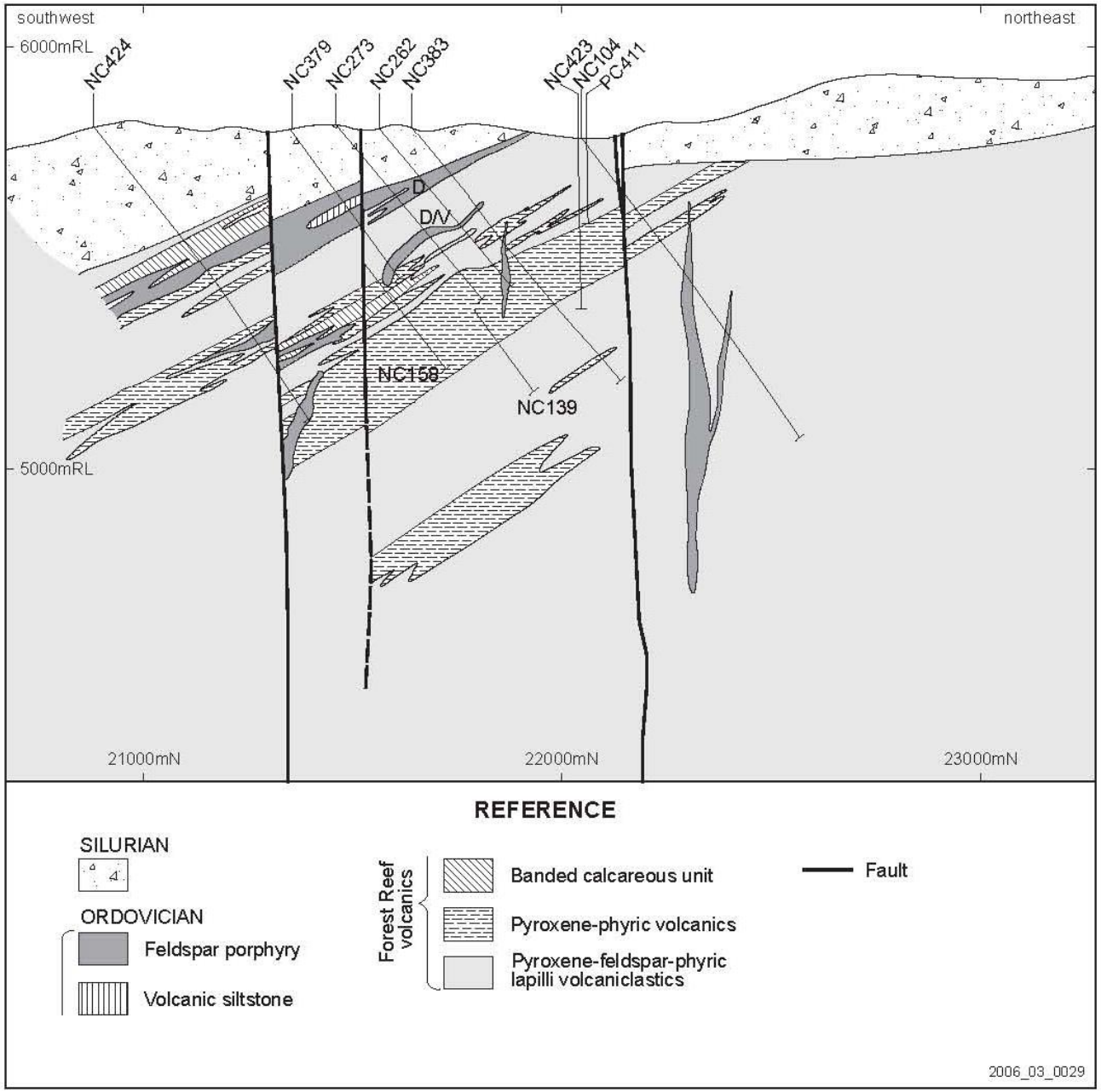
Ordovician turbidites and black shale

Silurian–Devonian basins (proven and inferred)

Late Devonian fluviatile sedimentary rock

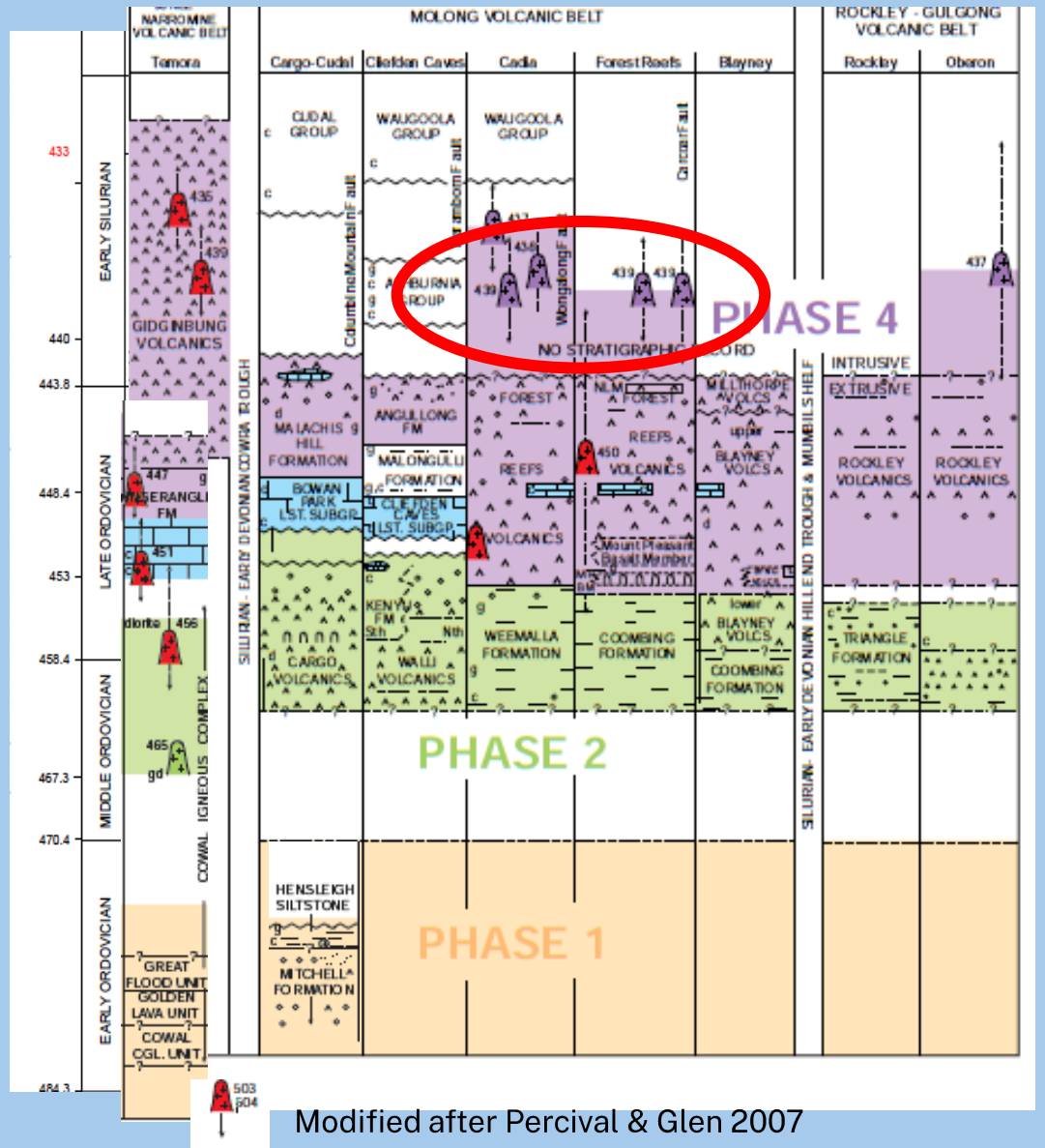


From Perkins et al. 1995, used by Glen et al 2007 AJES

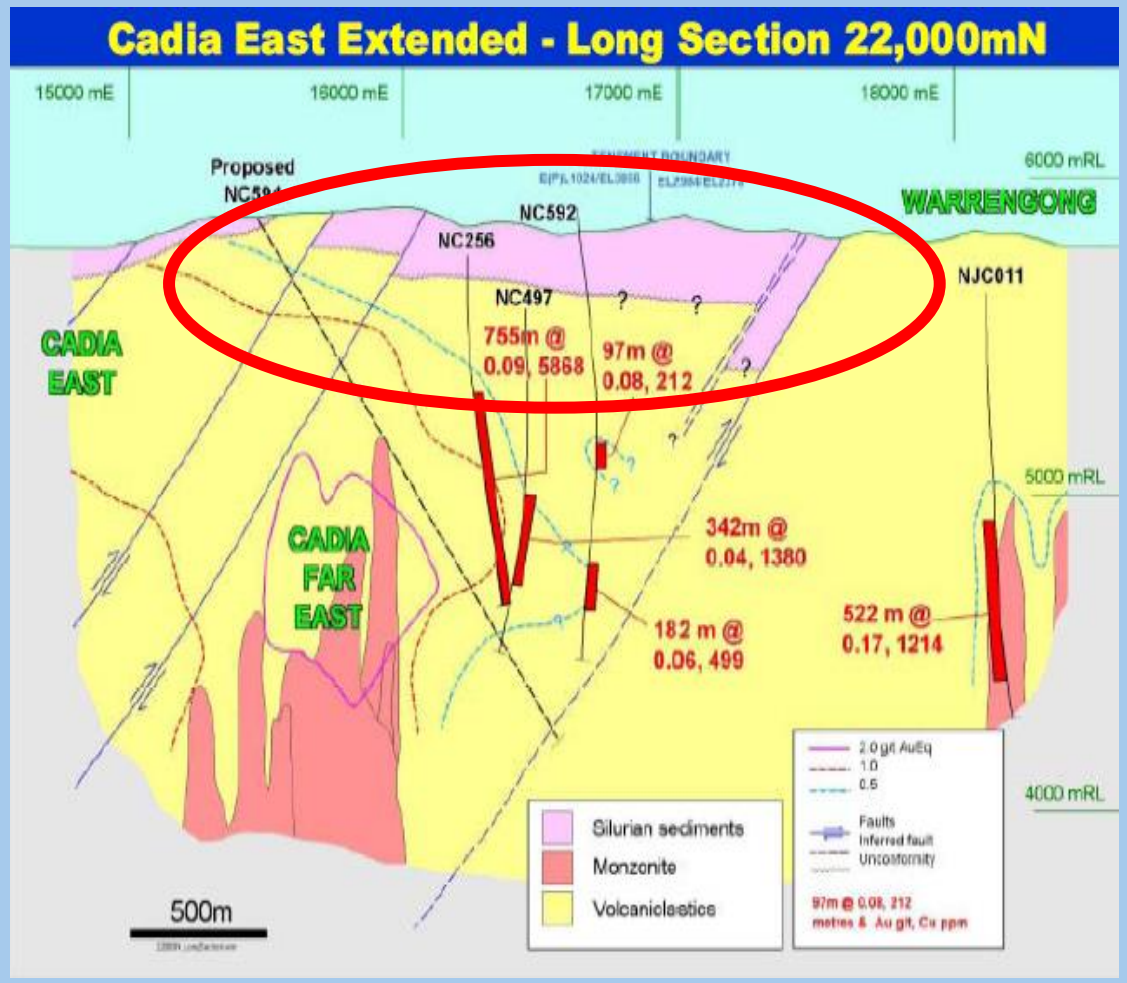


From Holliday et al. 2002, used by Glen et al. 2007 AJES

So why not explore under Silurian Shelves (e.g. Mumbil Shelf?)



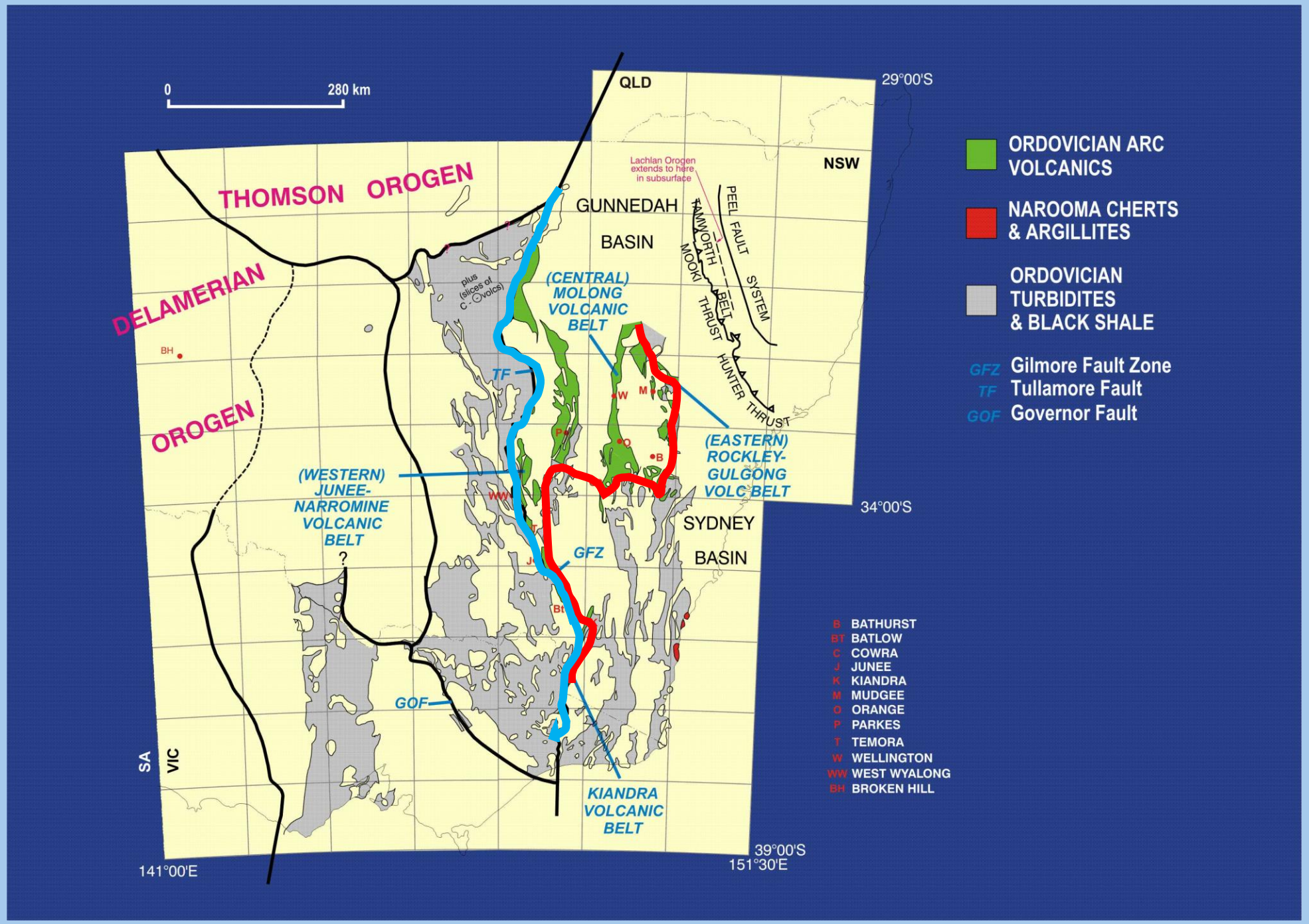
Modified after Percival & Glen 2007

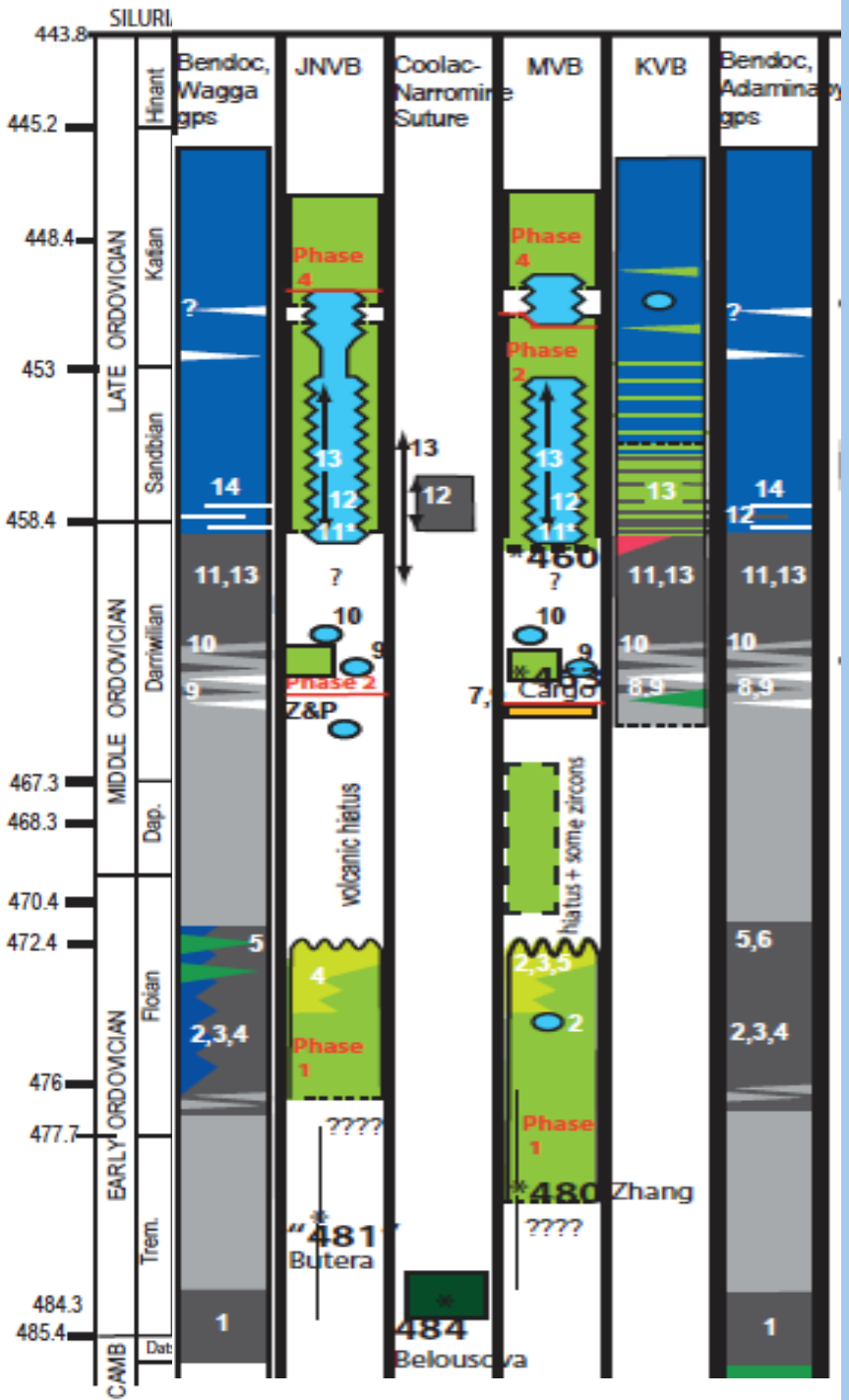


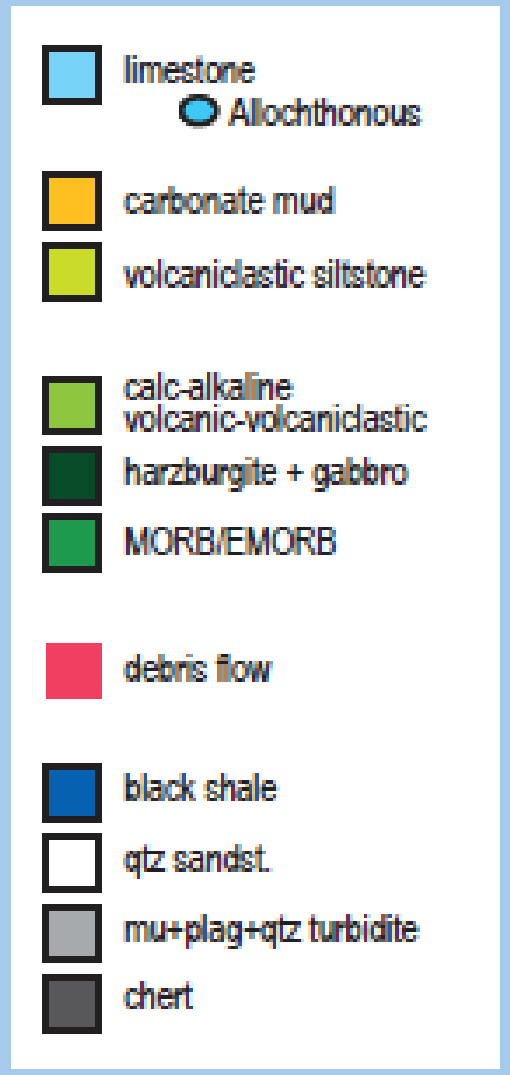
From Newcrest Exploration

2. Next arc: Ordovician Macquarie Arc

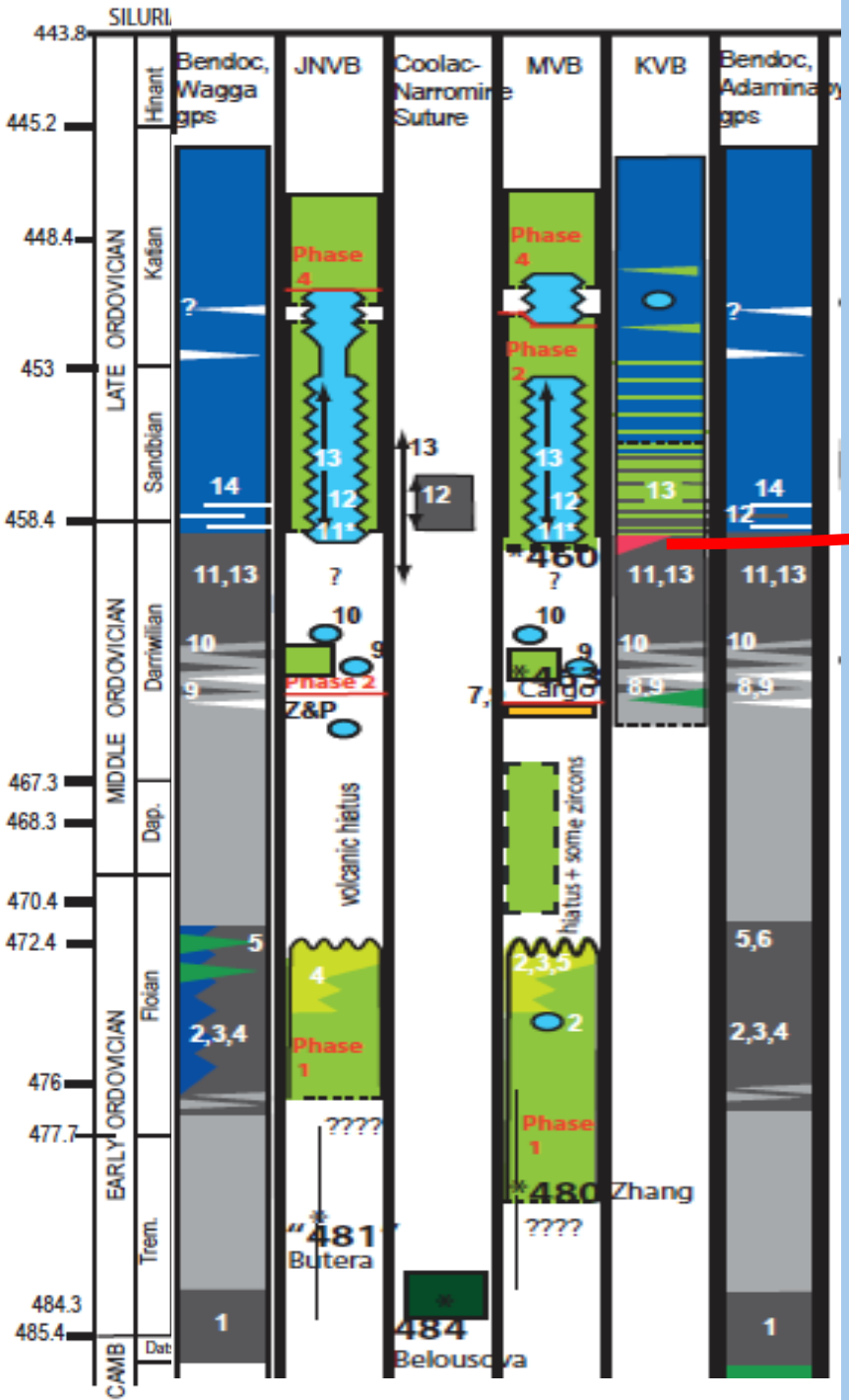
2b. Relation to flanking Ordovician sedimentary rocks

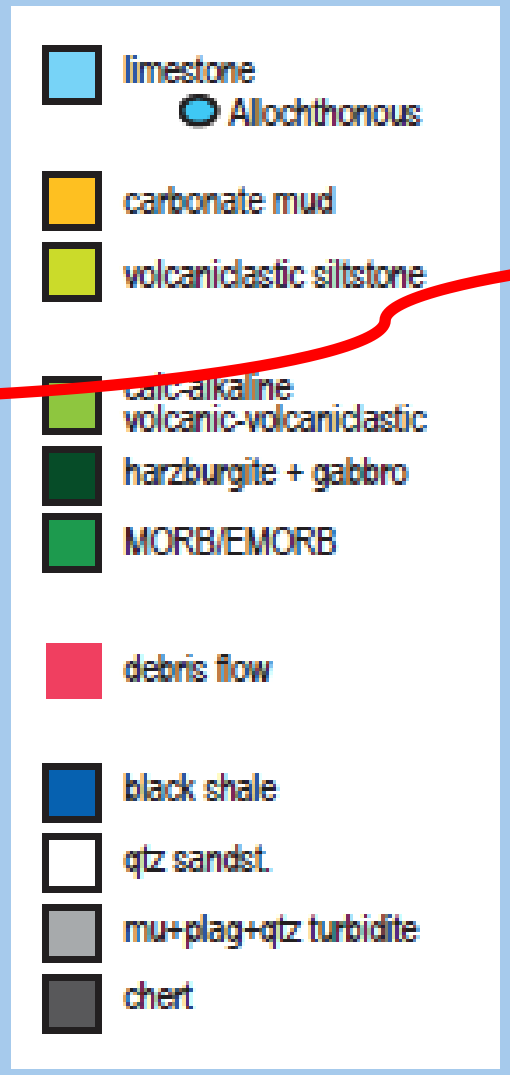

0
280 km
QLD
NSW
29°00'S
34°00'S
39°00'S
141°00'E
151°30'E
THOMSON OROGEN
DELAMERIAN OROGEN
Lachlan Orogen extends to here in subsurface
GUNNEDAH BASIN
SYDNEY BASIN
PEEL FAULT SYSTEM
TAMWORTH BELT
MOOKI THRUST
HUNTER THRUST
plus (slices of C-⊙volcs)
(CENTRAL) MOLONG VOLCANIC BELT
(EASTERN) ROCKLEY-GULGONG VOLC BELT
(WESTERN) JUNEE-NARROMINE VOLCANIC BELT
KIANDRA VOLCANIC BELT
TF
GFZ
GOF
BH
W
M
O
B
P
T
J
Bt
WW
SA
VIC
ORDOVICIAN ARC VOLCANICS
NAROOMA CHERTS & ARGILLITES
ORDOVICIAN TURBIDITES & BLACK SHALE
GFZ Gilmore Fault Zone
TF Tullamore Fault
GOF Governor Fault
B BATHURST
BT BATLOW
C COWRA
J JUNEE
K KIANDRA
M MUDGEE
O ORANGE
P PARKES
T TEMORA
W WELLINGTON
WW WEST WYALONG
BH BROKEN HILL





Modified after Quinn et al (2014), by Glen & Blevin (2019)





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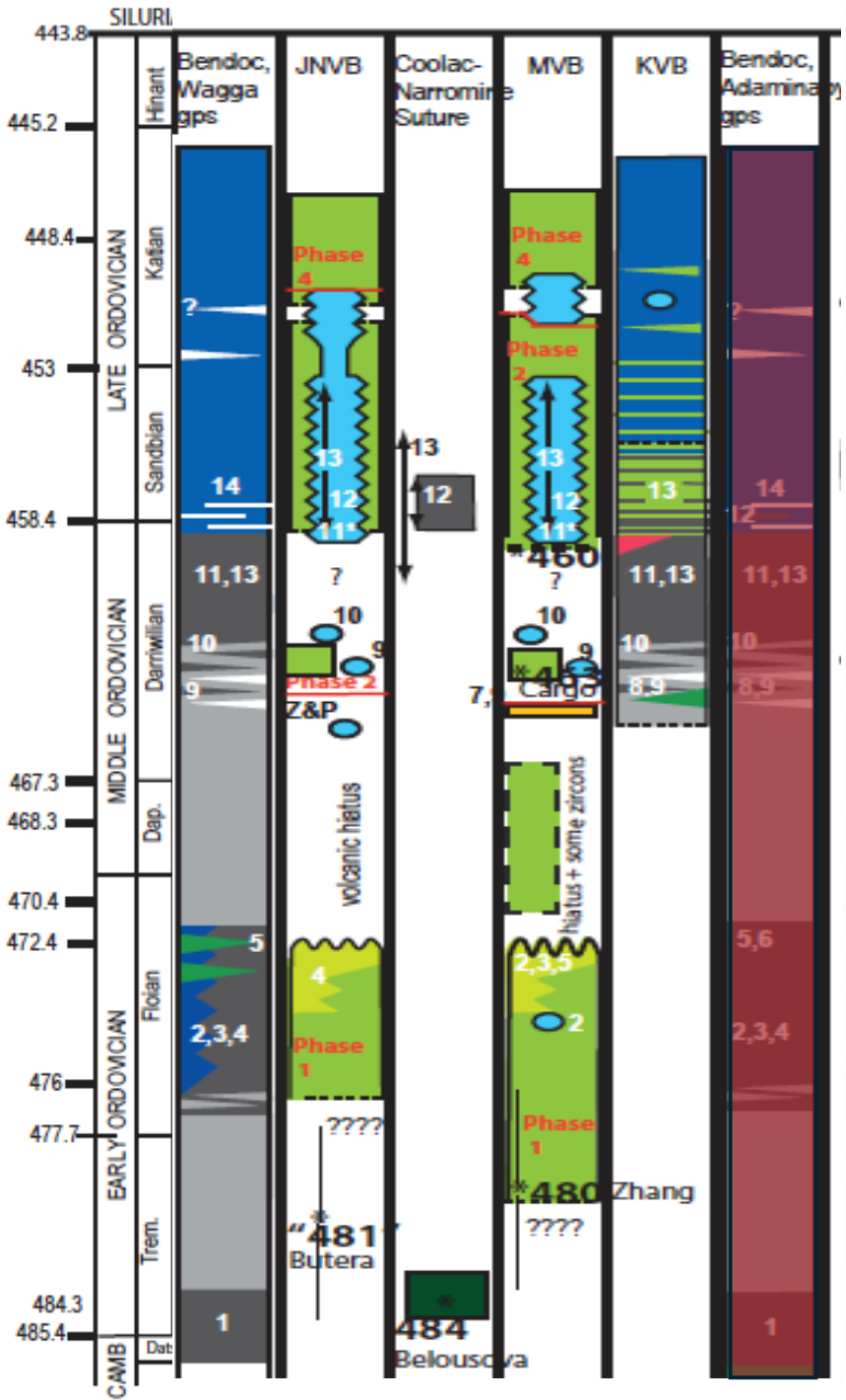
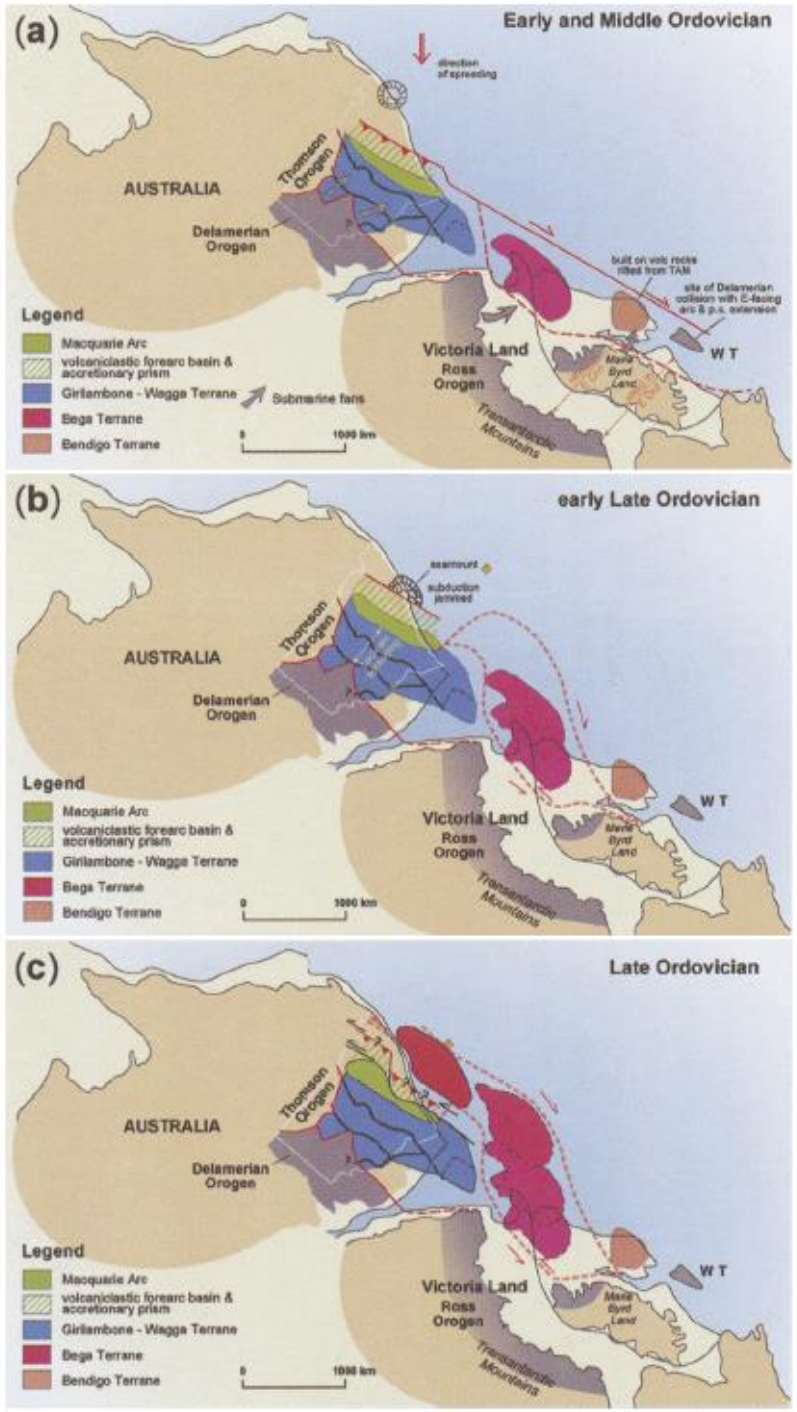




Modified after Quinn et al. (2014) by Glen & Blevin (2019) and Glen (2005)

CROSS STRUCTURES

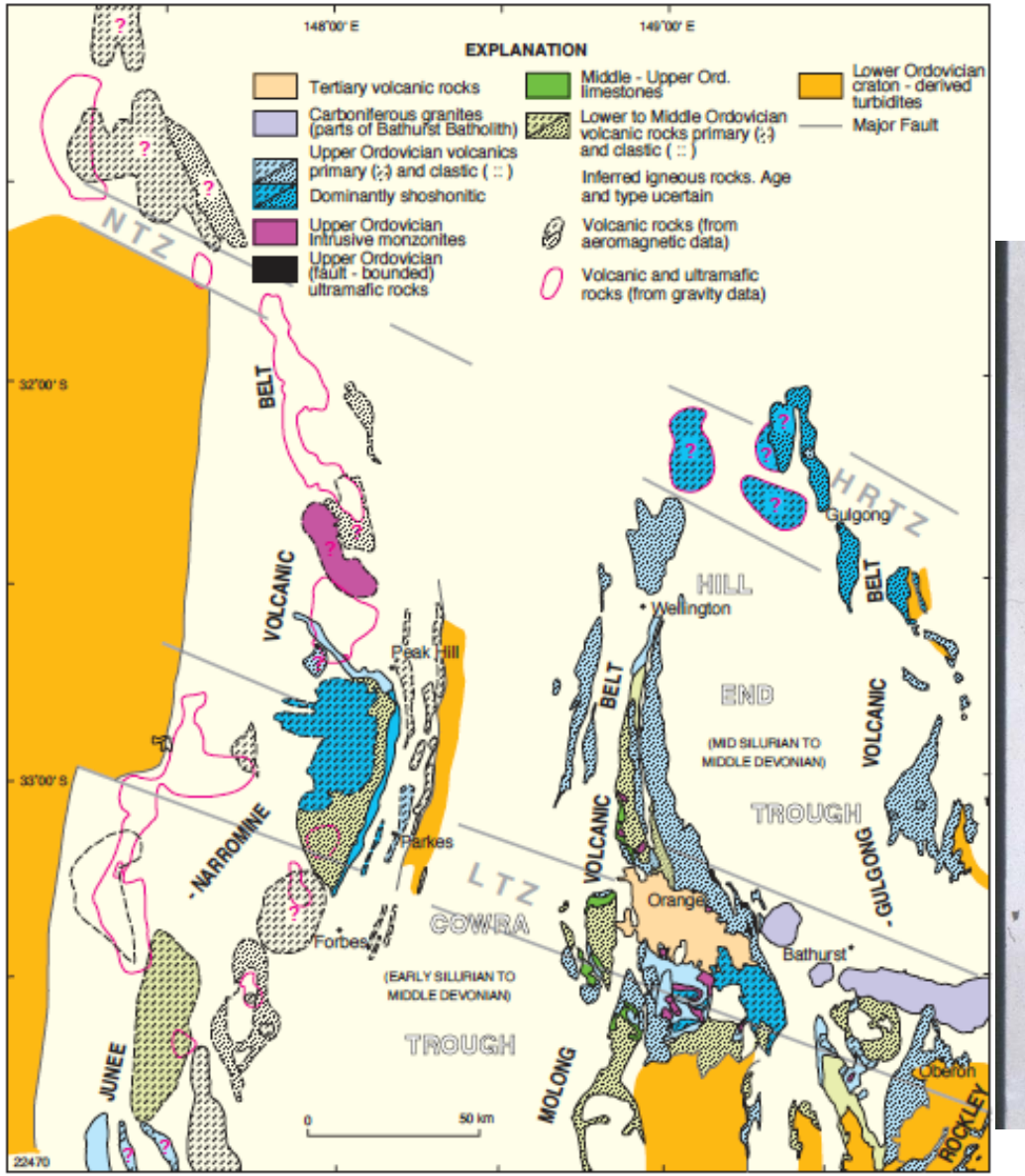
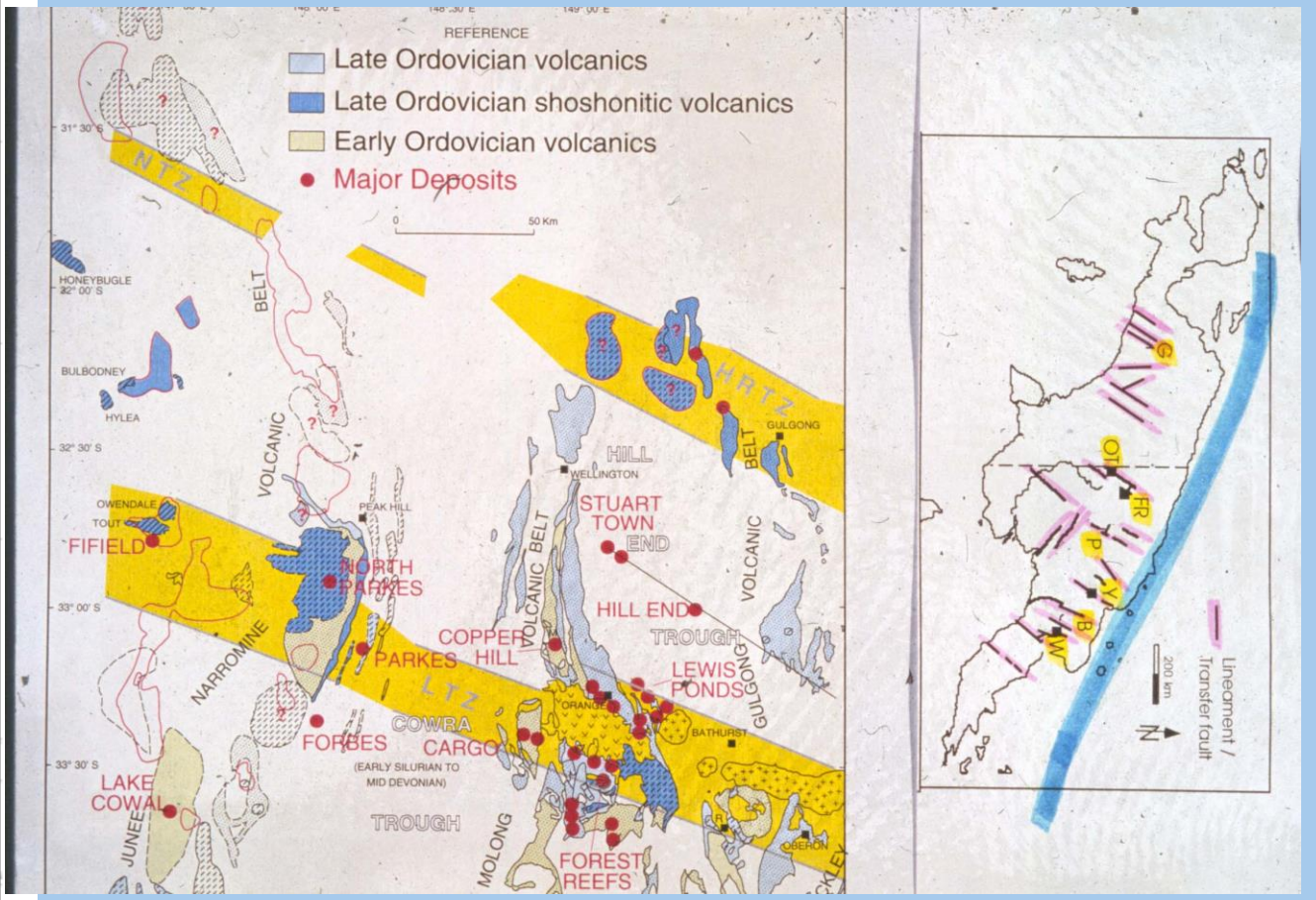
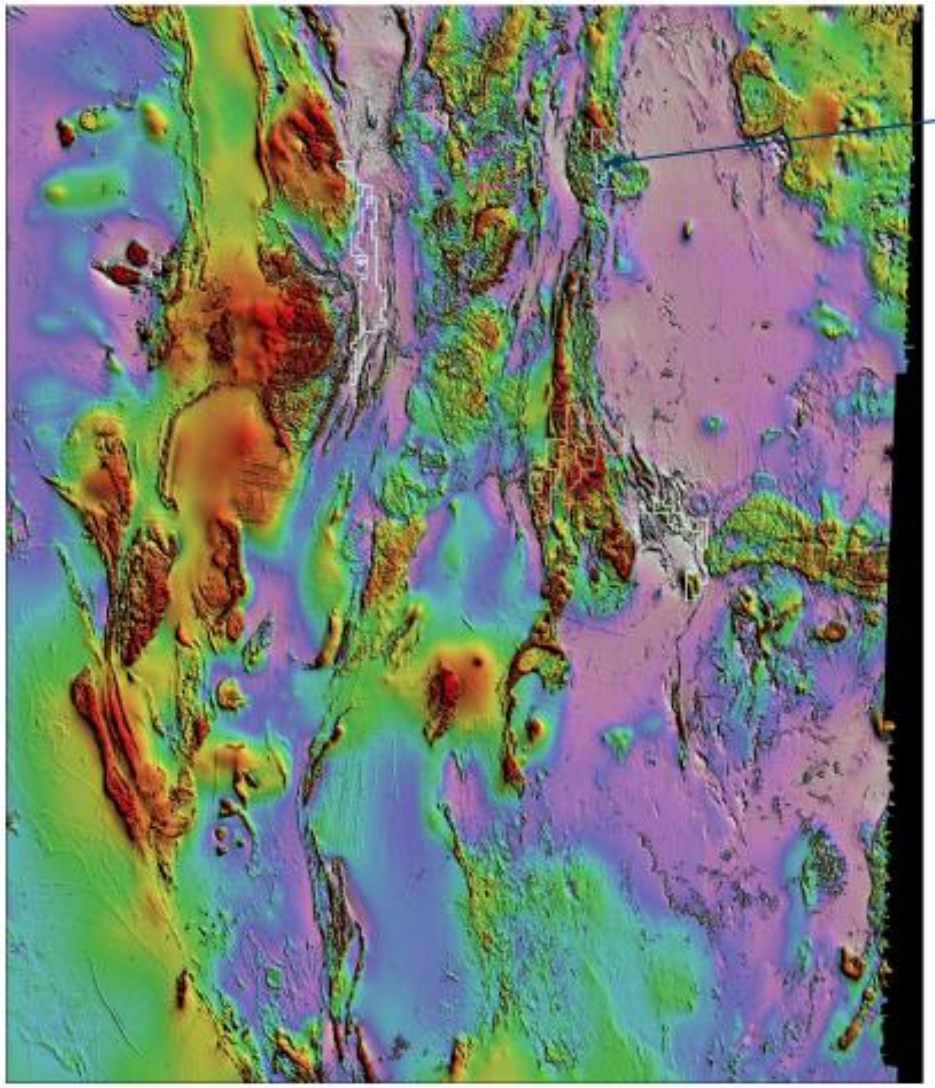


Figure 2. Details of three main Ordovician volcanic belts, Lower-Middle Ordovician turbidites (and overthrust Upper Ordovician shales), and younger basins. Lachlan transverse zone (LTZ) is from Glen and Wyborn (1997), Nyngan transverse zone (NTZ) is from Hilyard et al. (1996), and extension of Hunter River transverse zone (HRTZ) is also shown. Published mapping sources: southeast, Raymond et al. (1997), northeast, Colquhoun et al. (1997).



Glen et al., (1998)

Macquarie Arc: Aeromagnetics and Geology



NMPP Boda

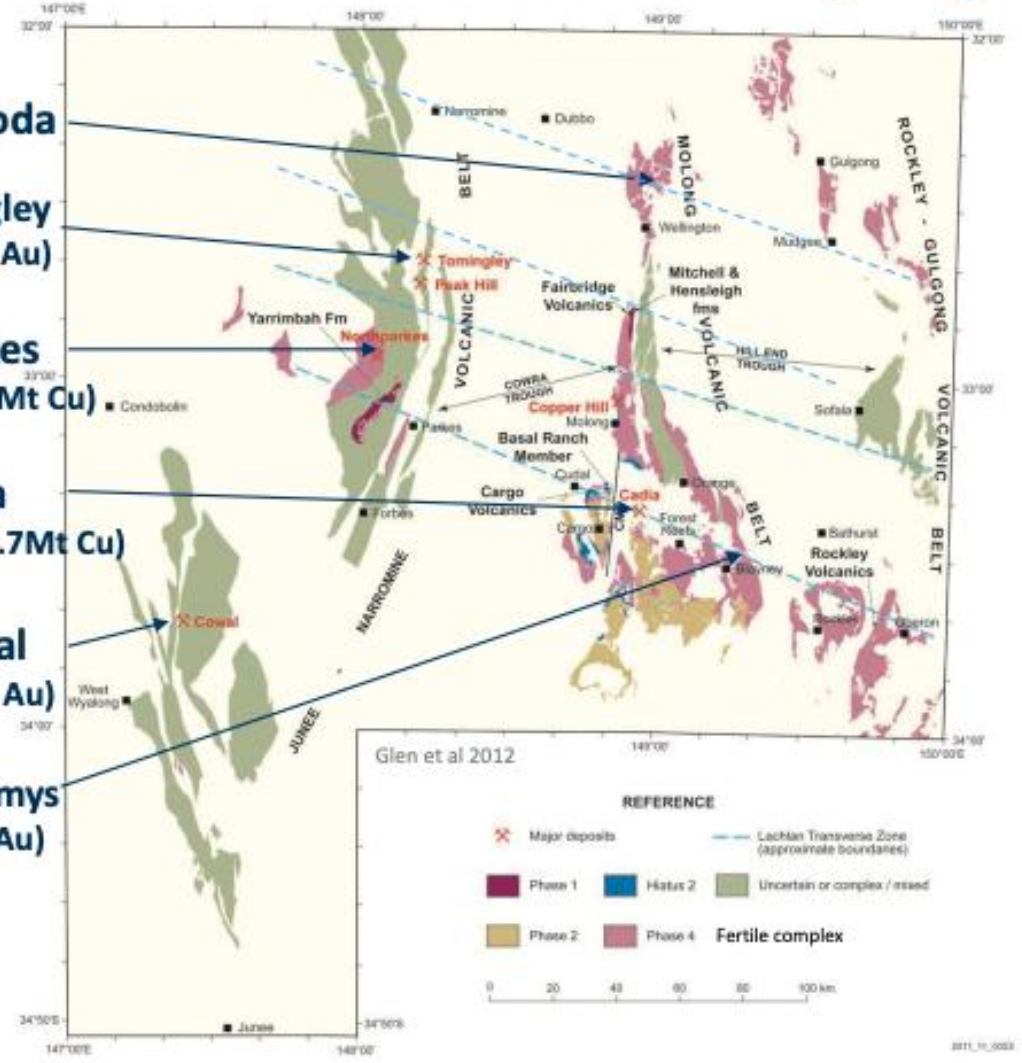
Tomingley
(~2Moz Au)

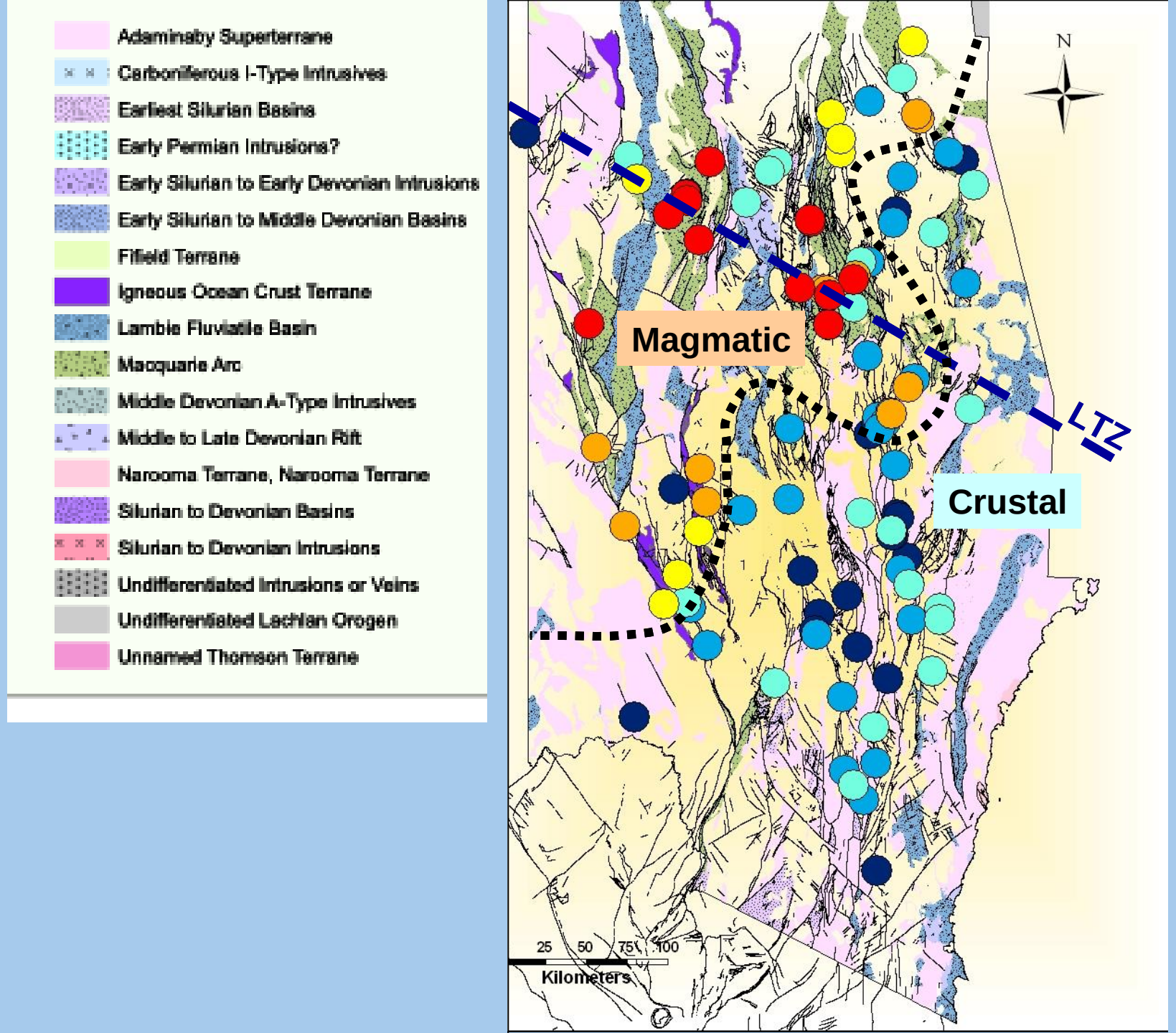
Northparkes
(5.2Moz Au + 4.4Mt Cu)

Cadia
(50Moz Au + 8.7Mt Cu)

Cowal
(11Moz Au)

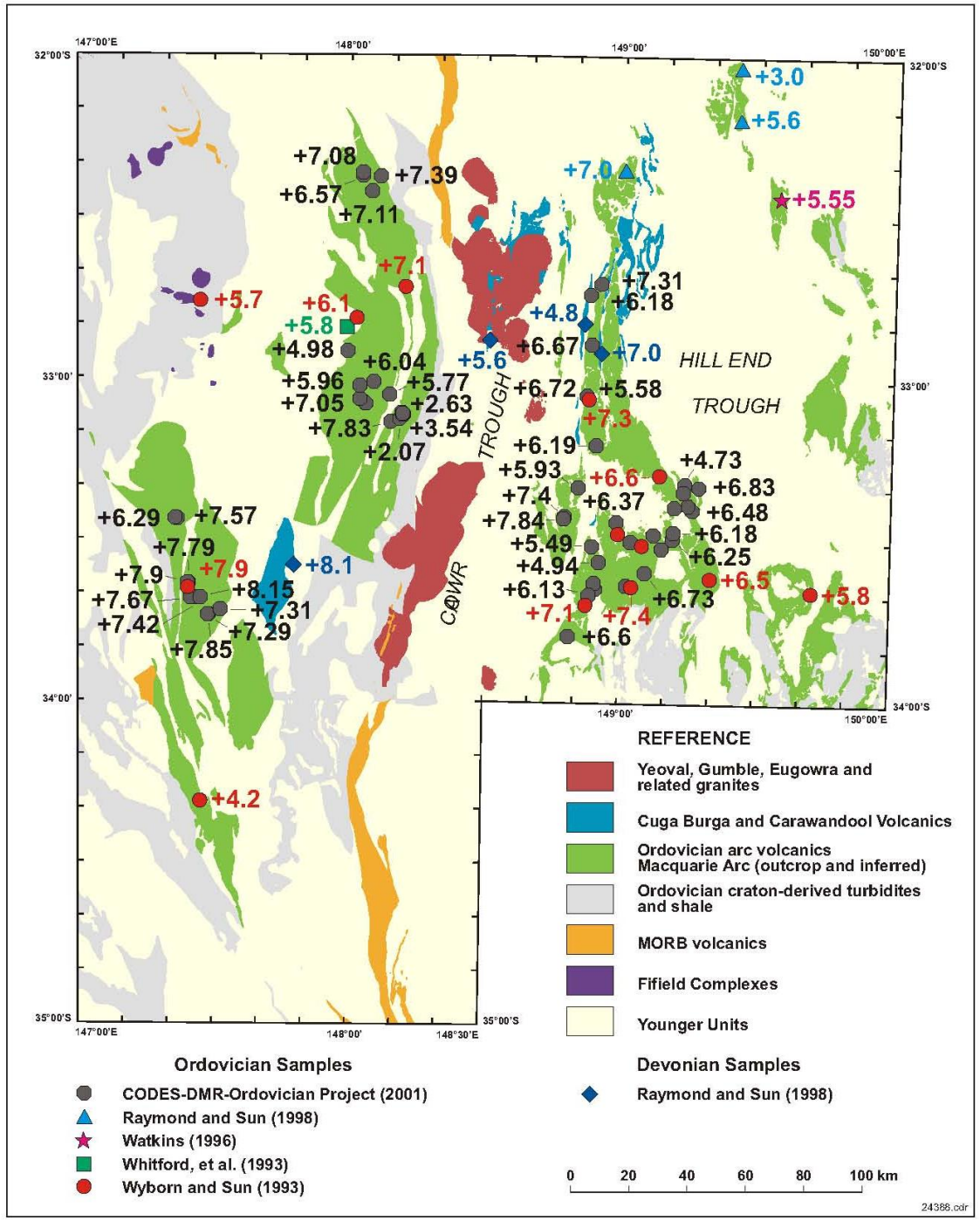
McPhillamys
(2.3Moz Au)





Mernagh & Glen 2008

POST Lower Silurian Intrusions, and ?gold and cross structures



Sm/Nd isotopes

Raymond & Sun 1998

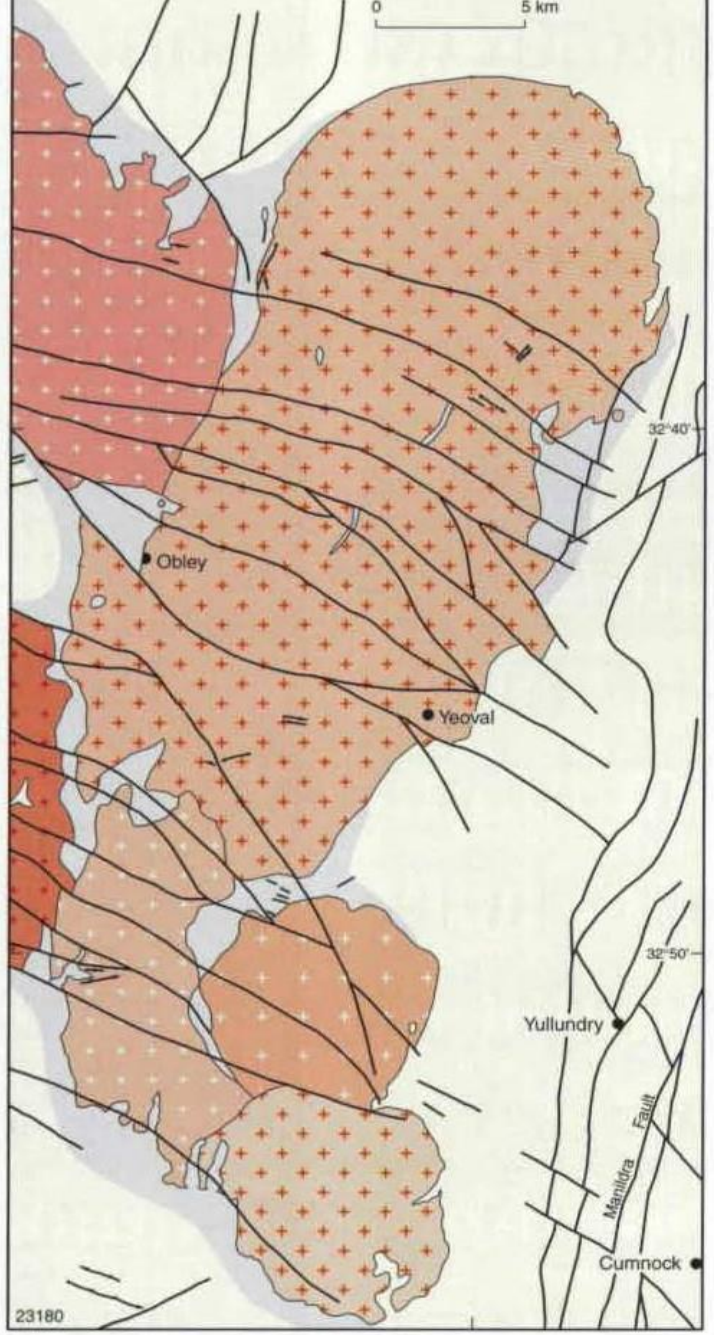
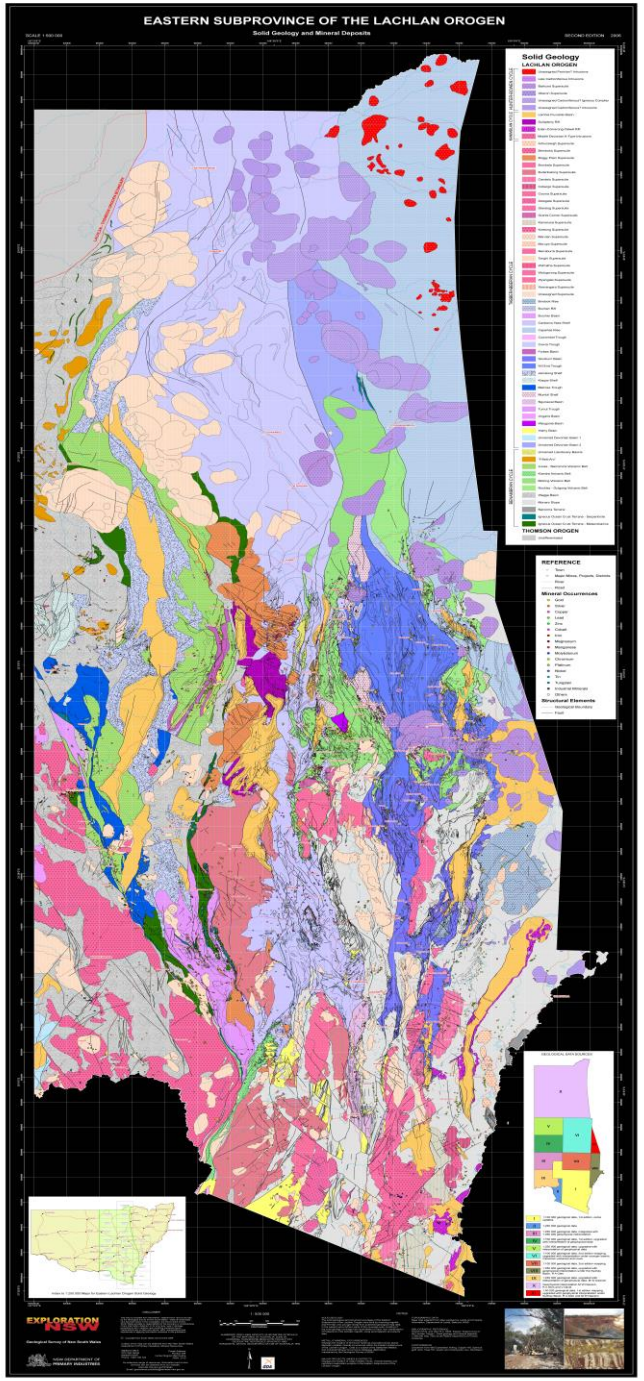
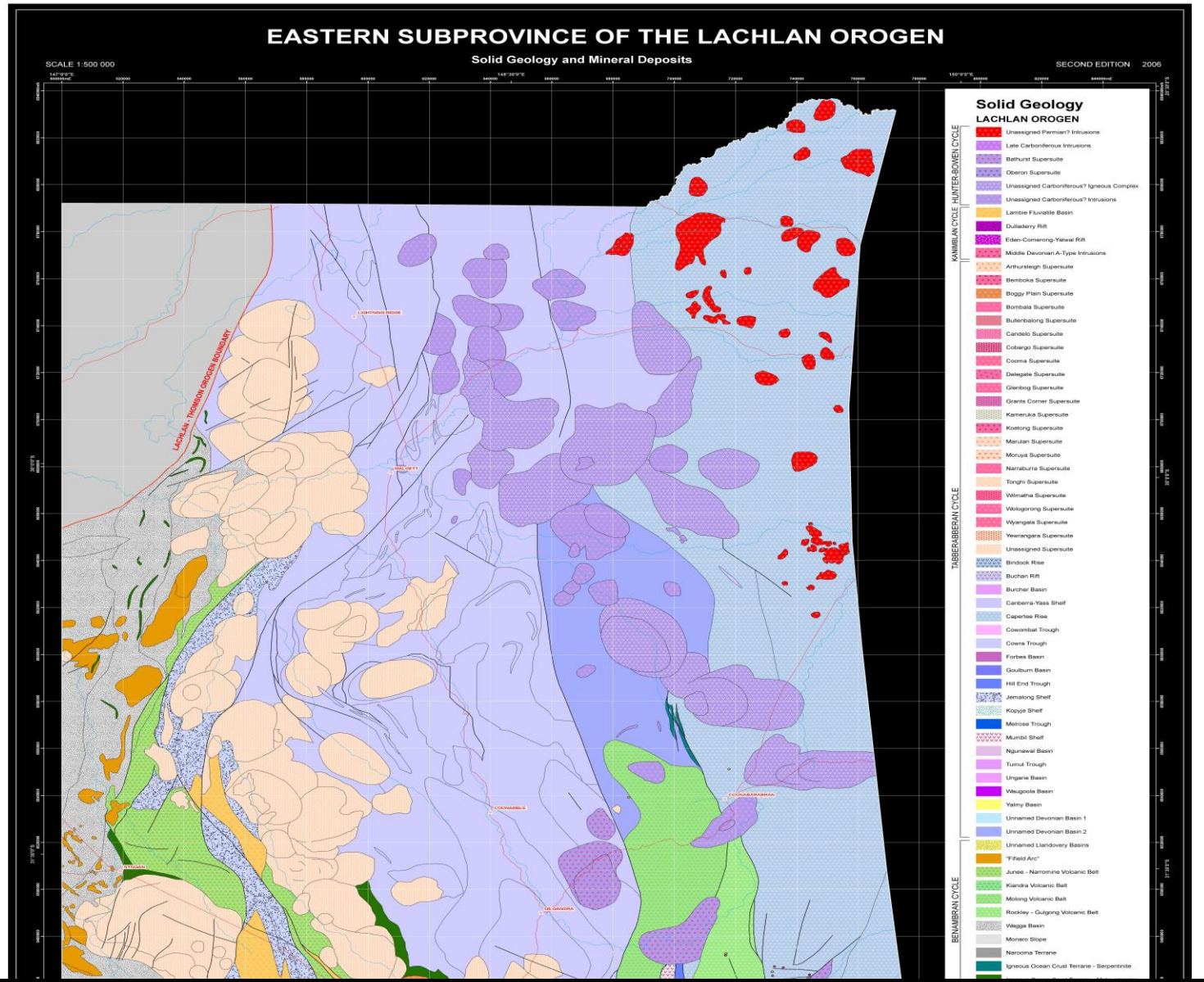


Figure 43. Plutons of the Yeoval Batholith in the Dubbo 1:250 000 map sheet area, with adjacent Devonian dykes

The largest copper deposit associated with post-Ordovician magmatism in south-eastern Australia is the Yeoval porphyry copper prospect (Blevin & Chappell 1995). This deposit is associated with the granodiorite to gabbro phase of the Early Devonian Yeoval Complex.

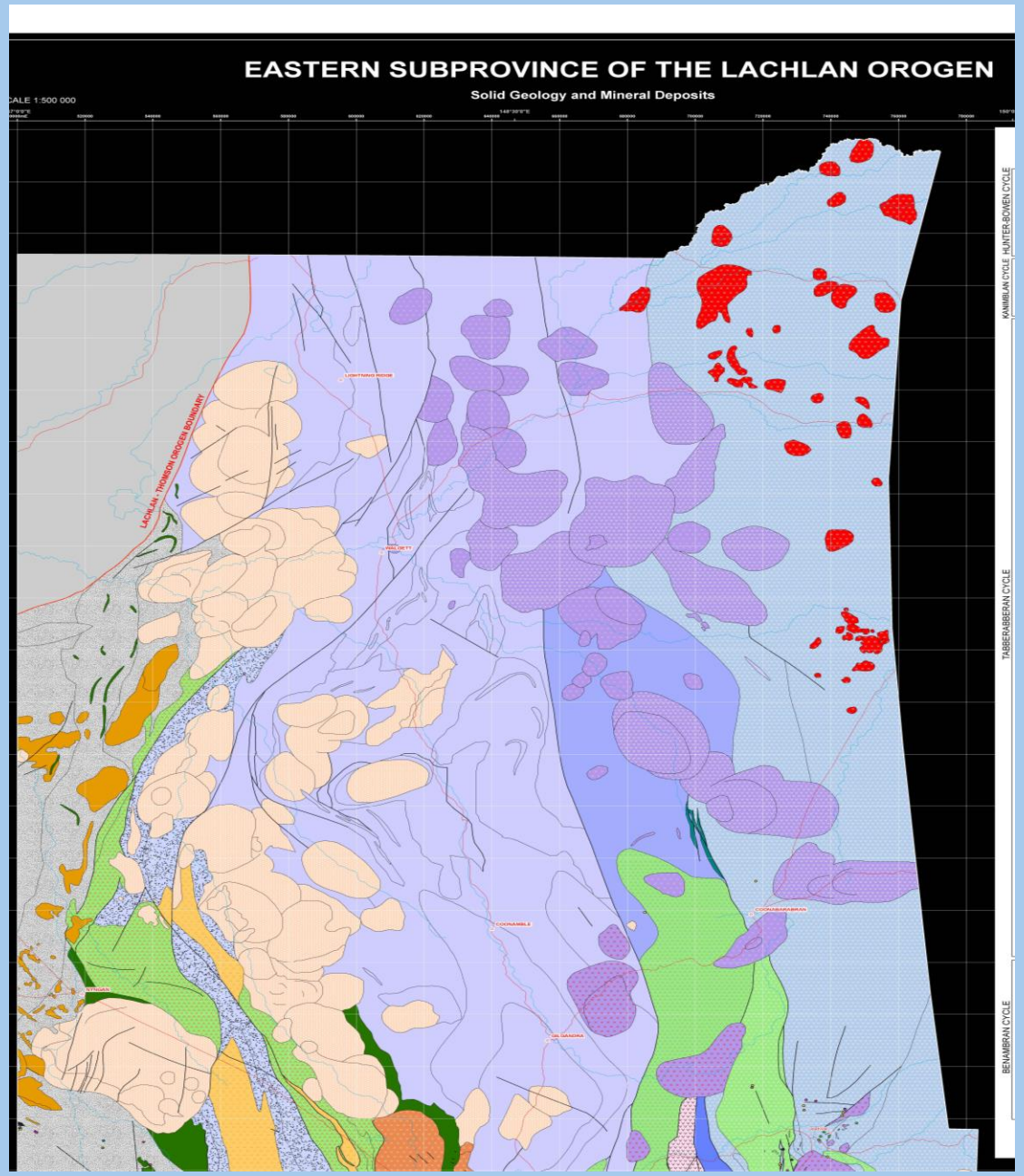
Wyborn et al., Yeoval Batholith in Dubbo 1:250,000 notes

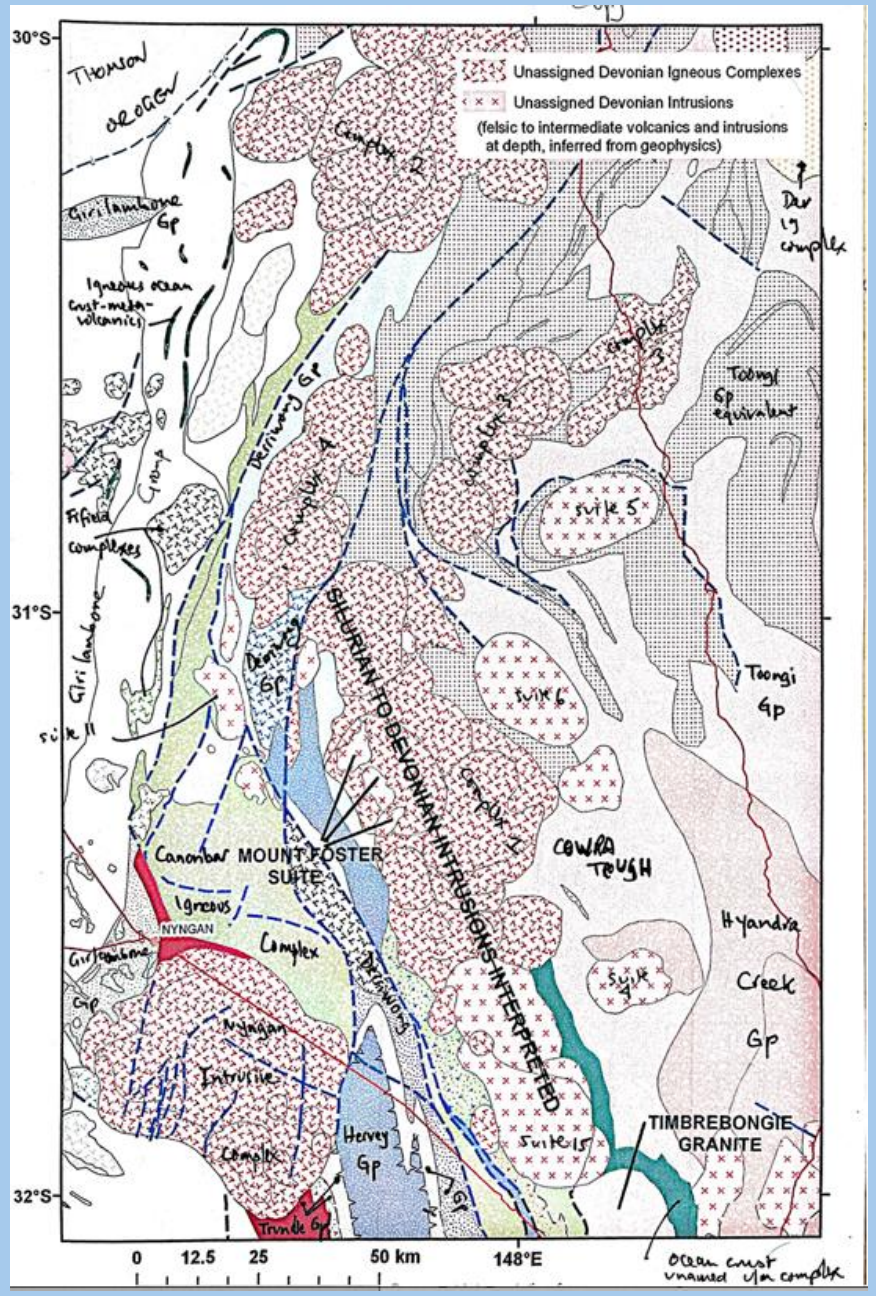




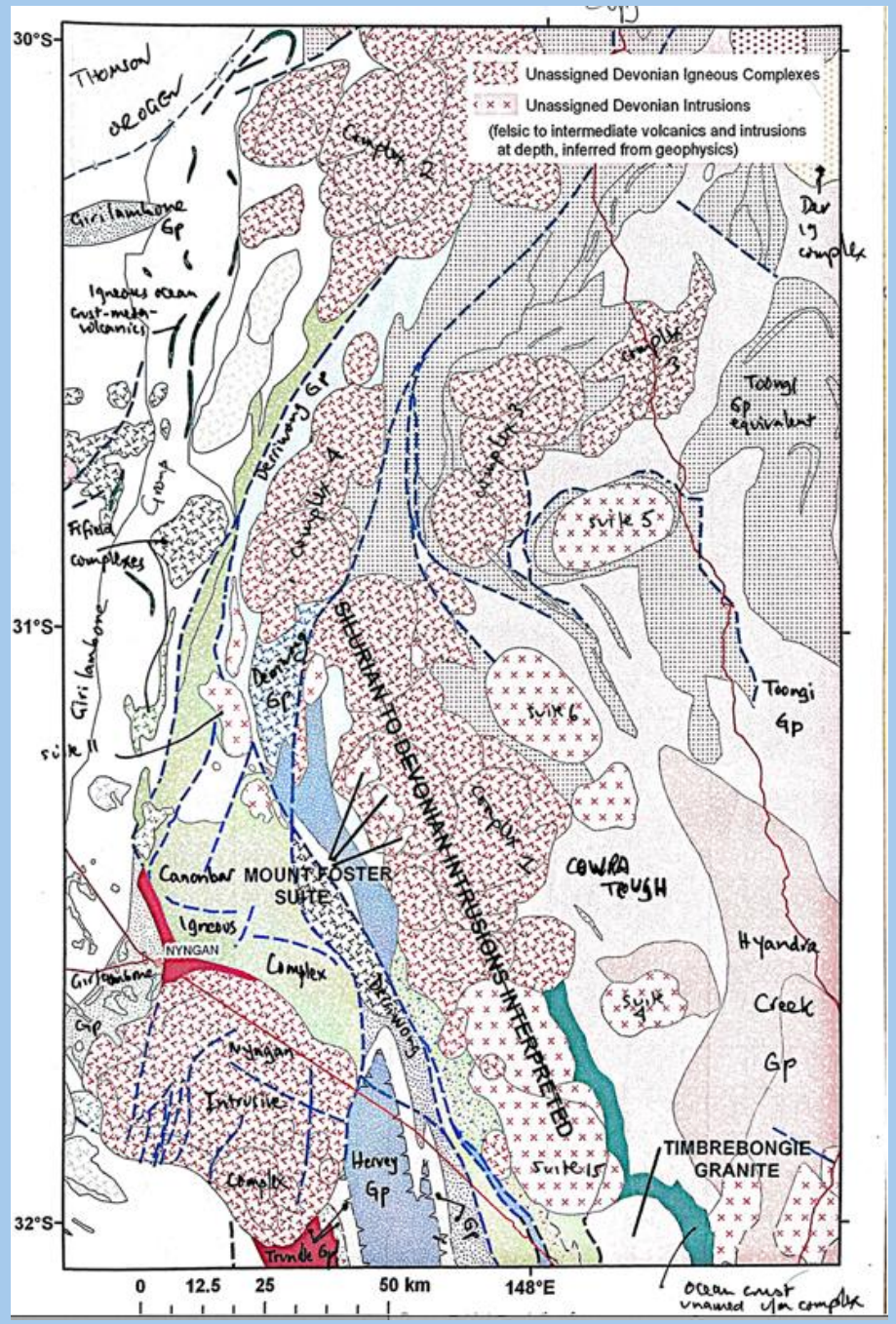
BIBLIOGRAPHIC REFERENCE

Dawson M.W. and Glen R.A. 2006. Eastern Subprovince of the Lachlan Orogen - Solid geology and mineral deposits, 1:500 000 map. New South Wales Department of Primary Industries.





RHS - David & Glen 2006, update to GIS unpublished



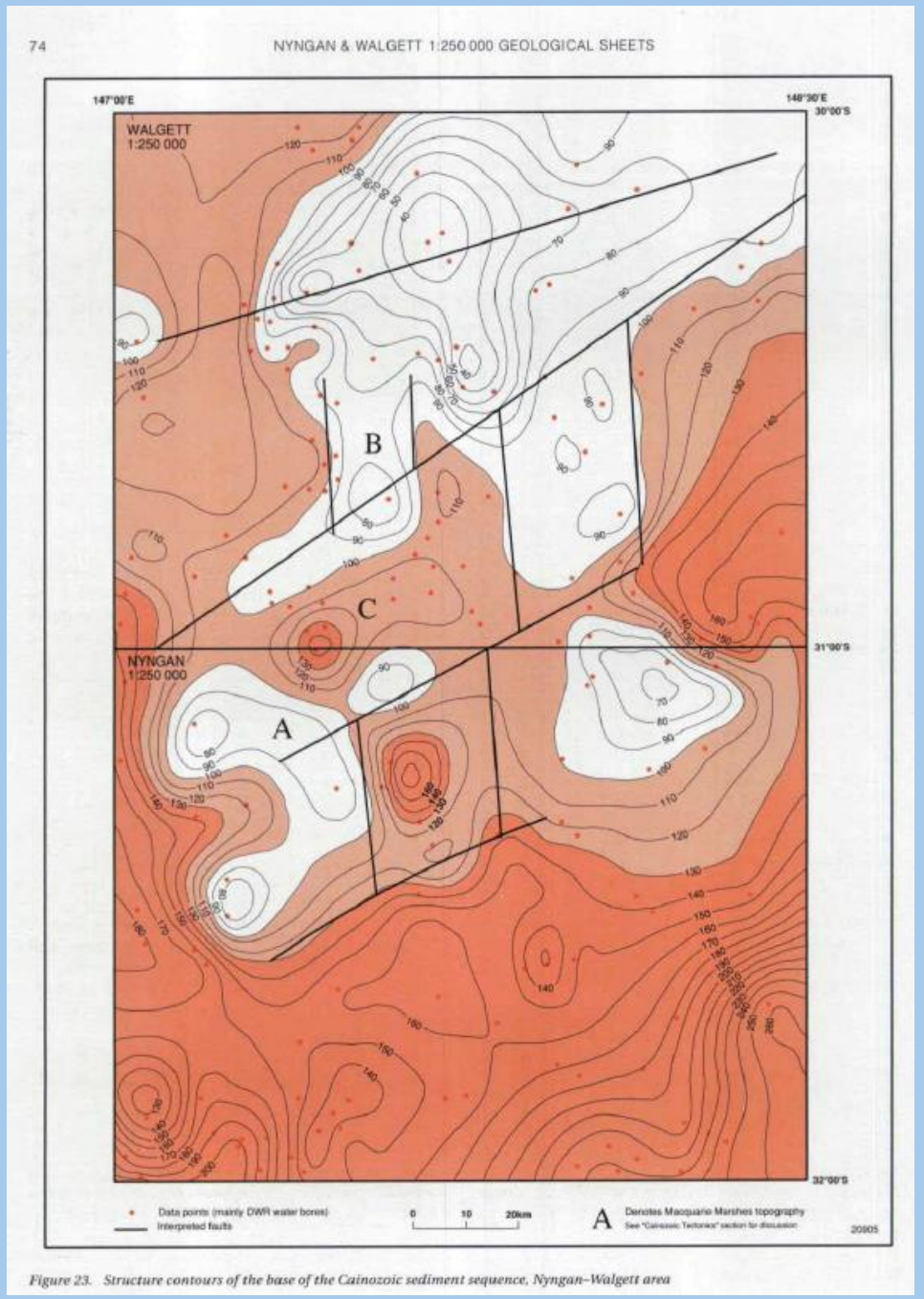
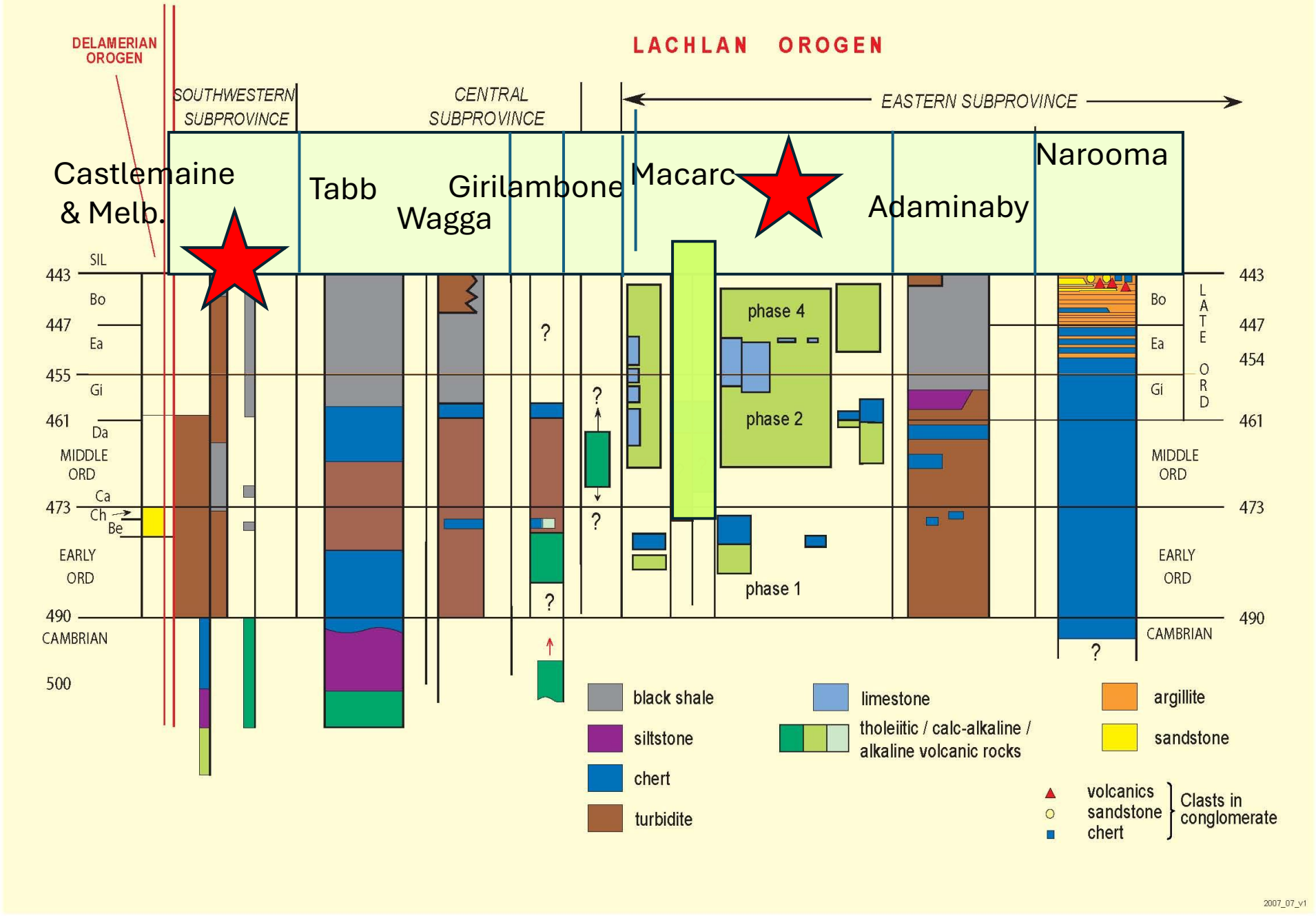
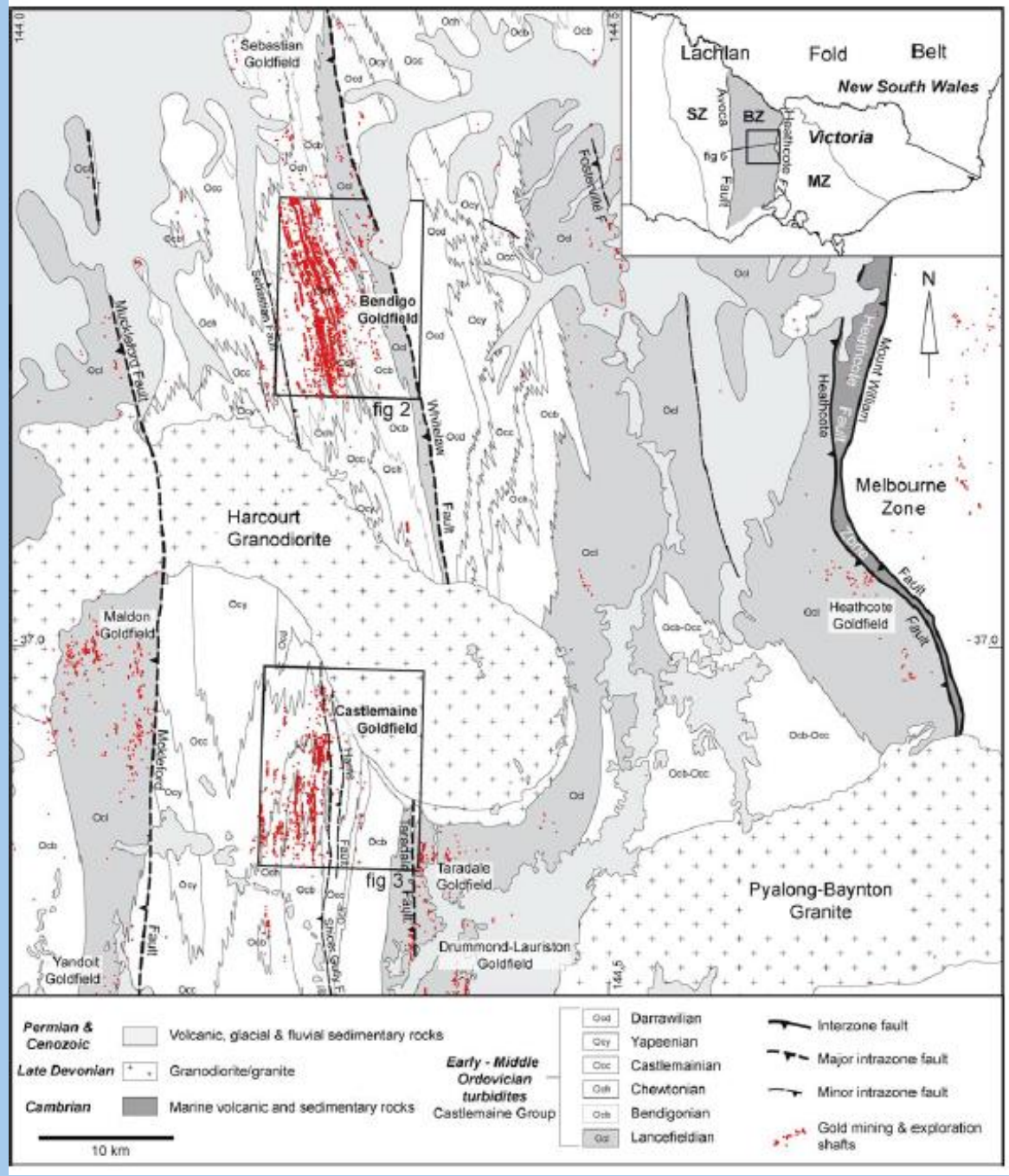


Figure 23. Structure contours of the base of the Cainozoic sediment sequence, Nyngan–Walgett area

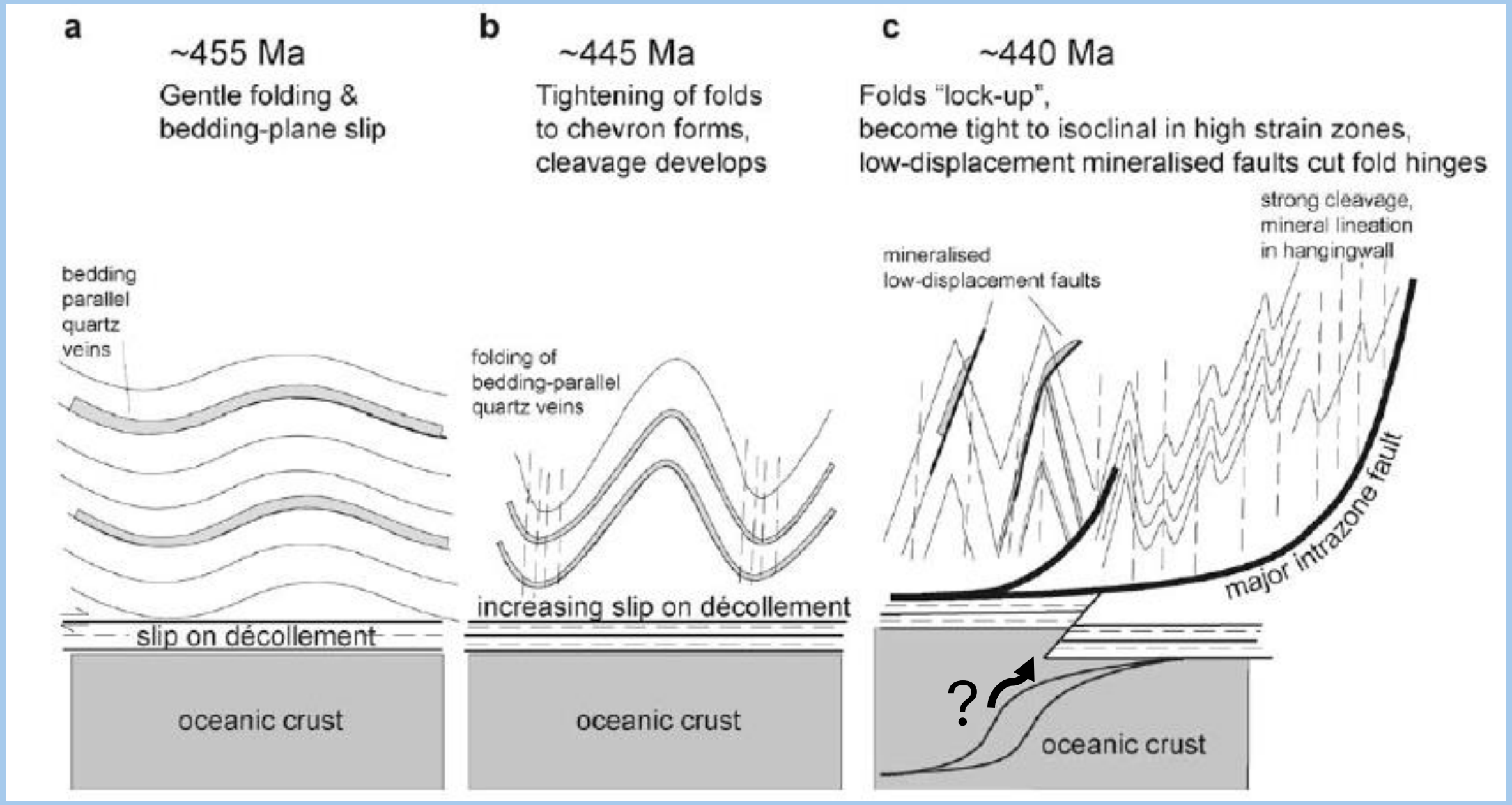
WATKINS J.J. & MEAKIN N.S. 1996. Nyngan and Walgett 1:250,000 Geological Sheets SH/55-15 & SH/55-11

Orogenic gold in Ordovician turbidites

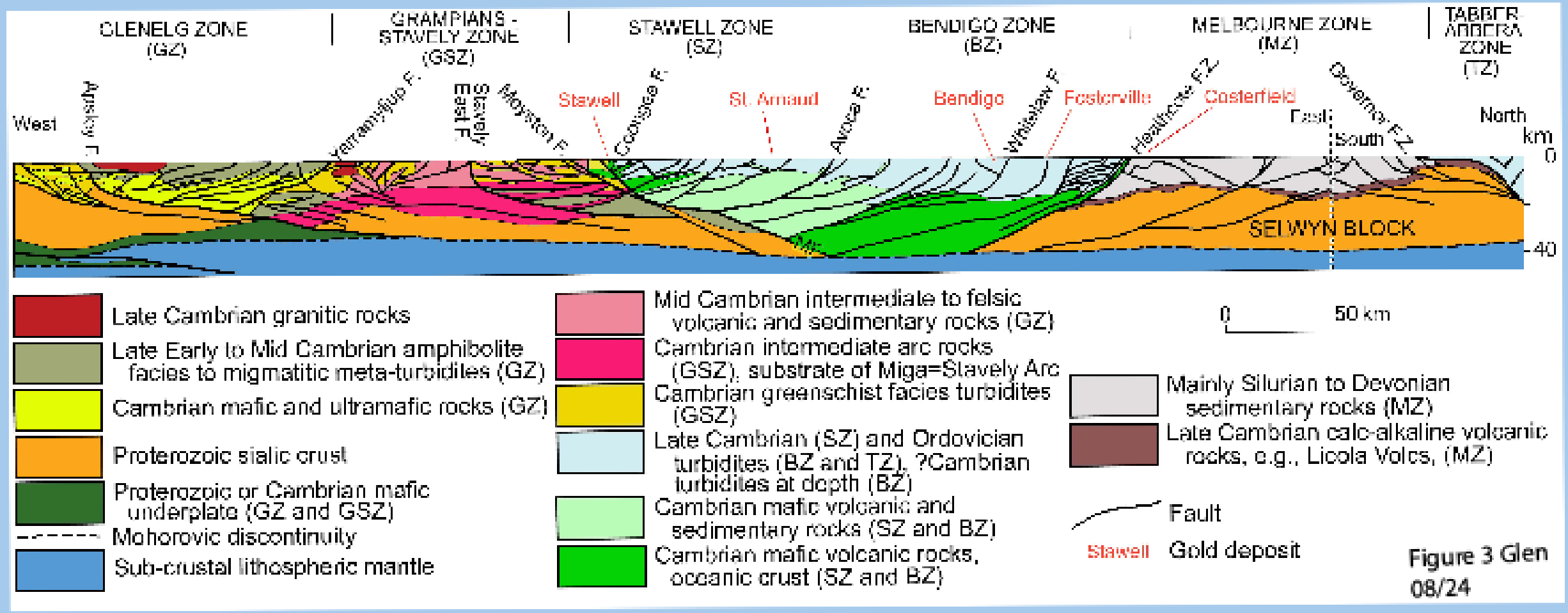

DELAMERIAN OROGEN
LACHLAN OROGEN
SOUTHWESTERN SUBPROVINCE
CENTRAL SUBPROVINCE
EASTERN SUBPROVINCE
Castlemaine & Melb.
Tabb
Wagga
Girilambone
Macarc
Adaminaby
Narooma
SIL
Bo
Ea
Gi
Da
Ca
Ch
Be
443
447
455
461
473
490
500
MIDDLE ORD
EARLY ORD
CAMBRIAN
LATE ORD
phase 4
phase 2
phase 1
black shale
siltstone
chert
turbidite
limestone
tholeiitic / calc-alkaline / alkaline volcanic rocks
argillite
sandstone
volcanics
sandstone
chert
Clasts in conglomerate
2007_07_v1



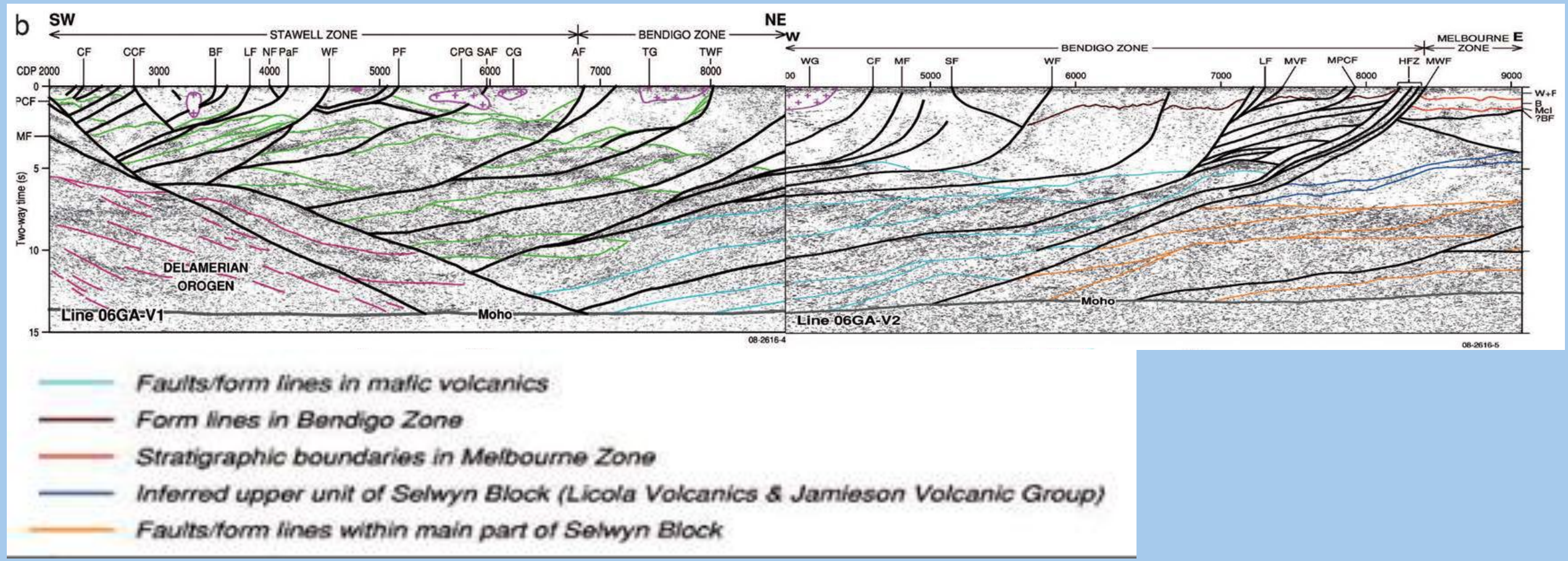
Willman 2007, Mineralium Deposita



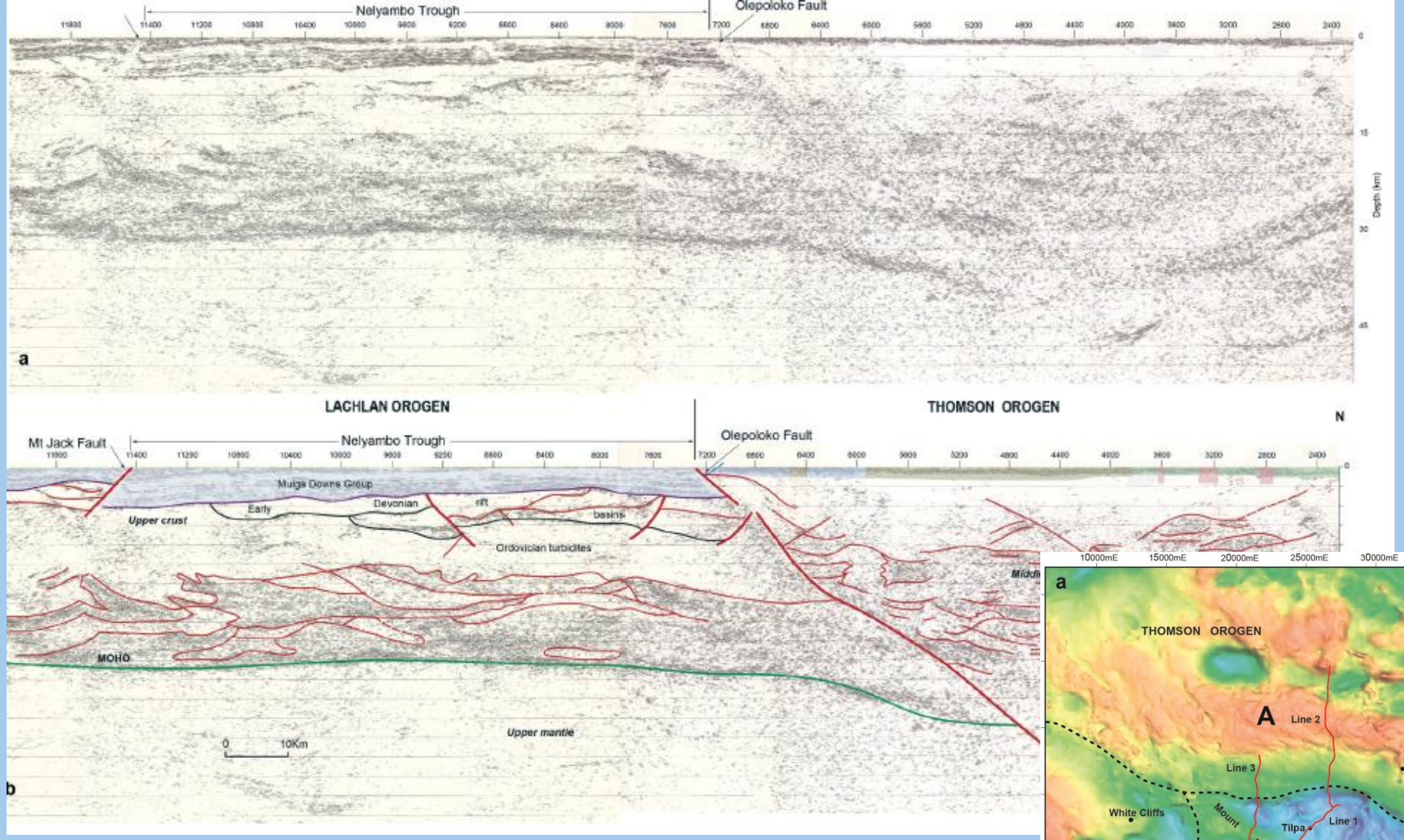
Willman 2007, Mineralium Deposita, with modification

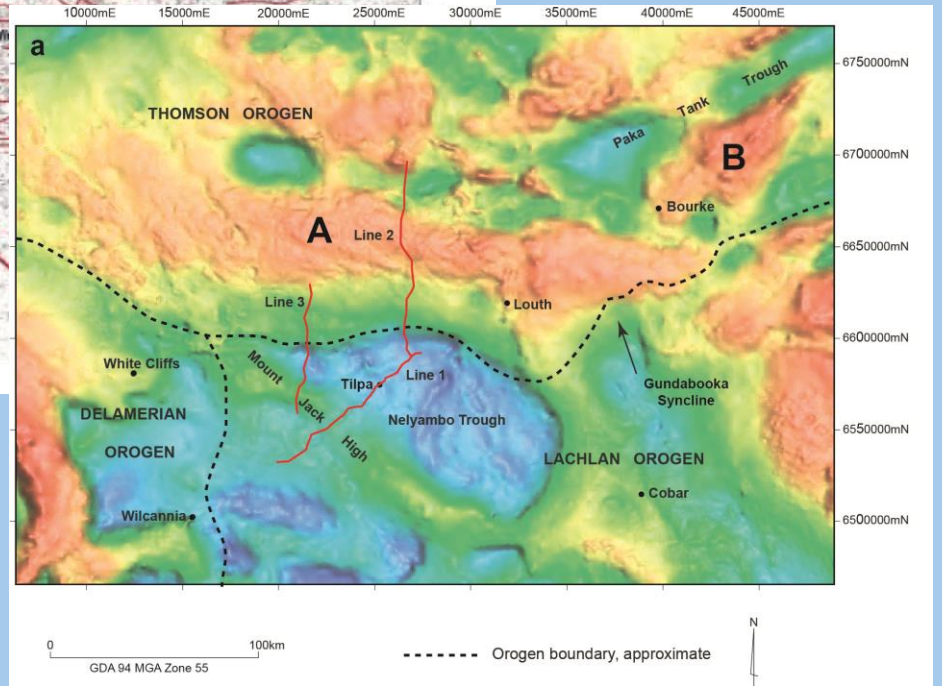


After Porter after Cayley et al. 2011 and Willman et al. 2010



Cayley et al. 2011



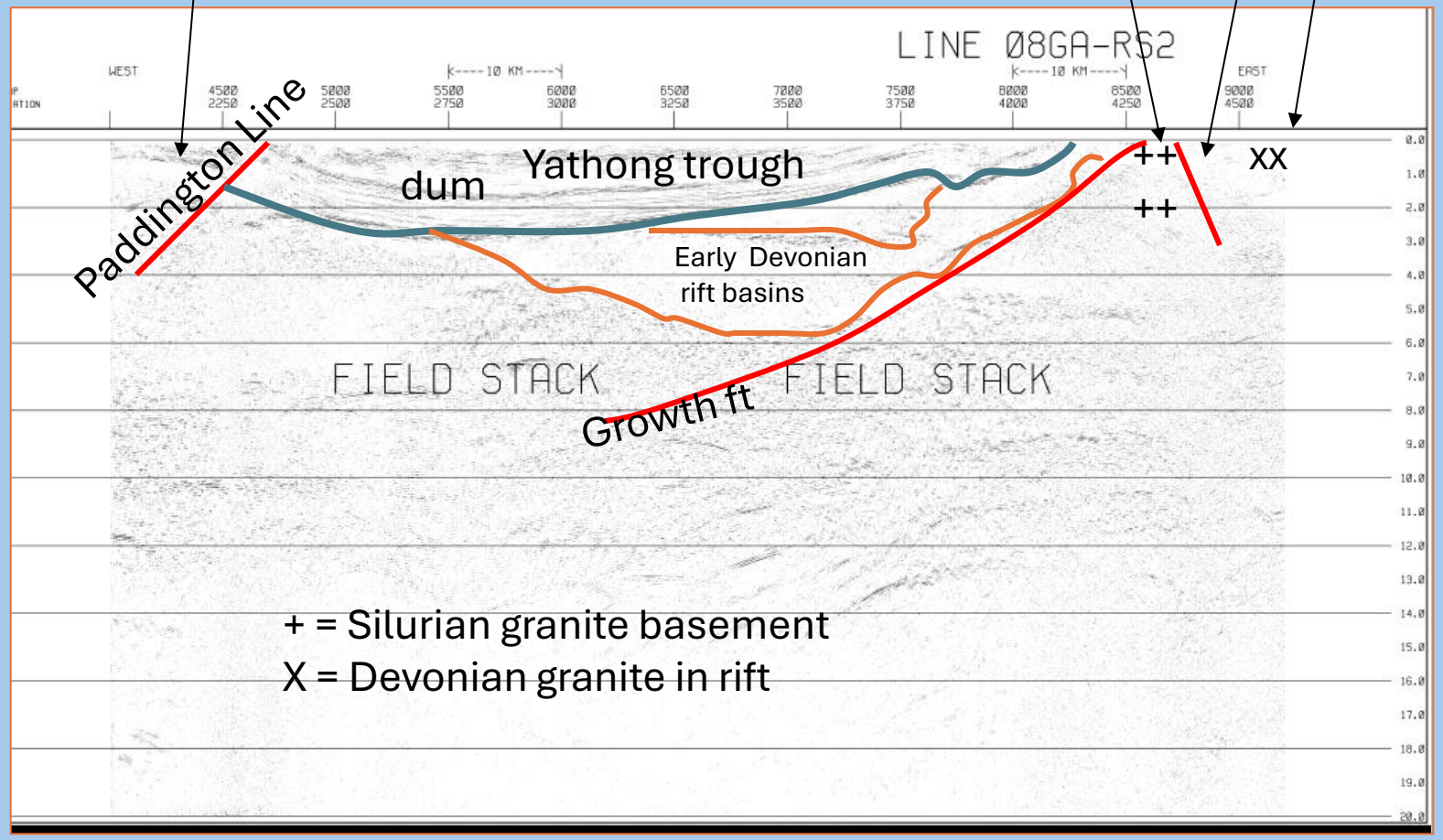


Glen et al., 2013, AJES

horst of basement granite

Mt Hope Trough= strongly inverted rift basin

Silurian-Devonian
??rift or shelf seds



After ASEG-PESA-AIG 2016 conference Handbook

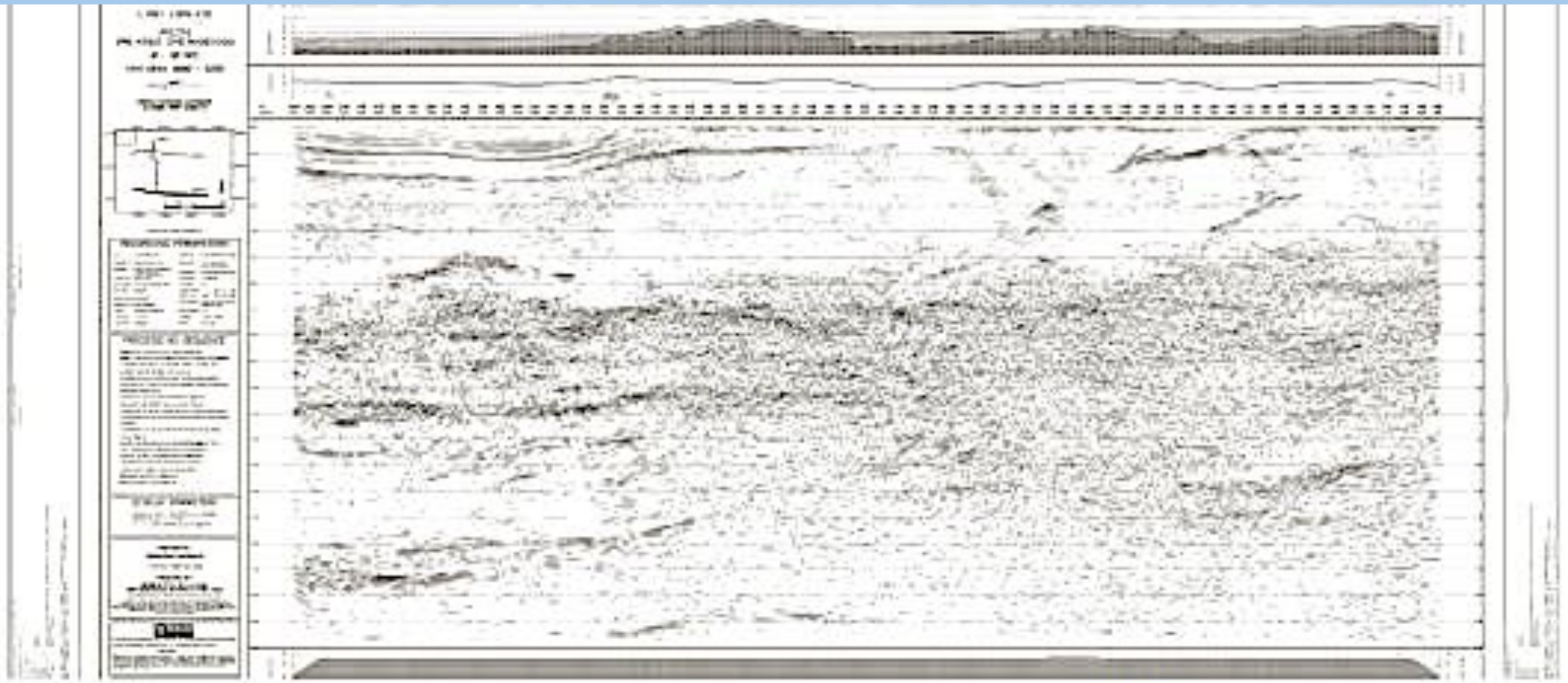
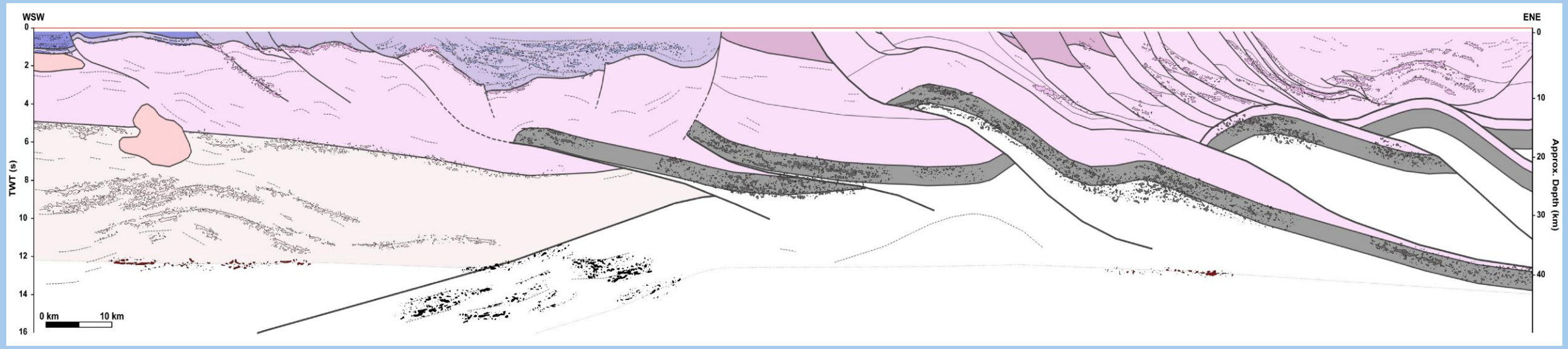
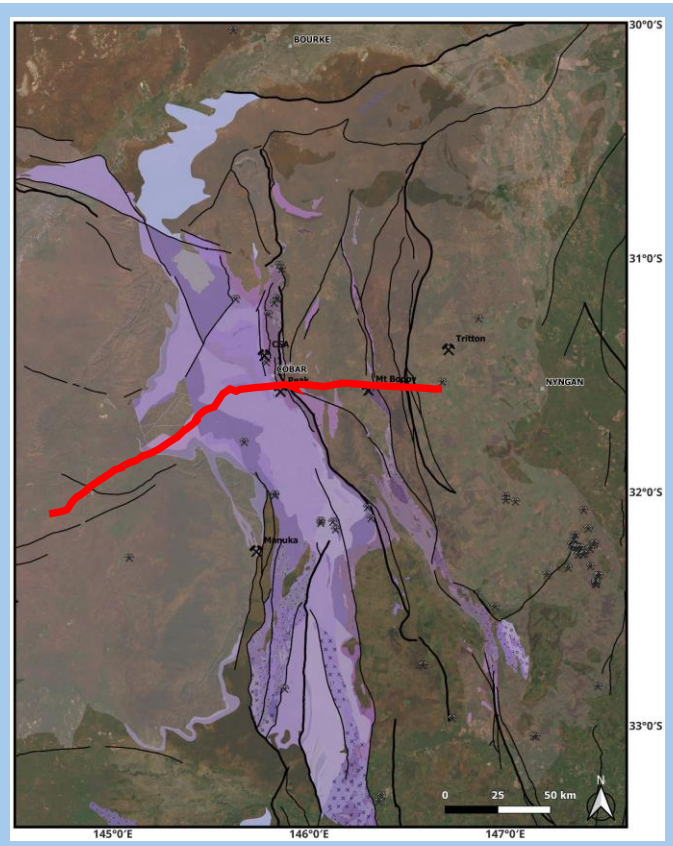


Figure 2. *(a) Location map of the Yathong 2D Seismic Survey in central NSW, shown over interpreted SEEBASE™ basement surface. (b) Seismic Line 13GA-YT02 data to 22 seconds, pre-stack time migrated.*



Mahoney et al. 2024

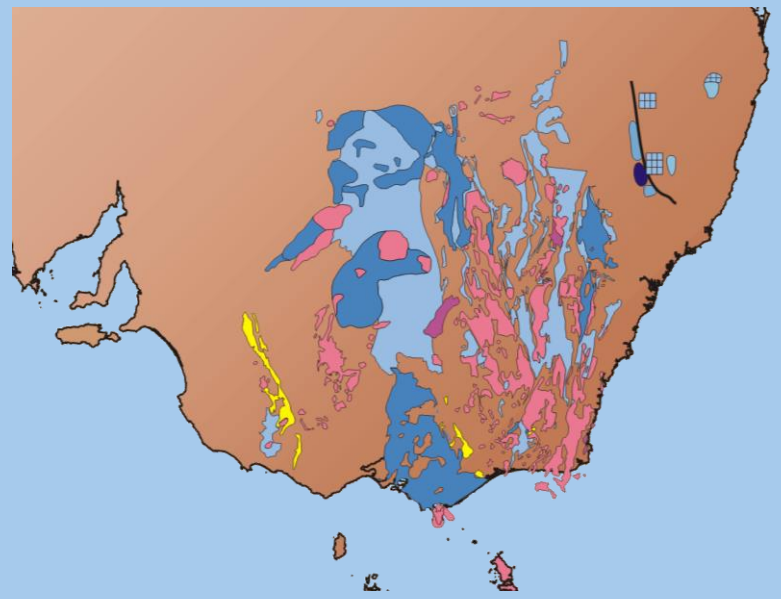
So is there some sort of boundary between different Ordovician and Cambrian packages? If so, does this indicate different potential for mineralization? Need more deep seismic!



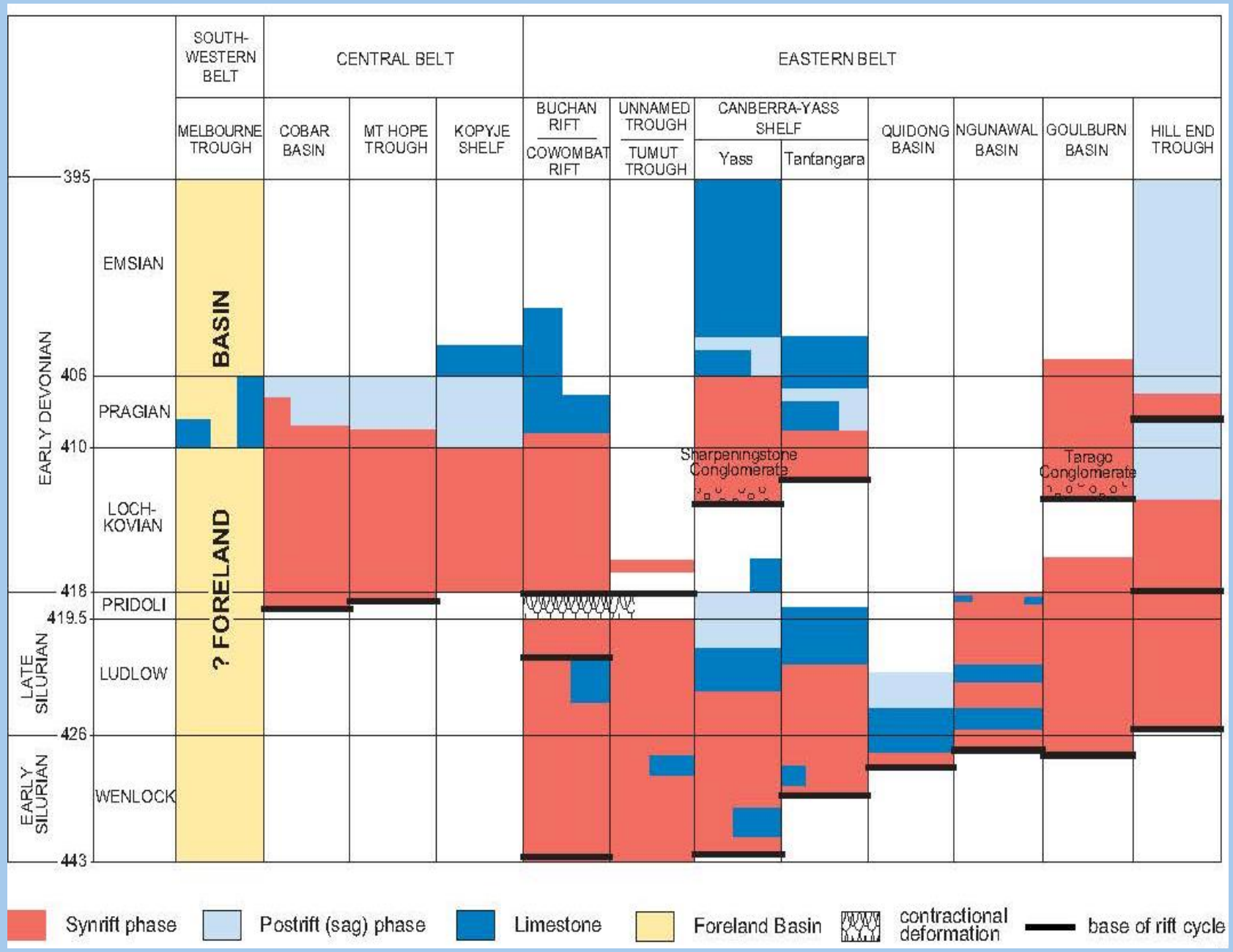
Late Silurian to Early Devonian activity 419-393 Ma

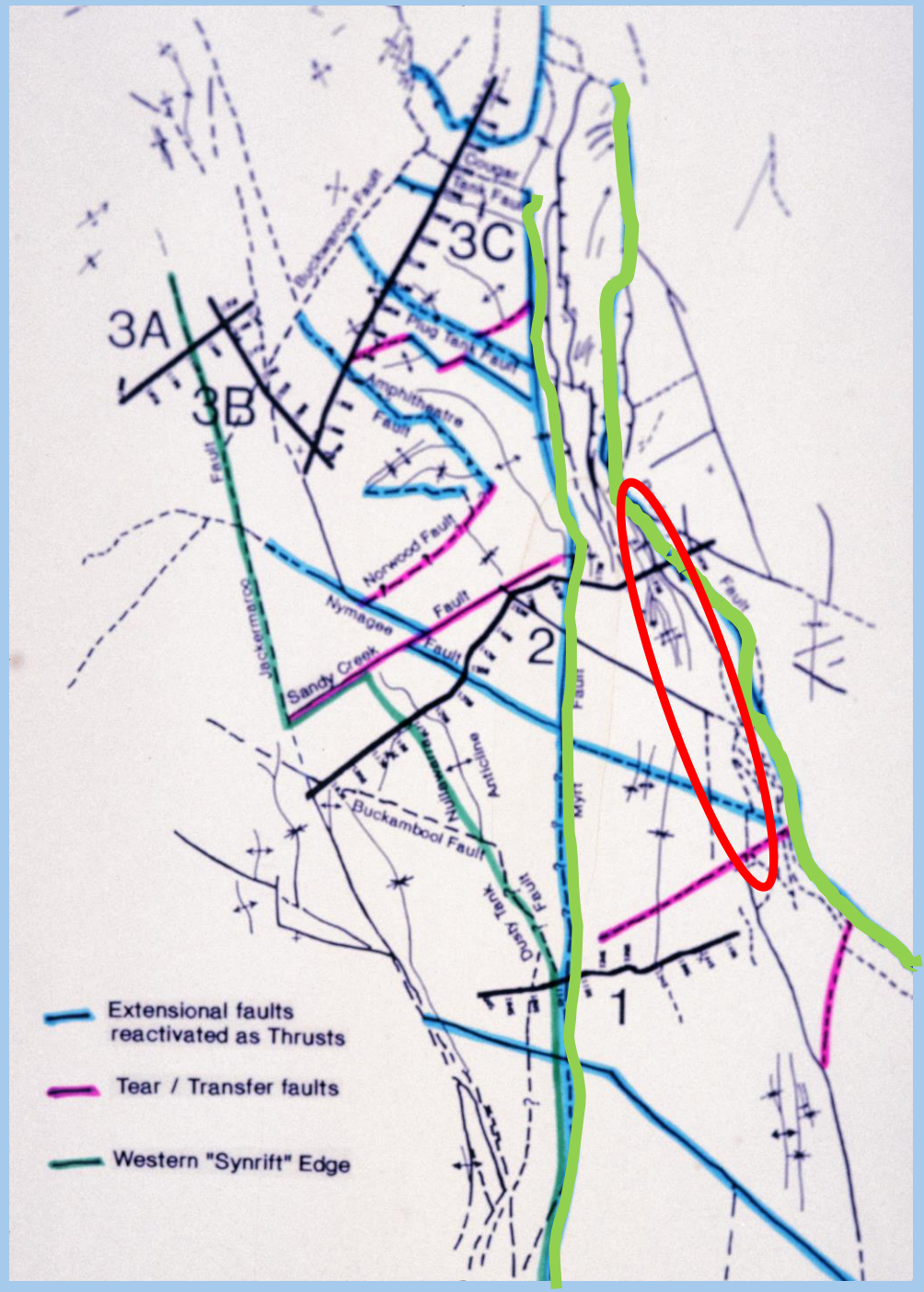
TWO BACK ARC RIFT EVENTS

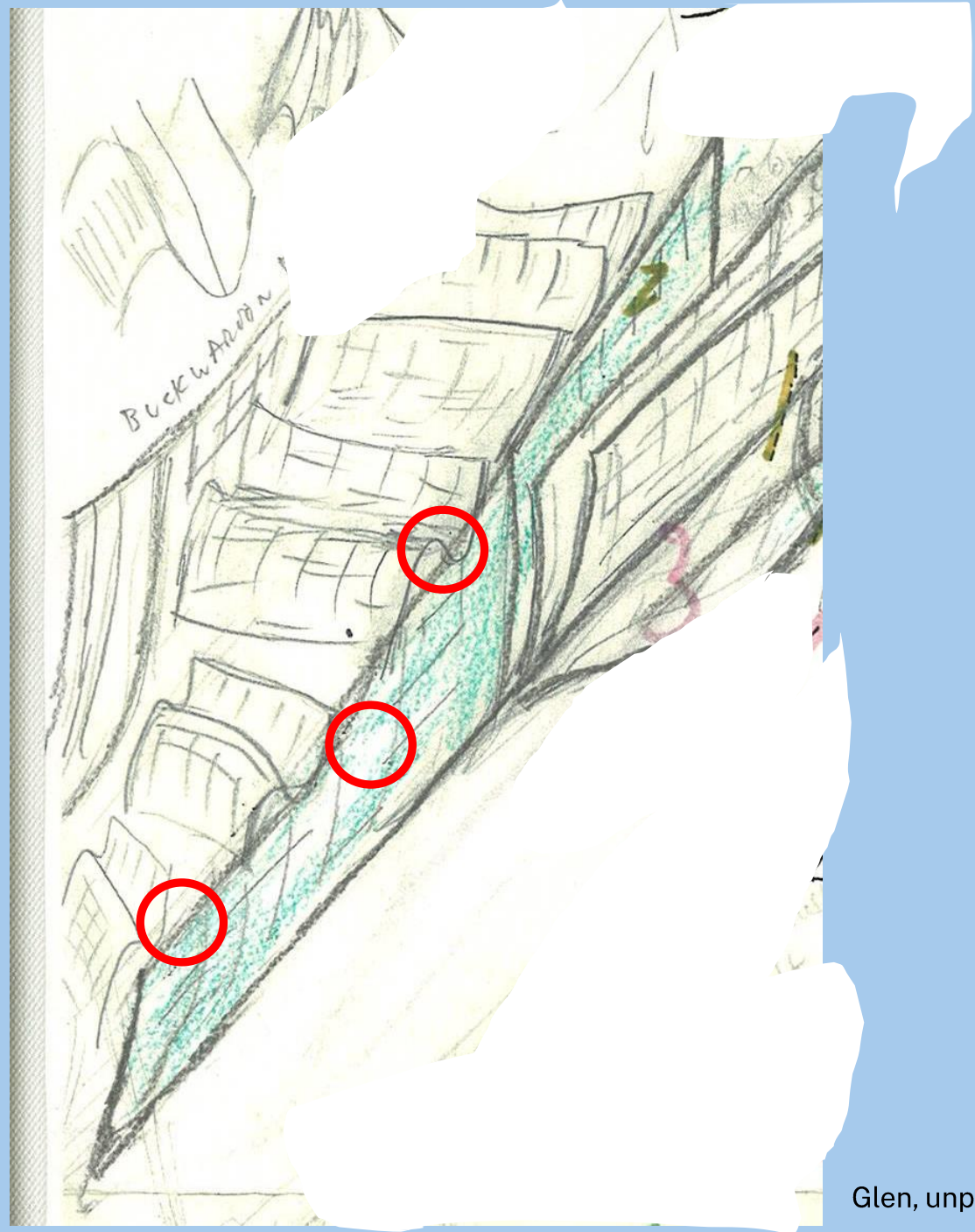
- Silurian- Middle Devonian RIFTING
- Granites MORB and BAB volcanics Arc signature melts



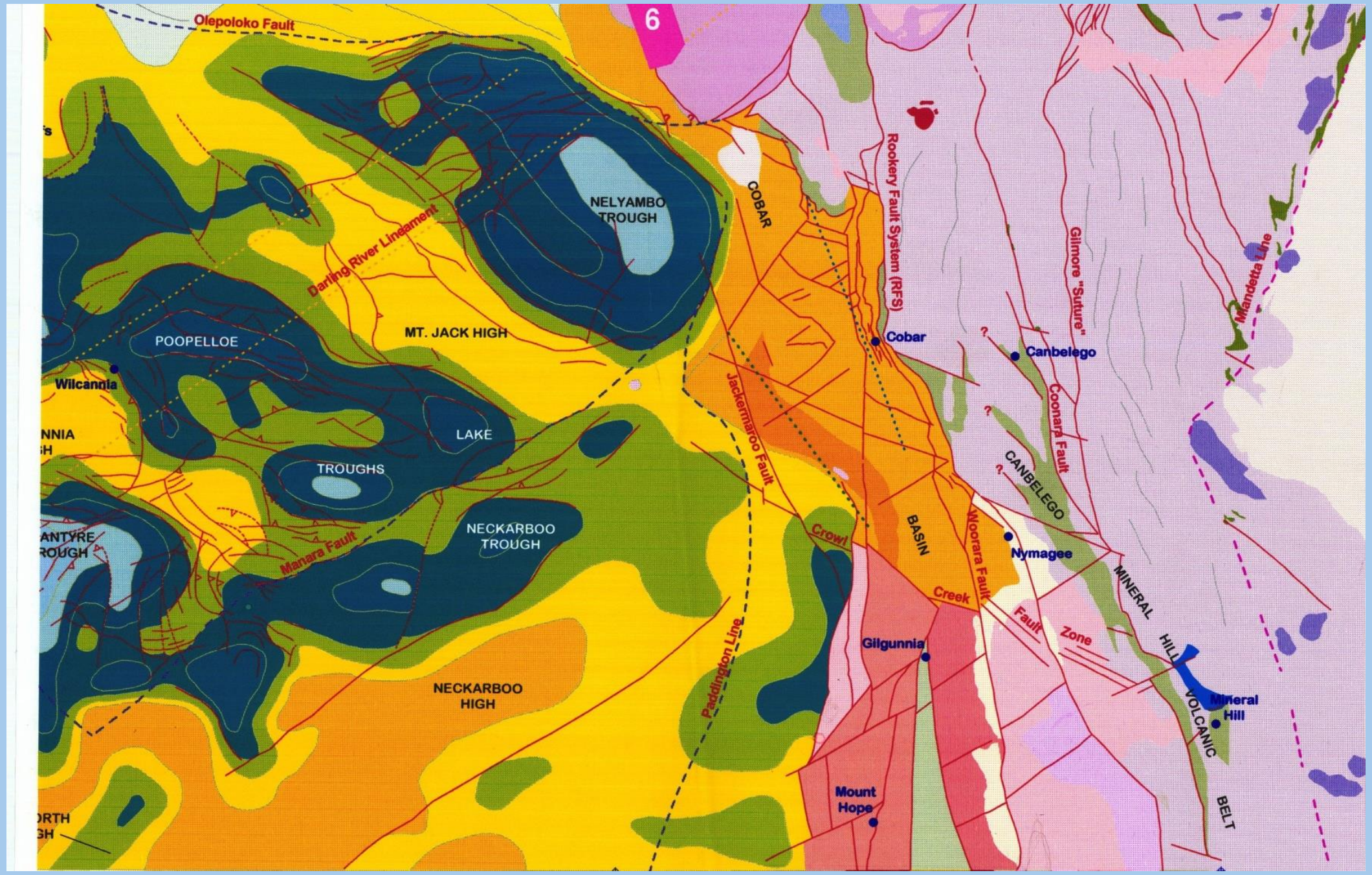
Glen 2005







Glen, unpublished



Glen et al. 1996 AIMM Cobar Volume

1. Vic geology explains why there are subsurface Camb rocks in NSW & gives insights into Cambrian mantle.

2. S.A, Victoria & NSW data on Delamerian arc indicates minor only, being followed by backarc rifting, behind an oceanward rolling back plate boundary. Fragments of arc and subduction zone rocks ended up in the Peel-Manning Fault System in the NEO.

3. Plate boundary was established offshore in the New England Orogen by end Ordovician & remained ~ there till end of Cretaceous.

4. Mac Arc is unusual in that the 4 phases of Crawford and Percival & Glen are vertically stacked for 50 Ma, that includes 2 hiatuses.

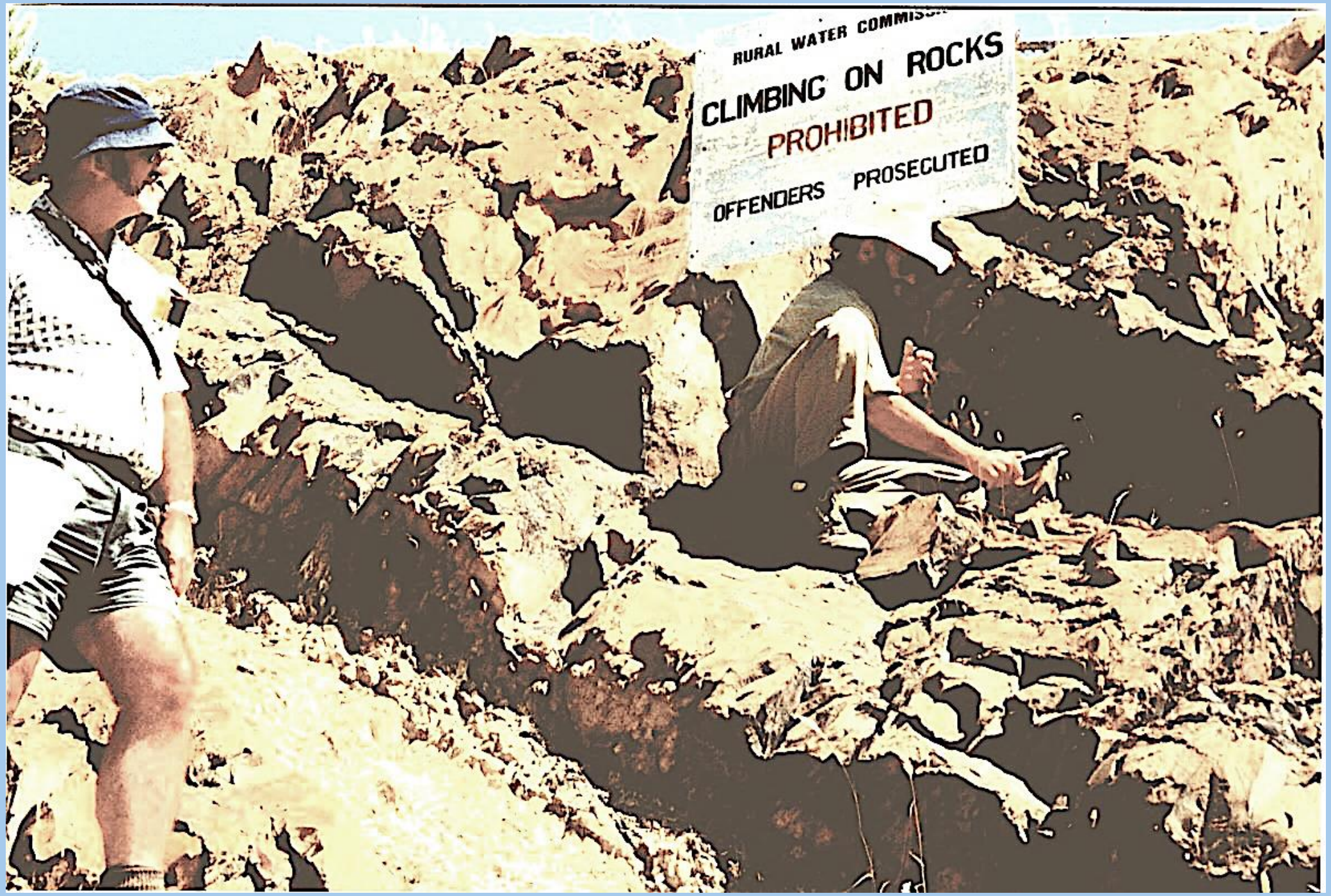
5. In the Early Silurian, the crust fell apart, permitting ingress of mantle-derived melts.
Reflects plate boundary rollback. Cadia and some of Alkane's north Molong porphyries are parts of this extensional event.

6. Plumbing systems v. important, esp. cross structures & intersections with arc-parallel ones undercover.

7. The Geol. Survey is ideally placed to open up these tracts by undertaking age dating/drilling coupled with deep seismic to ascertain the location of plumbing systems.

8. At the end of the day it depends on models which depend on field work and the wearing out of field boots.

RG 05.2025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