The giant Lachlan Orocline –

a powerful new predictive tool for mineral exploration under cover across Eastern Australia

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Geological Survey of Victoria, Geological Survey of NSW

DEPARTMENT OF STATE DEVELOPMENT BUSINESS AND INNOVATION

State Government Victoria

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September 2015

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It's a team effort

Australian Government

Geoscience Australia

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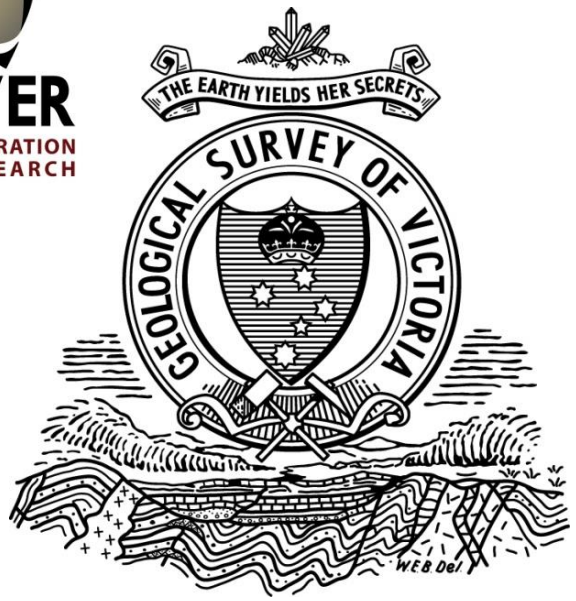

pmd*crc

AuScope

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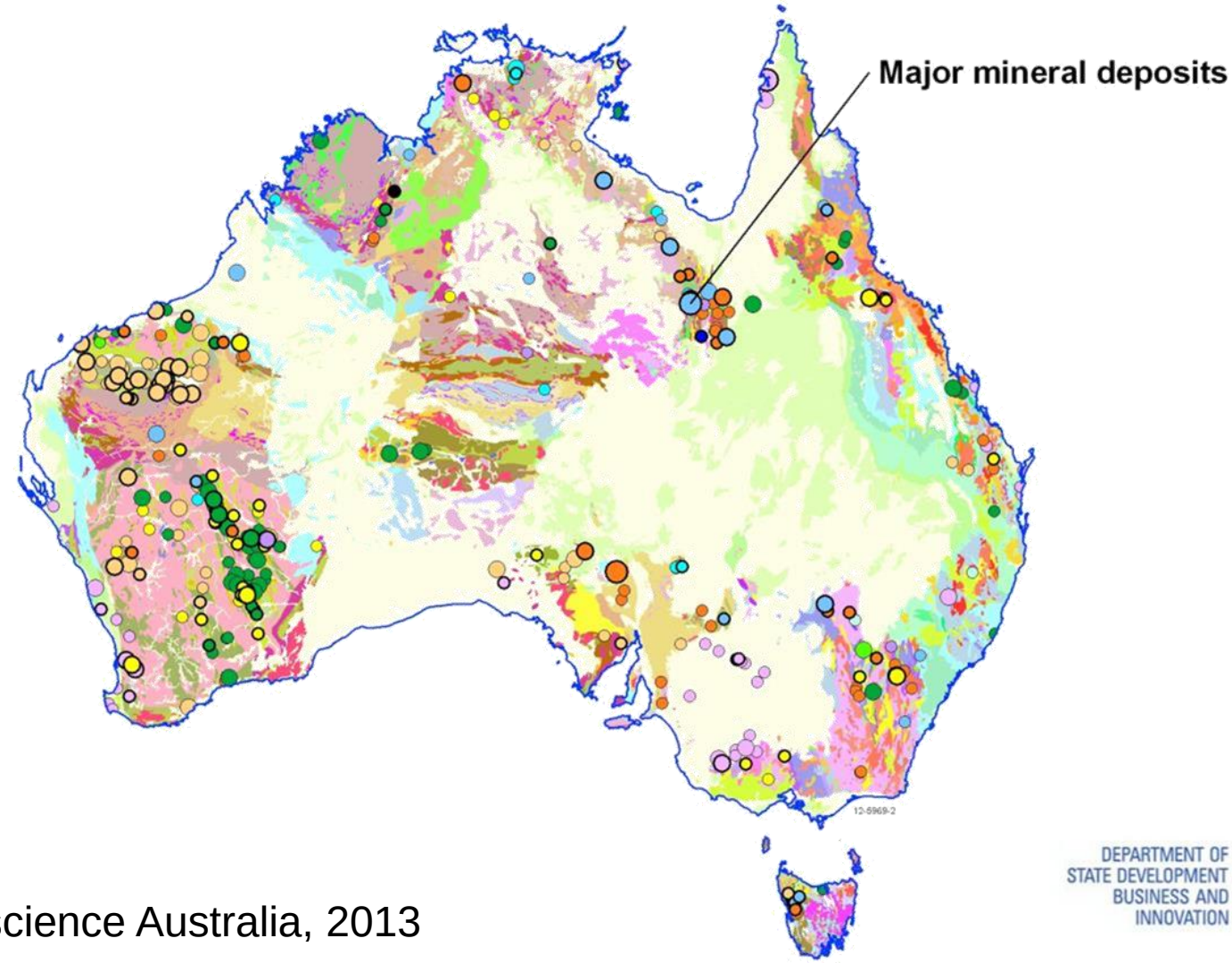
STATE DEVELOPMENT
BUSINESS AND
INNOVATION

Talk Outline

- **The problems**
- New data/concepts constrain viable solutions
- Retro-deformation, analogue and numerical modelling
-
- The Lachlan Orocline through time – a new geodynamic model for Ordovician-Devonian Australia
- How congested subduction zones resolve – key to understanding Tasmanian evolution
- What does it all mean for mineral prospectivity?



Source: Geoscience Australia, 2013

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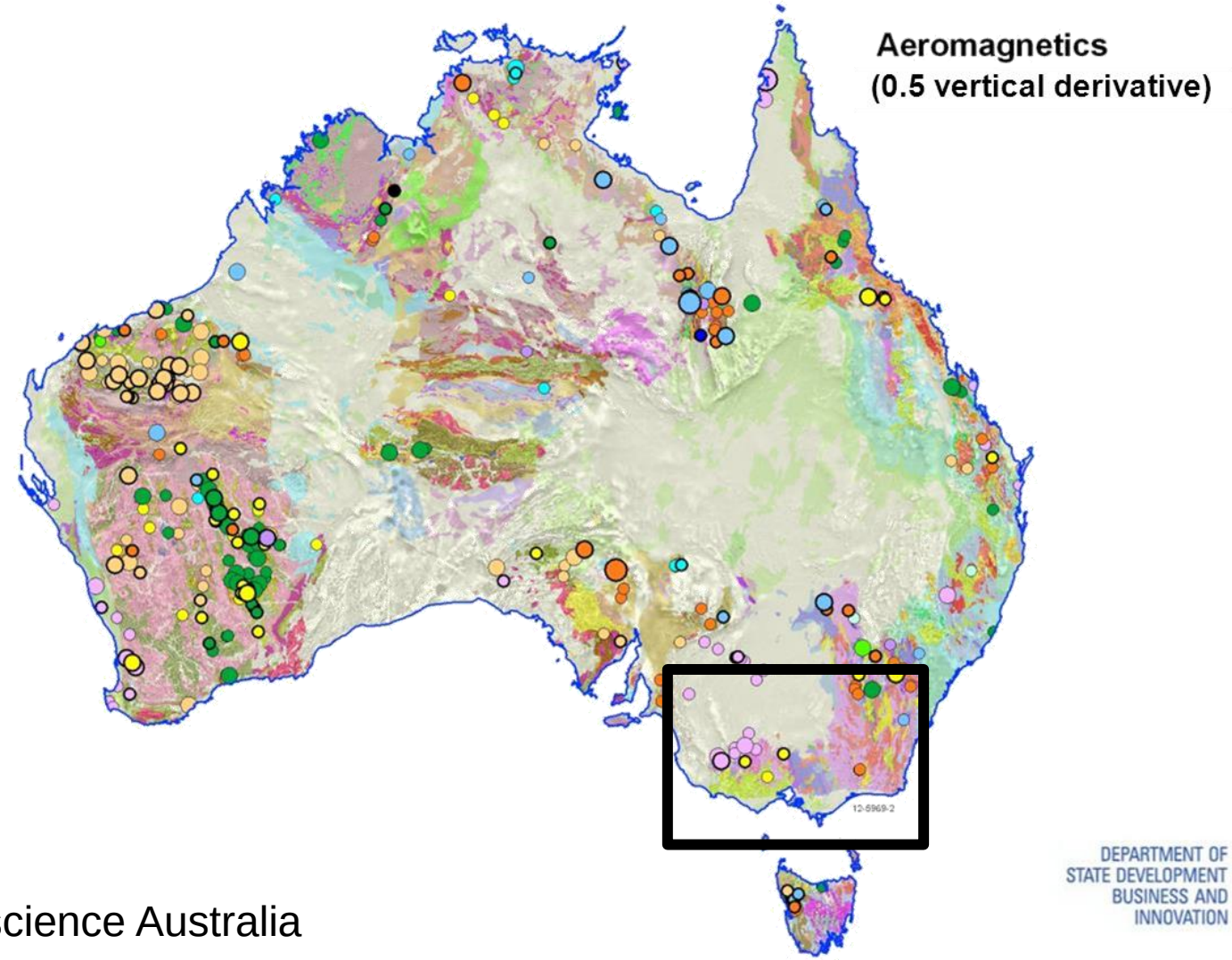

Source: Geoscience Australia

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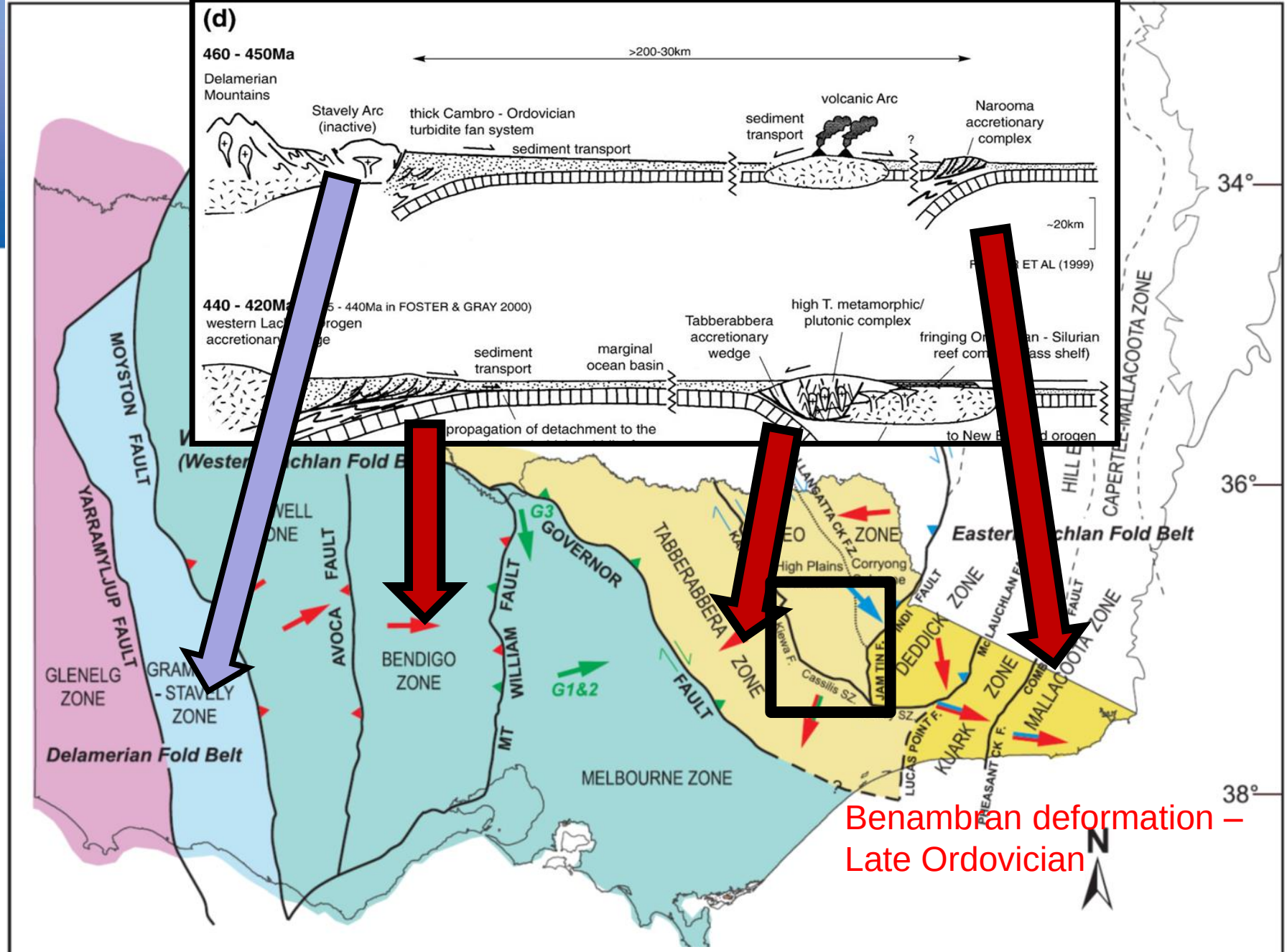
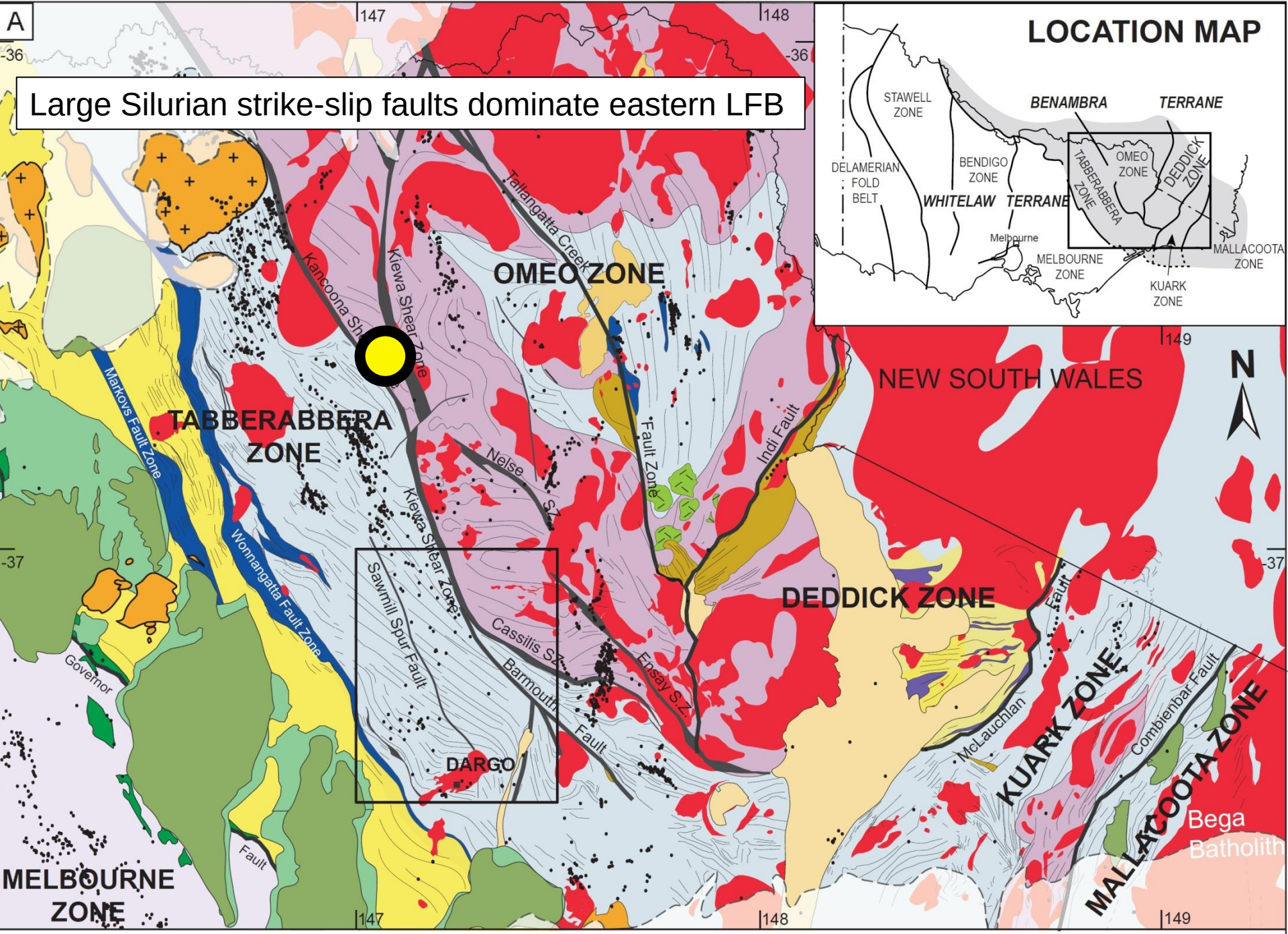
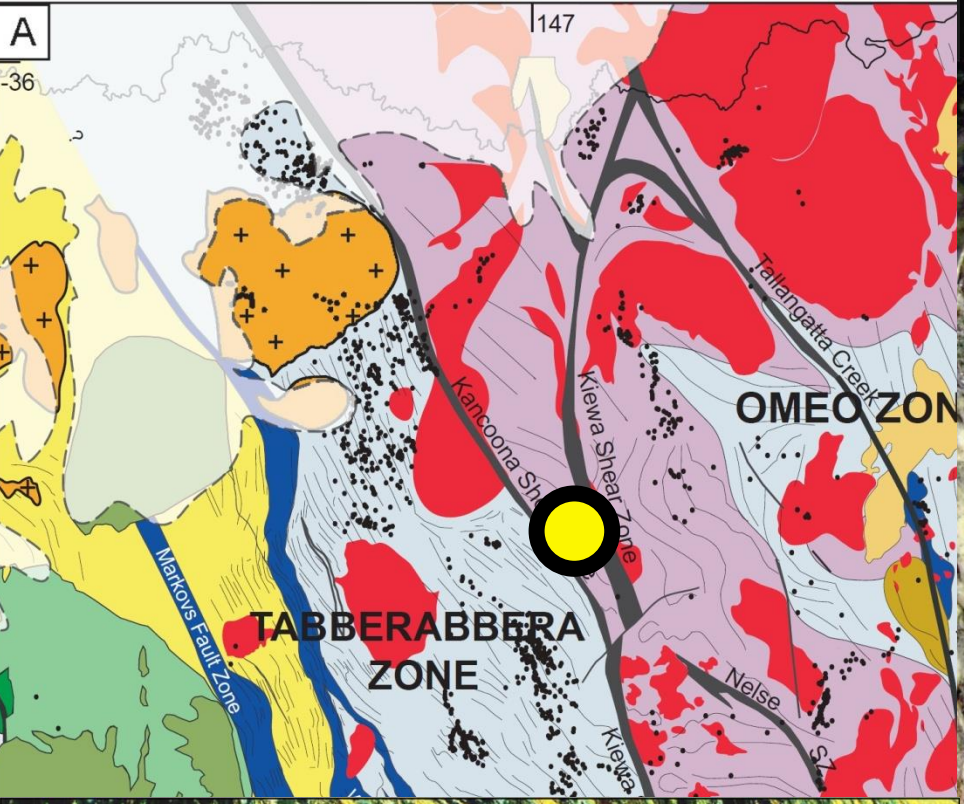
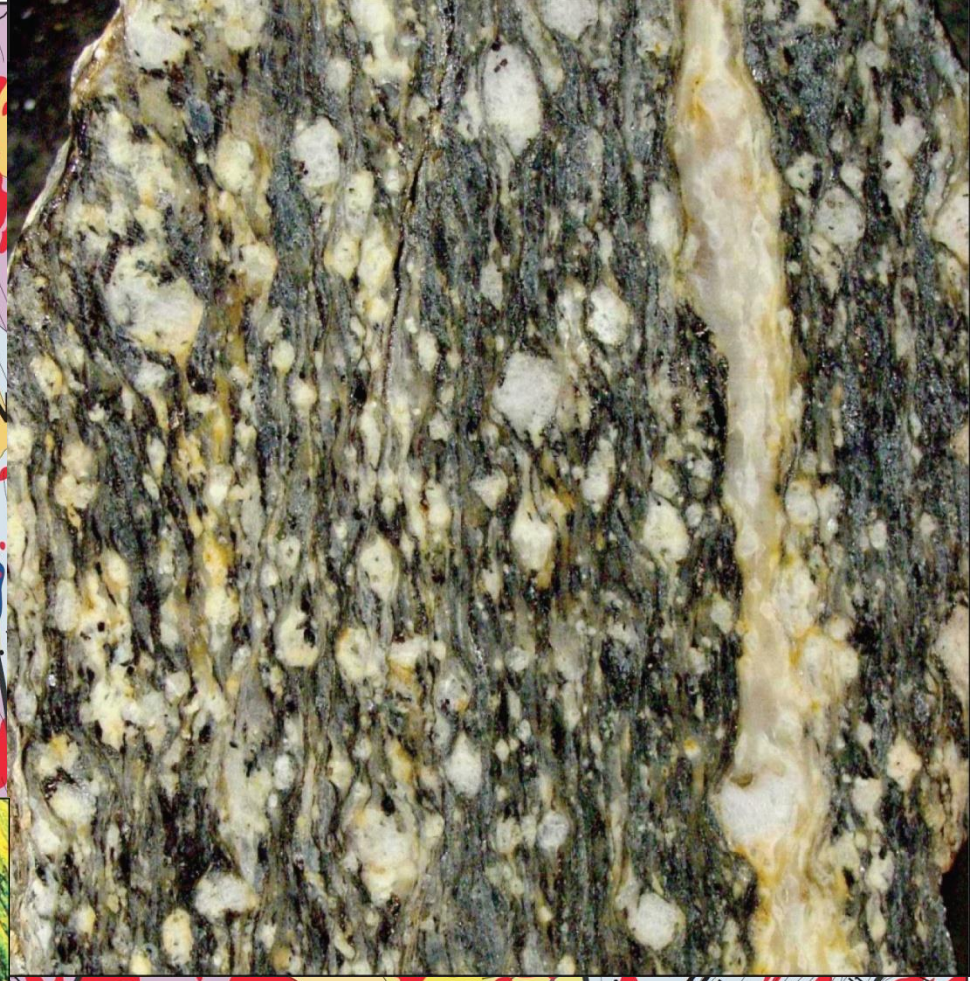


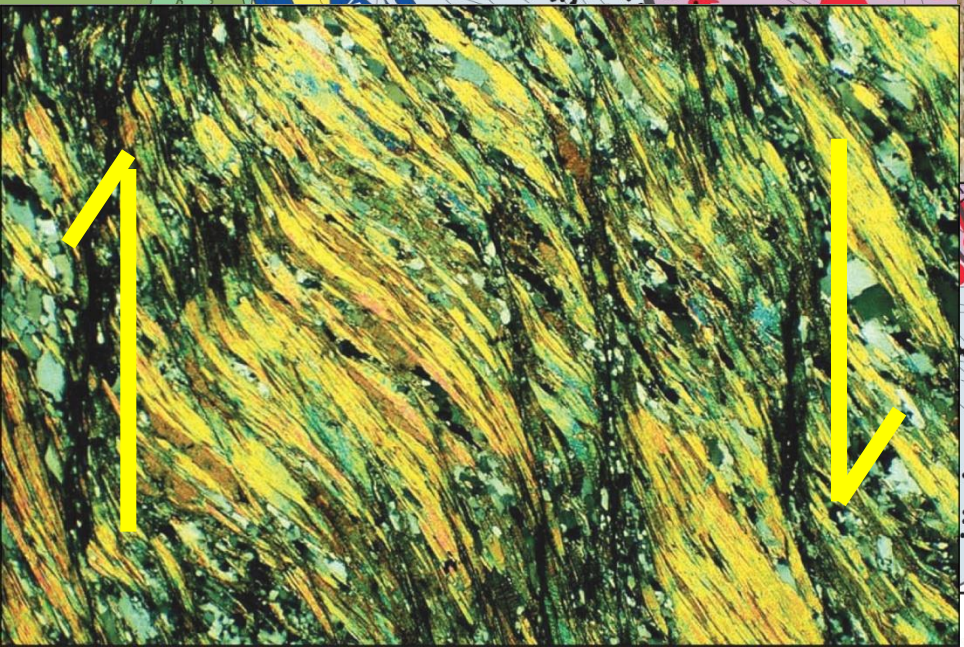
Benambran deformation – Late Ordovician

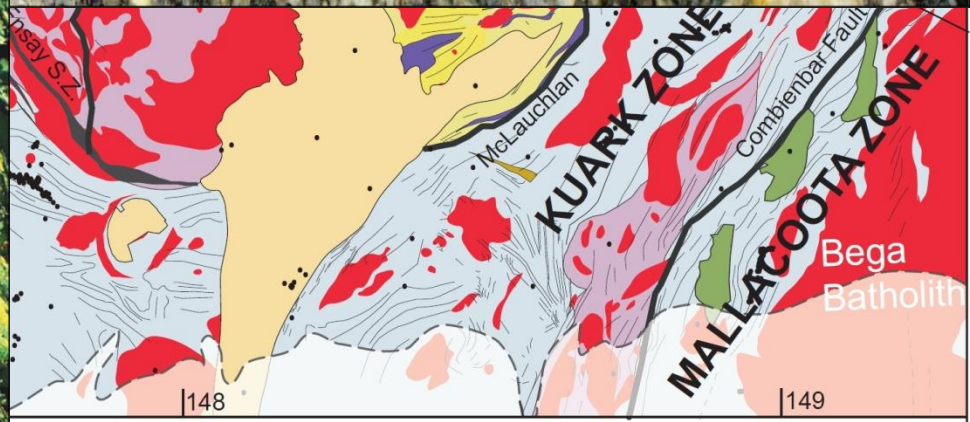
Models that honour structural vergence, accretionary character…..

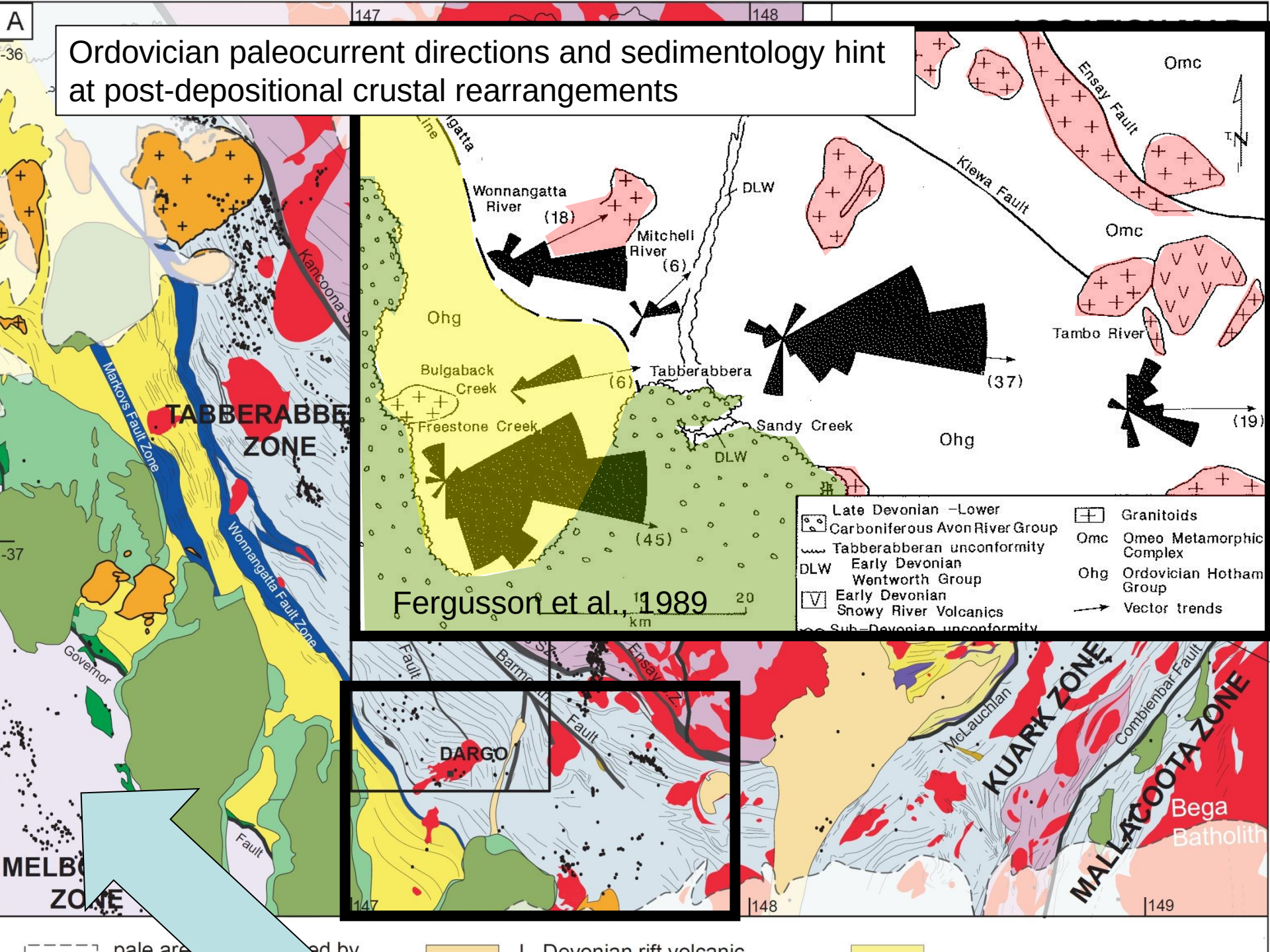

A
Large Silurian strike-slip faults dominate eastern LFB
LOCATION MAP
STAWELL ZONE
BENAMBRA
TERRANE
DELAMERIAN FOLD BELT
BENDIGO ZONE
TABBERABBERA ZONE
OMEO ZONE
DEDDICK ZONE
WHITELAW TERRANE
Melbourne
MELBOURNE ZONE
MALLACOOTA ZONE
KUARK ZONE
147
148
149
-36
-37
OMEO ZONE
Kancoona Sh
Kiewa Shear Zone
Tallangatta Creek
Fault Zone
Indi Fault
NEW SOUTH WALES
N
TABBERABBERA ZONE
Markovs Fault Zone
Wonnangatta Fault Zone
Nelse Sz
Kiewa Shear Zone
Sawmill Spur Fault
Cassilis Sz
Barmouth Fault
Ensay S.Z.
DEDDICK ZONE
Fault
McLauchlan
KUARK ZONE
Combienbar Fault
MALLACOOTA ZONE
Bega Batholith
DARGO
Governor
Fault
MELBOURNE ZONE


A
147
-36
Tallangatta Creek
Kiewa Shear Zone
OMEO ZON
Markovs Fault Zone
TABBERABBERA
ZONE
Nelse
Kiewa






McLauchlan
KUARK ZONE
Combienbar Fault
MALLACOOTA ZONE
Bega
Batholith
148
149

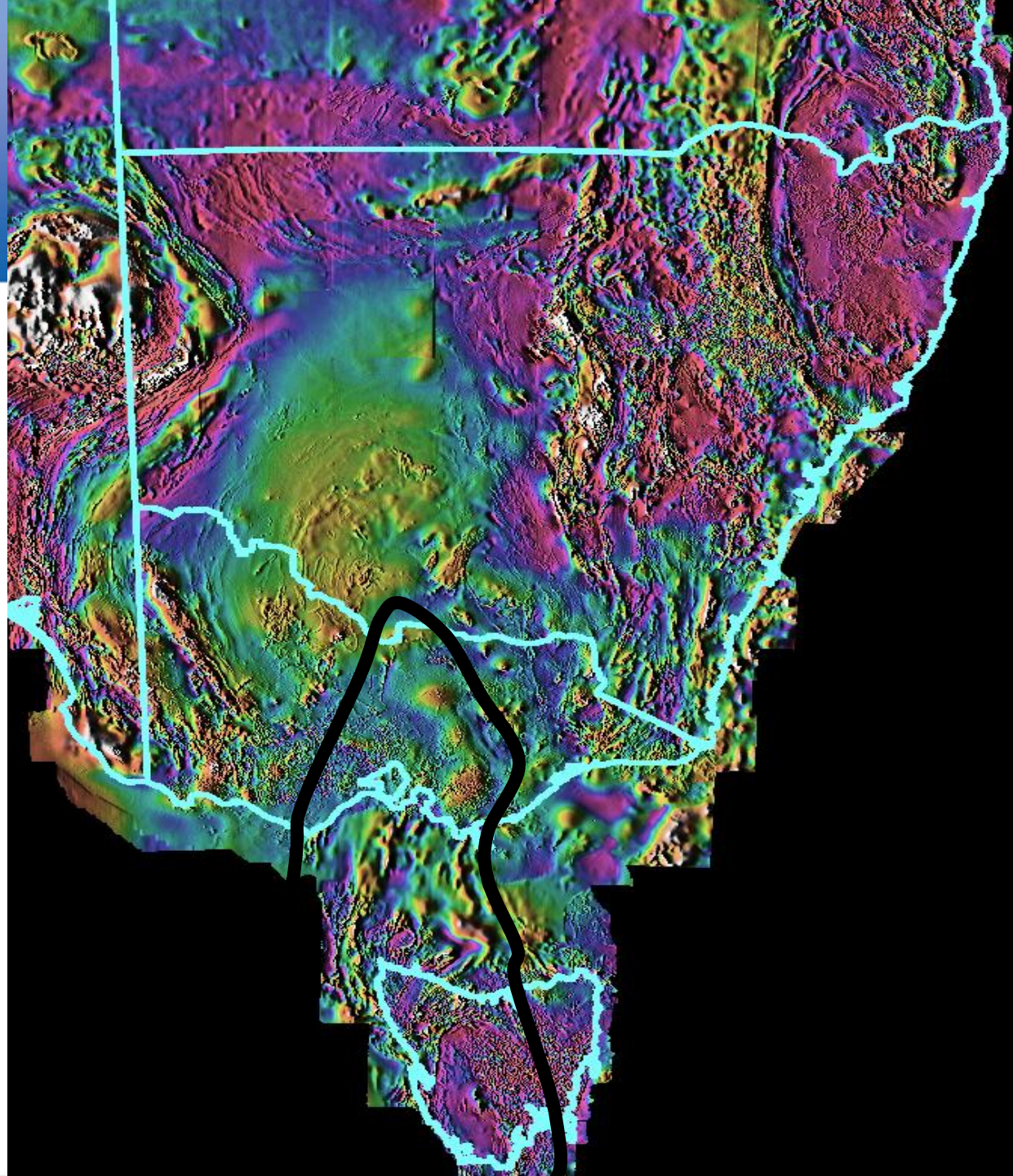

Ordovician paleocurrent directions and sedimentology hint at post-depositional crustal rearrangements
Wonnangatta River
(18)
Mitchell River
(6)
DLW
Kiewa Fault
Ensay Fault
Omc
Ohg
Bulgaback Creek
(6)
Tabberabbera
(37)
Tambo River
(19)
Freestone Creek
Sandy Creek
(45)
Fergusson et al., 1989
Late Devonian –Lower Carboniferous Avon River Group
Tabberabberan unconformity
Early Devonian Wentworth Group
Early Devonian Snowy River Volcanics
Granitoids
Omeo Metamorphic Complex
Ordovician Hotham Group
Vector trends
TABBERABBE ZONE
Markovs Fault Zone
Wonnangatta Fault Zone
Governor
Fault
MELBO ZONE
DARGO
Barmah
Ensay
McLauchlan
KUARK ZONE
Combienbar Fault
MALLACOOTA ZONE
Bega Batholith
147
148
149

Vandieland (Cayley et al, 2002)

A Mesoproterozoic microcontinent…..

includes Western Tasmania and the ‘Selwyn Block’…

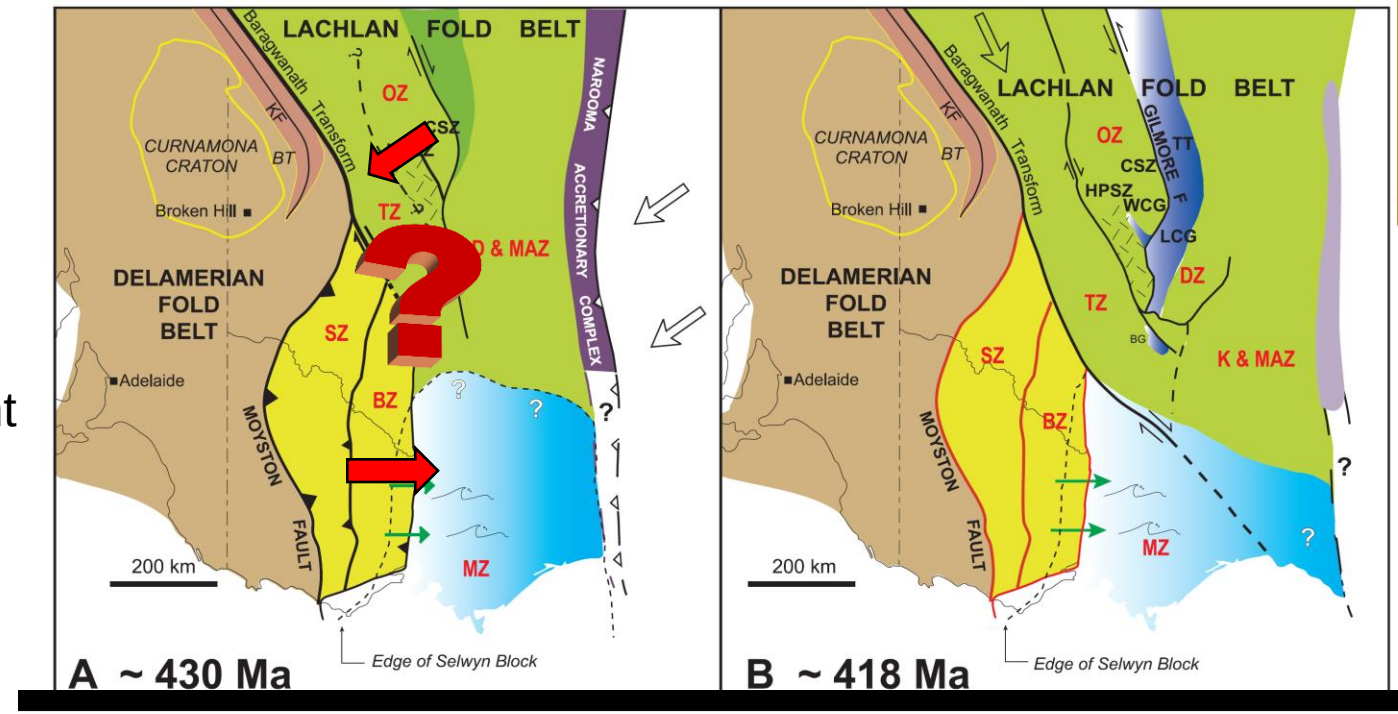
embedded within the Paleozoic Lachlan Fold Belt…

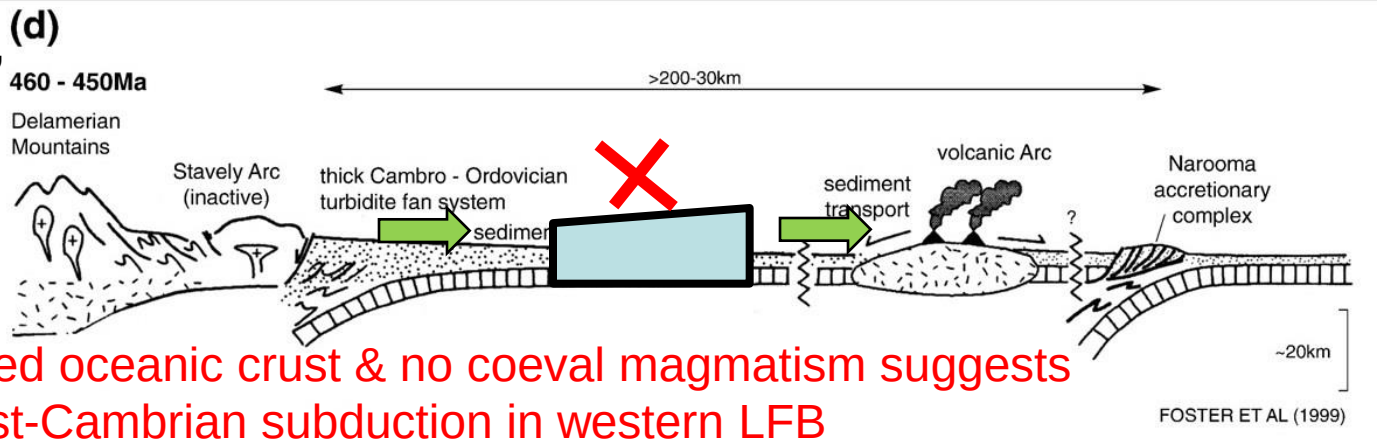


Models that honour paleogeographic constraints, and account for strike-slip faults…..

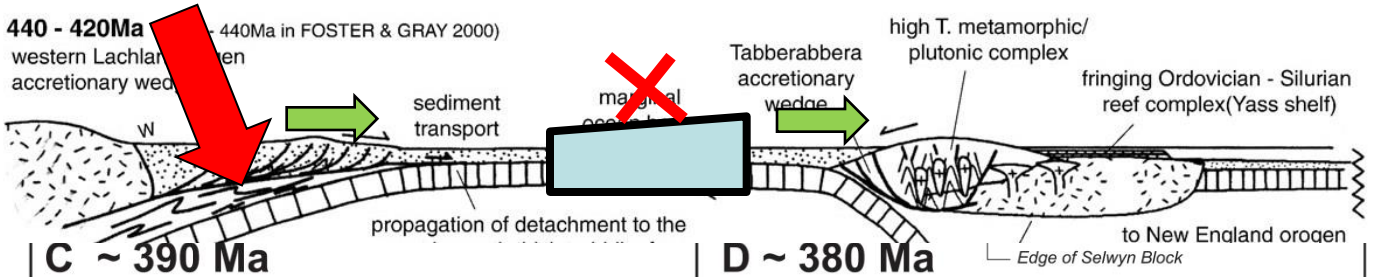
eg. the Baragwanath Transform concept…

(VandenBerg et al. 2000, Willman et al., 2002)





Imbricated oceanic crust & no coeval magmatism suggests little post-Cambrian subduction in western LFB



Victoria
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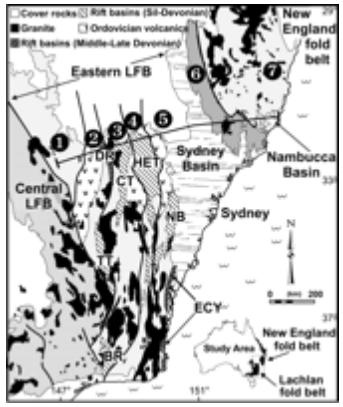
Recognition of the critical role of roll-back in LFB evolution….

Tectonic switching and roll-back in the LFB

Collins, 2002 (Geology)



Extension and the tripartite association:

S-type granites, arcs and back-arc basins

Collins and Richards, 2008 (Geology)

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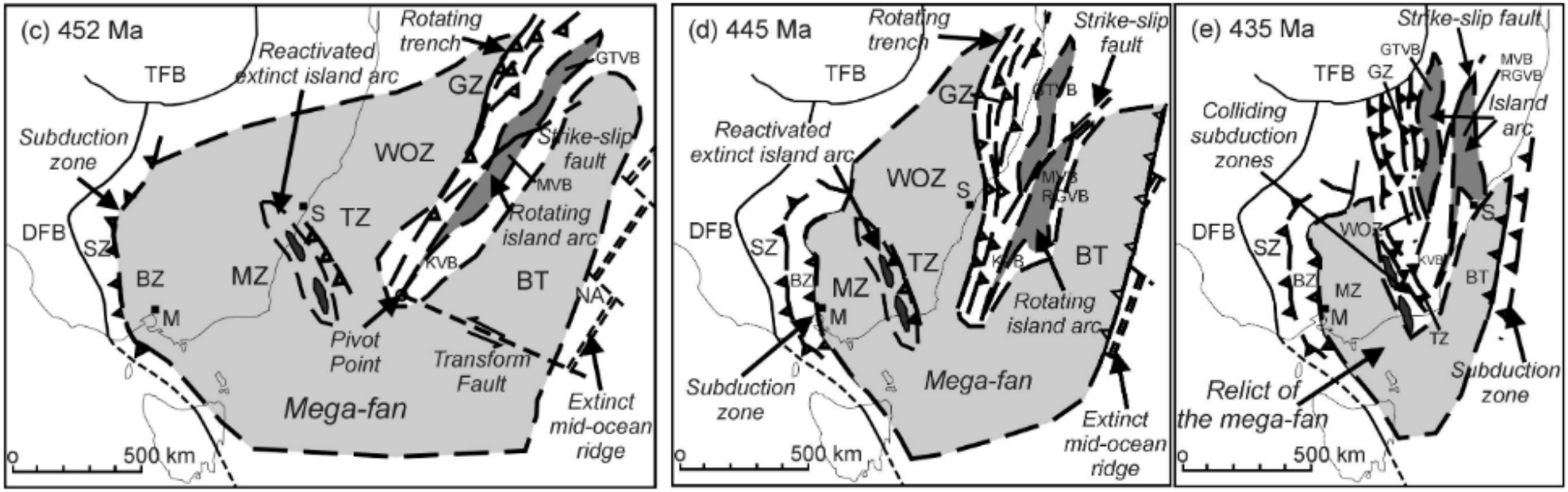


Models that suggest the possibility of strike-slip repetition of Macquarie Arc segments:

Packham, 1987 (AGU Geodynamics Series 19)

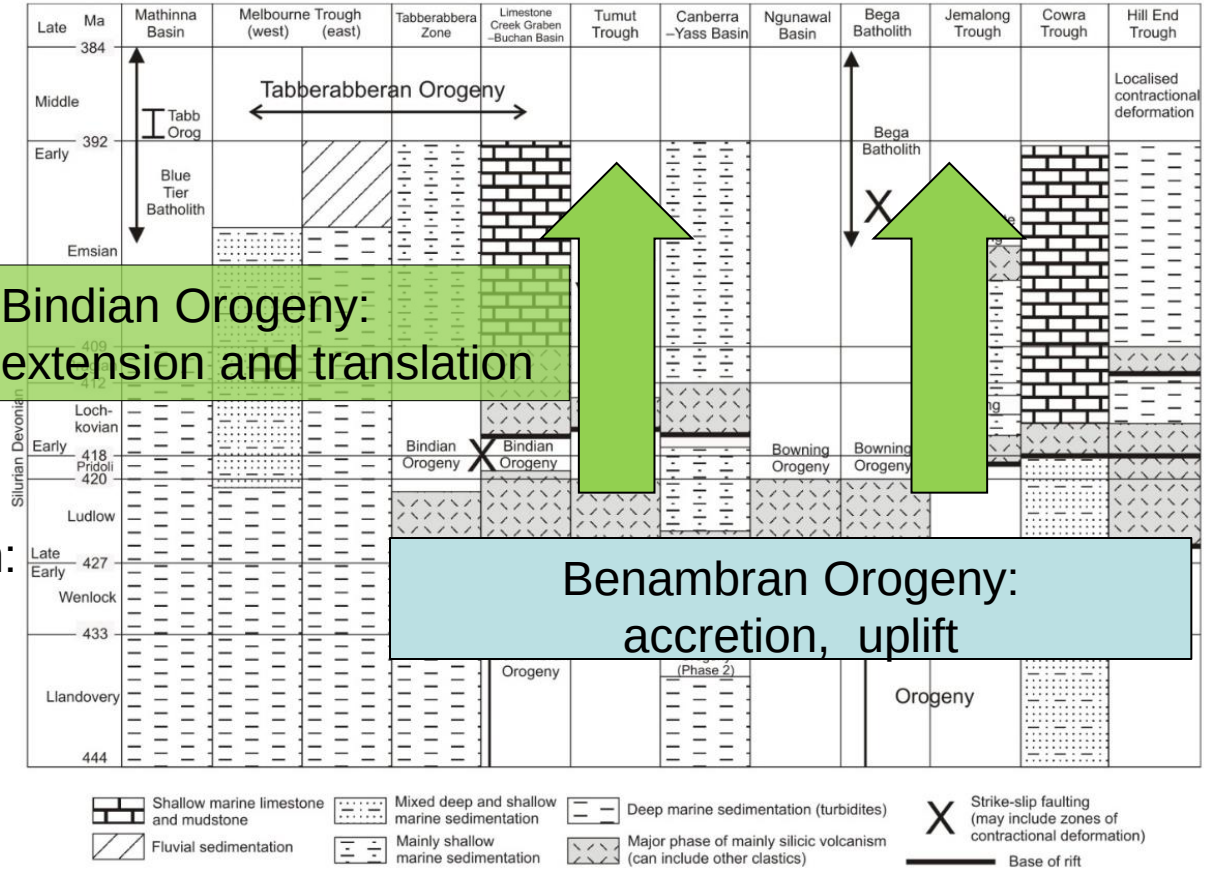
Fergusson, 2009 (AJES)

Models that link extension to sedimentation in the LFB:

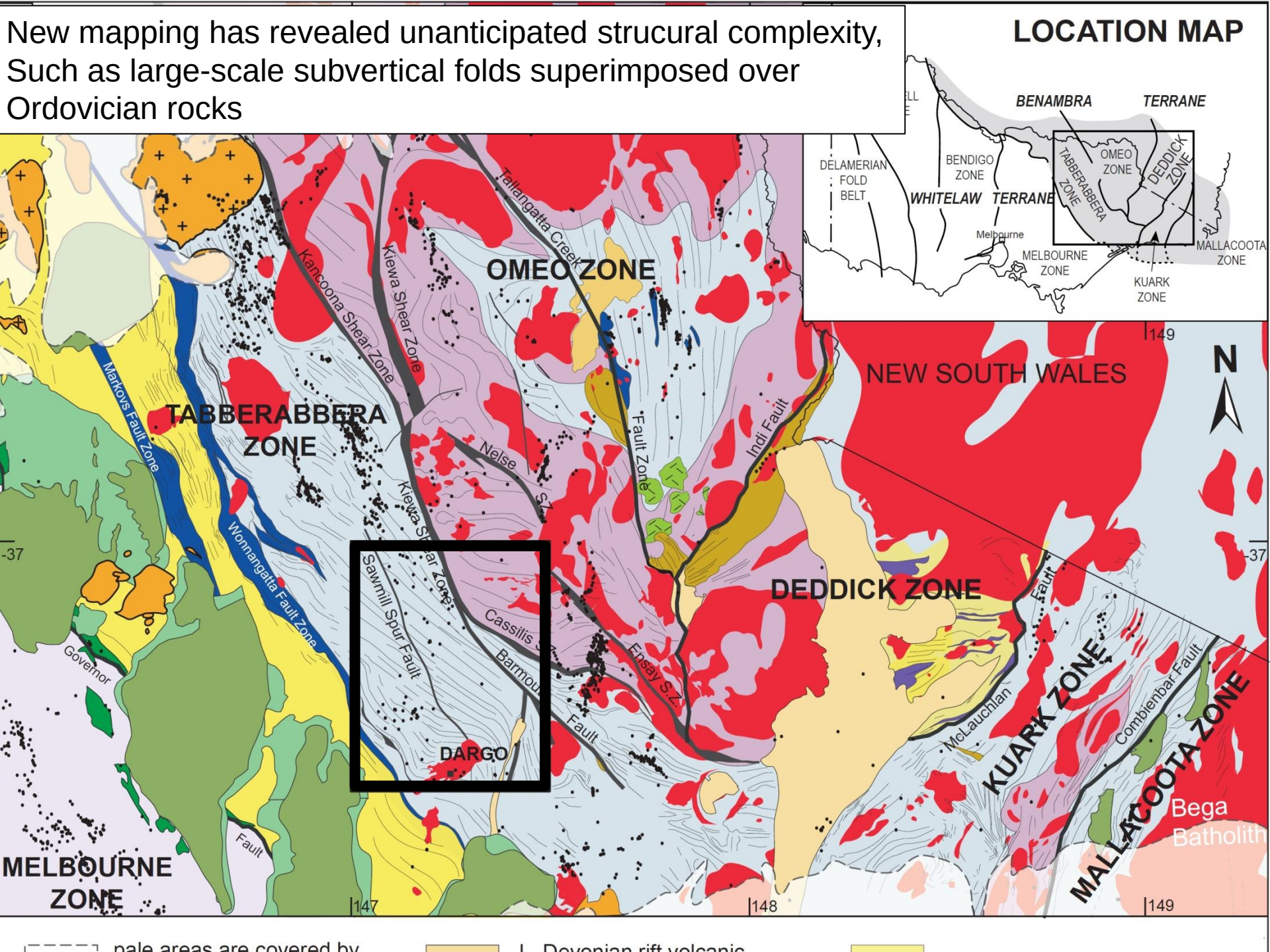
Fergusson, 2010: AJES:

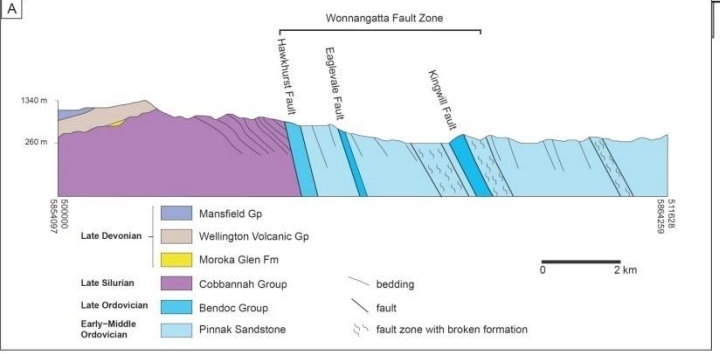
Lachlan Fold Belt sedimentation:

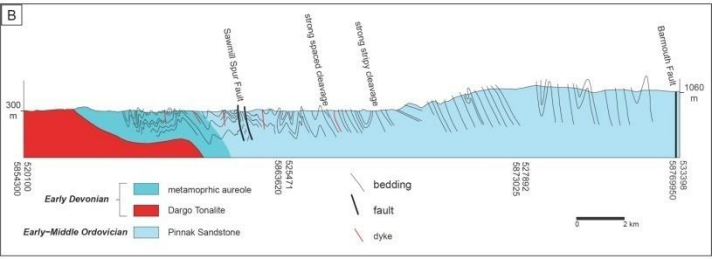
Late Silurian-Middle Devonian
plate-driven extension and convergence

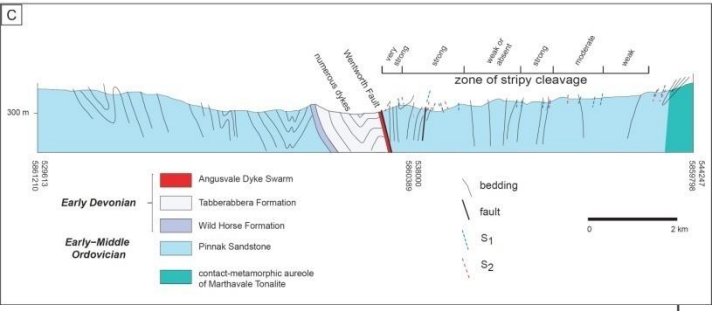


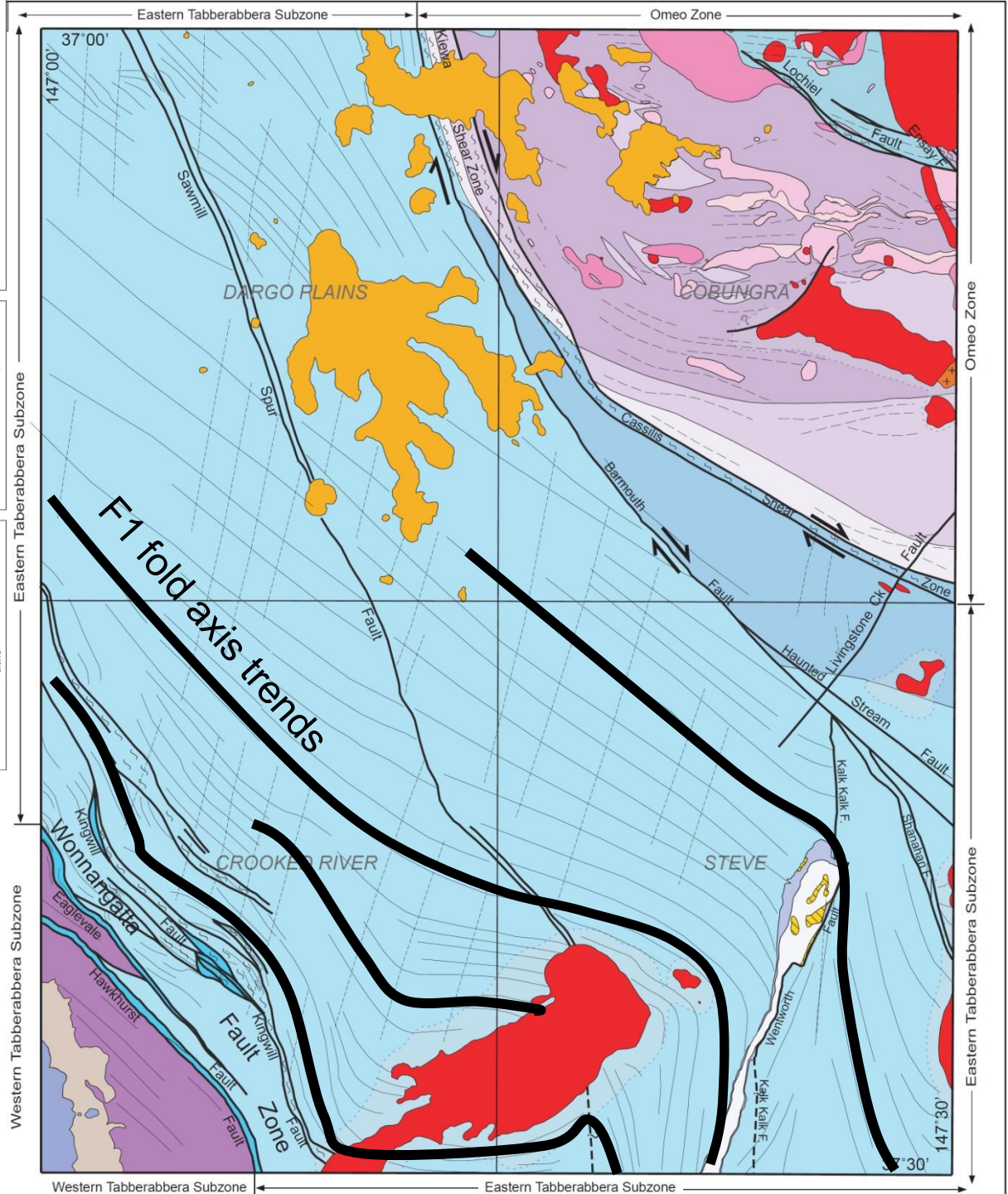
New mapping has revealed unanticipated strucural complexity, Such as large-scale subvertical folds superimposed over Ordovician rocks











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Willman et al., 2005.
GSV Report 126: Dargo

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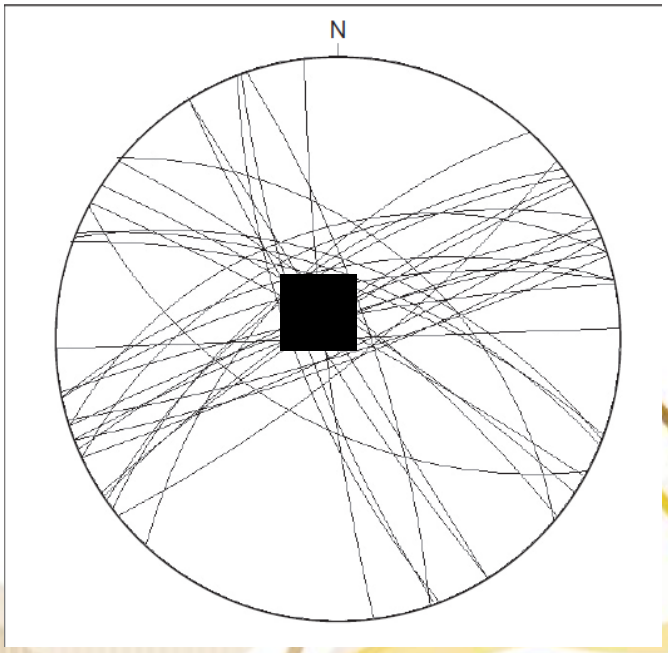
DARGO 1:100 000 sheet:

Stereoplot (equal area projection):
34 great-circle traces of
F1 fold axial surfaces (Benambran).

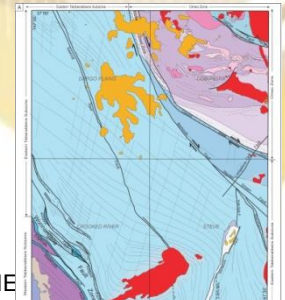


Calculated β-axis for this dataset:
79º towards 333º

= average orientation
of large-scale (Bindian) F2 folds

Large, subvertical-plunging second-generation folds within Tabberabbera Zone: Parasitic ?

Willman et al., 2005.
GSV Report 126: Dargo



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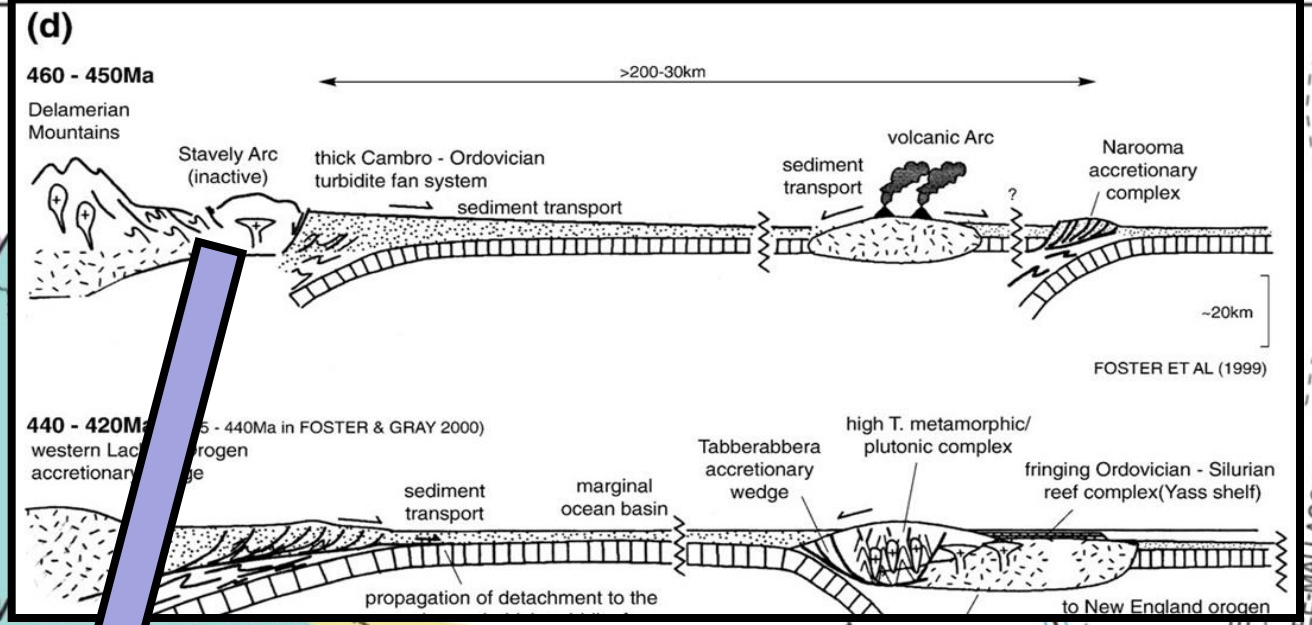
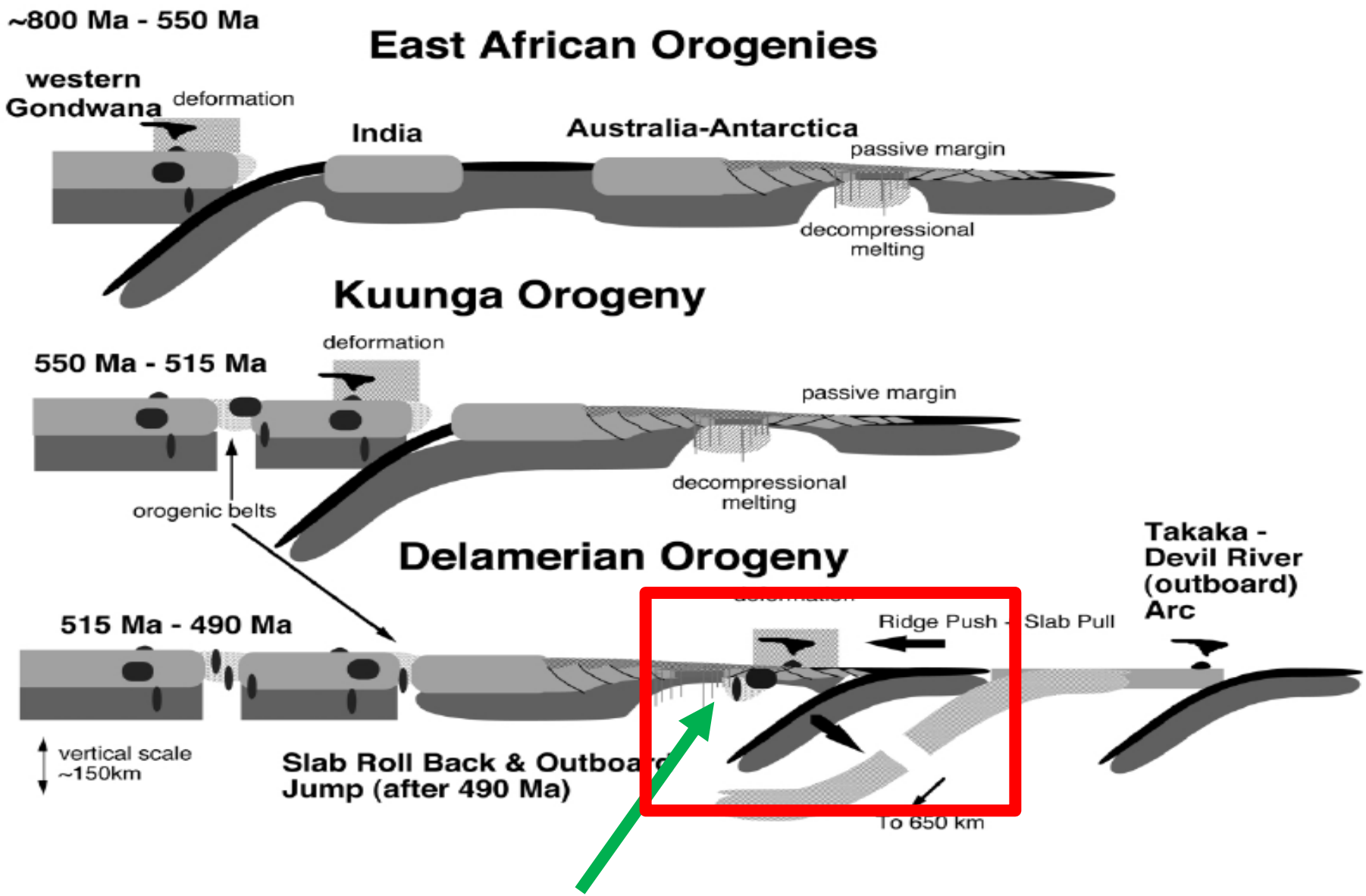


Benambran deformation – Late Ordovician

Models that honour structural vergence, accretionary character…..



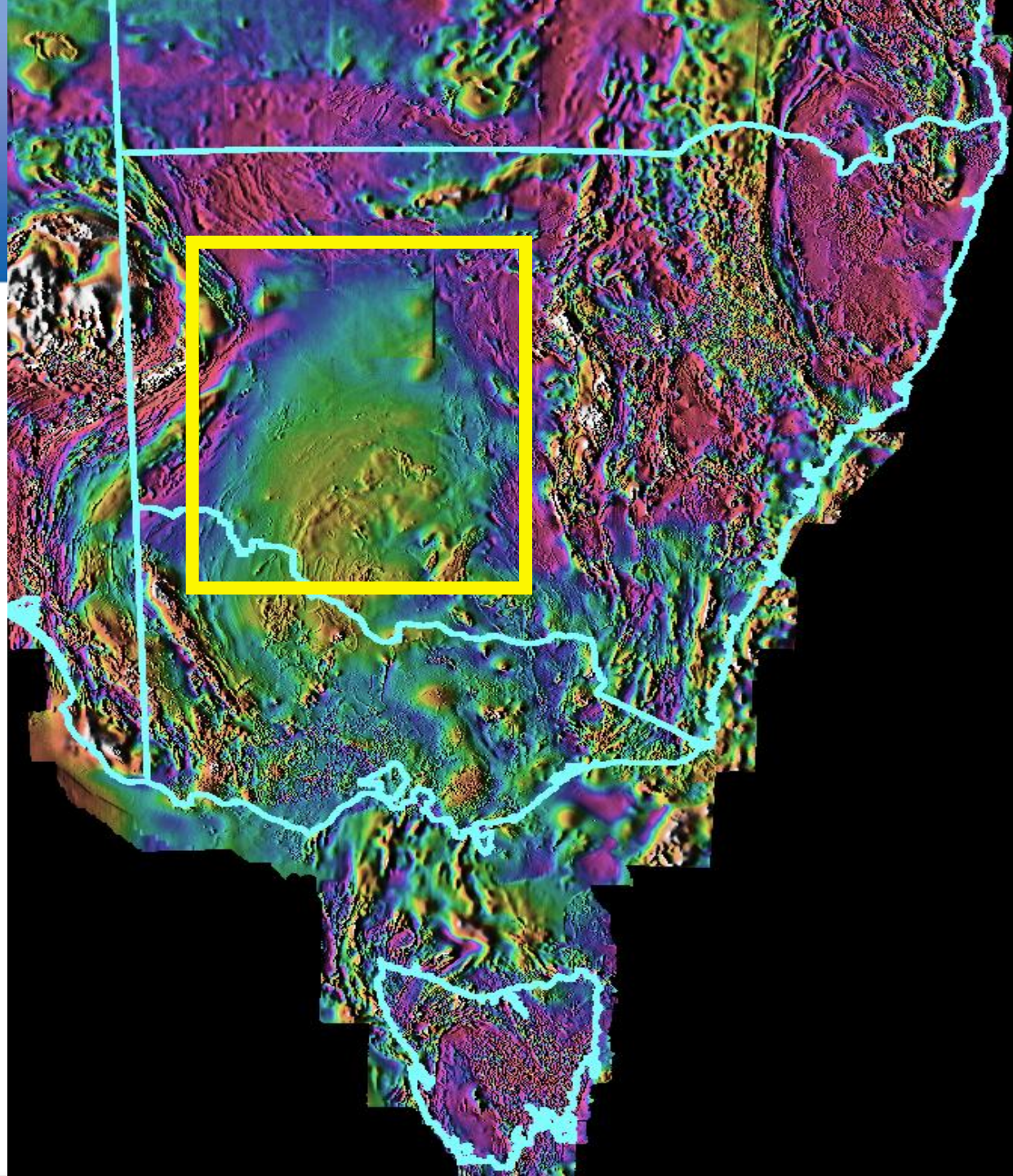
Boninites/'Sanukitoids' at ~514Ma: *Kemp, 2003*

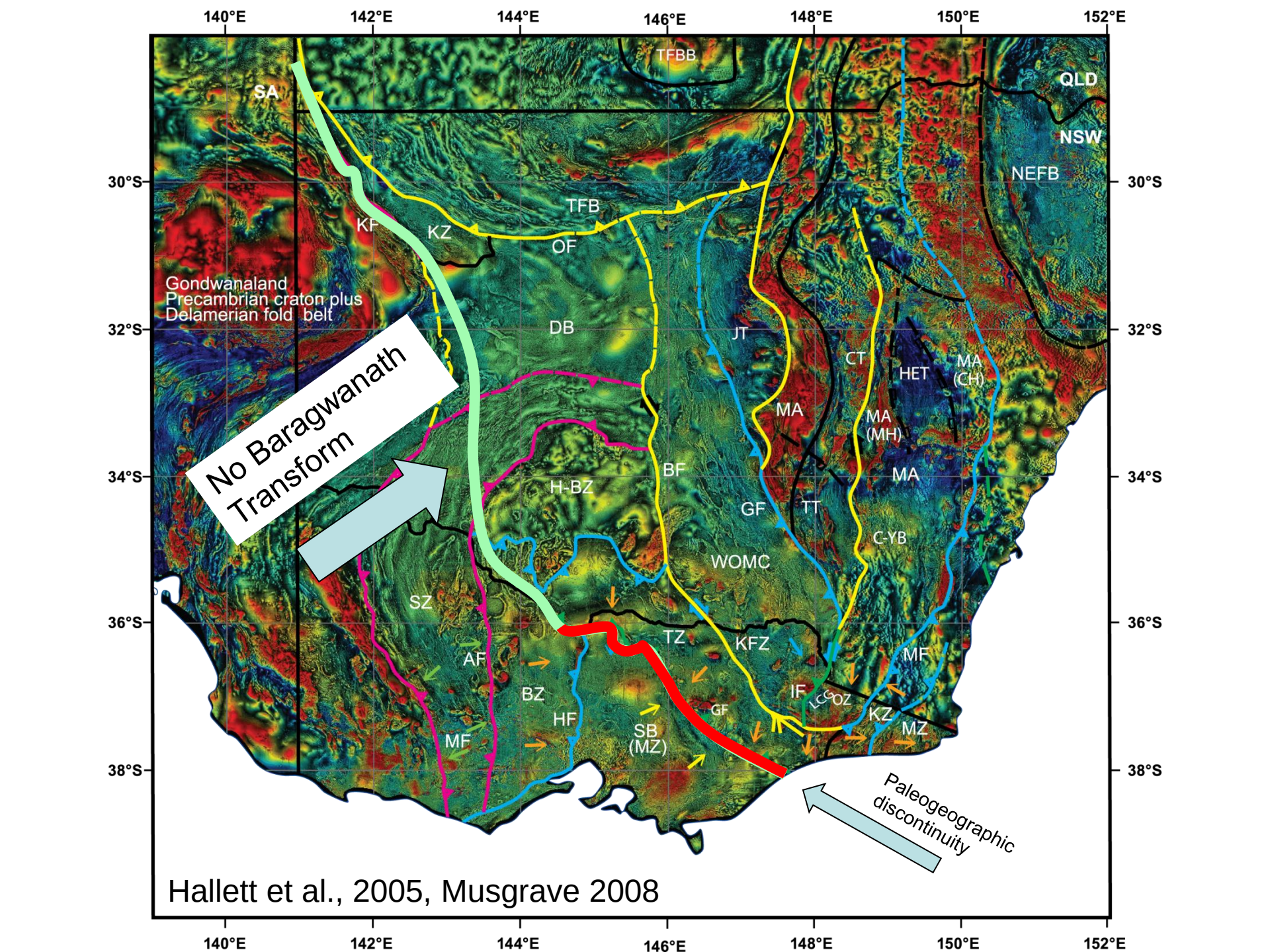
Foden et al., 2006 (Journal of Geology 114)

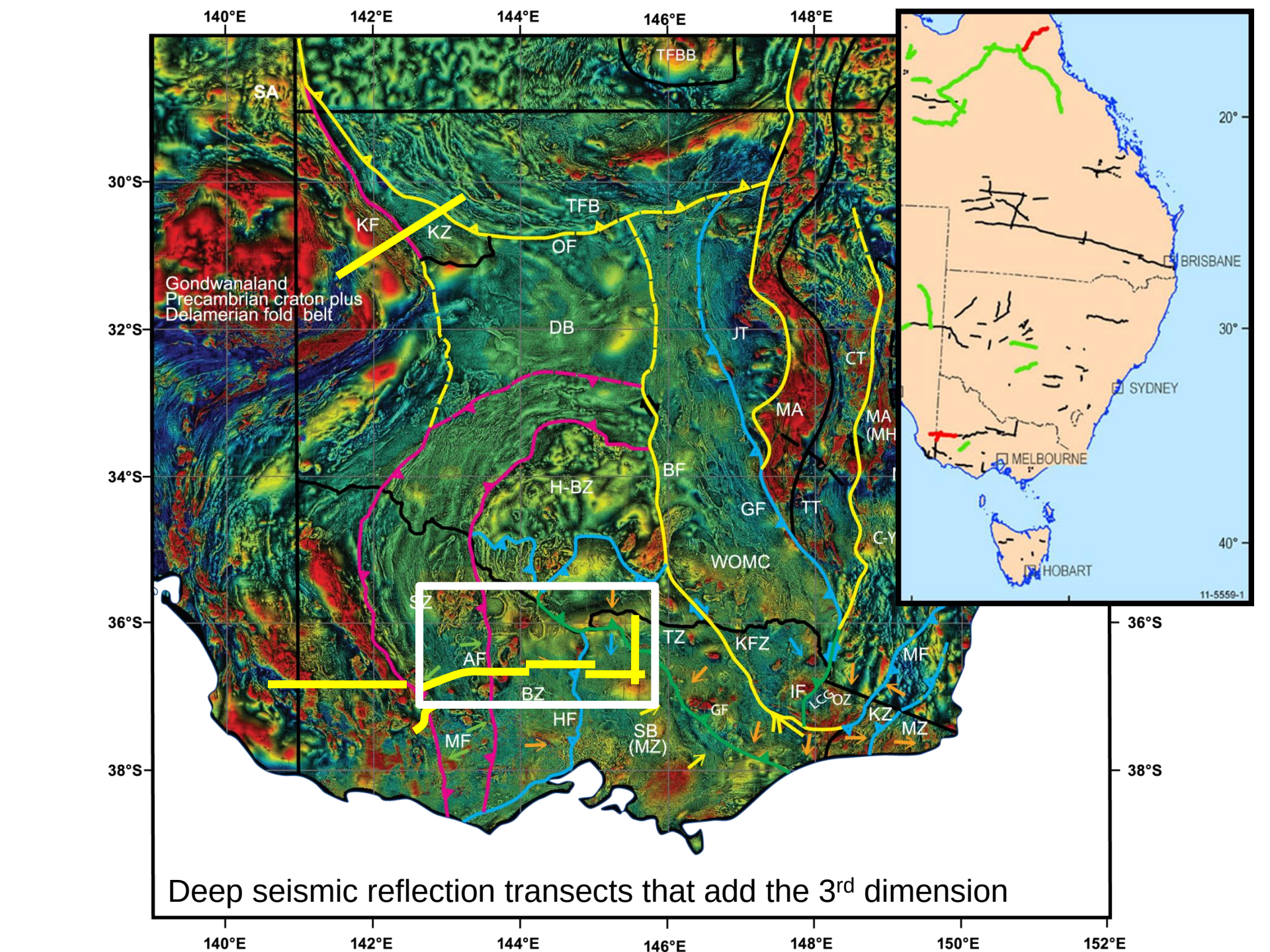
New, high quality

Aeromagnetic data infill….

…..where it matters….



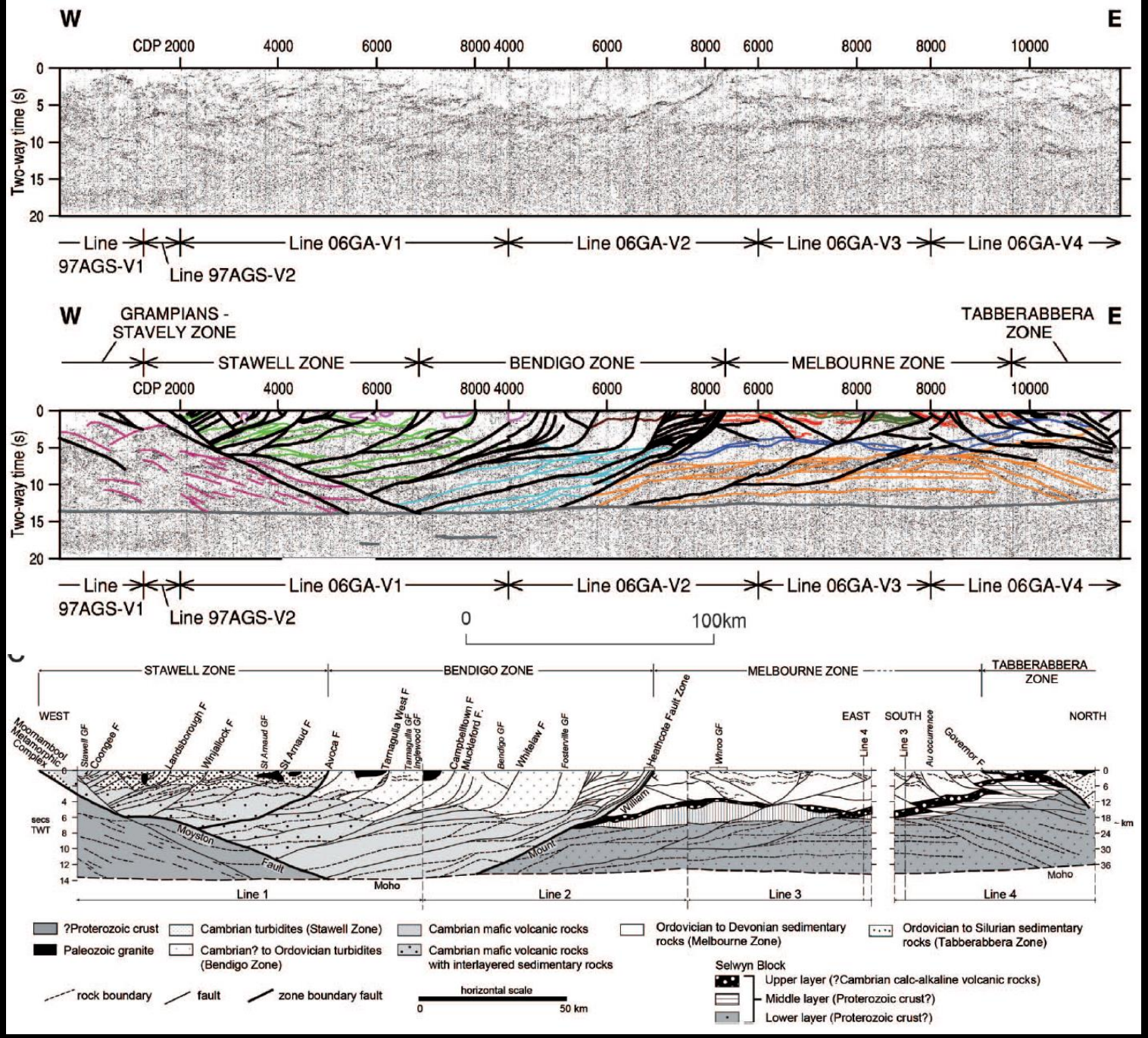

140°E
142°E
144°E
146°E
148°E
150°E
152°E
30°S
32°S
34°S
36°S
38°S
SA
QLD
NSW
TFBB
NEFB
TFB
KF
KZ
OF
Gondwanaland
Precambrian craton plus
Delamerian fold belt
DB
JT
CT
HET
MA
(CH)
MA
MA
(MH)
No Baragwanath
Transform
BF
H-BZ
GF
TT
C-YB
WOMC
SZ
TZ
KFZ
MF
AF
BZ
IF
LCC
OZ
HF
GF
KZ
MZ
SB
(MZ)
MF
Paleogeographic
discontinuity
Hallett et al., 2005, Musgrave 2008



Deep seismic reflection transects that add the 3rd dimension

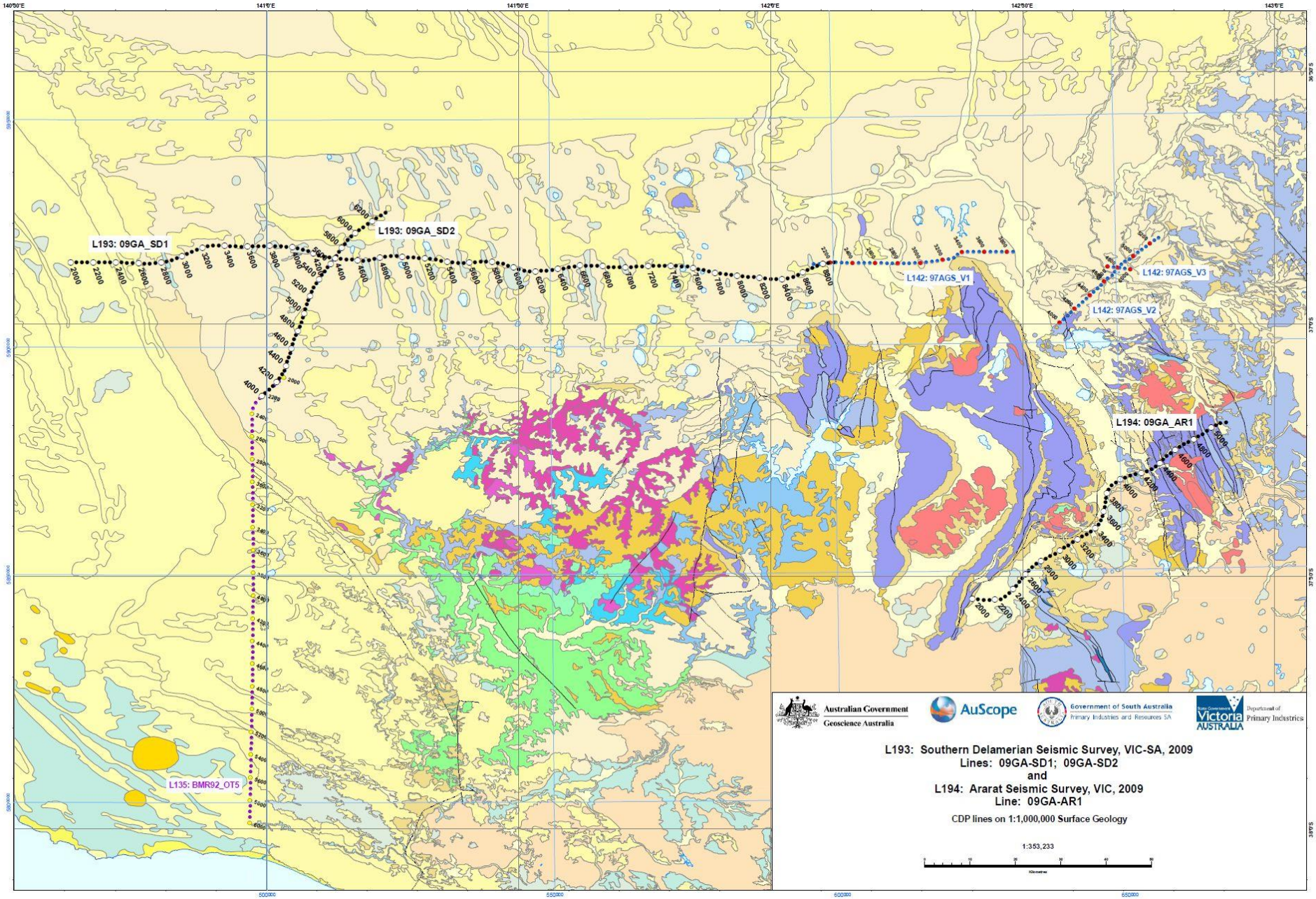
Fault
Fault
Line 1
Line 2
Fault Zone
Govenor
Line 3
Line 4
Moyston
Avoca
Heathcote
Melbourne
Fault
N
0
50

Regional deep seismic transects: pmd*crc, AUSCOPE



Cayley et al., 2011

Regional deep seismic transects: pmd*crc, AUSCOPE


L193: 09GA_SD1
L193: 09GA_SD2
L142: 97AGS_V1
L142: 97AGS_V2
L142: 97AGS_V3
L194: 09GA_AR1
L135: BMR92_OT5
Australian Government
Geoscience Australia
AuScope
Government of South Australia
Primary Industries and Resources SA
Victoria
AUSTRALIA
Department of
Primary Industries
L193: Southern Delamerian Seismic Survey, VIC-SA, 2009
Lines: 09GA-SD1; 09GA-SD2
and
L194: Ararat Seismic Survey, VIC, 2009
Line: 09GA-AR1
CDP lines on 1:1,000,000 Surface Geology
1:353,233

Thursdays Gossan Cu

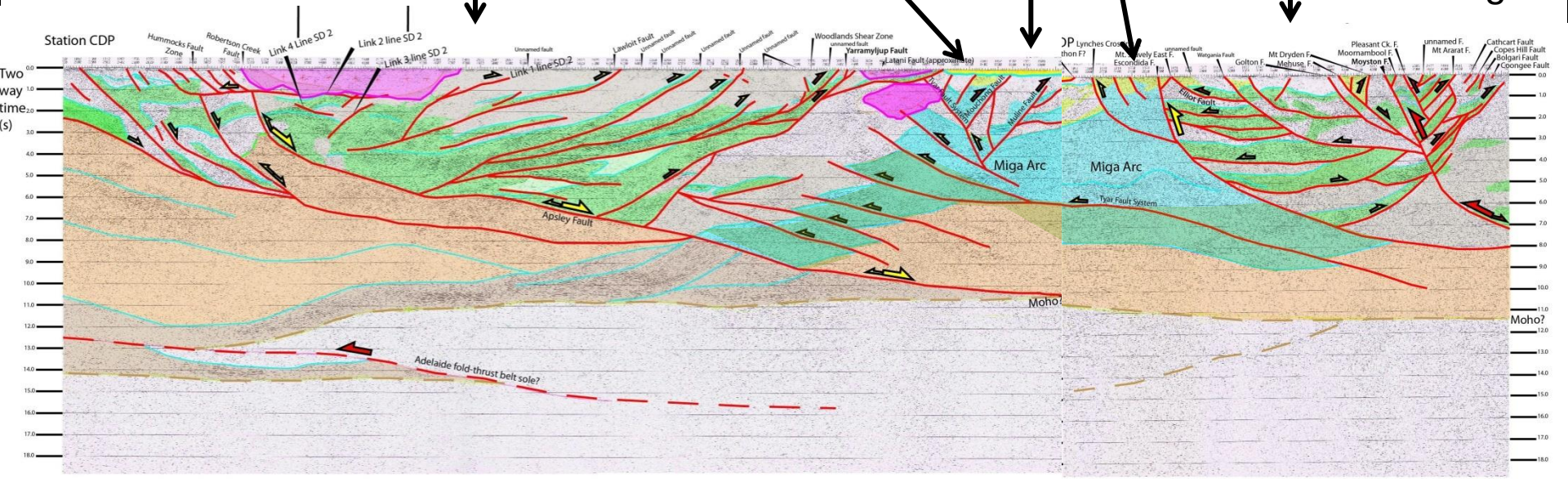
McRaes
Prospect Cu-Au

Primitive arc
geochemistry

Arc?
Calc-alkaline

Back-arc / rift geochemistry

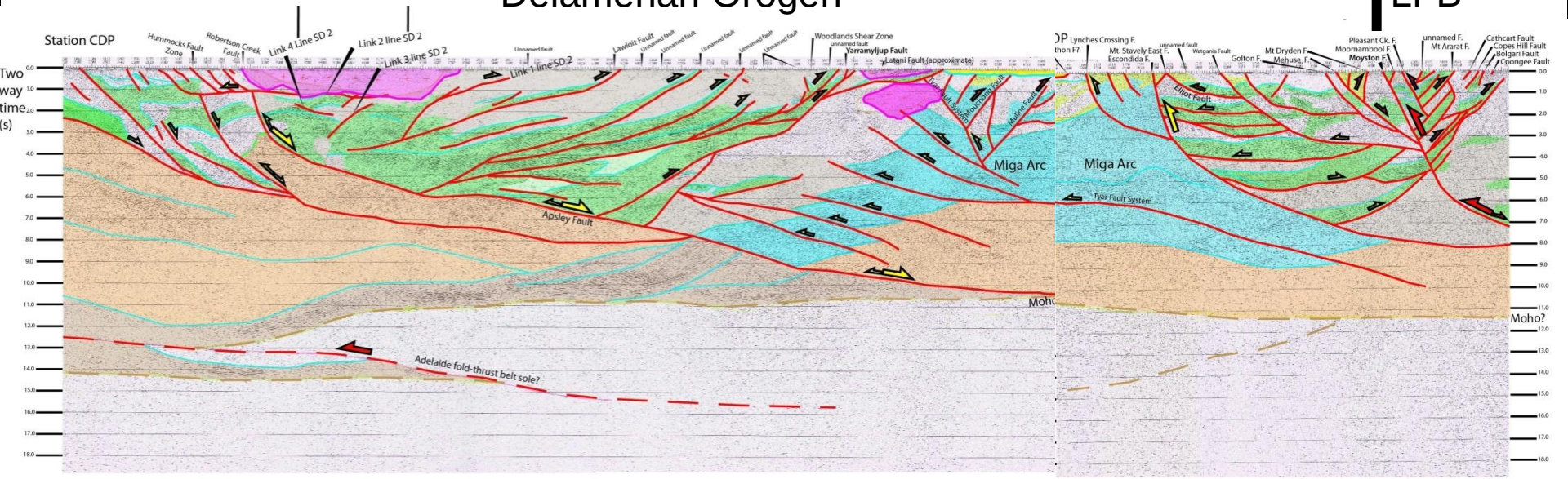
Wedge



AuScope

Delamerian Orogen

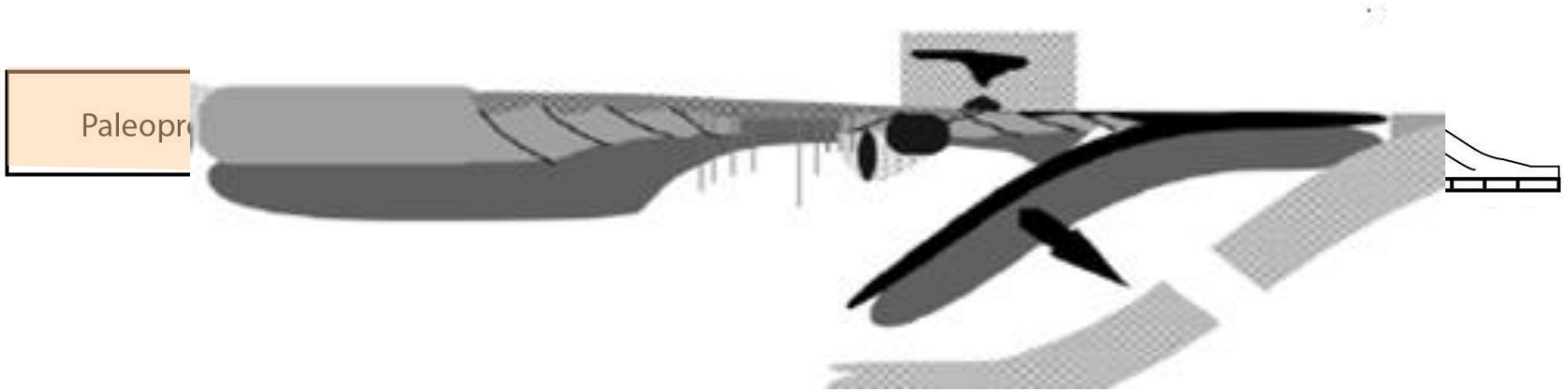
LFB

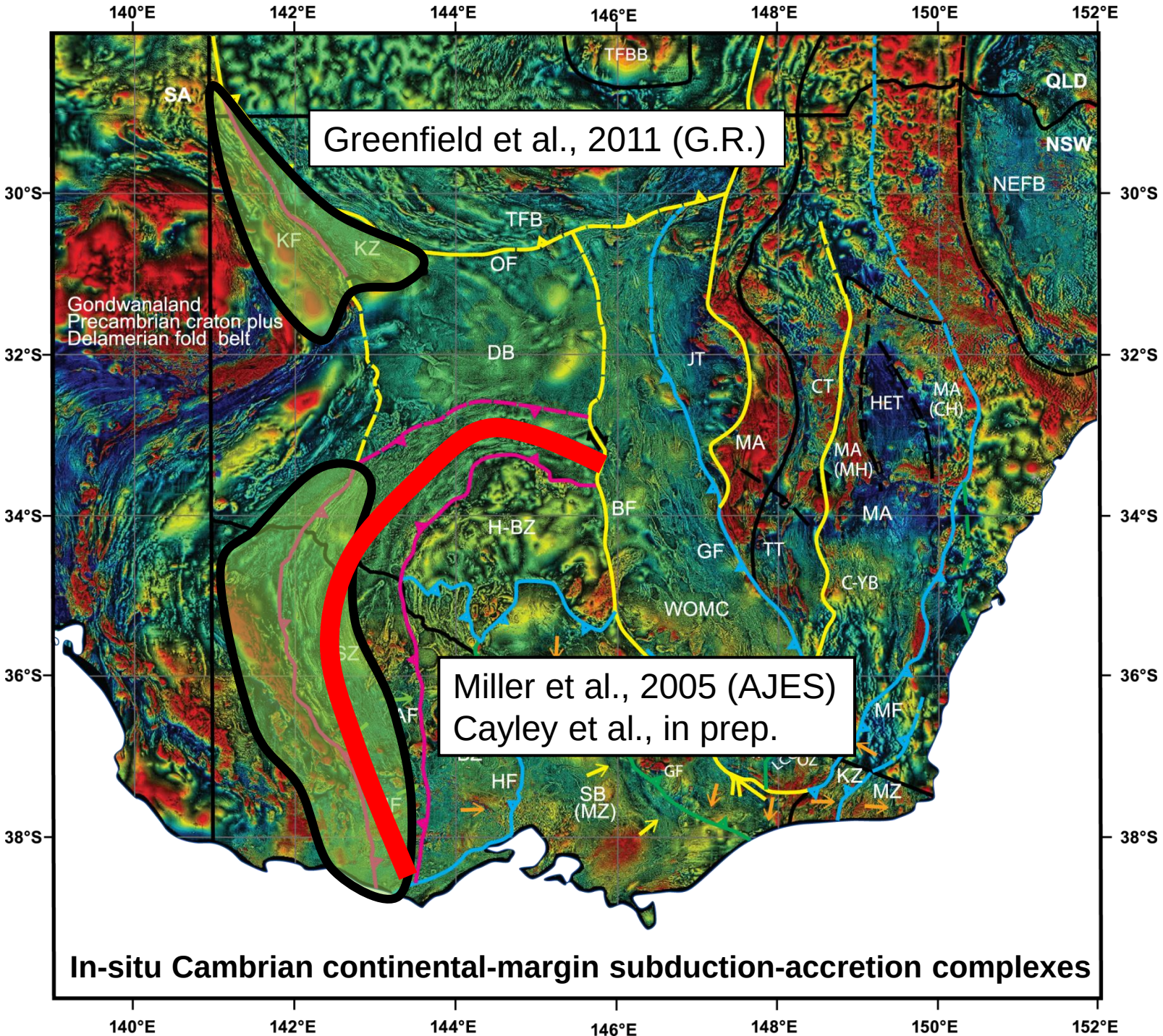


B: 500 - 495 Ma

Delamerian Fold Belt (upper plate) | Lachlan Fold Belt (lower plate)

west Paleoproterozoic Australian craton | Glenelg Zone | Grampians-Stavely Zone | Moornambool Metamorphic Complex | Stawell Zone east




140°E
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148°E
150°E
152°E
30°S
32°S
34°S
36°S
38°S
SA
QLD
NSW
TFBB
NEFB
Greenfield et al., 2011 (G.R.)
TFB
OF
KF
KZ
Gondwanaland
Precambrian craton plus
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DB
JT
CT
HET
MA
(CH)
MA
MA
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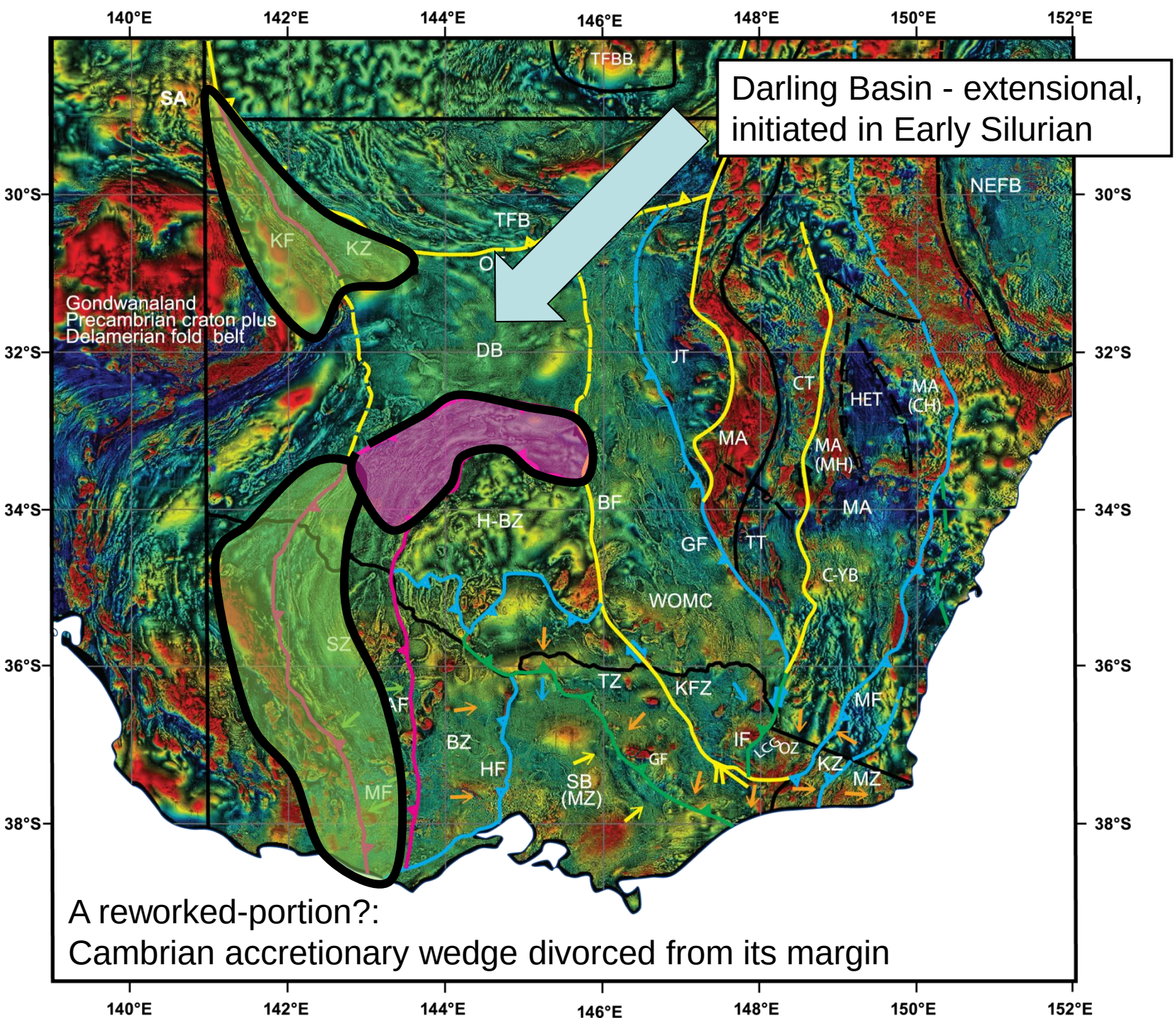
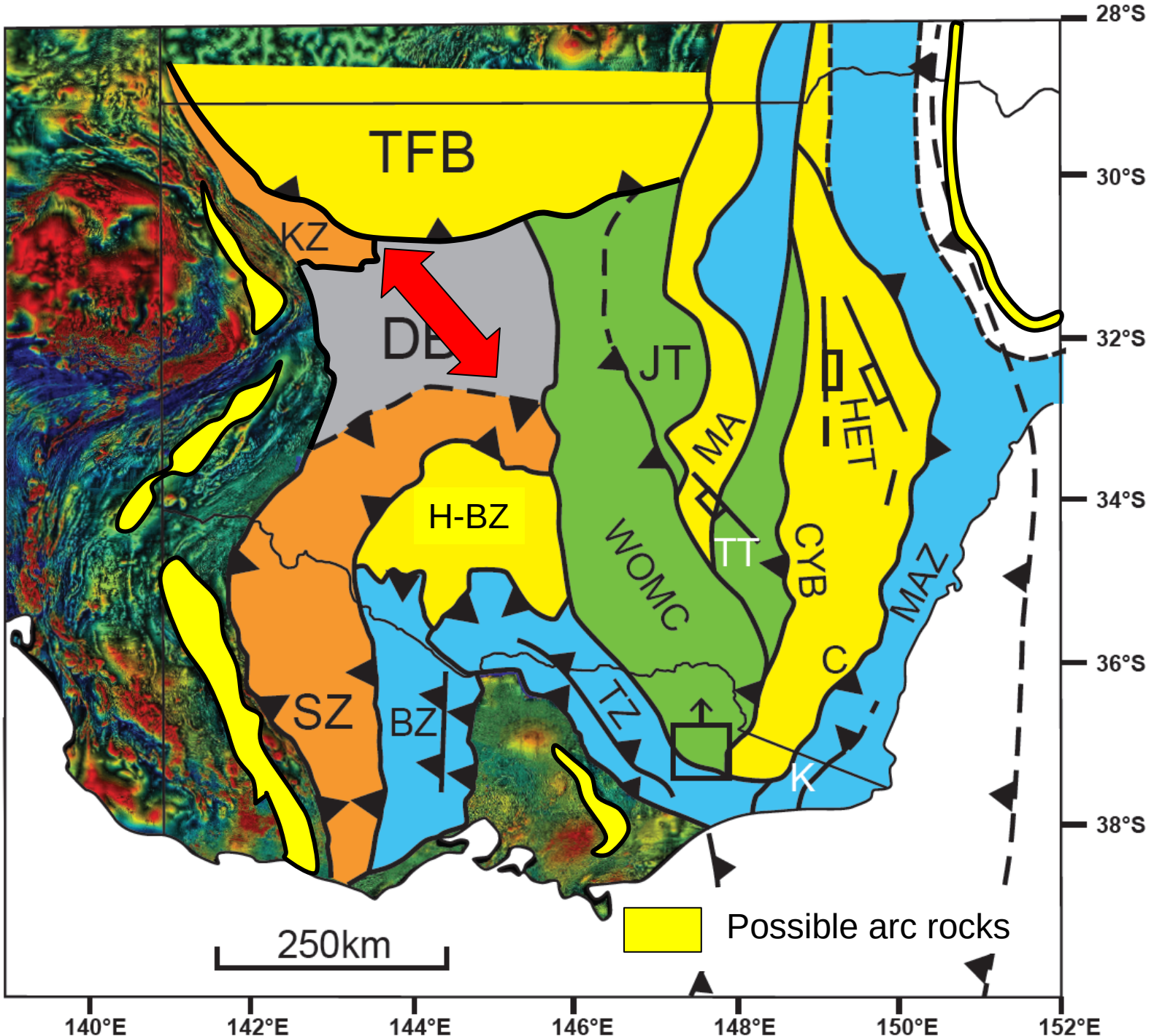
MA
BF
H-BZ
GF
TT
C-YB
WOMC
Miller et al., 2005 (AJES)
Cayley et al., in prep.
MF
HF
SB
(MZ)
GF
KZ
MZ
In-situ Cambrian continental-margin subduction-accretion complexes


Darling Basin - extensional, initiated in Early Silurian
Gondwanaland
Precambrian craton plus
Delamerian fold belt
A reworked-portion?:
Cambrian accretionary wedge divorced from its margin
140°E
142°E
144°E
146°E
148°E
150°E
152°E
30°S
32°S
34°S
36°S
38°S
SA
TFBB
TFB
KF
KZ
O
DB
NEFB
JT
CT
HET
MA (CH)
MA
MA (MH)
MA
BF
H-BZ
GF
TT
C-YB
WOMC
SZ
TZ
KFZ
MF
BZ
HF
SB (MZ)
GF
IF
LCCOZ
KZ
MZ
MF

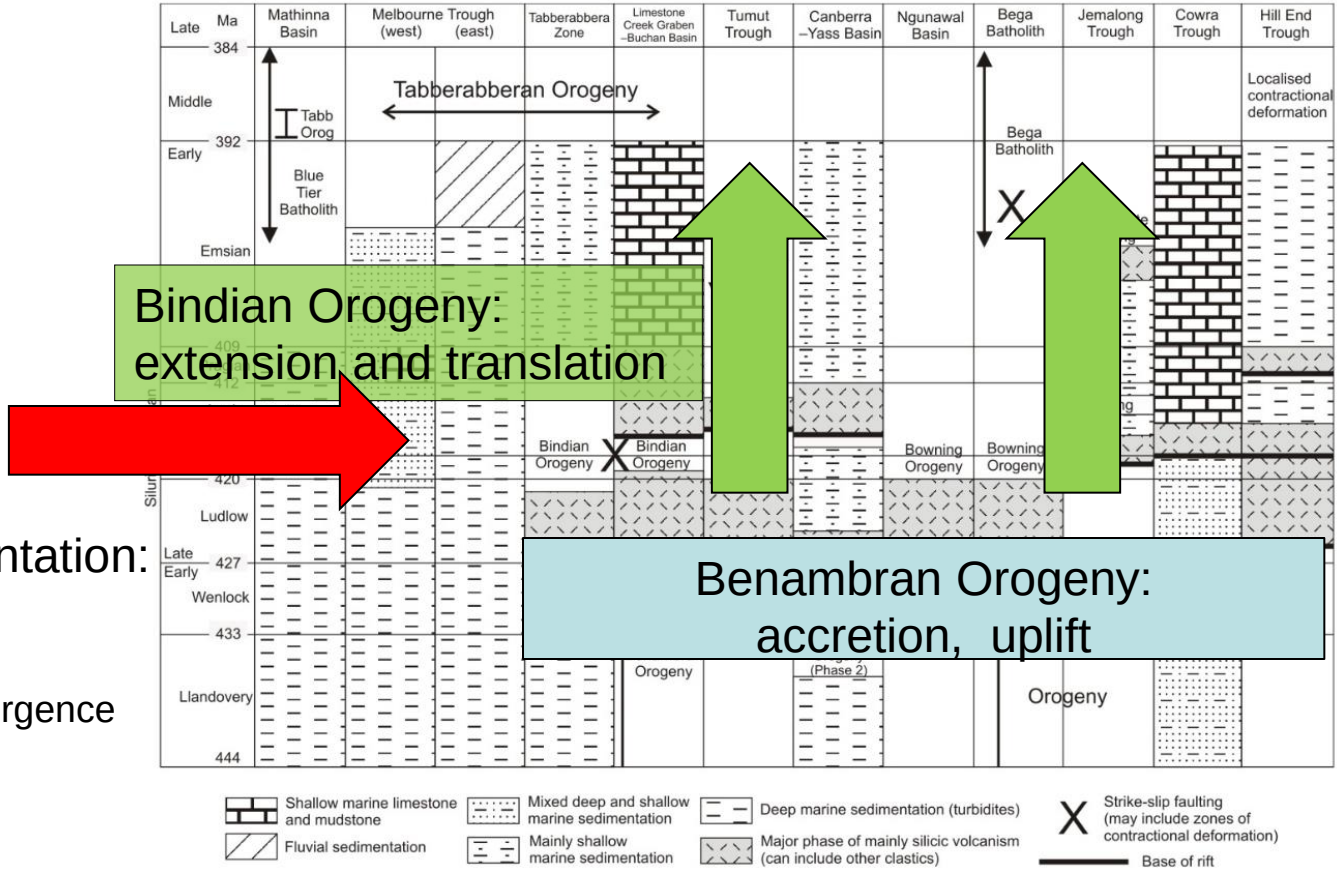

TFB
KZ
DB
JT
MA
HET
H-BZ
WOMC
TT
CYB
MAZ
SZ
BZ
TZ
C
K
250km
Possible arc rocks
28°S
30°S
32°S
34°S
36°S
38°S
140°E
142°E
144°E
146°E
148°E
150°E
152°E

Models that link extension to sedimentation in the LFB:

Fergusson, 2010: AJES:

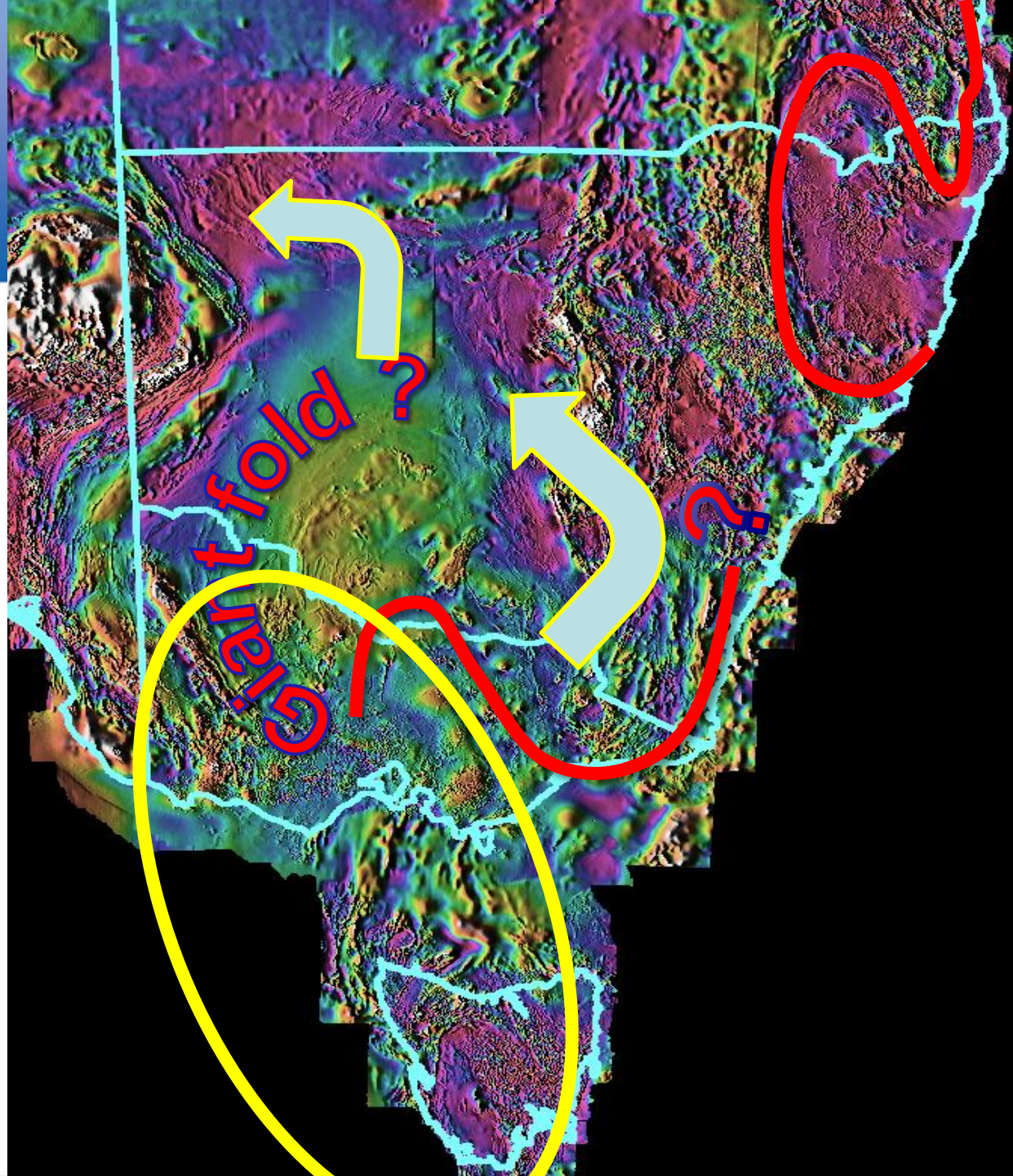
Lachlan Fold Belt sedimentation:

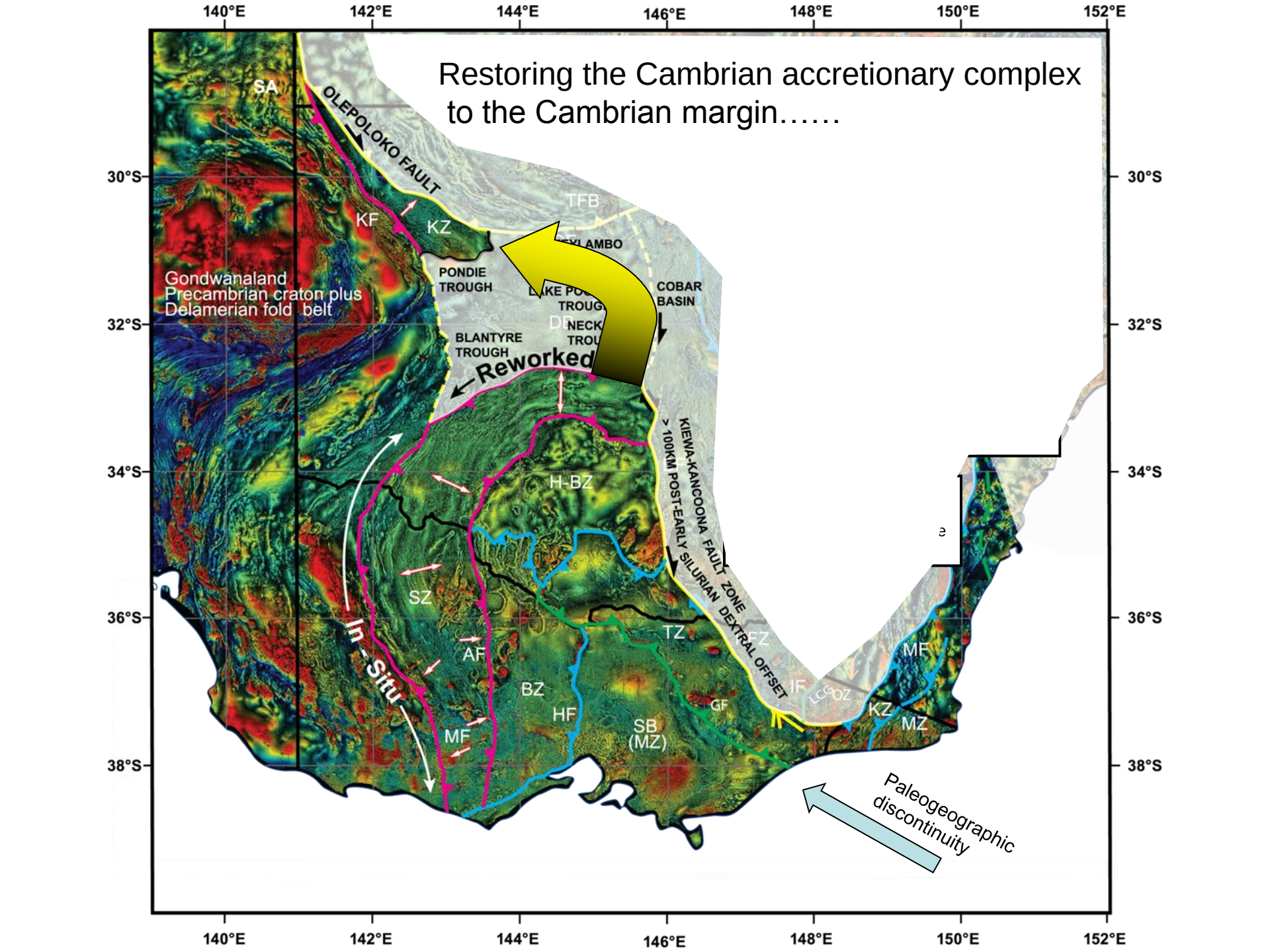
Late Silurian-Middle Devonian
plate-driven extension and convergence

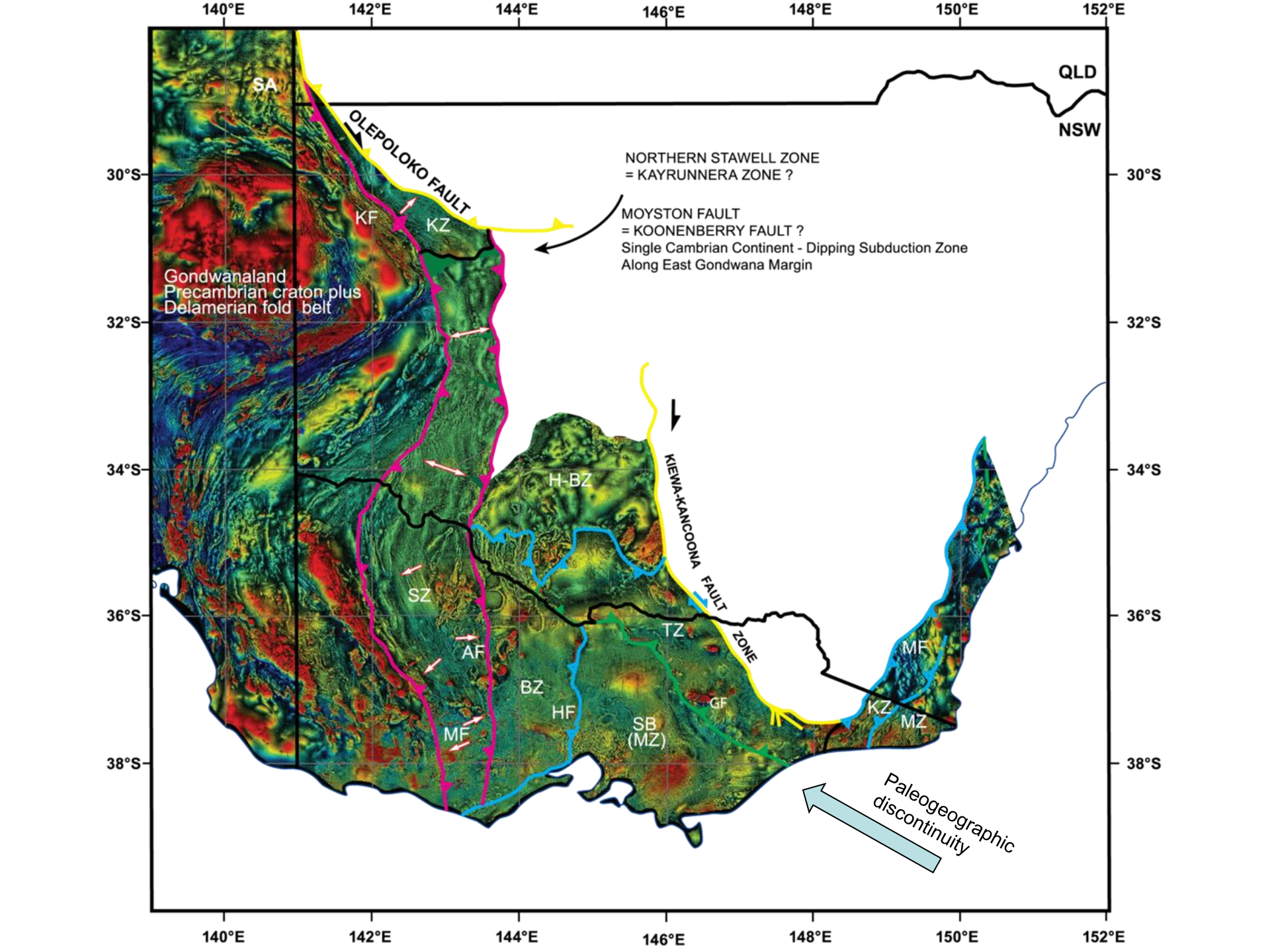


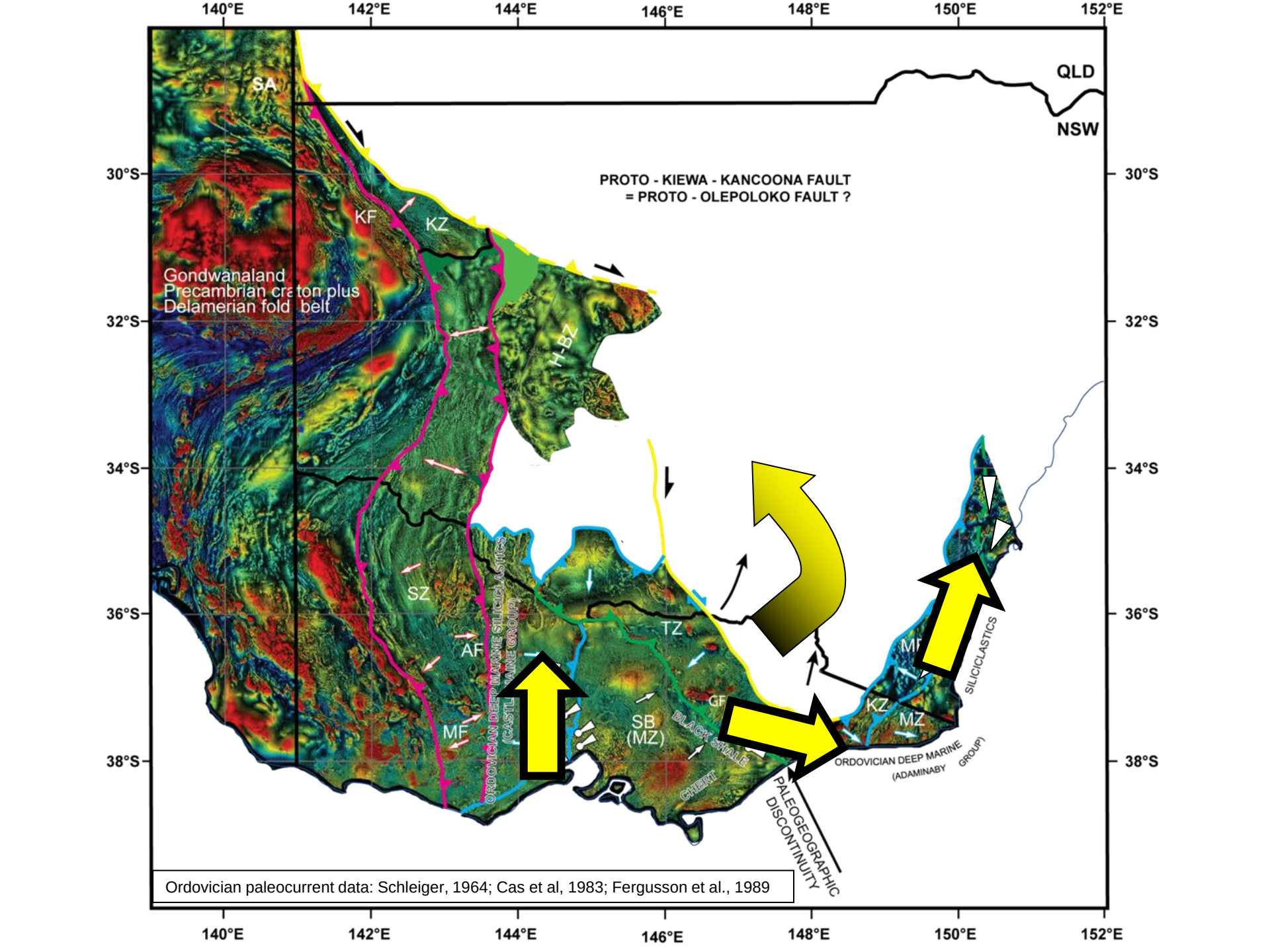
Regional

Total Magnetic Intensity

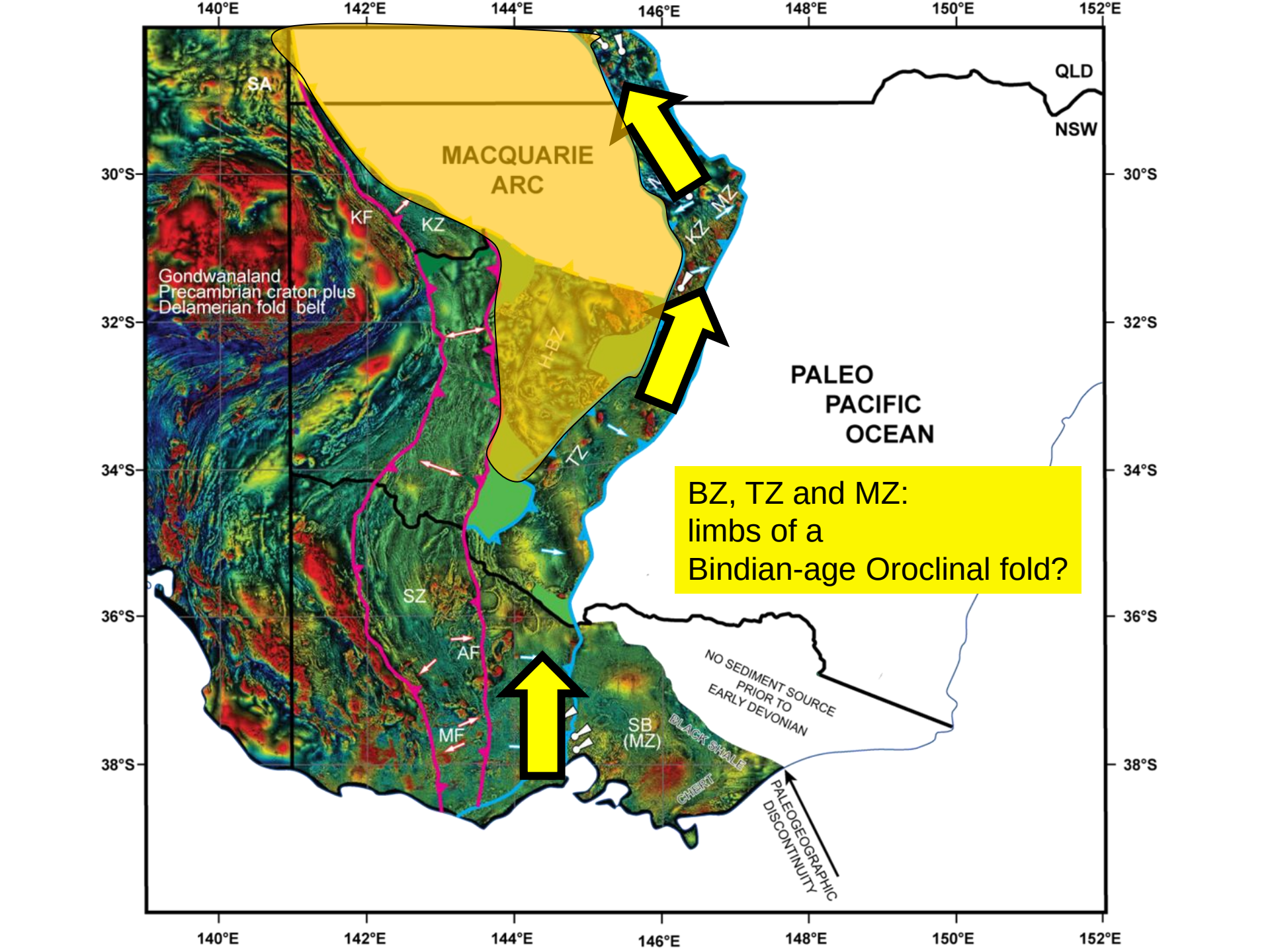



Restoring the Cambrian accretionary complex to the Cambrian margin……
SA
OLEPOLOKO FAULT
KF
KZ
TFB
PONDIE TROUGH
COBAR BASIN
Gondwanaland
Precambrian craton plus
Delamerian fold belt
BLANTYRE TROUGH
Reworked
H-BZ
KIEWA-KANCOONA FAULT ZONE
~100KM POST-EARLY SILURIAN DEXTRAL OFFSET
SZ
In-Situ
AF
BZ
HF
MF
SB (MZ)
TZ
EZ
IF
GF
OZ
KZ
MZ
MF
Paleogeographic discontinuity
140°E
142°E
144°E
146°E
148°E
150°E
152°E
30°S
32°S
34°S
36°S
38°S


140°E
142°E
144°E
146°E
148°E
150°E
152°E
30°S
32°S
34°S
36°S
38°S
SA
QLD
NSW
OLEPOLOKO FAULT
KF
KZ
NORTHERN STAWELL ZONE
= KAYRUNNERA ZONE ?
MOYSTON FAULT
= KOONENBERRY FAULT ?
Single Cambrian Continent - Dipping Subduction Zone
Along East Gondwana Margin
Gondwanaland
Precambrian craton plus
Delamerian fold belt
H-BZ
KIEWA-KANCOONA FAULT ZONE
SZ
AF
BZ
HF
MF
SB
(MZ)
TZ
GF
MF
KZ
MZ
Paleogeographic
discontinuity



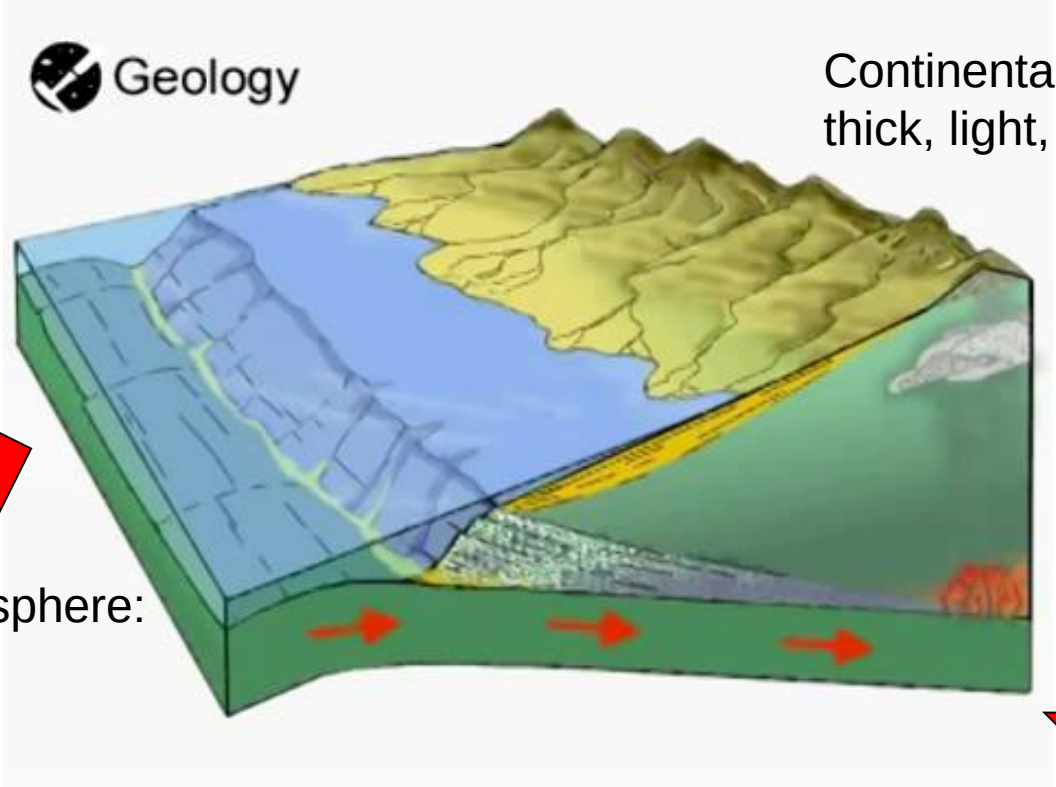
Ordovician paleocurrent data: Schleiger, 1964; Cas et al, 1983; Fergusson et al., 1989


140°E
142°E
144°E
146°E
148°E
150°E
152°E
30°S
32°S
34°S
36°S
38°S
SA
QLD
NSW
MACQUARIE ARC
KF
KZ
NZ
Gondwanaland
Precambrian craton plus
Delamerian fold belt
H-BZ
TZ
PALEO
PACIFIC
OCEAN
BZ, TZ and MZ:
limbs of a
Bindian-age Oroclinal fold?
SZ
AF
MF
SB
(MZ)
BLACK SHALE
CHERT
NO SEDIMENT SOURCE
PRIOR TO
EARLY DEVONIAN
PALEOGEOGRAPHIC
DISCONTINUITY

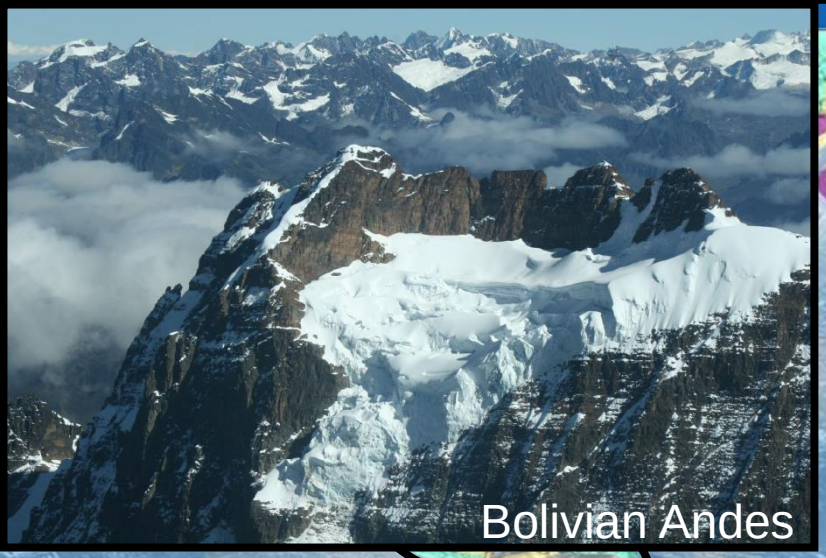
Talk Outline

- The problems
- New data/concepts constrain viable solutions
- **Retro-deformation, analogue and numerical modelling**
- The Lachlan Orocline through time – a new geodynamic model for Ordovician-Devonian Australia
- How congested subduction zones resolve – key to understanding Tasmanian evolution
- What does it all mean for mineral prospectivity?

Subduction:
when oceans and continents collide:



Ocean plate advances faster than it sinks: Collision!
pushes up and supports high mountain ranges =
the Andes. Crust shortened and thickened.

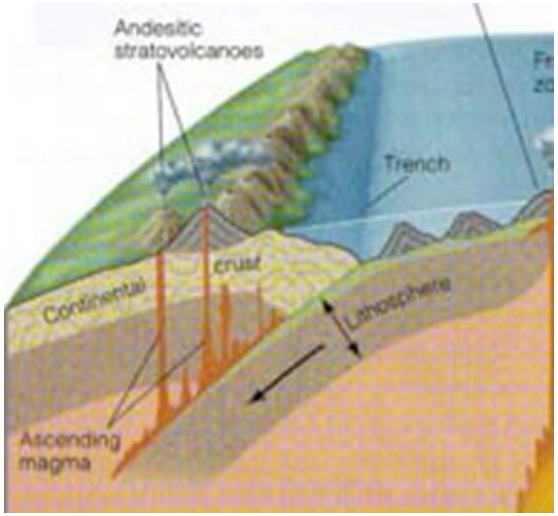


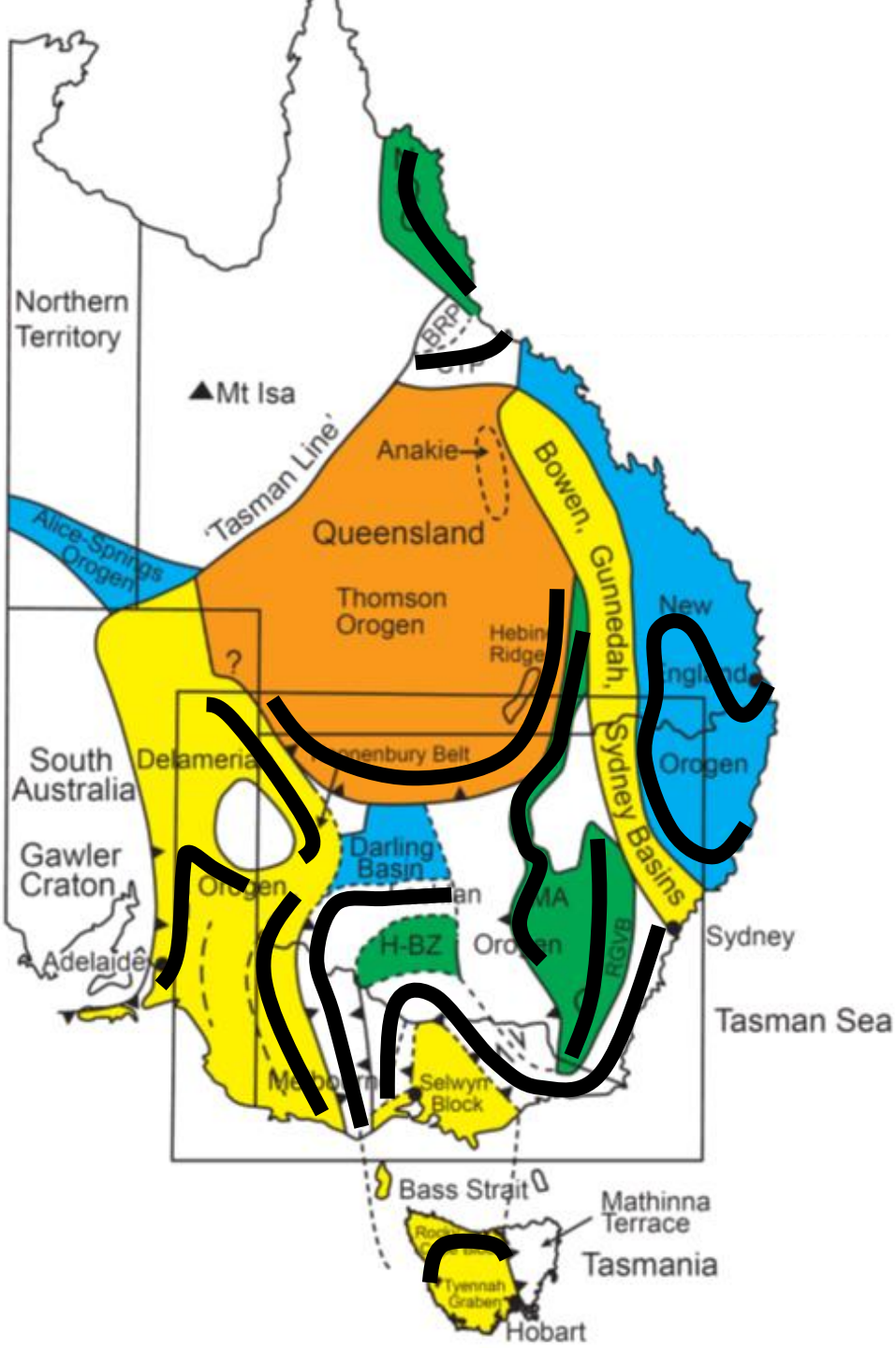
Ocean plate sinks faster than it advances: Extension!
makes huge holes that mountains collapse into =
west Pacific / Indonesia, Aleutian Islands.
Crust extended and thinned.

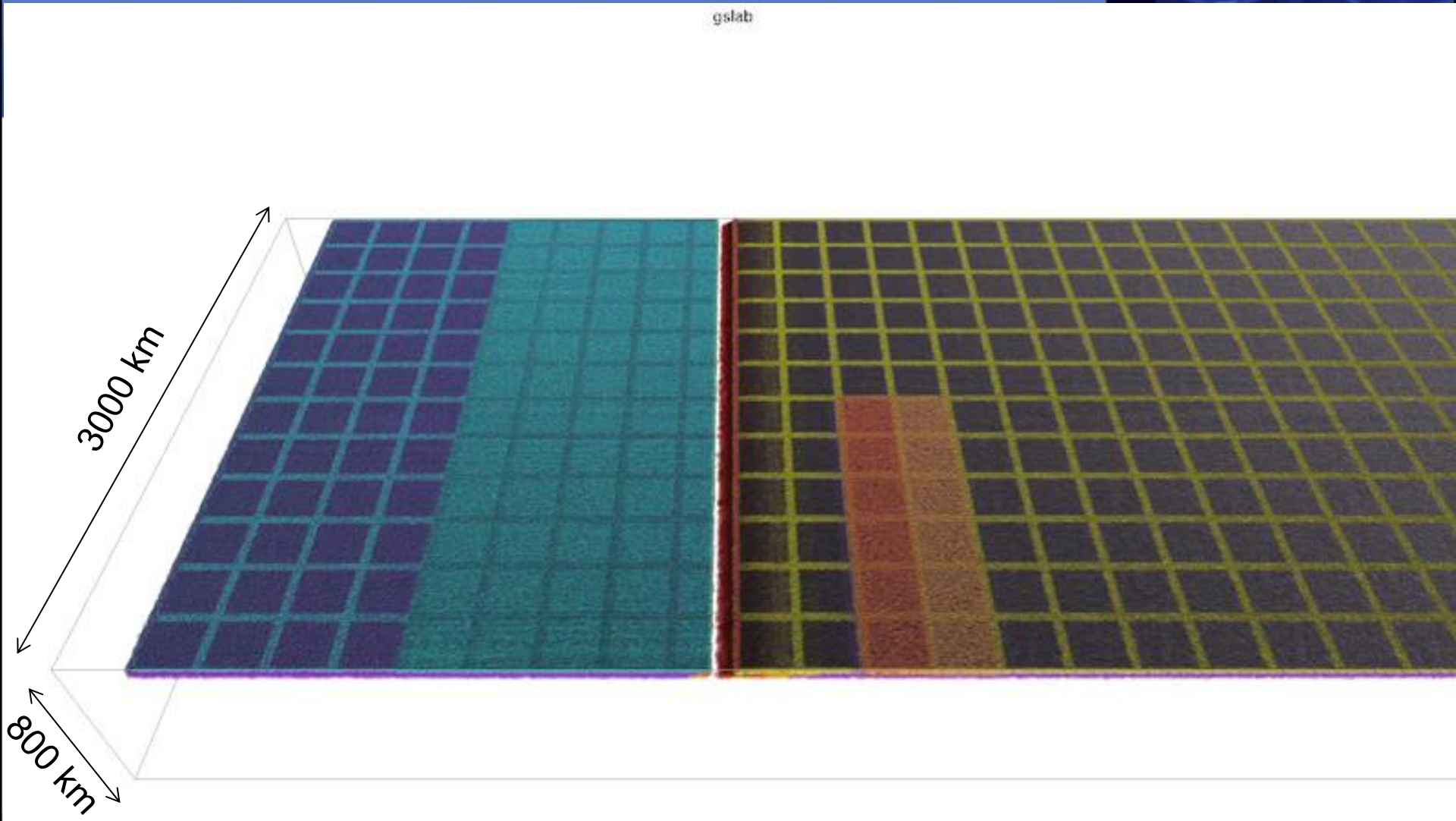
U.S. Geological Survey

Eastern Australian geology….

…all screwed up….

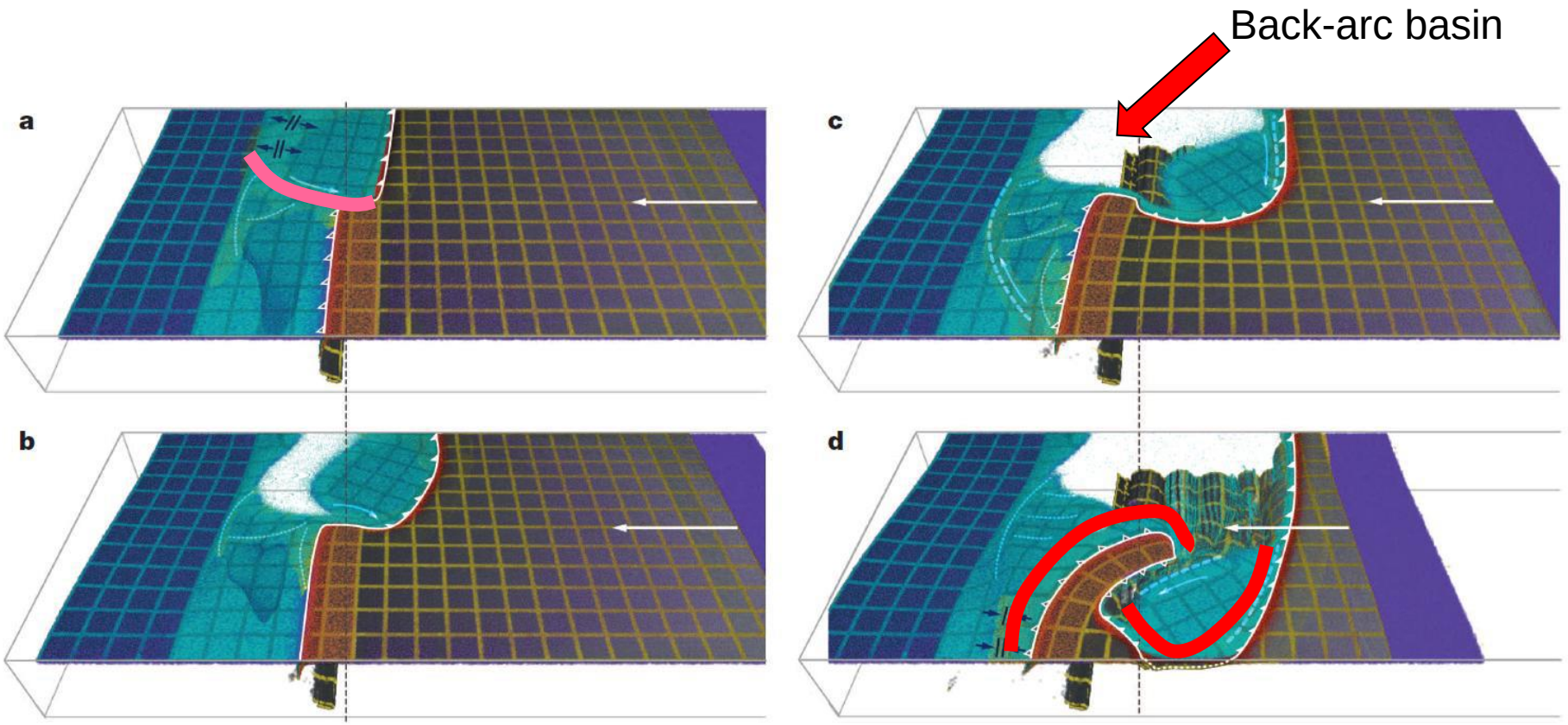




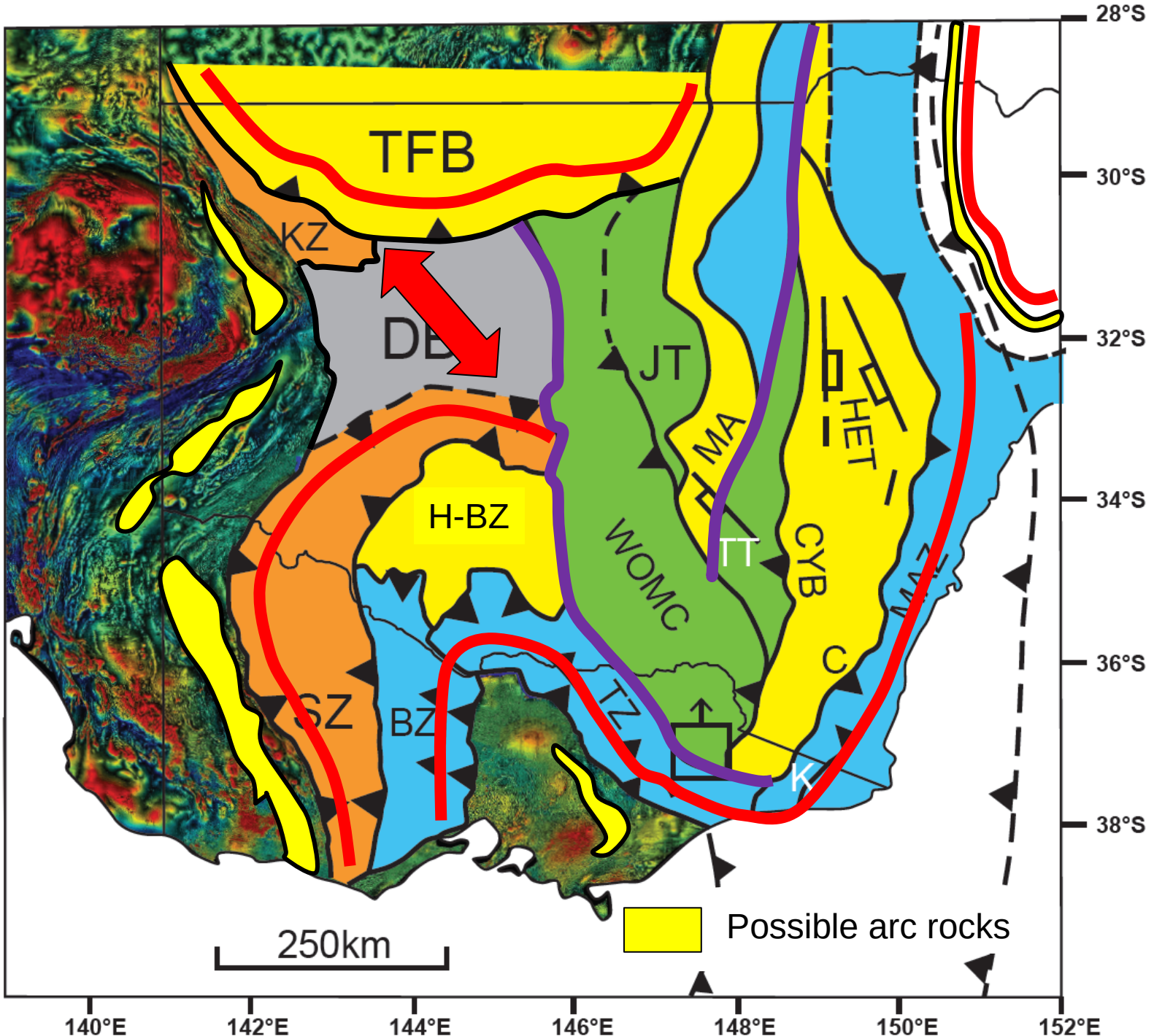


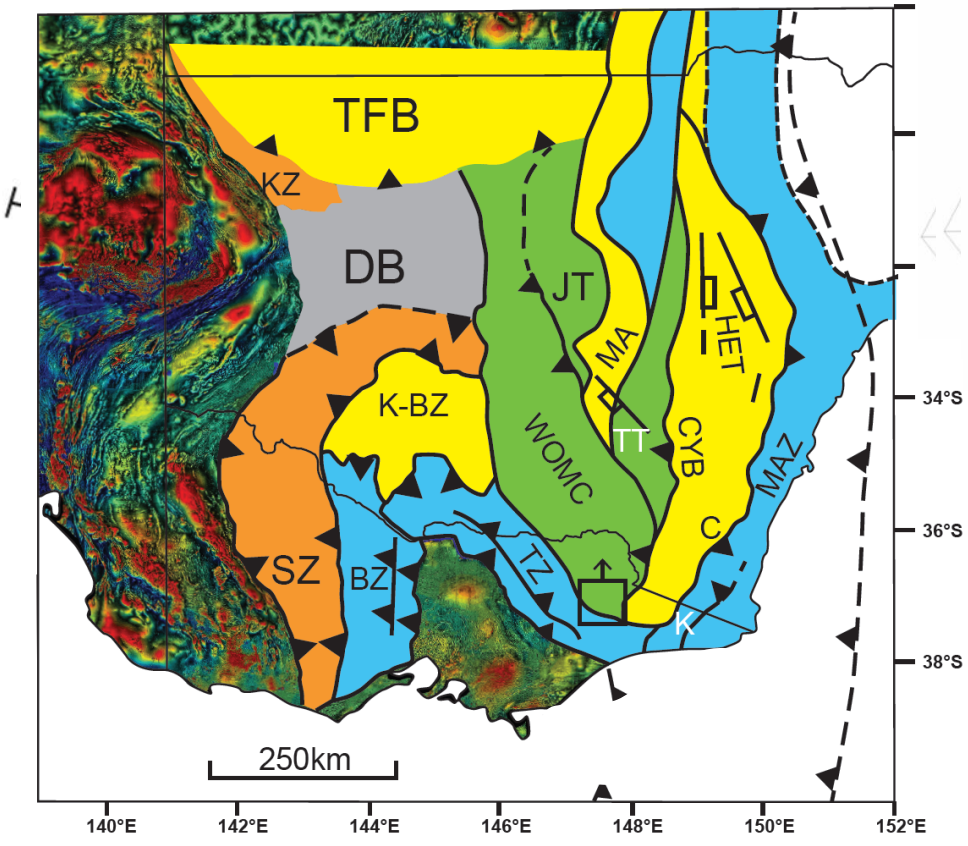
Moresi, Betts, Miller, Cayley, 2014: NATURE

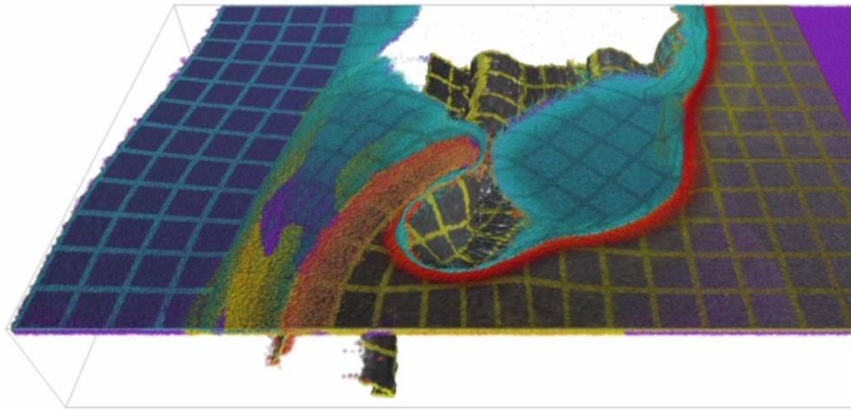
Numerical modelling…



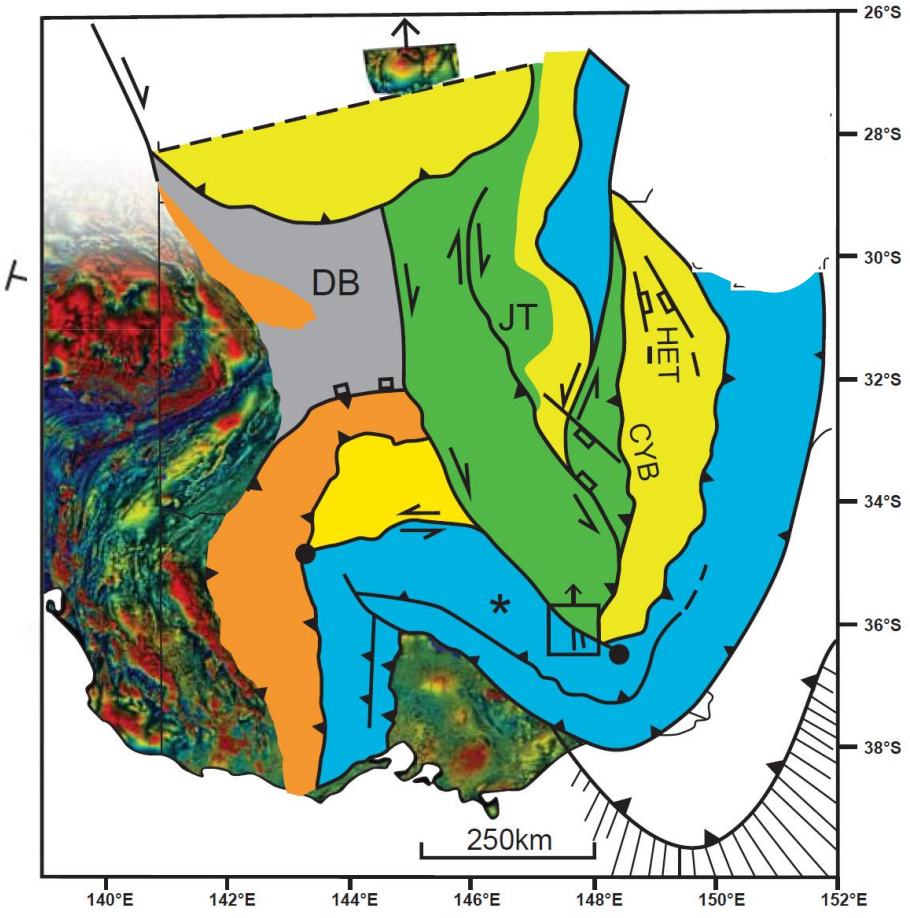
Moresi, Betts, Miller, Cayley, 2014: NATURE

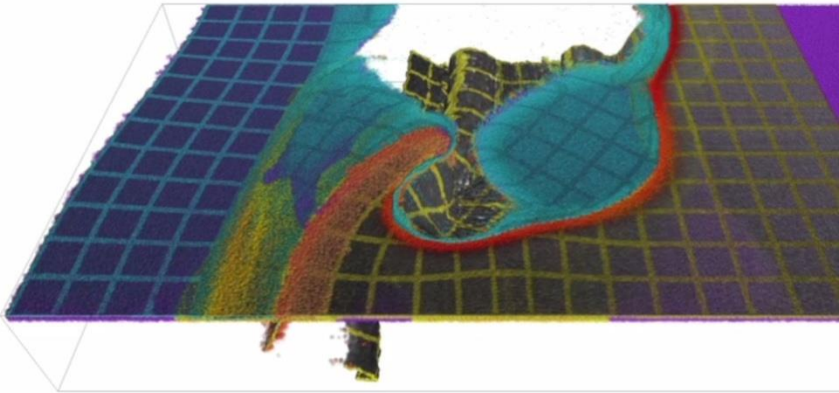

TFB
KZ
DB
JT
MA
HET
H-BZ
WOMC
TT
CYB
C
MZ
SZ
BZ
TZ
K
250km
Possible arc rocks
28°S
30°S
32°S
34°S
36°S
38°S
140°E
142°E
144°E
146°E
148°E
150°E
152°E



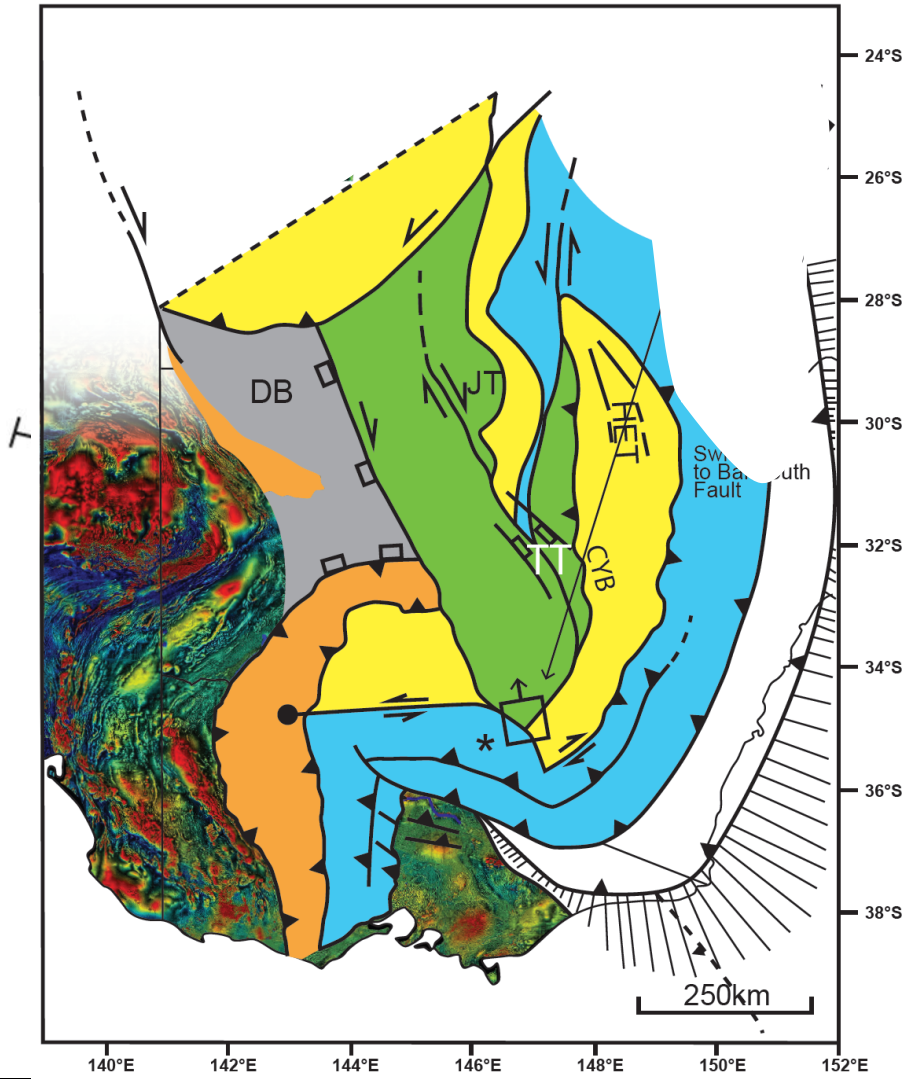


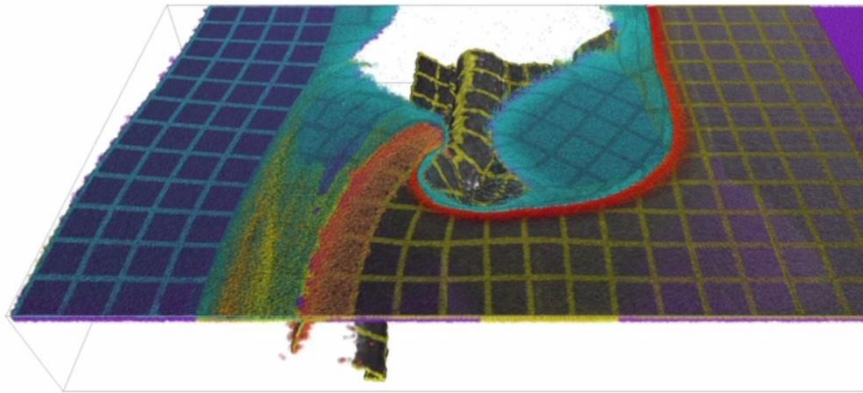
Moresi, Betts, Miller & Cayley 2014, NATURE.



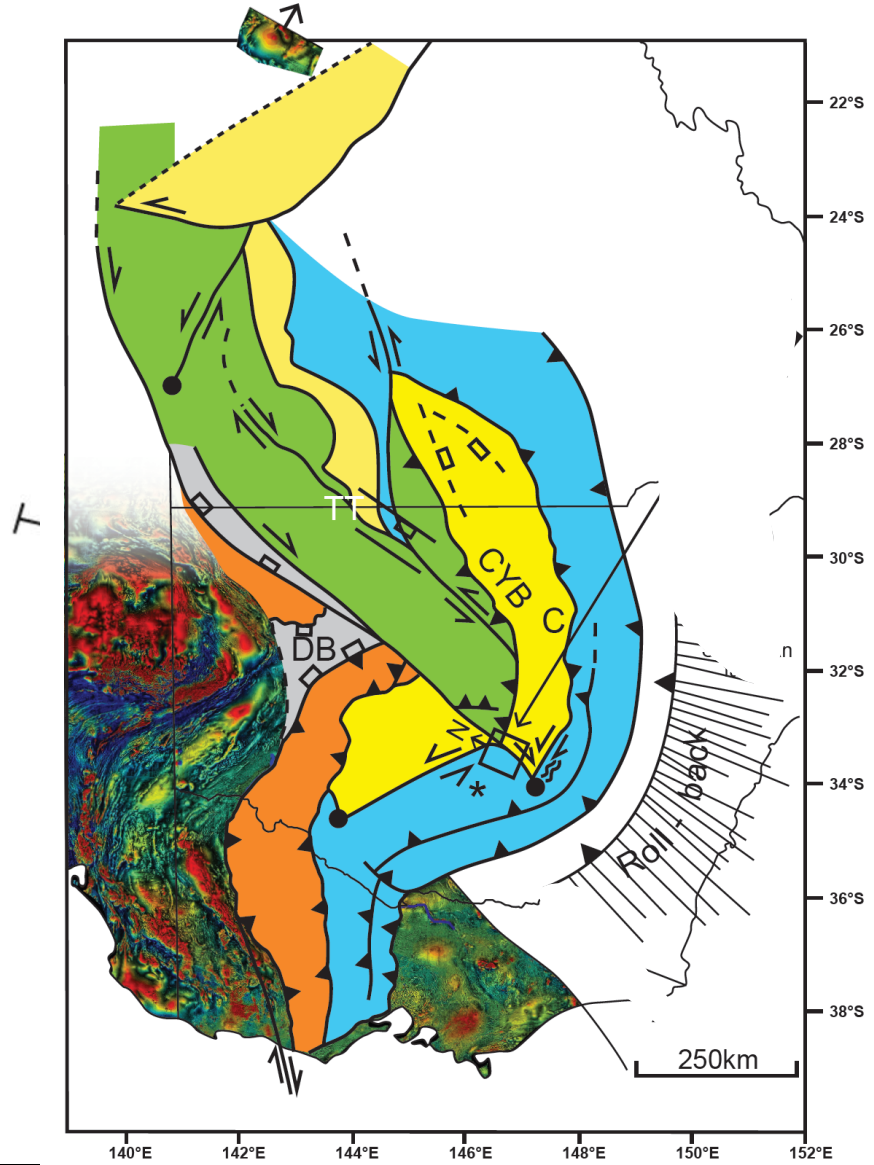


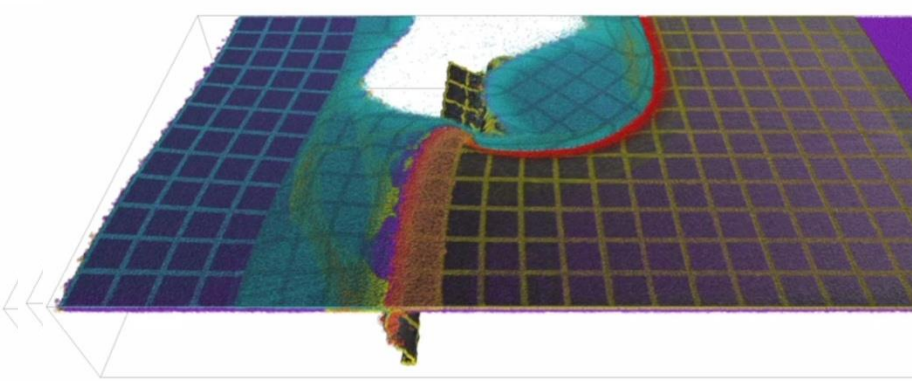
Moresi, Betts, Miller & Cayley 2014, NATURE.



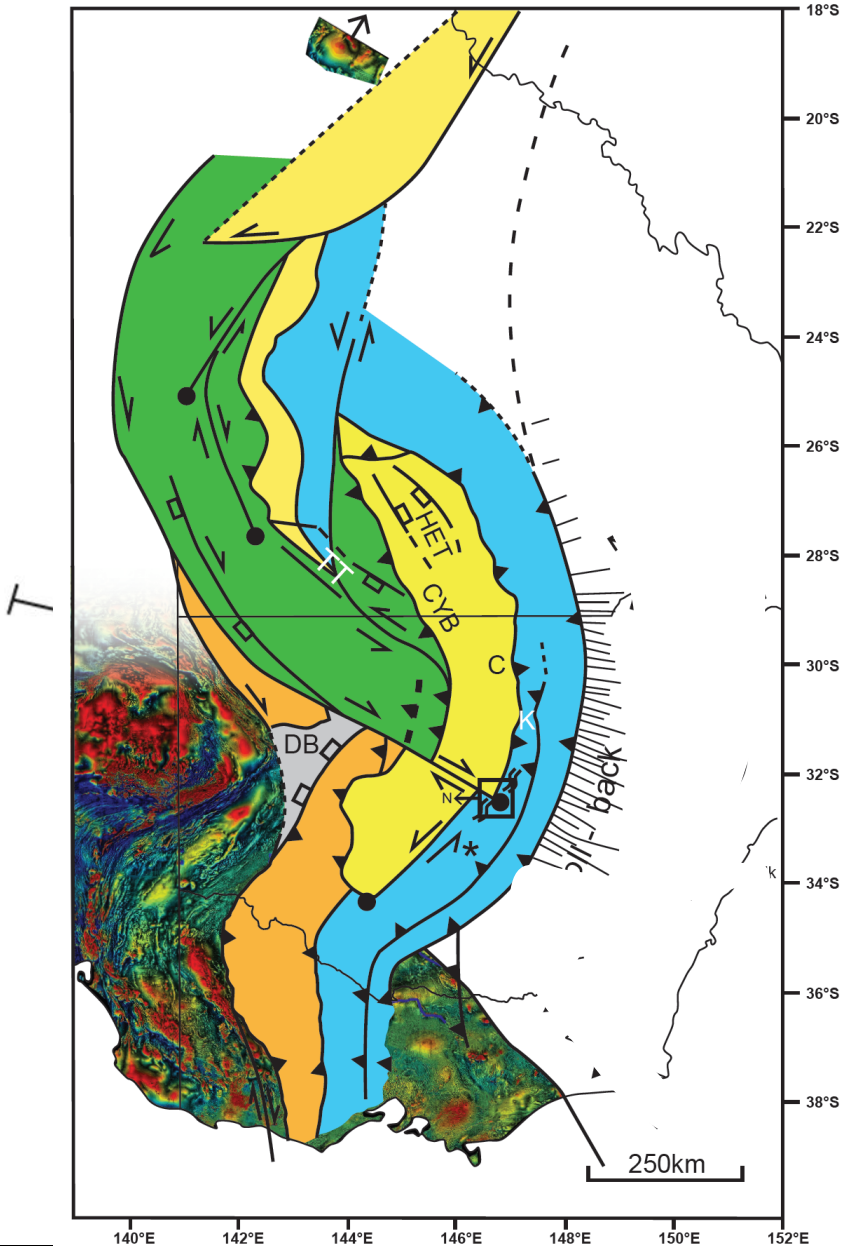


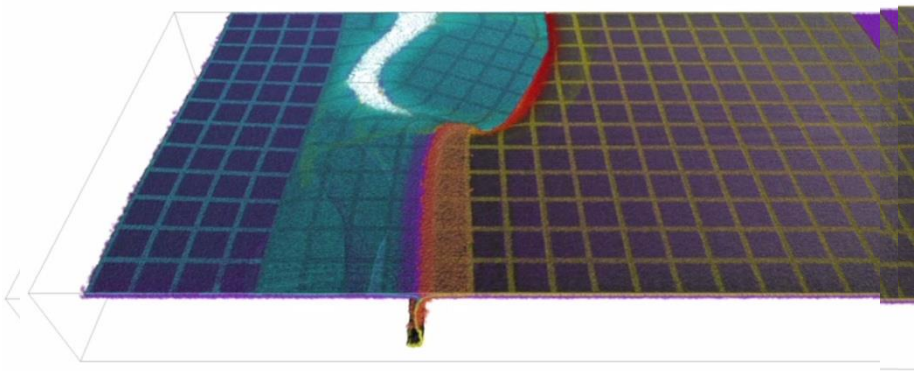
Moresi, Betts, Miller & Cayley 2014, NATURE.



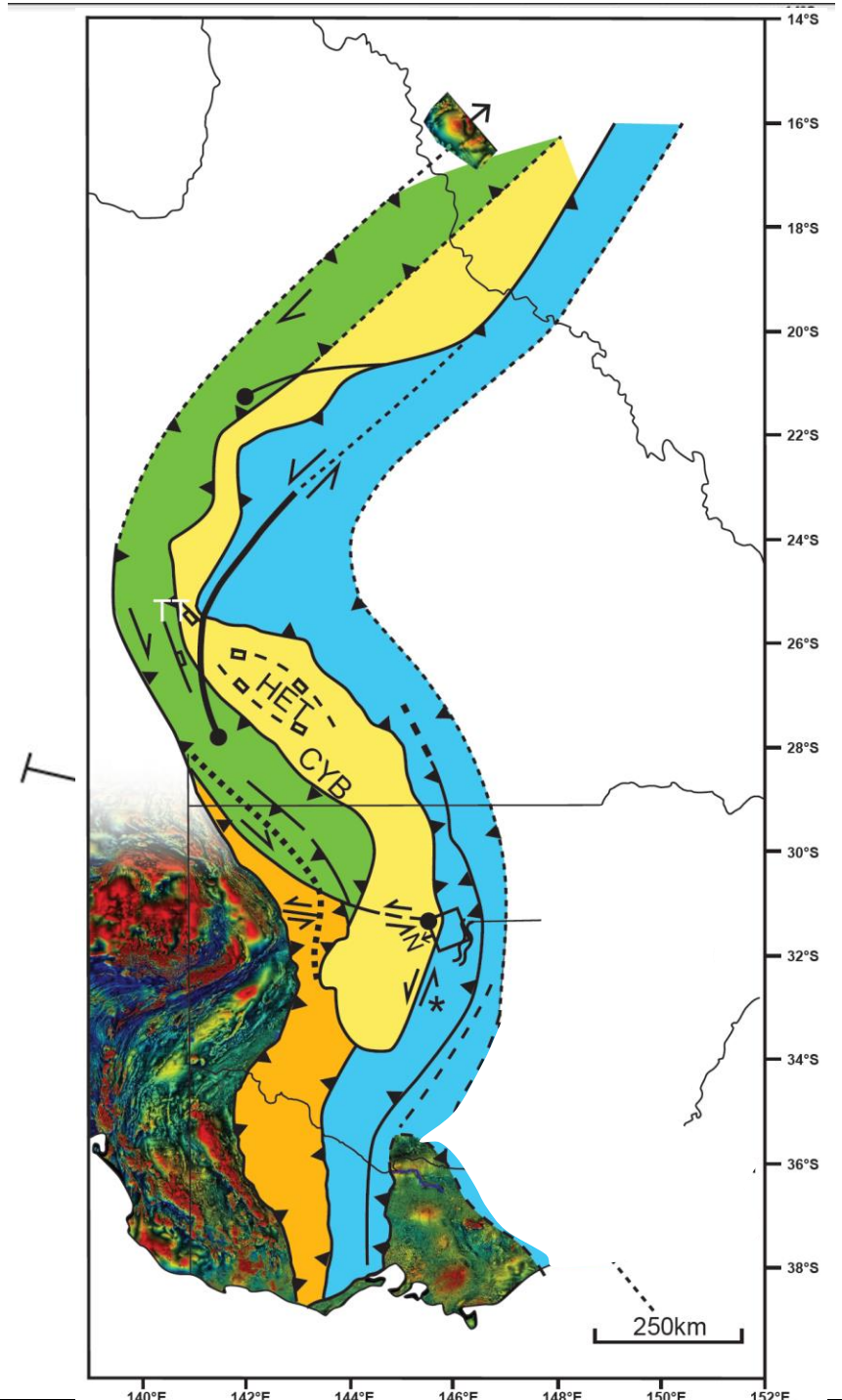


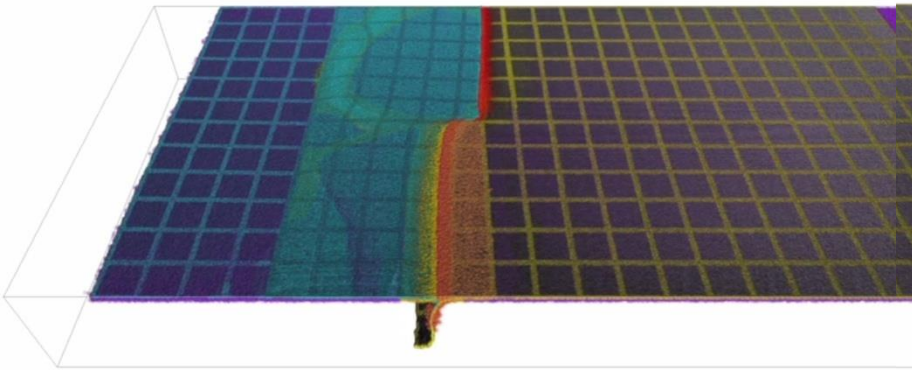
Moresi, Betts, Miller & Cayley 2014, NATURE.





Moresi, Betts, Miller & Cayley 2014, NATURE.





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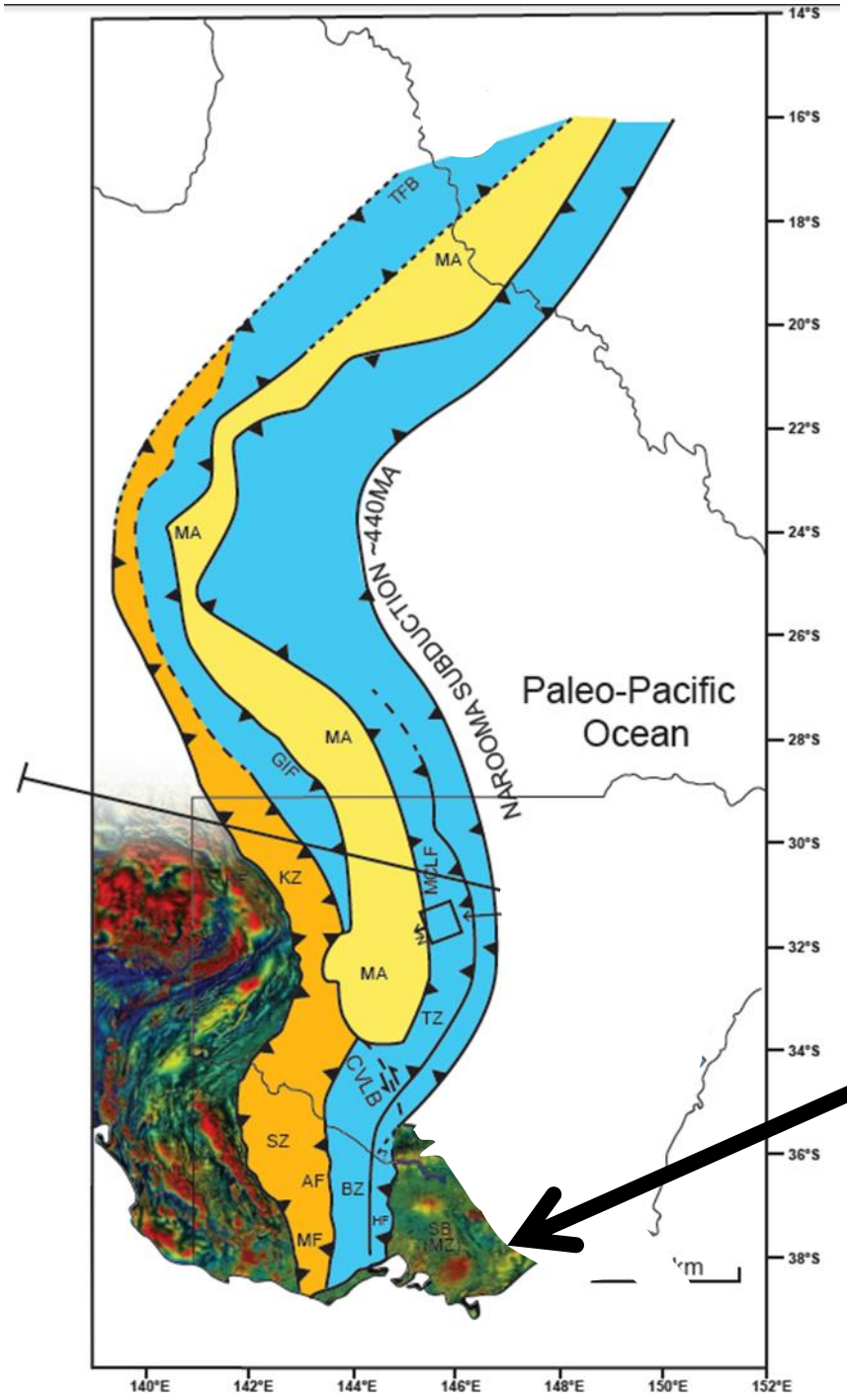
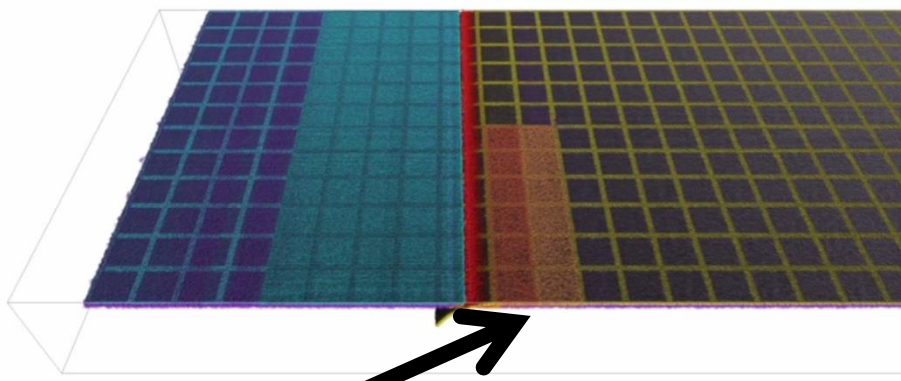
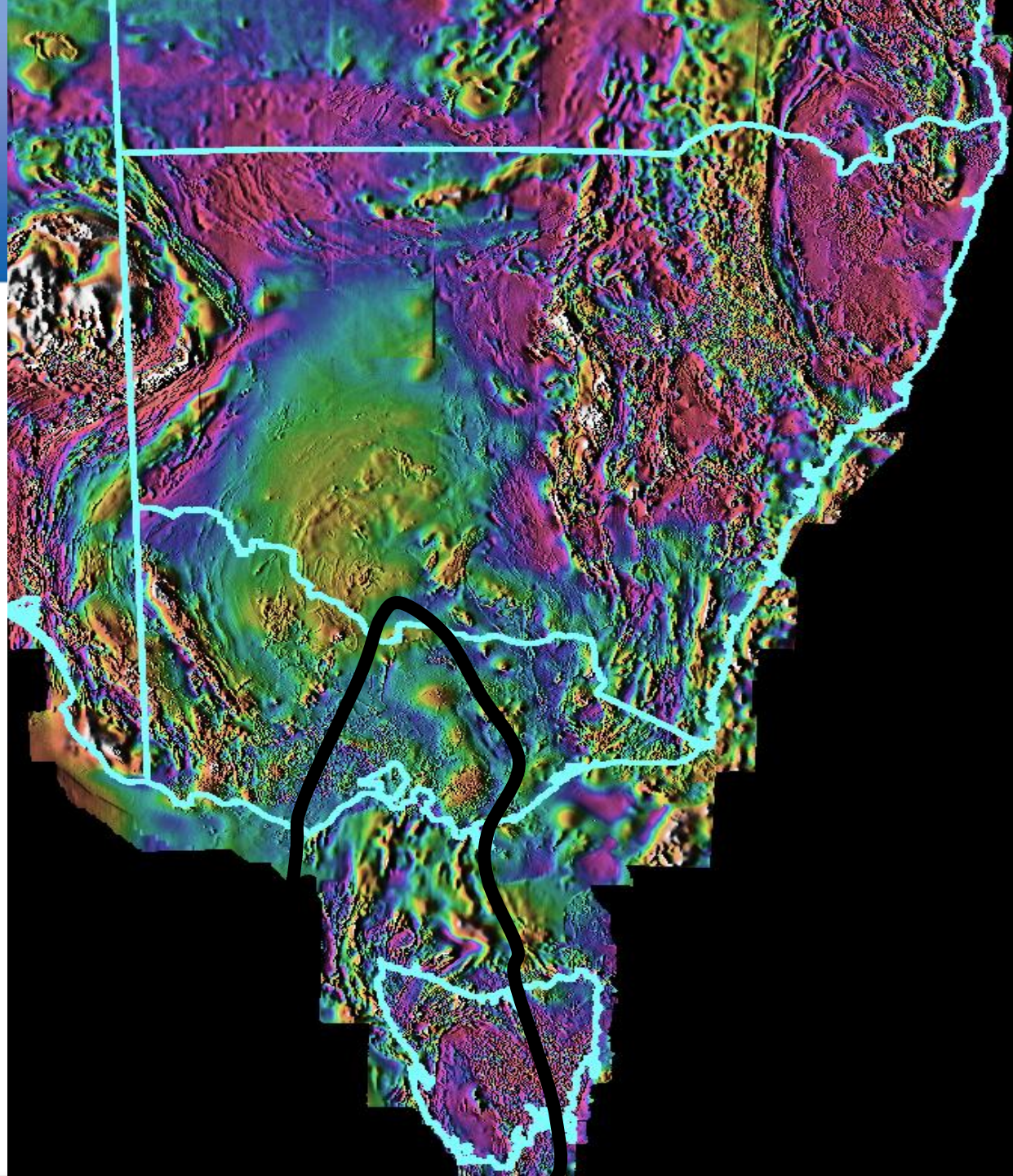




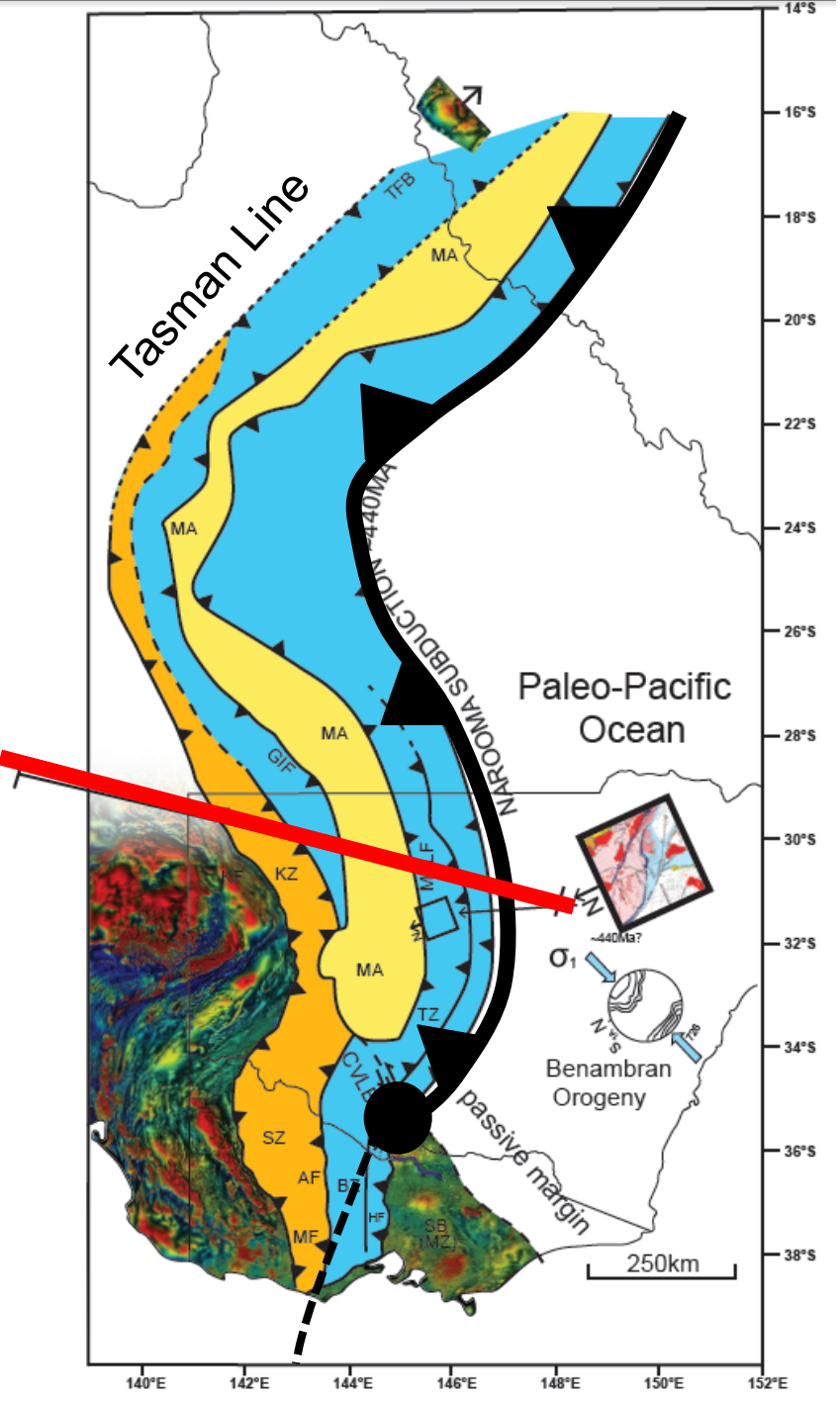
Moresi, Betts, Miller & Cayley 2014, NATURE.

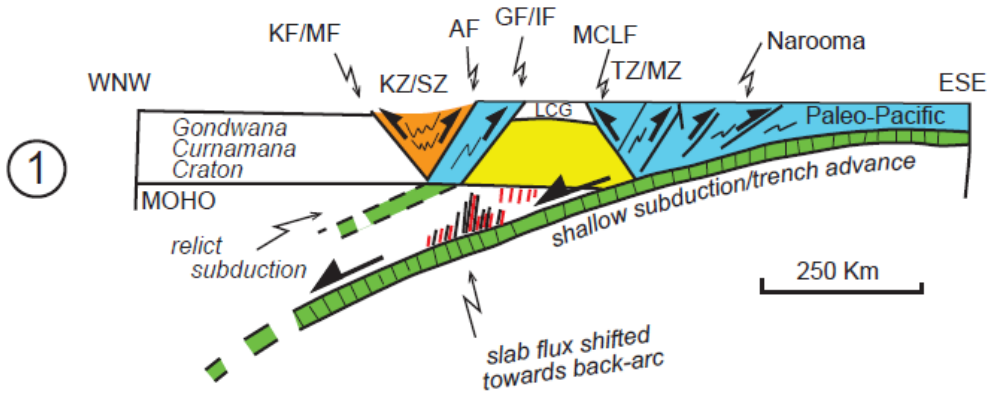
Western Tasmania –

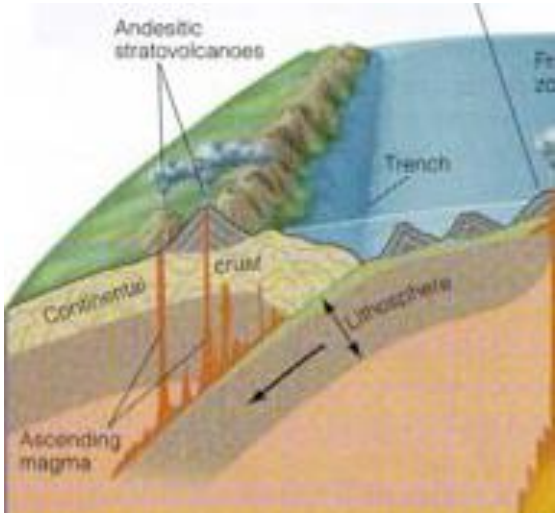
part of an exotic micro-continent



Cayley & Musgrave, in prep.







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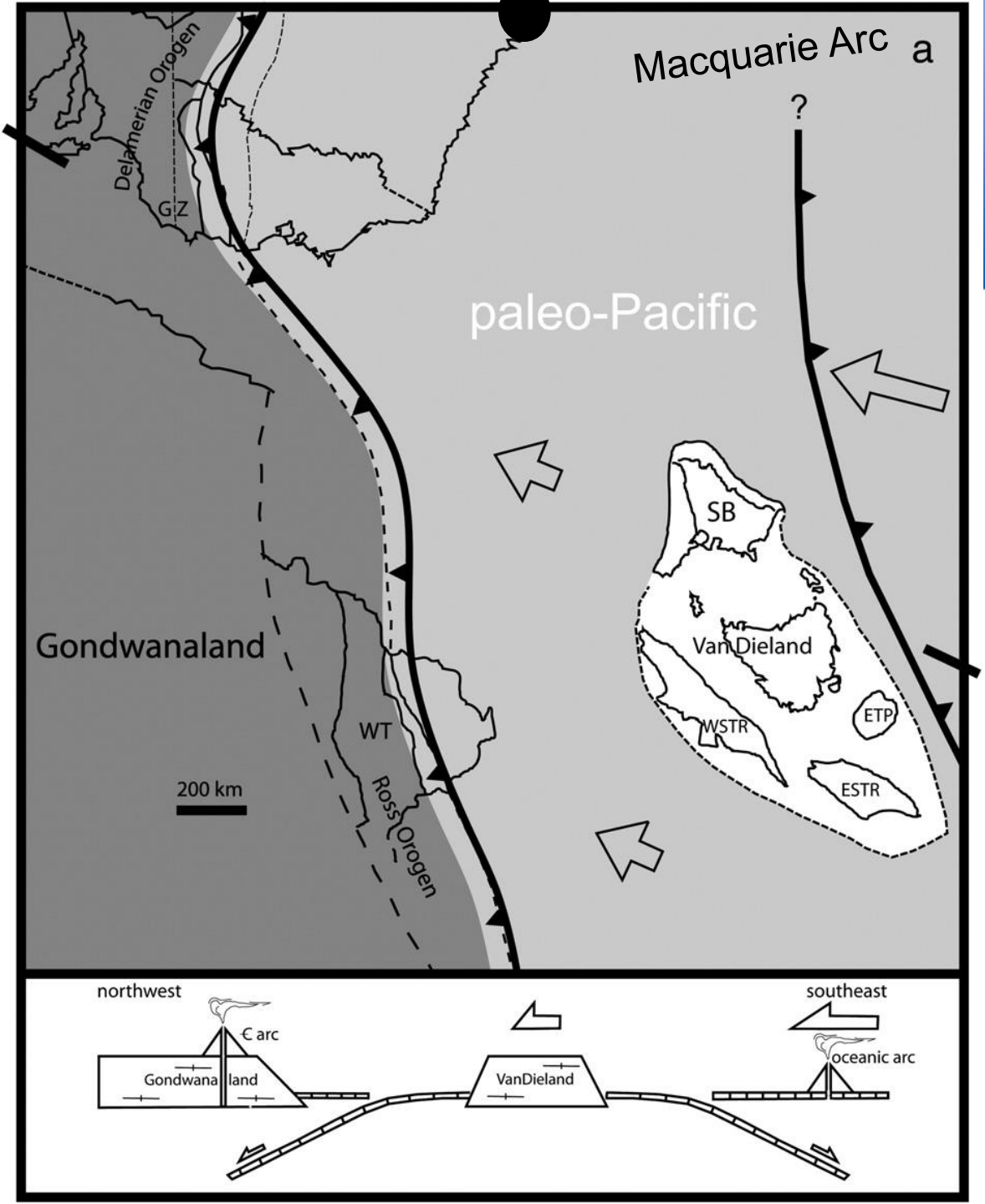
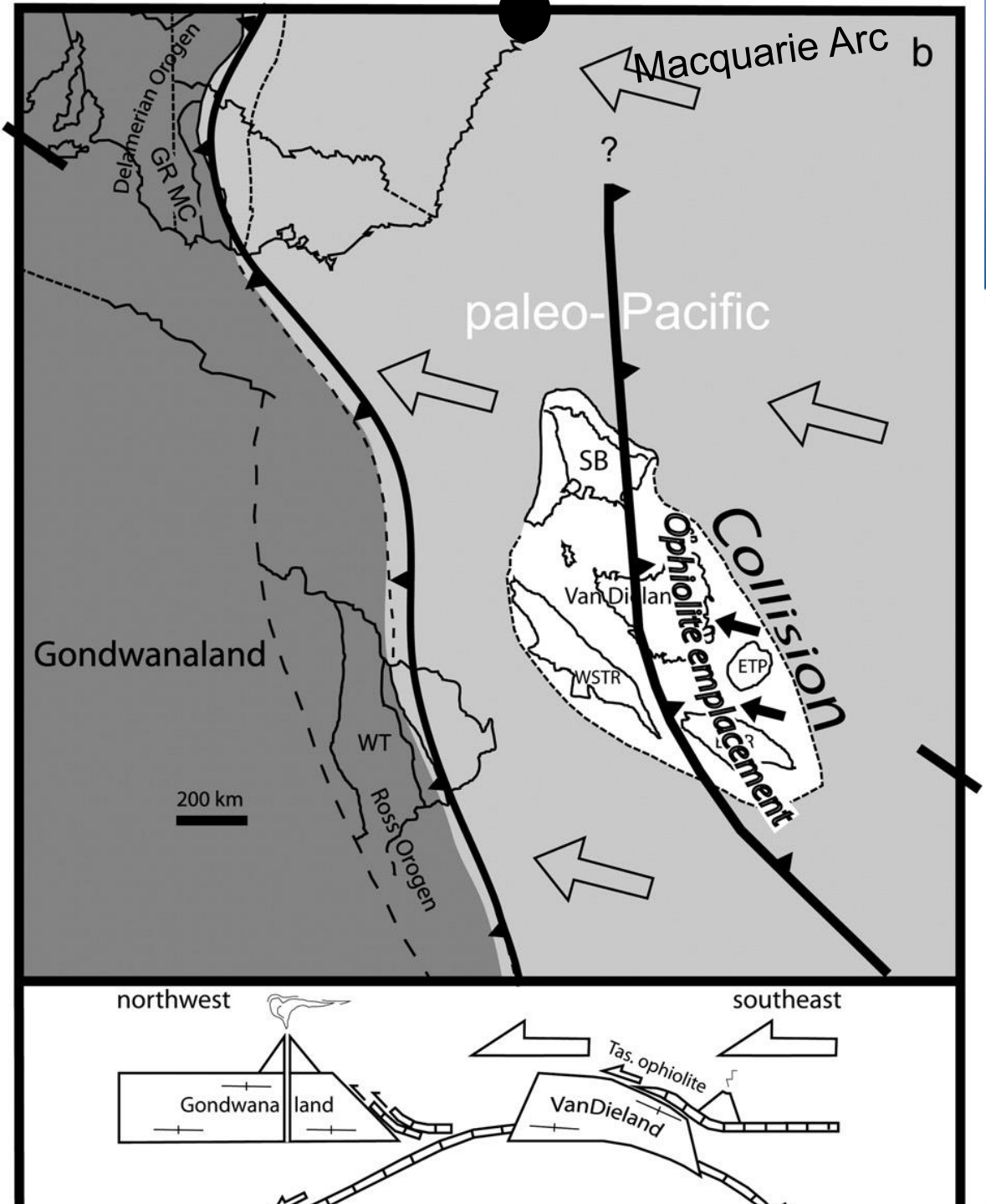


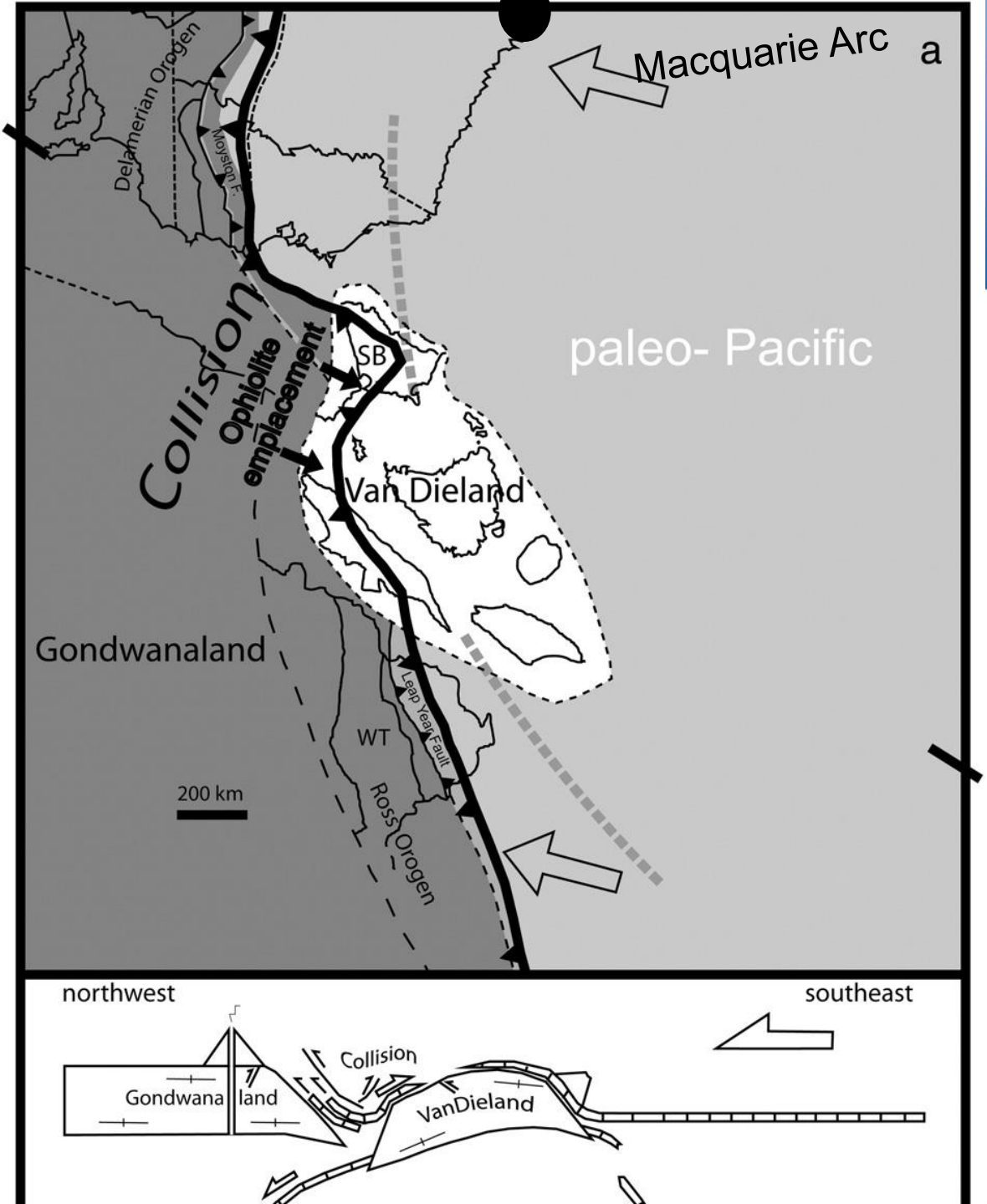
Cayley, 2011



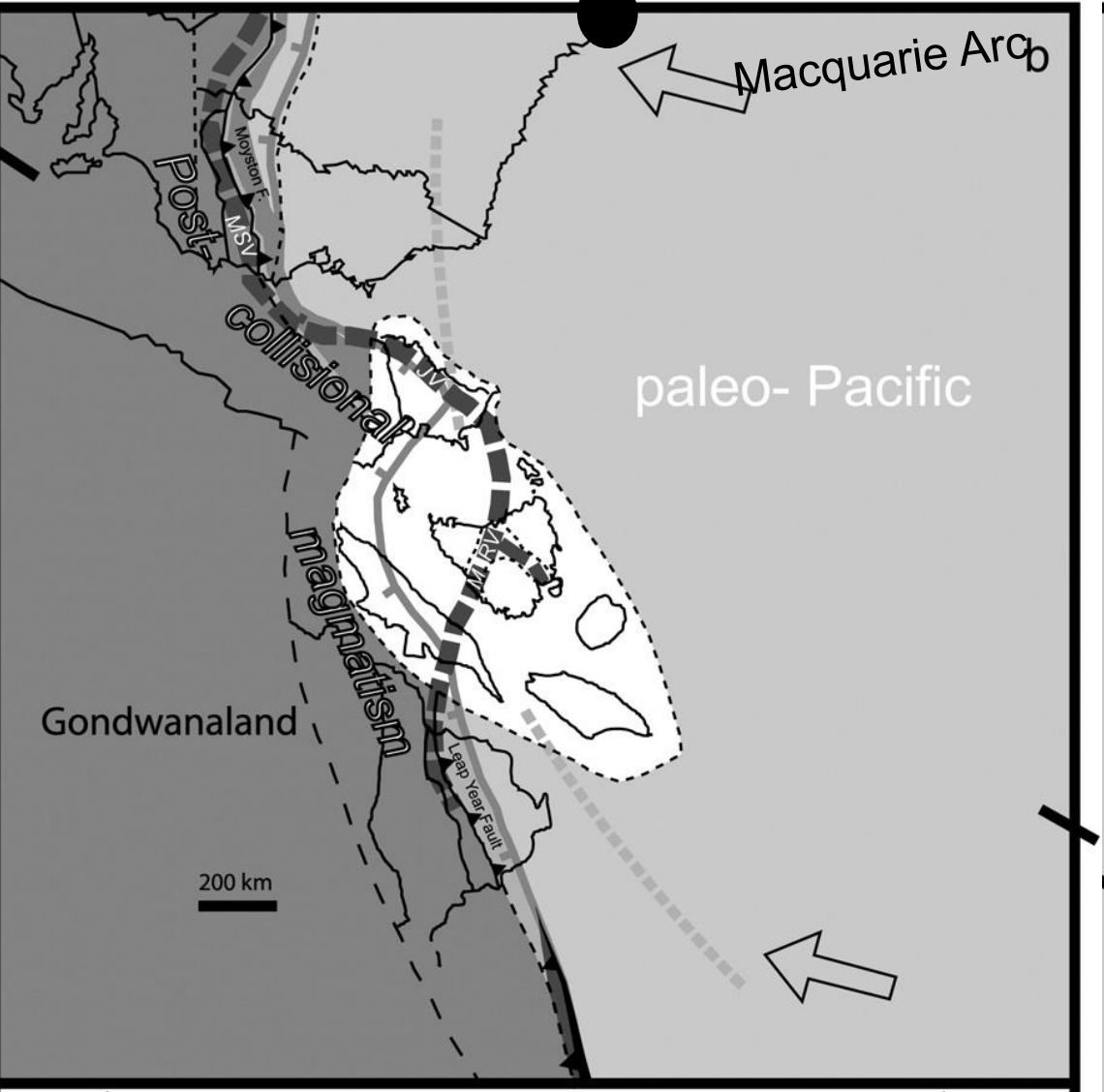
Cayley, 2011

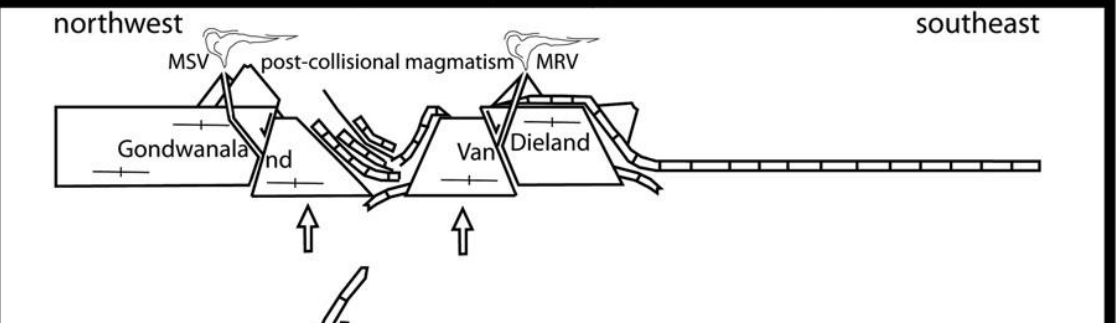
DEPARTMENT OF STATE DEVELOPMENT BUSINESS AND INNOVATION

State Government Victoria



Cayley, 2011





Cayley, 2011

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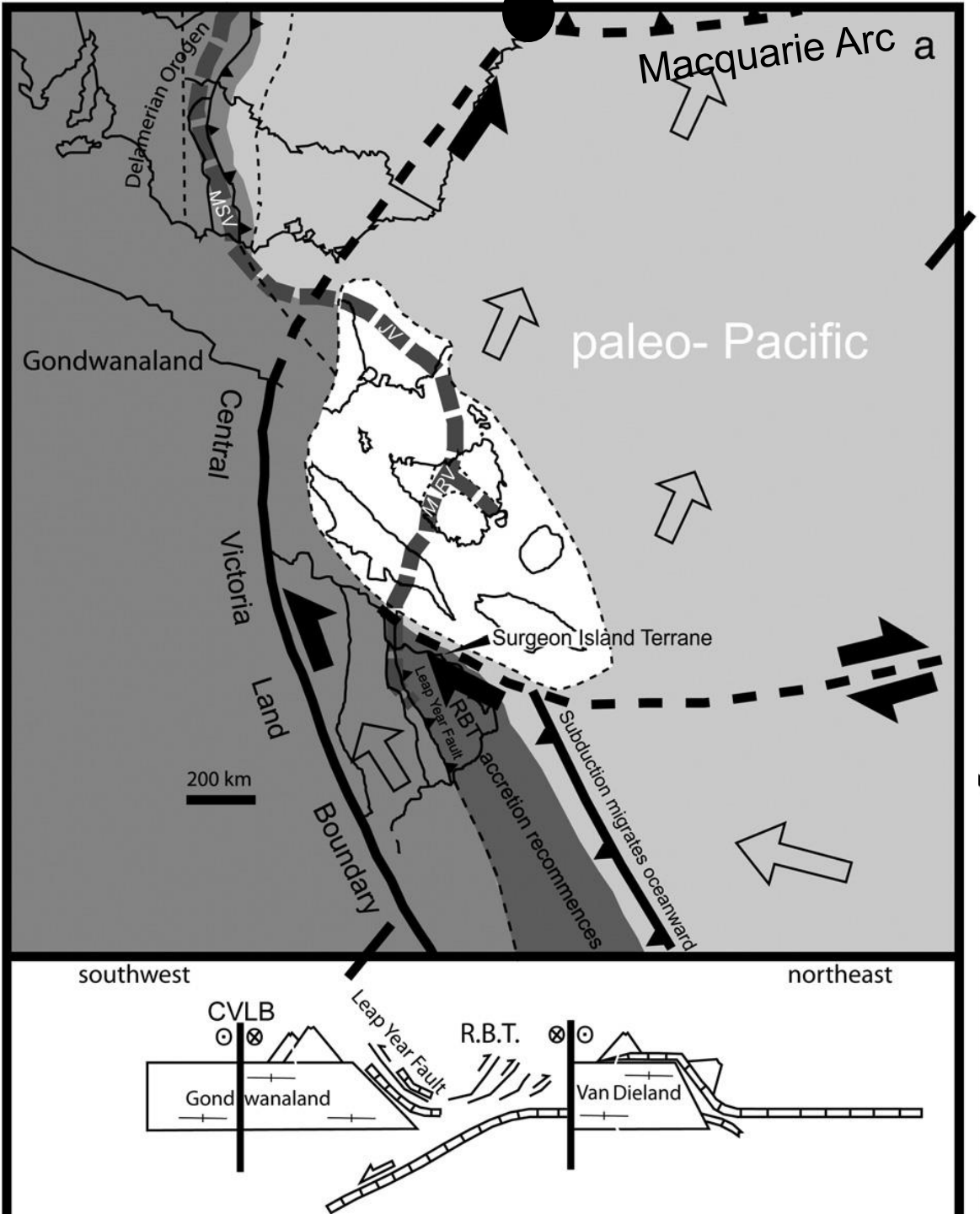
State Government Victoria



Cayley, 2011

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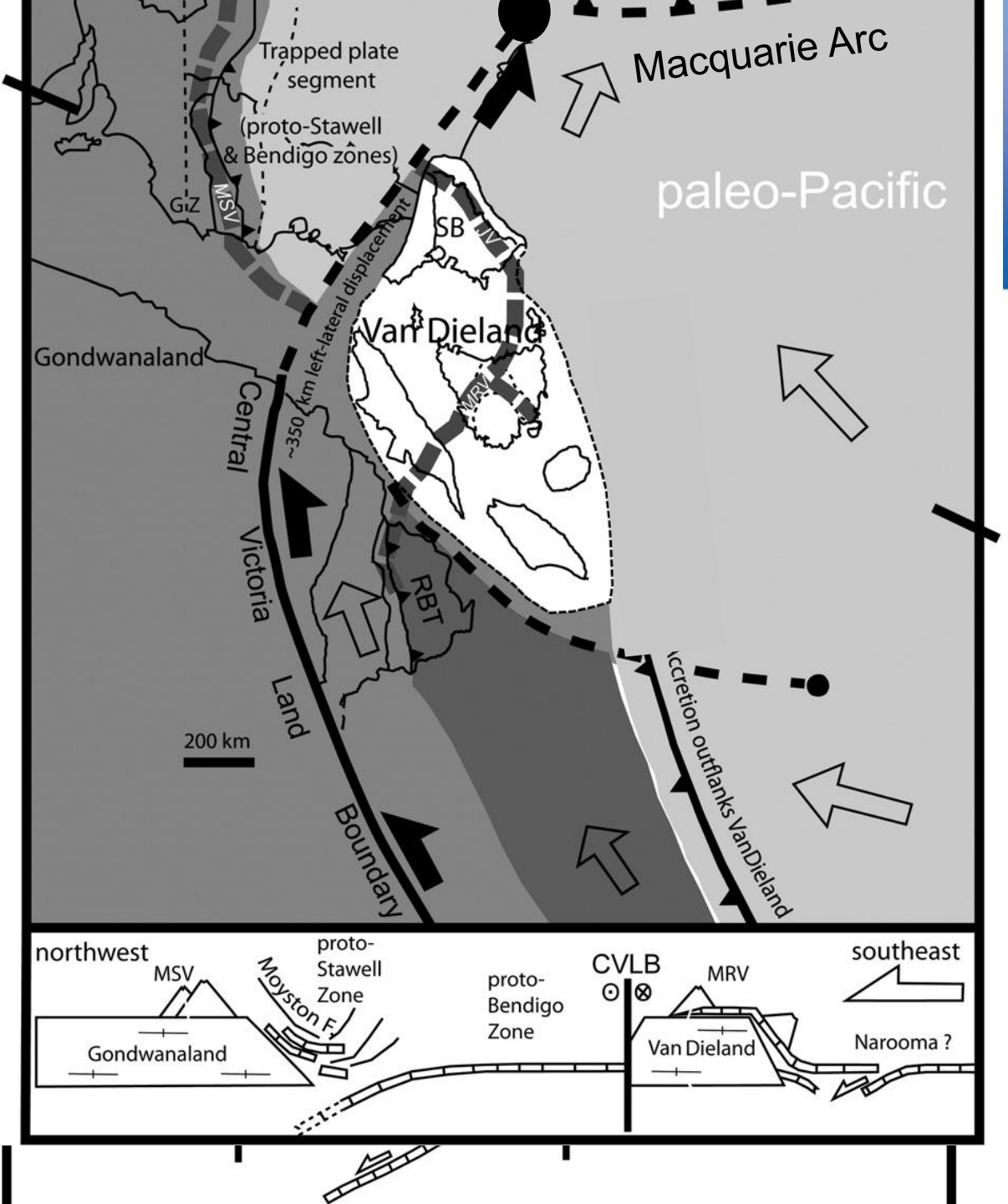
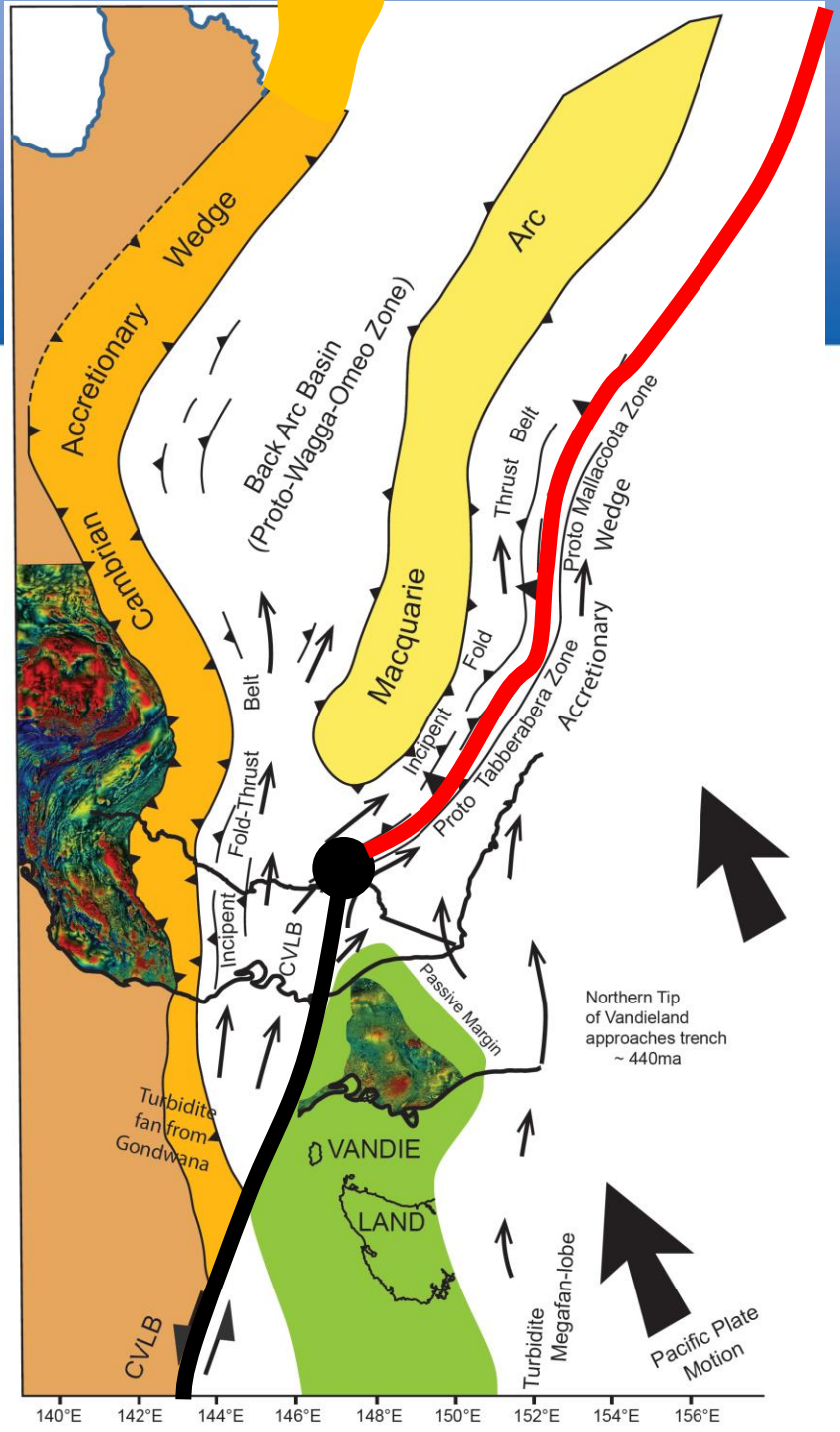
State Government Victoria



Cayley, 2011

DEPARTMENT OF STATE DEVELOPMENT BUSINESS AND INNOVATION
State Government Victoria

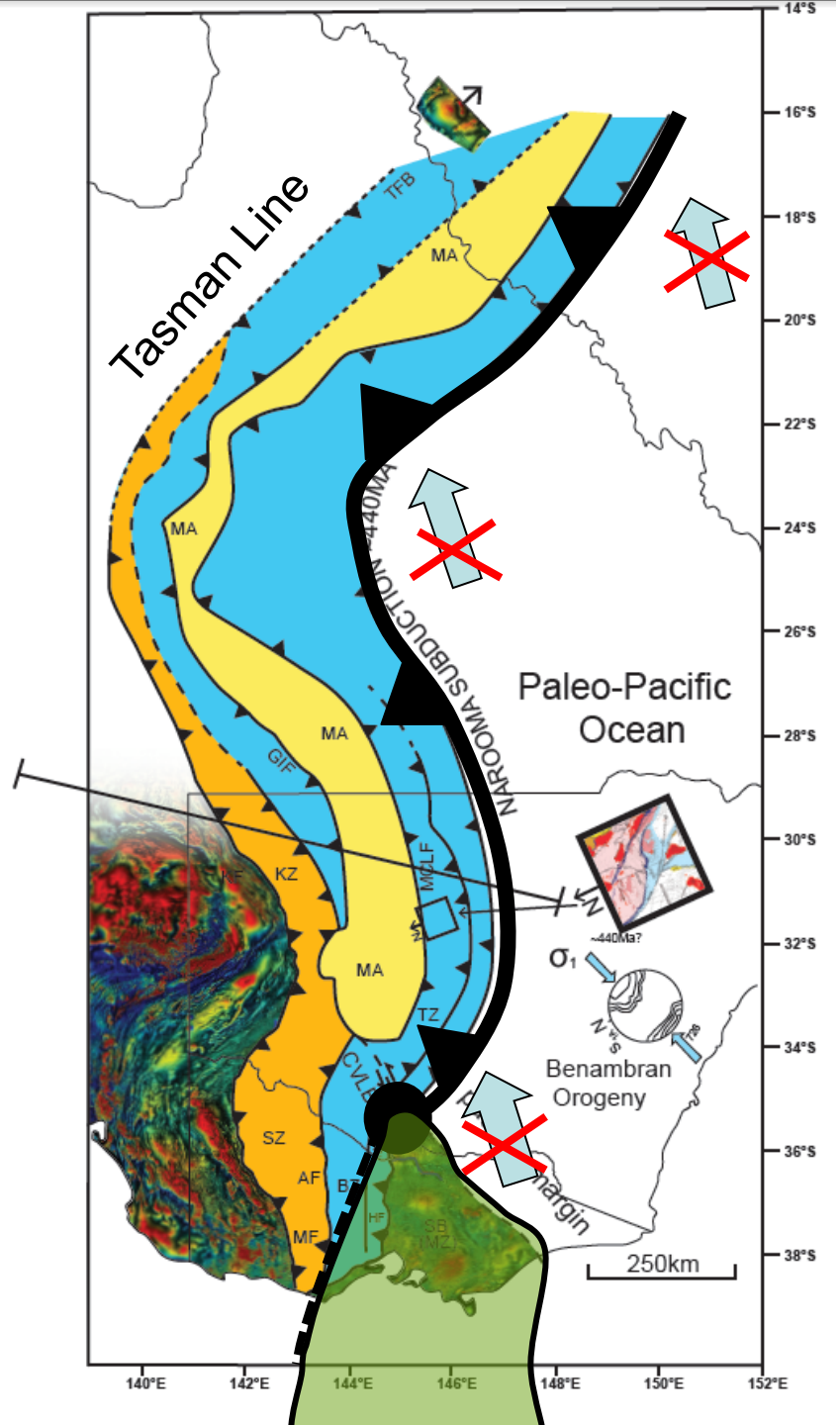


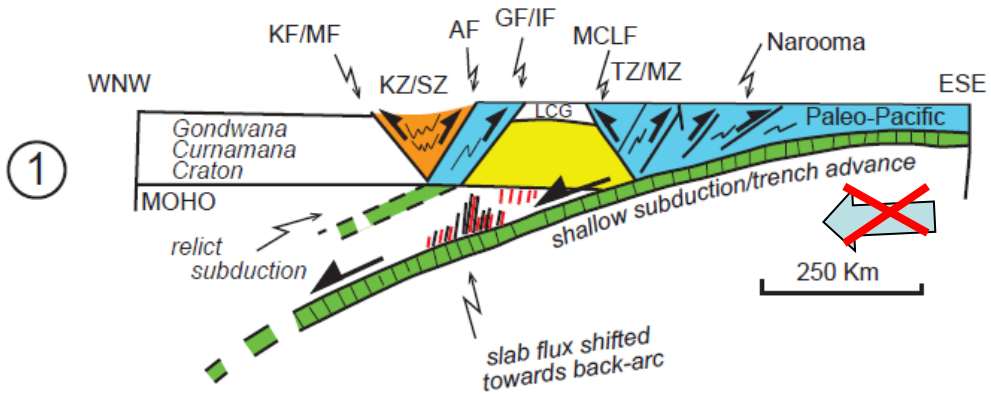
Cayley & Musgrave, in prep.

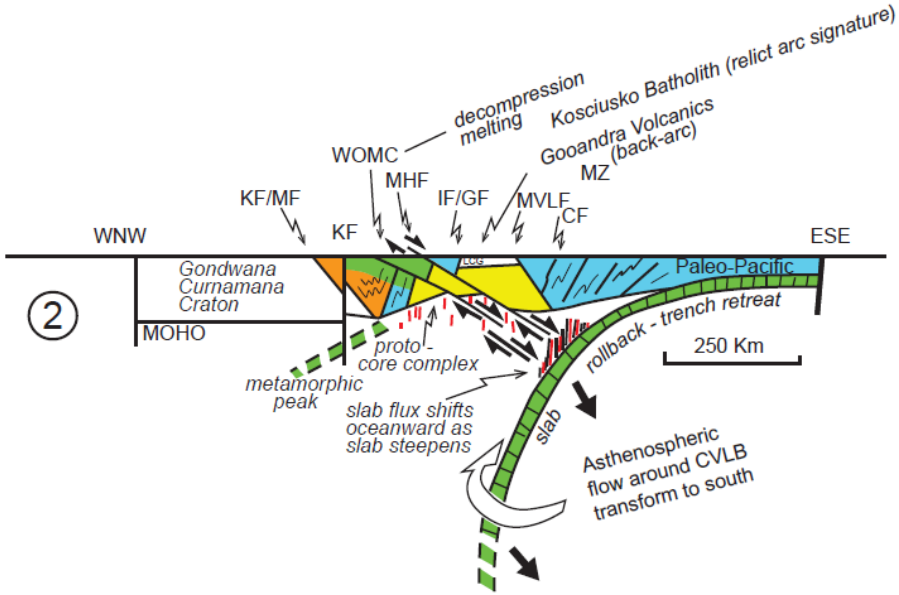
DEPARTMENT OF STATE DEVELOPMENT BUSINESS AND INNOVATION

State Government Victoria

Cayley & Musgrave, in prep.



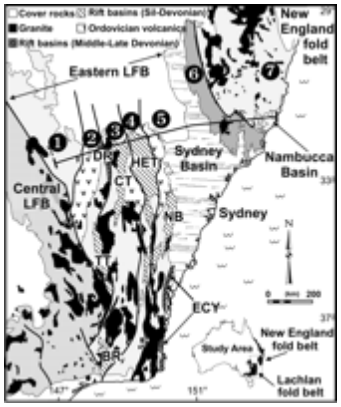




Vandieland, Mk 2 (Post-Tyennan/Delamerian)

Tectonic switching and roll-back in the LFB

Collins, 2002 (Geology)



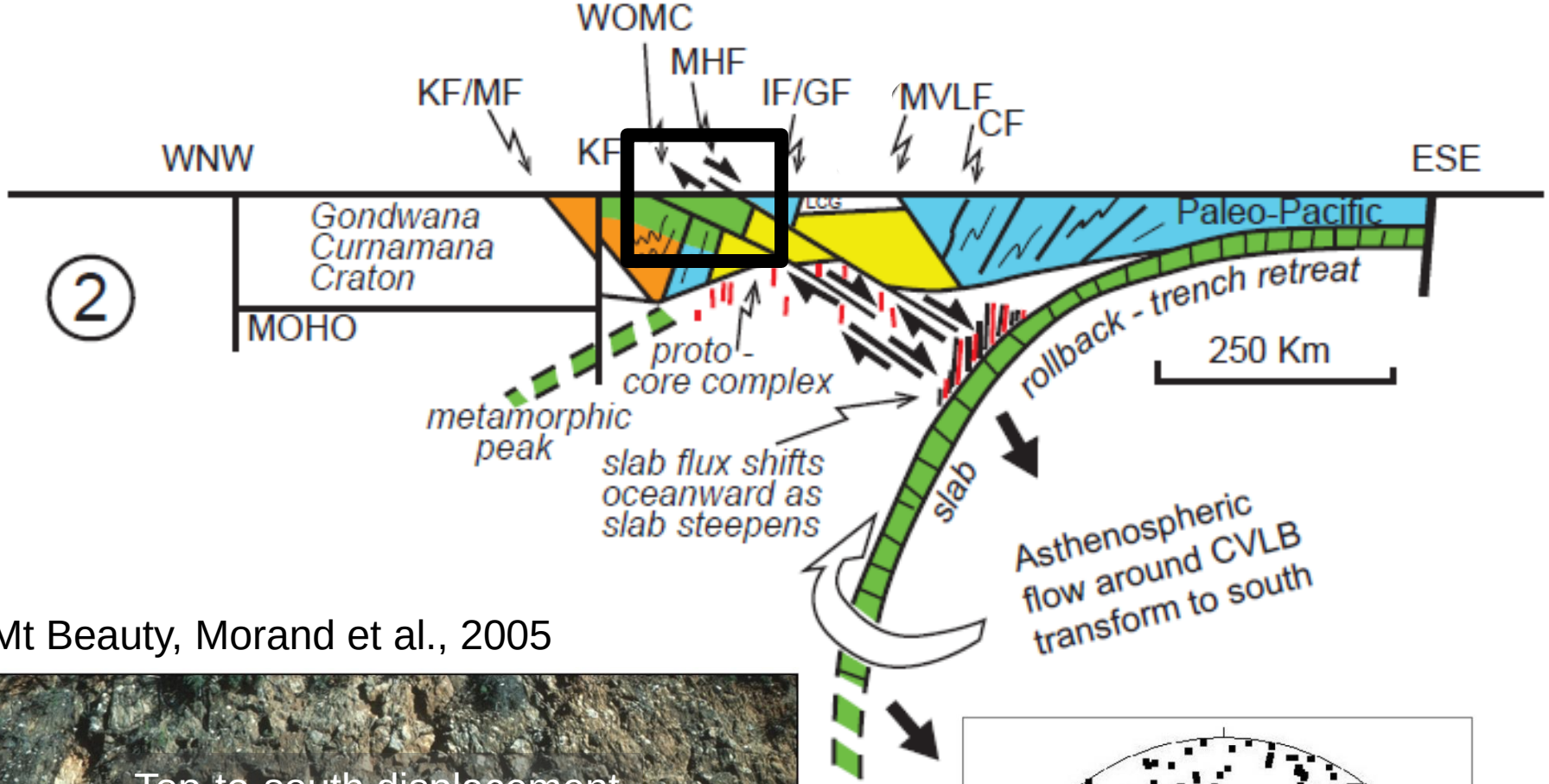
Extension and the tri-partite association:

S-type granites, arcs and back-arc basins

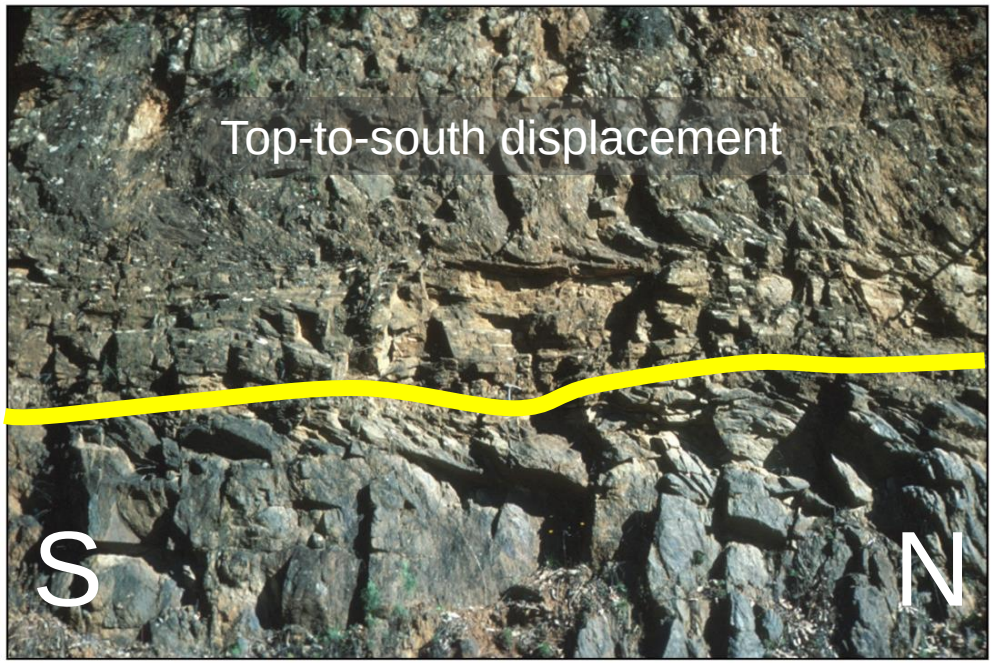
Collins and Richards, 2008 (Geology)

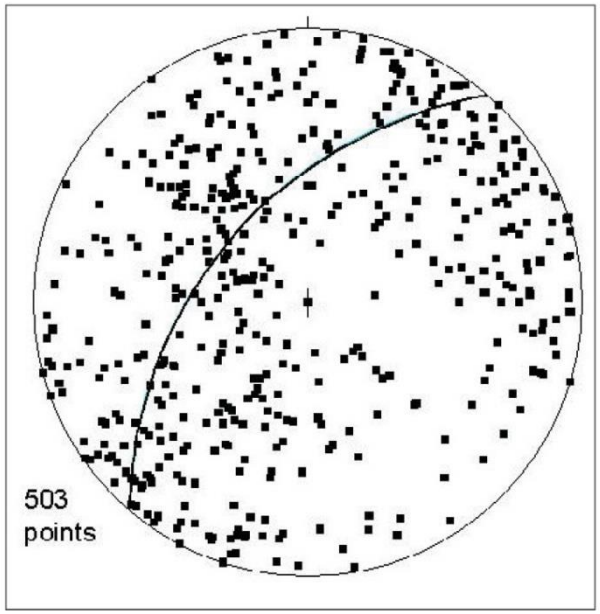
DEPARTMENT OF STATE DEVELOPMENT BUSINESS AND INNOVATION

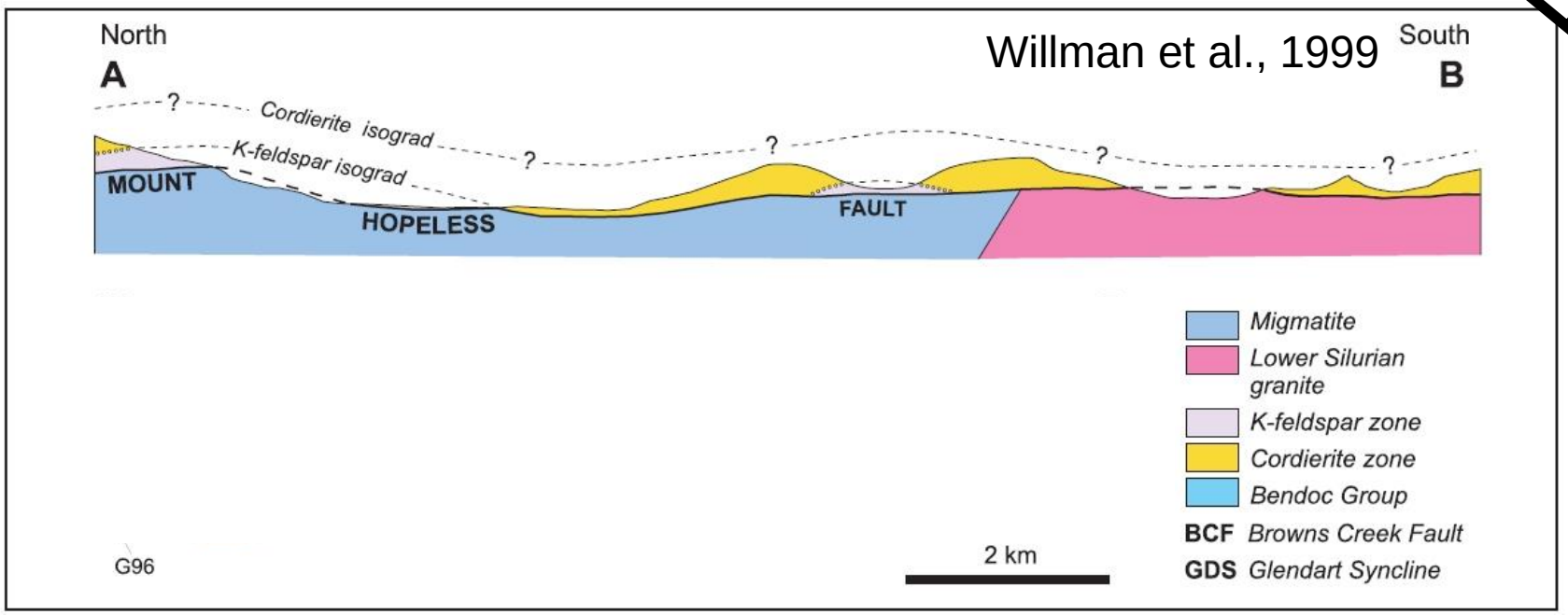
State Government Victoria



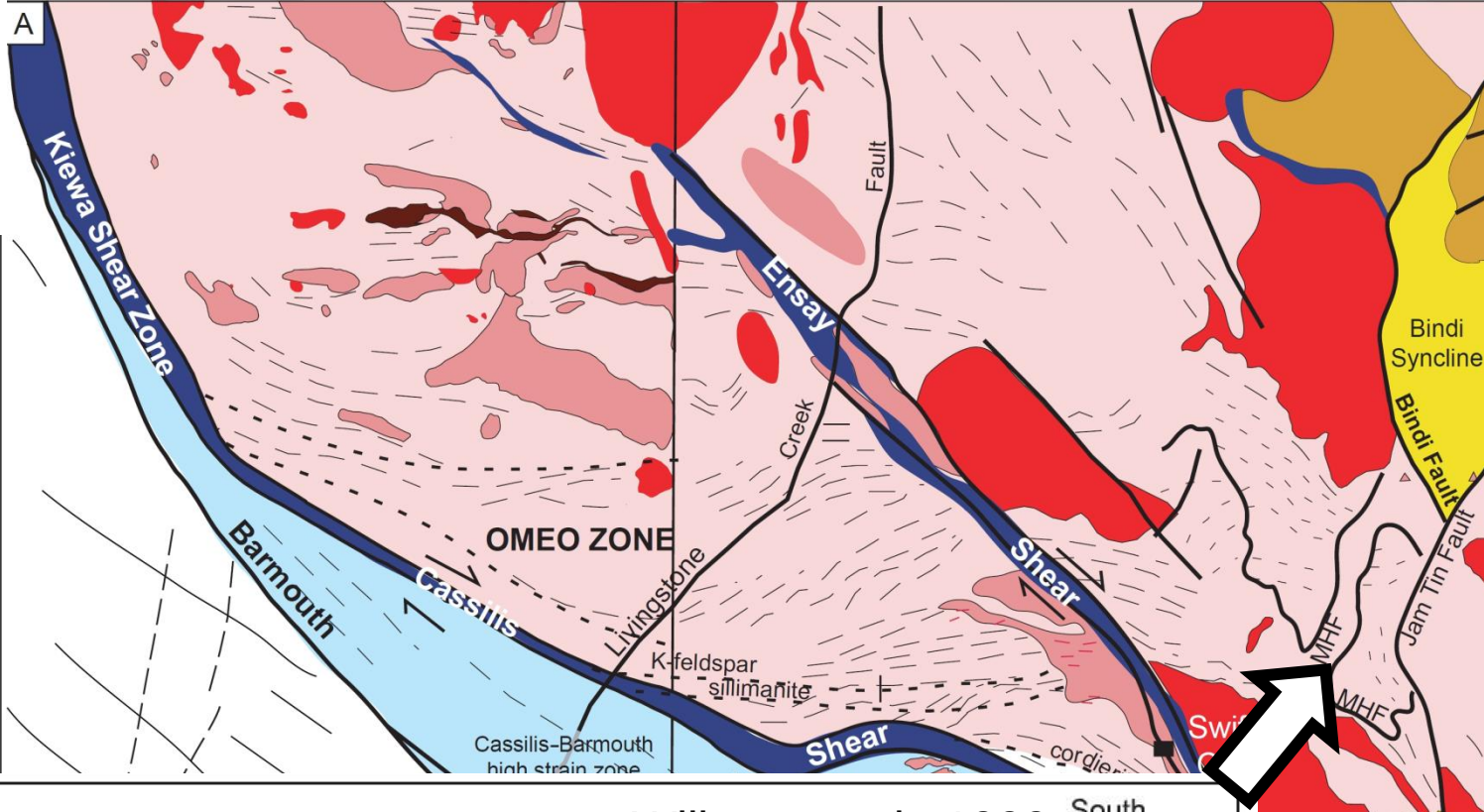
Mt Beauty, Morand et al., 2005



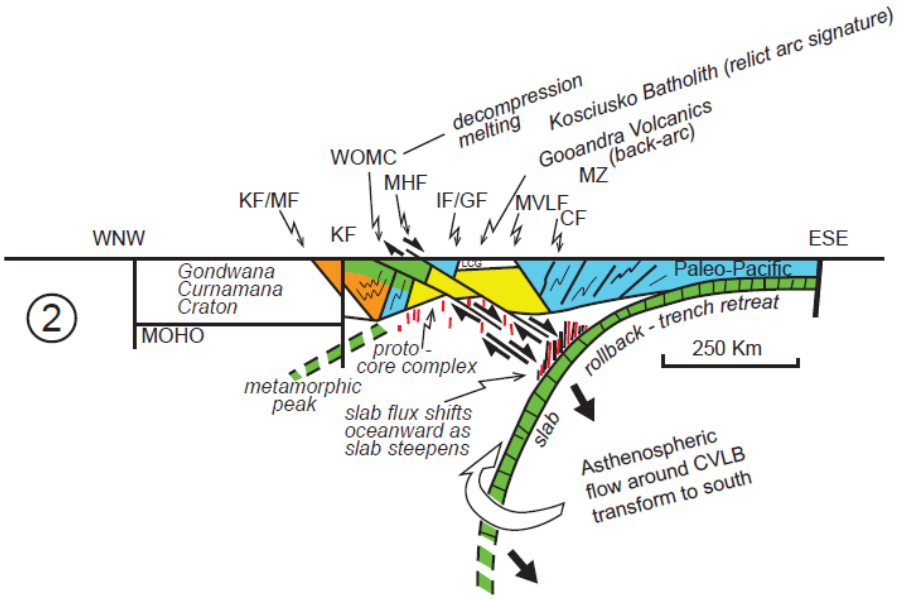


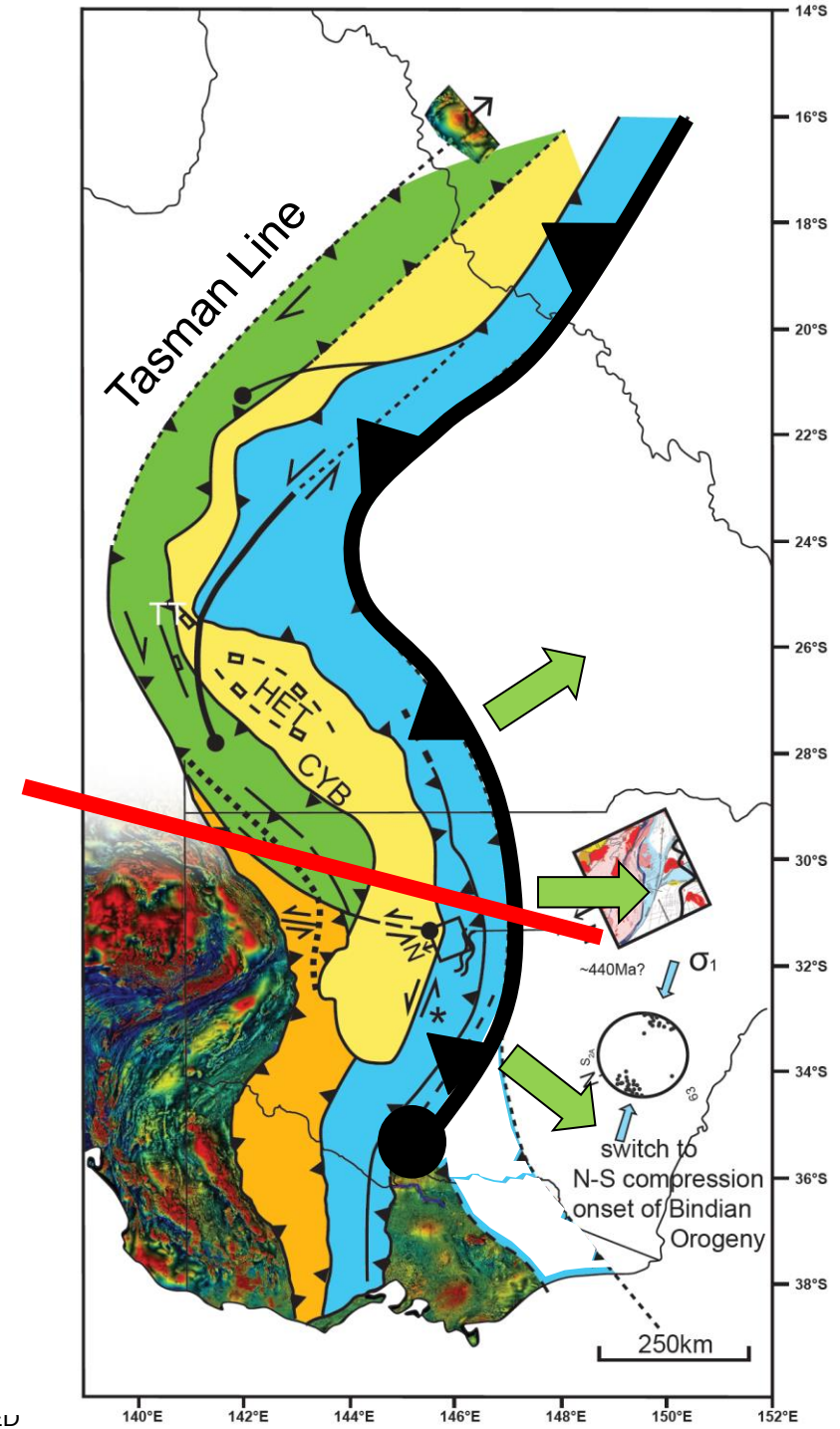


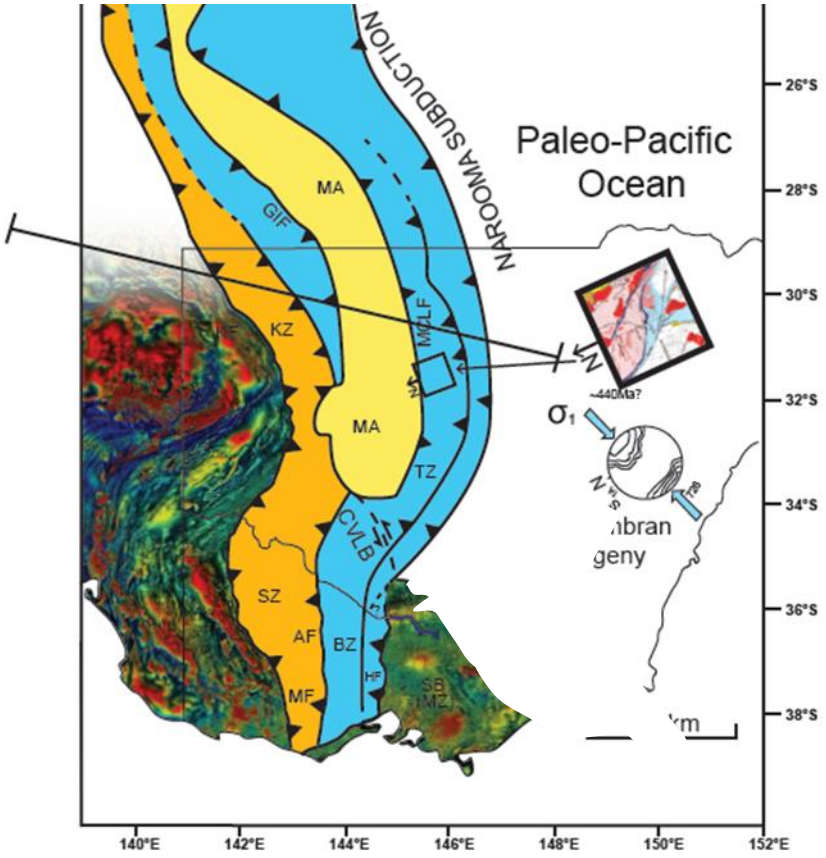
Willman et al., 1999

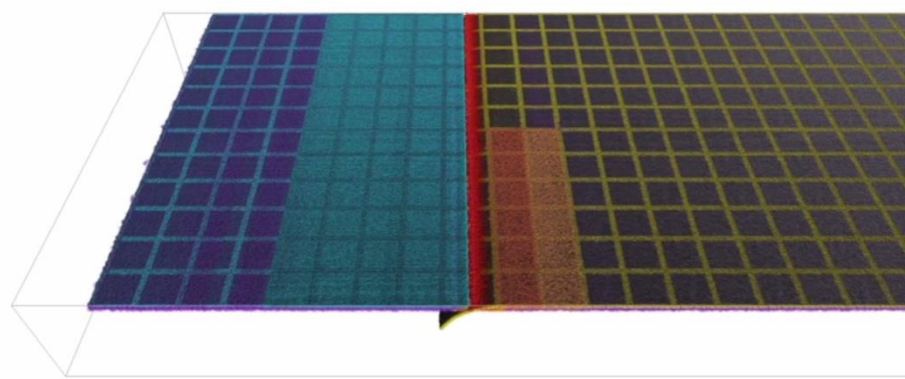


et al., 2005.
port 126: Dargo

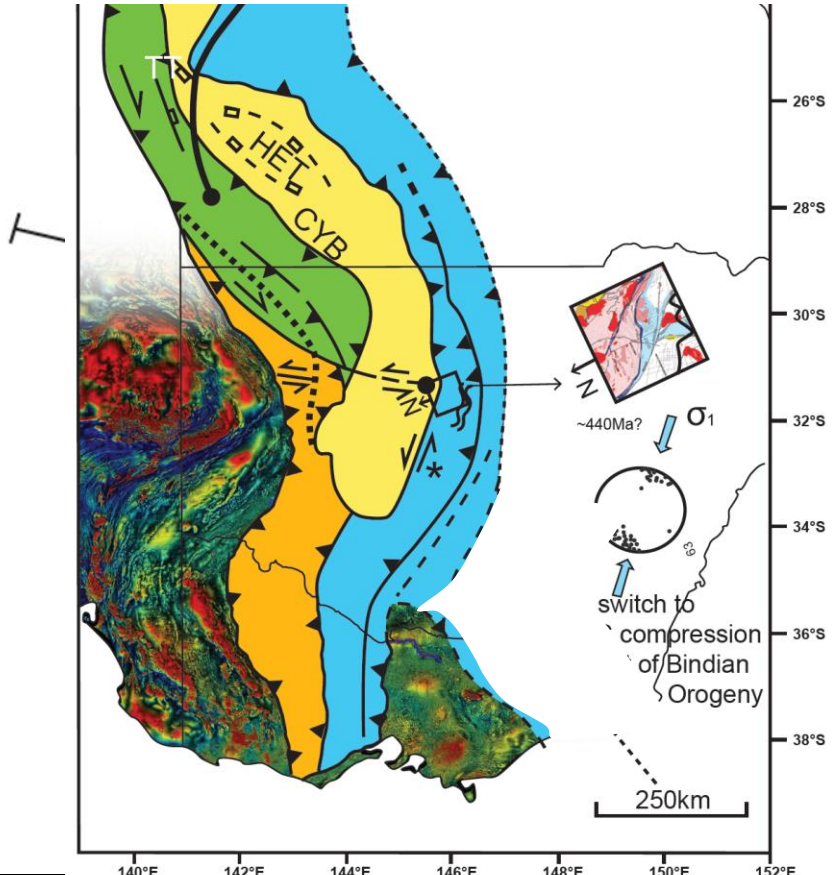

WNW
ESE
WOMC
MHF
KF/MF
KF
IF/GF
MVLF
CF
MZ
decompression melting
Kosciusko Batholith (relict arc signature)
Gooandra Volcanics (back-arc)
Gondwana Curnamana Craton
MOHO
Paleo-Pacific
proto-core complex
metamorphic peak
slab flux shifts oceanward as slab steepens
rollback - trench retreat
slab
250 Km
Asthenospheric flow around CVLB transform to south
2

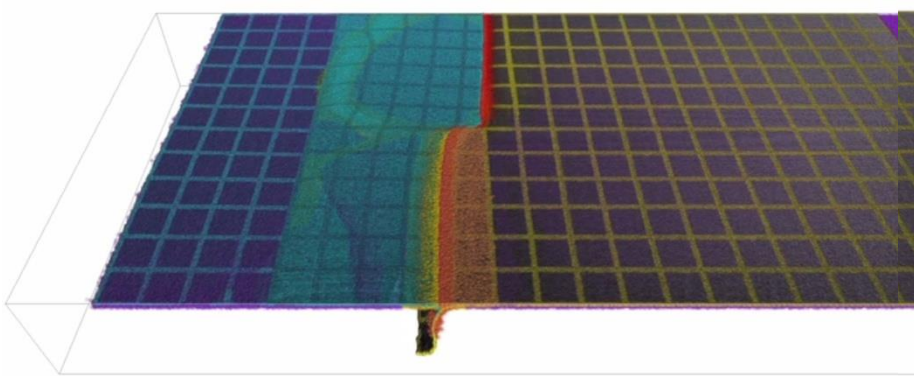

Tasman Line
TTd
HETB
CYB
~440Ma?
σ1
switch to N-S compression onset of Bindian Orogeny
250km
14°S
16°S
18°S
20°S
22°S
24°S
26°S
28°S
30°S
32°S
34°S
36°S
38°S
140°E
142°E
144°E
146°E
148°E
150°E
152°E



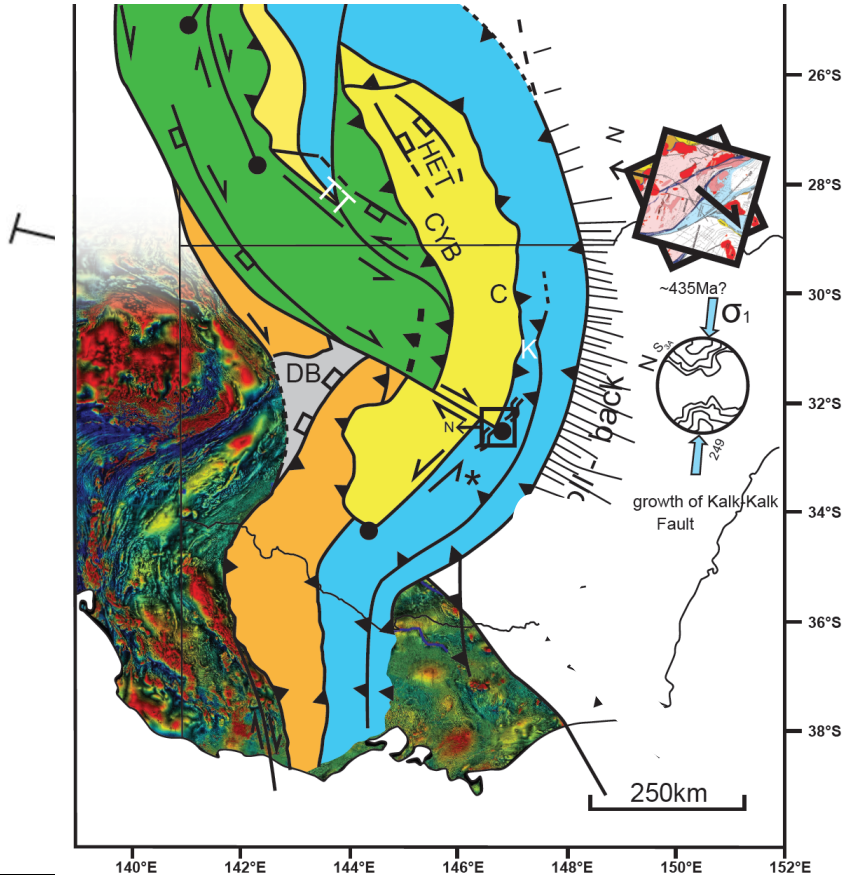


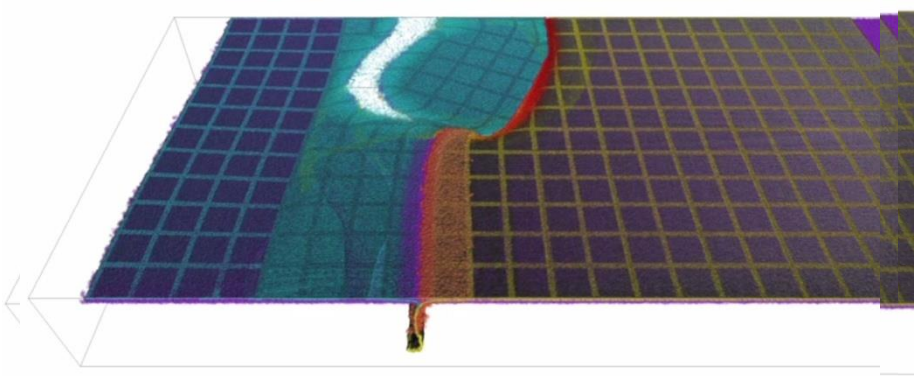
Moresi, Betts, Miller & Cayley 2014, NATURE.



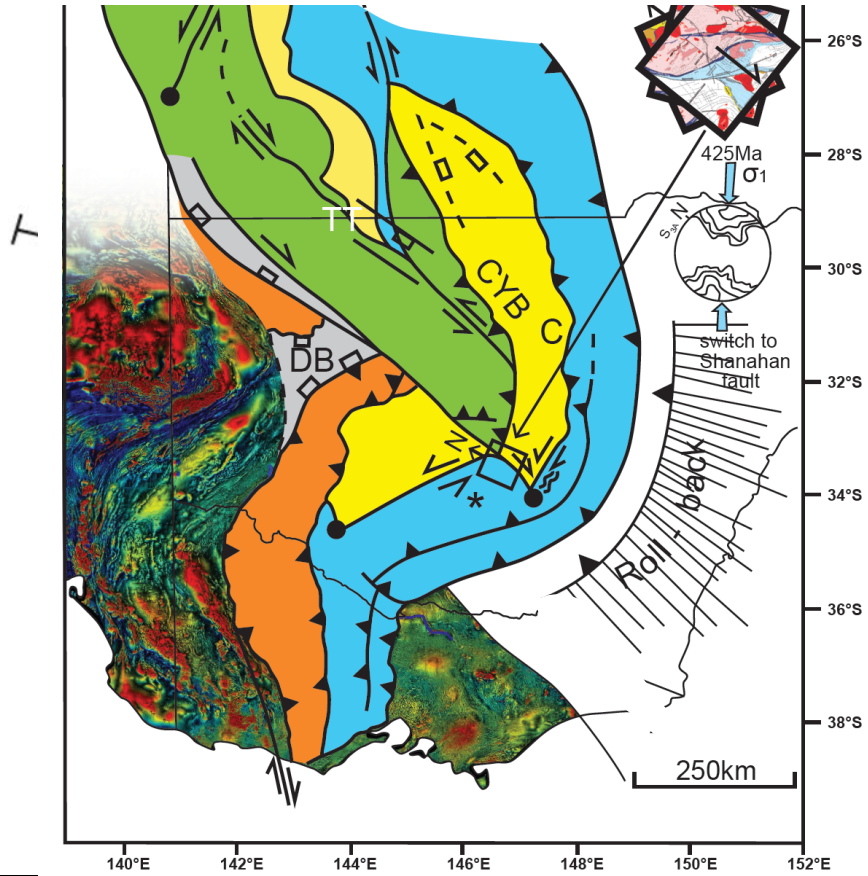


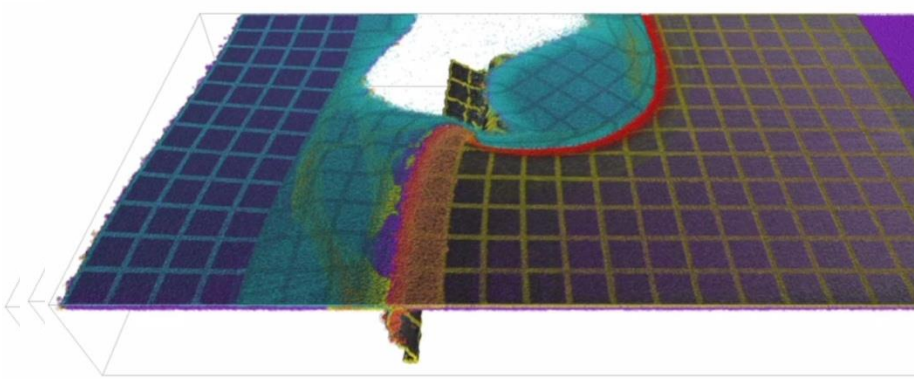
Moresi, Betts, Miller & Cayley 2014, NATURE.



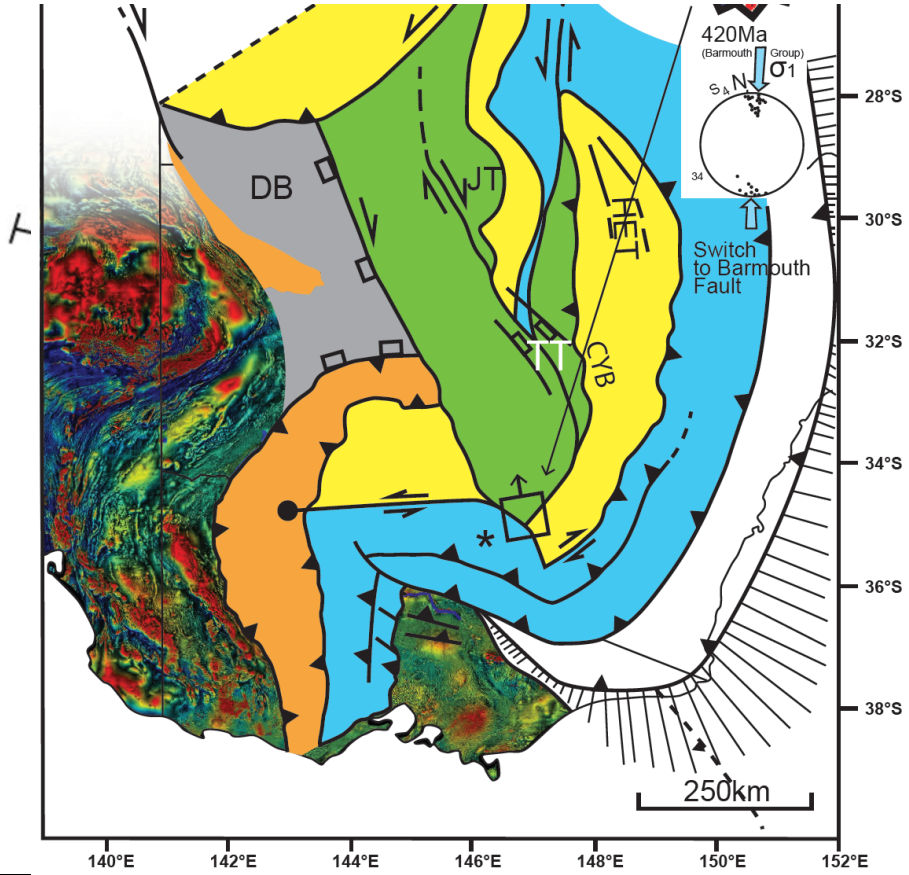


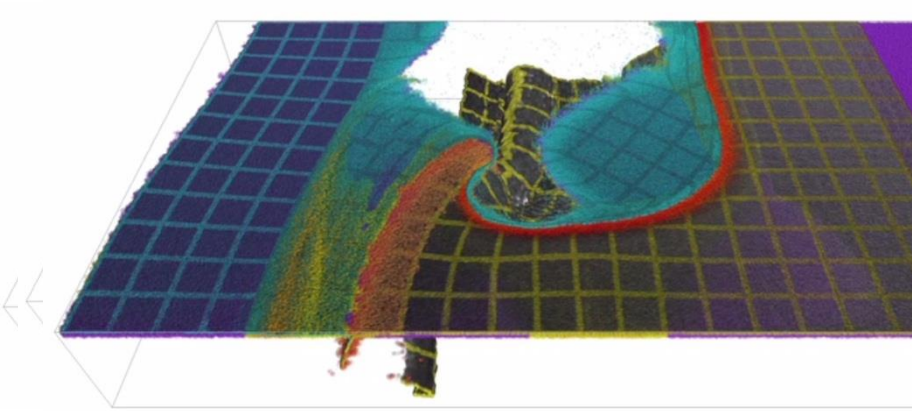
Moresi, Betts, Miller & Cayley 2014, NATURE.



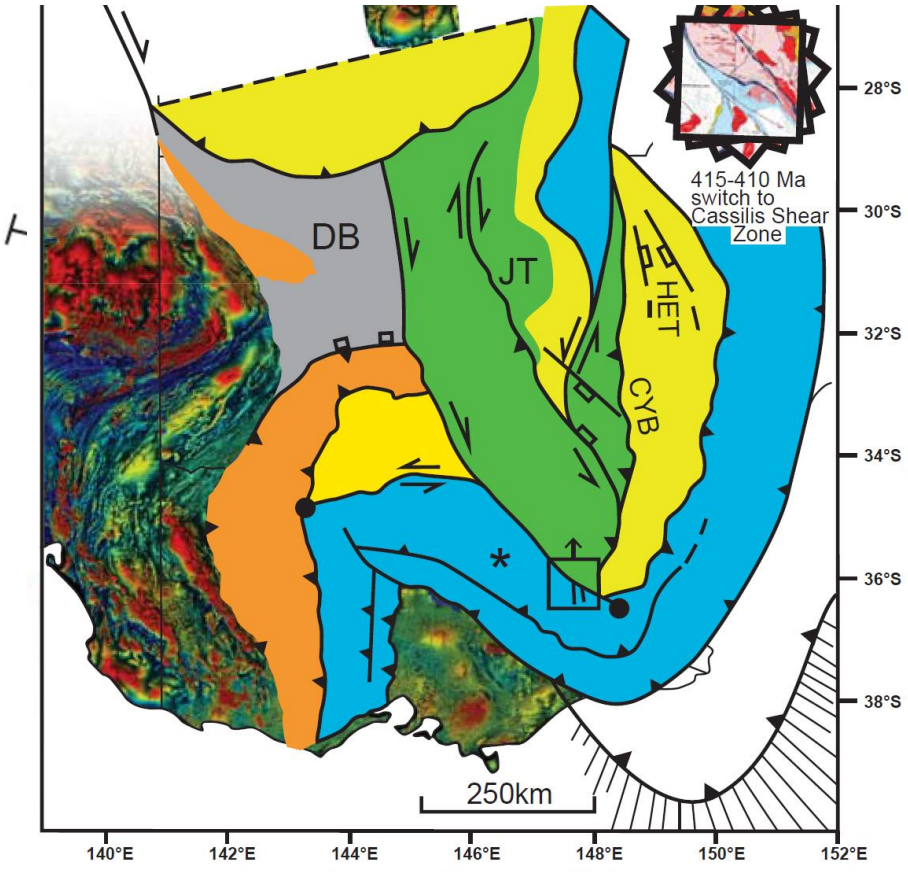


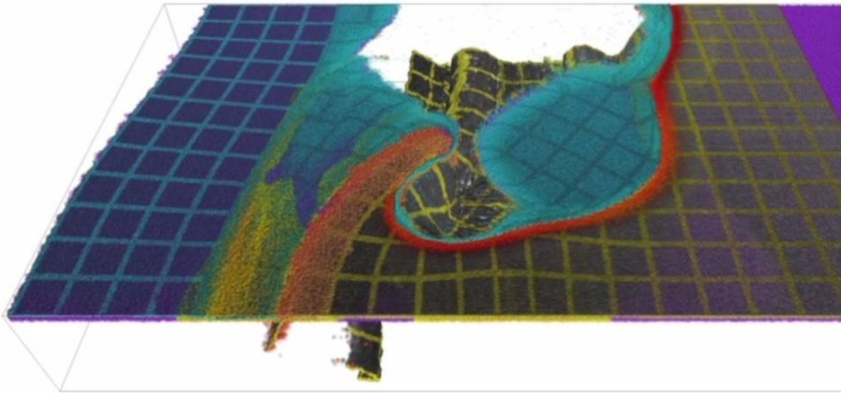
Moresi, Betts, Miller & Cayley 2014, NATURE.



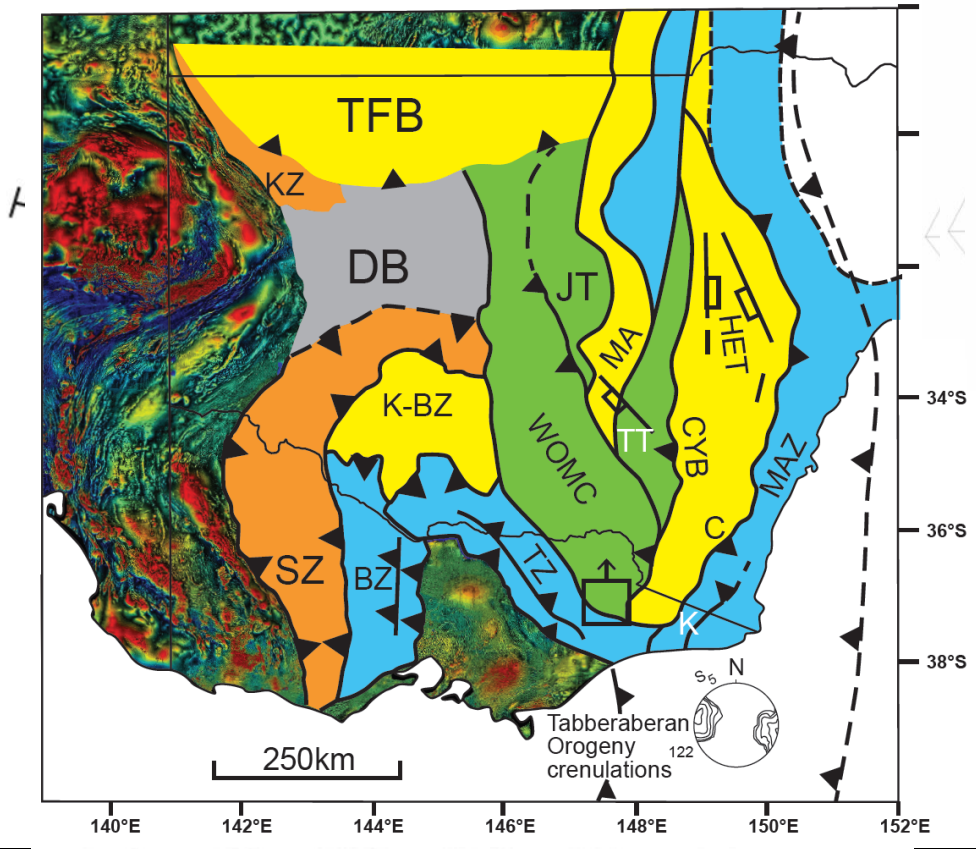


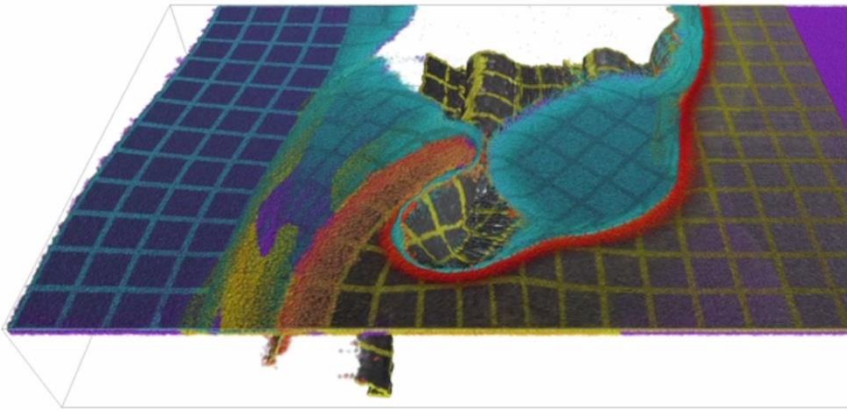
Moresi, Betts, Miller & Cayley 2014, NATURE.





Moresi, Betts, Miller & Cayley 2014, NATURE.

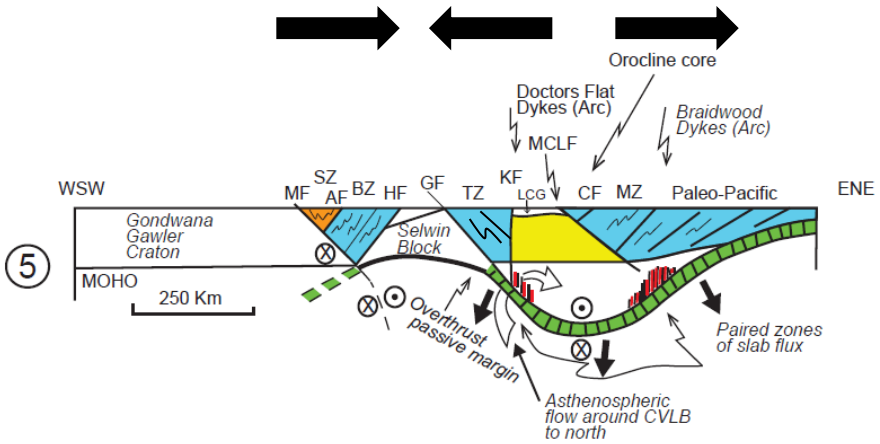


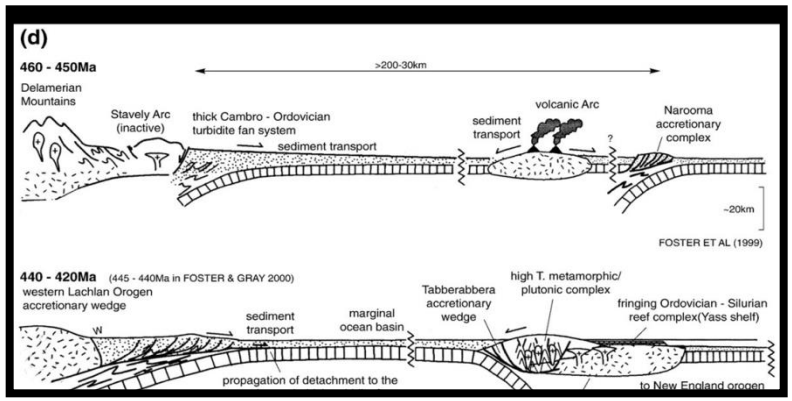


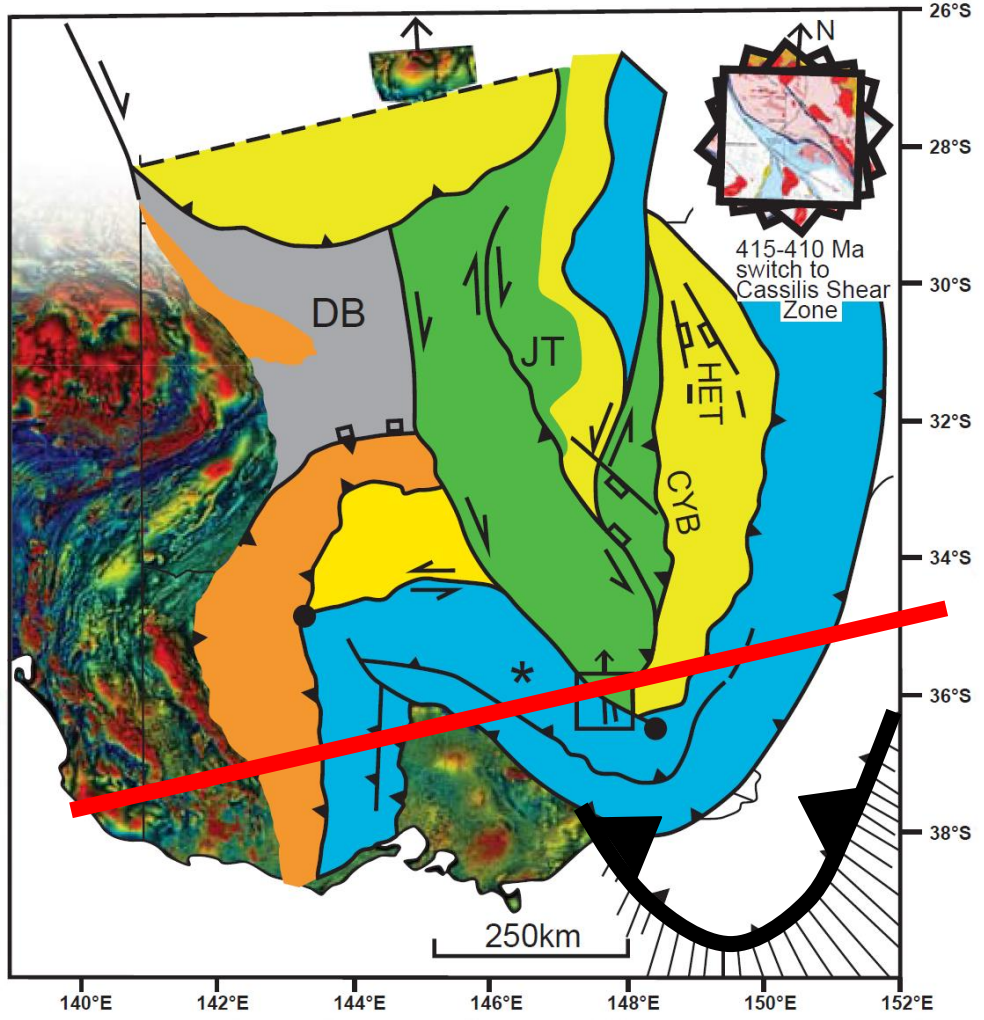
Moresi, Betts, Miller & Cayley 2014, NATURE.

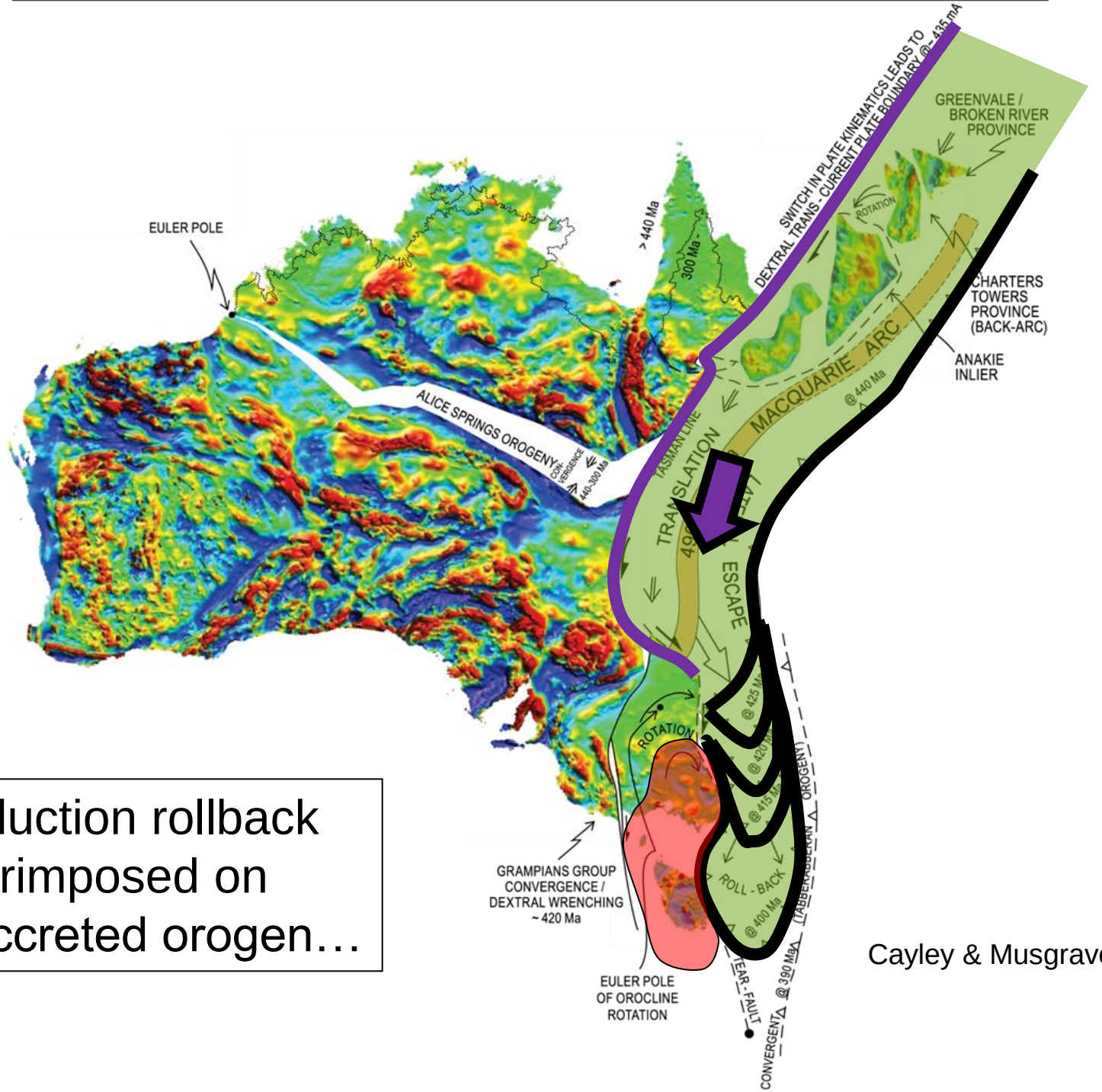
The Lachlan Orocline:

an alternative explanation of apparent vergence reversals in Ordovician LFB:





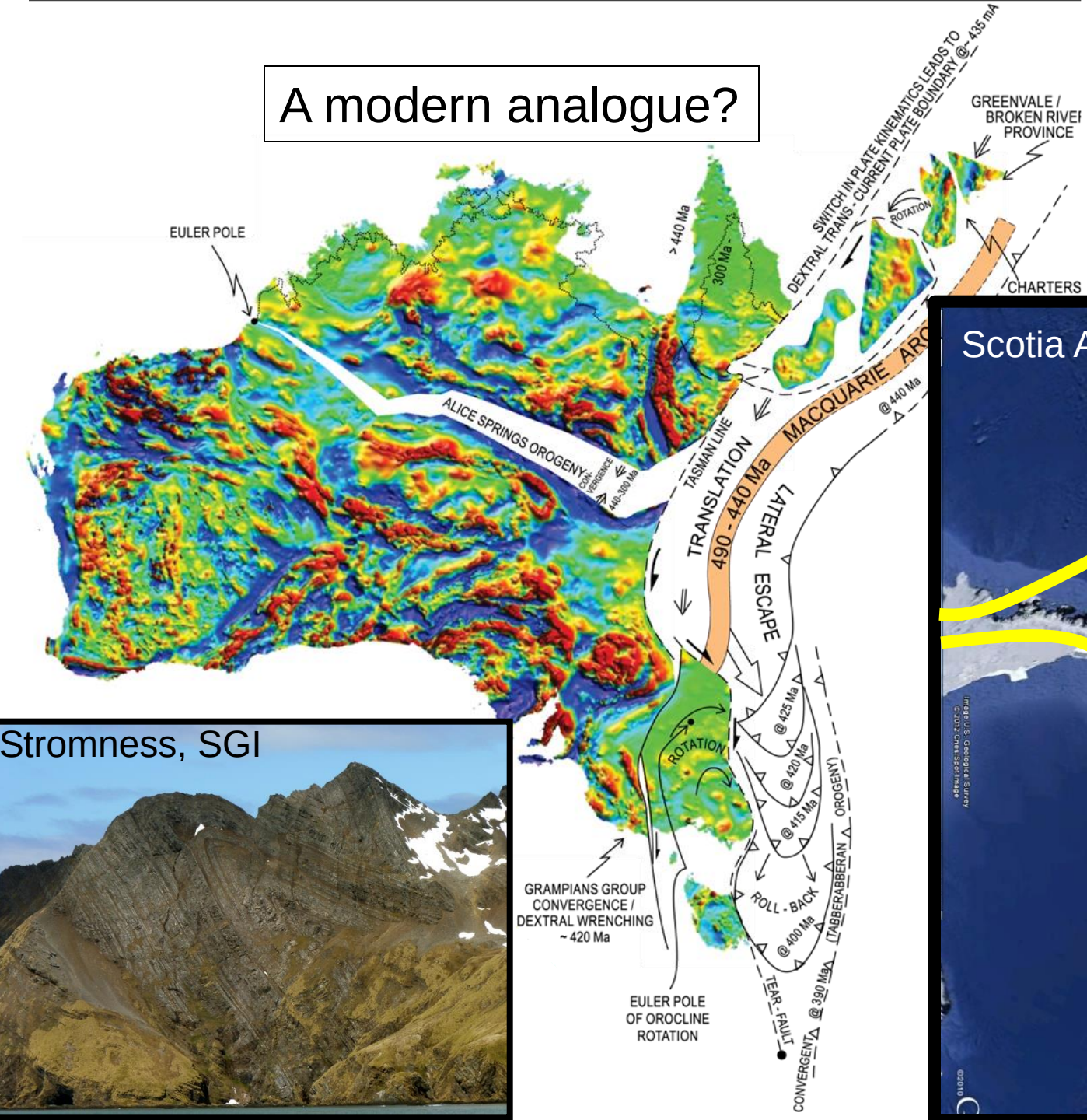


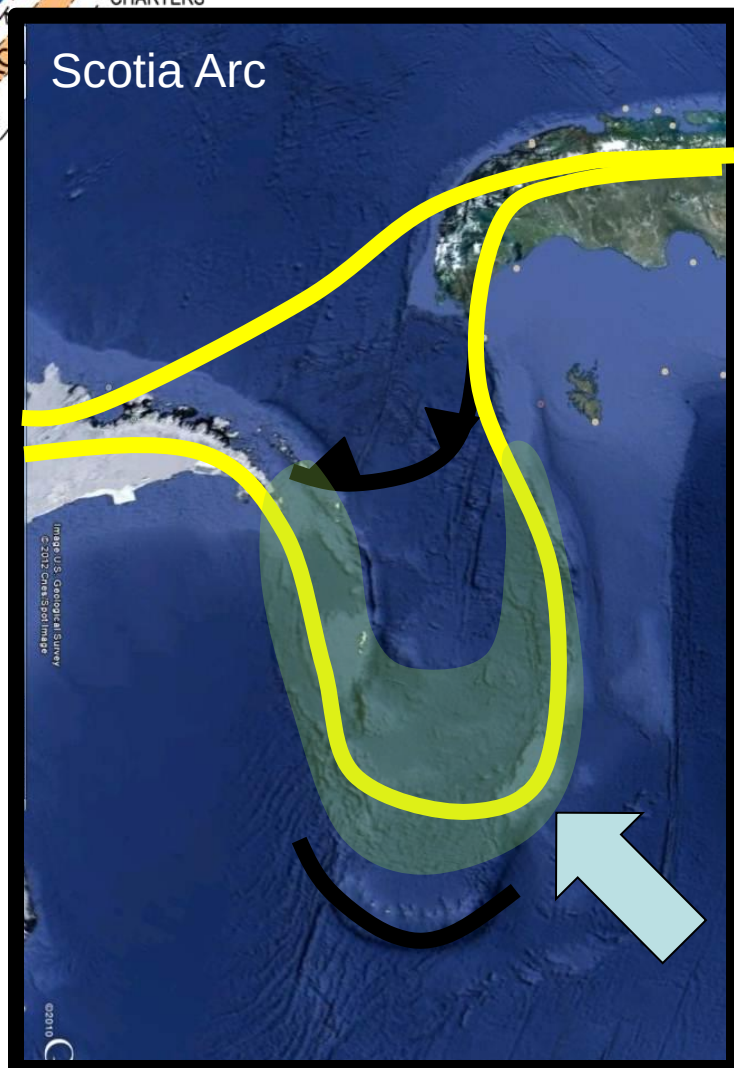


Subduction rollback superimposed on an accreted orogen…

Cayley & Musgrave, in prep.

A modern analogue?



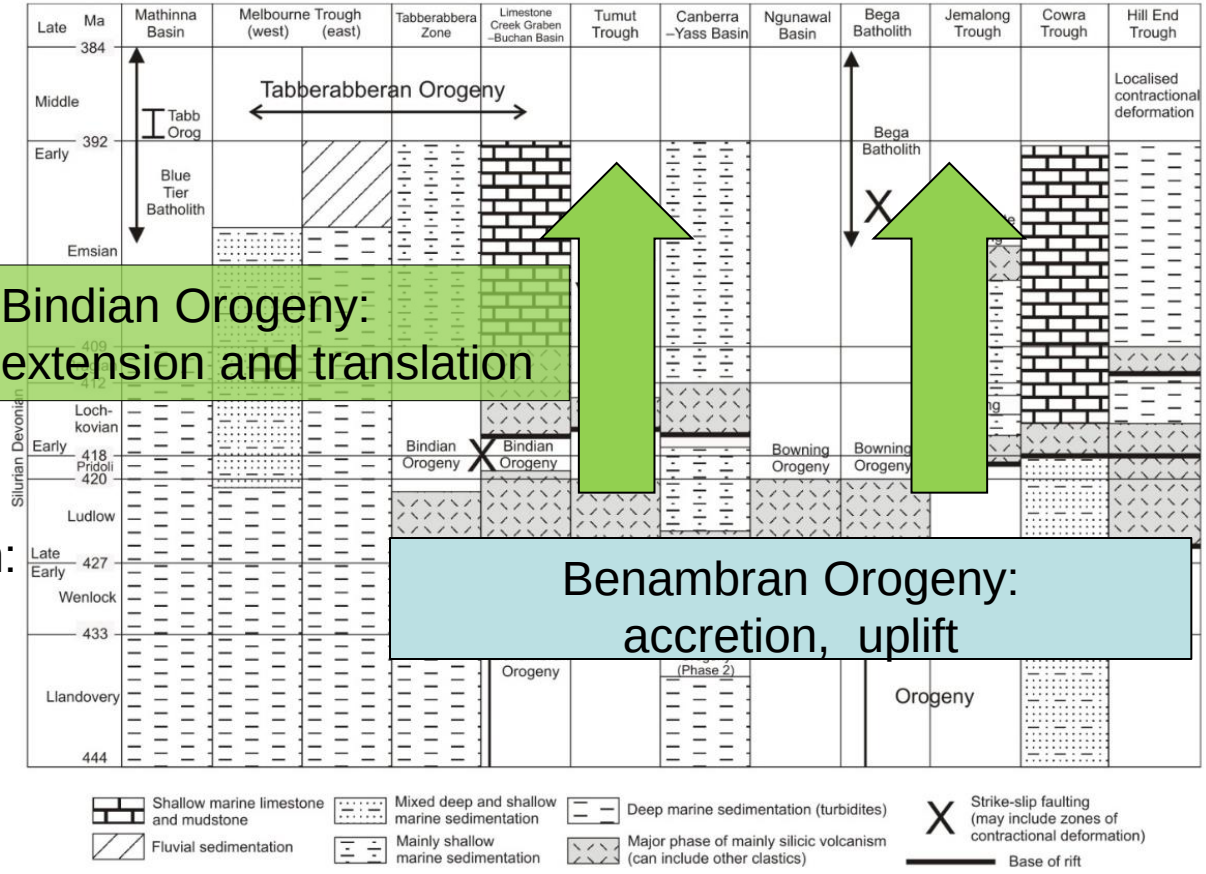


Models that link extension to sedimentation in the LFB:

Fergusson, 2010: AJES:

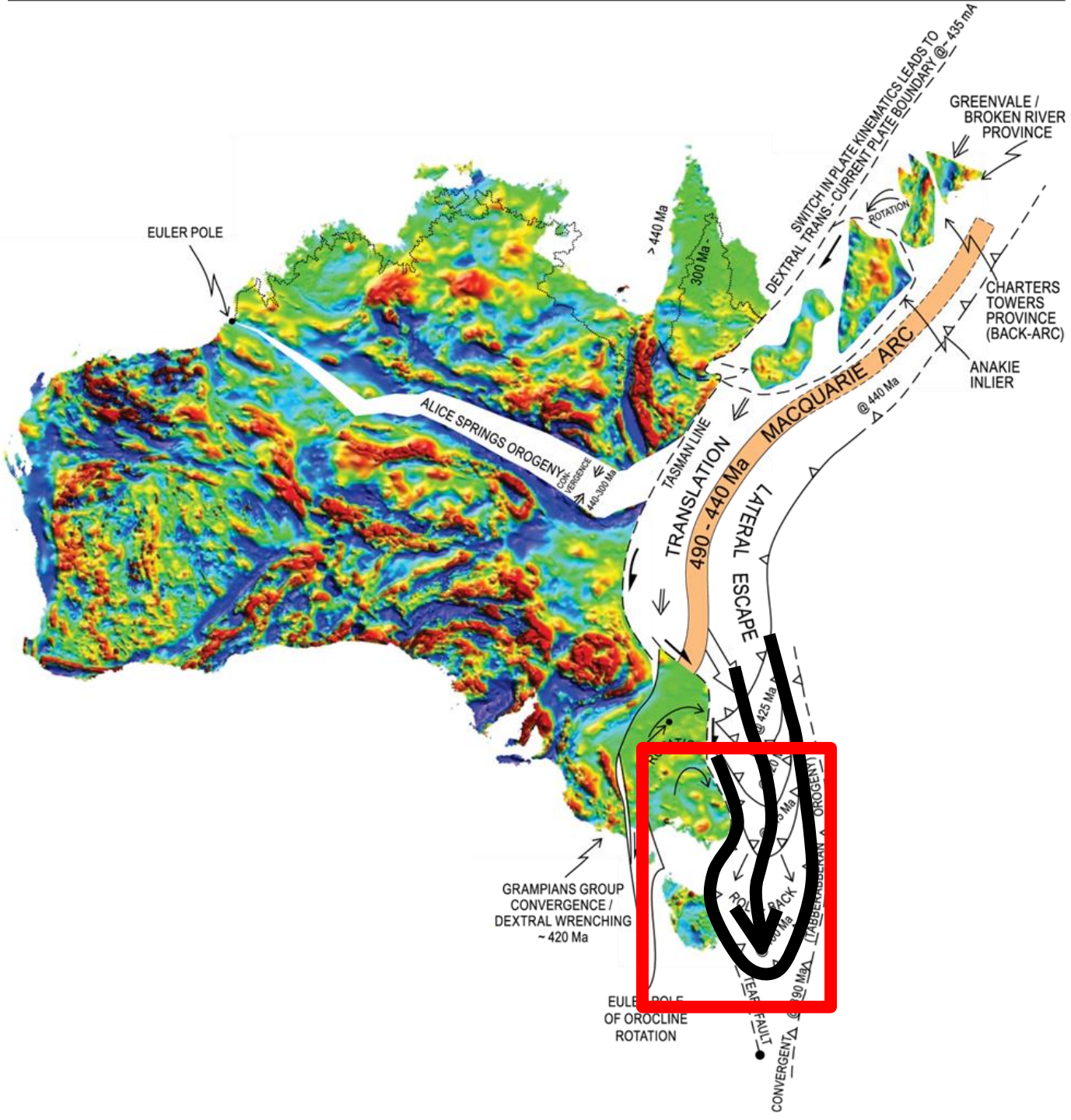
Lachlan Fold Belt sedimentation:

Late Silurian-Middle Devonian
plate-driven extension and convergence



Talk Outline

- The problems
- New data/concepts constrain viable solutions
- Retro-deformation, analogue and numerical modelling
-
- The Lachlan Orocline through time – a new geodynamic model for Ordovician-Devonian Australia
- **How congested subduction zones resolve – key to understanding Tasmanian evolution**
- What does it all mean for mineral prospectivity?

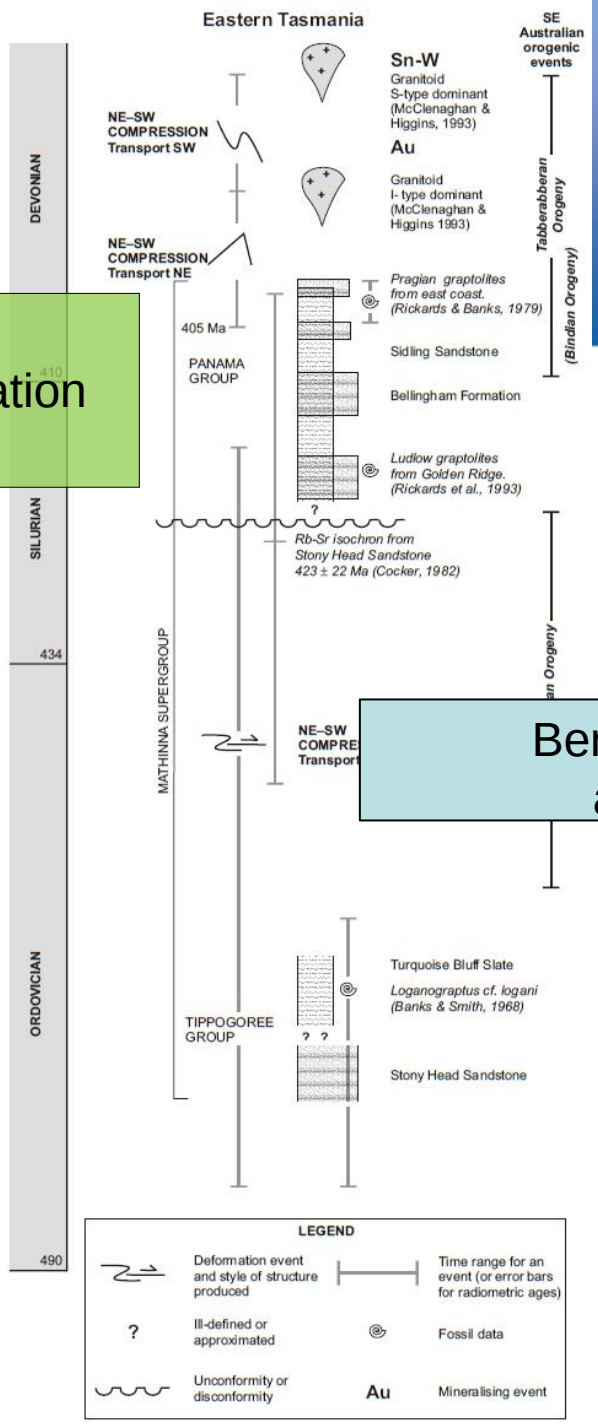

EULER POLE
> 440 Ma
300 Ma
SWITCH IN PLATE KINEMATICS LEADS TO DEXTRAL TRANS - CURRENT PLATE BOUNDARY @ ~ 435 mA
GREENVALE / BROKEN RIVER PROVINCE
ROTATION
CHARTERS TOWERS PROVINCE (BACK-ARC)
ANAKIE INLIER
ALICE SPRINGS OROGENY
CON-VERGENCE
440-300 Ma
TASMAN LINE
TRANSLATION
490 - 440 Ma
MACQUARIE ARC
@ 440 Ma
LATERAL ESCAPE
@ 425 Ma
GRAMPIANS GROUP CONVERGENCE / DEXTRAL WRENCHING ~ 420 Ma
EULE POLE OF OROCLINE ROTATION
FAULT
CONVERGENT

Bindian Orogeny: extension,sedimentation and translation

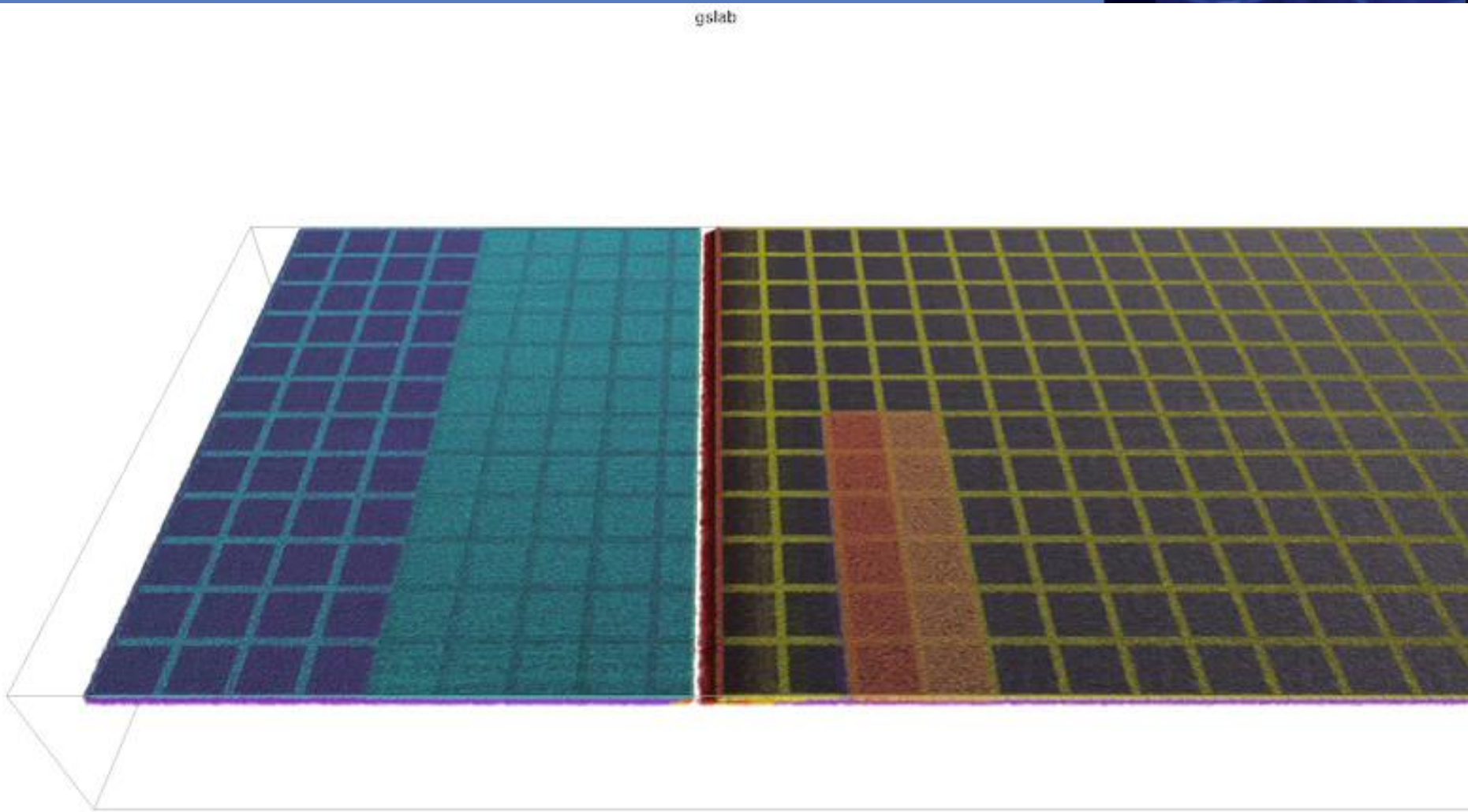
Models that link extension to sedimentation in the LFB:

Reed 2001:

Revised NE Tasmania stratigraphy:

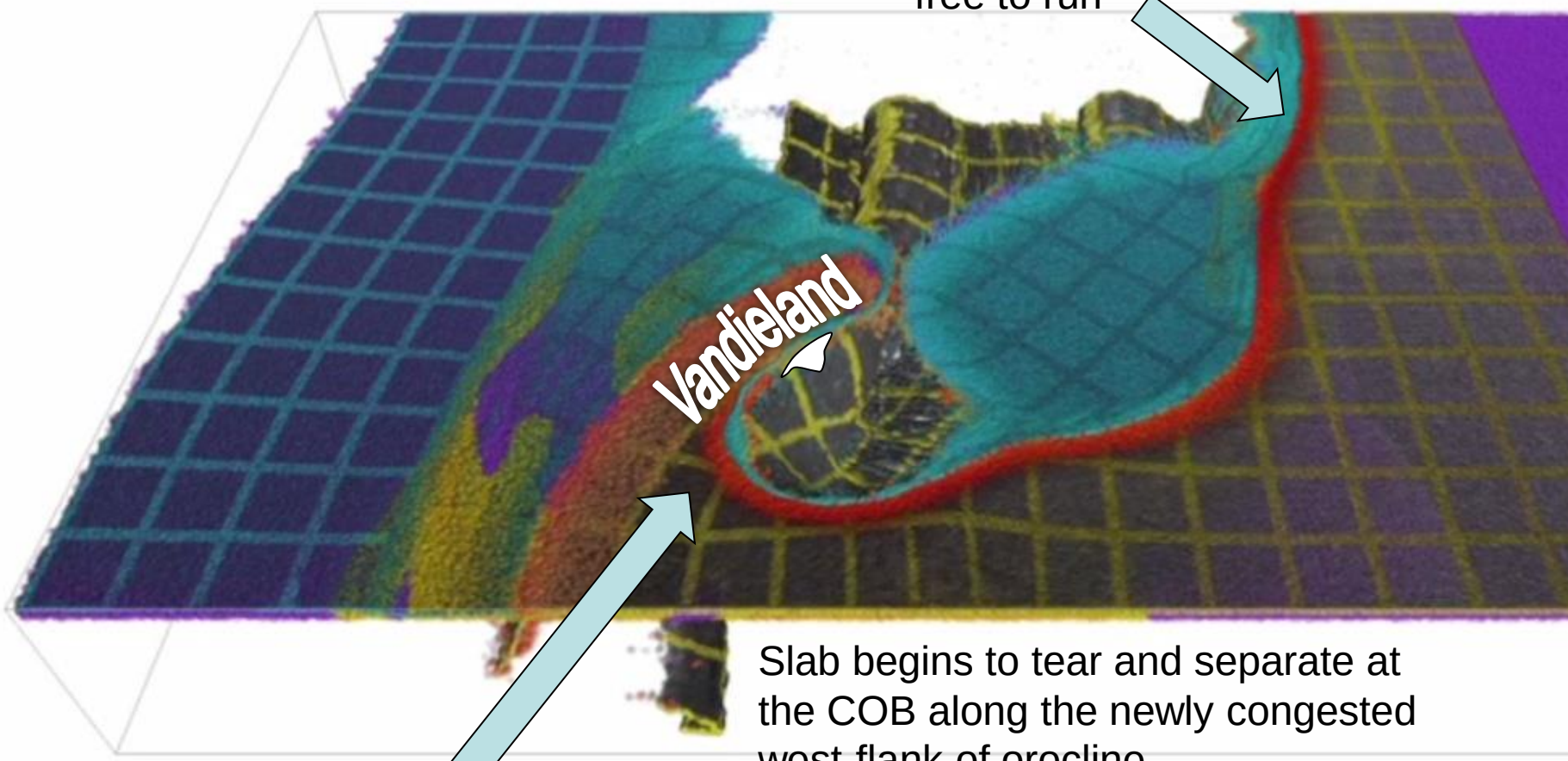


Benambran Orogeny: accretion, uplift



Moresi, Betts, Miller, Cayley, 2014: NATURE

East flank facing open ocean – free to run

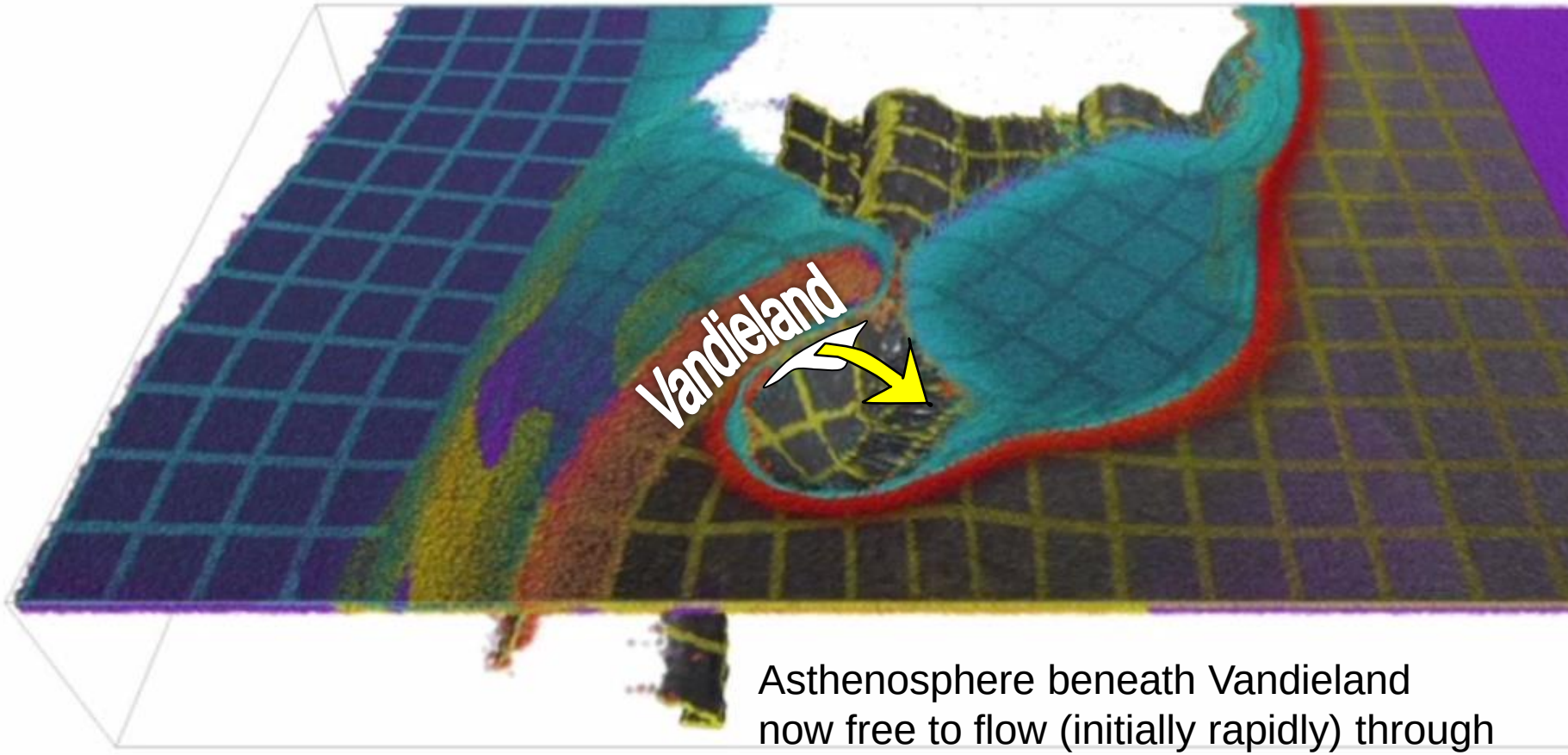


Slab begins to tear and separate at the COB along the newly congested west-flank of orocline
– for the LFB this was a window-tear, not a zip-tear

West flank becoming progressively congested

…marks beginning of final transfer of Vandieland onto the upper plate (of the remaining active east flank of the subduction zone)

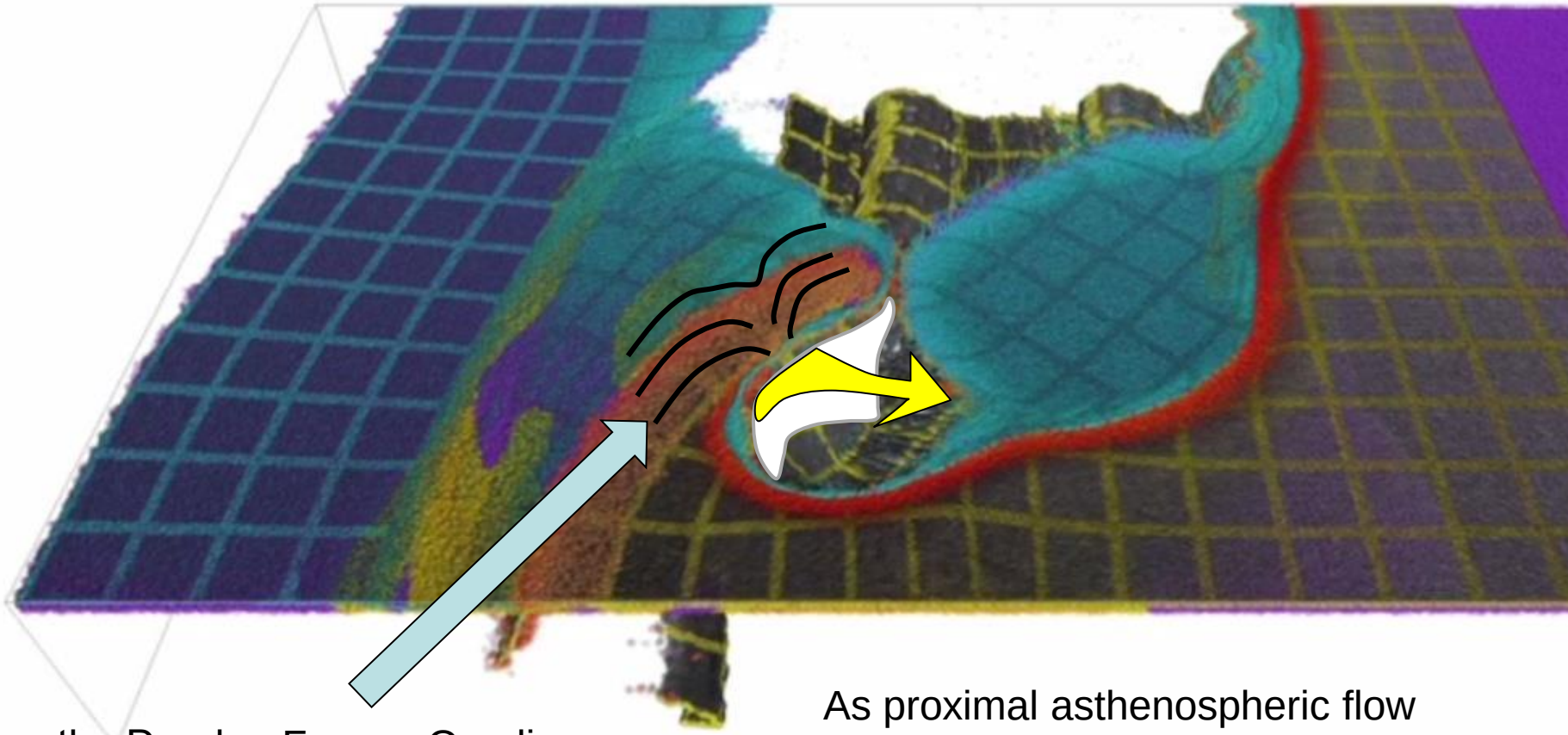
Moresi, Betts, Miller & Cayley 2014, NATURE.



Asthenosphere beneath Vandieland
now free to flow (initially rapidly) through
slab window, and directly into
the site of ongoing slab-foundering

(for the first time since it's initial accretion…..
40 million years earlier)

Moresi, Betts, Miller & Cayley
2014, NATURE.



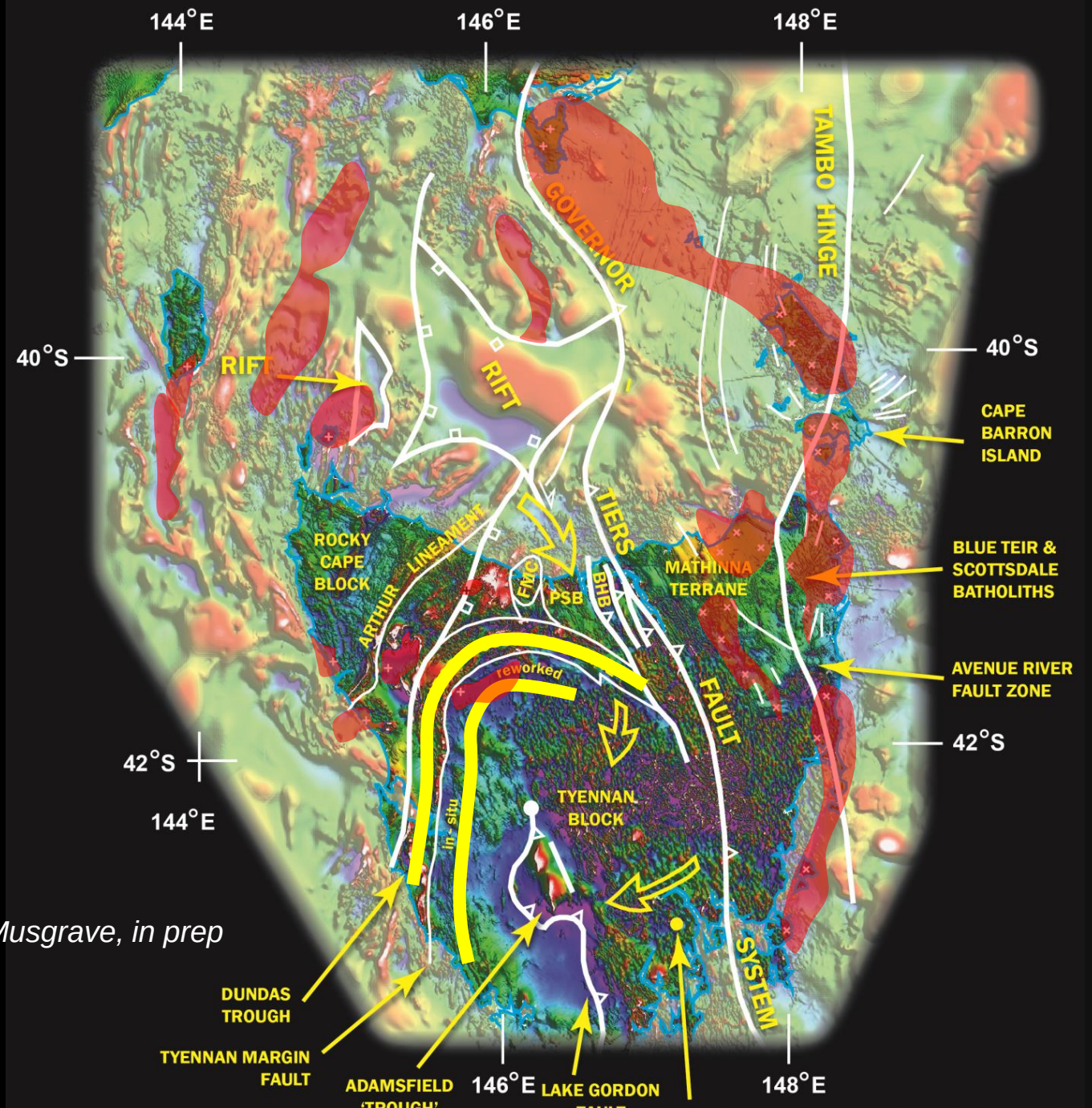
…the Dundas-Fossey Orocline

As proximal asthenospheric flow gathers momentum, the resulting flow-gradient drives extension in the overlying lithosphere –

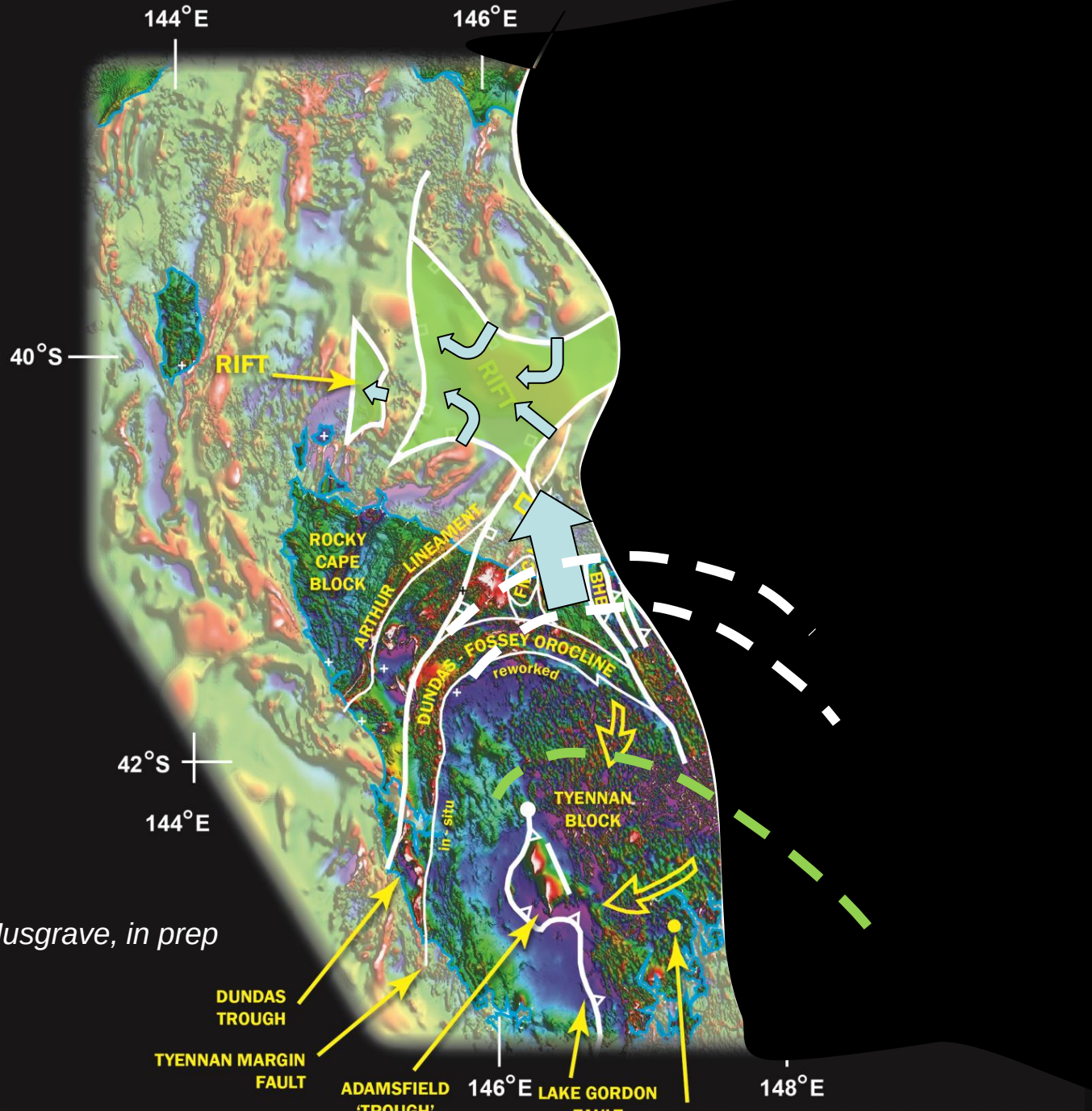
it's thinned (Bass Strait),

and rafted along for the ride (orocline)…

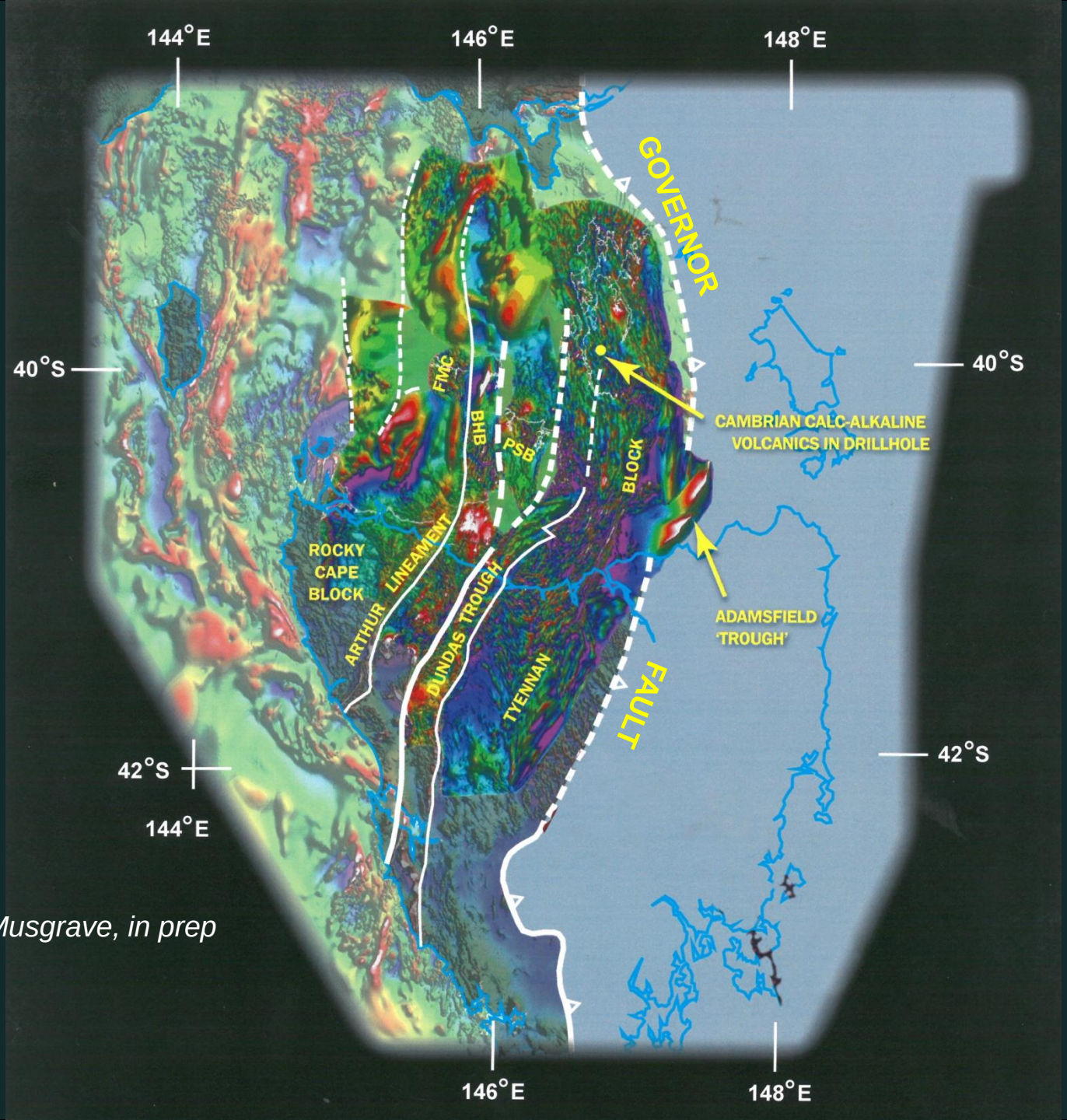
Cayley & Musgrave, in prep



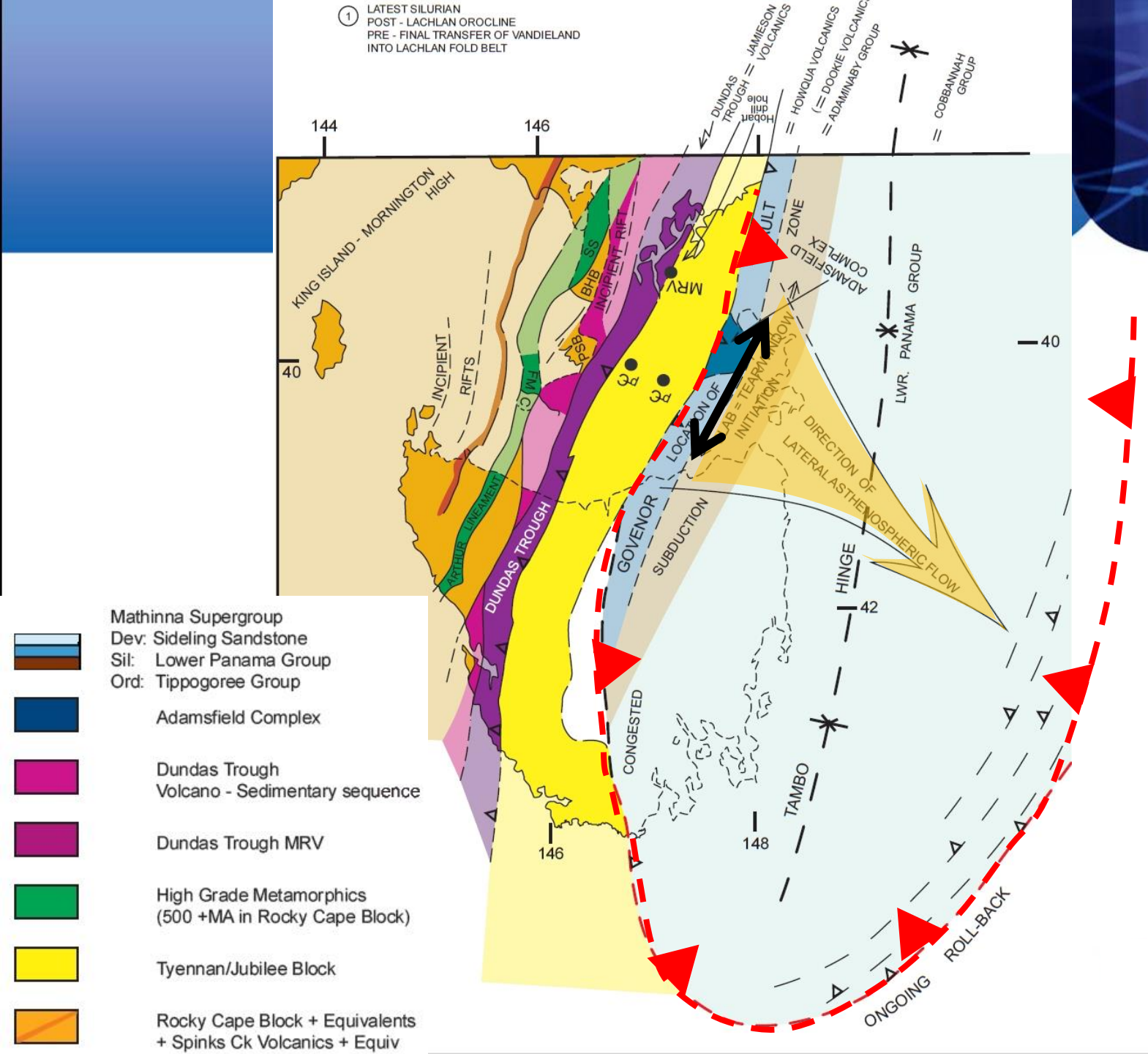
Cayley & Musgrave, in prep



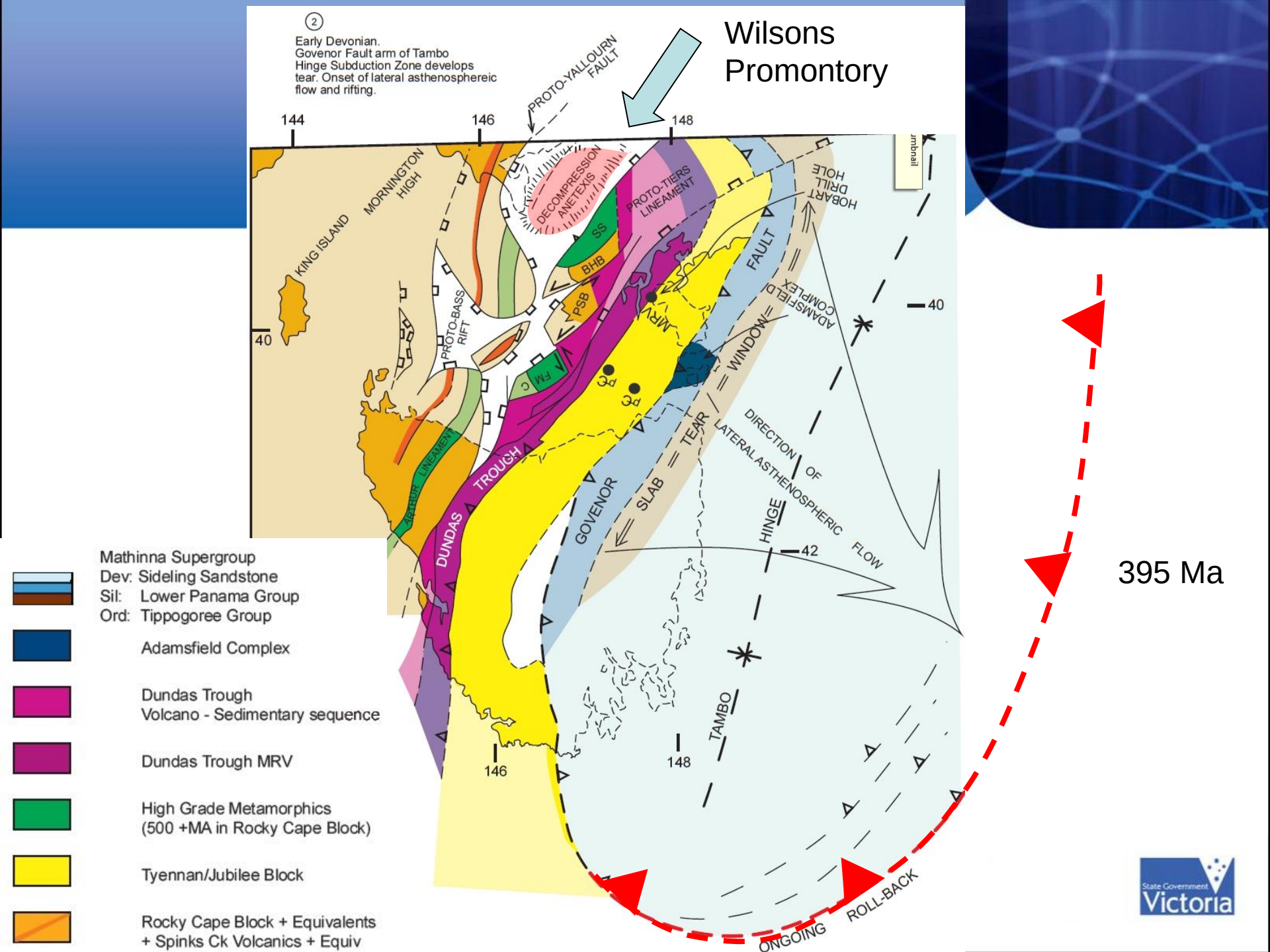
Cayley & Musgrave, in prep

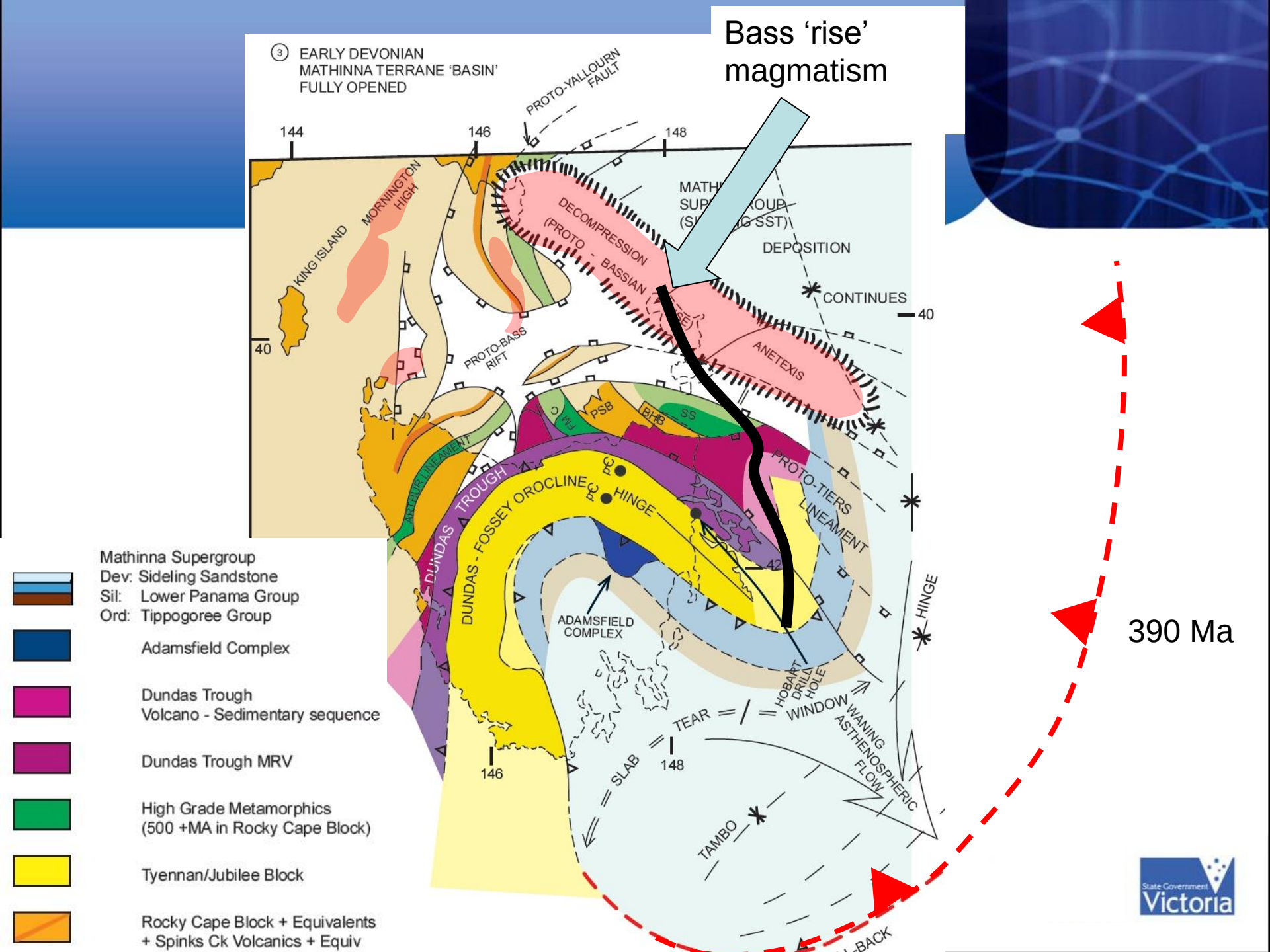


Cayley & Musgrave, in prep


1 LATEST SILURIAN
POST - LACHLAN OROCLINE
PRE - FINAL TRANSFER OF VANDIELAND
INTO LACHLAN FOLD BELT
144
146
148
40
42
KING ISLAND - MORNINGTON HIGH
INCIPIENT RIFTS
INCIPIENT RIFT
DUNDAS TROUGH
ARTHUR LINEAMENT
GOVENOR
SUBDUCTION
CONGESTED
TAMBO
HINGE
ONGOING ROLL-BACK
DIRECTION OF LATERAL ASTHENOSPHERIC FLOW
ADAMSFIELD COMPLEX
LWR. PANAMA GROUP
COBBANNAH GROUP
DUNDAS TROUGH = JAMIESON VOLCANICS
= HOWQUA VOLCANICS
(= DOOKIE VOLCANICS)
= ADAMINABY GROUP
Hobart drill hole
MRV
BHB
SS
FM
C
Mathinna Supergroup
Dev: Sideling Sandstone
Sil: Lower Panama Group
Ord: Tippogoree Group
Adamsfield Complex
Dundas Trough
Volcano - Sedimentary sequence
Dundas Trough MRV
High Grade Metamorphics
(500 +MA in Rocky Cape Block)
Tyennan/Jubilee Block
Rocky Cape Block + Equivalents
+ Spinks Ck Volcanics + Equiv

400 Ma


2
Early Devonian.
Govenor Fault arm of Tambo
Hinge Subduction Zone develops
tear. Onset of lateral asthenosphereic
flow and rifting.
Wilsons
Promontory
PROTO-YALLOURN FAULT
144
146
148
KING ISLAND
MORNINGTON HIGH
DECOMPRESSION ANETEXIS
PROTO-TIERS LINEAMENT
SS
BHB
PSB
MRV
FM
C
PROTO-BASS RIFT
HOBART DRILL HOLE
ADAMSFIELD COMPLEX
FAULT
WINDON
40
42
DUNDAS TROUGH
APOLLO LINEAMENT
GOVENOR
SLAB
TEAR
DIRECTION OF LATERAL ASTHENOSPHERIC FLOW
HINGE
TAMBO
ONGOING ROLL-BACK
395 Ma
Mathinna Supergroup
Dev: Sideling Sandstone
Sil: Lower Panama Group
Ord: Tippogoree Group
Adamsfield Complex
Dundas Trough
Volcano - Sedimentary sequence
Dundas Trough MRV
High Grade Metamorphics
(500 +MA in Rocky Cape Block)
Tyennan/Jubilee Block
Rocky Cape Block + Equivalents
+ Spinks Ck Volcanics + Equiv


Bass ‘rise’ magmatism
③ EARLY DEVONIAN
MATHINNA TERRANE ‘BASIN’
FULLY OPENED
PROTO-YALLOURN FAULT
144
146
148
MORNINGTON HIGH
KING ISLAND
DECOMPRESSION
(PROTO - BASSIAN)
DEPOSITION
CONTINUES
40
PROTO-BASS RIFT
ANETEXIS
PSB
BHB
SS
ARTHUR LINEAMENT
PROTO-TIERS LINEAMENT
DUNDAS TROUGH
DUNDAS - FOSSEY OROCLINE
HINGE
ADAMSFIELD COMPLEX
HOBART DRILL HOLE
WINDOW
WANING ASTHENOSPHERIC FLOW
TEAR
SLAB
TAMBO
Mathinna Supergroup
Dev: Sideling Sandstone
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Ord: Tippogoree Group
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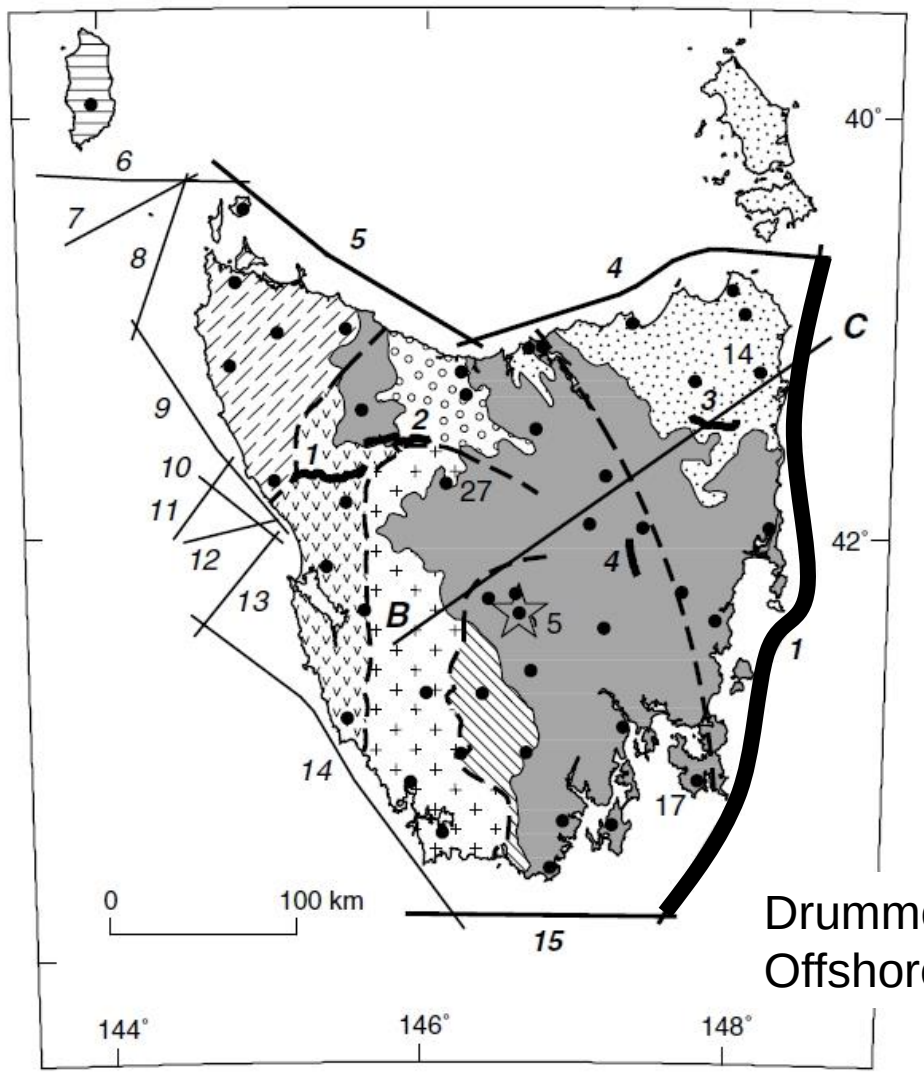
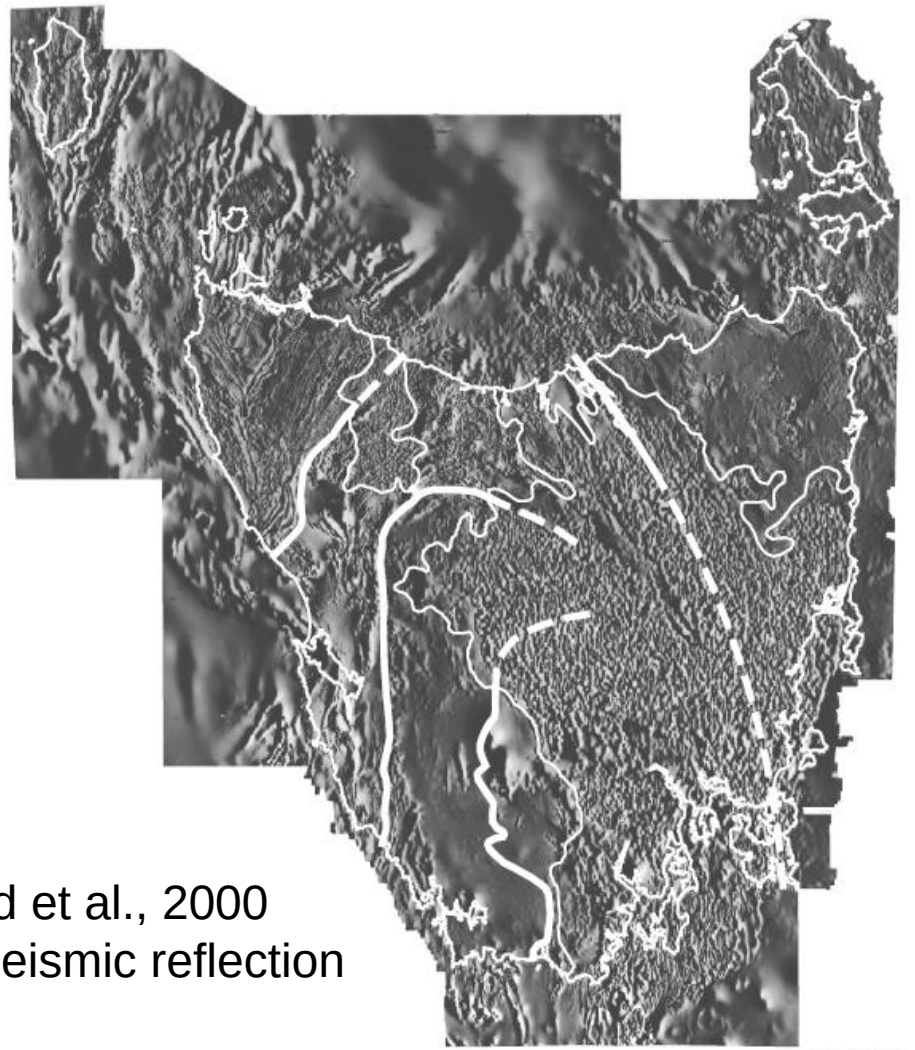
Dundas Trough
Volcano - Sedimentary sequence
Dundas Trough MRV
High Grade Metamorphics
(500 +MA in Rocky Cape Block)
Tyennan/Jubilee Block
Rocky Cape Block + Equivalents
+ Spinks Ck Volcanics + Equiv
390 Ma
State Government Victoria





26/K55/19

Drummond et al., 2000
Offshore seismic reflection

Drummond et al, 2000: interpreted highly extended Precambrian continental margin beneath Mathinna Terrane

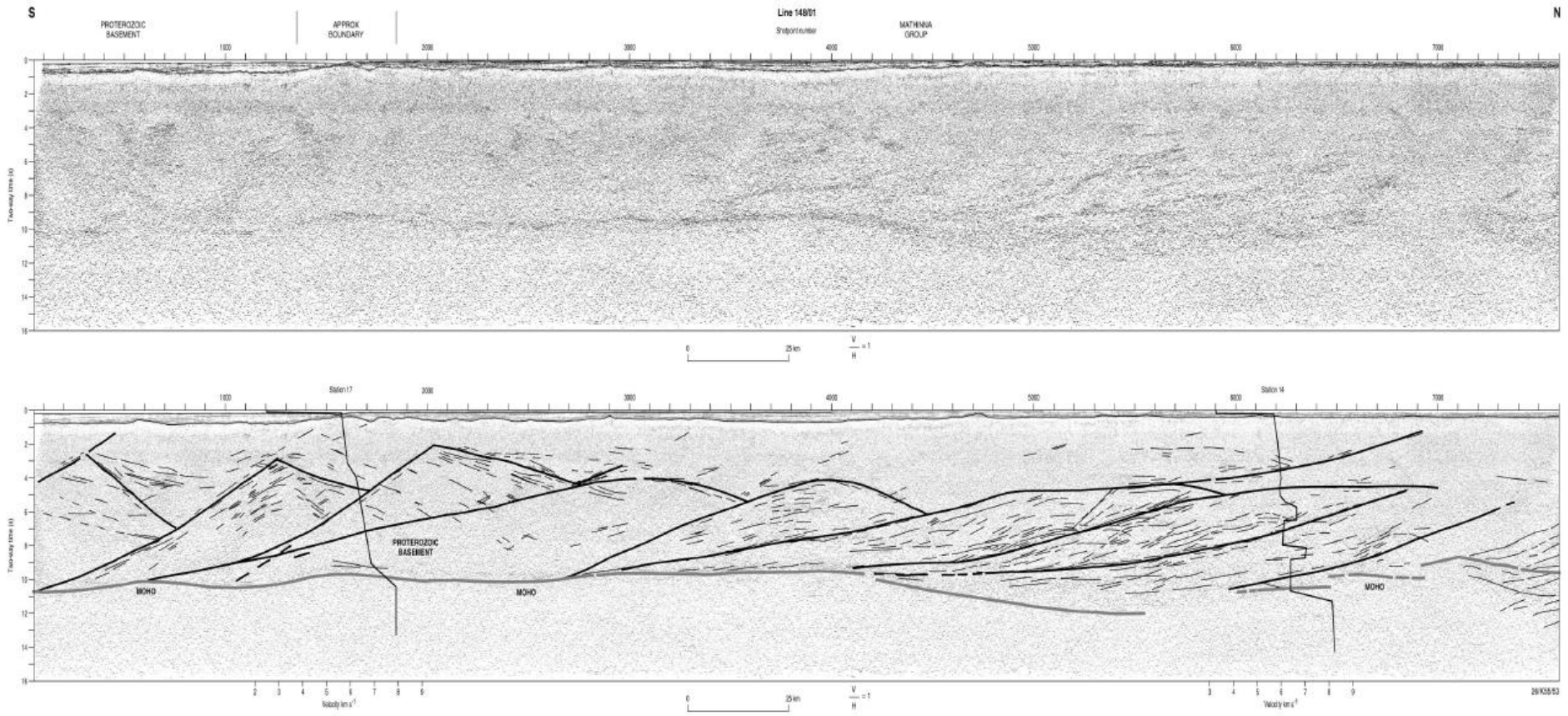
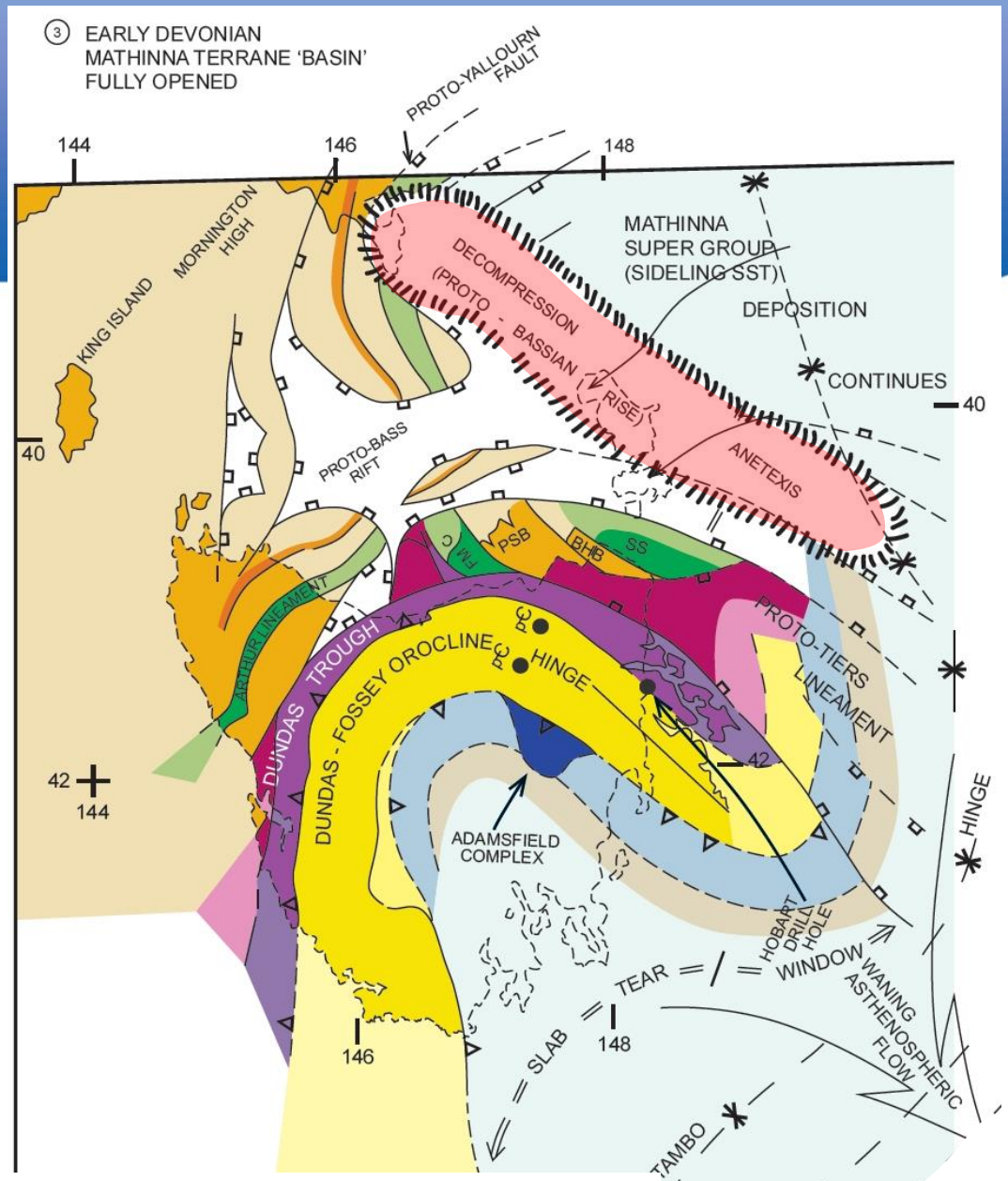
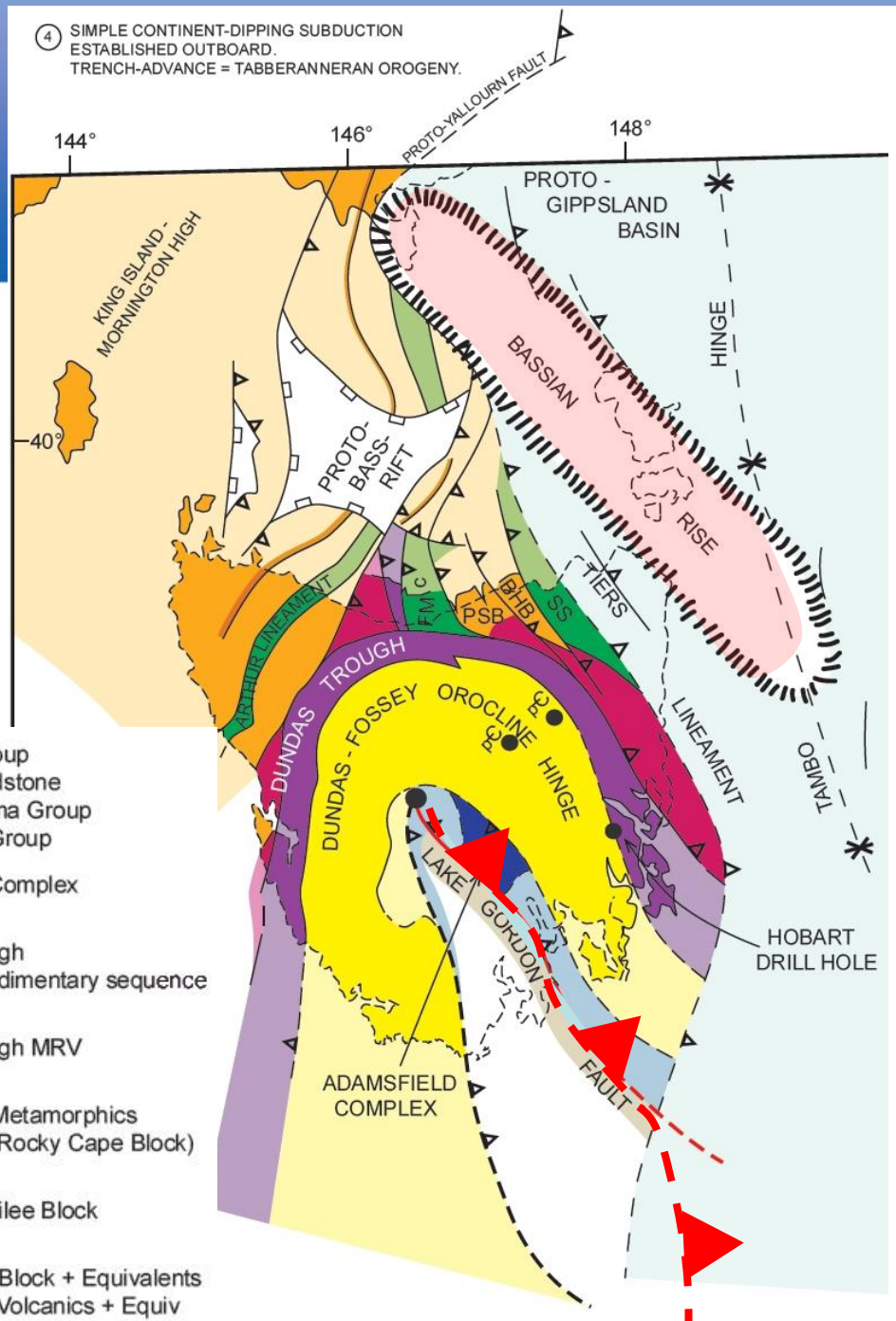


Fig. 3. (a) Seismic reflection data from offshore Line 1. Data are post stack wave equation migrated. $VH = 1$ (assuming a seismic velocity of 6.0 km s^{-1}). (b) Interpreted reflection section. 1D models of velocity vs two-way-travel time were derived for the data in Fig. 2.



390 Ma

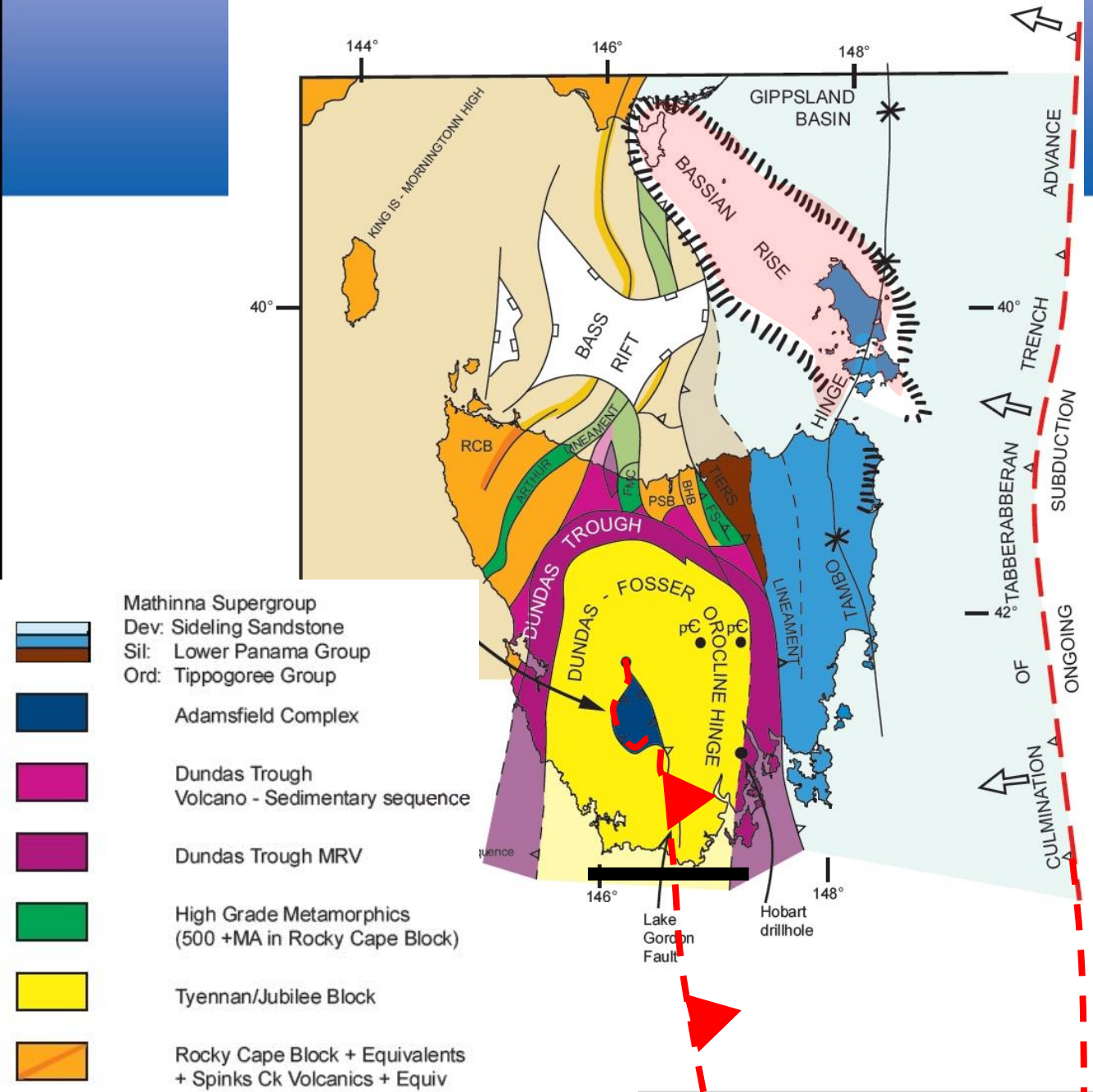
Single continent-dipping subduction zone re-established outboard……..



advance

Onset of Tabberabberan Orogeny ~380 Ma

Trench



Culmination of Tabberabberan Orogeny ~375 Ma

State Government Victoria

Lake Gordon Fault

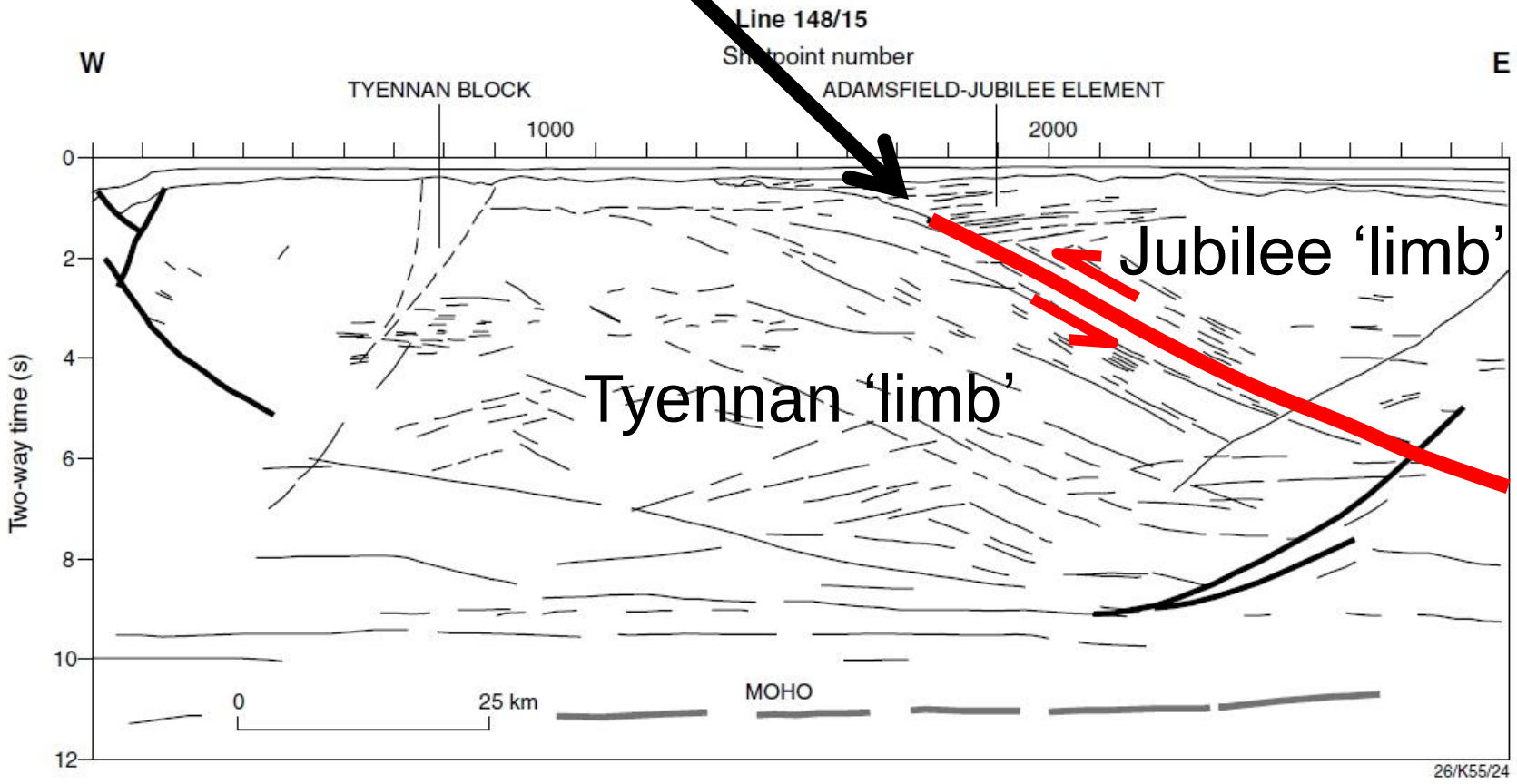


Fig. 8. Line diagram of offshore Line 15 along the southern coastline.

Drummond et al, 2000

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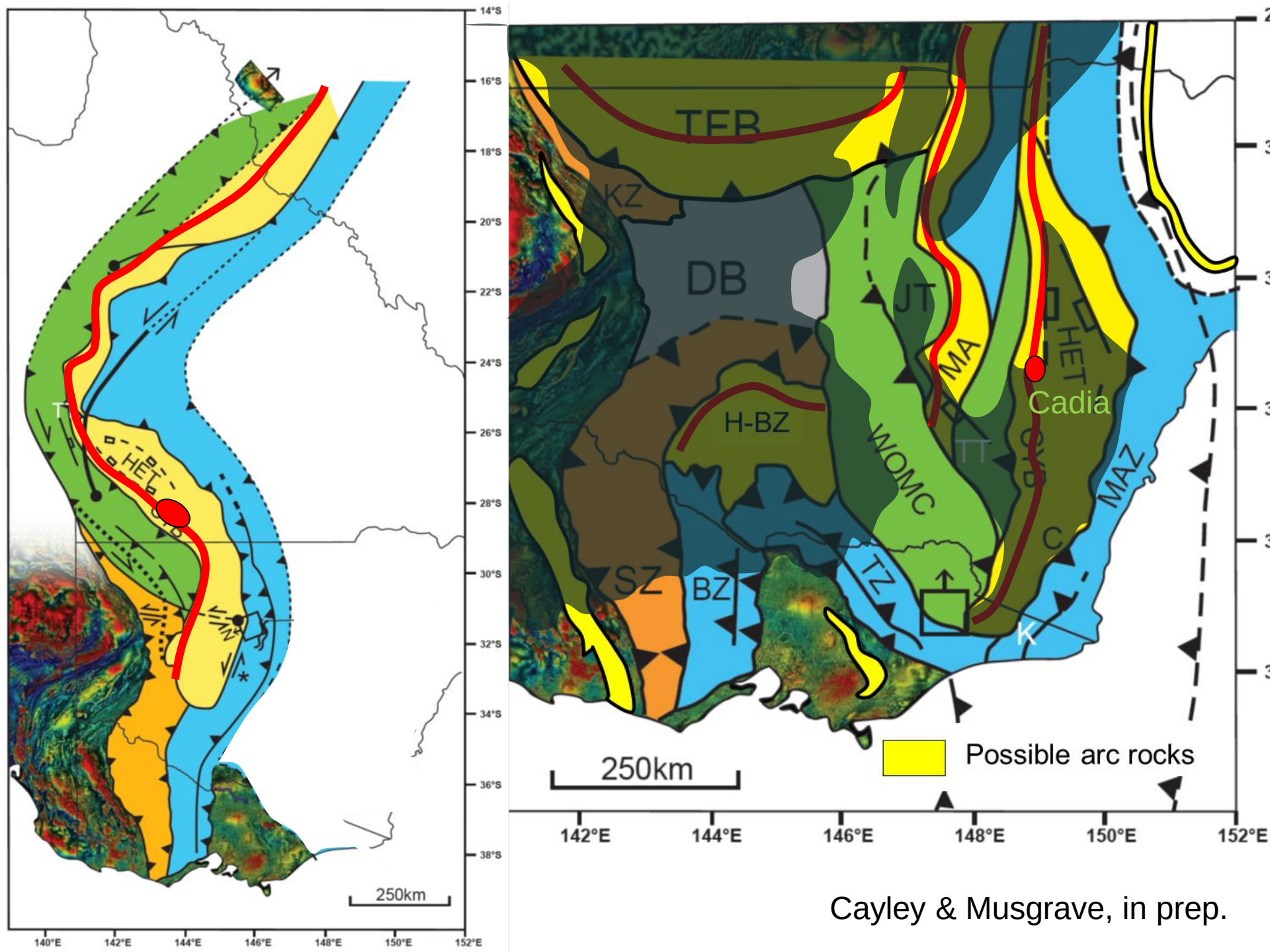
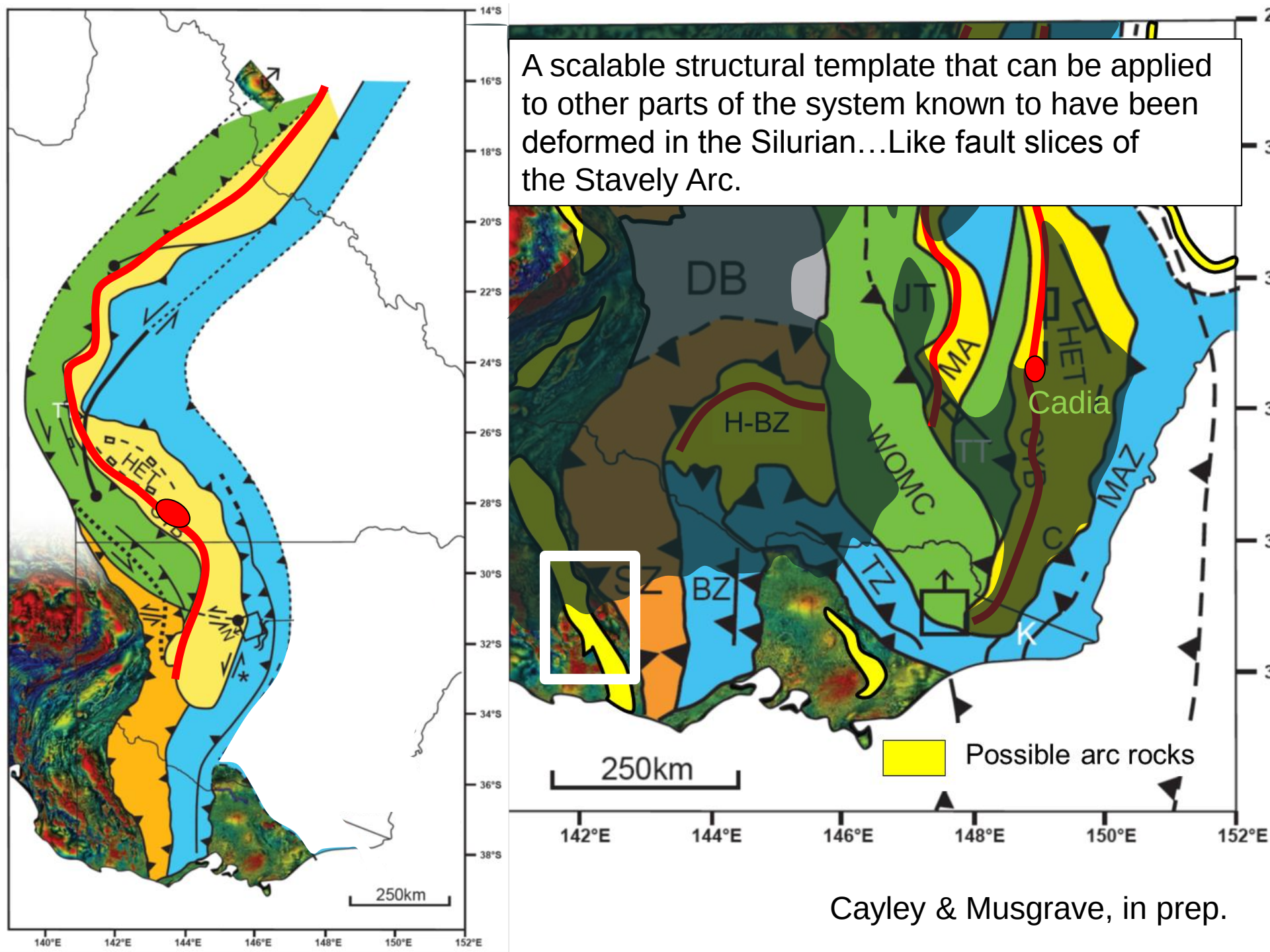
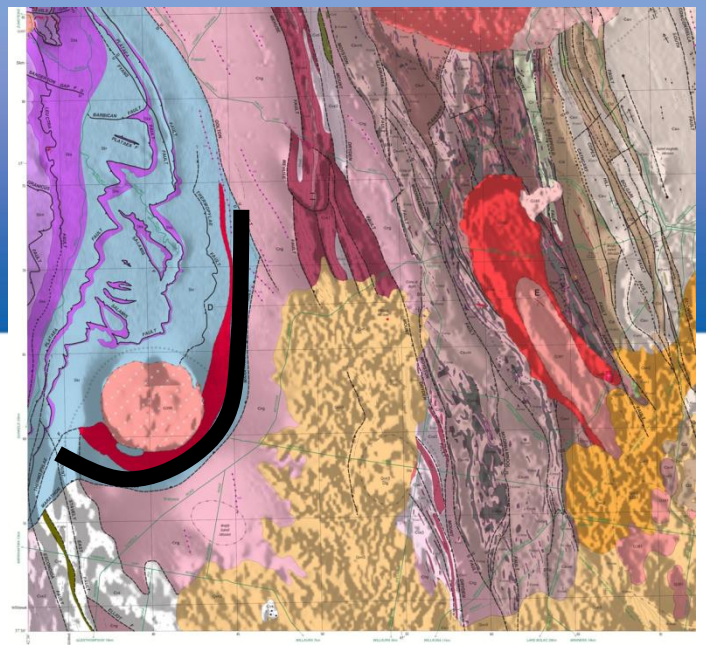


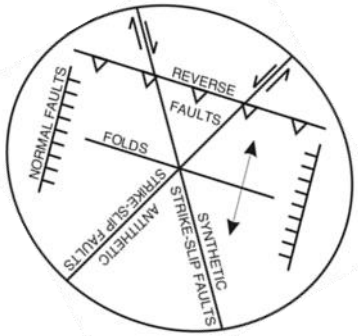
Cayley & Musgrave, in prep.

A scalable structural template that can be applied to other parts of the system known to have been deformed in the Silurian…Like fault slices of the Stavely Arc.

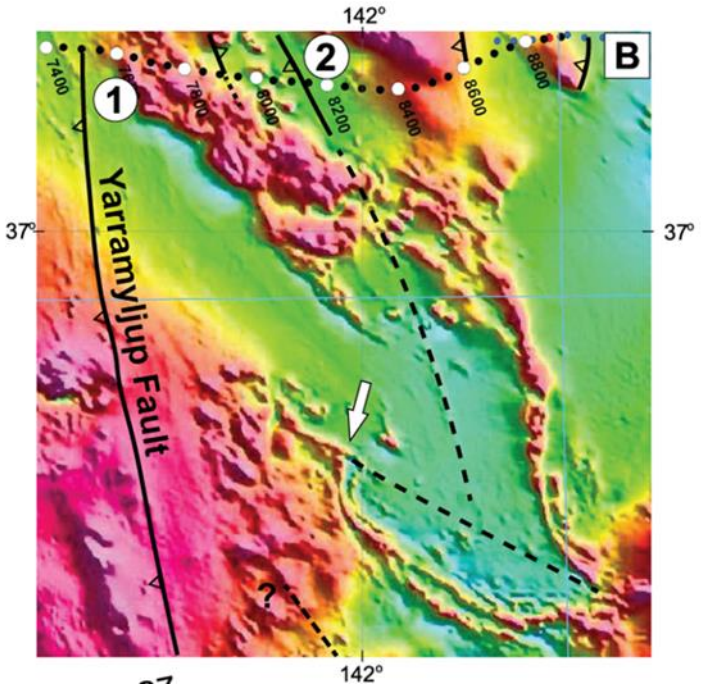


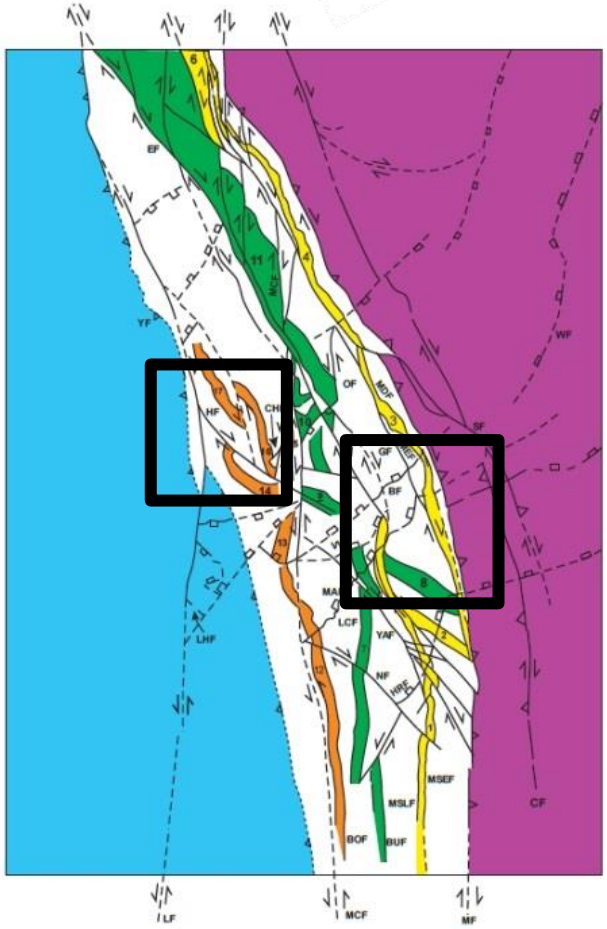
Cayley & Musgrave, in prep.



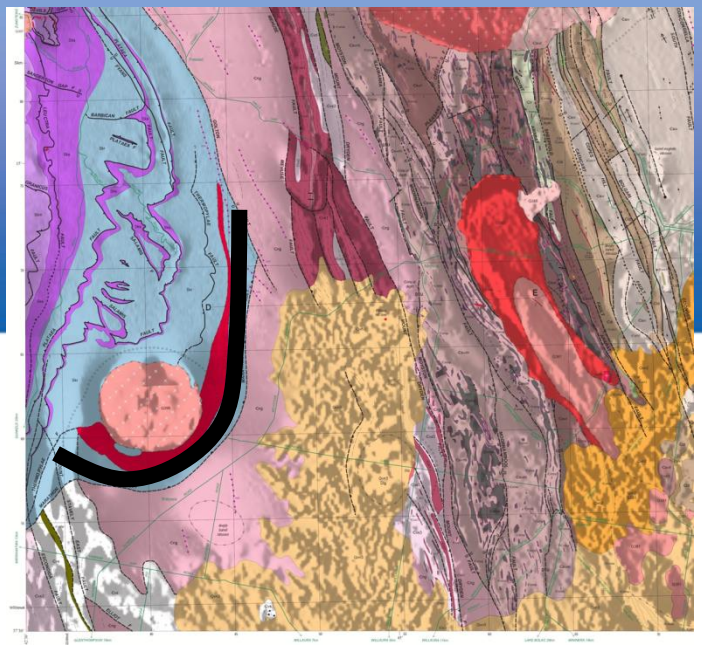


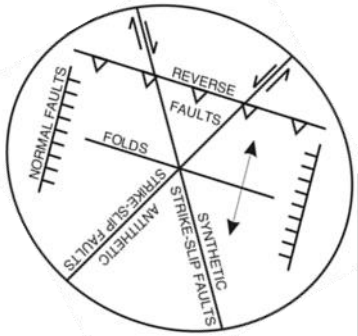
The Grampians Group constrains the age of some deformation to the Late Silurian (Cayley & Taylor, 1997)



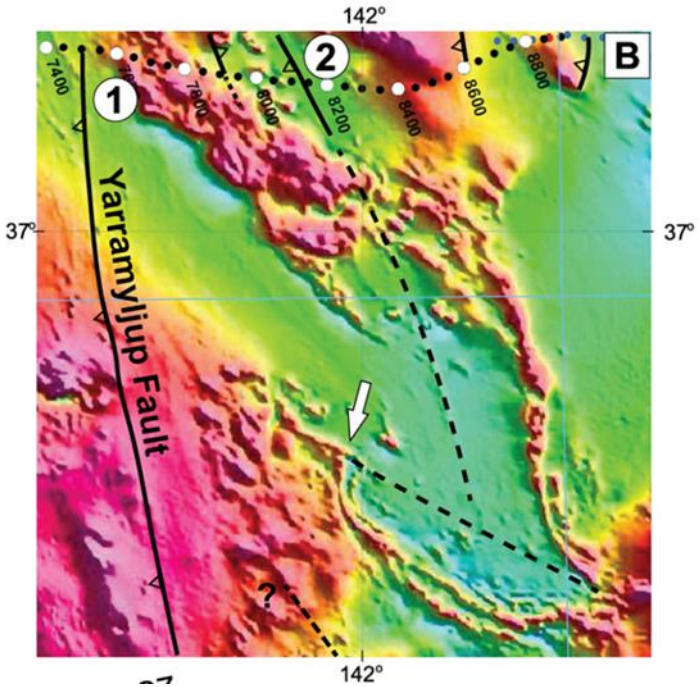


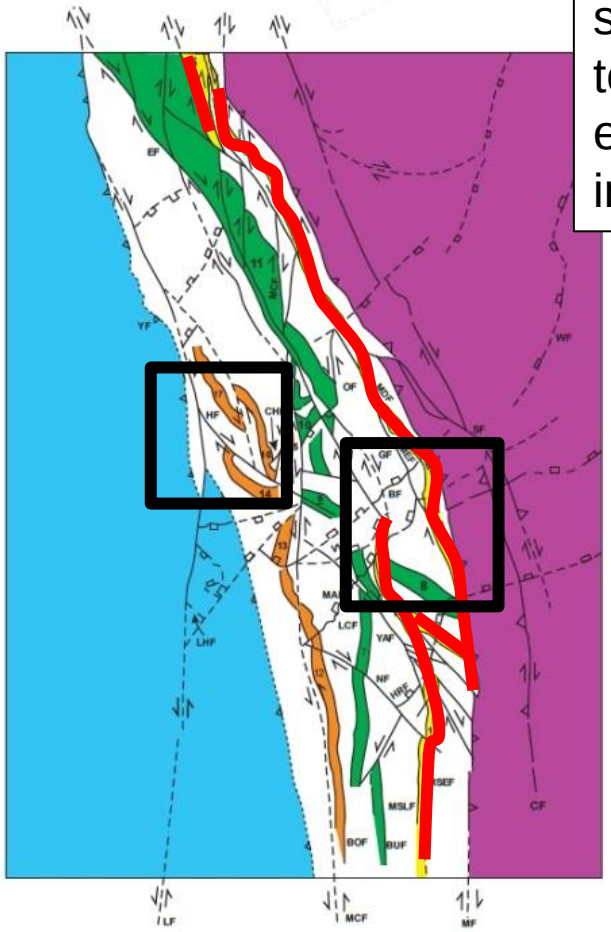
Mount Stavely Arc – restoration of Silurian deformation





The template constrains retrodeformation of Cambrian fault slice segments back to simple parallel faults: eg.: Stavely-Dryden, in red





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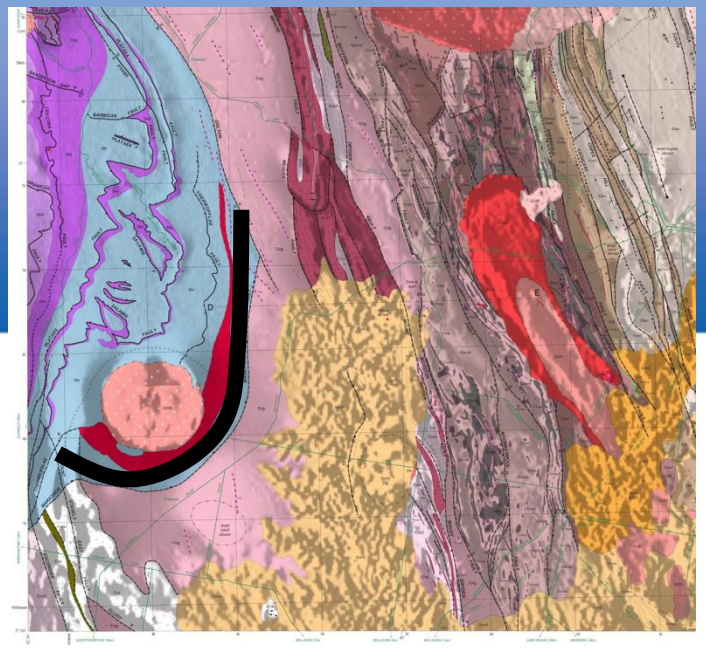

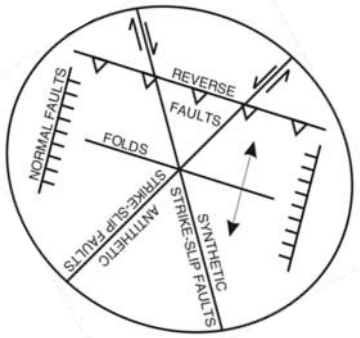

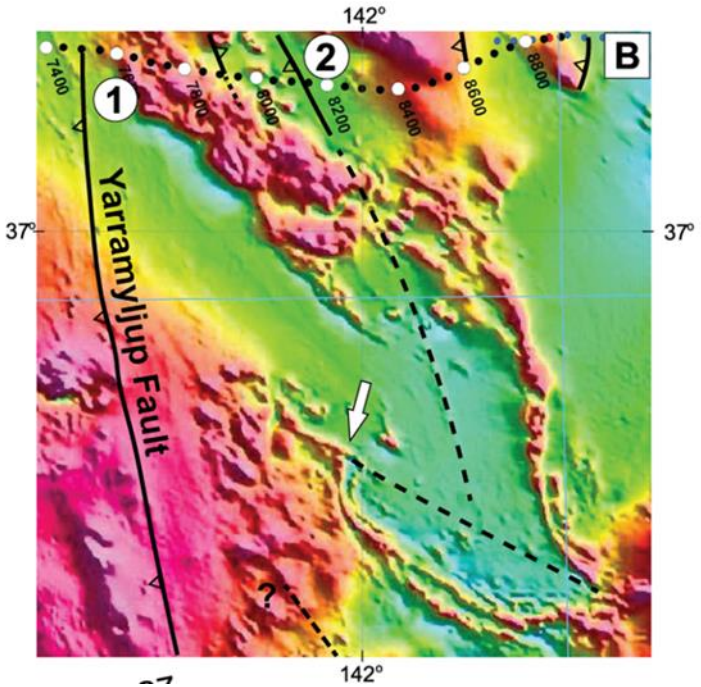

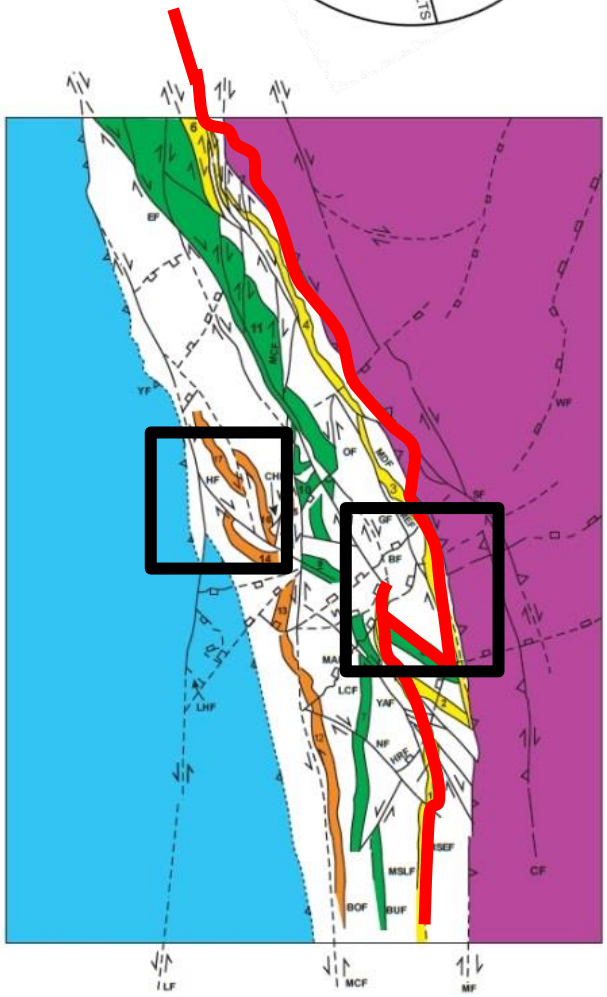

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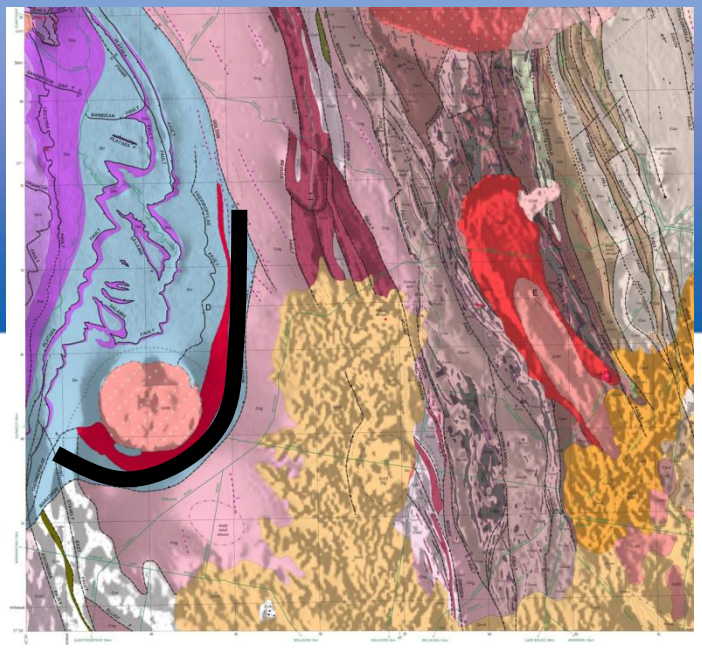

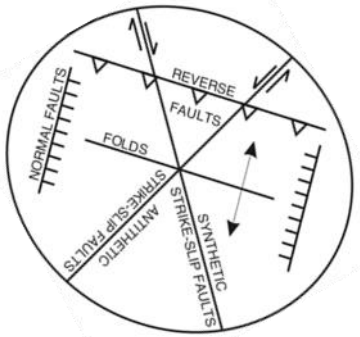

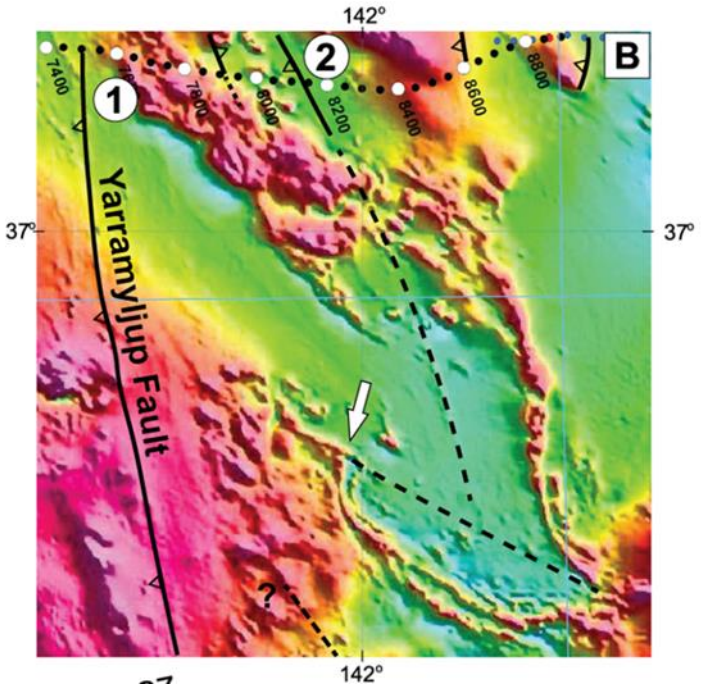

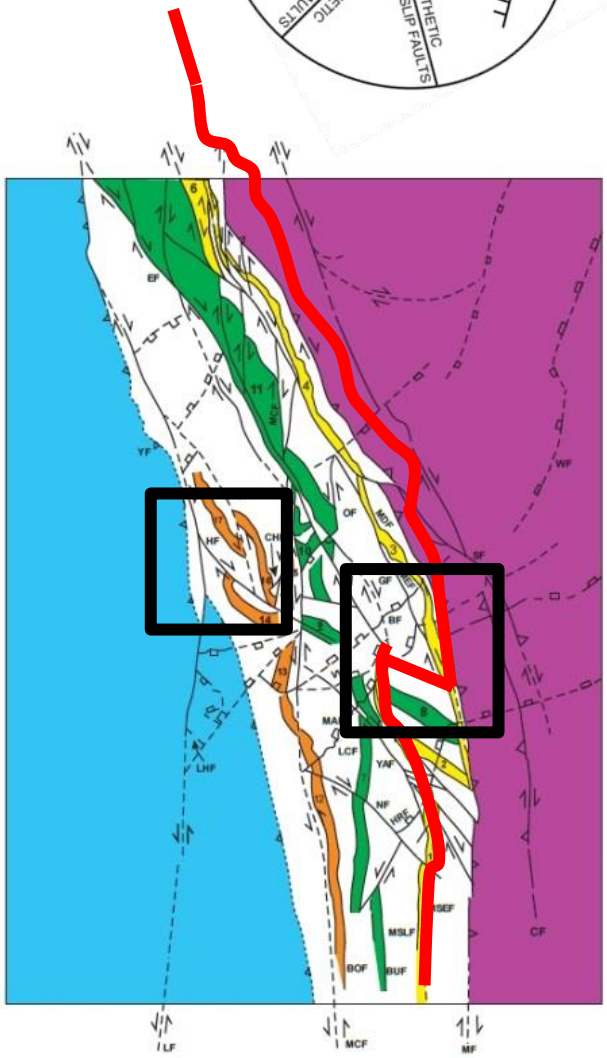

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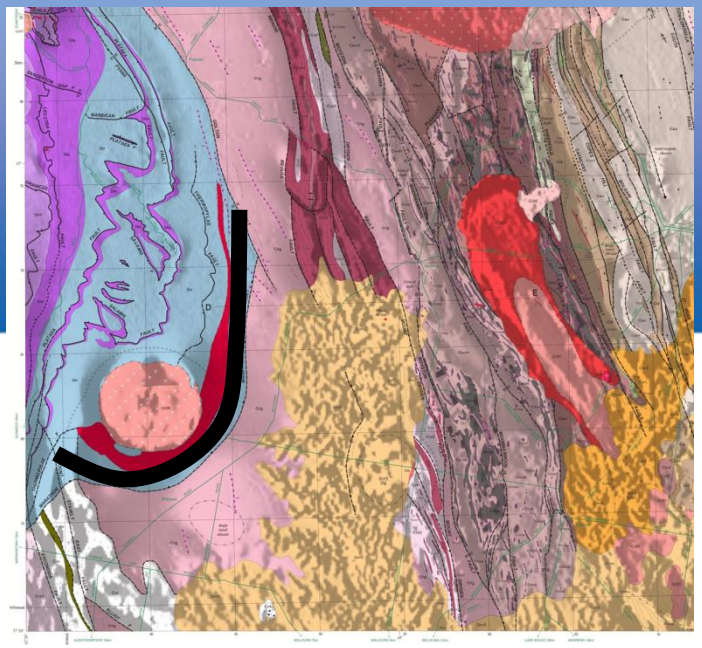

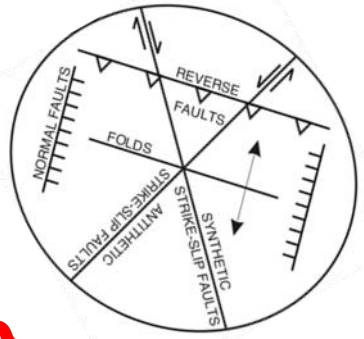

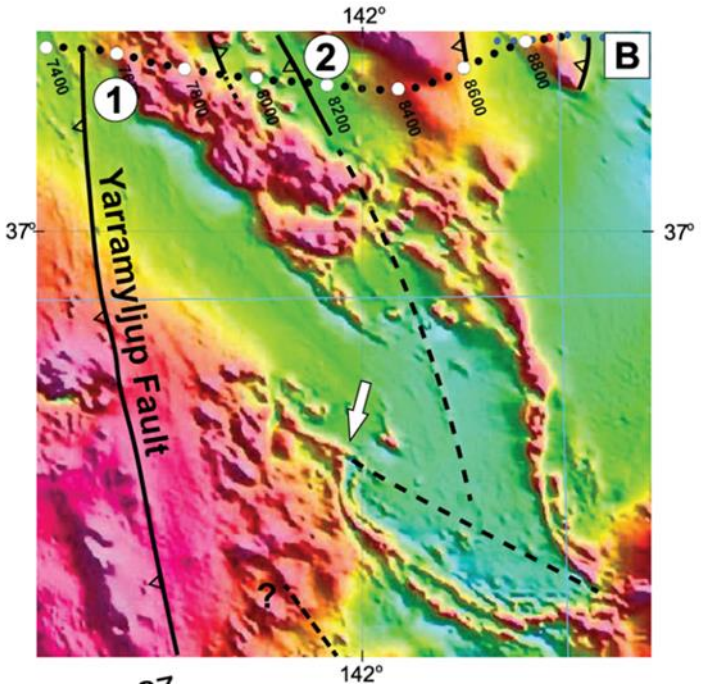

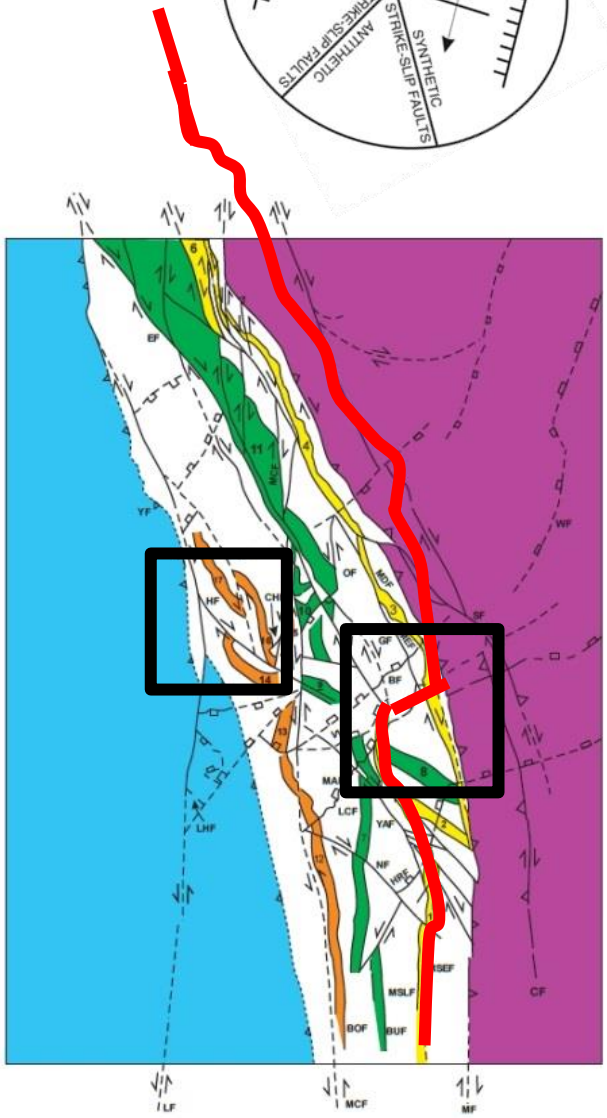

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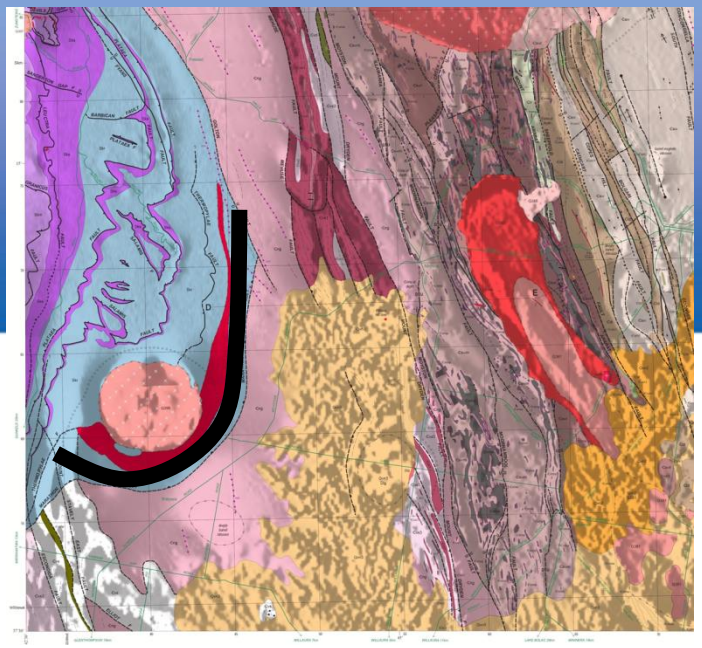

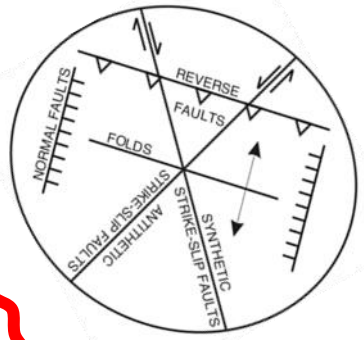

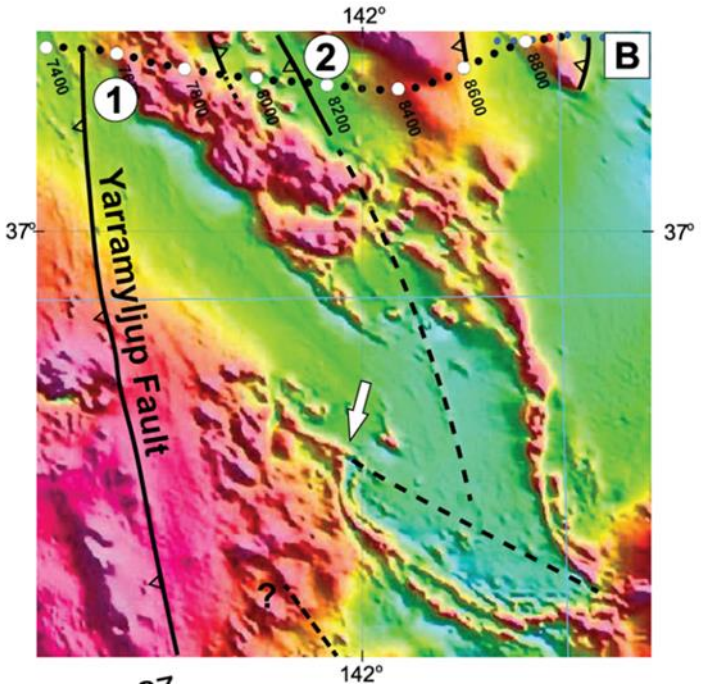

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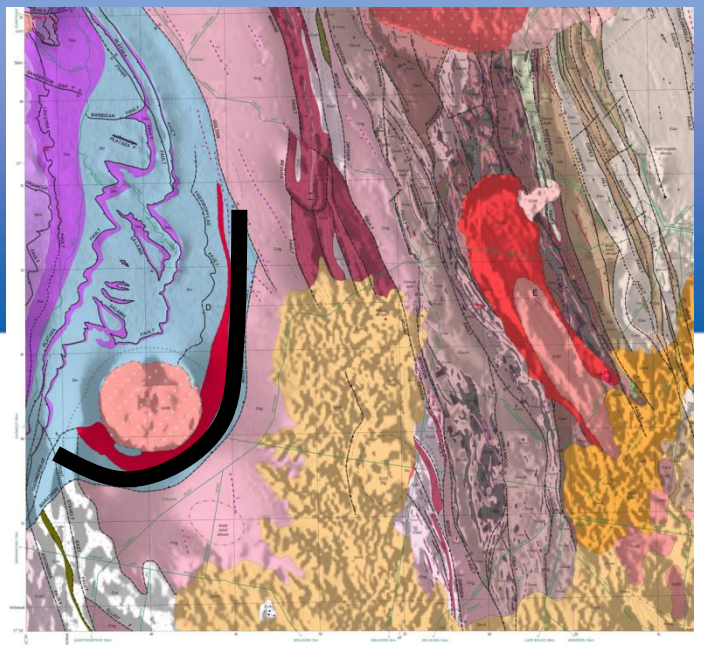
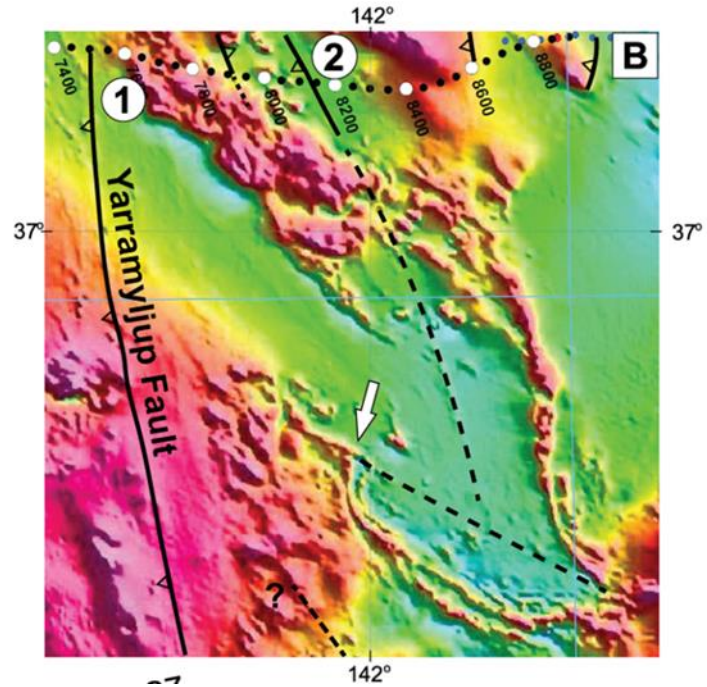
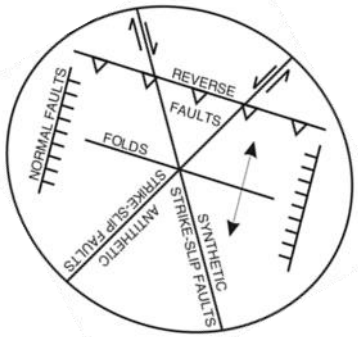
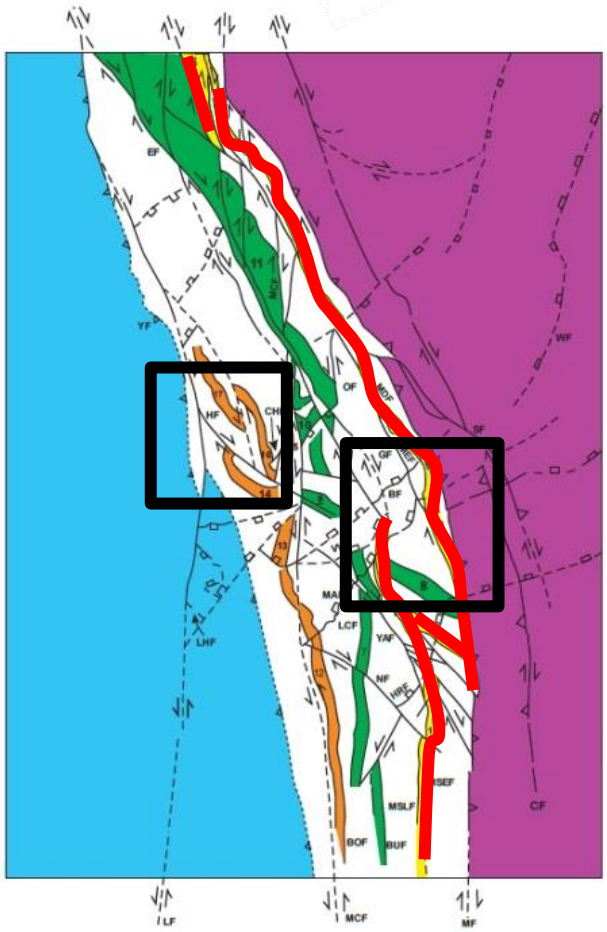
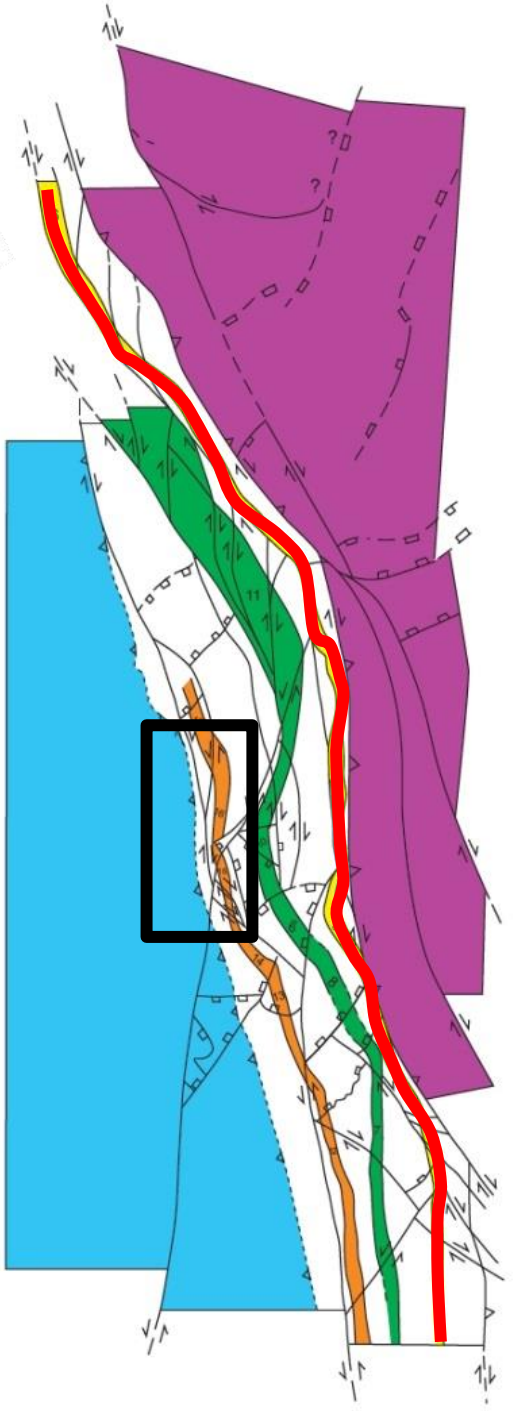




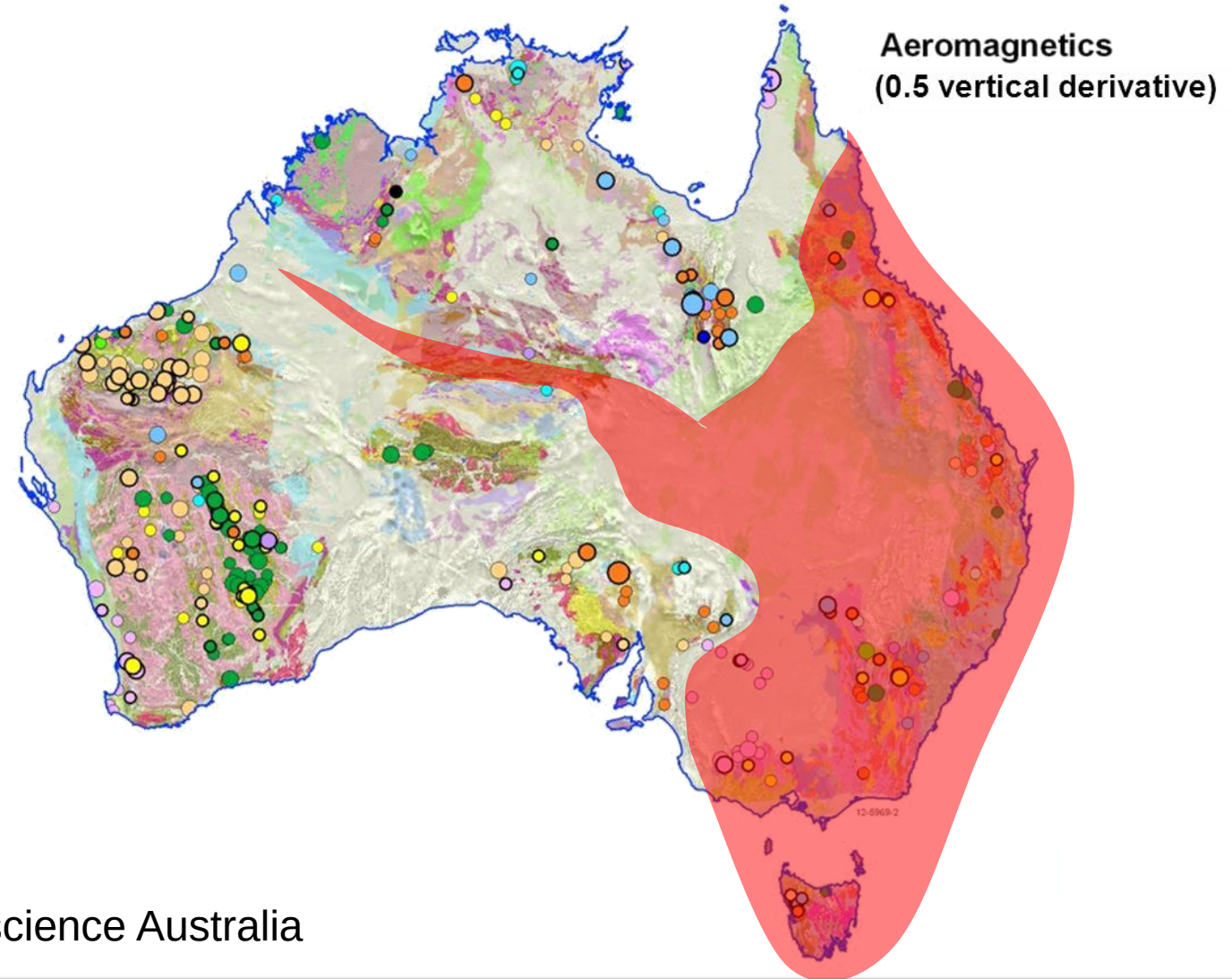






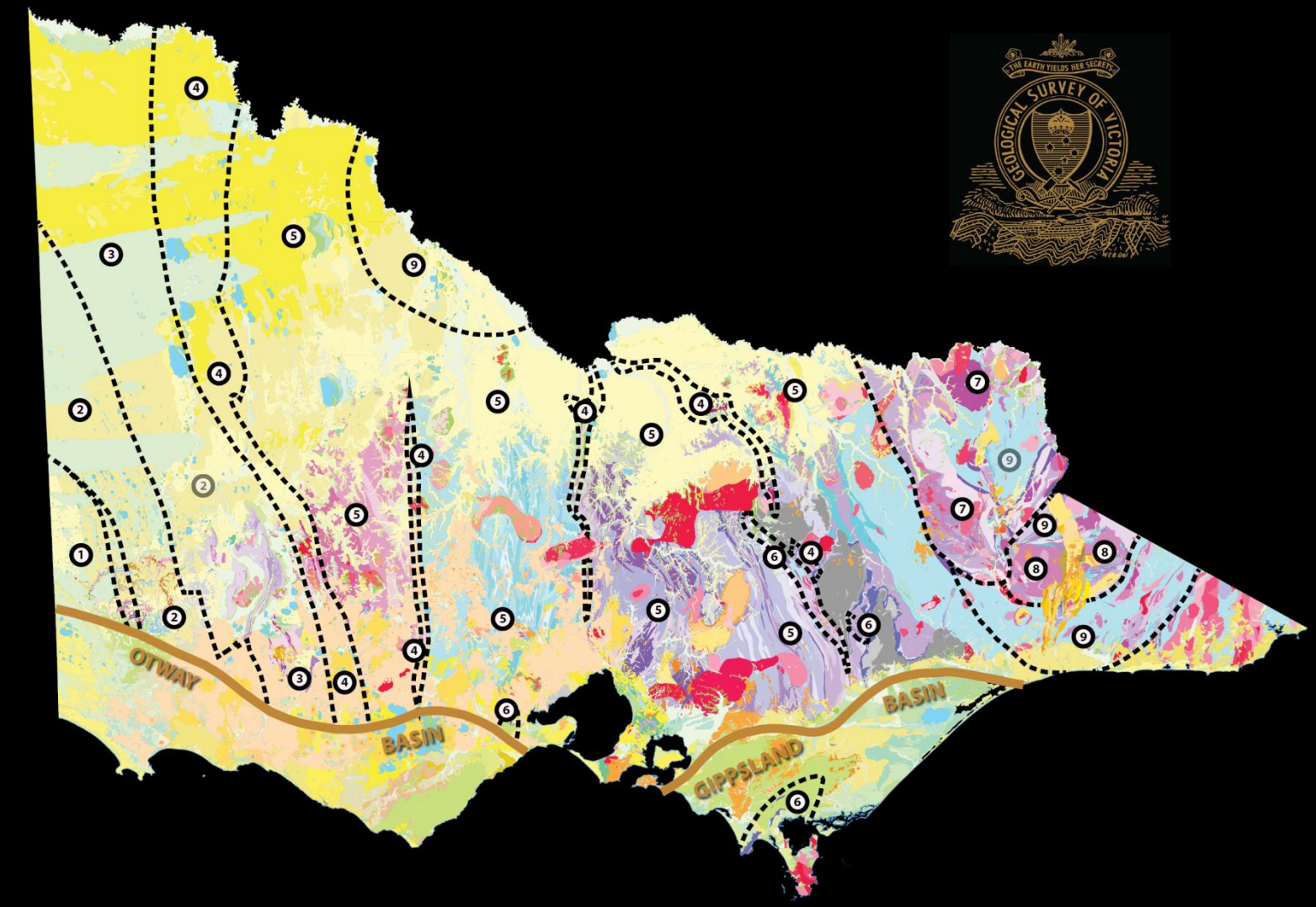
Mount Stavely Arc – restoration of Silurian deformation

This is the scale of influence of the Lachlan Orocline model – a significant proportion of the continent….



Source: Geoscience Australia

Enables a ‘systems’ approach to classify major mineral exploration ‘fairways’



1: Kanmantoo – Strathalbyn SEDEX

2: Delamerian Ultramafic Ni

3: Miga Arc base metals gold

4: Greenstone orogenic gold

5: Bendigo orogenic gold

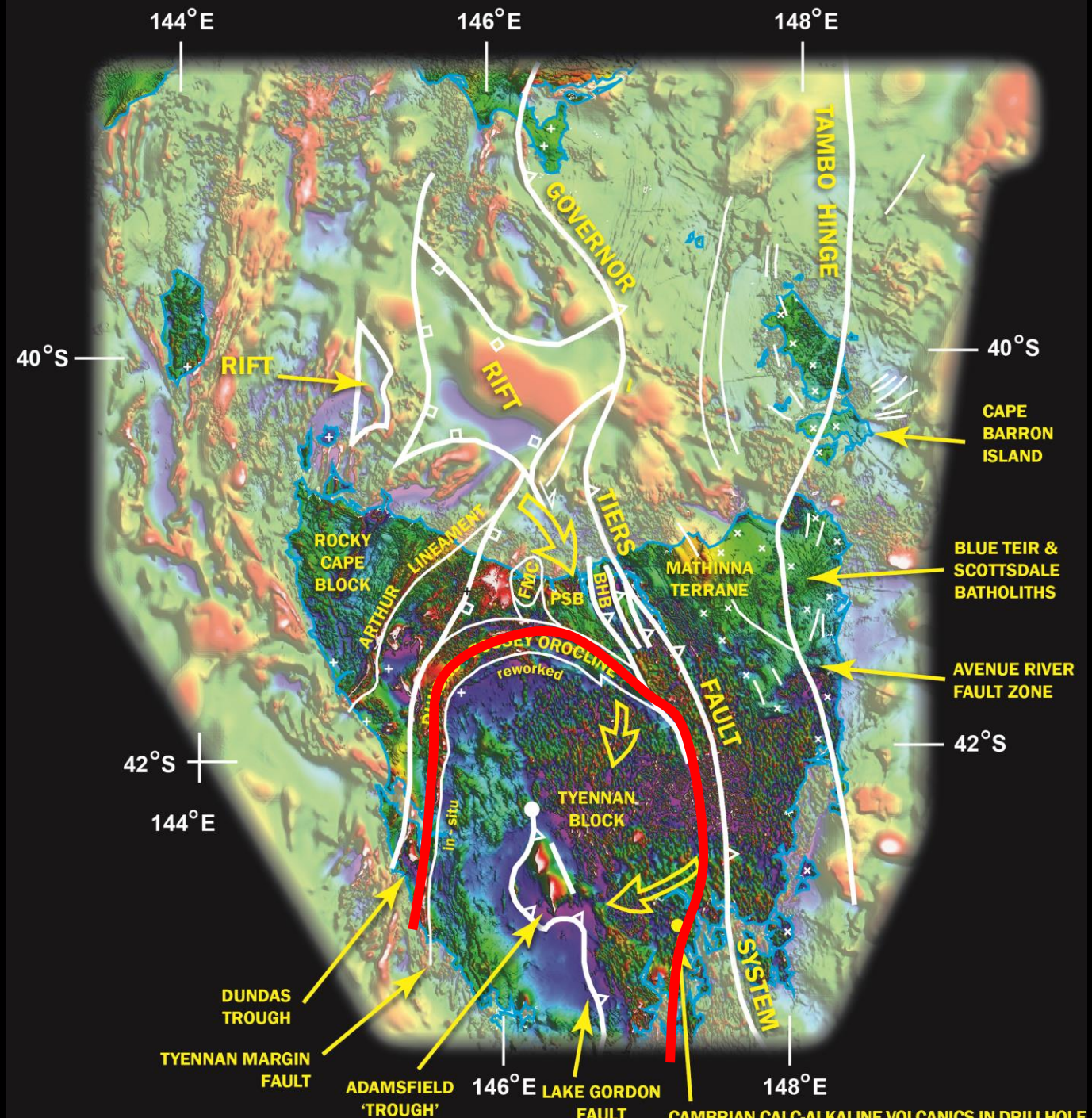
6: Selwyn Block base metals (gold)

7: Wagga-Omeo Zone tin

8: Macquarie Arc base metals (gold)

9: Macquarie Arc derivatives base metals (gold)’

10; Devonian magmatic metals


144°E
146°E
148°E
40°S
42°S
TAMBO HINGE
GOVERNOR
RIFT
RIFT
CAPE BARRON ISLAND
ROCKY CAPE BLOCK
ARTHUR LINEAMENT
FMC
PSB
BHB
TIERS
MATHINNA TERRANE
BLUE TEIR & SCOTTSDALE BATHOLITHS
reworked
FAULT
AVENUE RIVER FAULT ZONE
TYENNAN BLOCK
in situ
SYSTEM
DUNDAS TROUGH
TYENNAN MARGIN FAULT
ADAMSFIELD 'TROUGH'
LAKE GORDON FAULT

Conclusions

- The Lachlan Orocline- fundamental to understanding LFB, DFB (and TFB) and Tasmanian evolution and mineral prospectivity
- Restored Ordovician DFB, LFB/TFB: narrow, simple, single continent-directed subduction zones and accretionary complexes — multiple subduction not needed
- Late Ordovician-Early Silurian LFB/TFB – mode-switch to asymmetric roll-back triggered by ingestion of Vandieland – context for mineralised MA porphyries.
- Post-Silurian LFB/TFB: wide and complex— dextral strike-slip faults & oroclines in an extending and fragmenting upper plate, chasing a slab in asymmetric SE-directed roll-back
- One simple geodynamic system explains Palaeozoic Qld, NSW, Vic. & Tas. and the origin of the Alice Springs Orogen. A template for finding buried arc segments.