

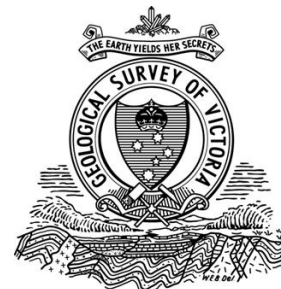


Gold in Victoria

The current State of Play

Ross Cayley

Geological Survey of Victoria
Department of Economic Development, Jobs,
Transport & Resources



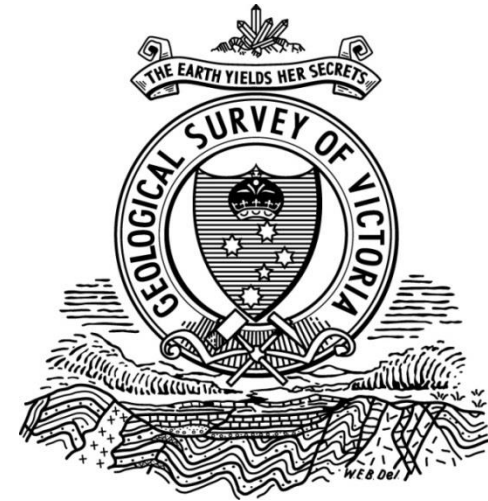
Understanding Victorian gold is a team effort



Australian Government
Geoscience Australia



UNCOVER
AUSTRALIAN EXPLORATION
GEOSCIENCE RESEARCH



MONASH University



ANSIR NATIONAL RESEARCH
FACILITY FOR
EARTH SOUNDING



**GEOLOGICAL SURVEY
OF NEW SOUTH WALES**



AuScope



pmd*crc

Talk Outline


























- The size of the prize: how rich is Victoria in gold?
- Mineral Systems Analysis and the gold source – understanding Victorian gold potential by understanding the geology
- How understanding plumbing systems gives regional-scale predictive capacity
- The Lachlan Orocline – extending Victoria's goldfield terrane

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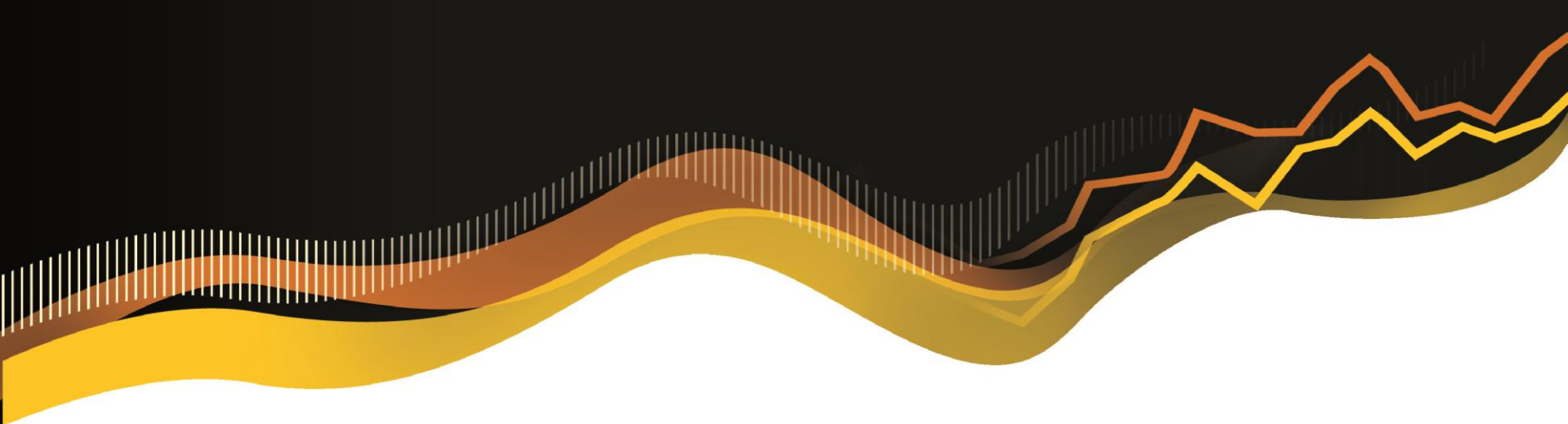


Significant Drill Intersections of 2017 to Date

rank	country	company	project	intersection
1		Kirkland Lake Gold Ltd. (TSX, OTCQX)	Fosterville	15.15m @ 1429g/t Au from 345.55m
2		Cordoba Minerals Corp. (TSX-V, OTCQX)	San Matias resource definition 	23-Jan ACD036 5.00m @ 800.90g/t Au, 88.63g/t Ag, 3.65% Cu, 8.60% Zn from 112m  37.6% 4069
3		Nevsun Resources Ltd. (TSX, NYSE MKT)	Timok resource definition 	27-Feb TC160130 256.3m @ 6.0% Cu, 3.79g/t Au from 438.8m  -1.4% 3239
4		IAMGOLD Corp. (TSX, NYSE)	Saramacca exploration 	29-Mar SMDD17-077 60.5m @ 40.91g/t Au from 14.5m  2.3% 2475
5		Osisko Mining Inc. (TSX)	Windfall Lake resource definition 	3-May OSK-W-17-820 2.5m @ 936g/t Au from 616.5m  1.6% 2340
6		Leagold Mining Corp. (TSX)	Los Filos mining 	12-Apr BD-02-16 85.90m @ 25.3g/t Au from 585.15m  16.9% 2173
7		UEX Corp. (TSX)	Christie Lake exploration 	14-Feb CB-109 17.70m @ 11.46% U3O8 from 475.10m  3.9% 2166
8		Paramount Gold Nevada Corp. (NYSE MKT)	Grassy Mountain resource definition 	30-Jan GM16-02 43.0m @ 47.51g/t Au, 12.68g/t Ag from 166.12m  0.0% 2051
9		Arizona Mining Inc. (TSX)	Hermosa resource definition 	12-Jan HDS-396 159.7m @ 78.69g/t Ag, 6.87% Pb, 8.47% Zn, 0.40% Cu from 542.2m  13.7% 1861



Fosterville
>2% Au

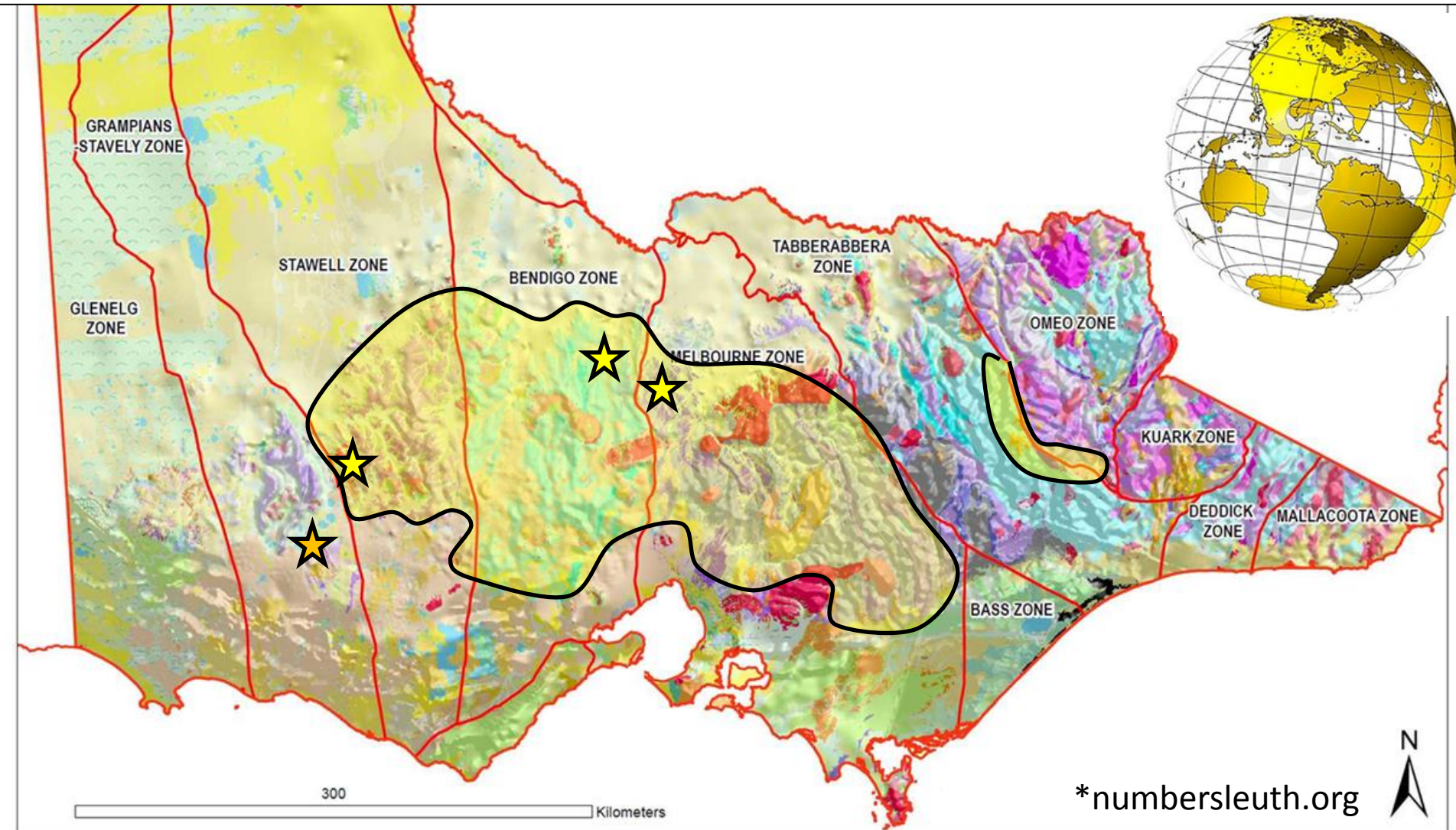


Top 3 global drill results
(May, 2017)

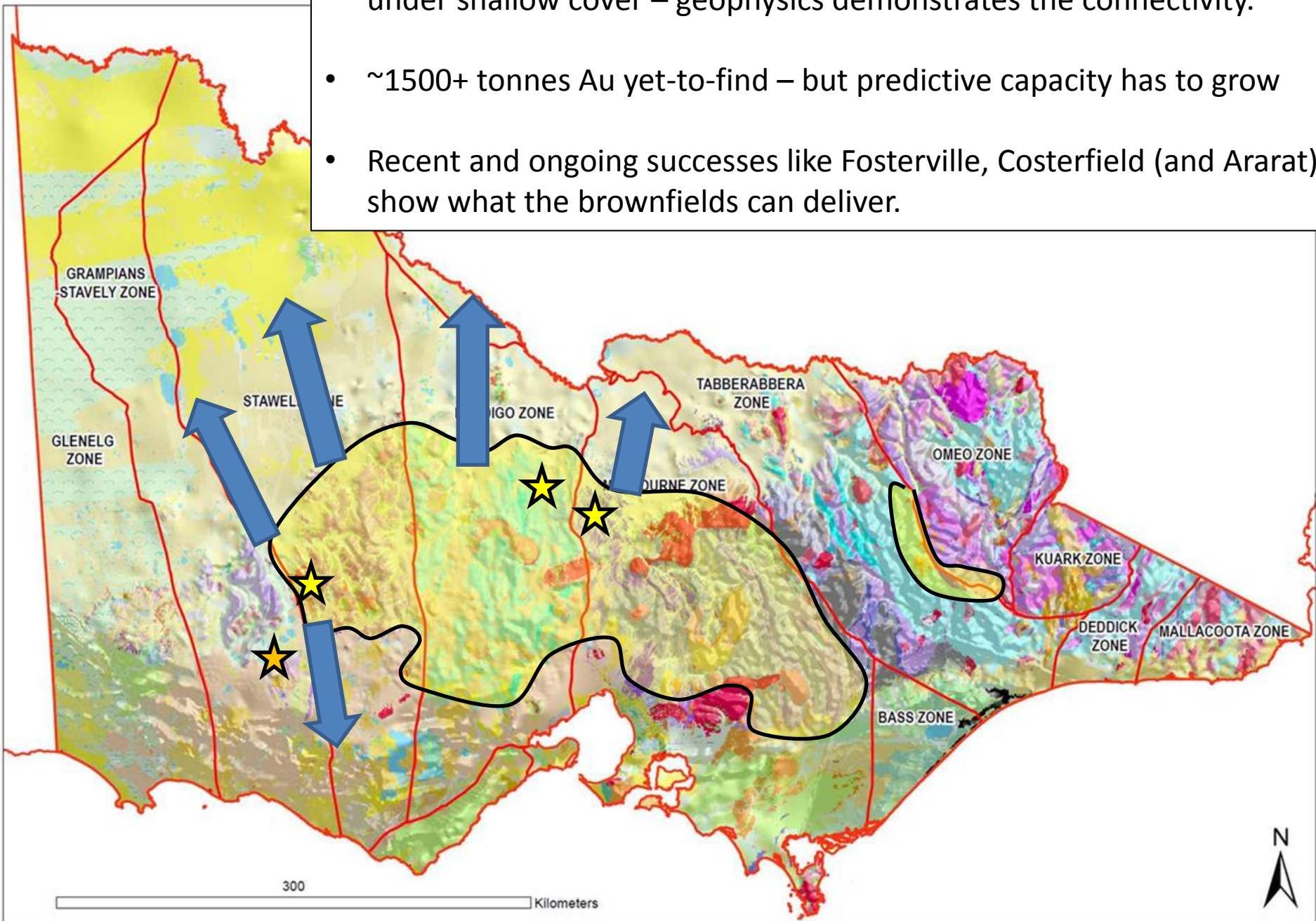
	country	company		(AuEq.)m
1		Kirkland Lake Gold Ltd. (TSX, OTCQX) <i>16m @ 404g/t Au from 113.2m</i>		6464
2		Osisko Mining Inc. (TSX) <i>2.5m @ 936g/t Au from 616.5m</i>		2340
3		Silver Standard Resources Inc. (NASDAQ, TSX) <i>1.6m @ 1004.74g/t Au from 235.2m</i>		1608

- Total all-time gold mined globally: ~165 000 tonnes *
- Victoria's recorded gold production (since 1851): ~2500 tonnes+
- **1.5%+** of all the worlds gold, from just 0.15% of global land area
- Victoria's productive goldfields occupy just 0.03% of global land area

Victoria's goldfield geology: **2 Orders of Magnitude (100x)** richer in gold than the global average.



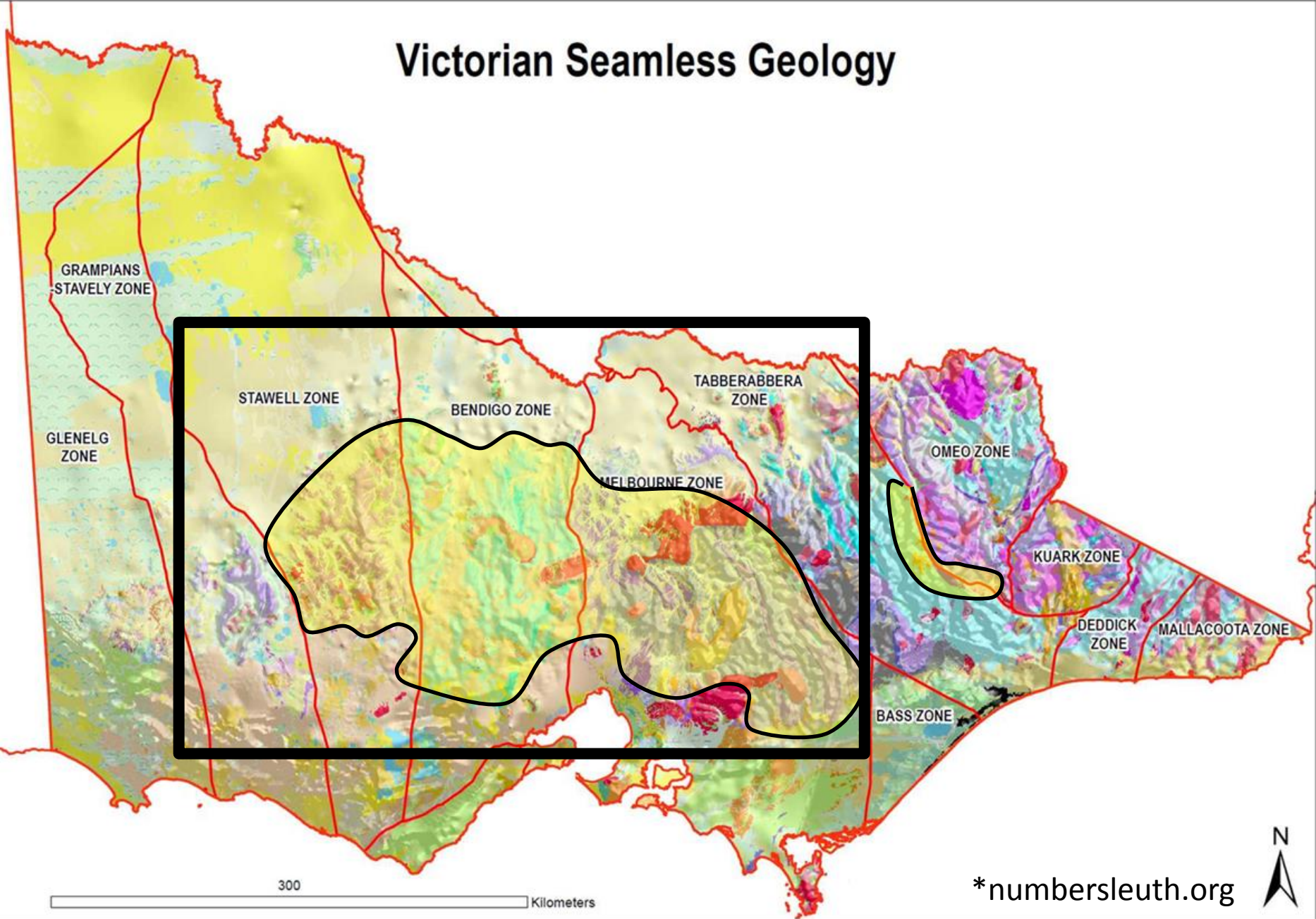
- Nearly 50% of the surface area of known goldfield geology extends under shallow cover – geophysics demonstrates the connectivity.
- ~1500+ tonnes Au yet-to-find – but predictive capacity has to grow
- Recent and ongoing successes like Fosterville, Costerfield (and Ararat) show what the brownfields can deliver.

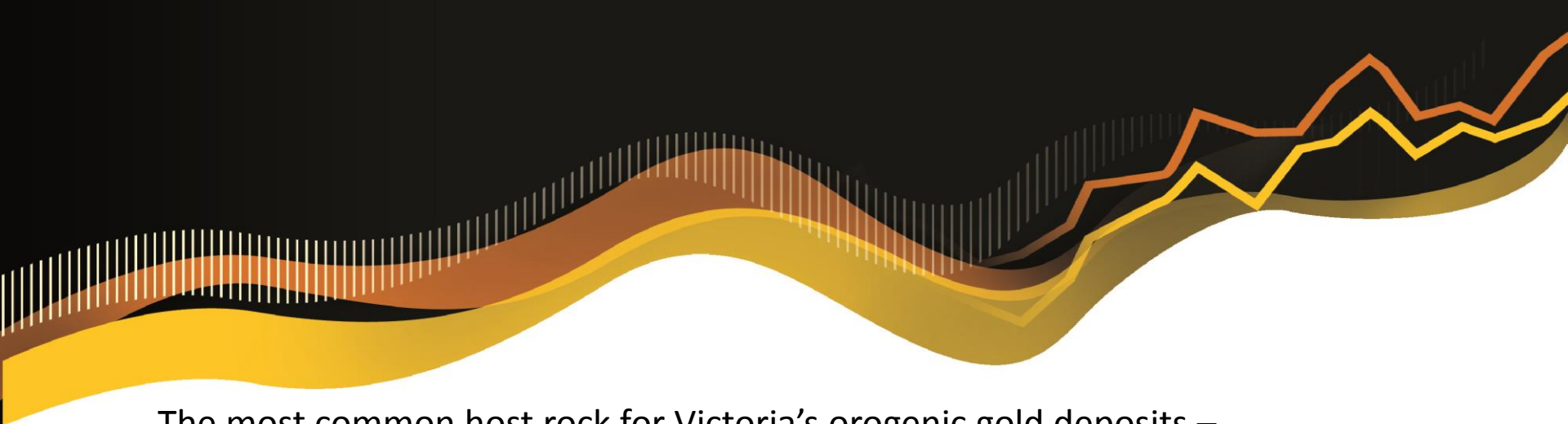


Talk Outline

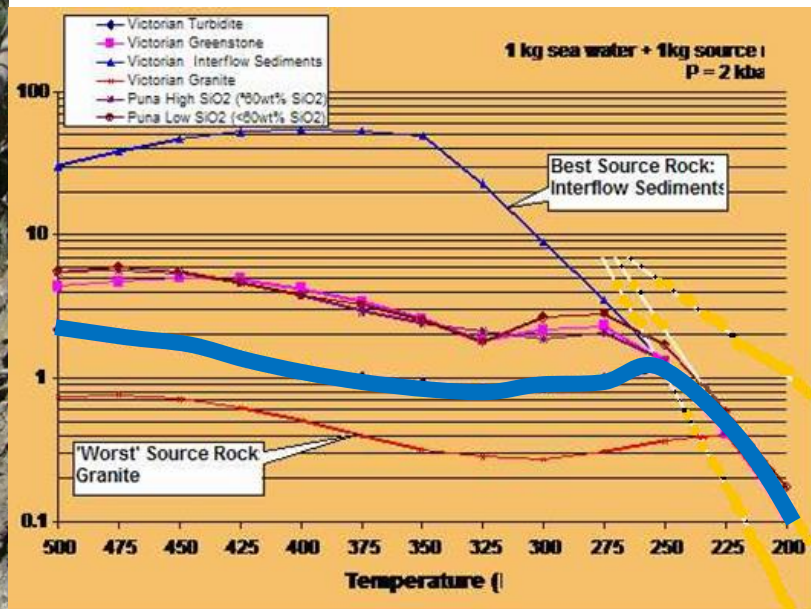
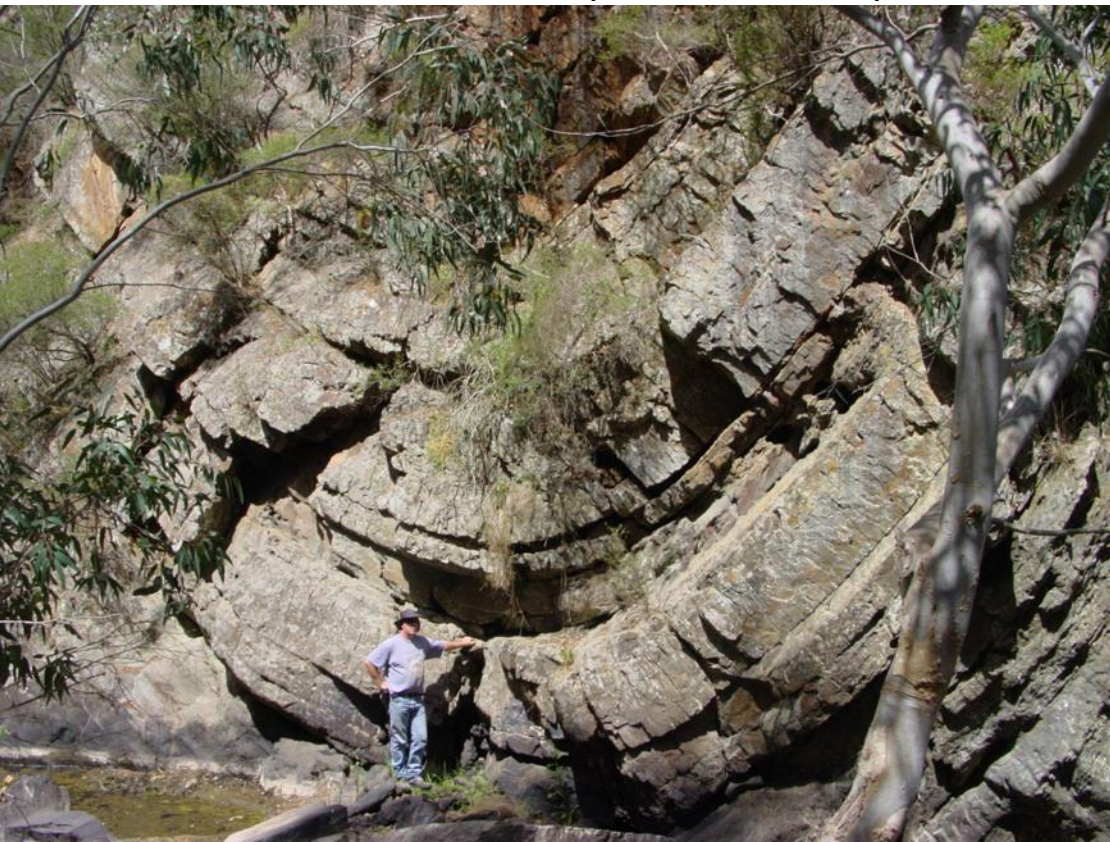
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Victorian Seamless Geology



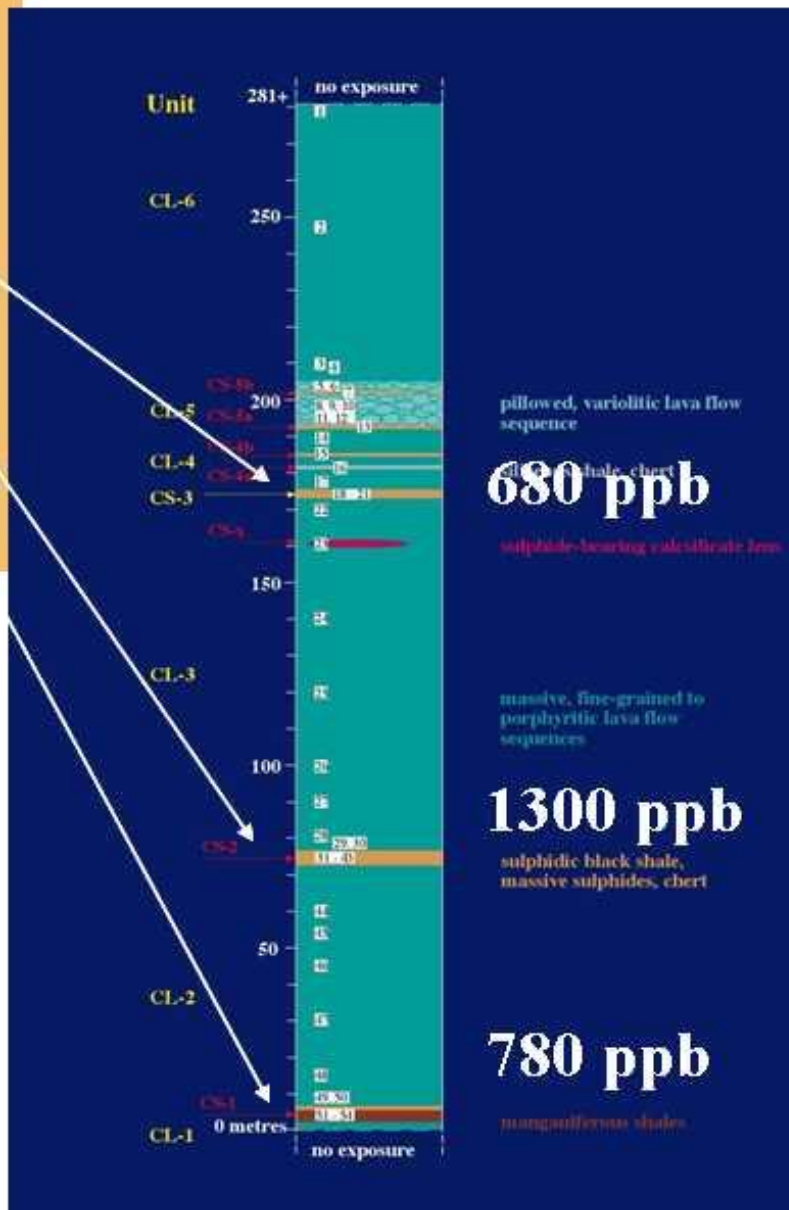
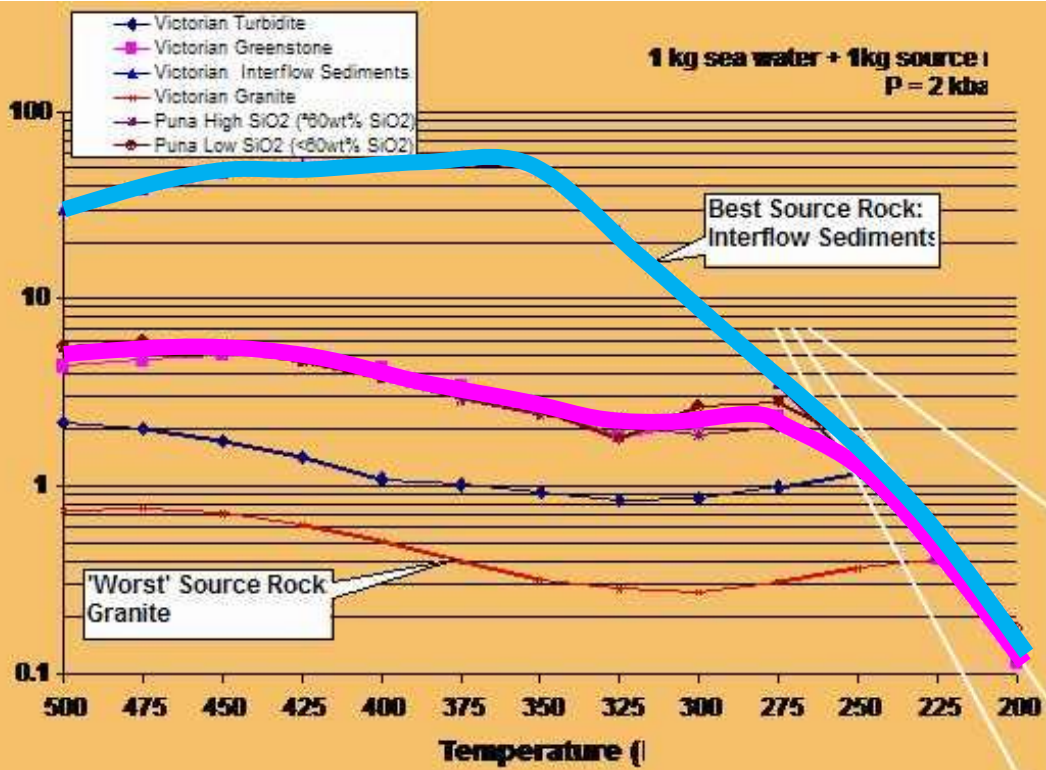


The most common host rock for Victoria's orogenic gold deposits – folded and faulted, quartz-rich deep marine sediments – **not inherently rich in gold**



(Bierlein, 2004)

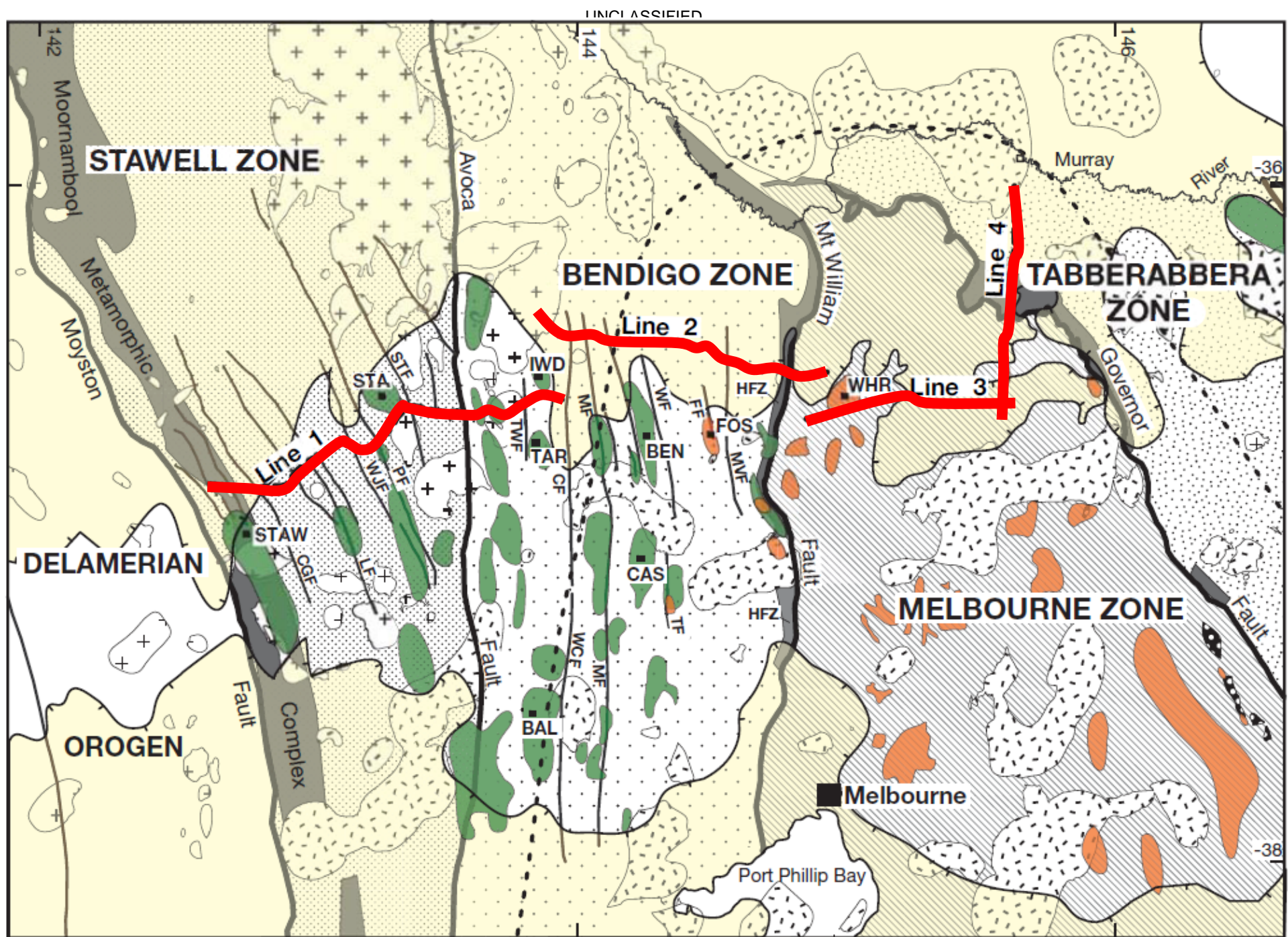


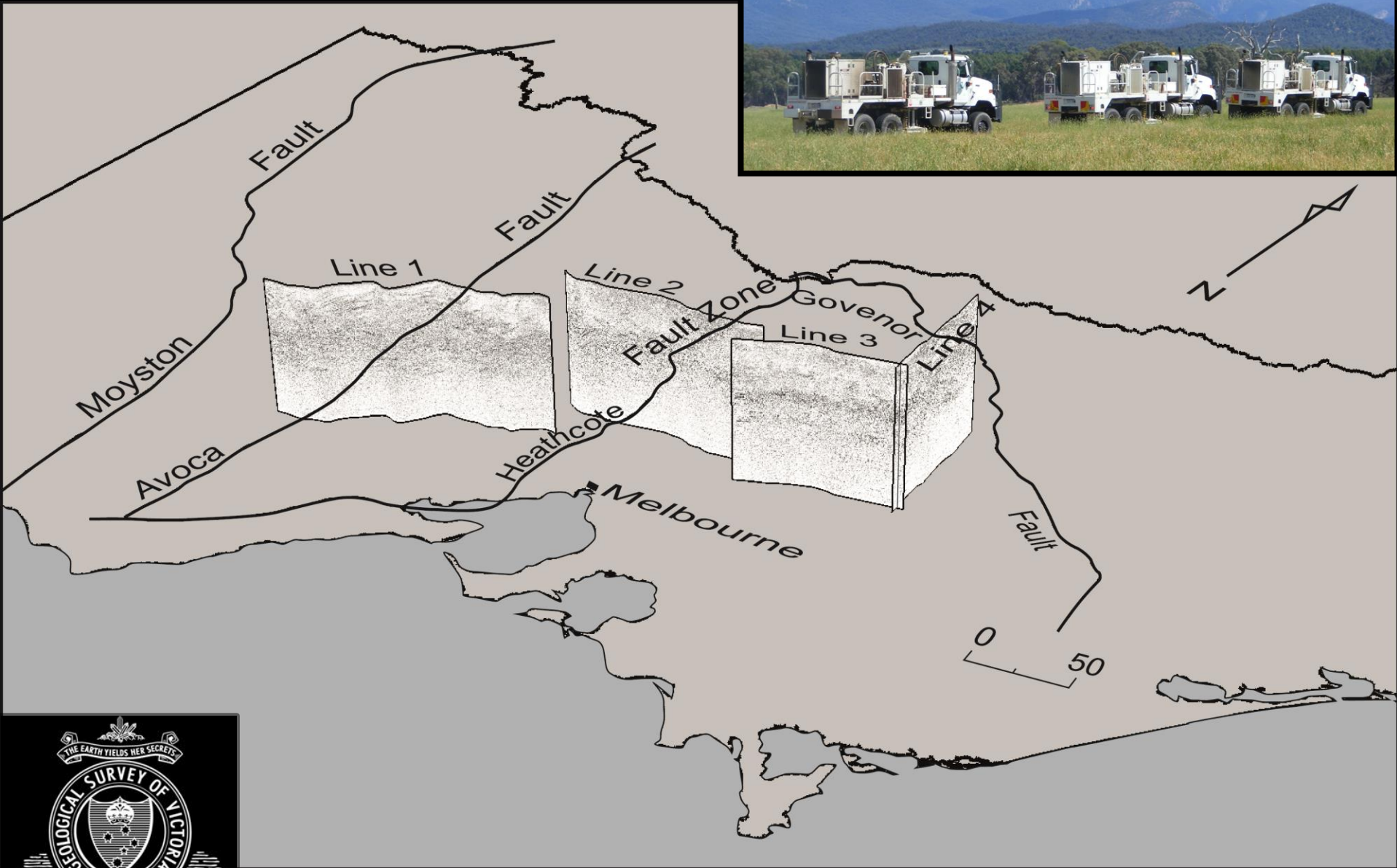


Possible source of gold:

Cambrian metavolcanics like those exposed in the Moornambool Metamorphic Complex, in the Avoca Fault, and in the Heathcote Fault Zone

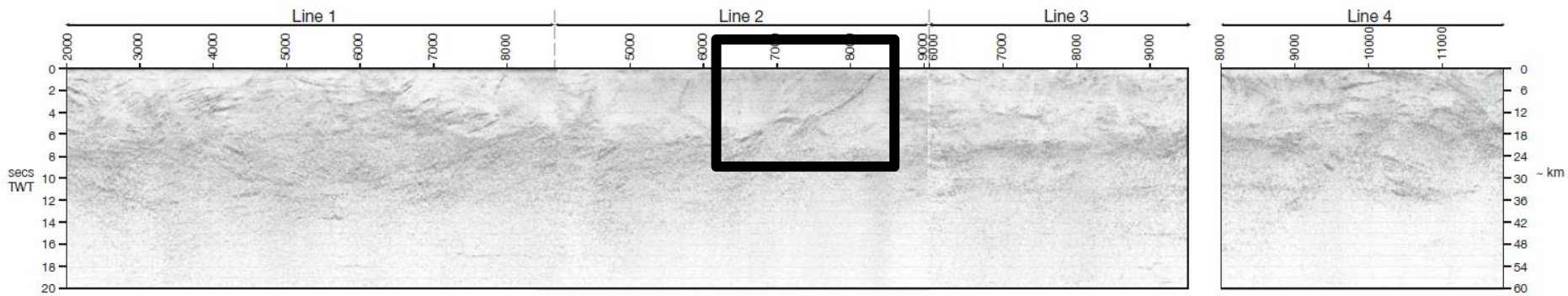
(Bierlein, 2004)





Regional deep seismic reflection transects: pmd*cr,





Detail of the Heathcote Fault Zone

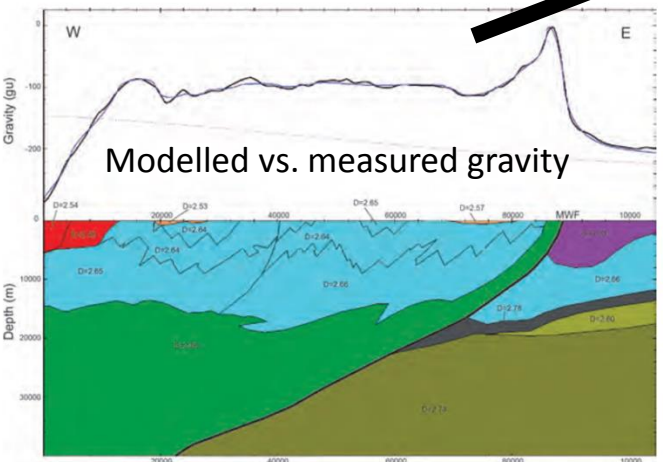
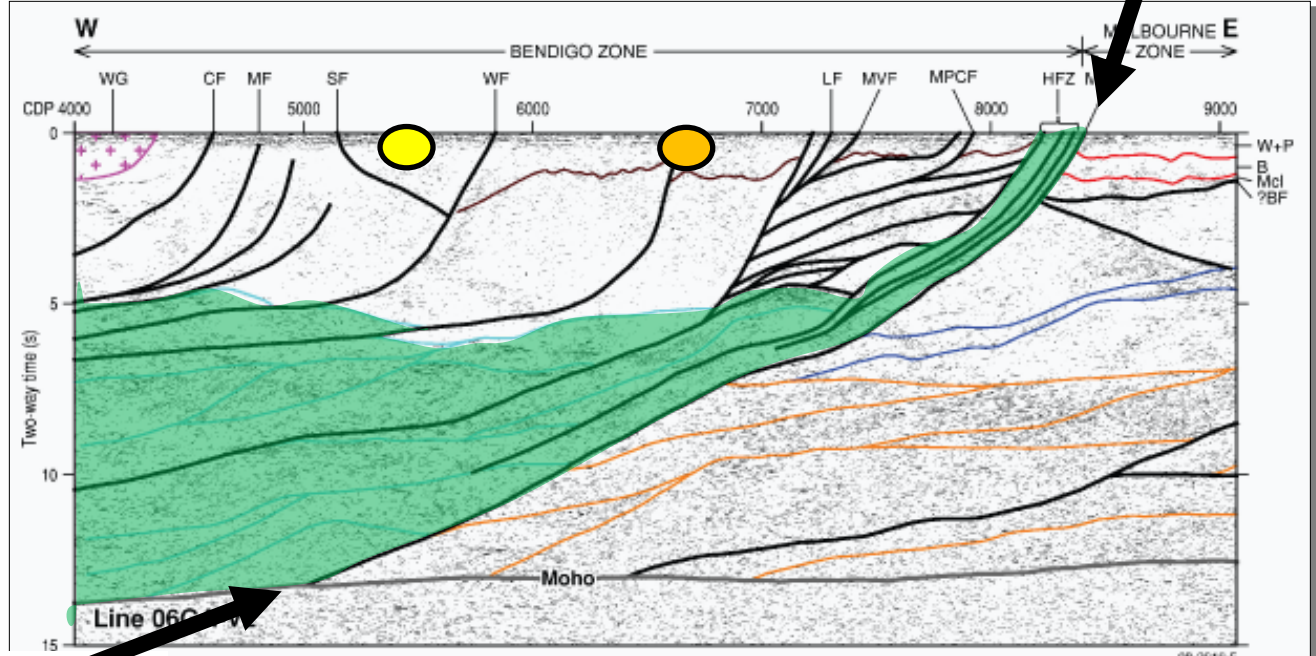


Line 06GA-V2 - interpretation

Gold-fluids from metovolcanics doesn't have to be an efficient process.

New work shows thousands of cubic kilometres of potential metovolcanic source rock underlies the goldfields

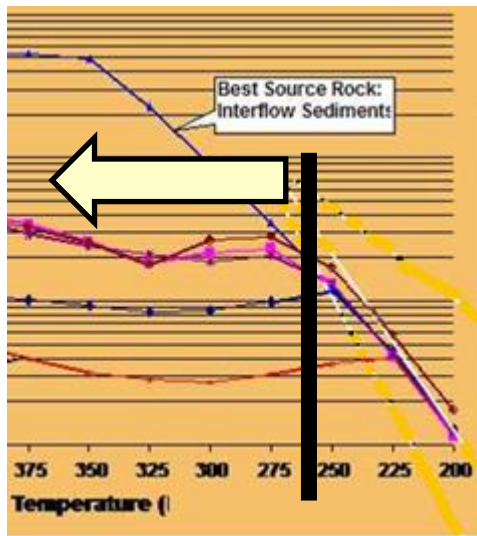
The Heathcote Fault is thick-skinned!



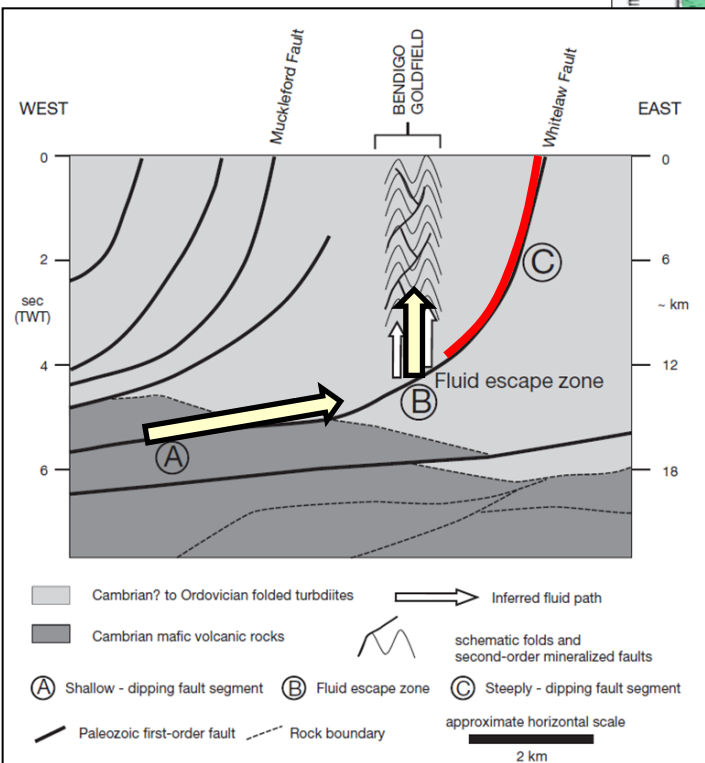
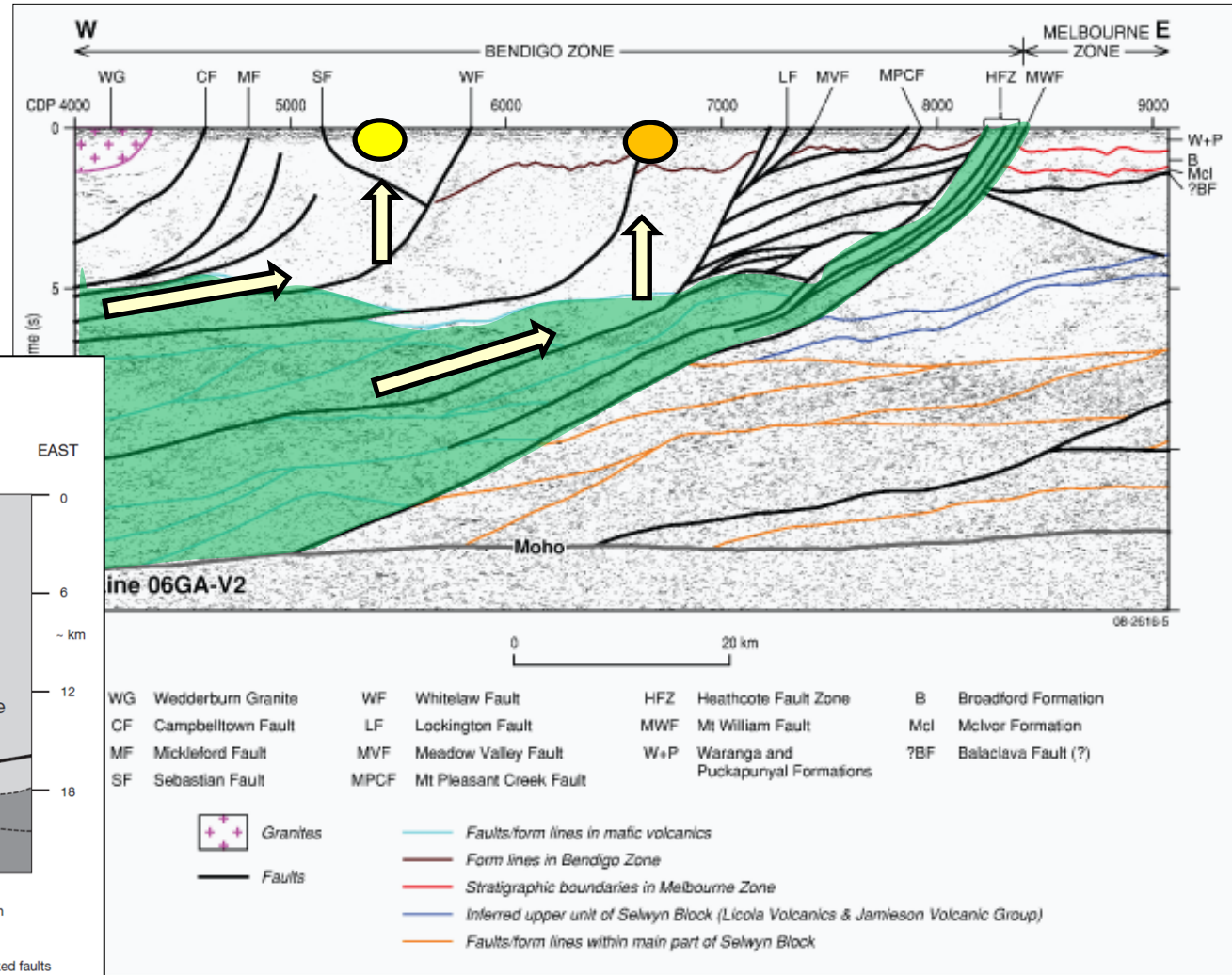
Wedderburn Granite	WF Whitelaw Fault	HFZ Heathcote Fault Zone	B Broadford Formation
Campbelltown Fault	LF Lockington Fault	MVF Mt William Fault	Mcl McIvor Formation
Mickleford Fault	MVF Meadow Valley Fault	W+P Waranga and Puckapunyal Formations	?BF Balaclava Fault (?)
Sebastian Fault	MPCF Mt Pleasant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

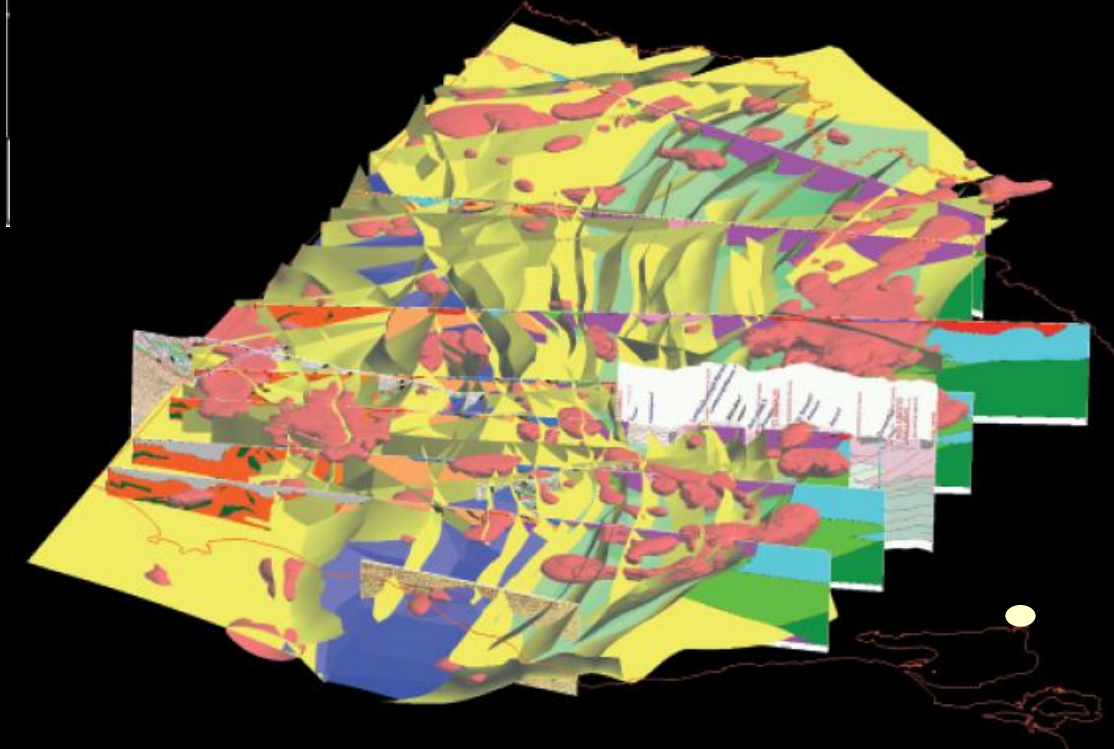
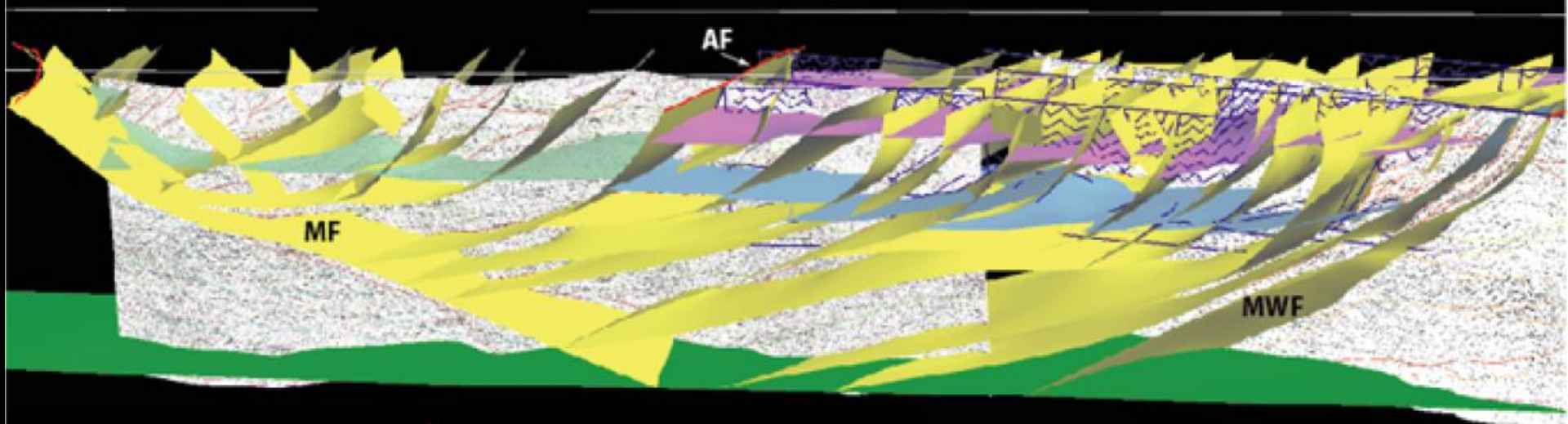
Granites	Faults/form lines in mafic volcanics
Faults	Form lines in Bendigo Zone
	Stratigraphic boundaries in Melbourne Zone
	Inferred upper unit of Selwyn Block (Licola Volcanics & Jamieson Volcanic Group)
	Faults/form lines within main part of Selwyn Block

Line 06GA-V2 - interpretation



Willman et al., 2010

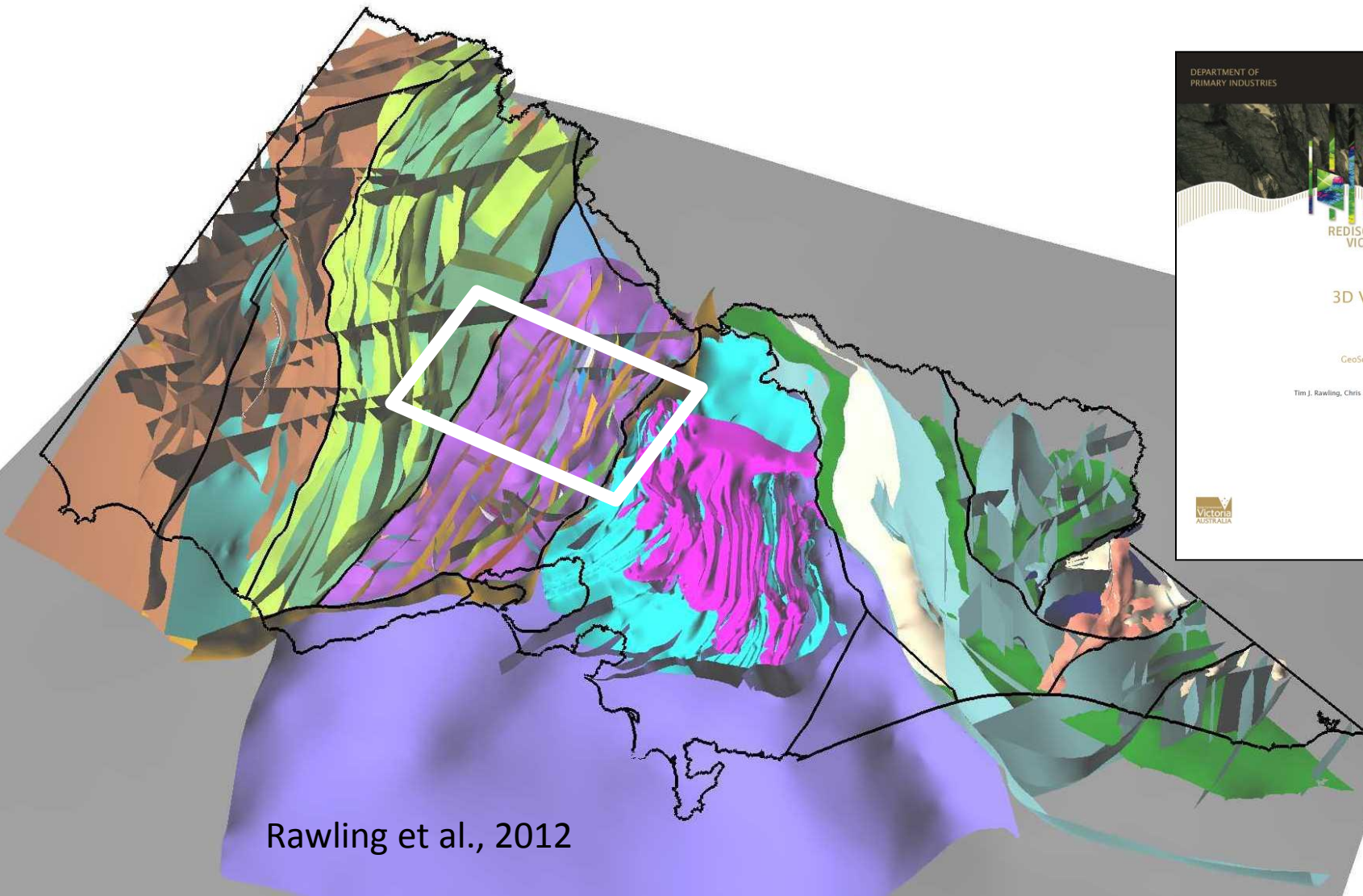




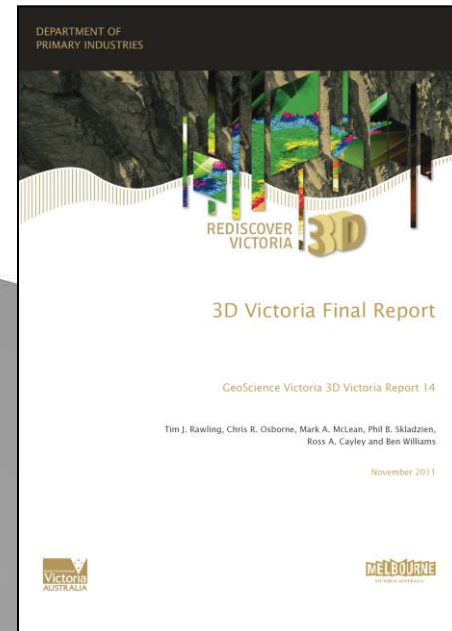
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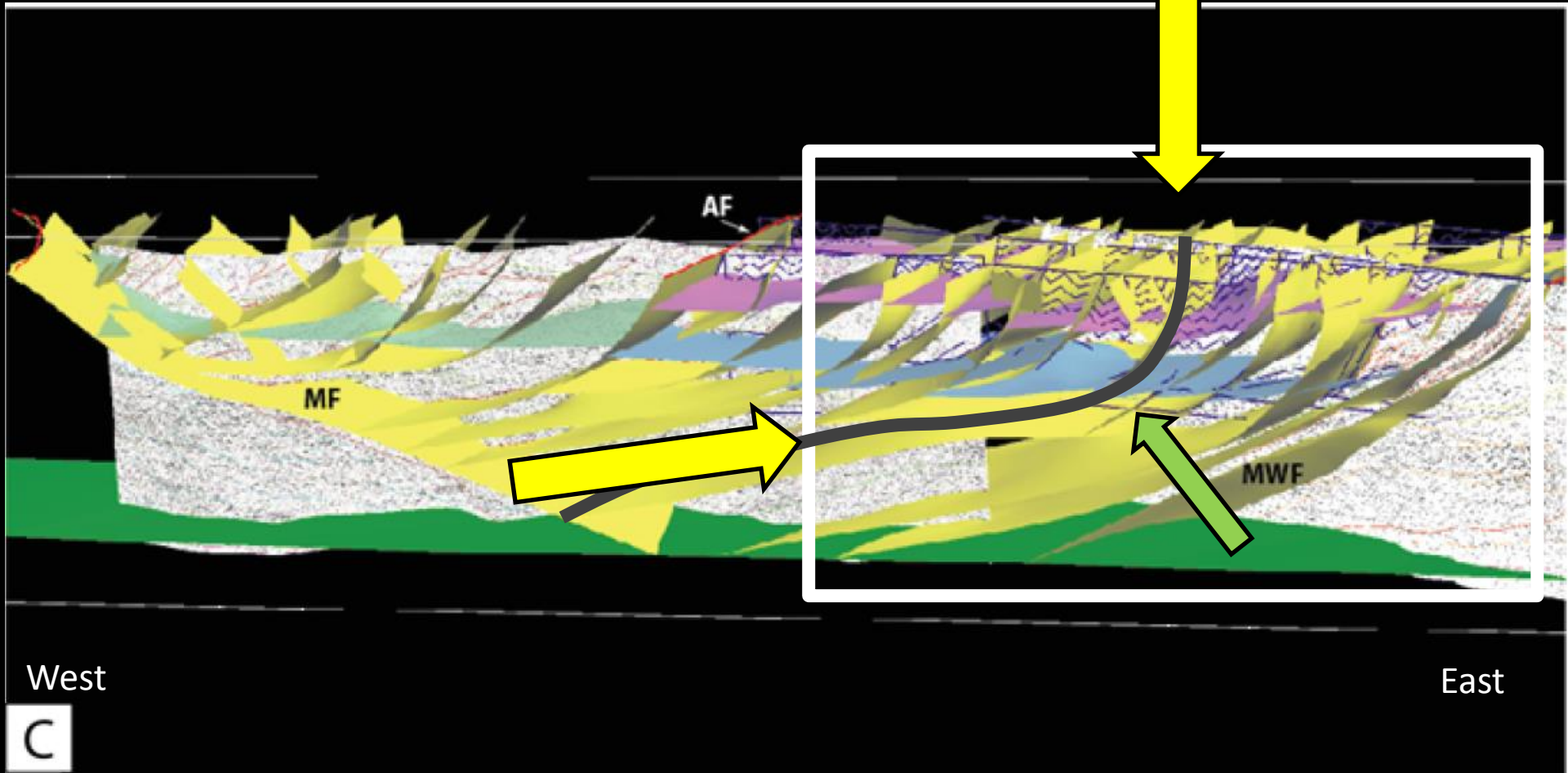
Full-crustal-thickness (40km!) geological model at 1:250 000 scale

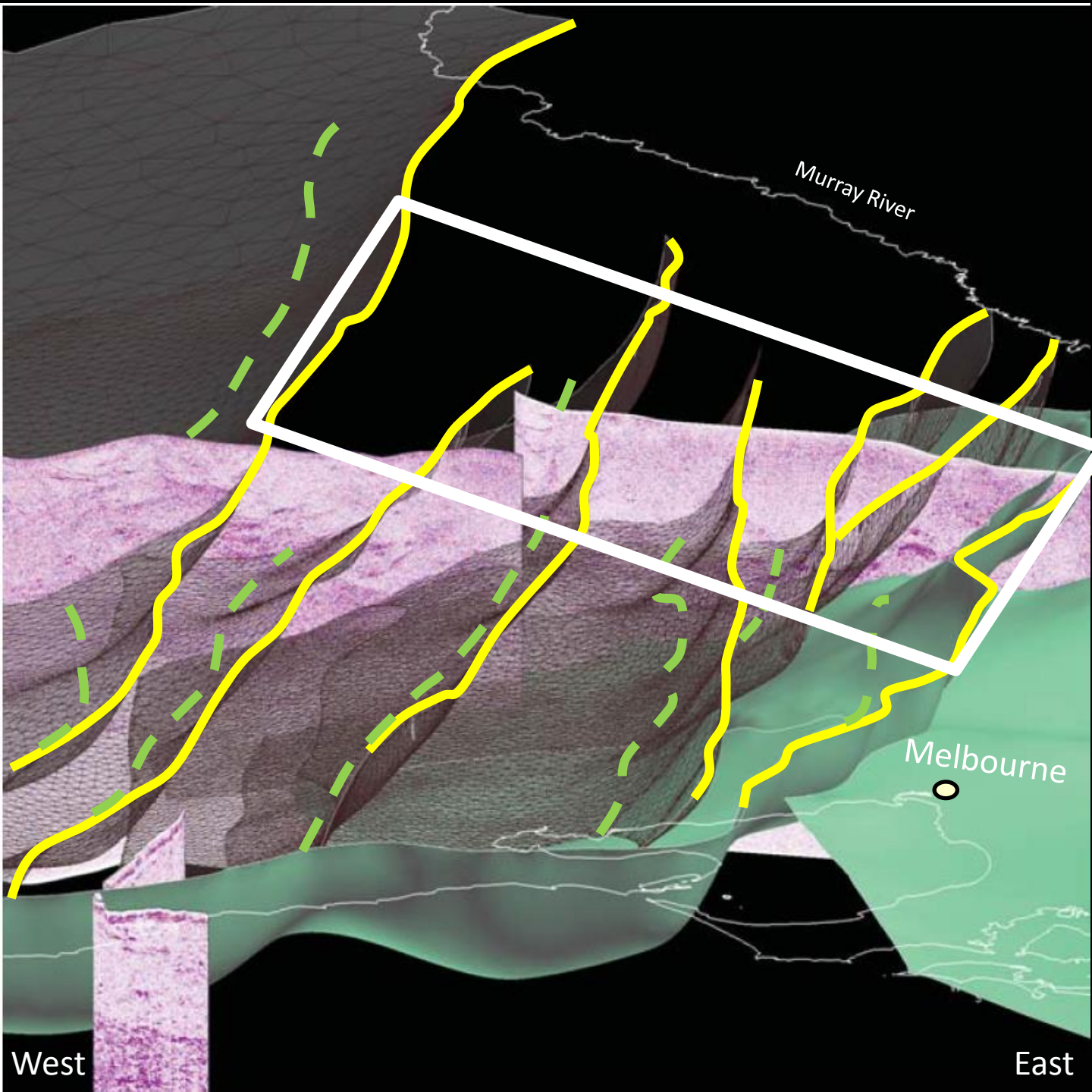


Rawling et al., 2012



Full crustal section, Stawell and Bendigo Zones





Murray River

Melbourne

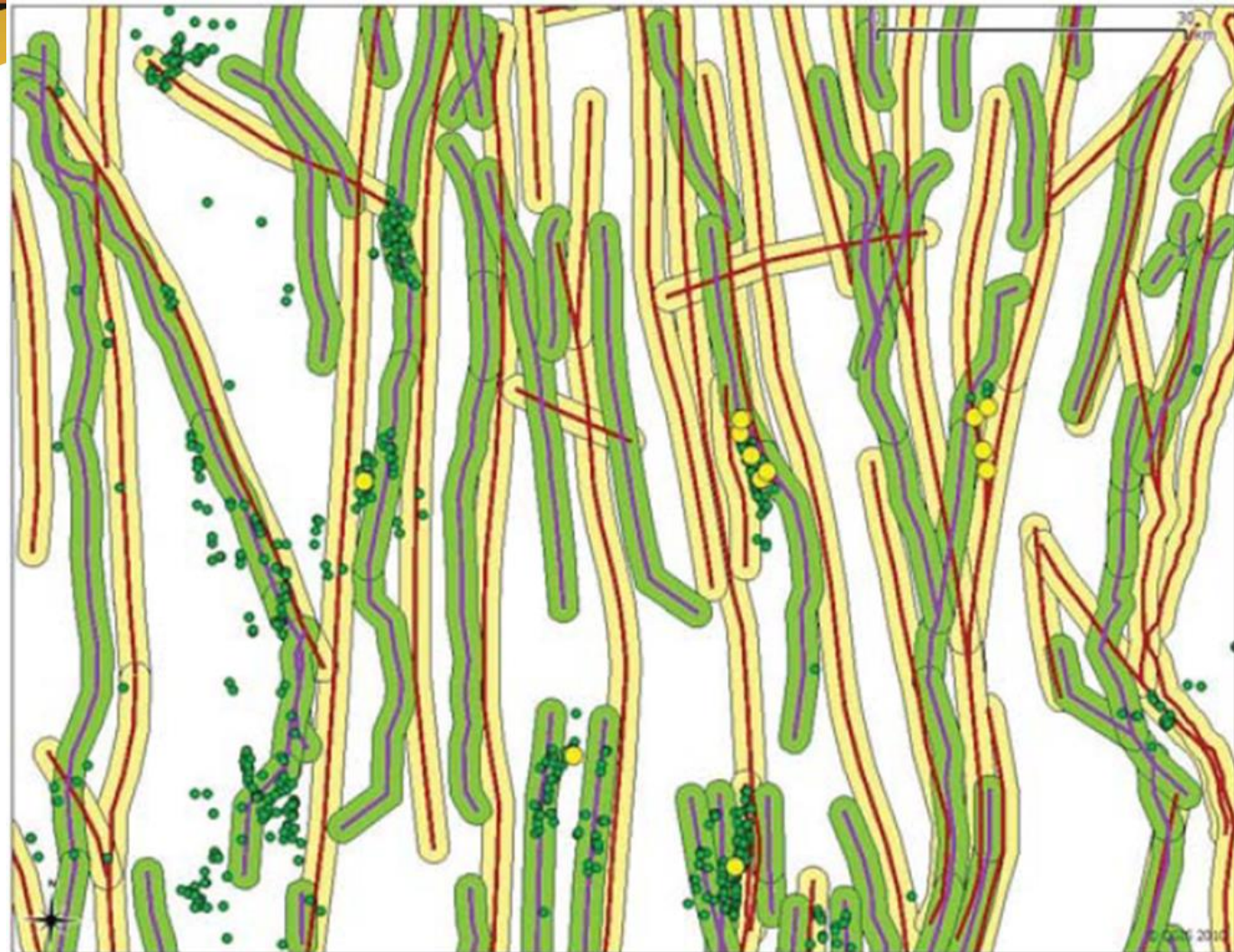
West

East

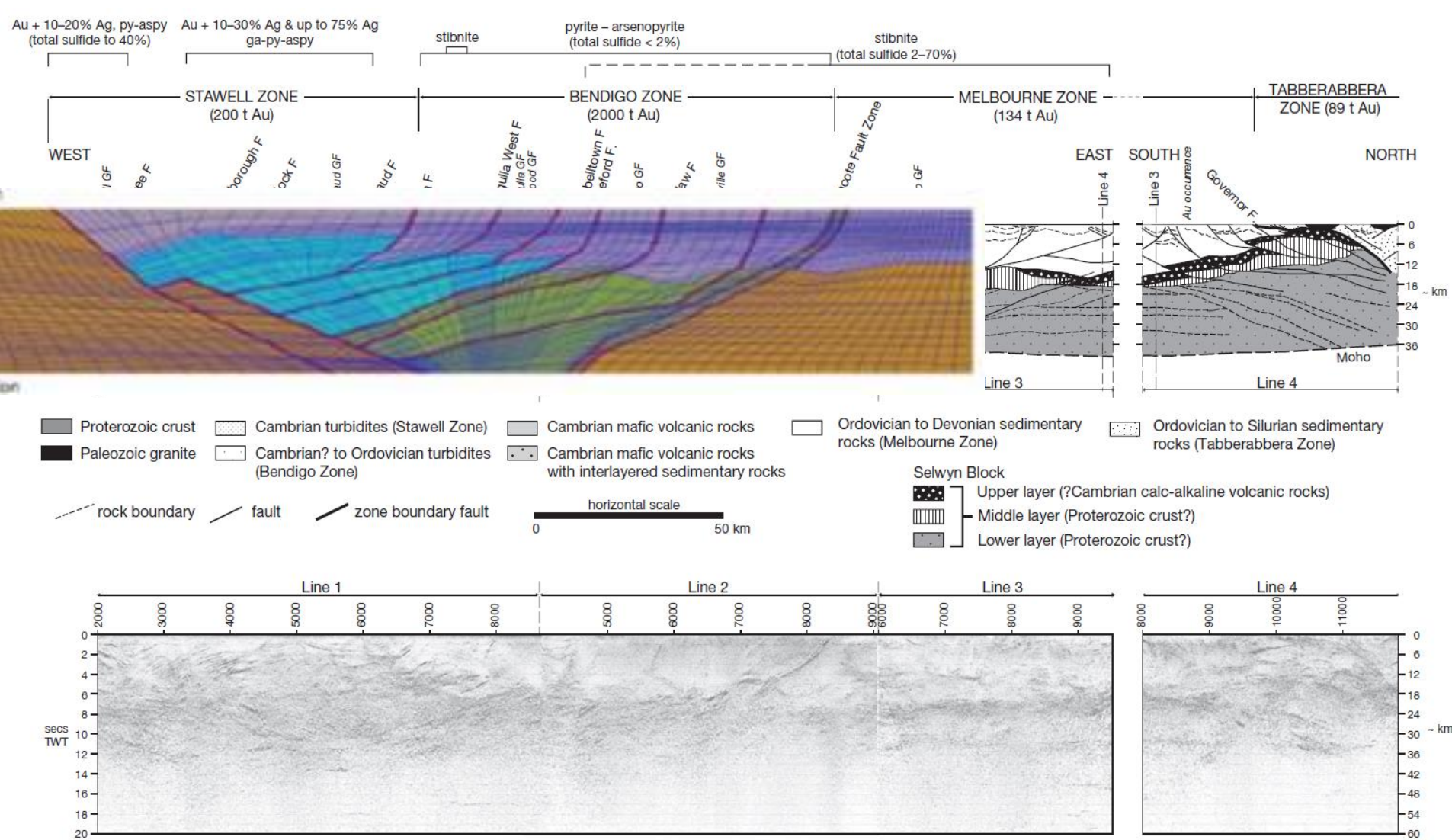
Inflection-point mapping, using the 3-D model

1500 metre buffer.....around surface fault traces (yellow around red):
Captures 41% known Au deposits, 27% intermediate-large size Au deposits

1500 metre buffer.....around inflection point upward projections (green around purple):
Captures 67% known Au deposits, 60% intermediate-large size Au deposits
+ 30% smaller buffer area = **Inflection point projections win as a goldfield predictor!**



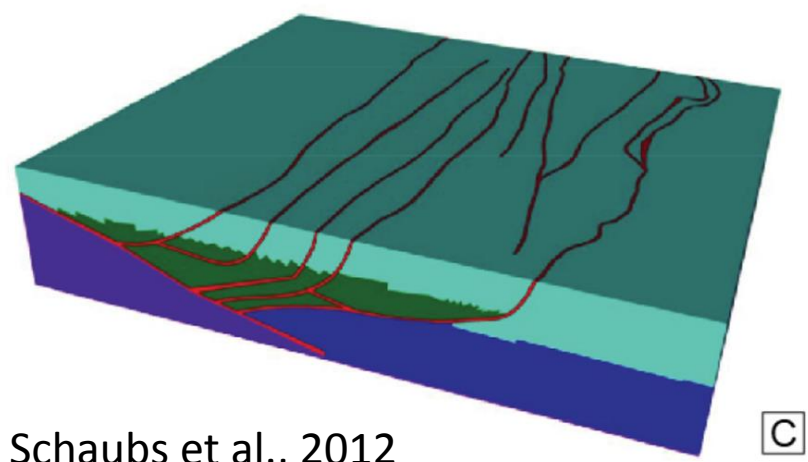
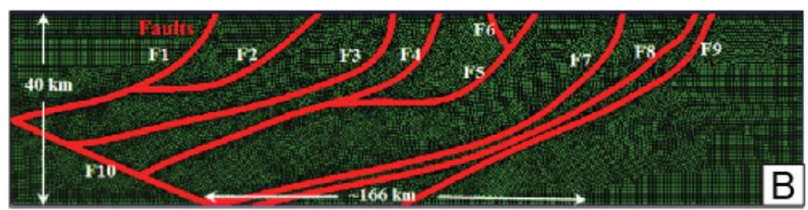
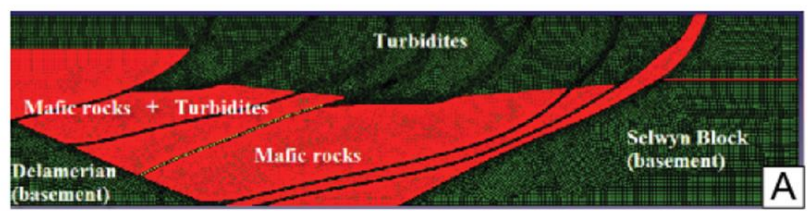
Rawling et al., 2012



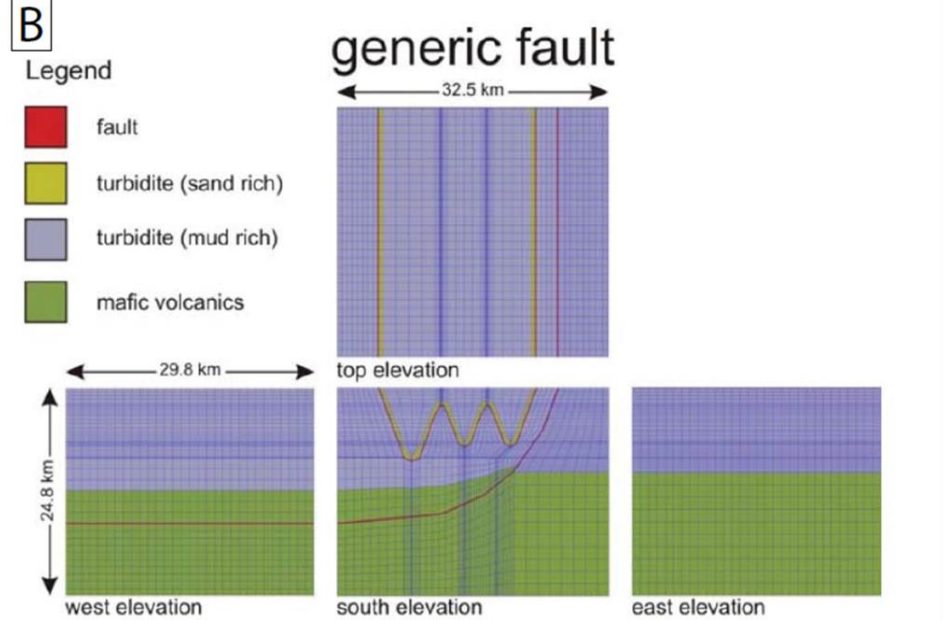
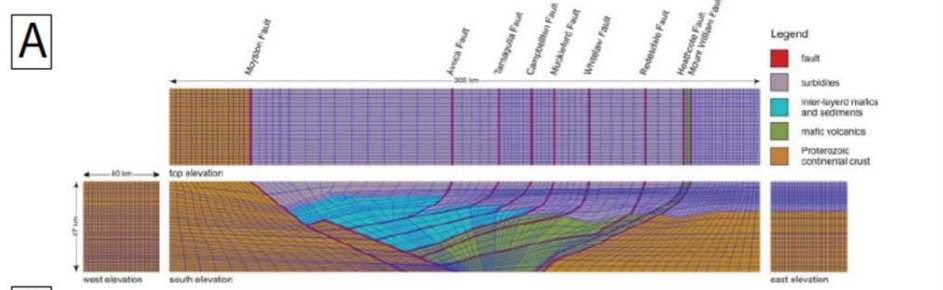
Numerical modelling of crustal-scale deformation.

Eg. Leader & Wilson, 2010

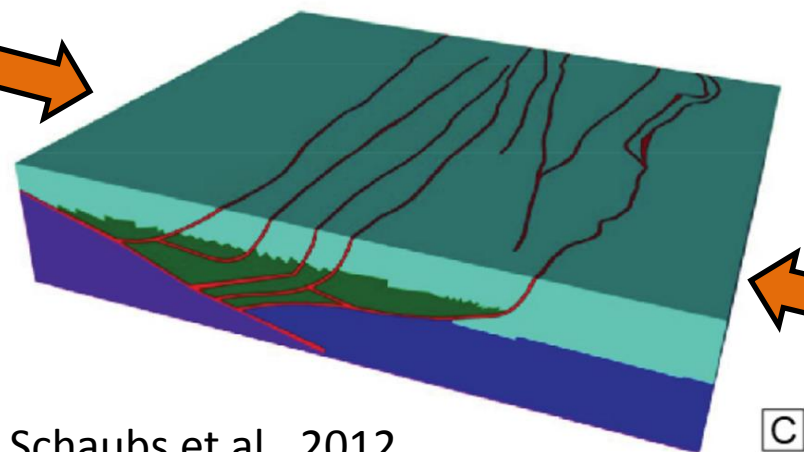
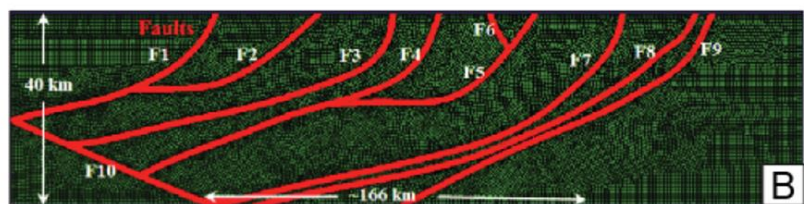
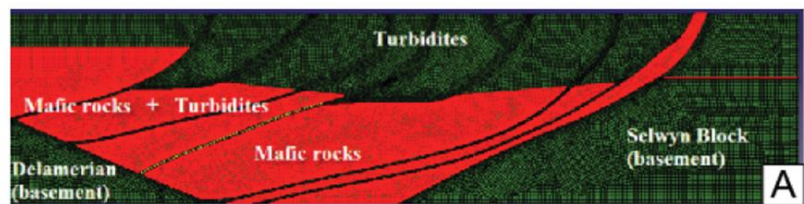
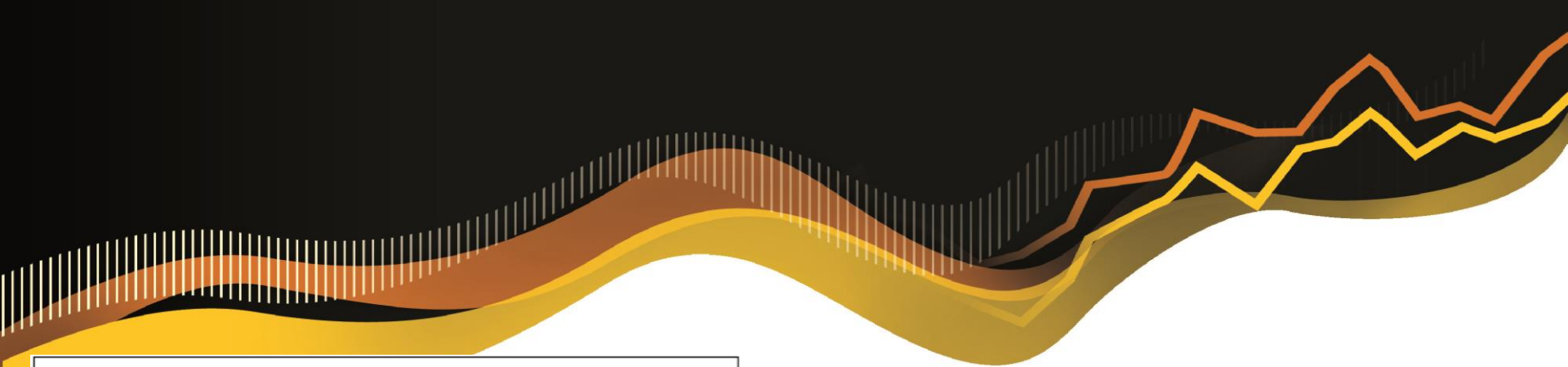
Cayley et al., 2011



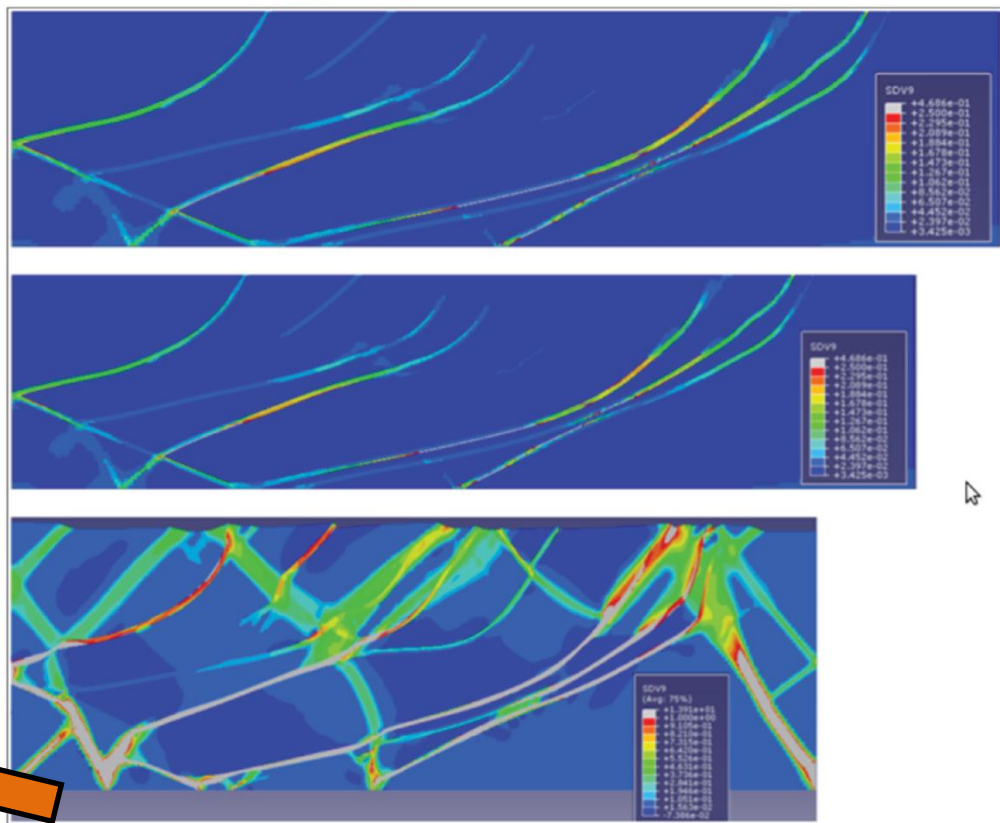
Schaubs et al., 2012



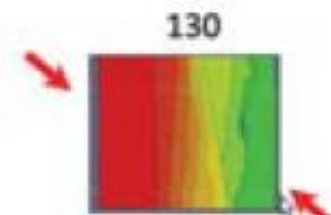
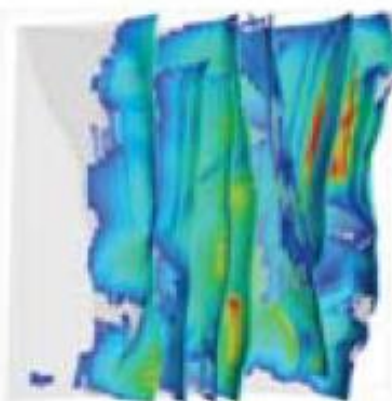
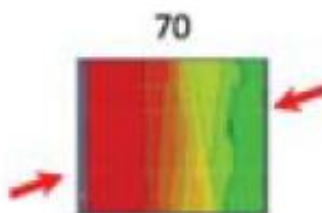
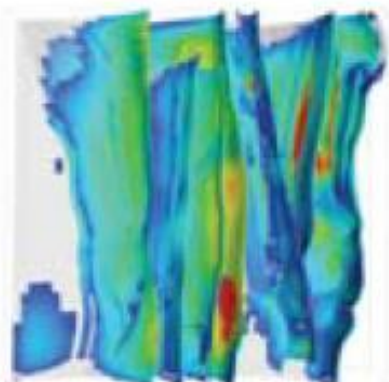
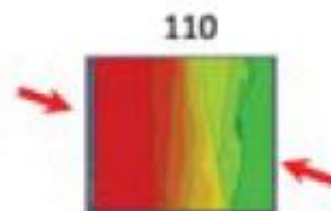
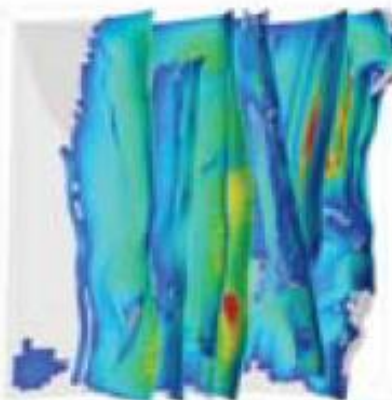
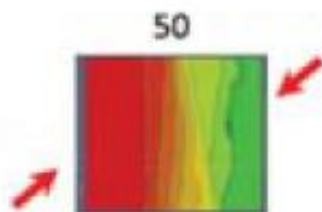
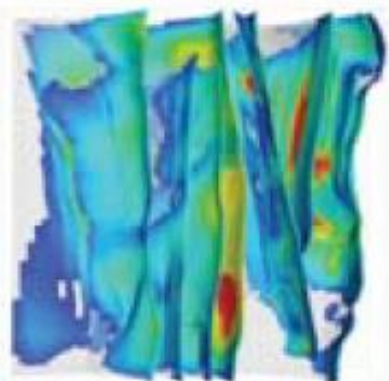
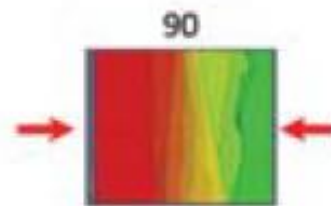
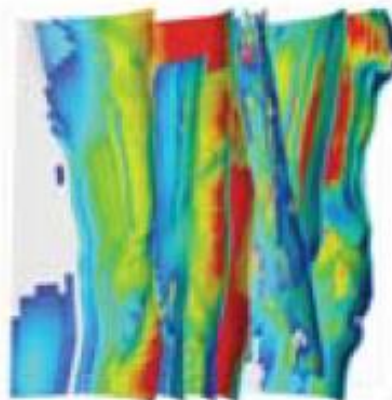
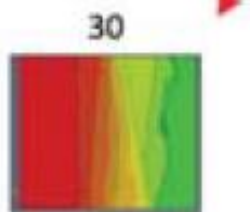
Leader & Wilson, 2010

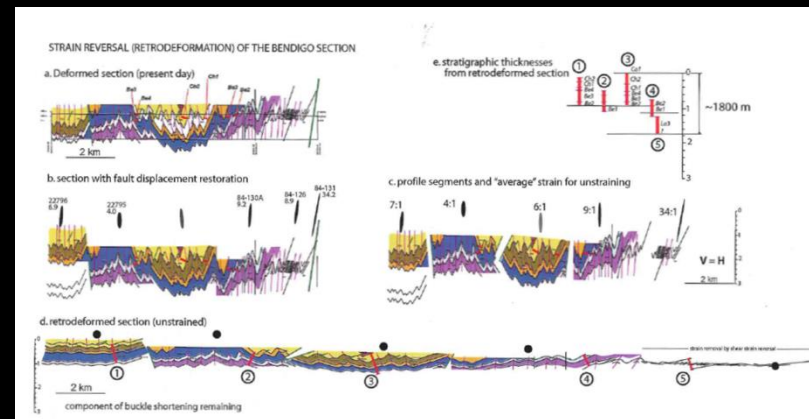


Schaubs et al., 2012

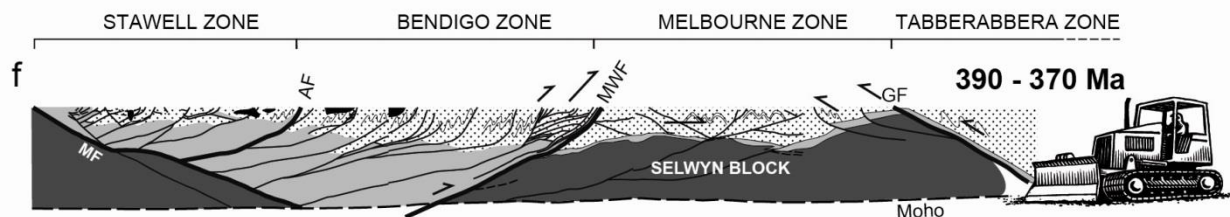


15% shortening



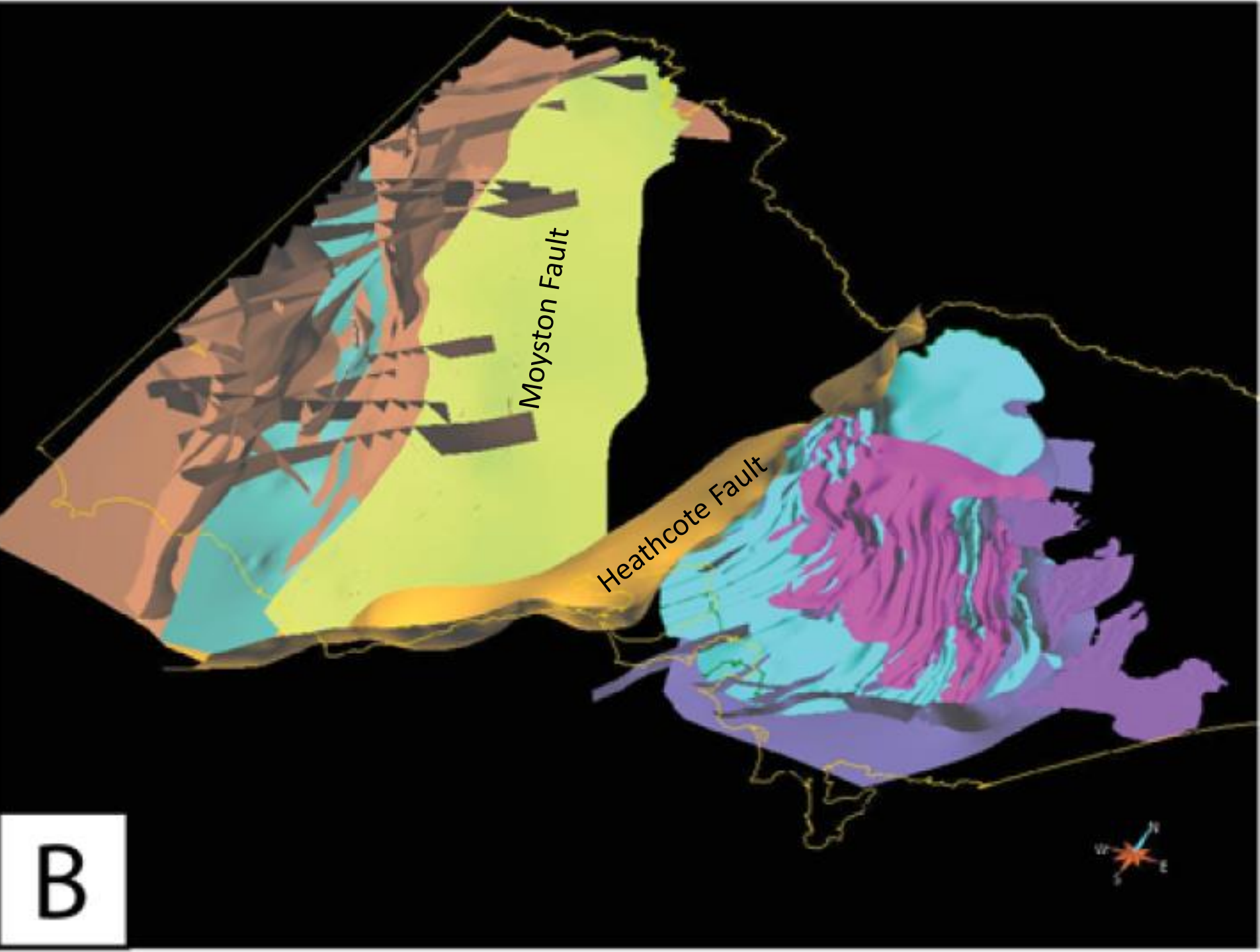


Gray et al, 2006

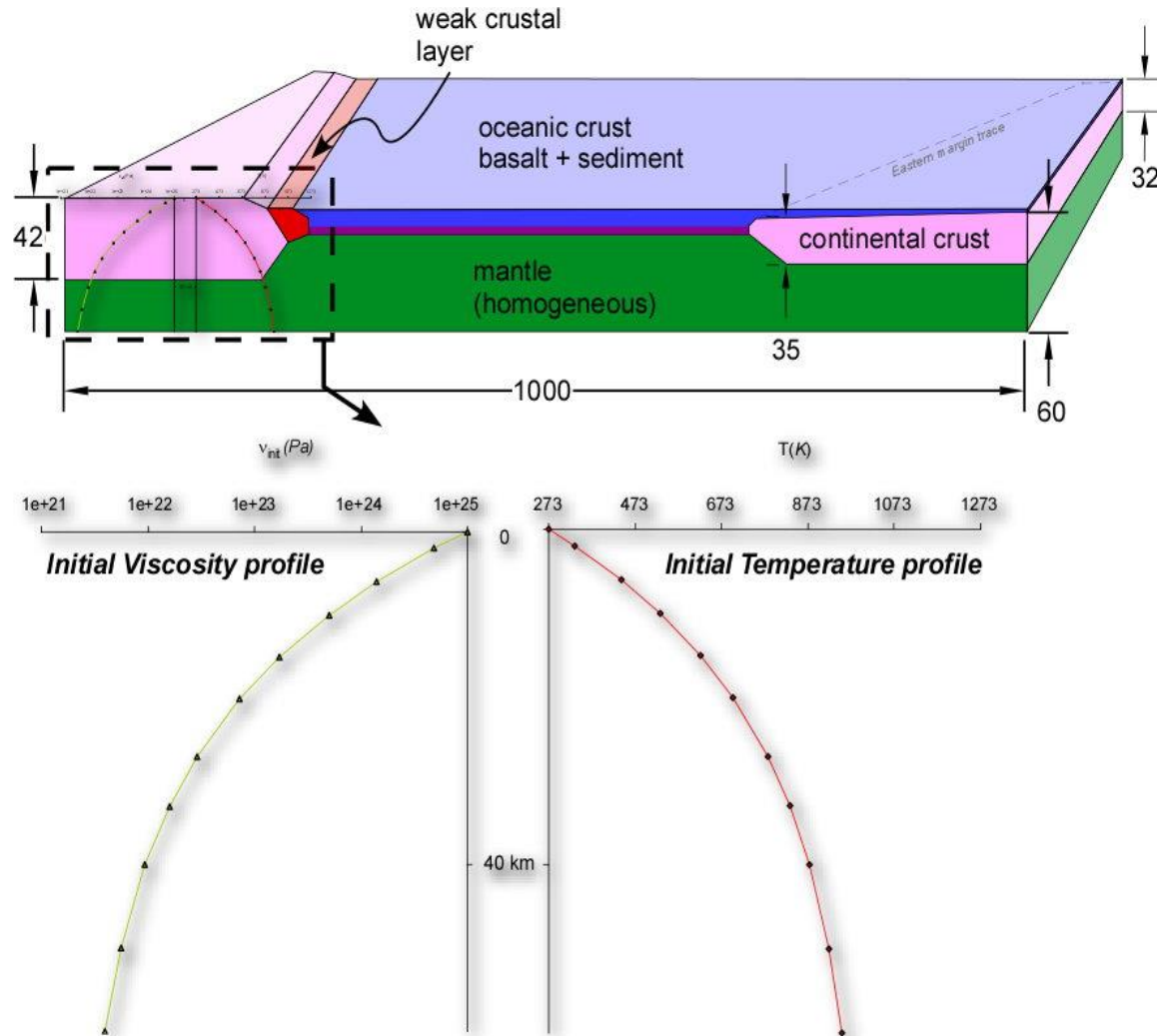


- marine sedimentary rocks
- mafic volcanic rocks and interlayered sedimentary rocks
- crust older than ~500 Ma
- bedding form lines
- fault
- zone boundary faults
- vertical scale = horizontal scale
- direction of movement
- 50km

Cayley et al., 2011

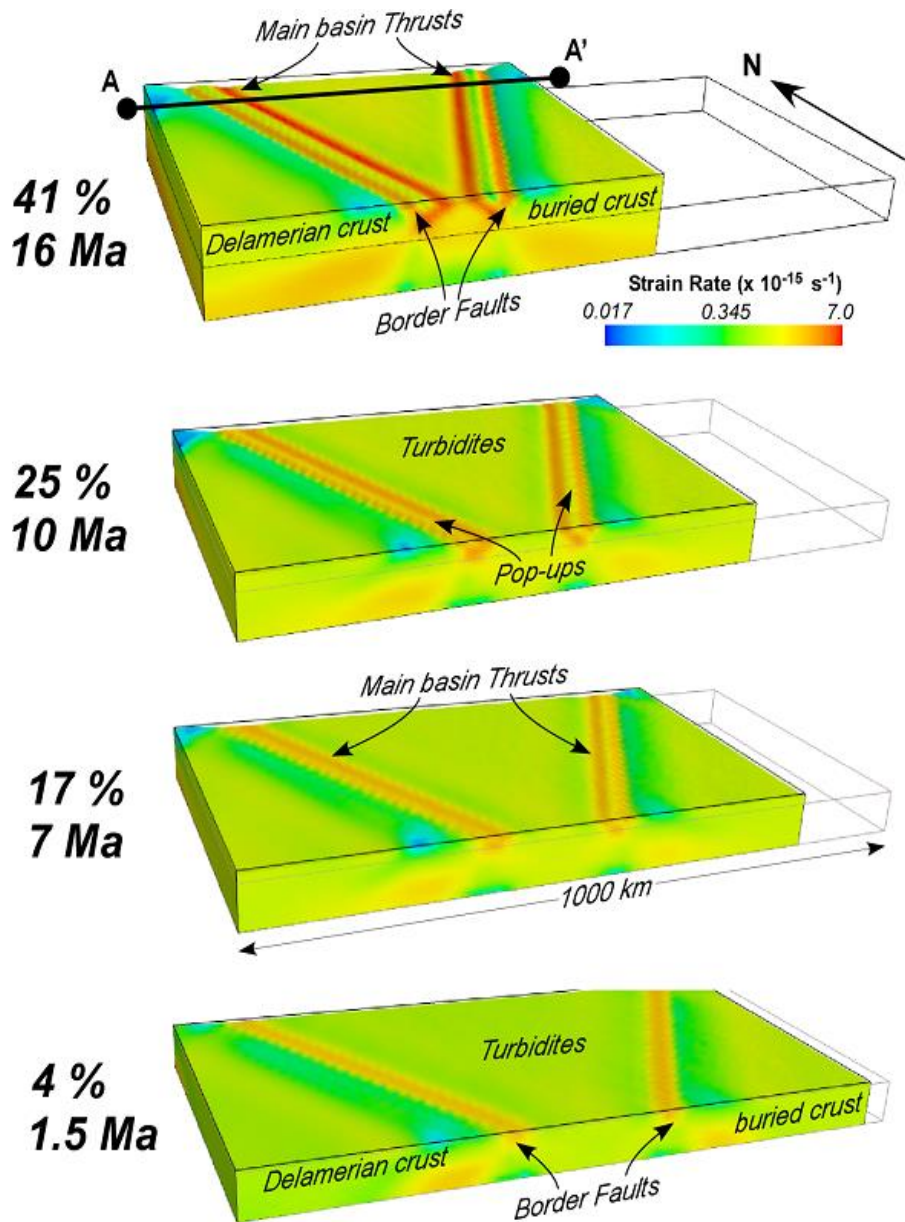


Gale simulations of basin closure

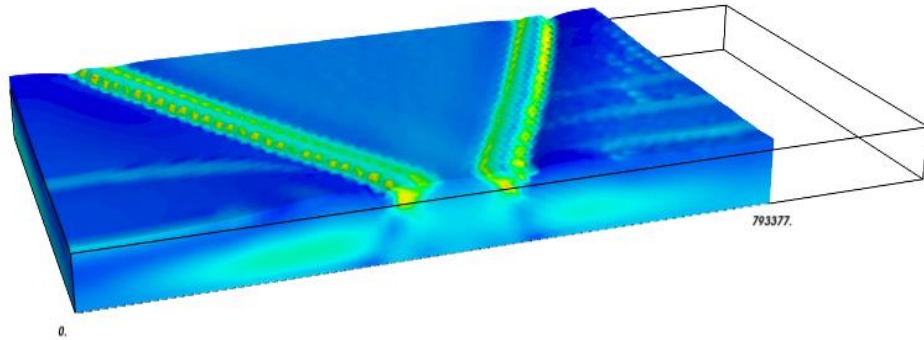


Gale simulations carried out by Guillaume Duclaux – CSIRO

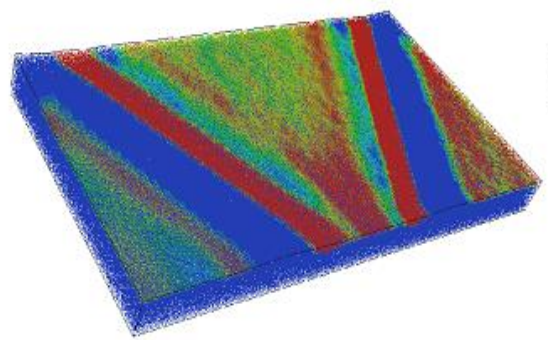
Gale simulations of basin closure



- Initial formation of basin bounding faults
 - Dip towards the basin
 - Moyston and Heathcote
- Subsequent development of back thrusts
 - Dip towards basement blocks
 - High strain zones form with the basin

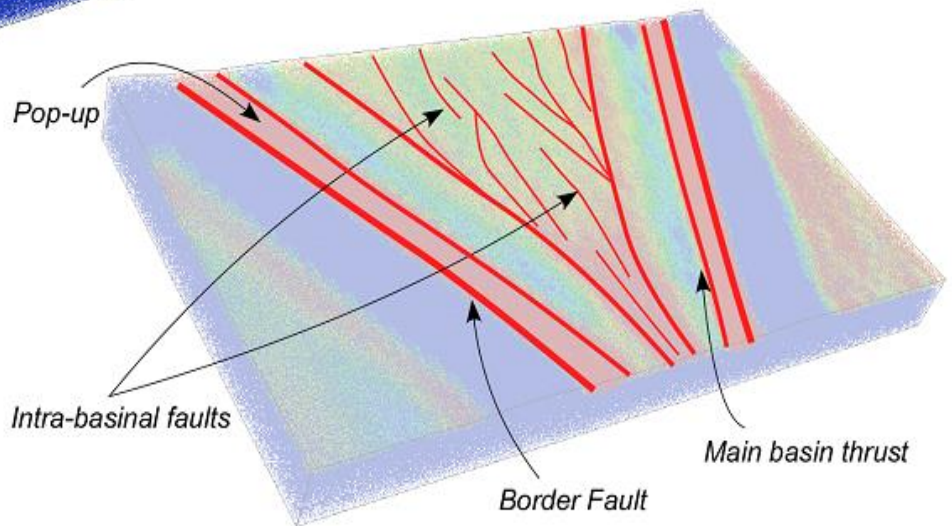
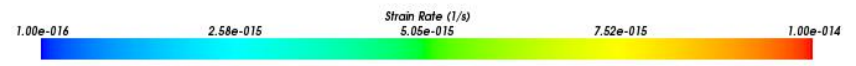


Recreates large bounding faults....
and a network of internal faults

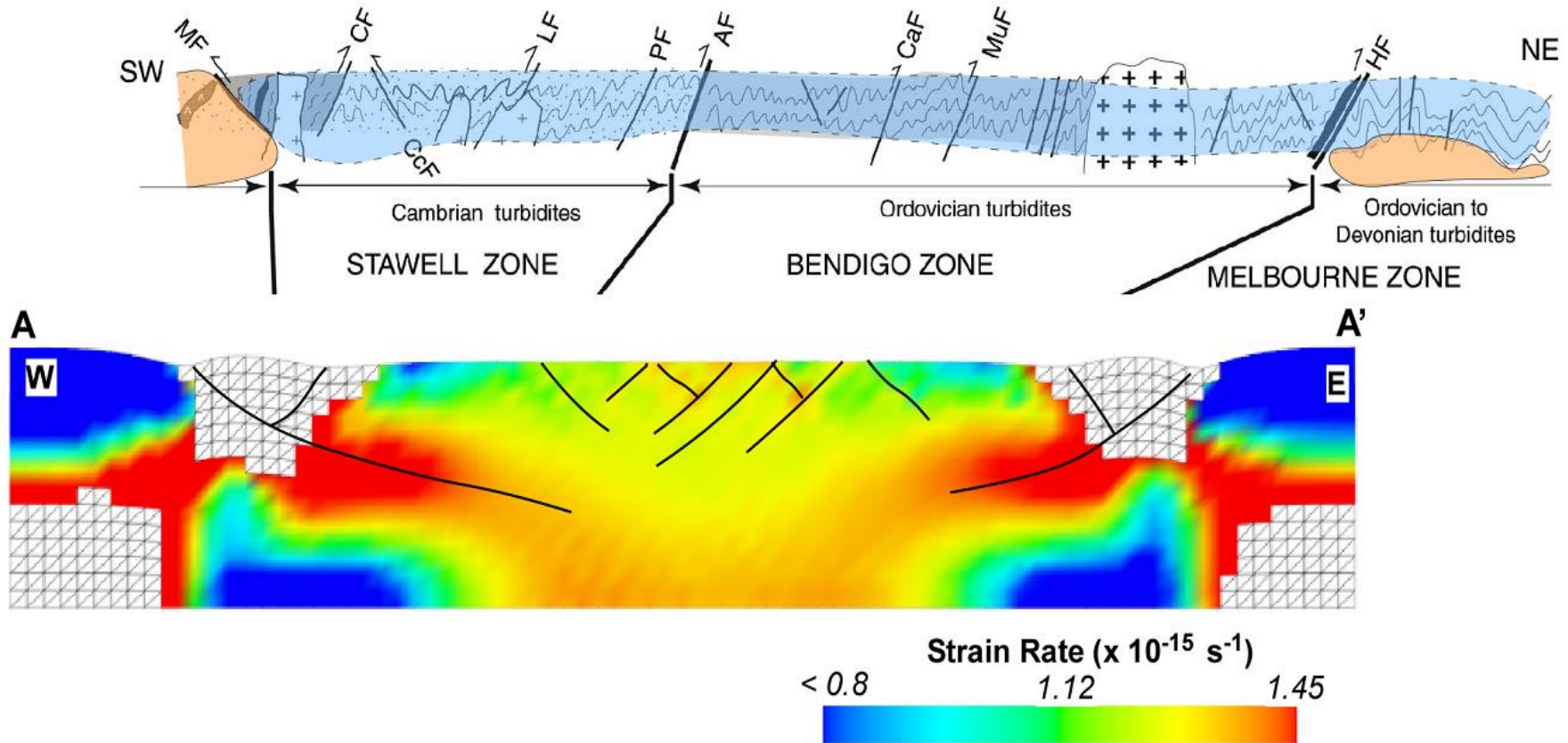


t = 10 Ma
25% cumulative shortening

Post Failure Strain
<10 % >15 %



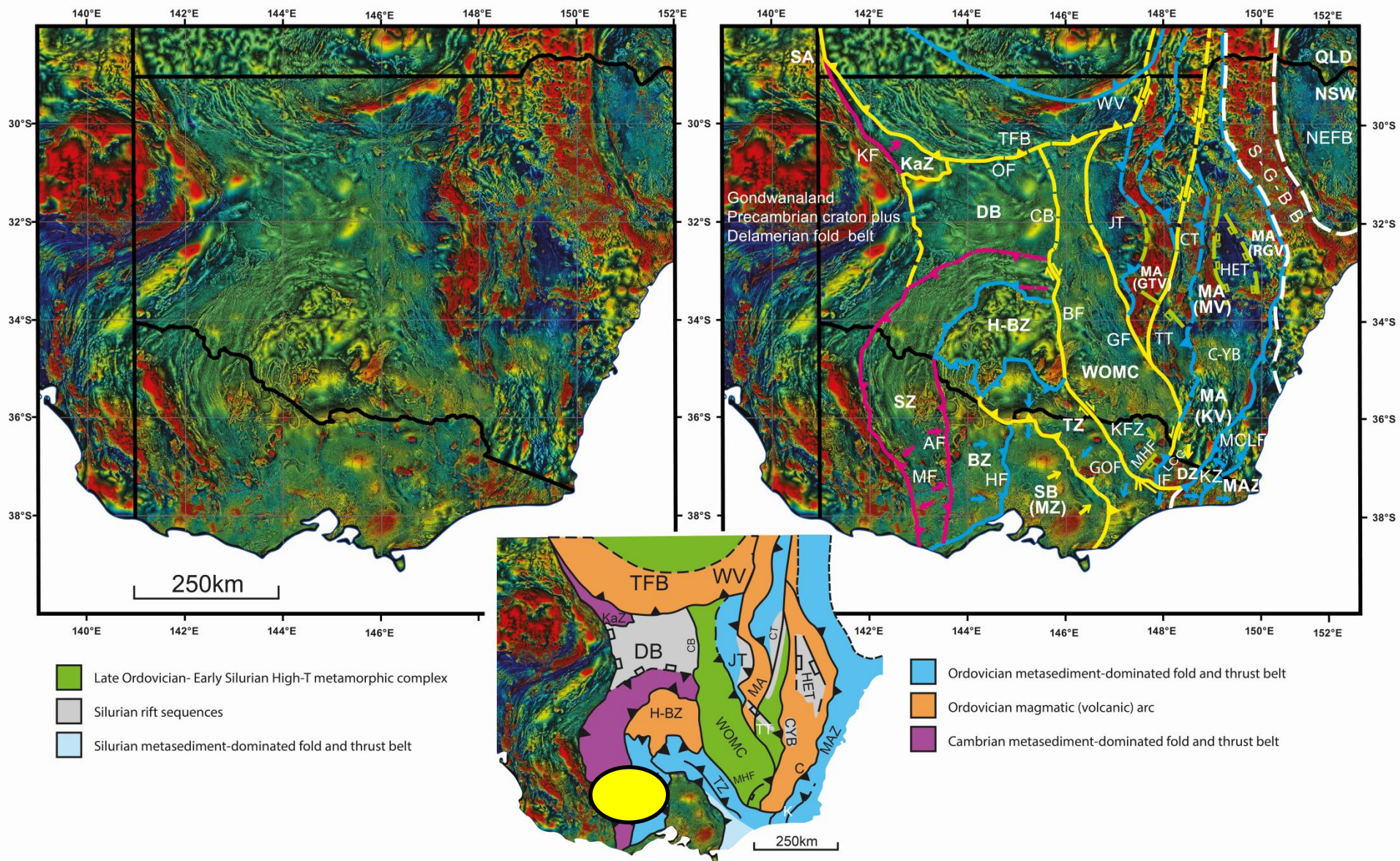
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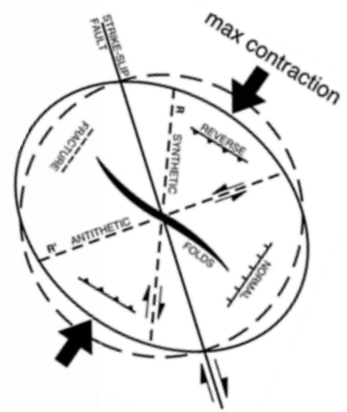
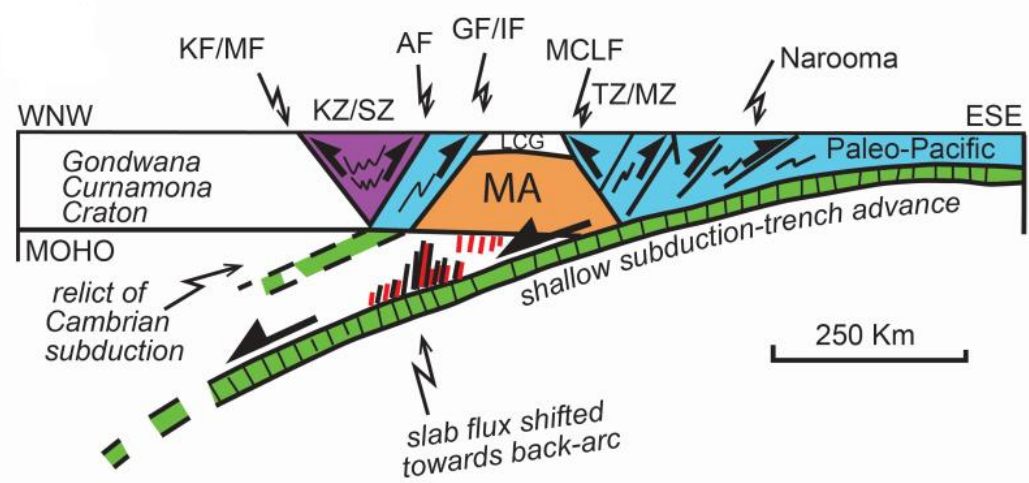
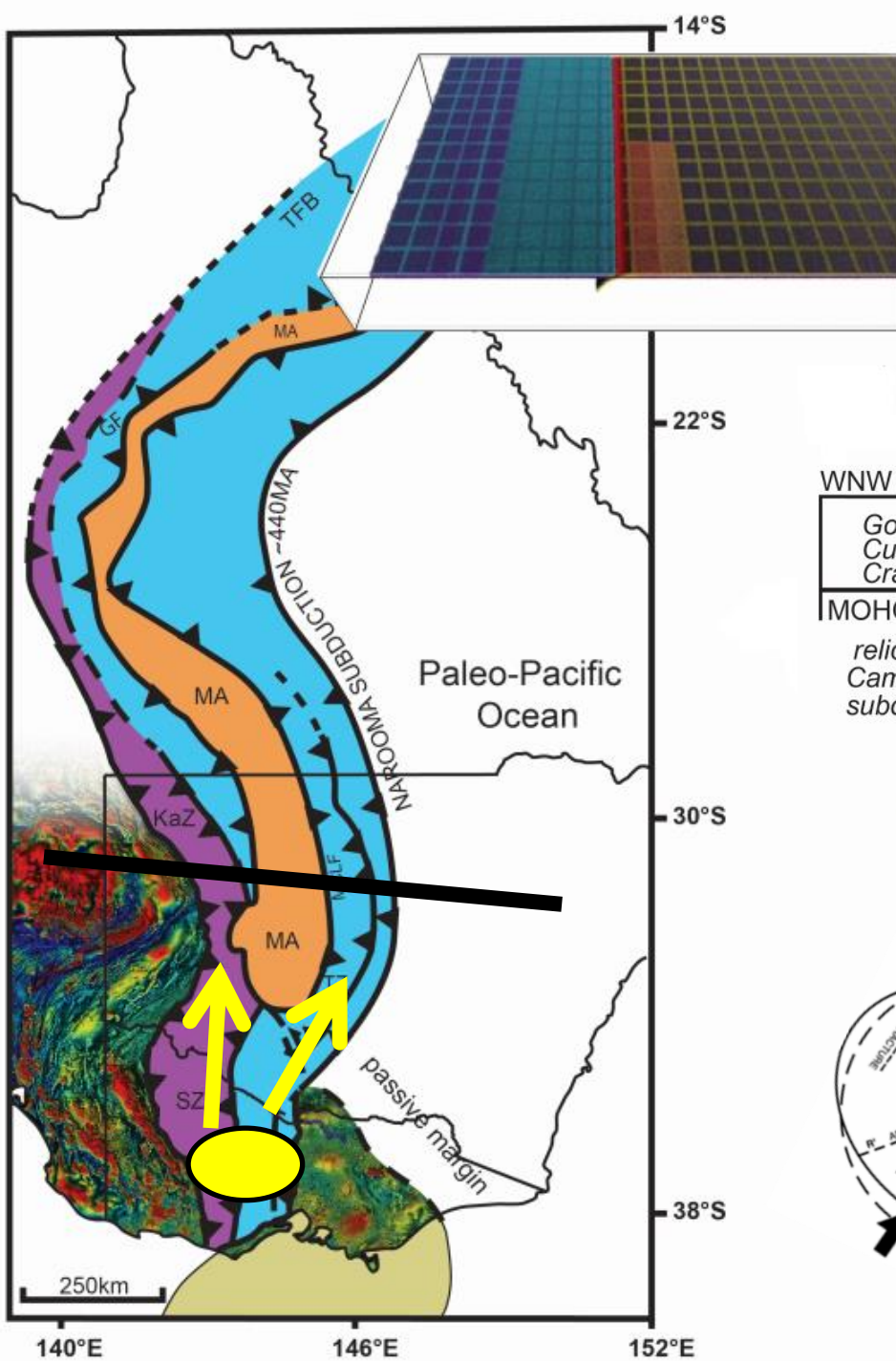


As these models are refined, improved predictive capacity for orogenic gold is sure to follow.....

Talk Outline

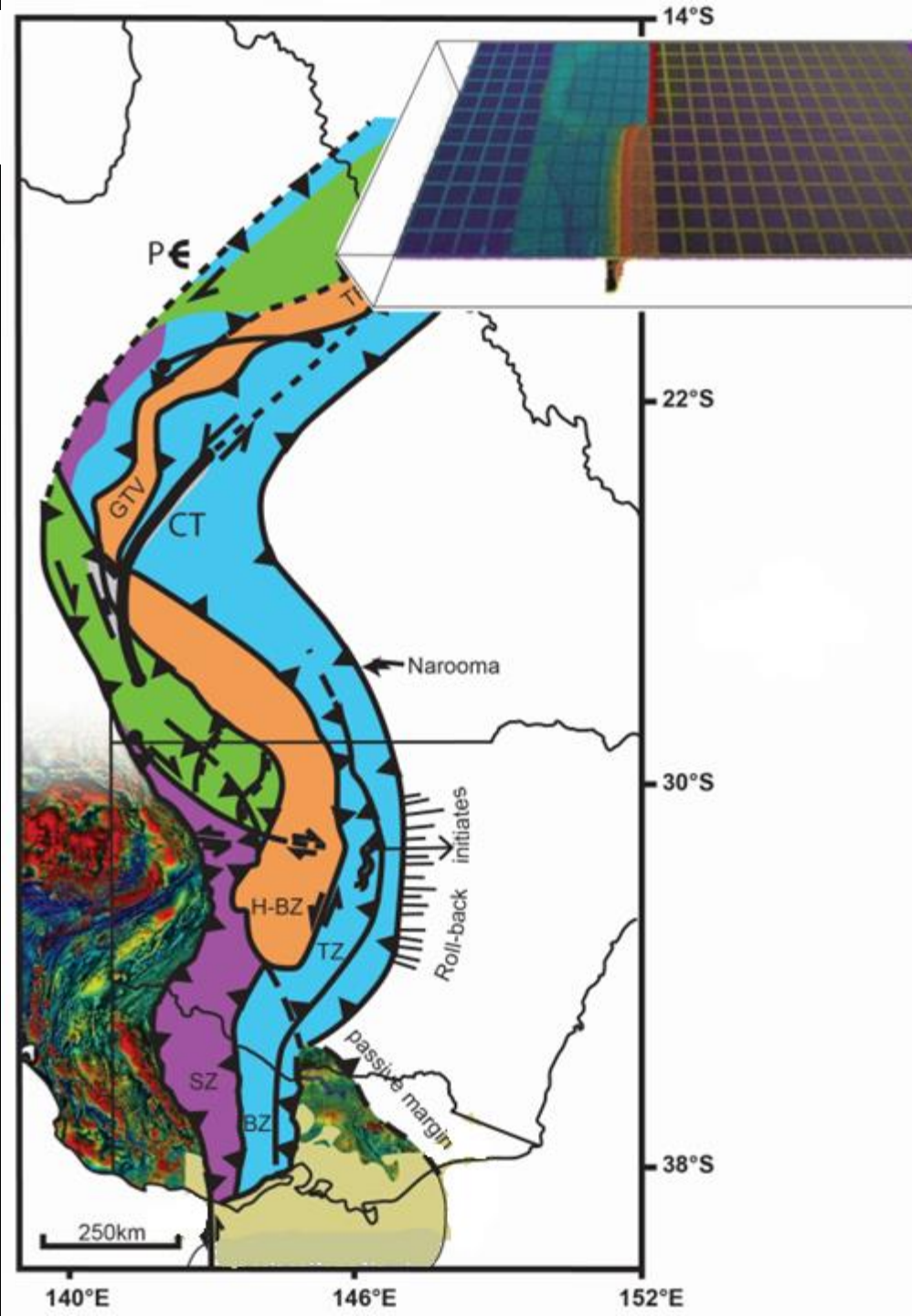
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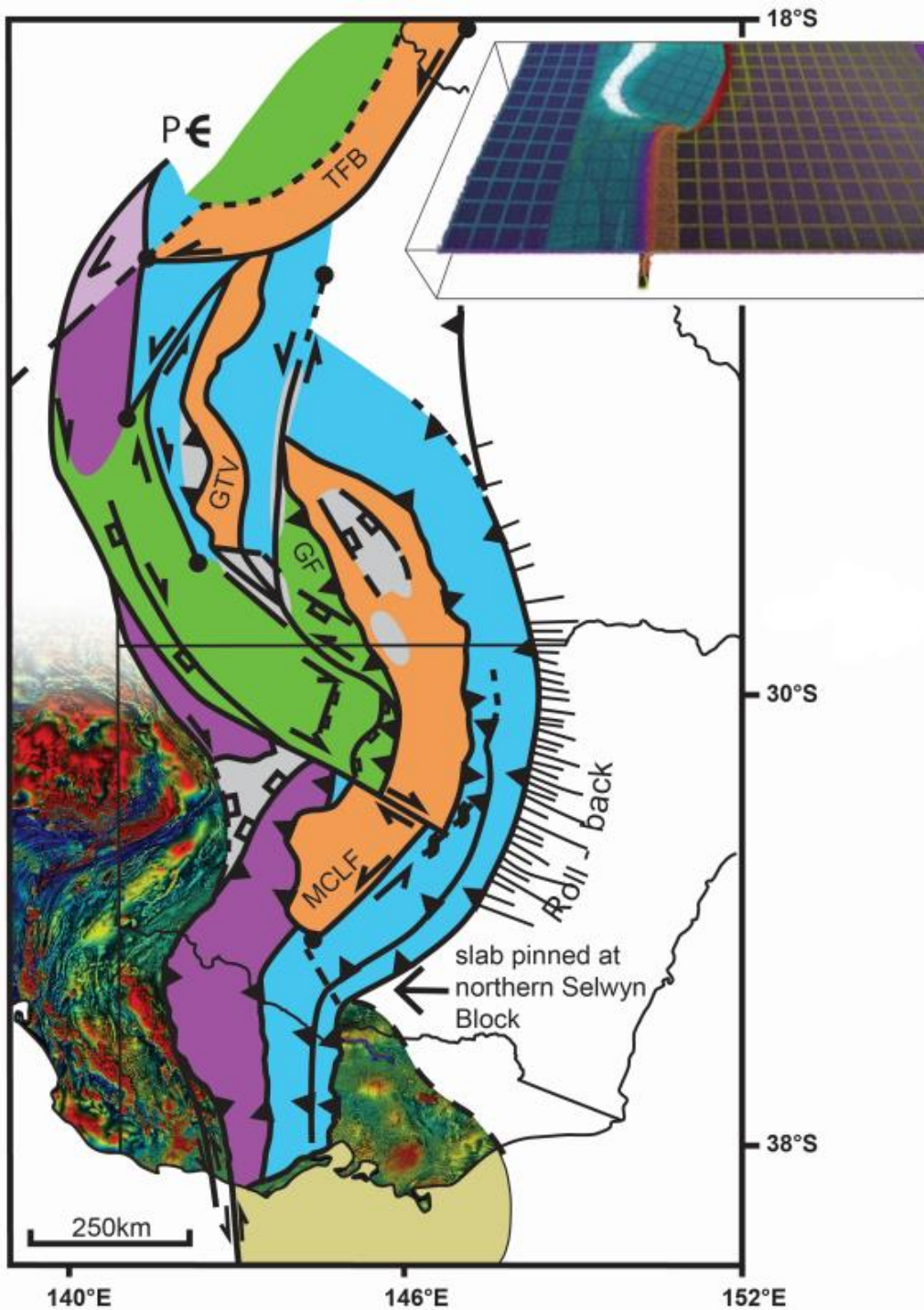
Moresi, Betts, Miller & Cayley 2014, NATURE.

Cayley & Musgrave, in review



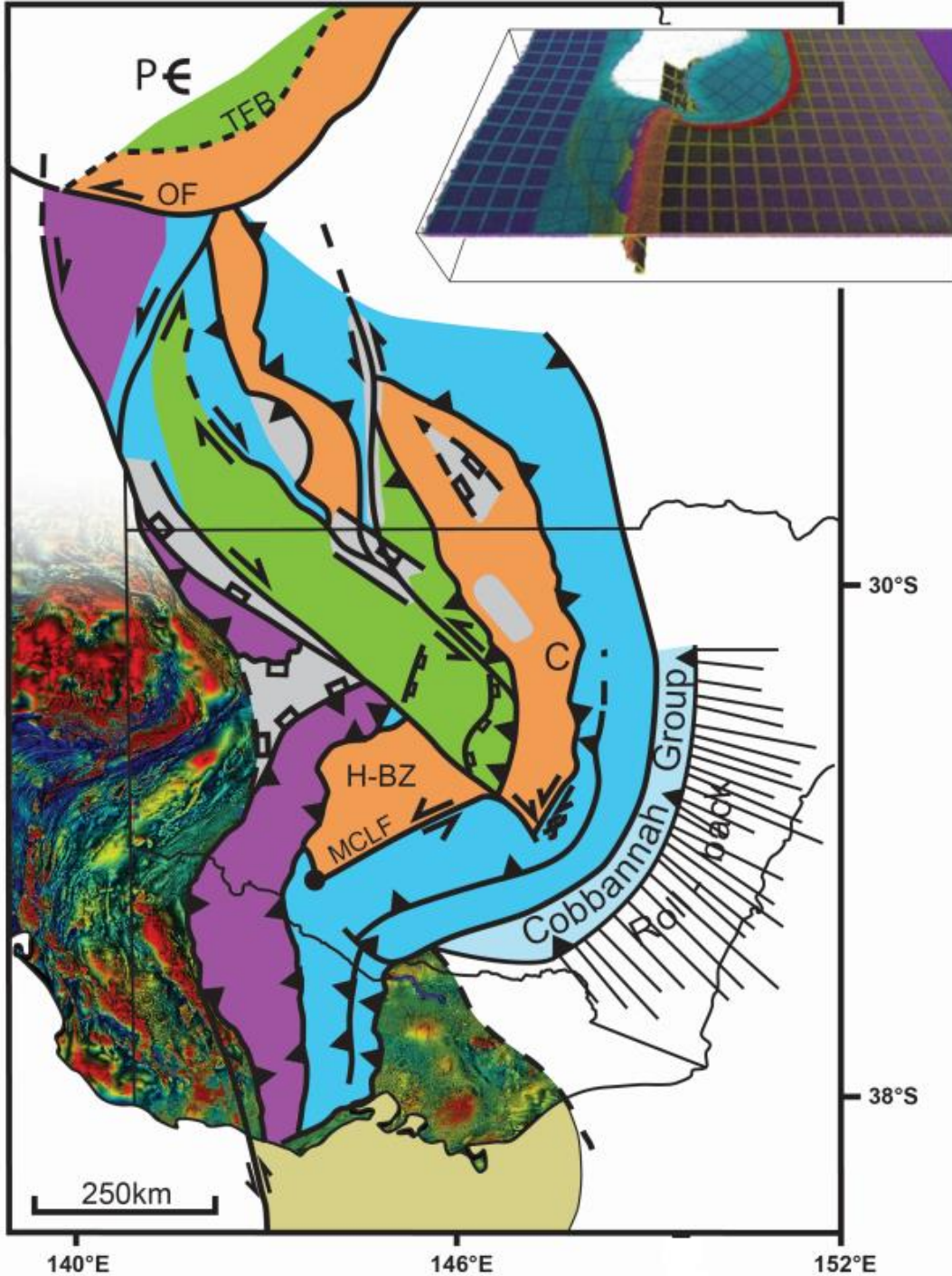
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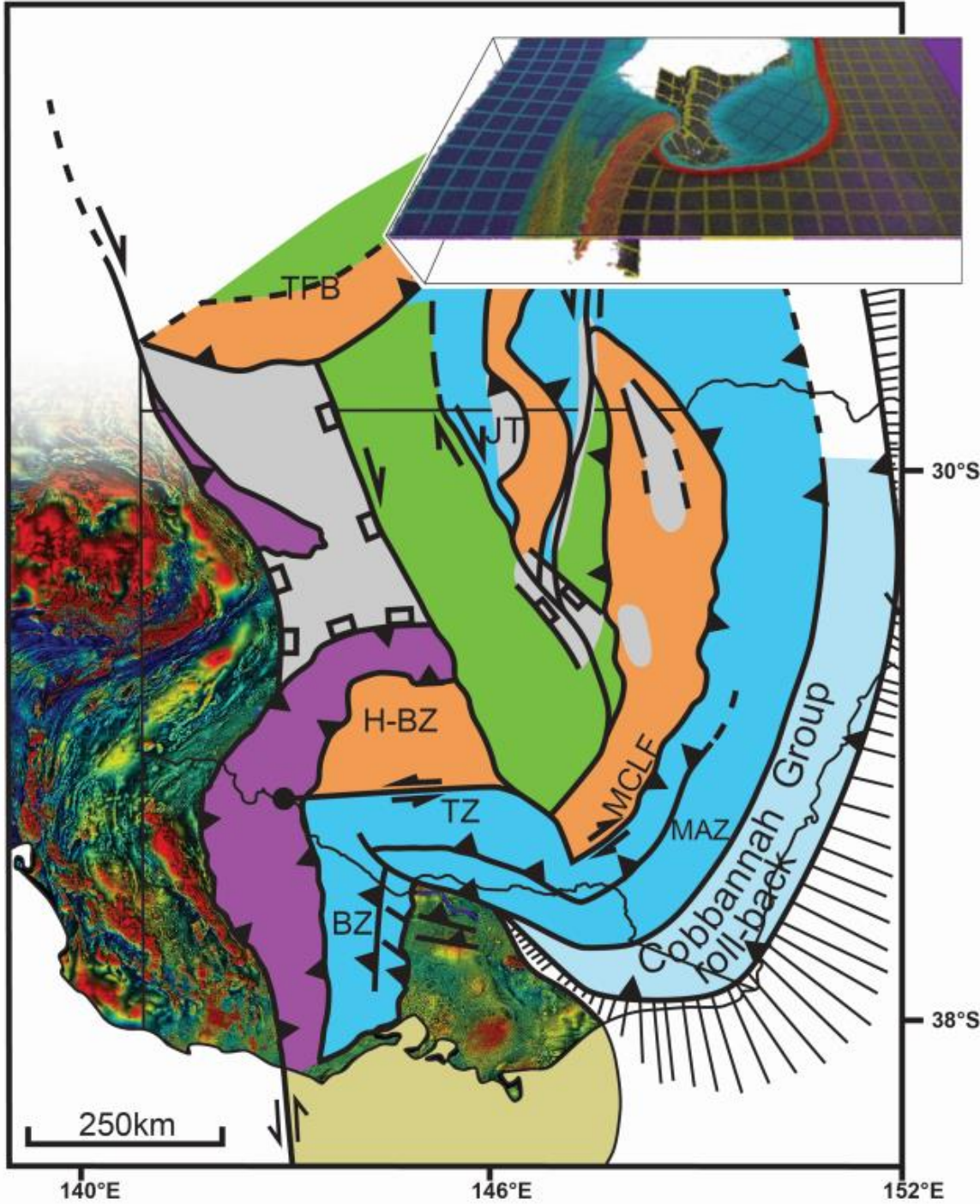
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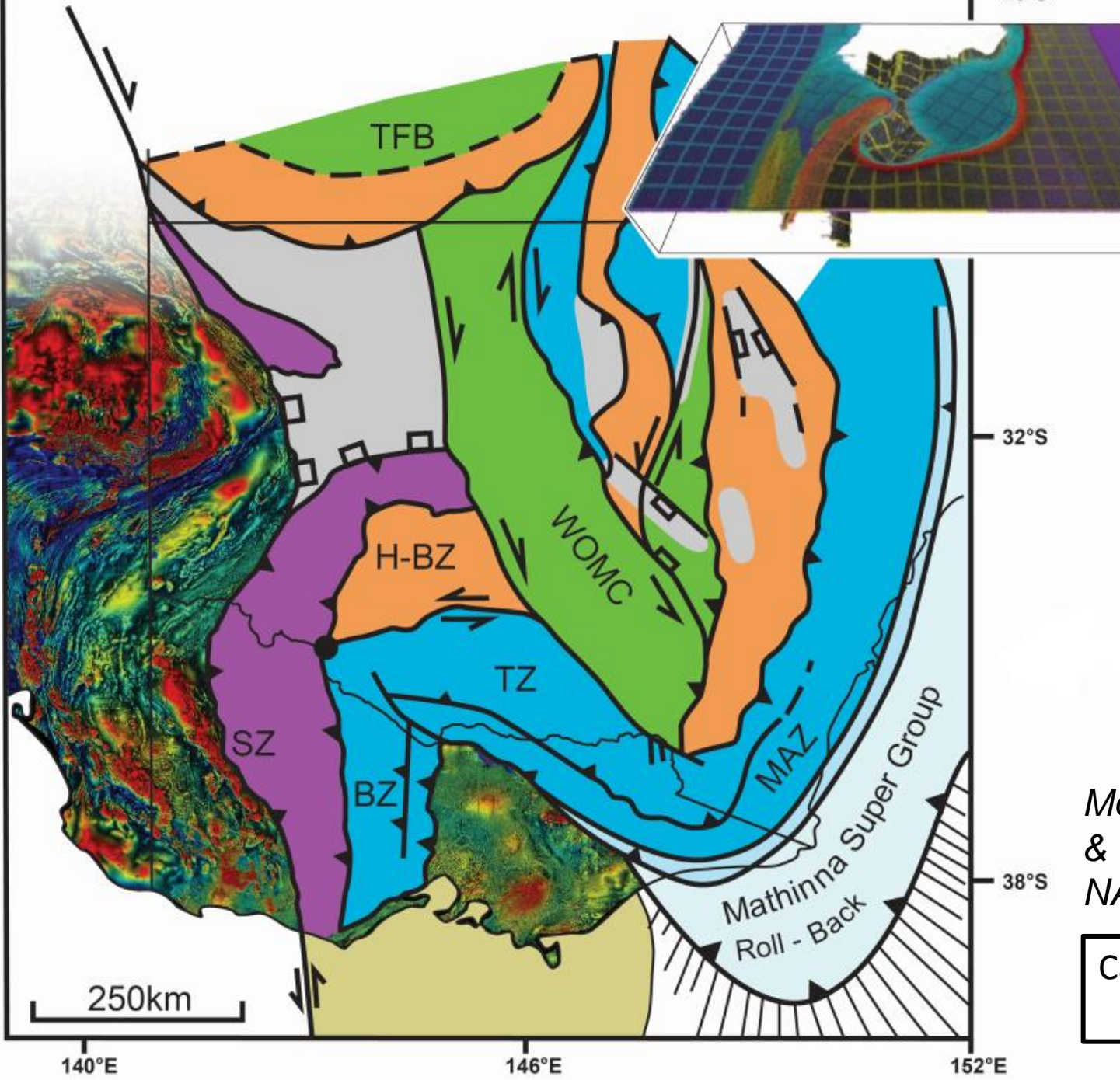
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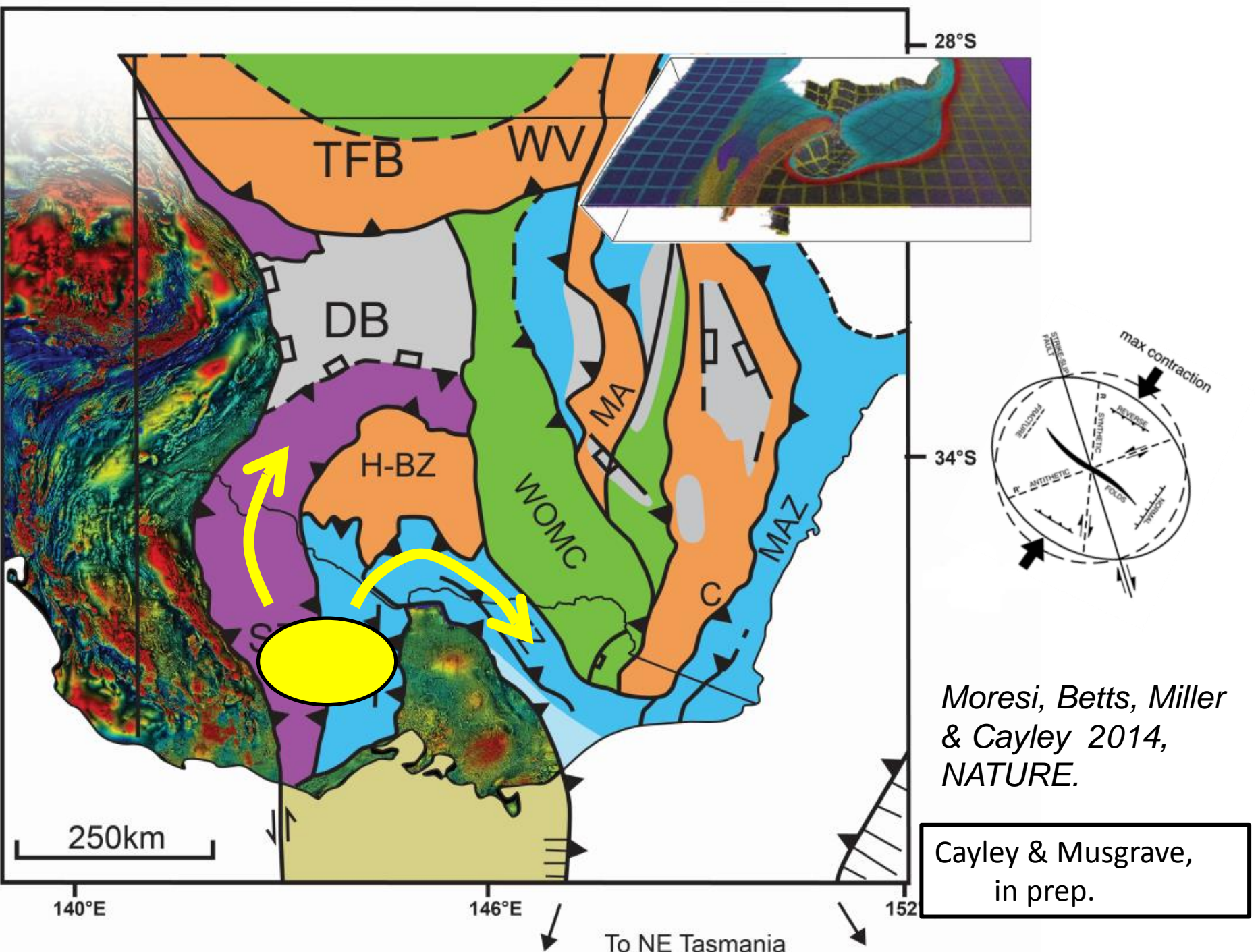
Moresi, Betts, Miller & Cayley 2014, NATURE.

Cayley & Musgrave, in review



Moresi, Betts, Miller & Cayley 2014, NATURE.

Cayley & Musgrave, in review



Conclusions



- There is huge upside for Victorian orogenic gold, brownfields and greenfields. Government keen to help (eg. pre-competitive geoscience, TARGET funding, Monash ARC linkage on Orogenic Gold).
- Developing predictive capacity through good science boosts confidence, helps overcome investment notions that Victorian gold is maybe 'too hard'....
- Good science, good exploration, can find new deposits (eg. Four Eagles), and can help Brownfields deliver (Fosterville, Costerfield, Ararat? Stavely?).
- New understanding (Lachlan Orocline) boosts the prospectivity of overlooked terranes (northern Tabberabbera Zone)
- New understanding of the geodynamic drivers of the system place Victorian orogenic gold into context with adjacent Arc terranes (Macquarie Arc, Stavely Arc) with proven potential for magmatic-related base-metals and gold.

