

The Stawell Zone (including the Stawell Corridor)

A Cambrian accretionary wedge infused with Ordovician gold


Stawell Gold Corridor Conference, Melbourne. November 2024

Ross Cayley (on behalf of the GSV research team)

27 November, 2024

OFFICIAL





We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it.

We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

Resources Victoria is committed to genuinely partnering with Victorian Traditional Owners and Victoria's Aboriginal community to progress their aspirations.



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MONASH University



pmd*crc



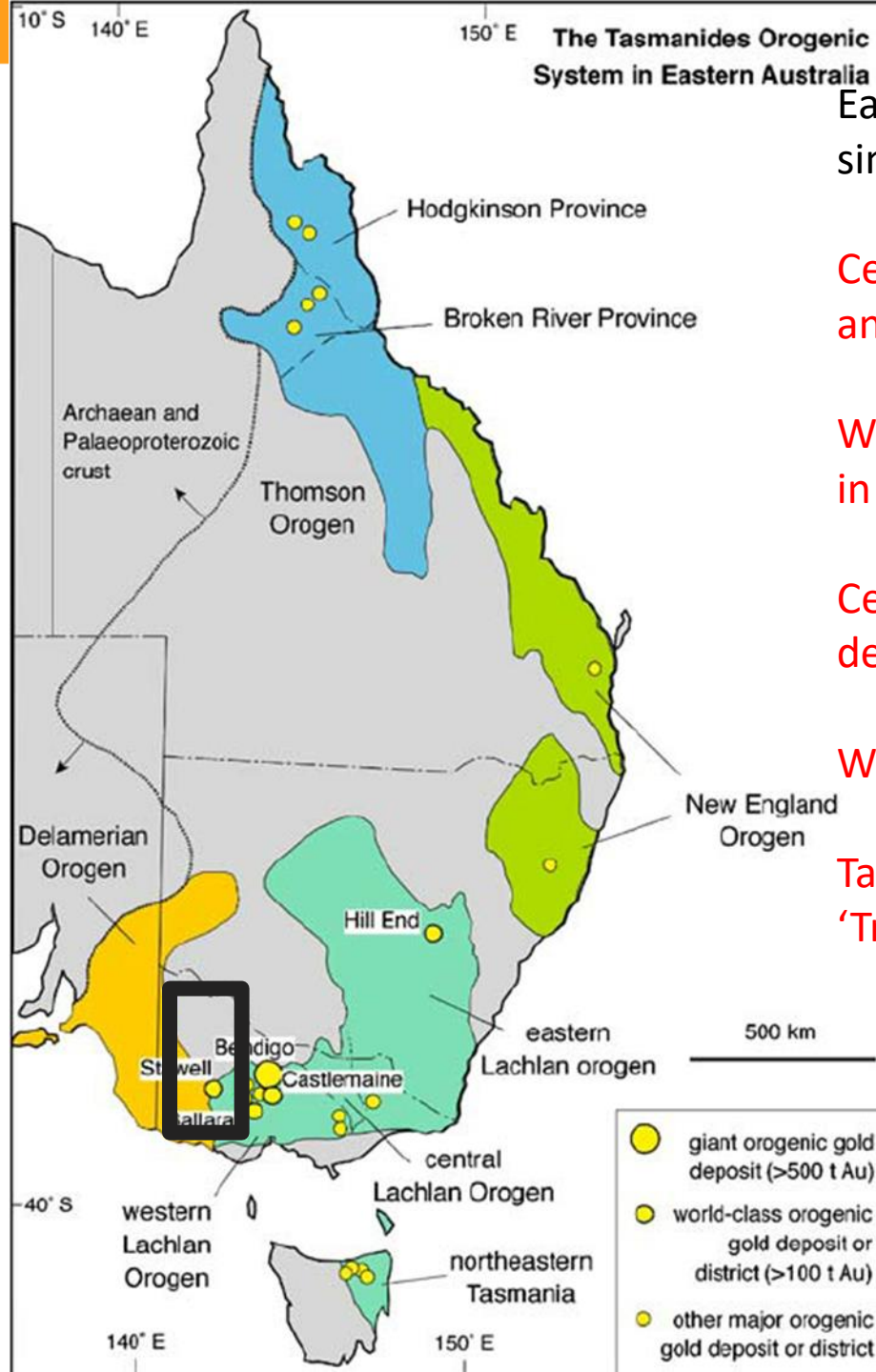
AuScope

ANSIR NATIONAL RESEARCH
FACILITY FOR
EARTH SOUNDING



RESOURCES VICTORIA





Early Palaeozoic rocks of similar age, provenance and appearance, with similar structural history, widespread throughout Eastern Australia.

Central-west Victoria: a cluster of proven giant orogenic gold deposits and proven large deposits in the Stawell Zone (Stawell Corridor).

West Victoria: recent and new intrusion-related base metals discoveries in the Grampians-Stavely Zone

Central NSW: a cluster of proven giant intrusion-related base metals+gold deposits. (Macquarie Arc)

Western NSW: a cluster of proven giant VMS deposits (Cobar)

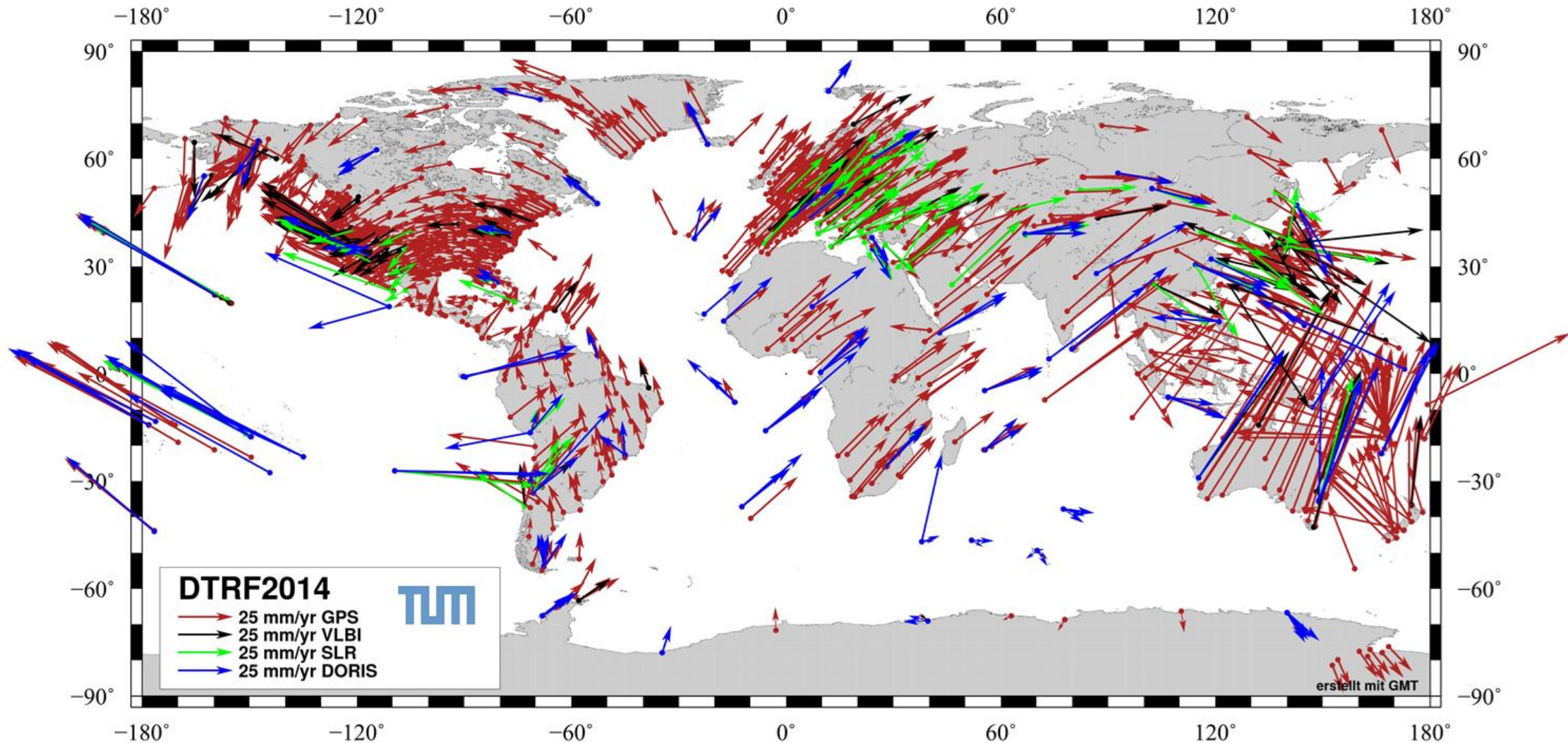
Tasmania: a cluster of proven giant VMS-related deposits (Dundas 'Trough')

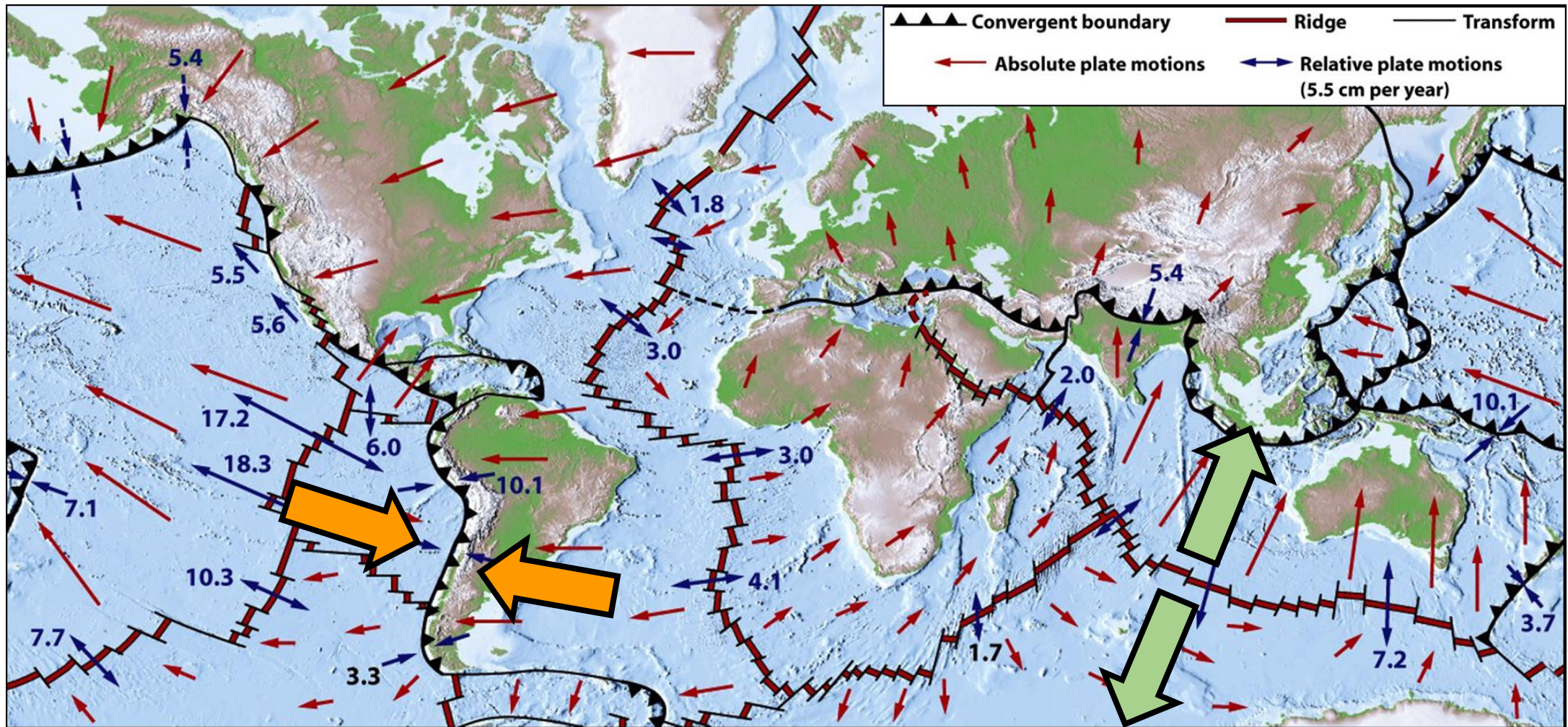
Already lots of action proven in western Victoria, but how big might it really be?

Talk outline

- **Geological Systems Analysis – a logical way to overcome tectonic ambiguity / complexity**
- The ‘Stawell Zone’ – where is it and what does it look like?
- The Moyston Fault and ‘Stawell Corridor’ – the complex faulted interface between the Stawell Zone and the Grampians-Stavely (Arc) Zone.
- Linking Stawell Zone geology to Stavely Arc geology – present-day Pacific Rim geology as an analogue for understanding Cambrian western Victorian geology and mineral endowment.
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- Further work (chasing Stawell Zone gold (and Stavely Arc base metals) prospectivity under cover.

Convergent margin key elements and systematics

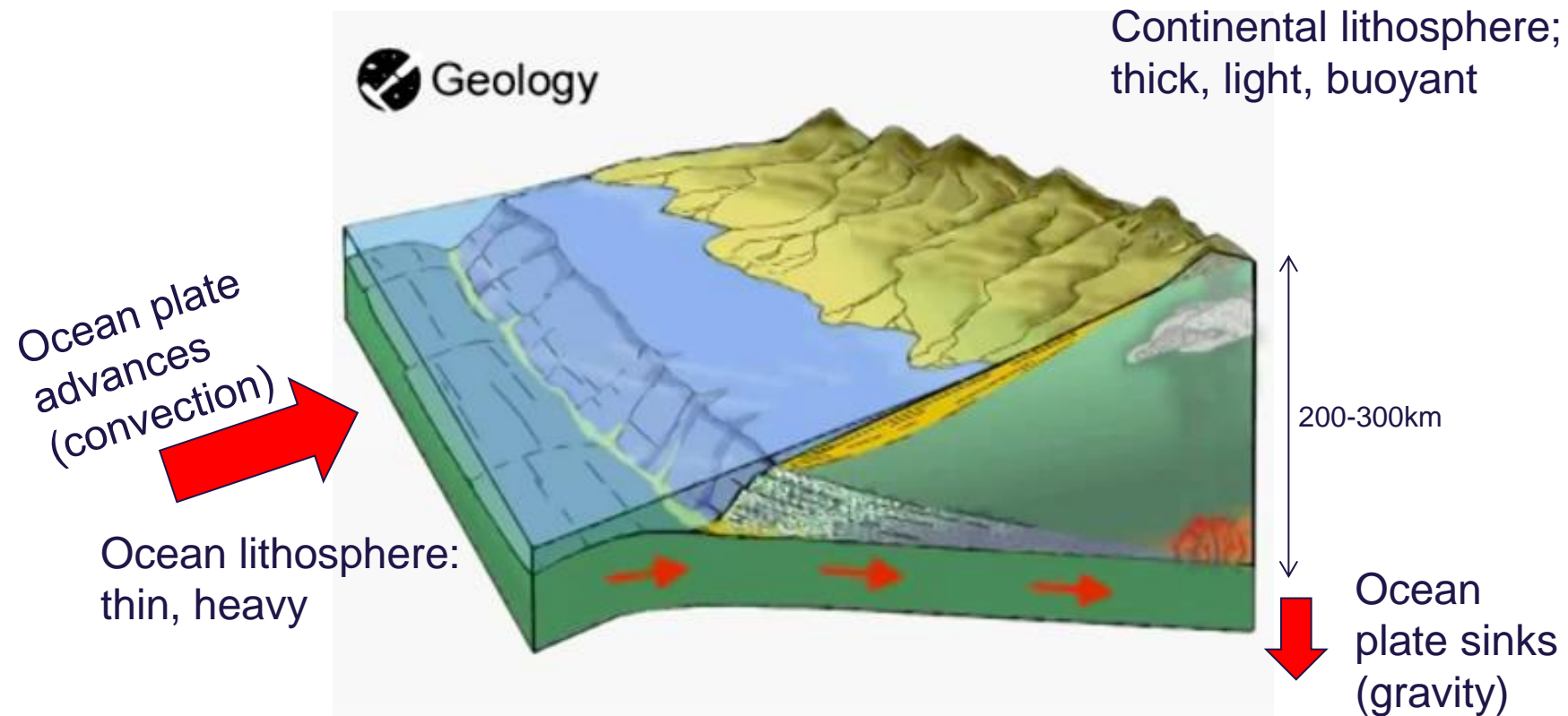




Convergent plate boundaries – plates move towards each other (rocks disappear below and/or eroded)

Divergent plate boundaries – plates move away from one another (rocks are replaced from below)

Convergent margin key elements and systematics



Convergent margin key elements and systematics

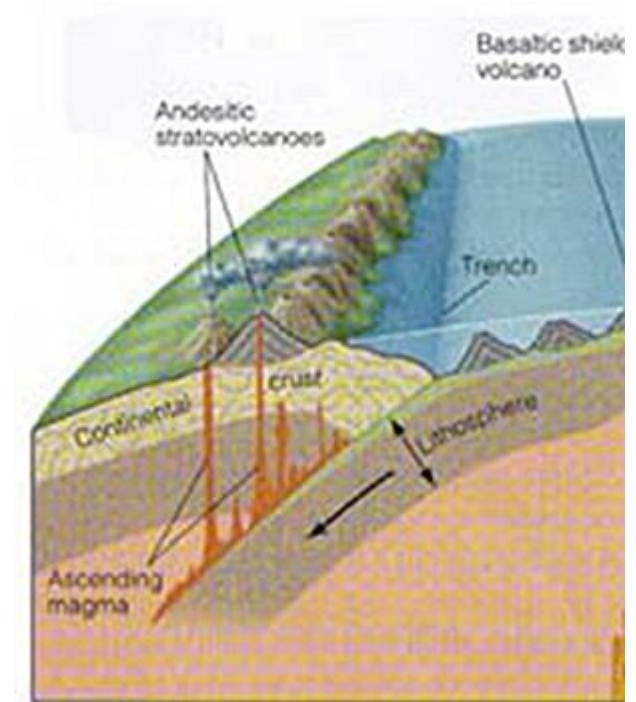
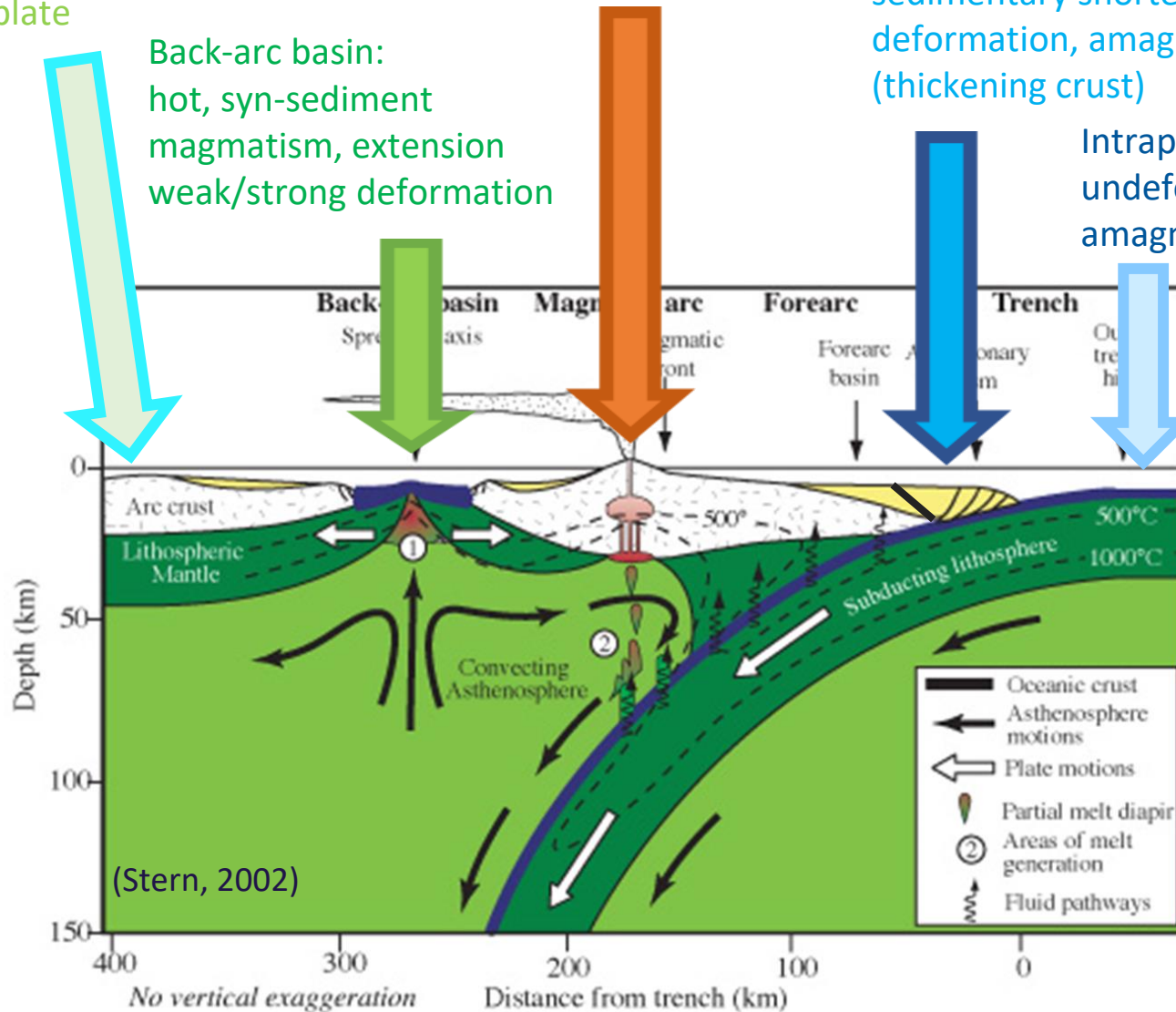
Distal back-arc:
transition to
intraplate

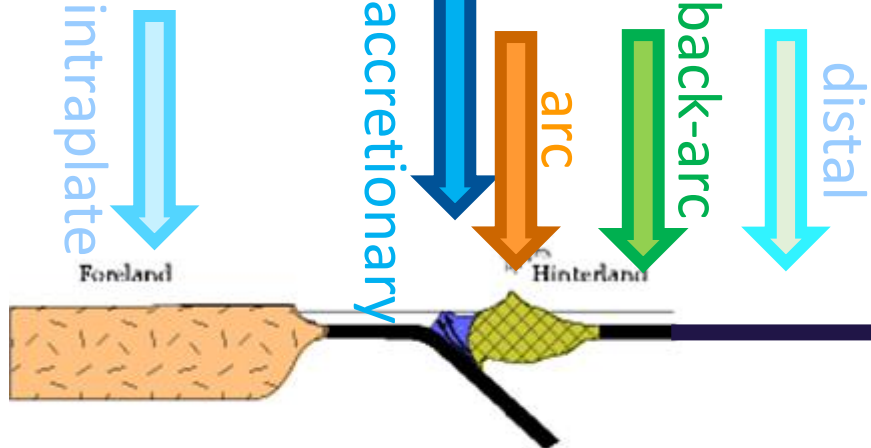
Magmatic arc:
hot, igneous-dominated

Accretionary wedge: cold, inherent
strong syn-
sedimentary shortening
deformation, amagmatic
(thickening crust)

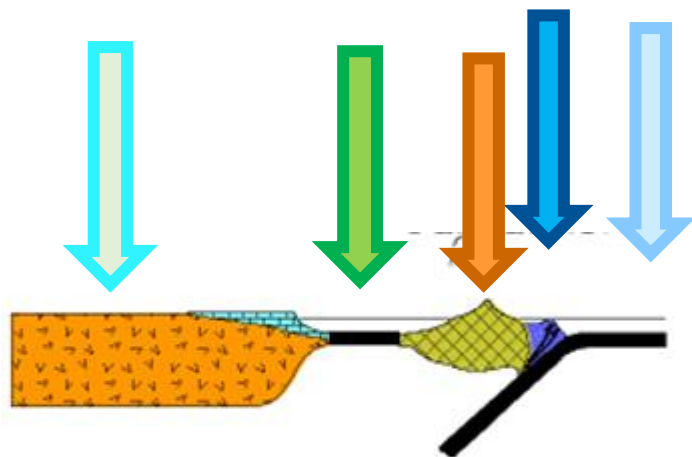
Back-arc basin:
hot, syn-sediment
magmatism, extension
weak/strong deformation

Intraplate: cold,
undeformed,
amagmatic

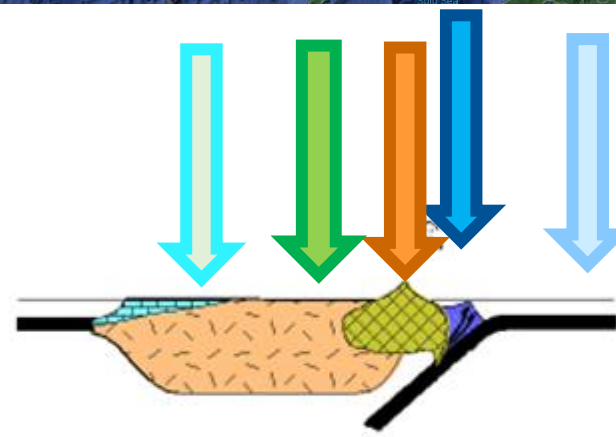
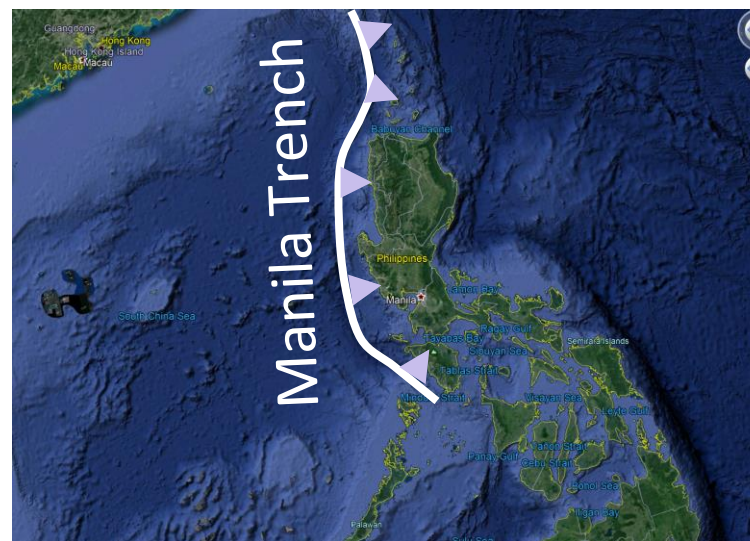
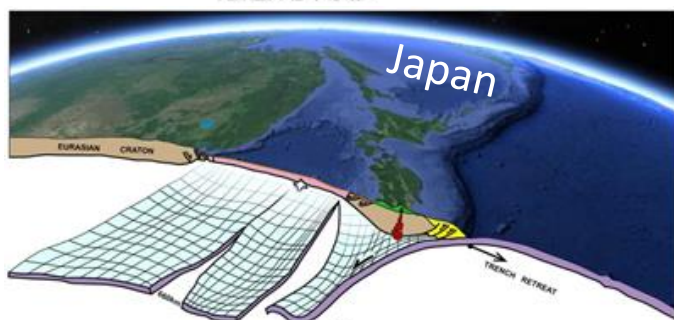




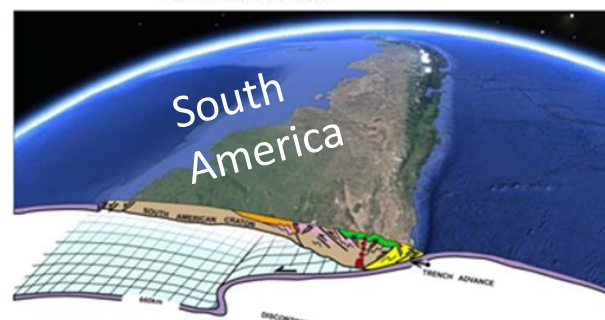
Continent-Island Arc Collision



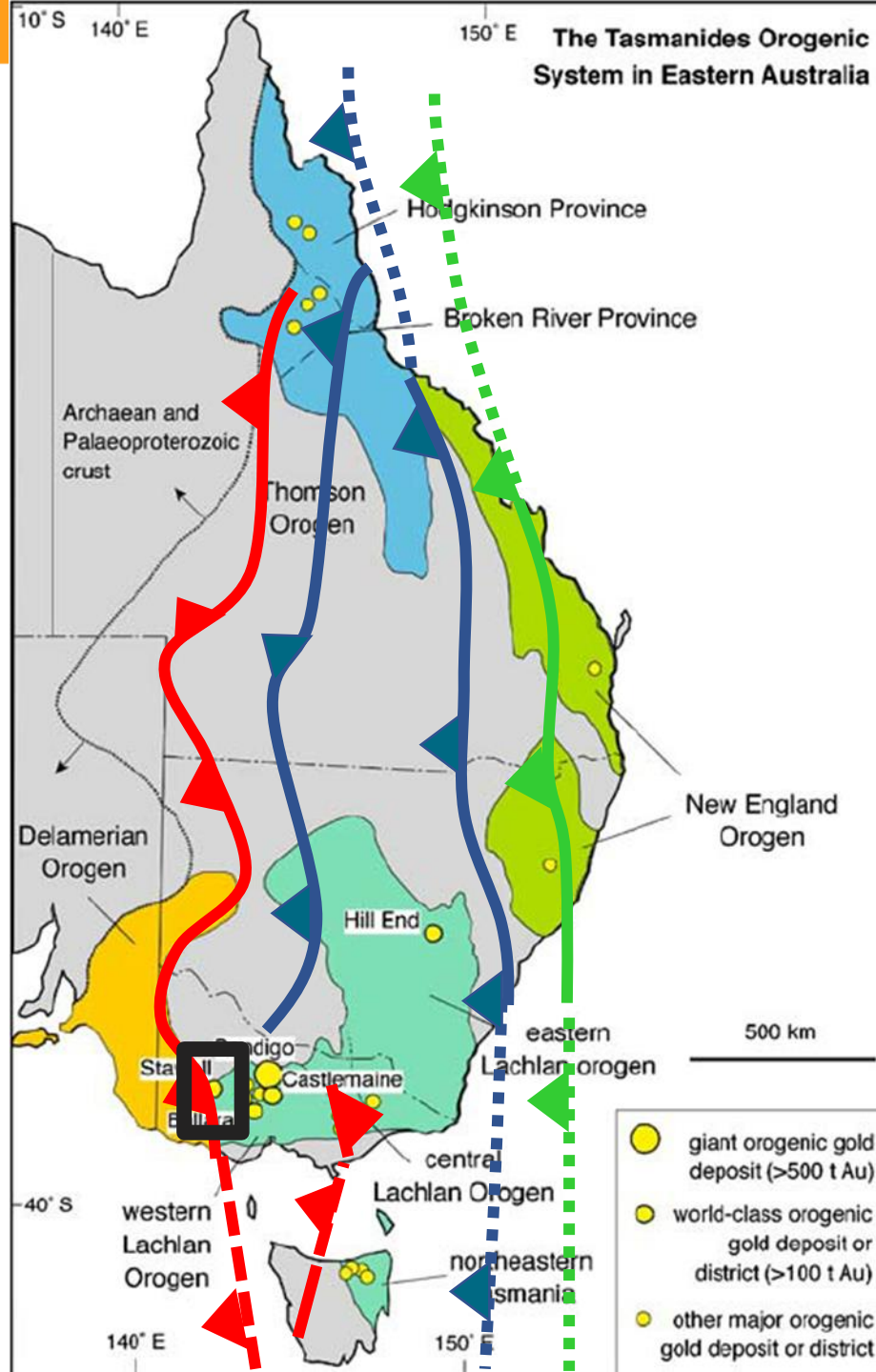
Island Arc



Cordilleran



Benchmarking
against modern
systems



The Tasman Fold Belt System –

3-4 cycles of Early-Mid Palaeozoic subduction-accretion that progressively built eastern Australia....

(Personally I think most were continent-dipping, but debate continues.....)

Today's talk is predominantly about the **Delamerian Orogen**

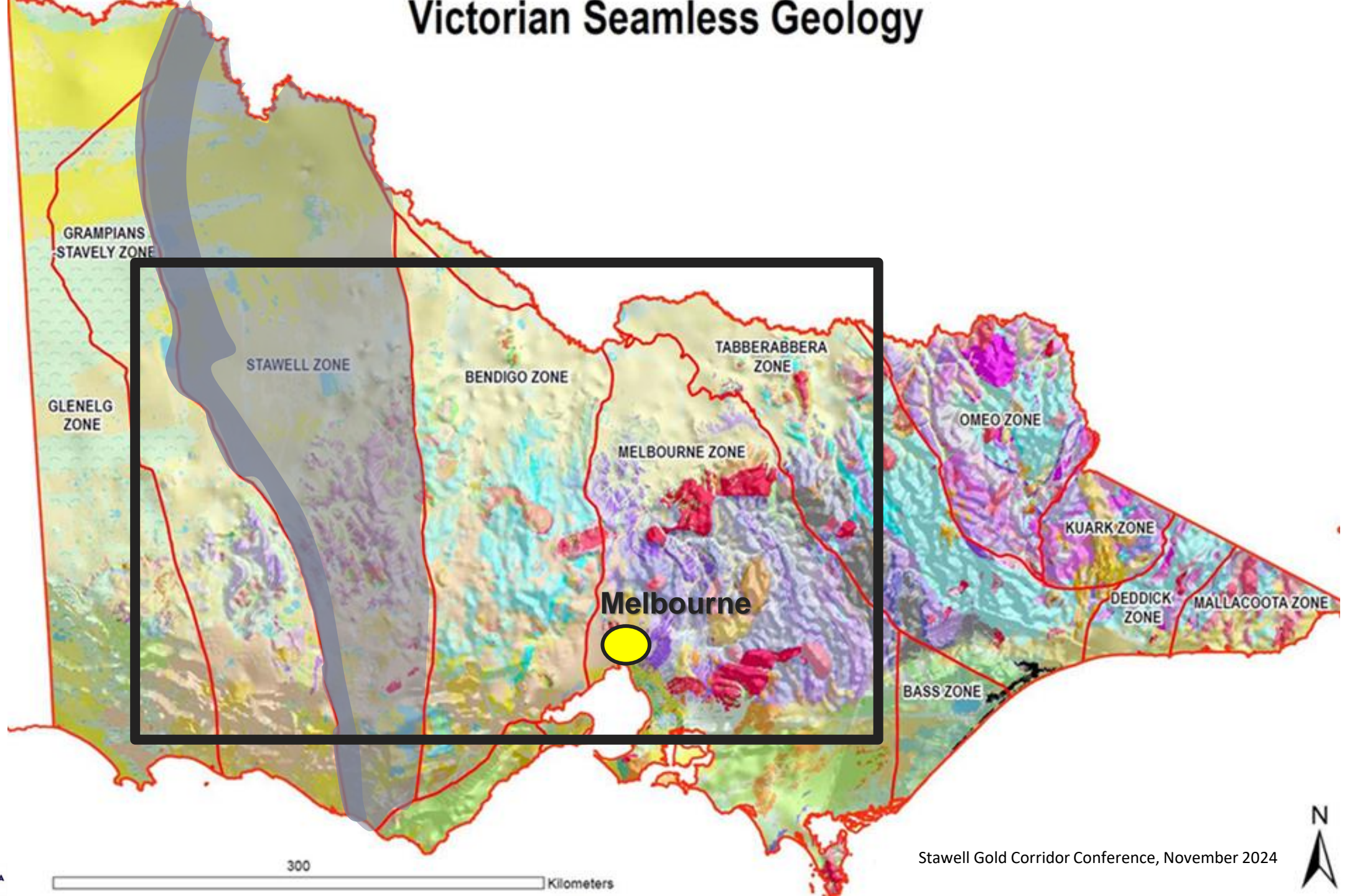
BUT:

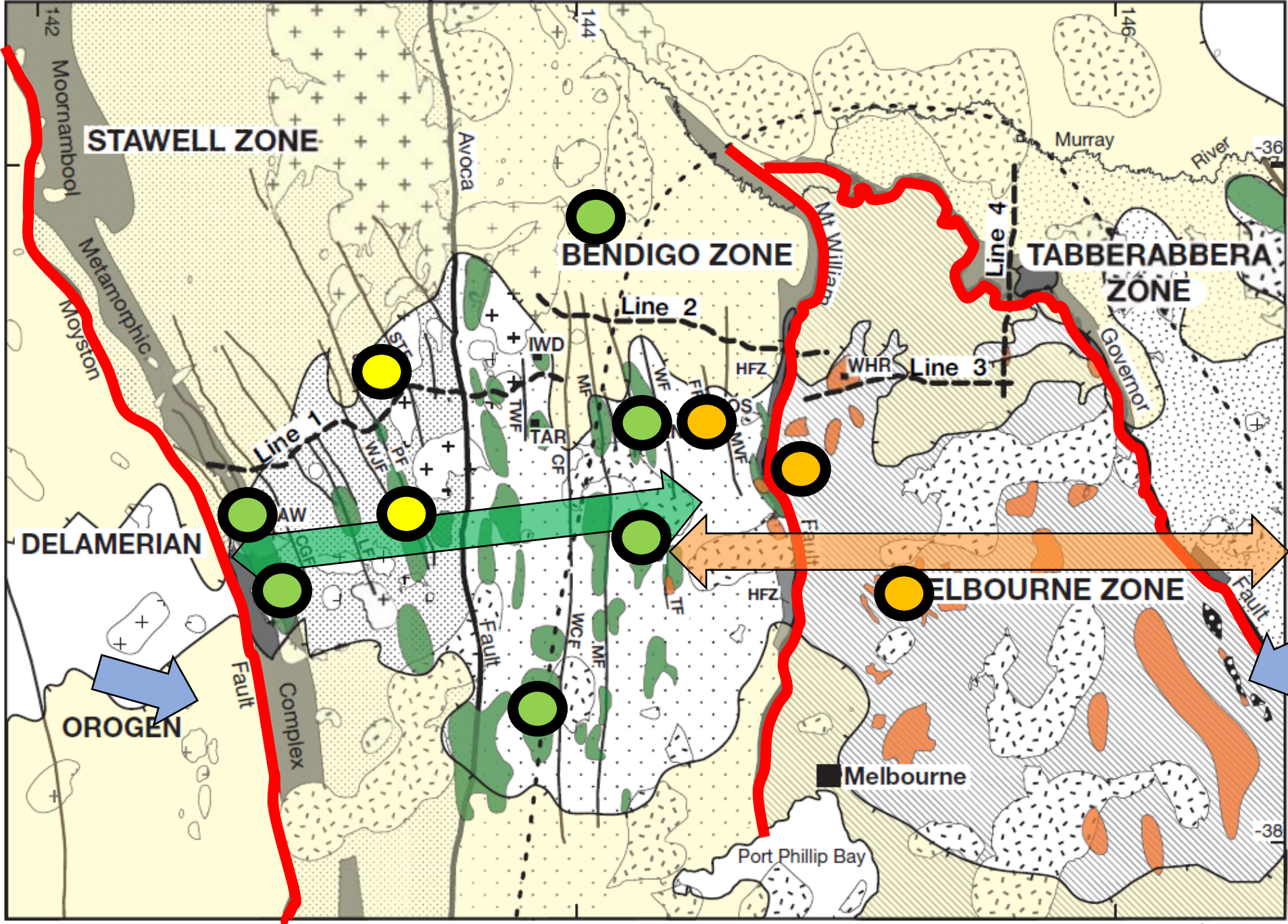
the gold part of the story is younger, superimposed from the **Lachlan Orogen**

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Victorian Seamless Geology





Orogenic gold

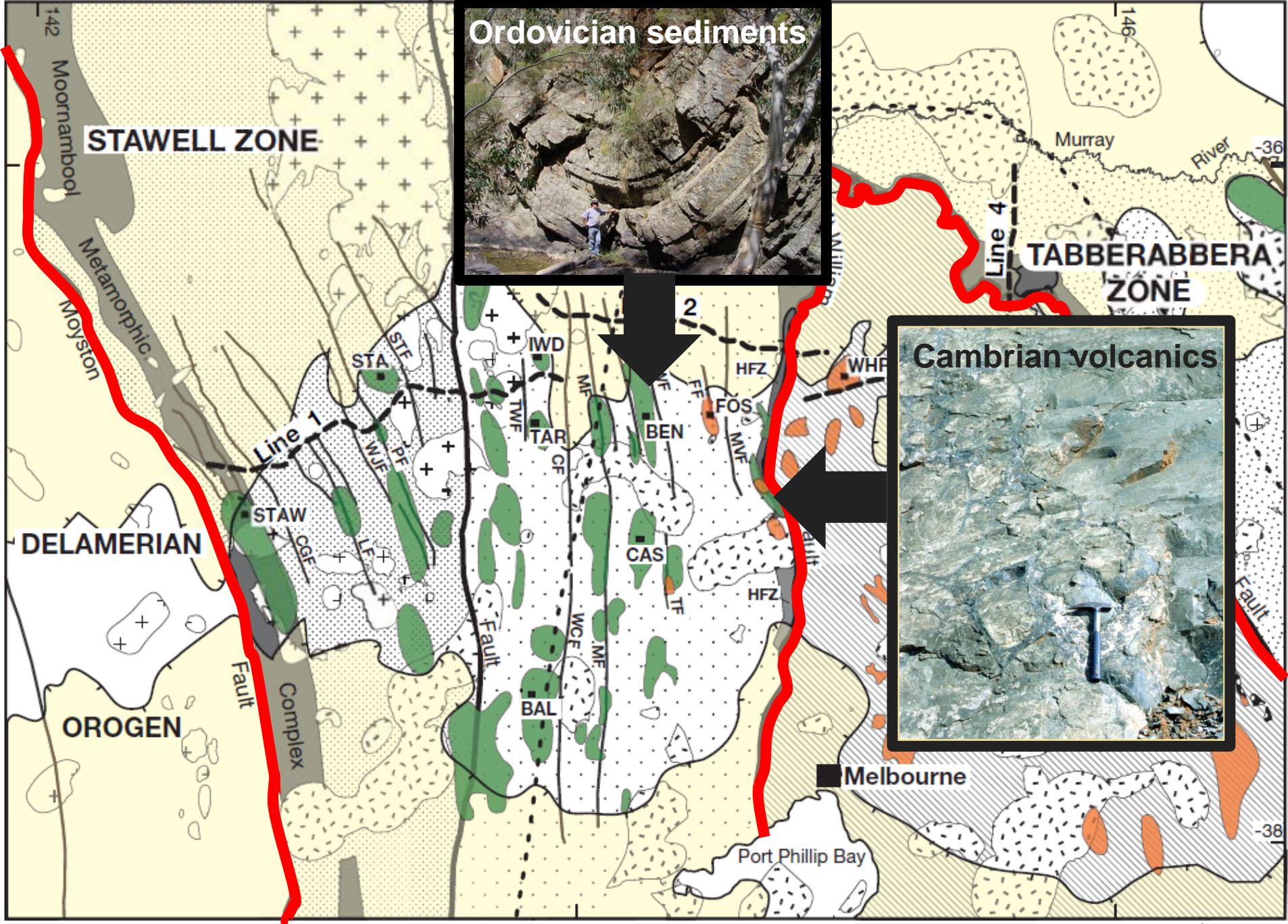
~450-440 Ma

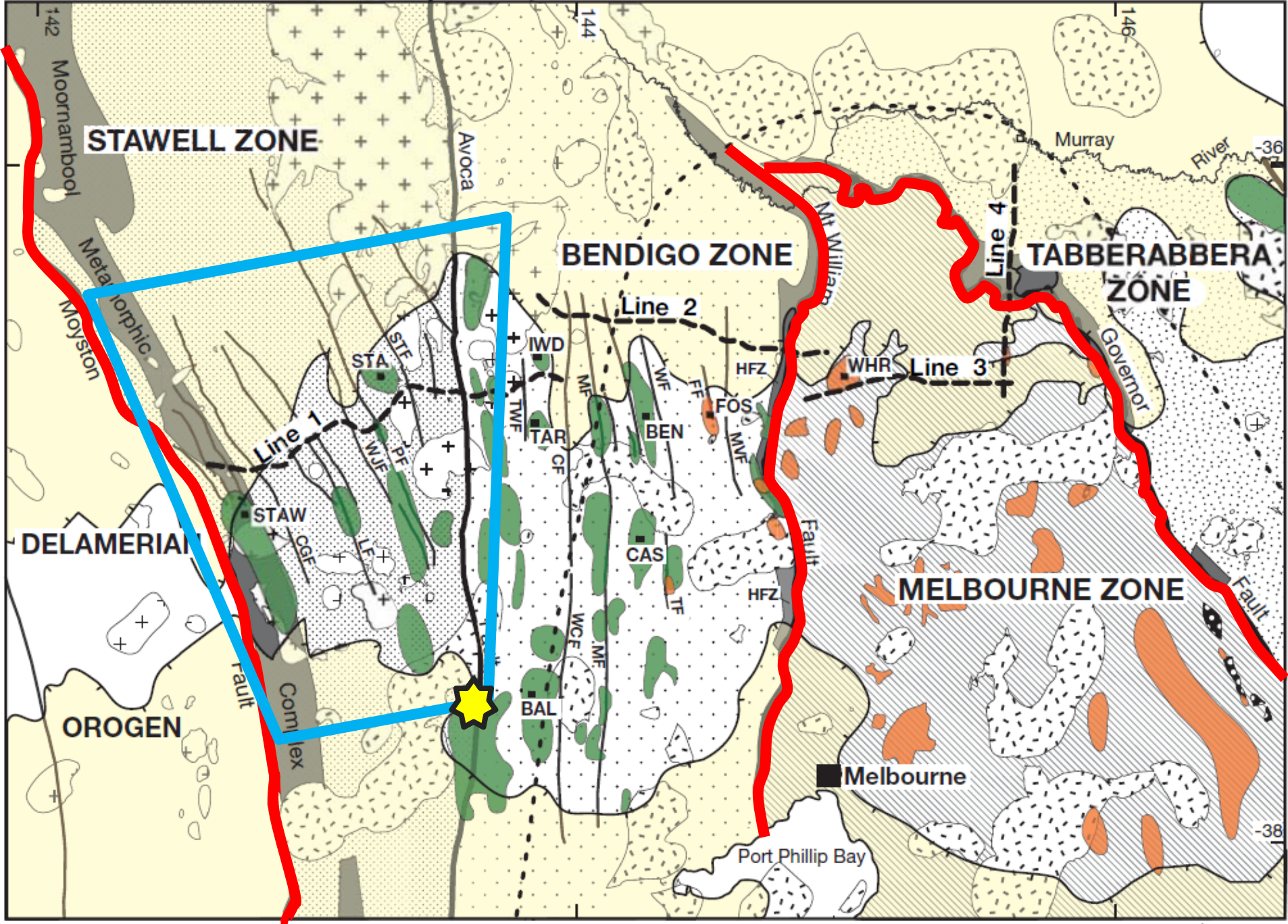
Intrusion-related
Cu / Au

~500 Ma

Orogenic gold

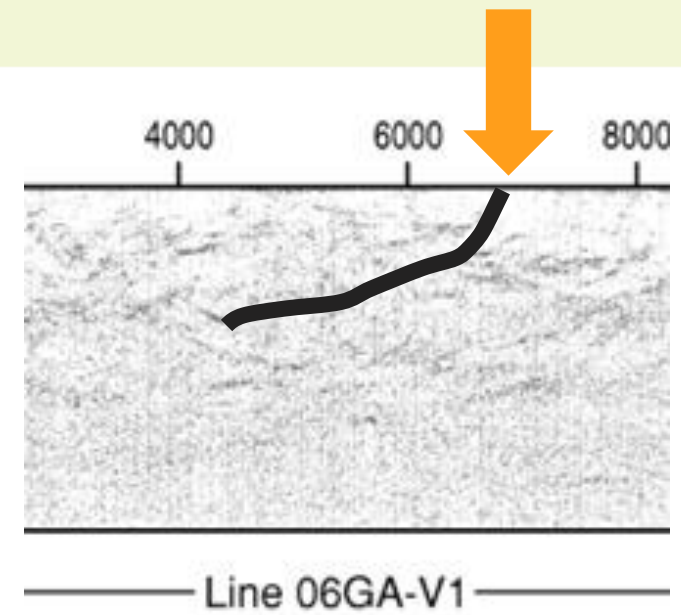
~400-375Ma



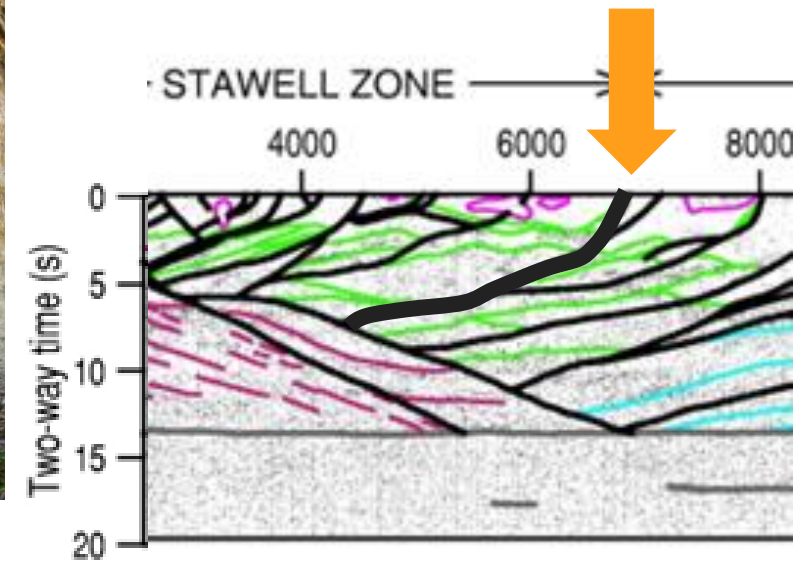


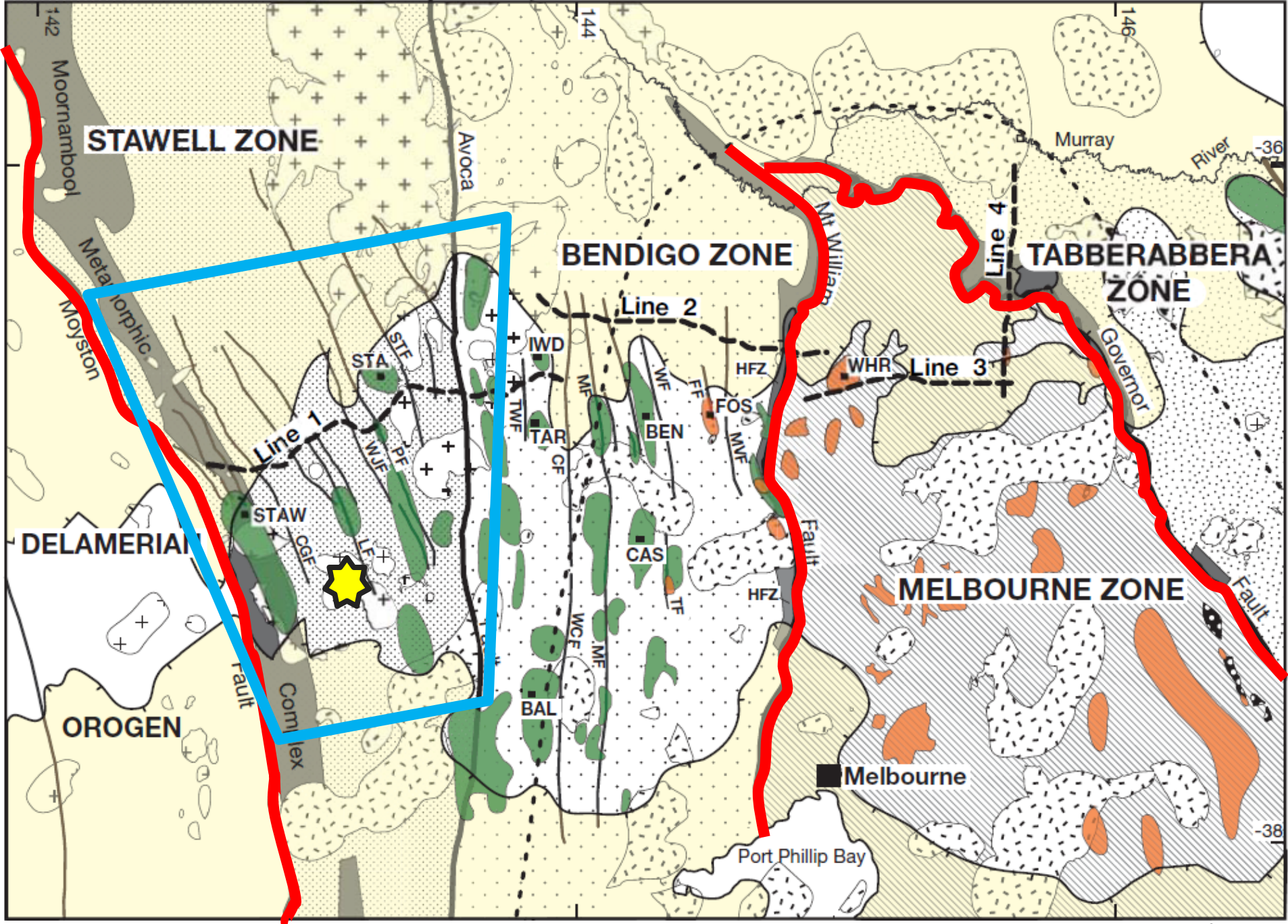


Eastern Stawell Zone boundary:
Avoca Fault



Cayley et al., 2011





Stawell Zone interior: upright, tightly-folded Cambrian metasediments (Saint Arnaud Group), cut by very large spaced, polydeformed faults (with gold deposits: eg Fiddlers Reef, St Arnaud)

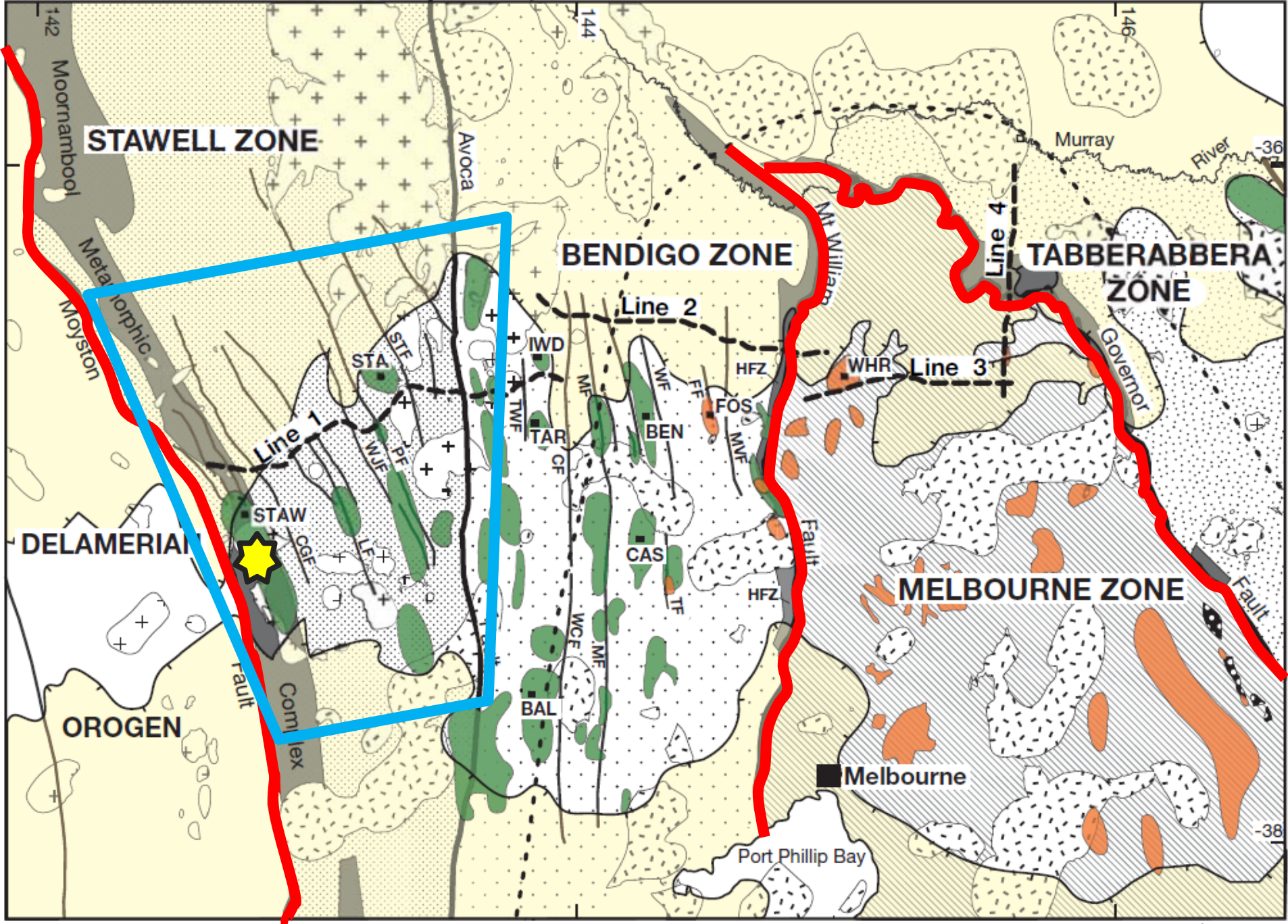


Carbonate concretions: some Stawell Zone sediments weren't deposited in super-deep water, like eg: Bendigo was



Folded and faulted Stawell Zone sediments are intruded by large Devonian granite bodies

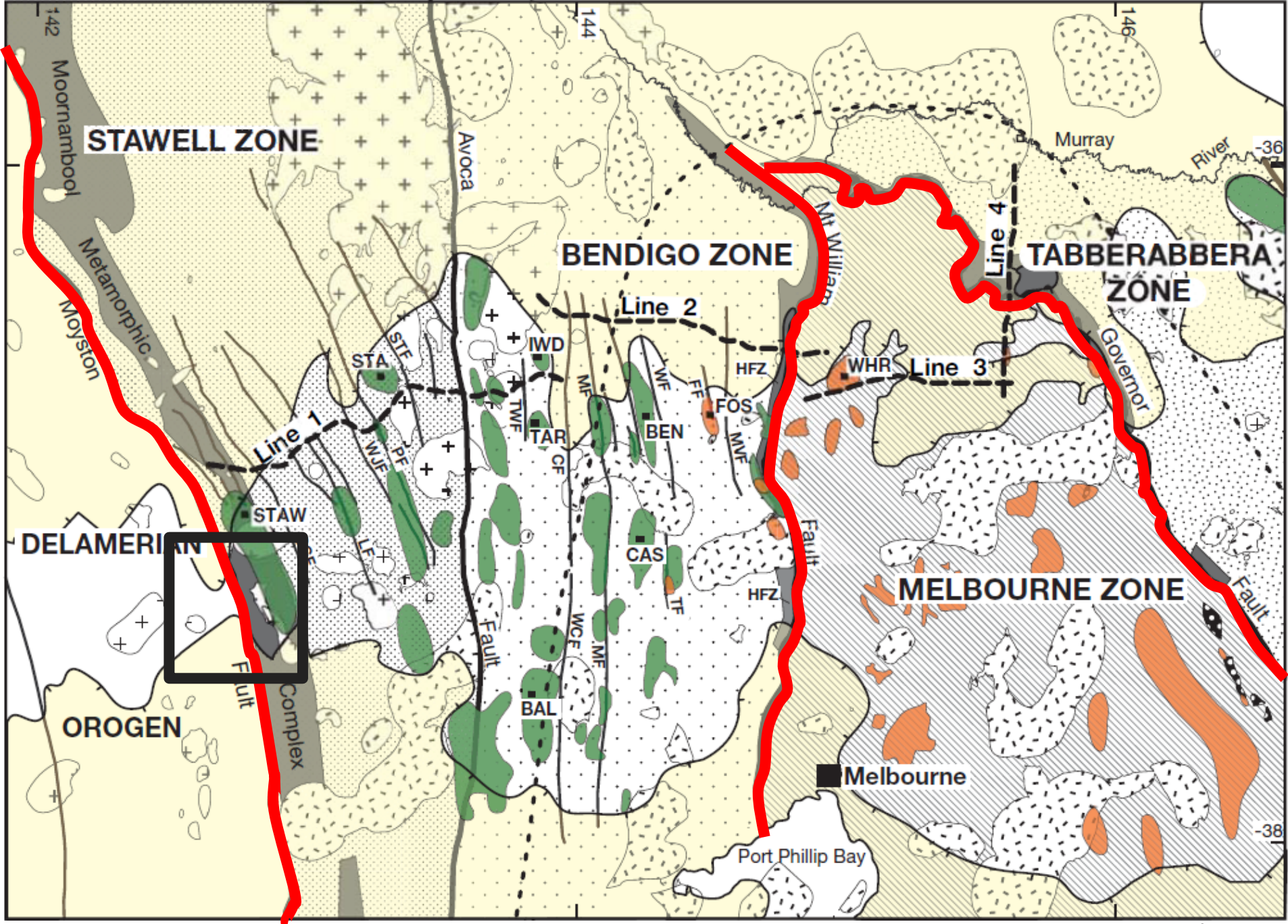


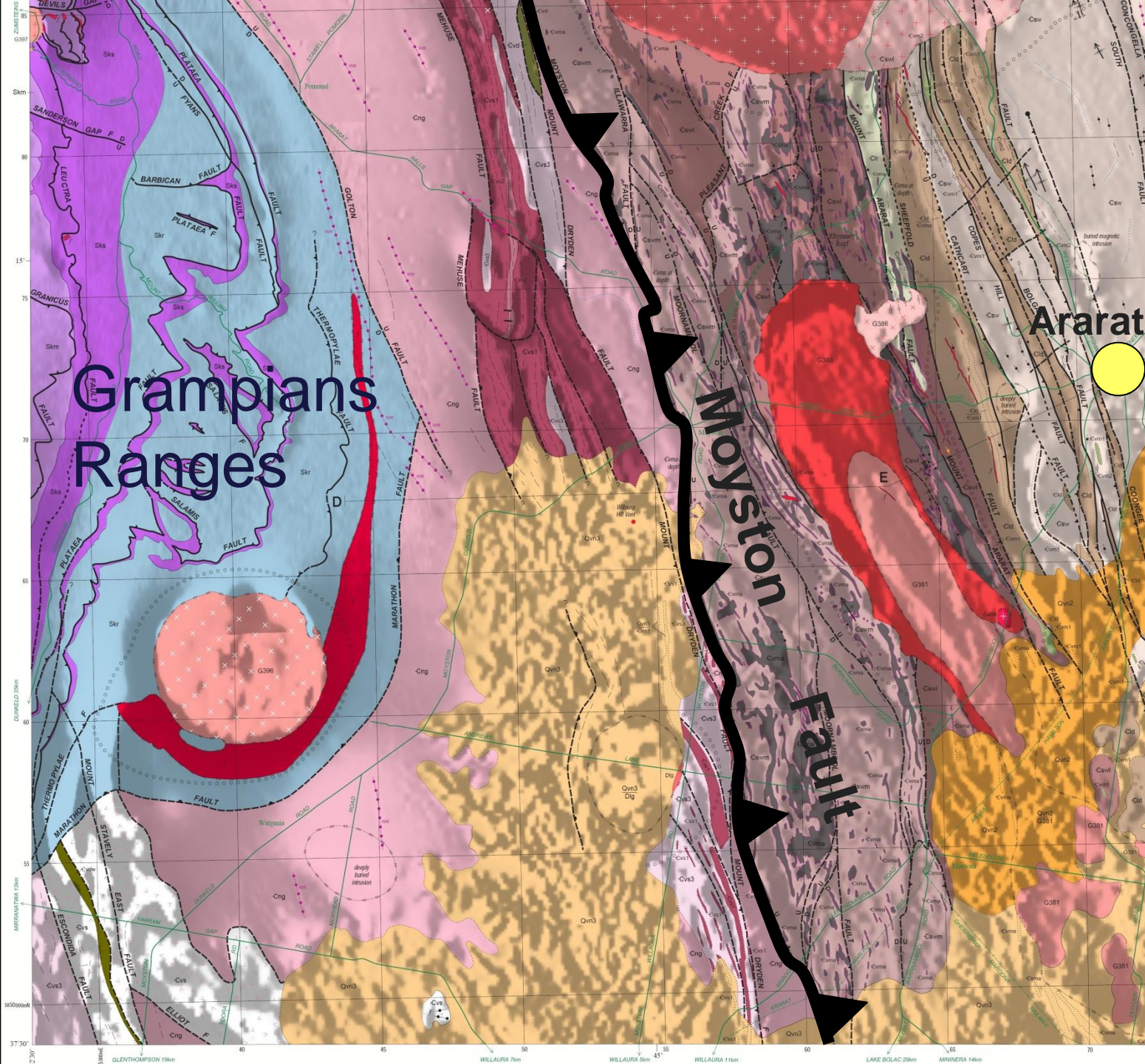




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Grampians
Ranges

Moyston

Fault

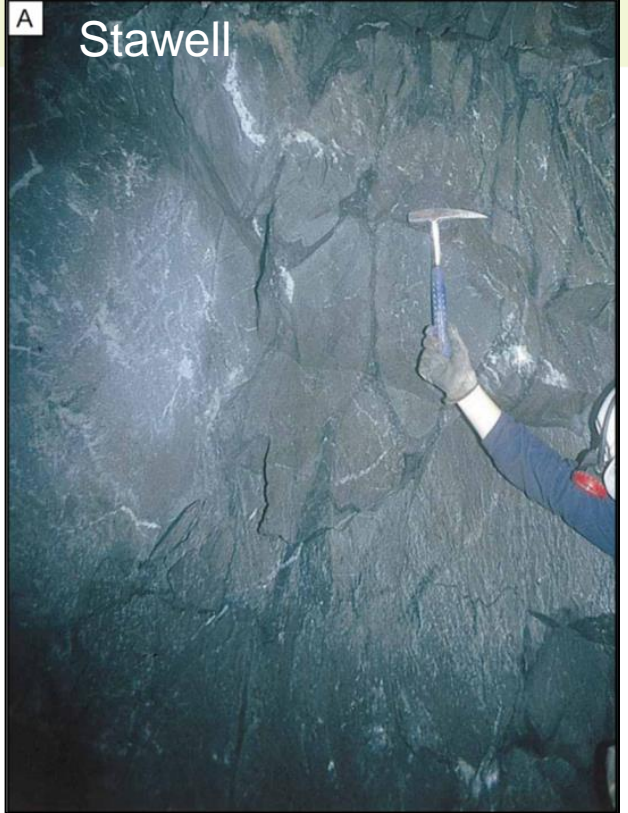
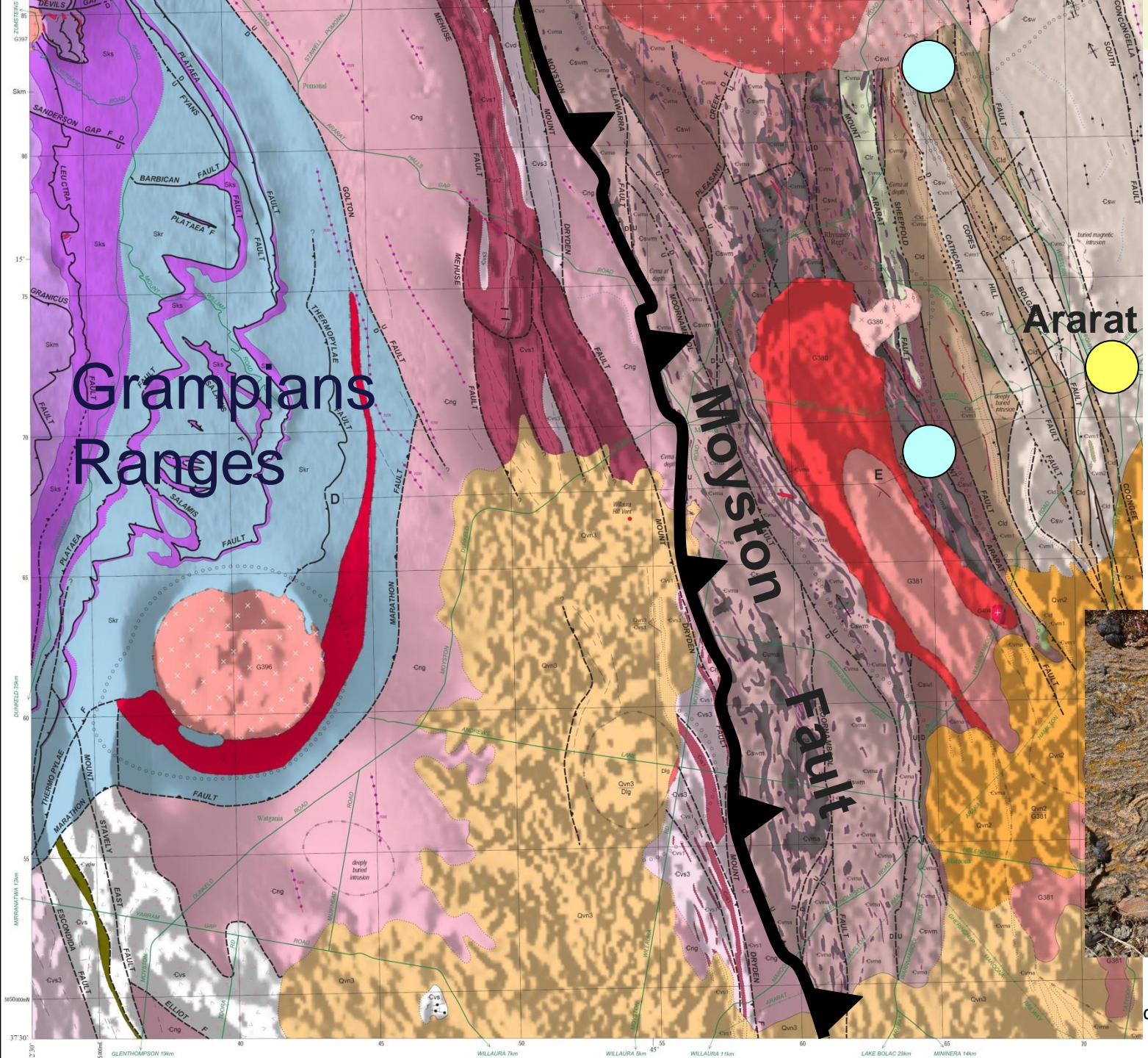
Ararat

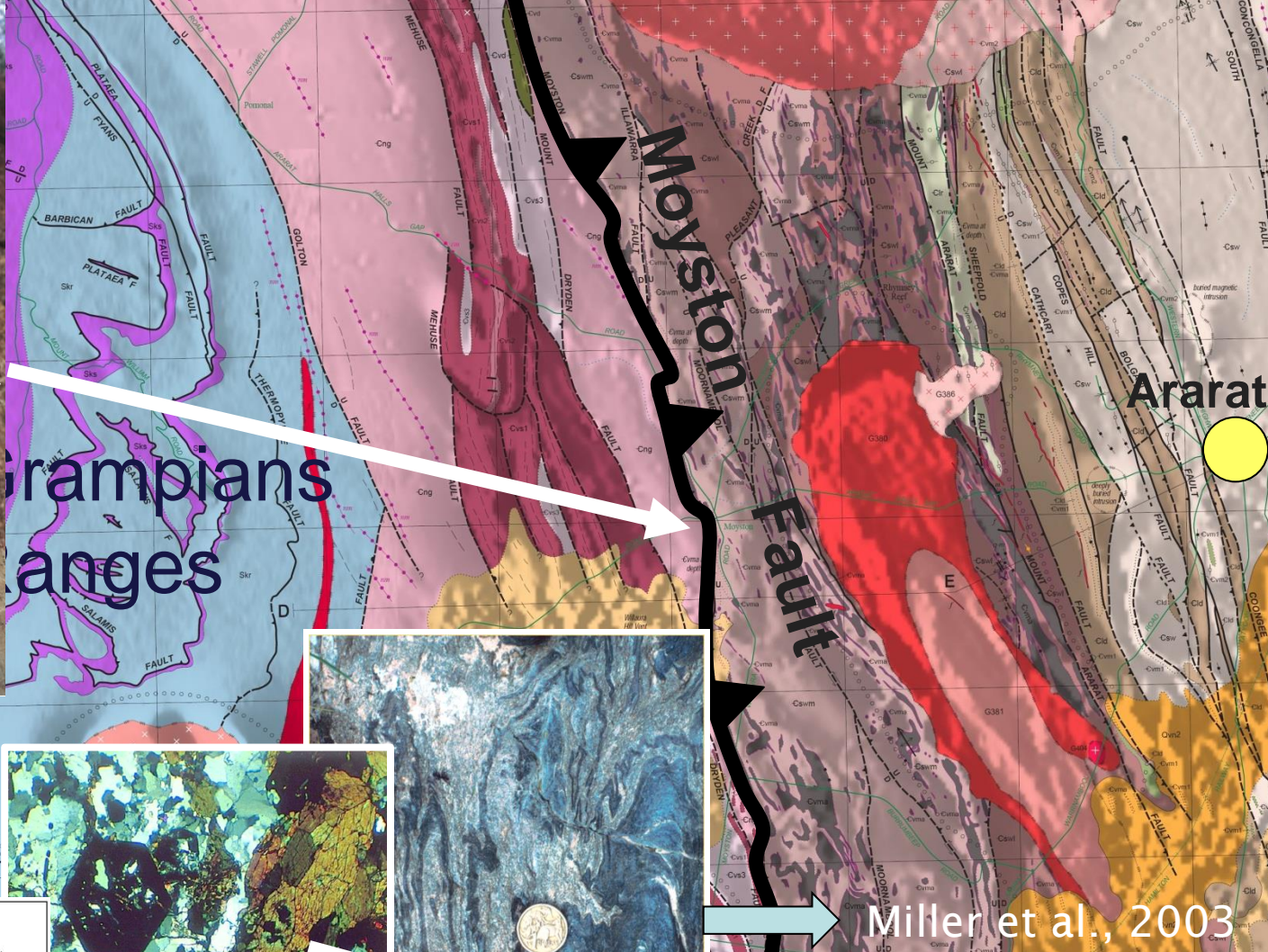


Cayley & Taylor, 2000, 2001

Eastern Moornambool Metamorphic Complex:

Melange of fault-intercalated mafic (Cambrian metabasalt) and pelitic (Cambrian metasediment) rocks metamorphosed to greenschist facies

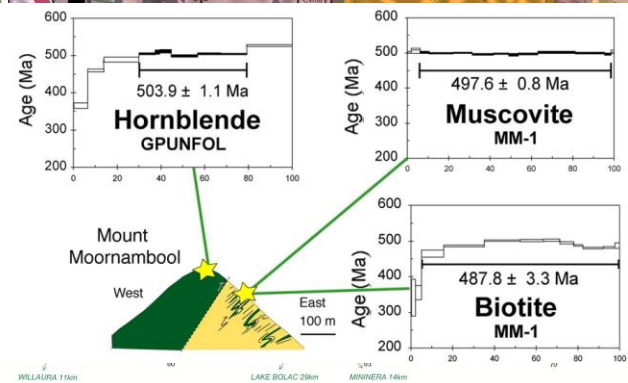
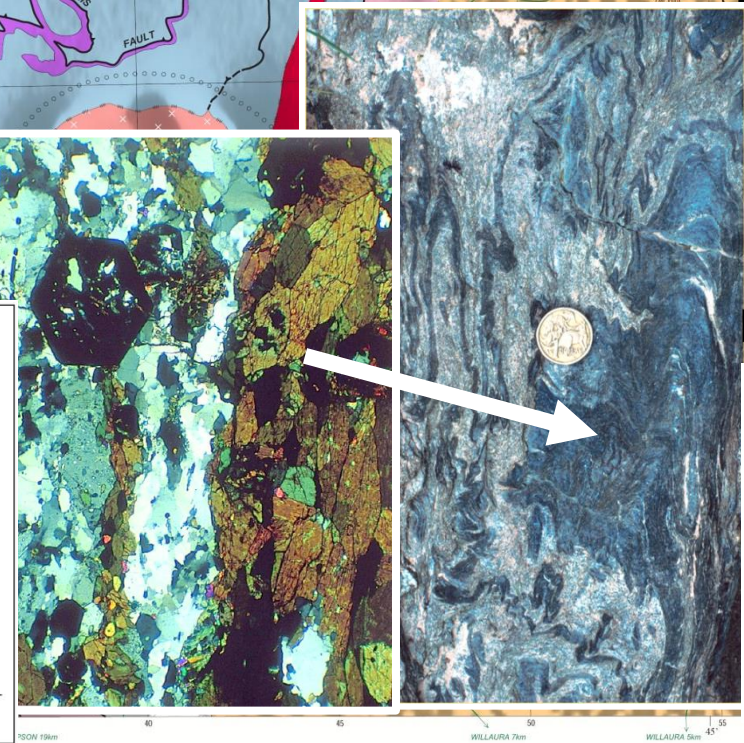
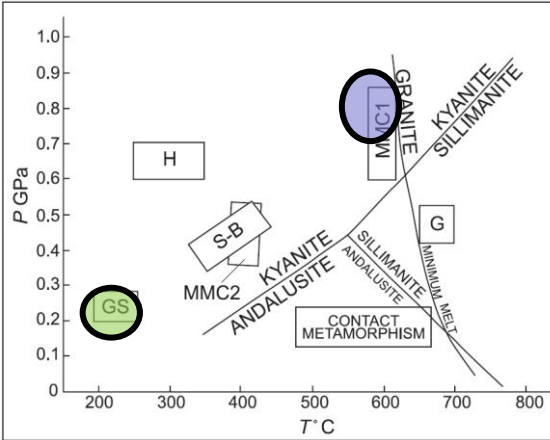


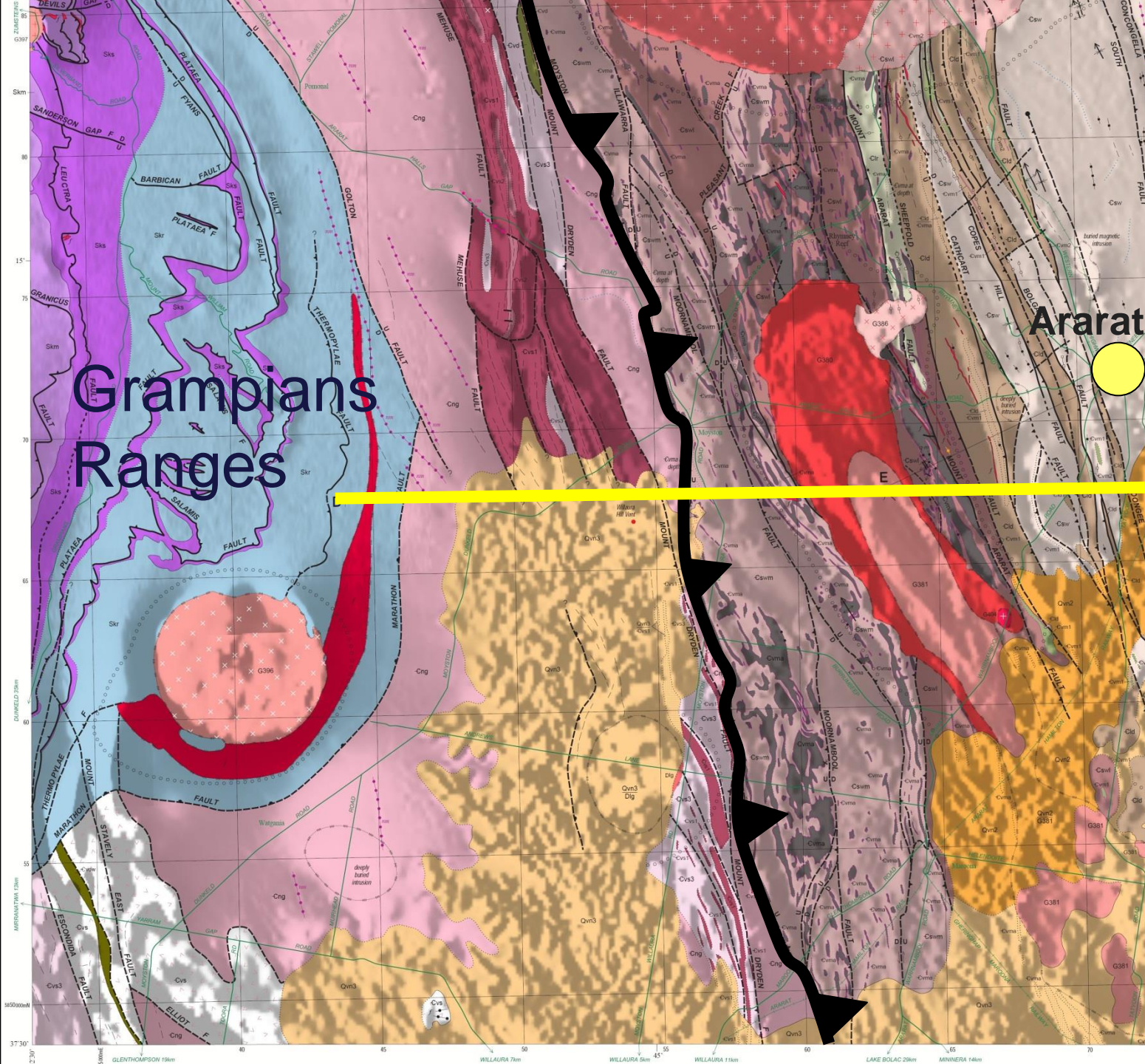


Western
Moornambool
Metamorphic
Complex:

Complex melange of
fault-intercalated
mafic and pelitic rocks
Metamorphosed to upper
amphibolite facies

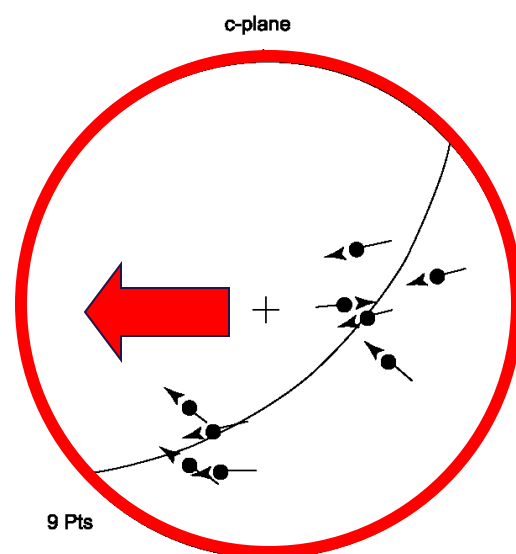
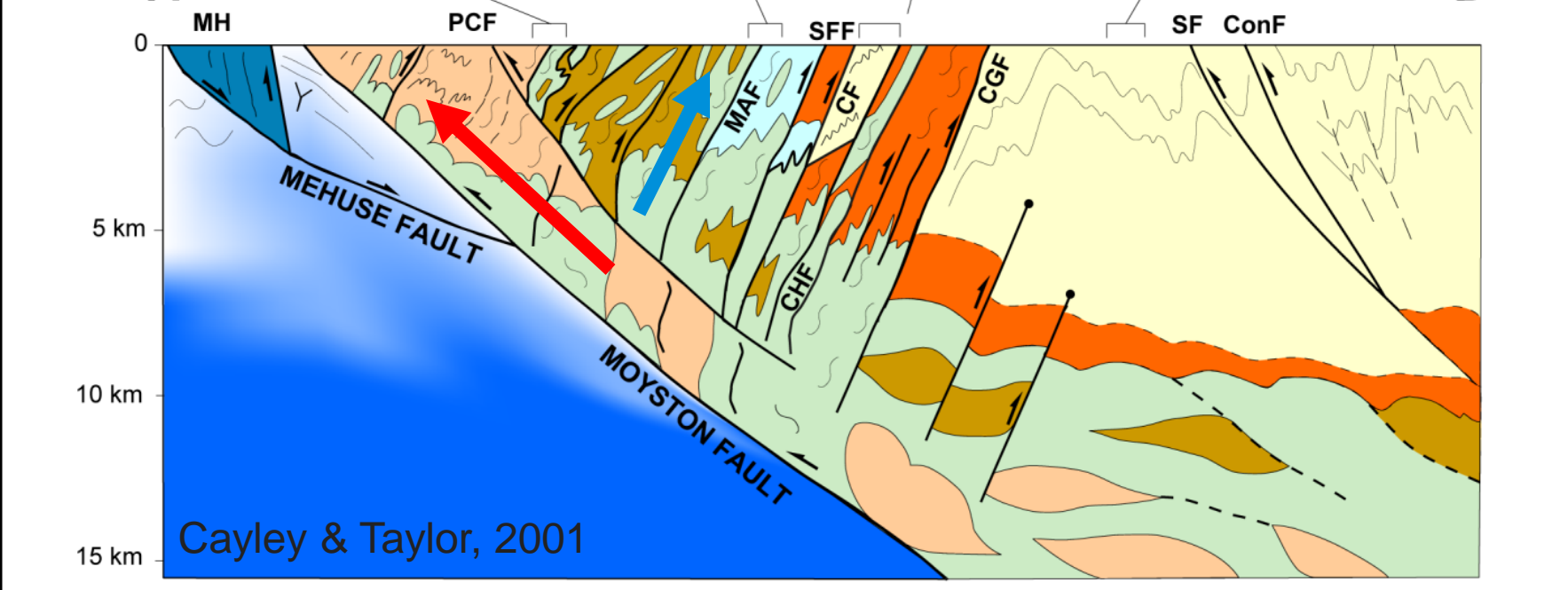
Cayley & Taylor, 2000, 2001



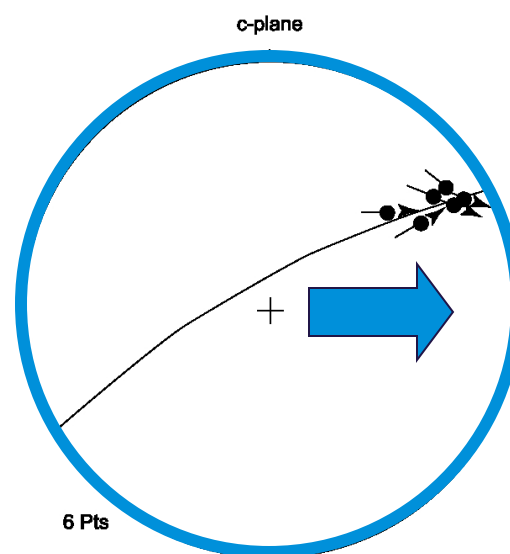


Cross-section drawn based on field mapping relationships and aeromagnetic and gravity data

Cayley & Taylor, 2000, 2001

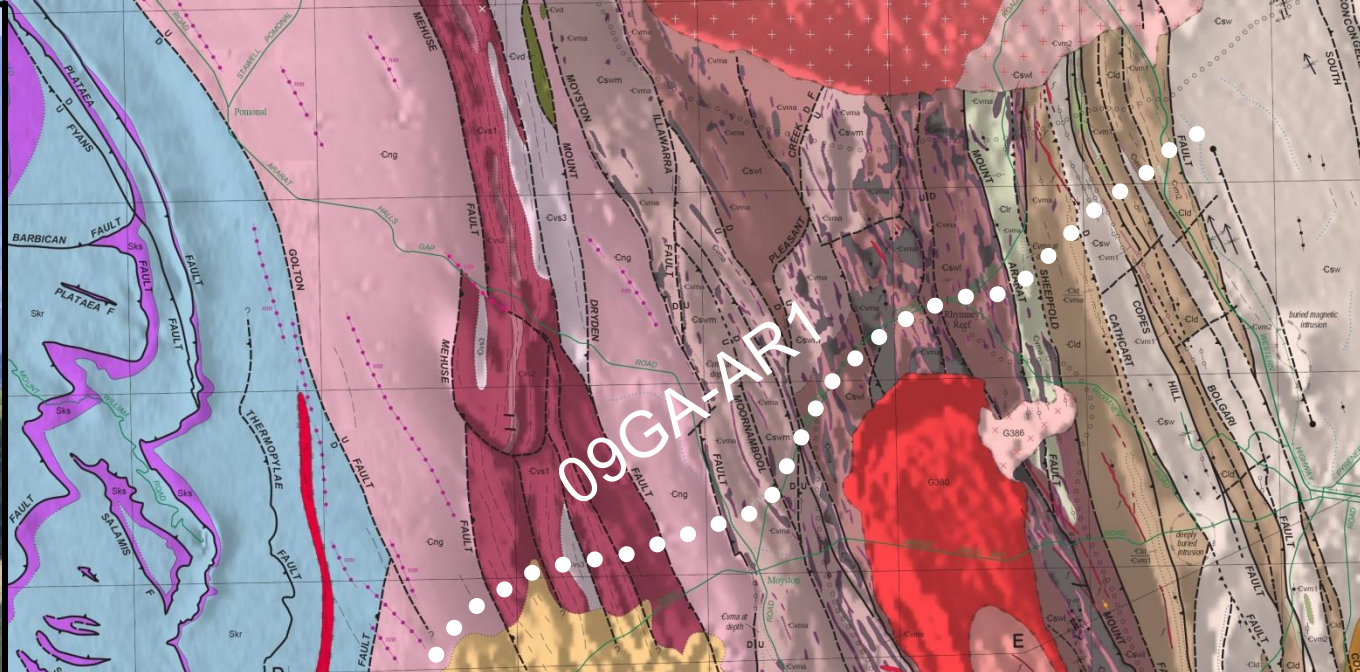


Spherical Mean=27-032
Spherical Variance=0.23
Calculated girdle: 64-139
Calculated beta axis: 26-319

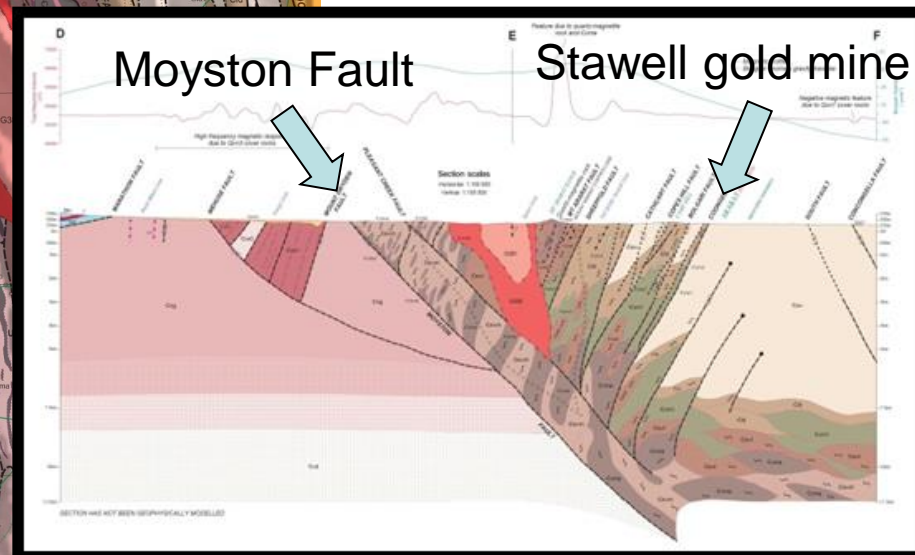
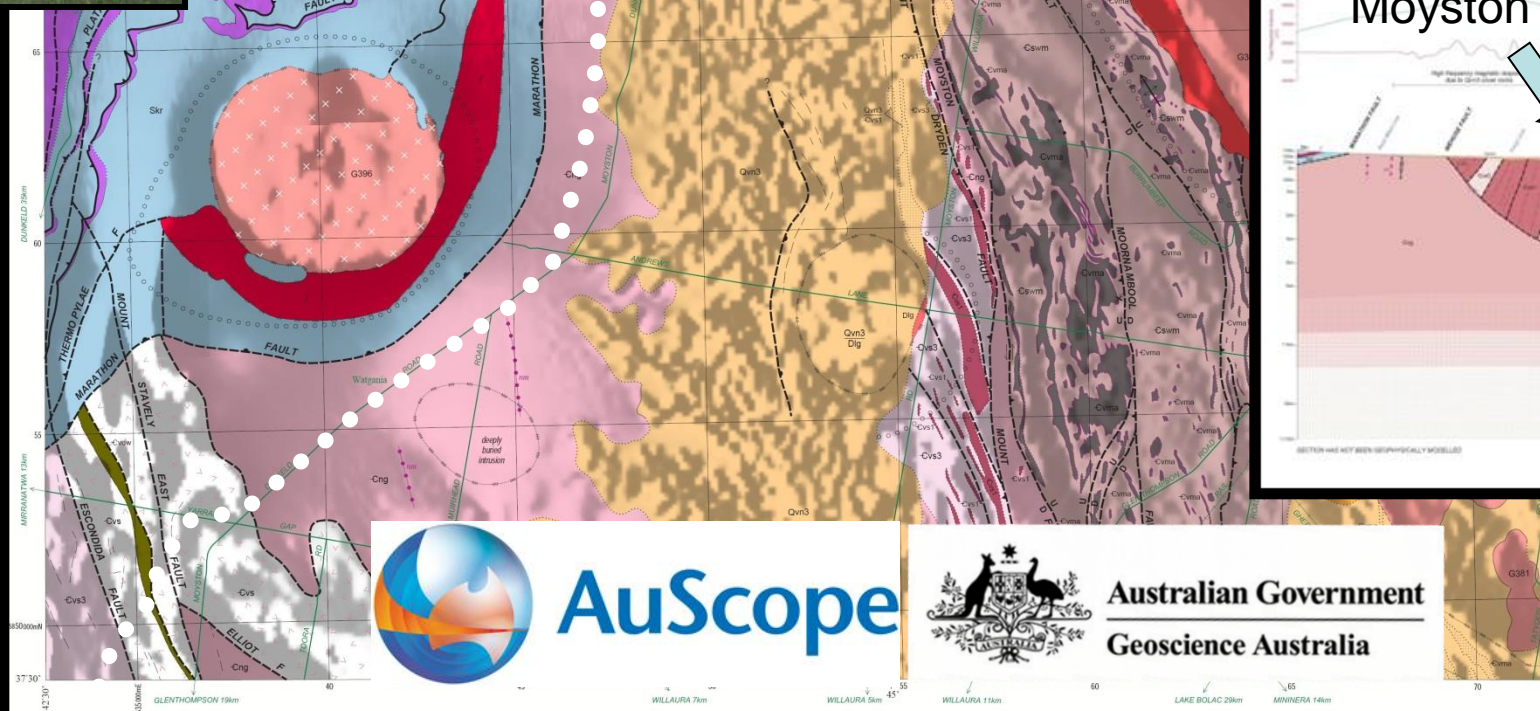


Spherical Mean=69-123
Spherical Variance=0.02
Calculated girdle: 80-331

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Deep seismic
reflection survey
traverse



Cayley & Taylor, 2000

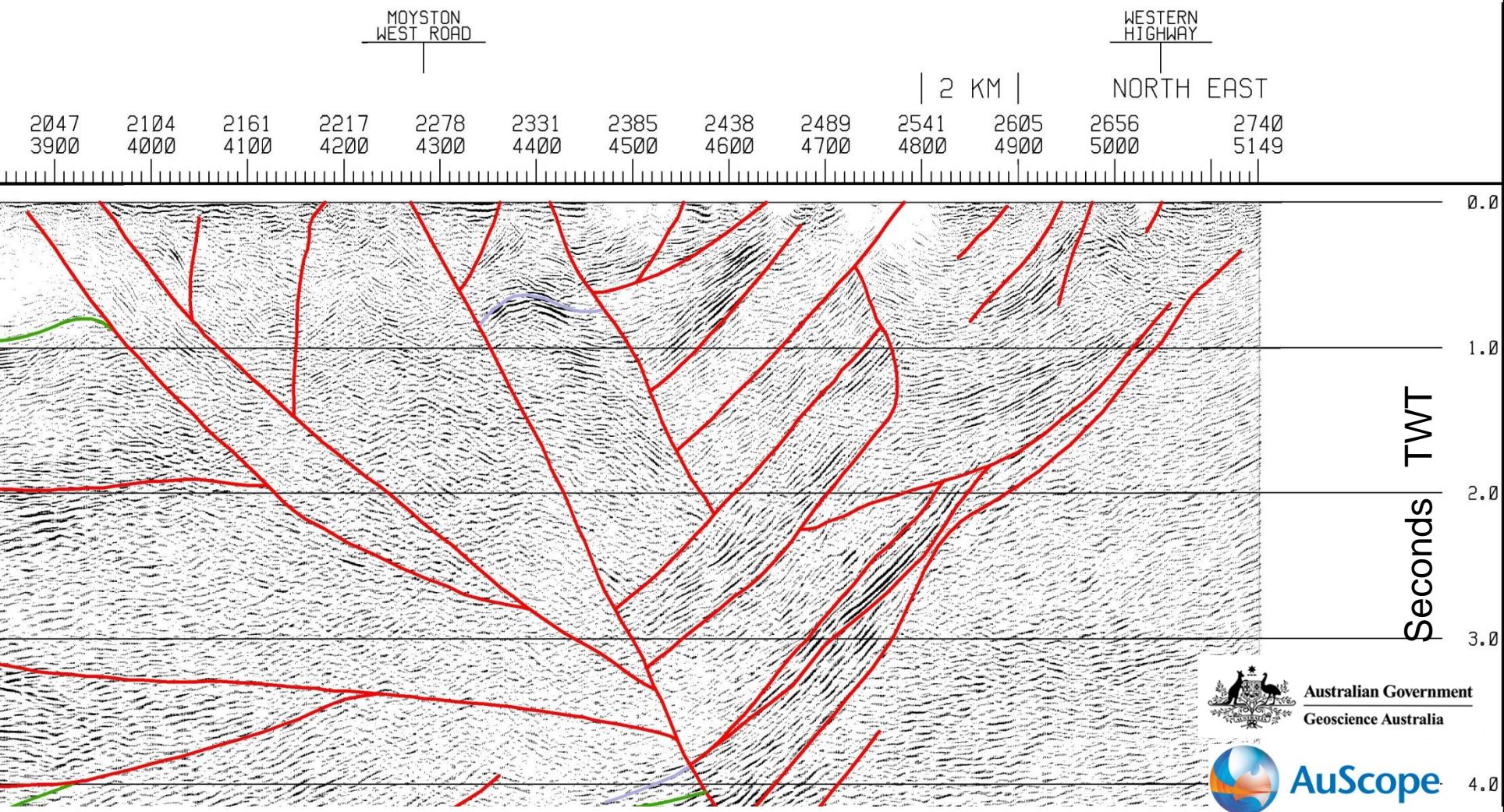


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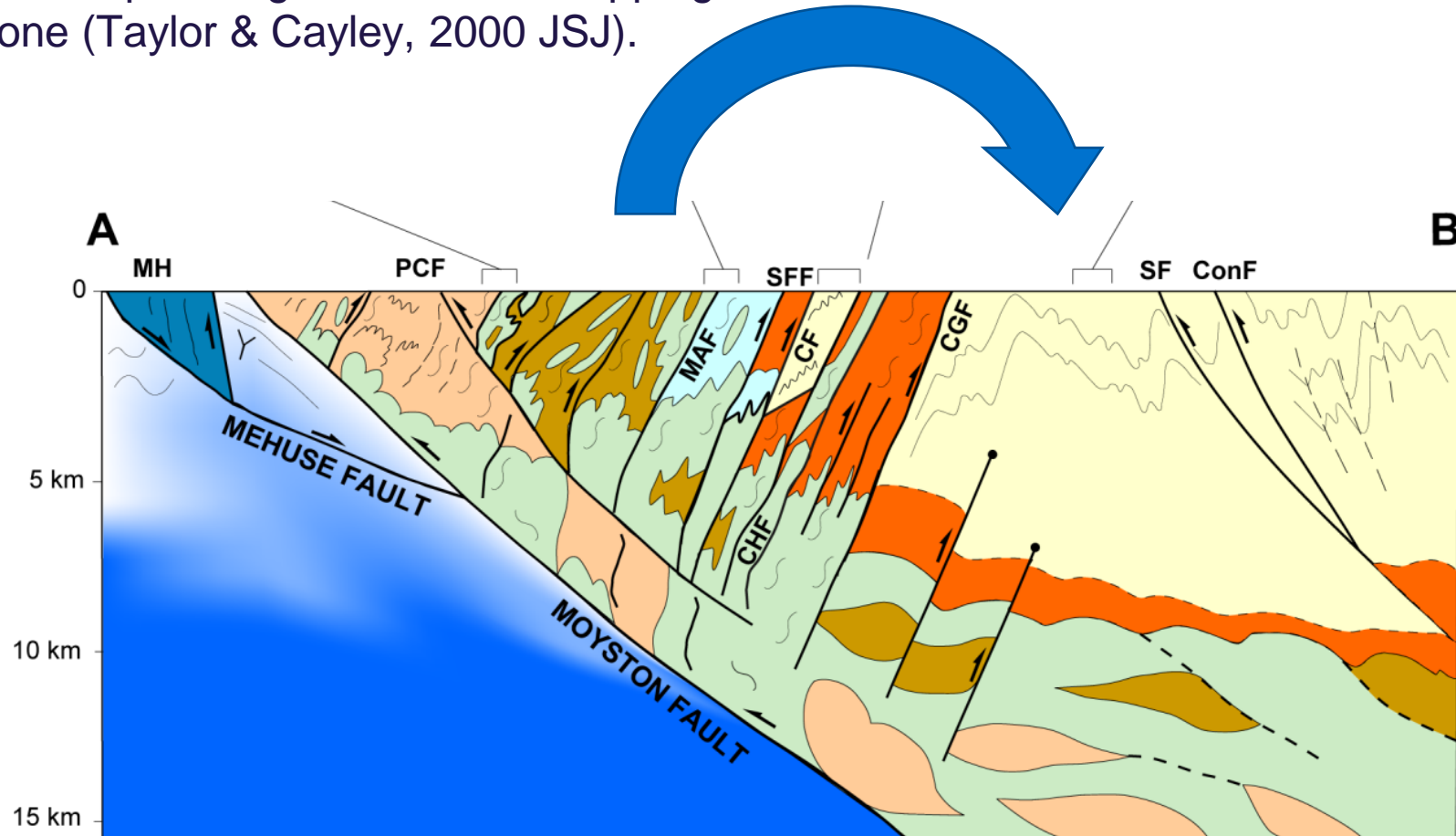
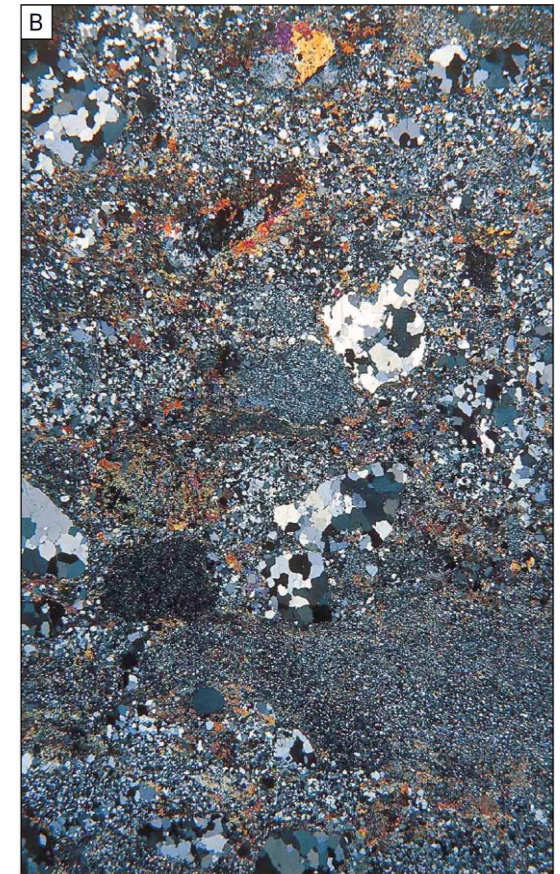
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Id Corridor Conference, November 2024 30



Overall geometry +
shallower water indications (carbonate concretions) +
tectonic mélange +
metamorphic character (high pressure) +
evidence of sediment recycling (Concongella
Gritstone) =
classic evidence for a 'Type 1' accretionary wedge
backstop setting above a west-dipping subduction
zone (Taylor & Cayley, 2000 JSJ).

Concongella Gritstone
Cayley & Taylor, 2001



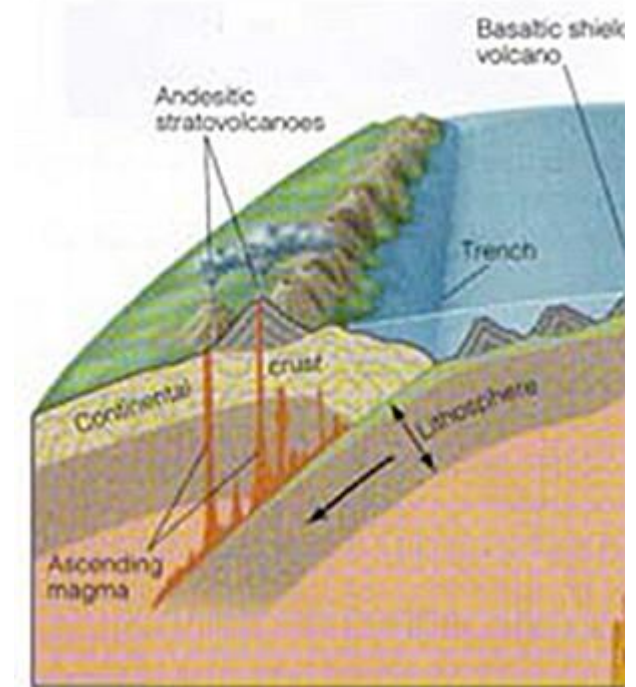
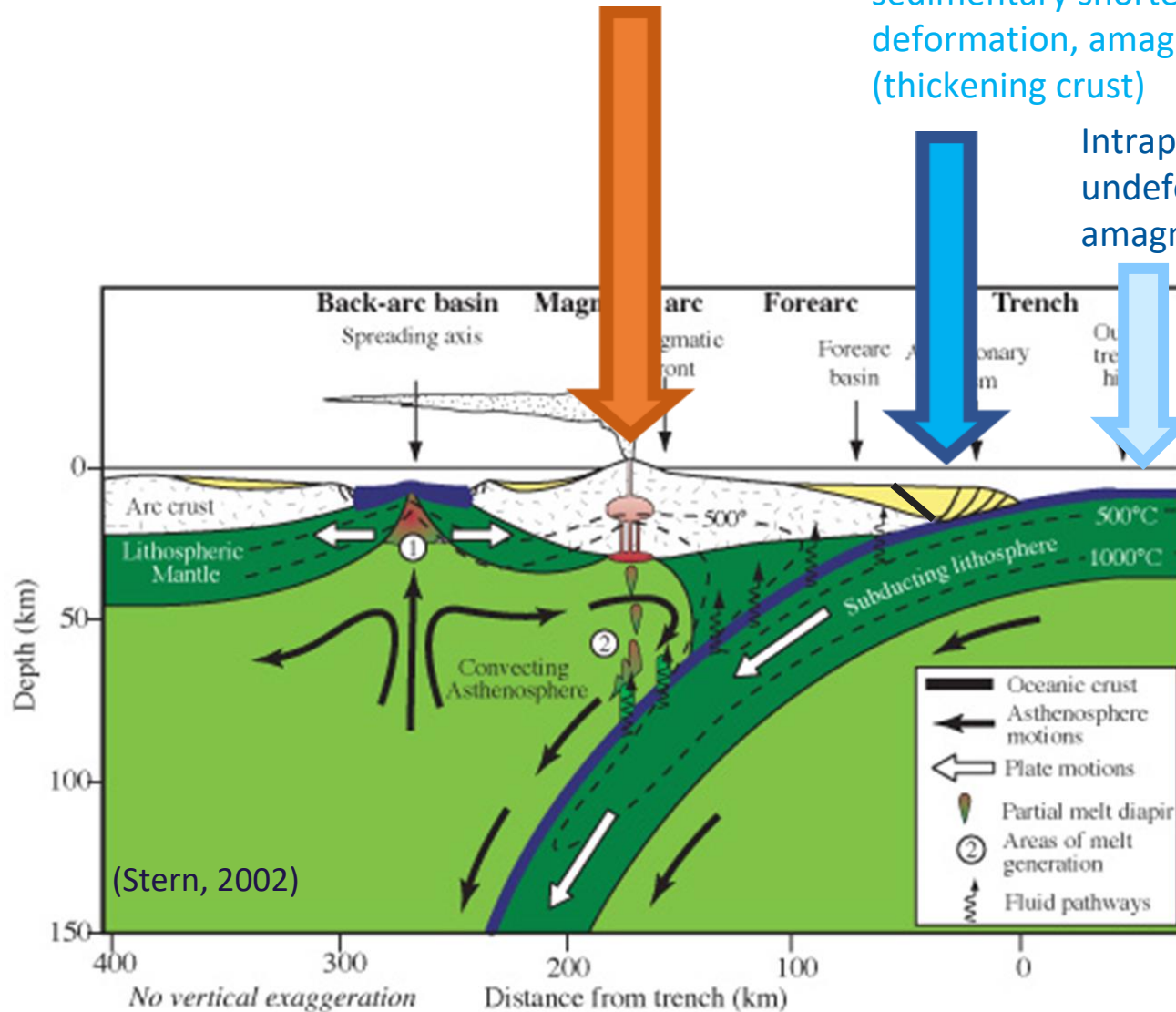
Convergent margin key elements and systematics

Magmatic arc:
hot, igneous-dominated

Accretionary wedge: cold, inherent
strong syn-
sedimentary shortening
deformation, amagmatic
(thickening crust)

= Stawell Zone in the Cambrian

Intraplate: cold,
undeformed, = Bendigo Zone in the Cambrian
amagmatic



West of the Moyston Fault – the Stavely Arc of the same age:





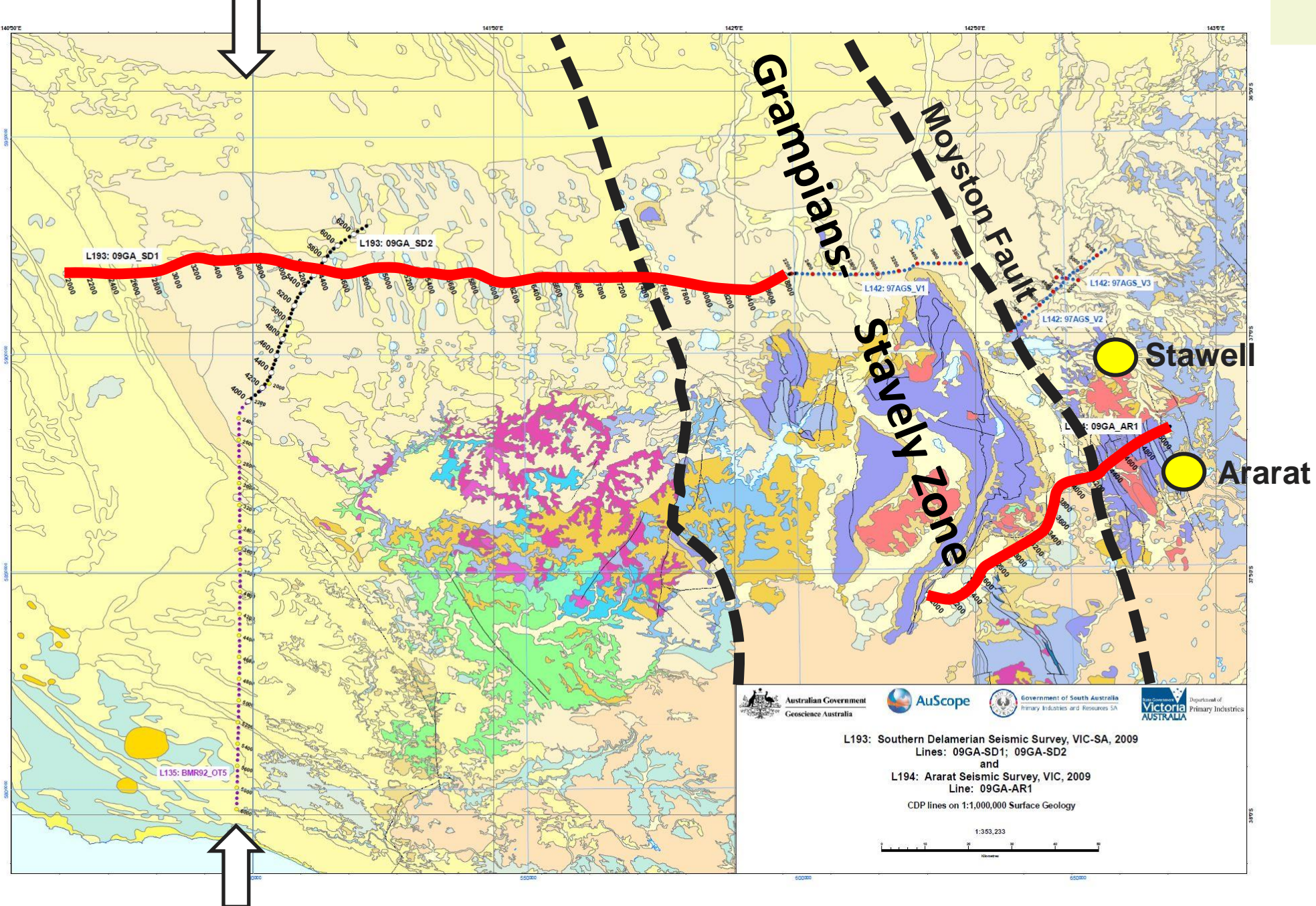
Cambrian andesite at Stavely.

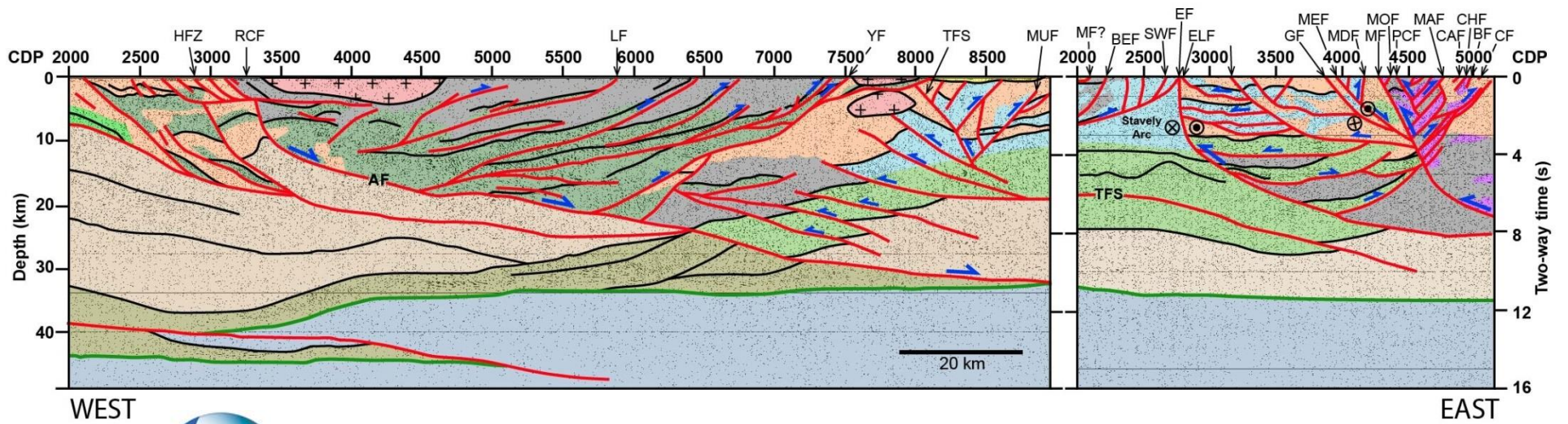
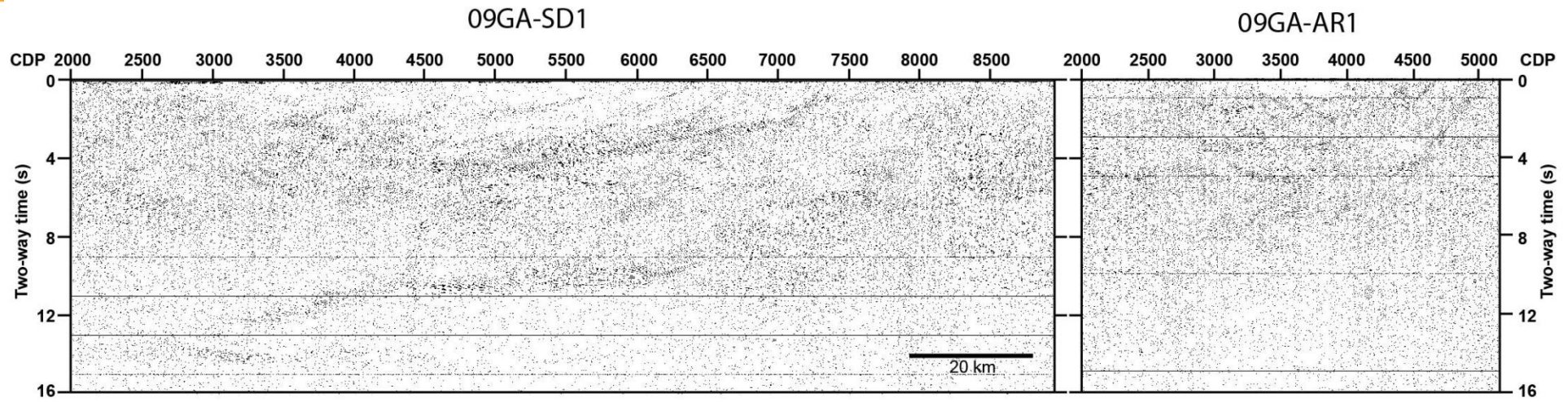
Cambrian andesite at Mount Dryden.



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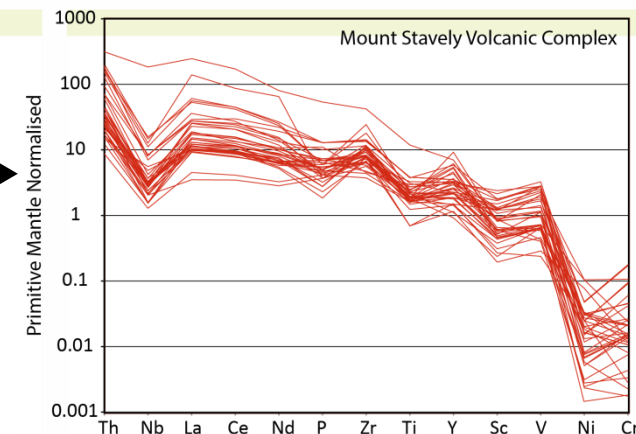




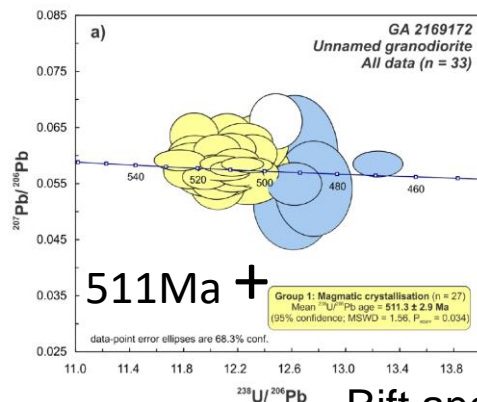
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Cayley et al, (still! in prep.)

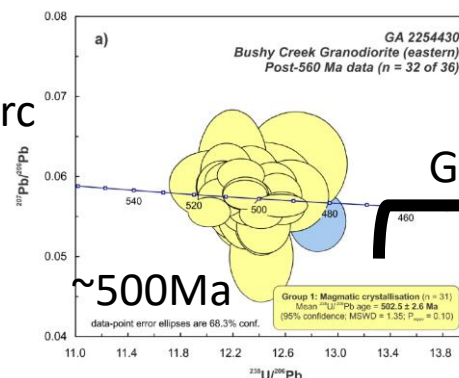
Depletion of Niobium relative to Lanthanum (and Potassium):
a key characteristic of subduction-related (arc) magmas
(fluid-immobile trace elements)



Whole-rock geochemistry - Continental arc (Schofield et al., 2018)



Stavelly Arc



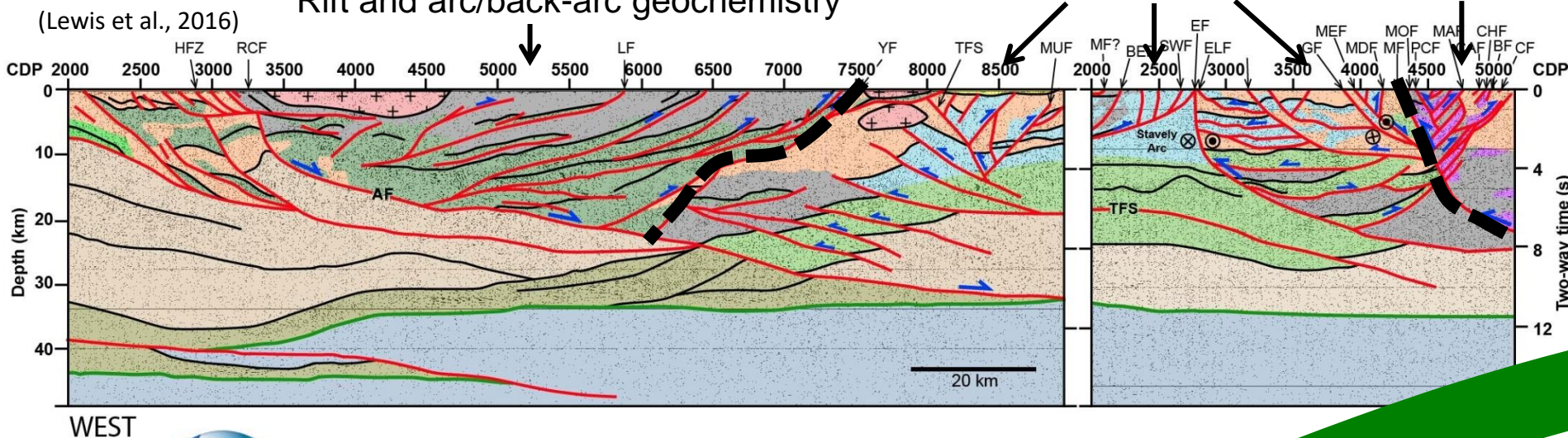
Grampians- Stavelly Zone

Stavelly Arc

Stawell Corridor
Accretionary Wedge

calc-alkaline igneous complex

Rift and arc/back-arc geochemistry



AuScope

Cayley et al, (still! in prep.)

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Distal back-arc:
transition to
intraplate

Magmatic arc:
hot, igneous-dominated

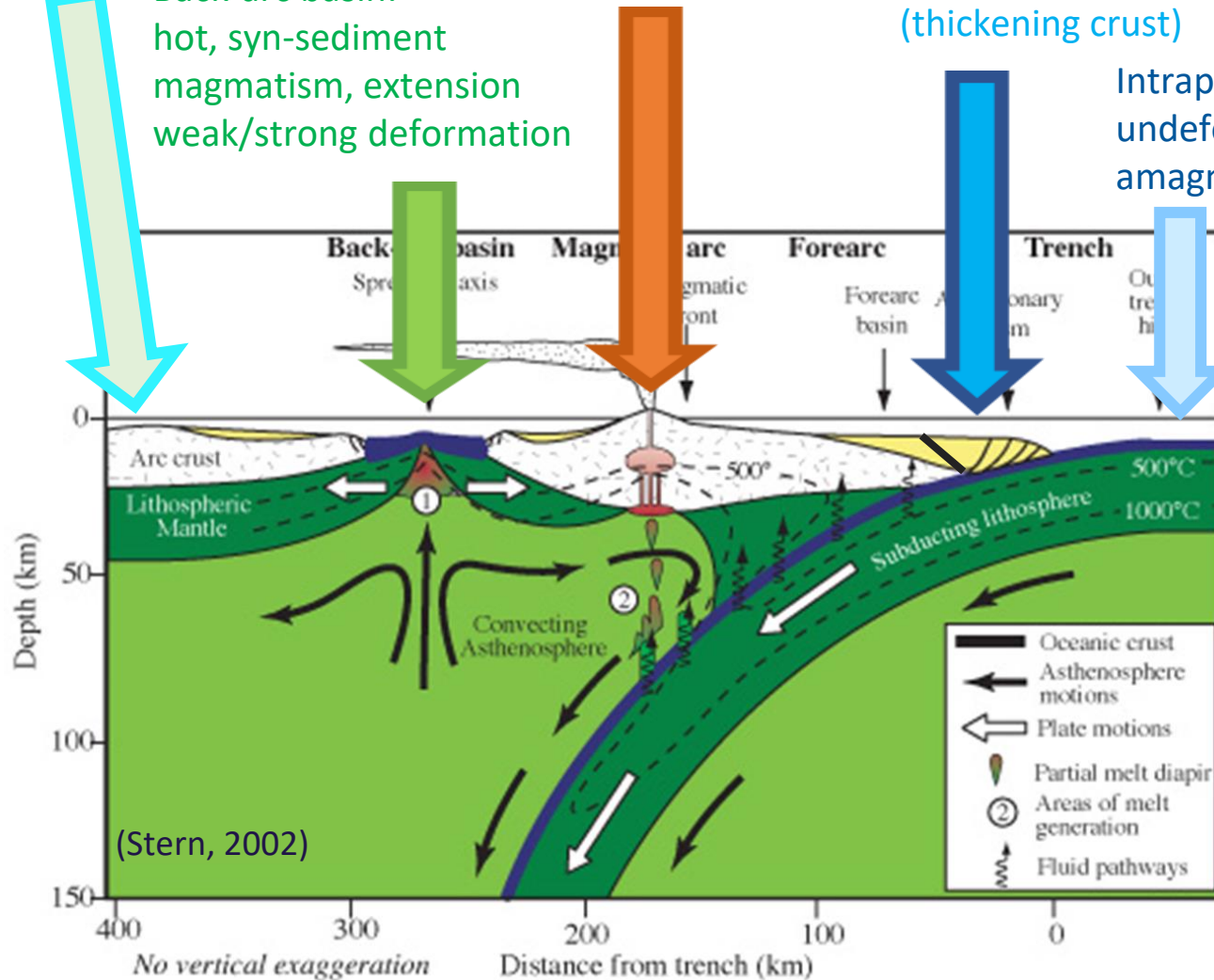
Accretionary wedge: cold, inherent
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= Stawell Zone in the Cambrian

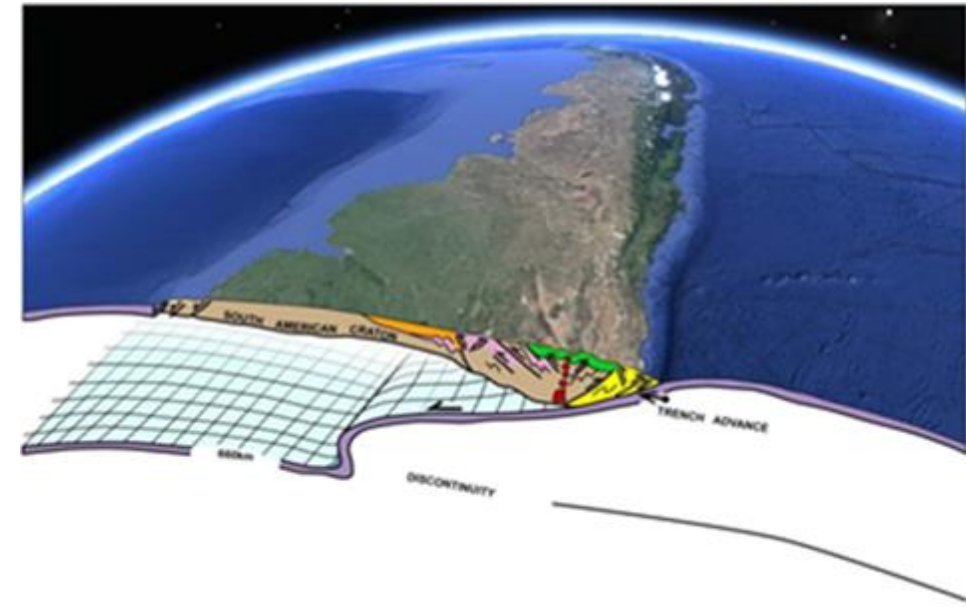
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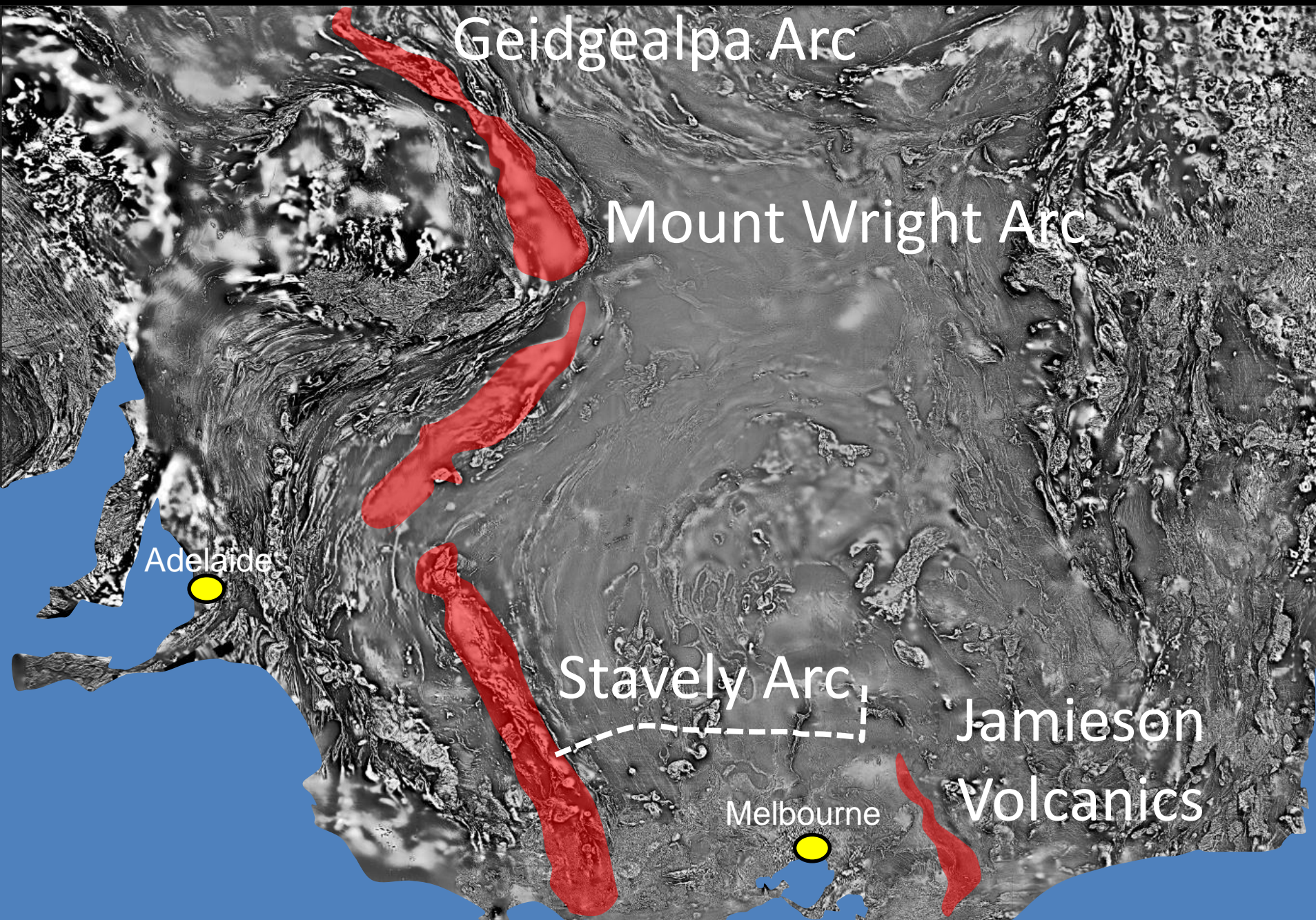
Intraplate: cold,
undeformed, = Bendigo Zone in the Cambrian
amagmatic

Stavelly Arc



South America, today

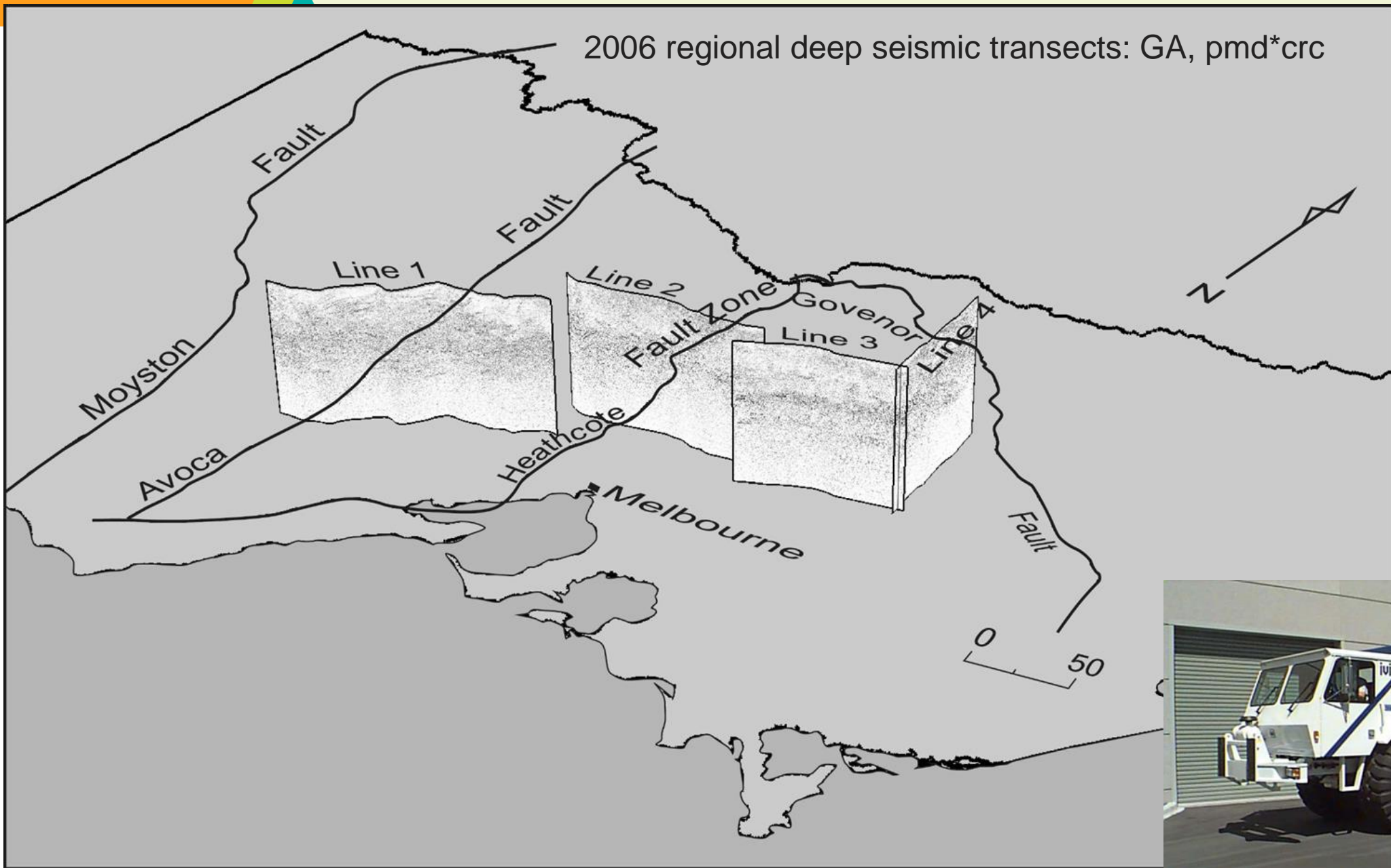


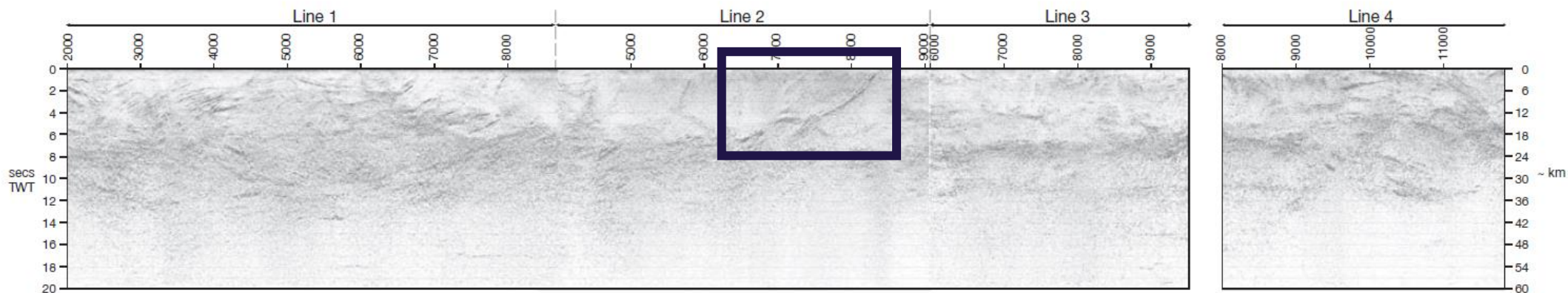
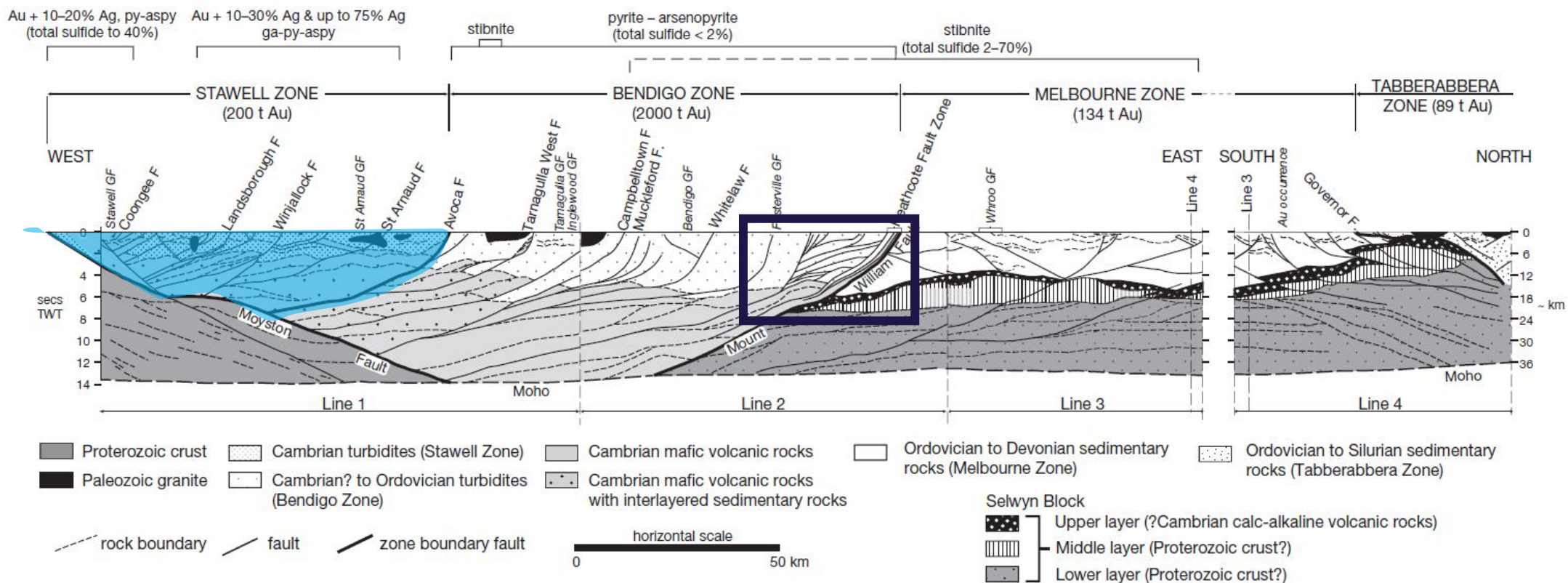


How big is the Stavely Arc?

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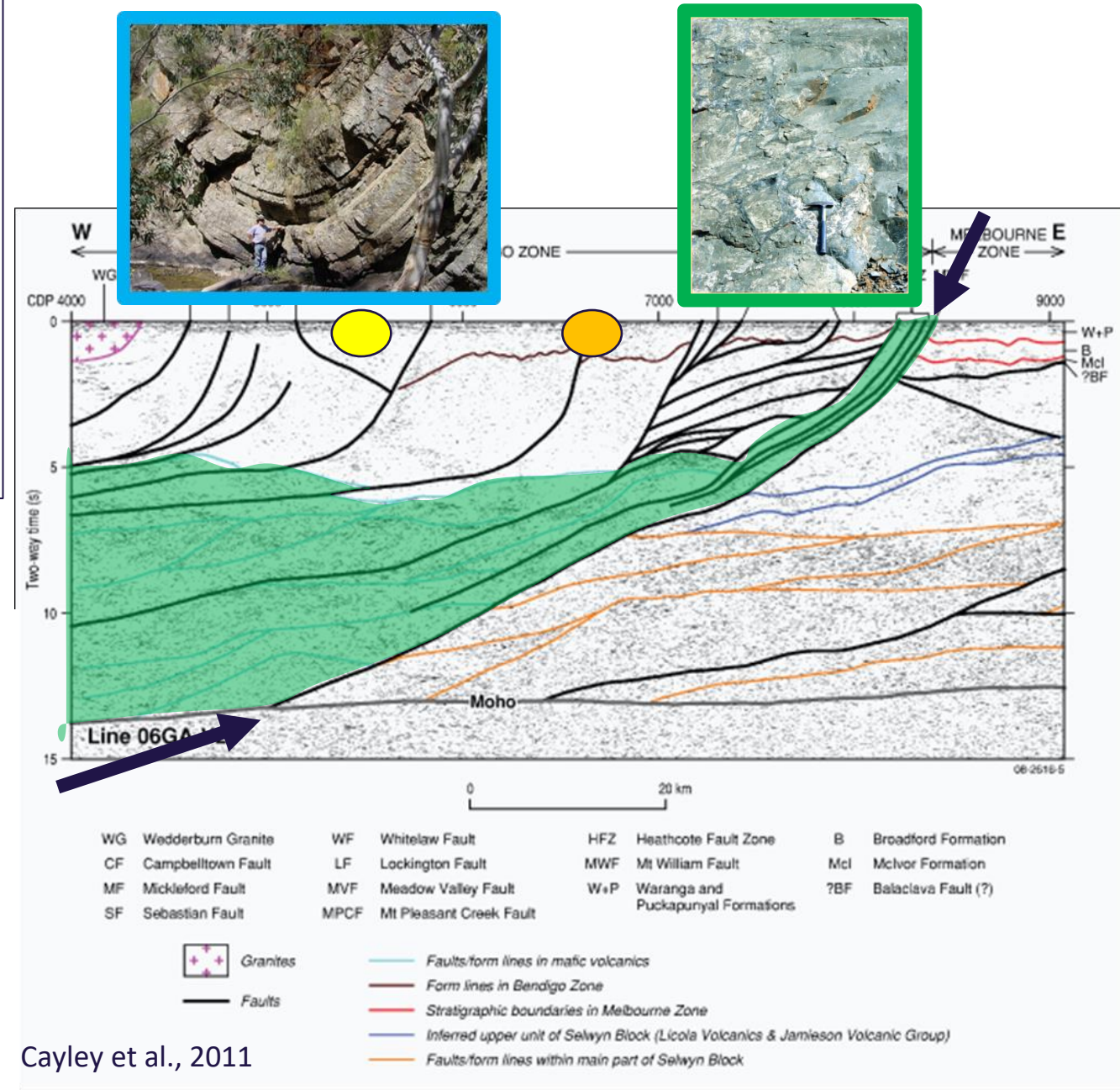




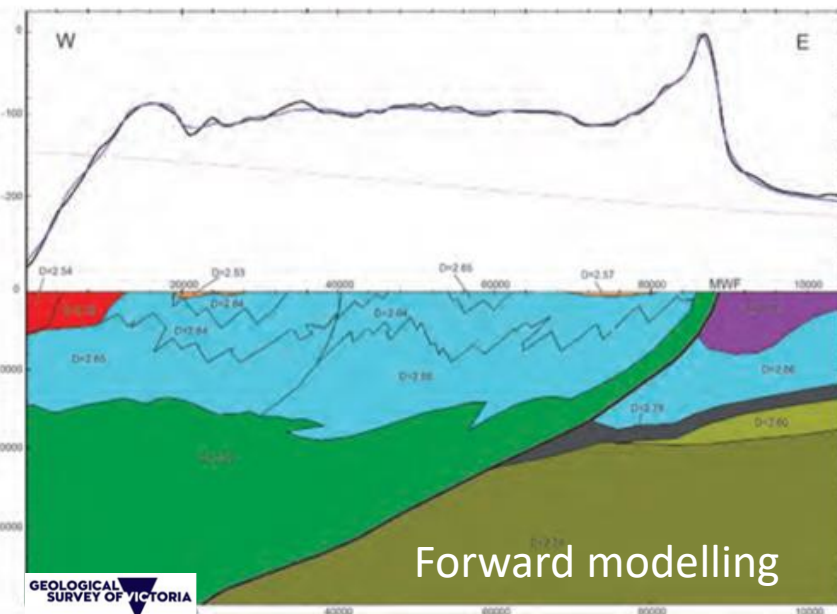
This research shows that tens of thousands of cubic kilometres of Cambrian metavolcanic rocks underlie the Bendigo goldfields

– a source for gold?

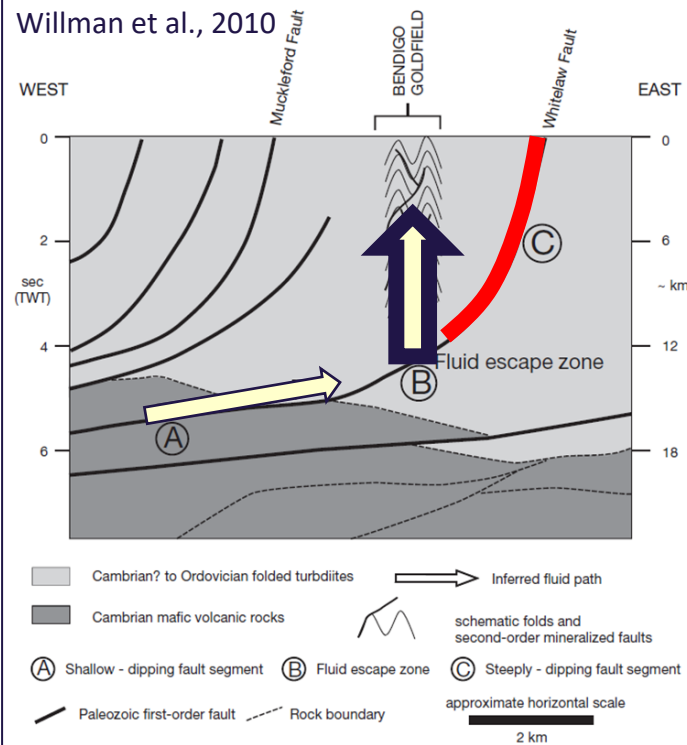
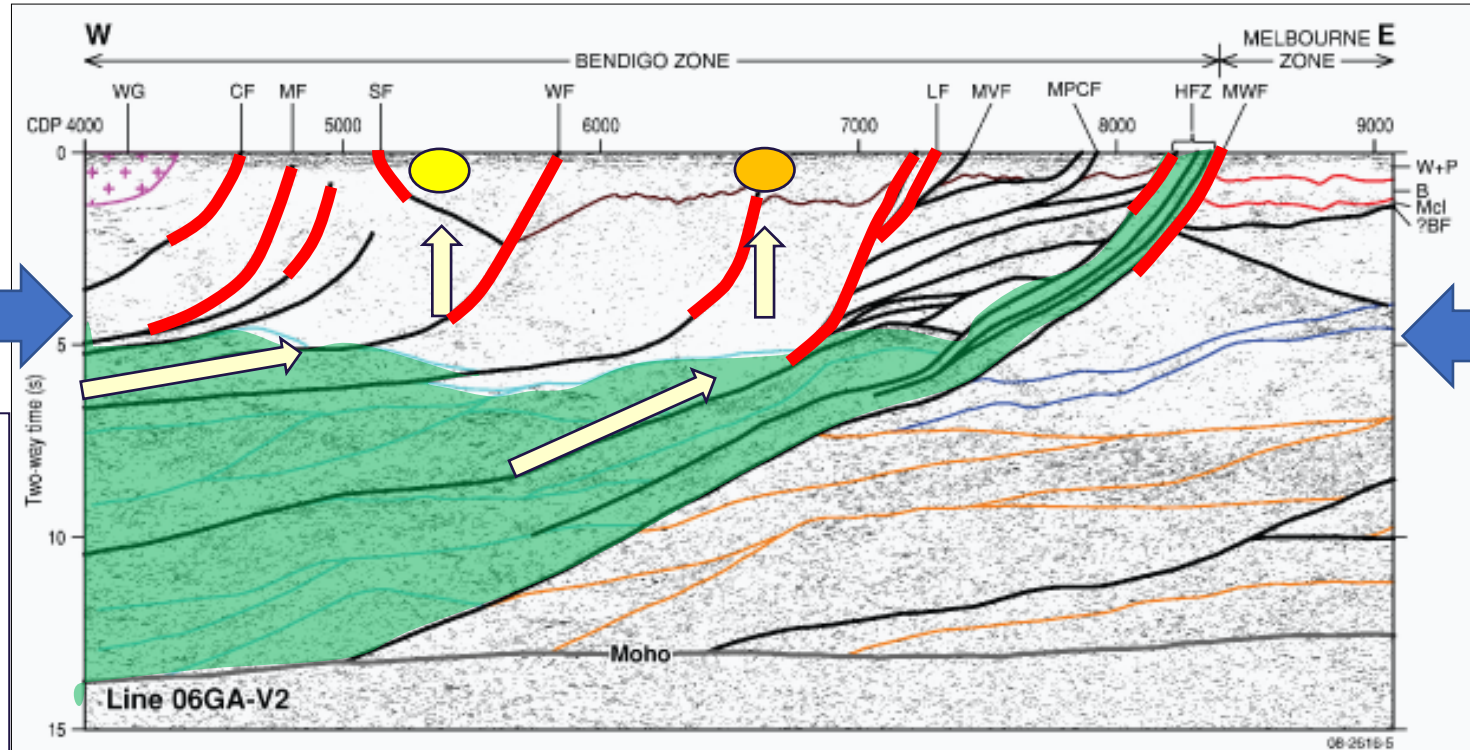
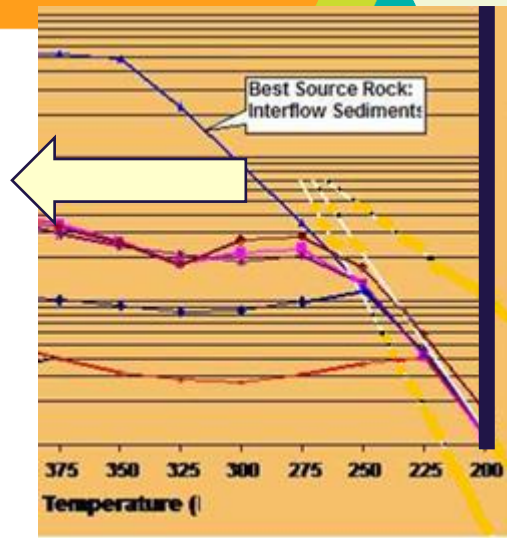
Goldfields geology is thick-skinned!



Cayley et al., 2011



This process need not be efficient – the data indicates
tens of thousands of cubic km of potential mafic igneous source rocks



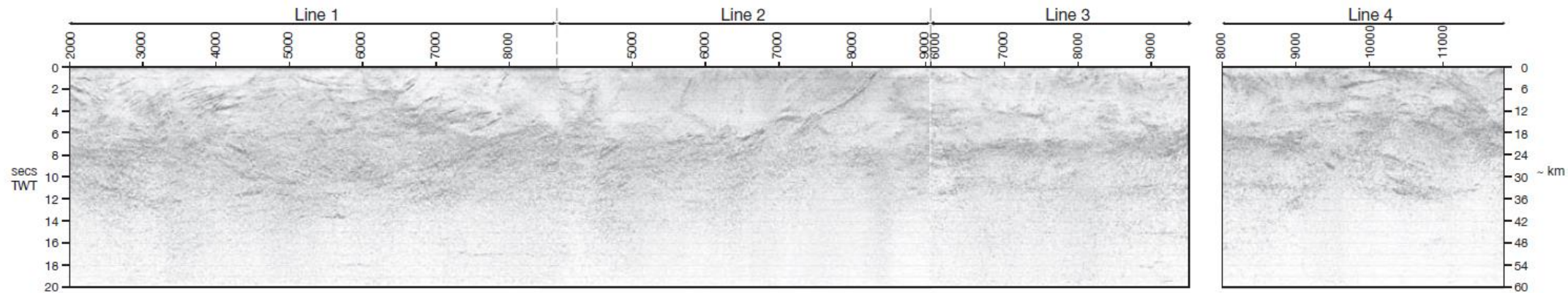
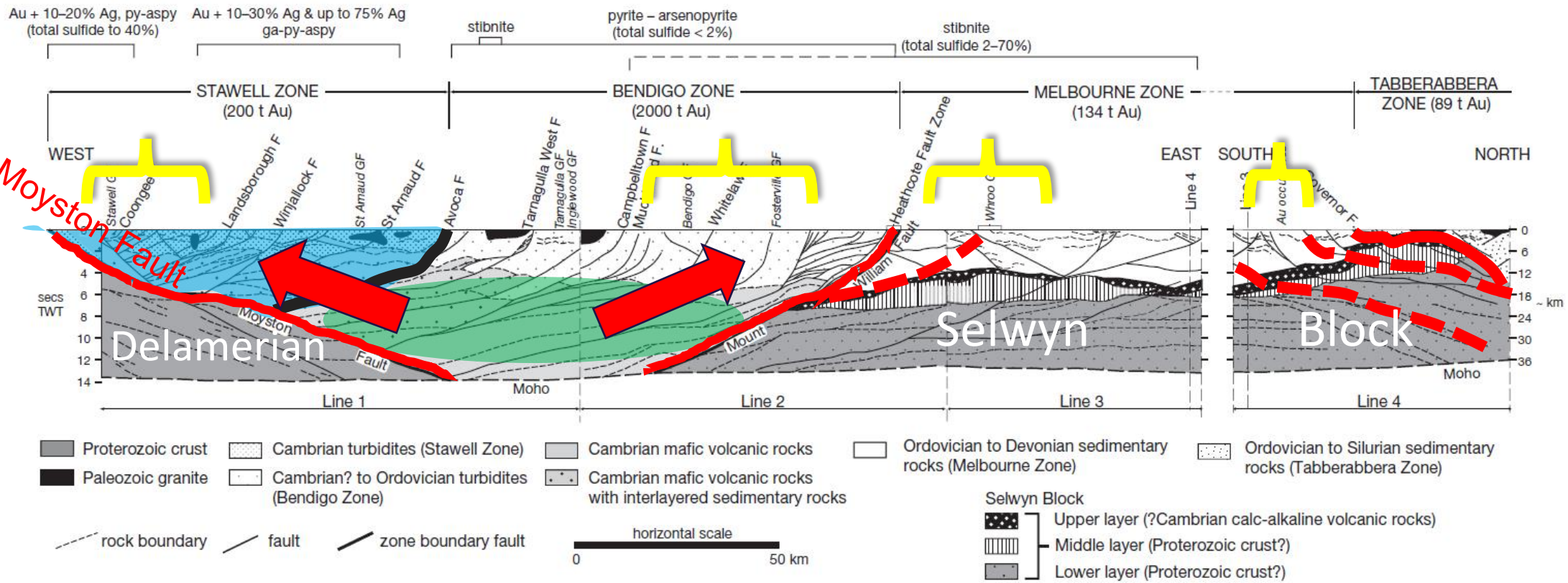
Line 06GA-V2 - interpretation

WG	Wedderburn Granite	WF	Whitelaw Fault	HFZ	Heathcote Fault Zone	B	Broadford Formation
CF	Campbelltown Fault	LF	Lockington Fault	MWF	Mt William Fault	Mcl	Mclvor Formation
MF	Mickleford Fault	MVF	Meadow Valley Fault	W+P	Waranga and Puckapunyal Formations	?BF	Balaclava Fault (?)
SF	Sebastian Fault	MPCF	Mt Pleasant Creek Fault				

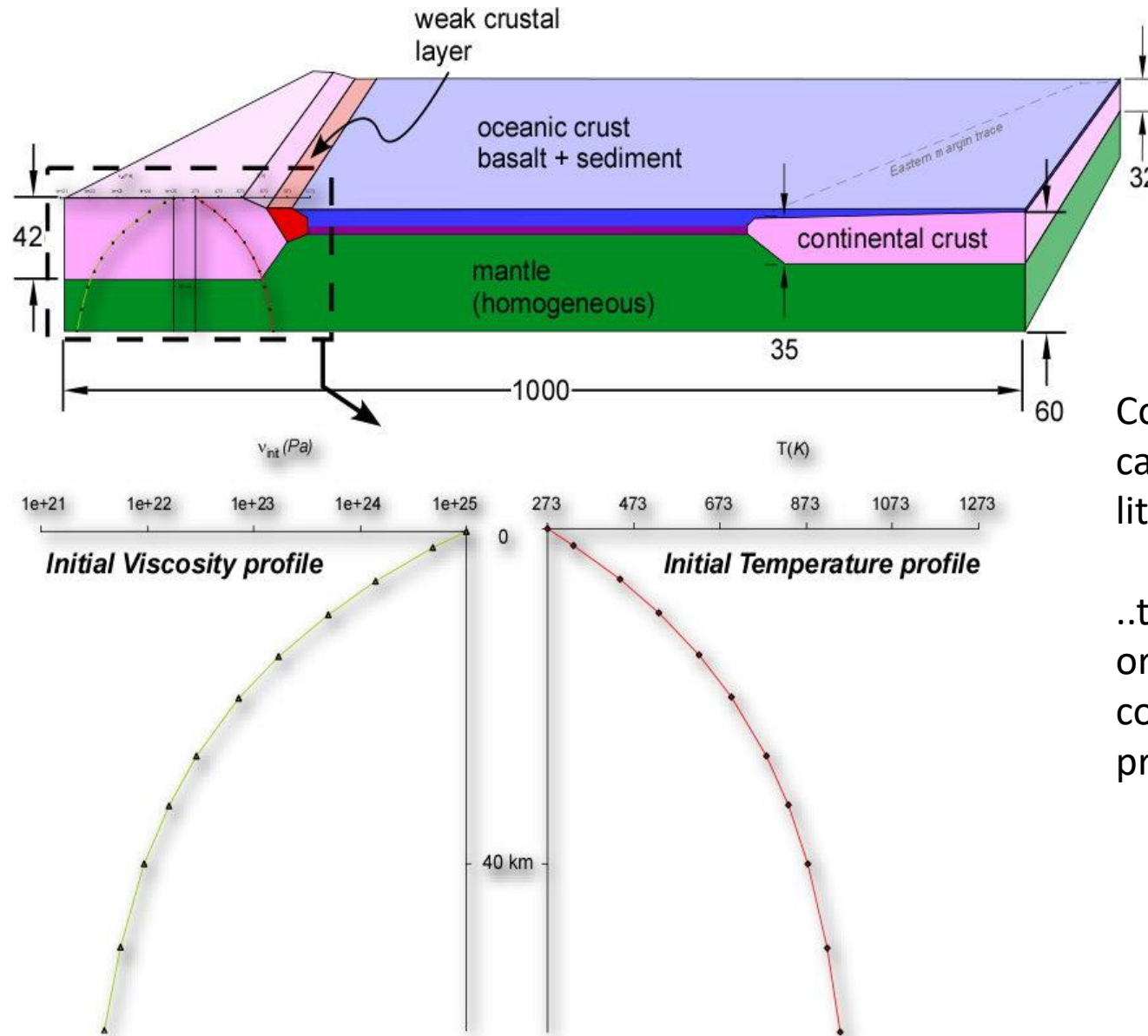


- Faults/form lines in mafic volcanics
- Form lines in Bendigo Zone
- Stratigraphic boundaries in Melbourne Zone
- Inferred upper unit of Selwyn Block (Licola Volcanics & Jamieson Volcanic Group)
- Faults/form lines within main part of Selwyn Block

Cayley et al., 2011



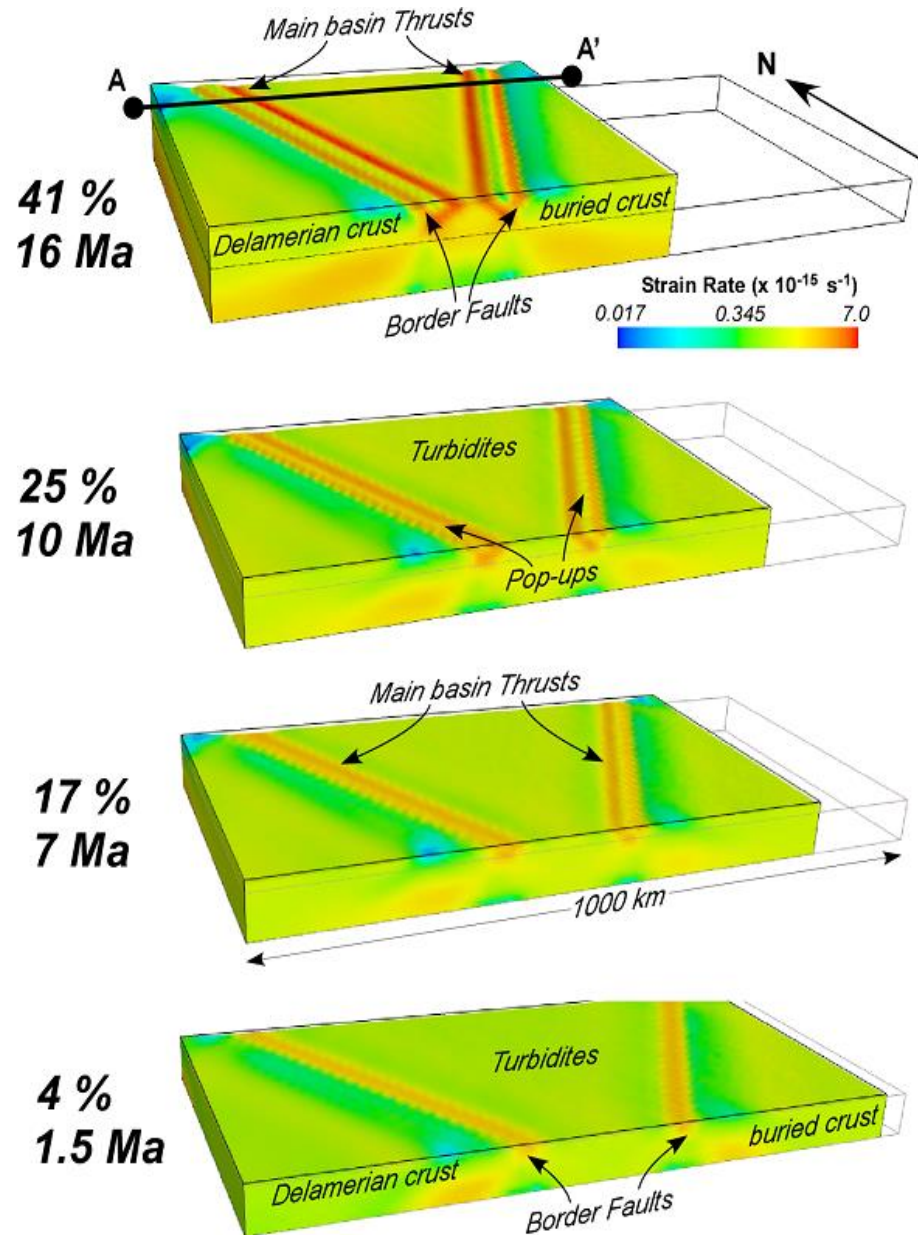
Gale simulations of basin closure (continental collision)



Constrained crustal-scale retrodeformations can give geometrical start-points for lithospheric-scale modelling of...

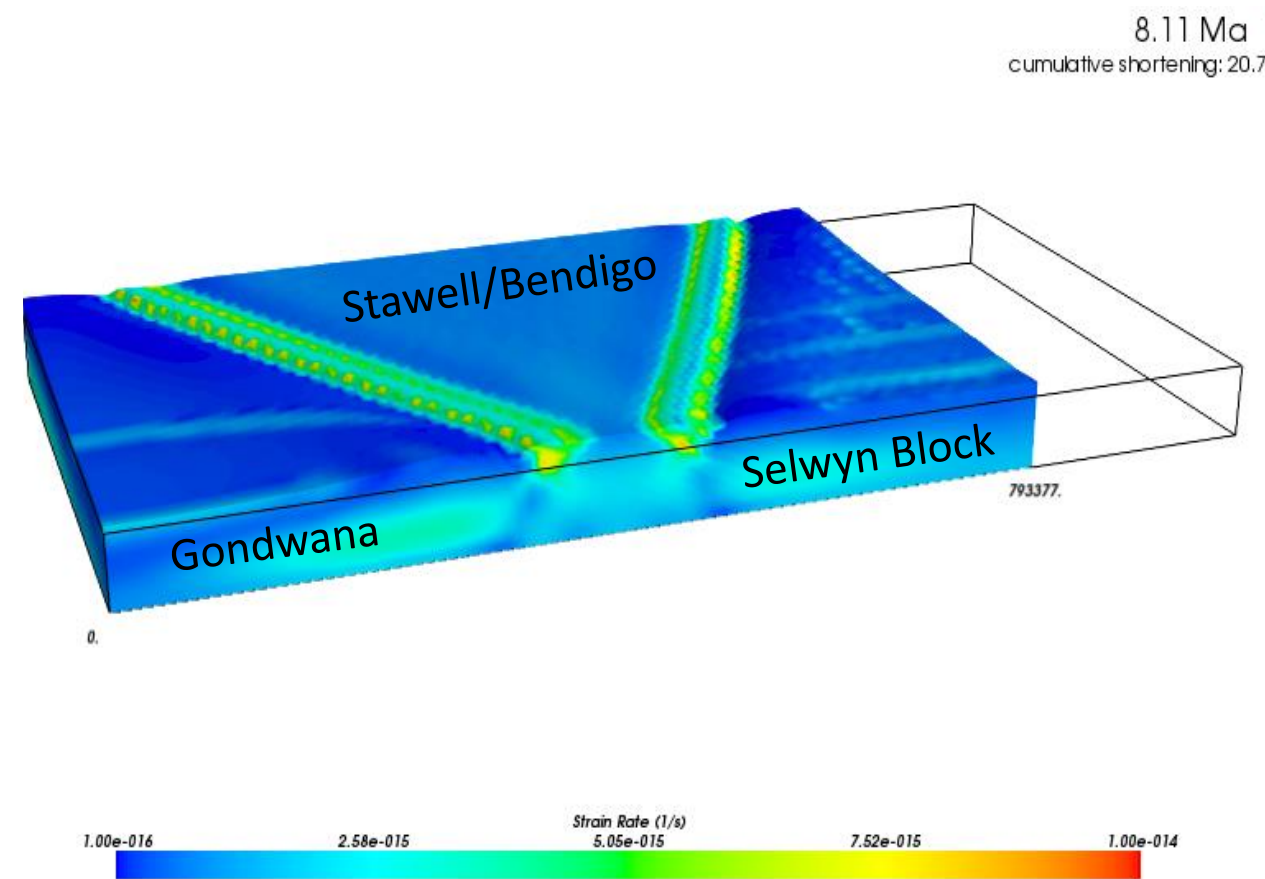
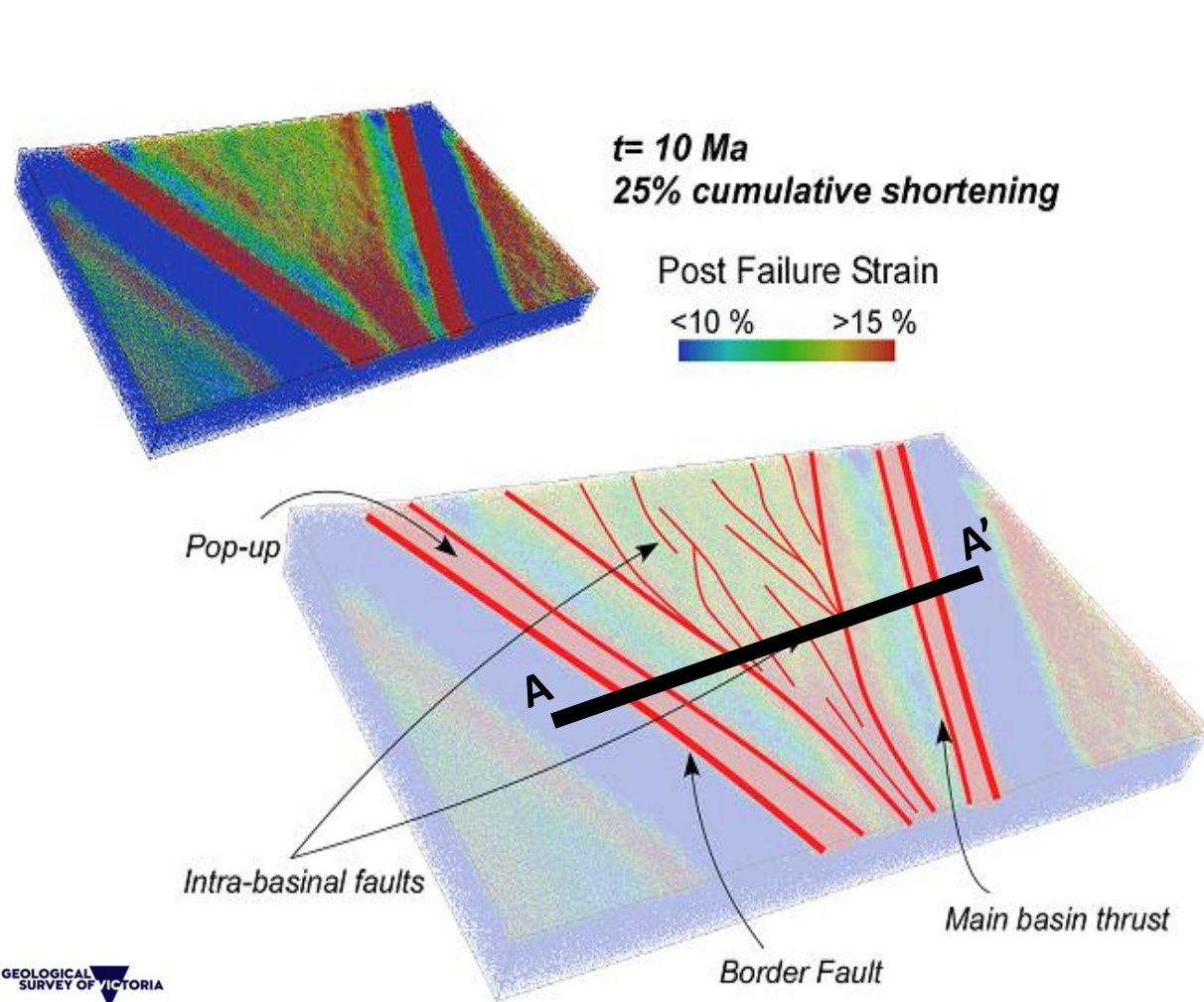
..tectonic scenarios that potentially formed orogenic-gold –laden continental crust from collisional thickening of an oceanic crust precursor (ie: no local crust subduction)

Gale simulations of basin closure



- Initial formation of basin-dipping bounding faults
- Moyston F., Heathcote F.
- Subsequent development of back thrusts
- High strain zones within the basin

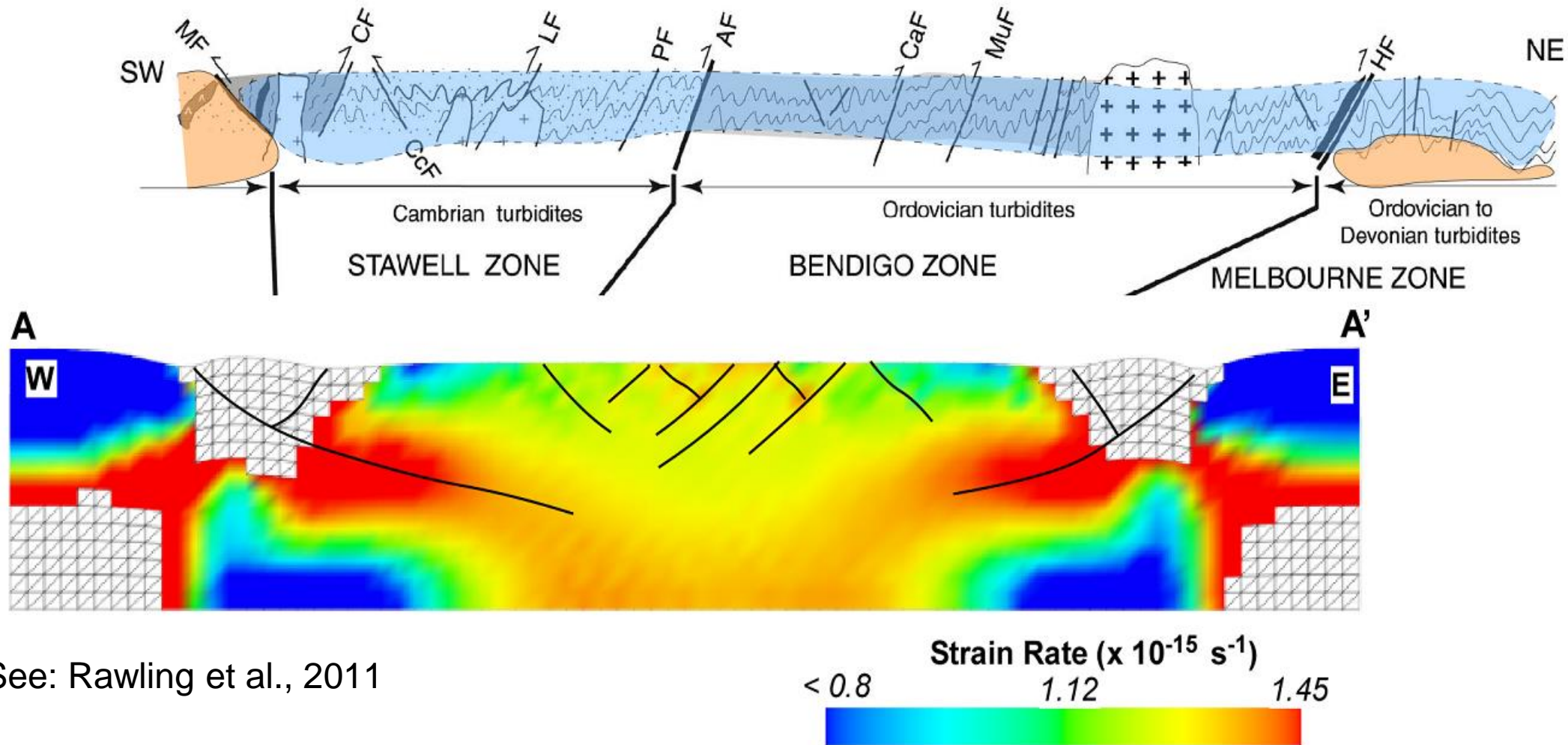
Recreates large bounding faults....
and a network of internal faults reminiscent of what is observed
in map-view in the Stawell and Bendigo zones



See: Rawling et al., 2011

Stawell Gold Corridor Conference, November 2024

...and reminiscent of what is observed
in cross-section in the Stawell and Bendigo zones.....

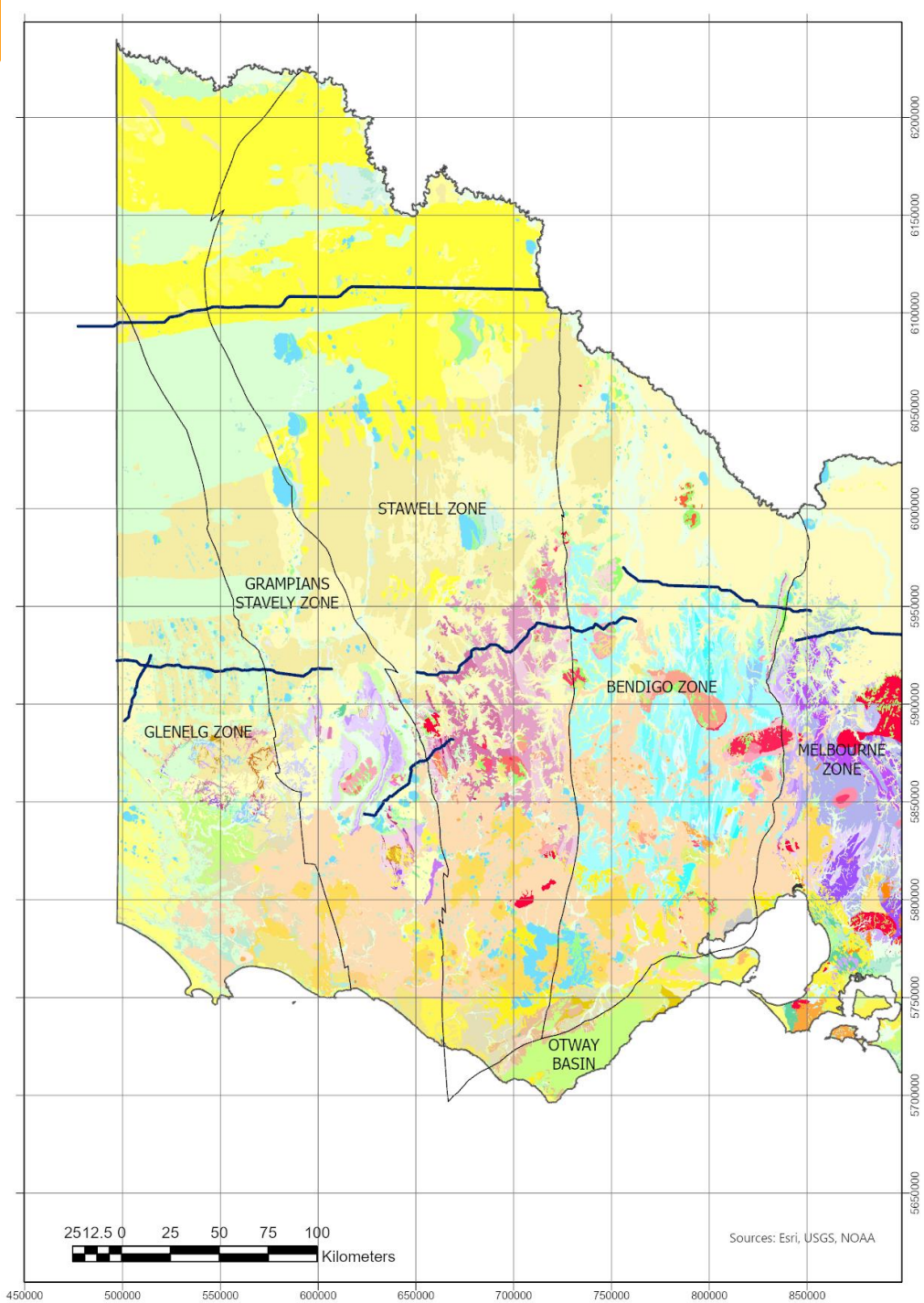


See: Rawling et al., 2011

As these models are refined, improved predictive capacity for orogenic gold is sure to follow.....

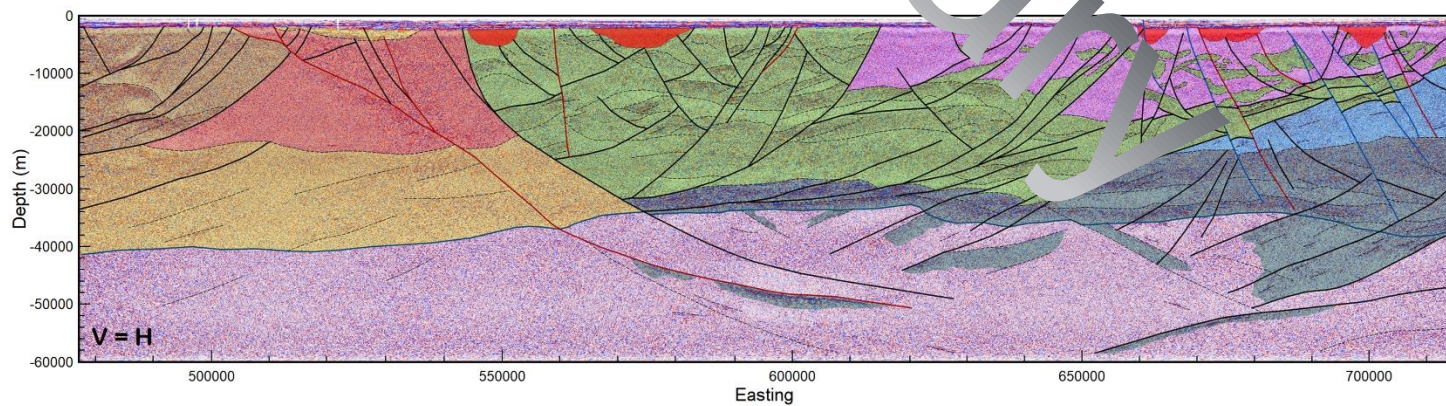
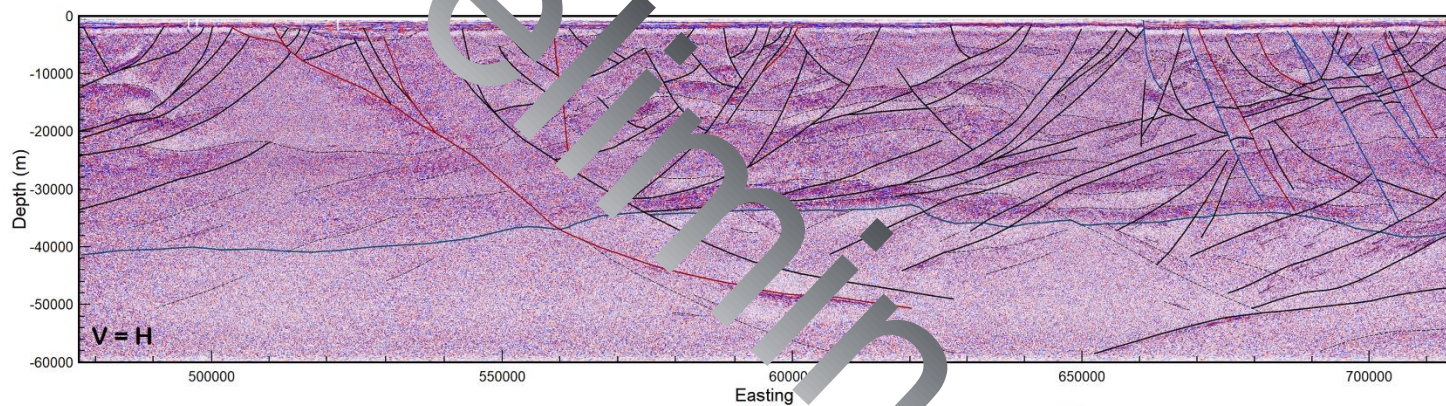
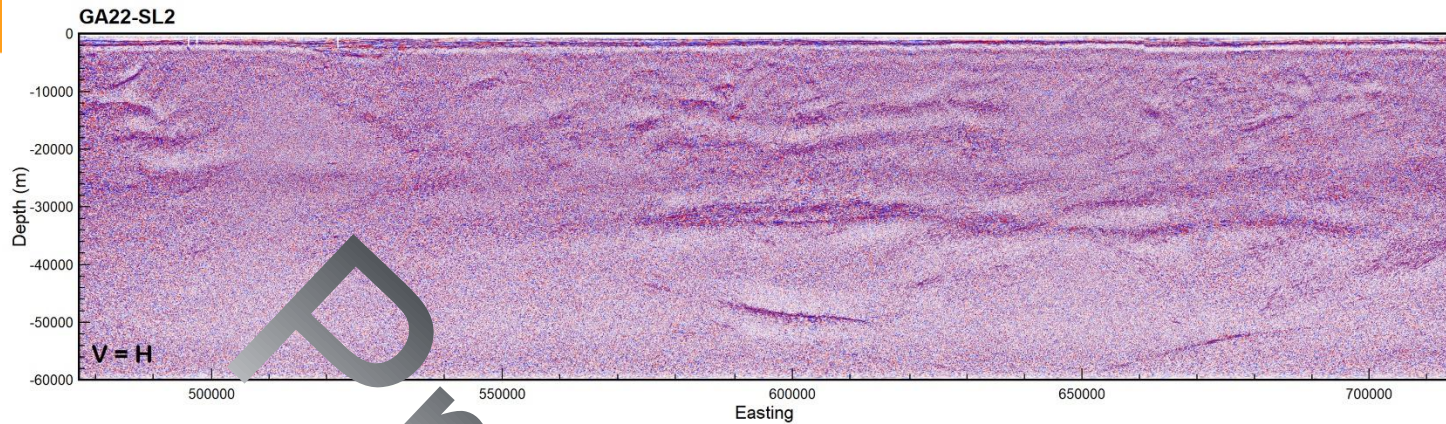
Talk outline

- Geological Systems Analysis – a logical way to overcome tectonic ambiguity / complexity
- The ‘Stawell Zone’ – where is it and what does it look like?
- The Moyston Fault and ‘Stawell Corridor’ – the complex faulted interface between the Stawell Zone and the Grampians-Stavely (Arc) Zone.
- Linking Stawell Zone geology to Stavely Arc geology – present-day Pacific Rim geology as an analogue for understanding Cambrian western Victorian geology and mineral endowment.
- How we think the ‘Stawell Corridor’ got most of its gold (hint: it stole it from the Bendigo Zone!)
- **Further work (chasing Stawell Zone gold (and Stavely Arc base metals) prospectivity under cover.**



Geoscience Australia (in prep): Line GA22-DL2





Geoscience Australia (in prep): Line GA22-DL2



Skladzien & Cayley, 2023

2022 Geoscience Australia (in prep): Line GA22-DL2

Avoca Fault

Moyston Fault

2006 regional deep seismic transects: GA, pmd*crc



Main take aways to remember:

- Common ages and geological systems analysis show that the Stawell Zone and the Stavelly Arc were components of a continental margin subduction-accretion system active in the Cambrian.
- The Stavelly Arc experienced a similar (but shorter) geological history to the modern Andes of South America – expected to have similar mineral systems styles (but likely smaller).
Thursdays Gossan deposit (*Pennzoil / Stavelly*); Morning Bill (*Navarre*); Eclipse/McRaes (*CRAE discovery*).
- The Stawell Zone was not significantly mineralized during its accretion in the Cambrian
- HOWEVER – mapping and seismic data both show that the Stawell Zone was piggy-backed over the deforming Bendigo Zone in the Late Ordovician.
- The Stawell Zone (especially the Stawell Corridor) was connected to the lower Bendigo Zone via the Moyston Fault..and this is where we think World Class Bendigo Zone gold came from.
The Stawell Zone has comparable gold potential to the Bendigo Zone.

**Thanks for listening.
Have a great conference everyone!**