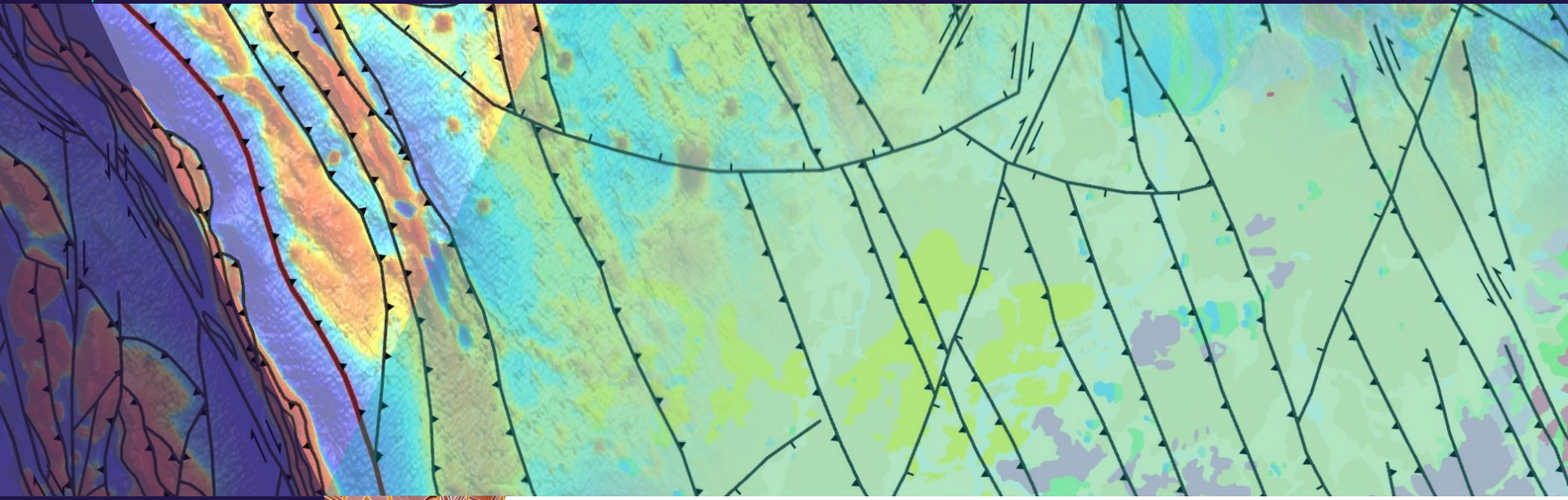
Faults everywhere.... but it's not all our fault!

Interpretations and implications of an updated regional fault network for central and western Victoria



Phil Skladzien

14 August 2024

GEOLOGICAL SURVEY OF VICTORIA

RESOURCES VICTORIA

VICTORIA State Government | Energy, Environment and Climate Action

Disclaimer

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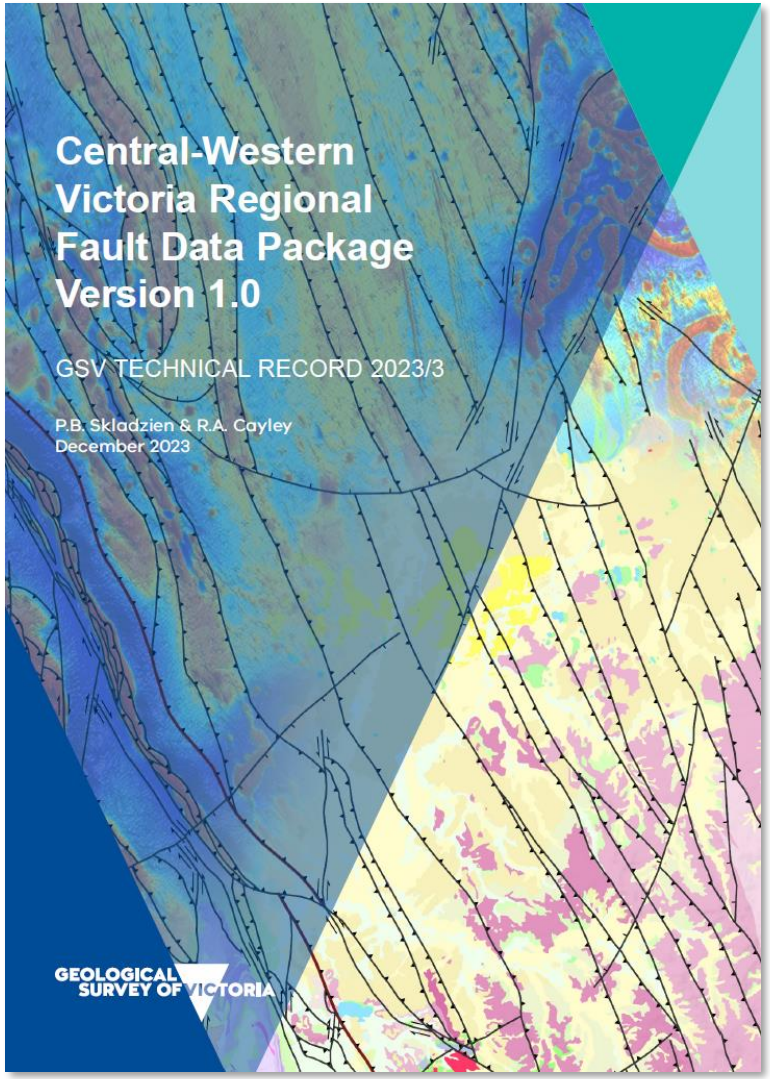

Central-Western
Victoria Regional
Fault Data Package
Version 1.0
GSV TECHNICAL RECORD 2023/3
P.B. Skladzien & R.A. Cayley
December 2023
GEOLOGICAL SURVEY OF VICTORIA

Outline

- **Background – legacy mapping, 3D modelling programs and geophysical interpretation**
- **Central-west Victorian Regional Fault dataset**
- **Implications for regional prospectivity**
- **Data package delivery**
- **Take-aways**

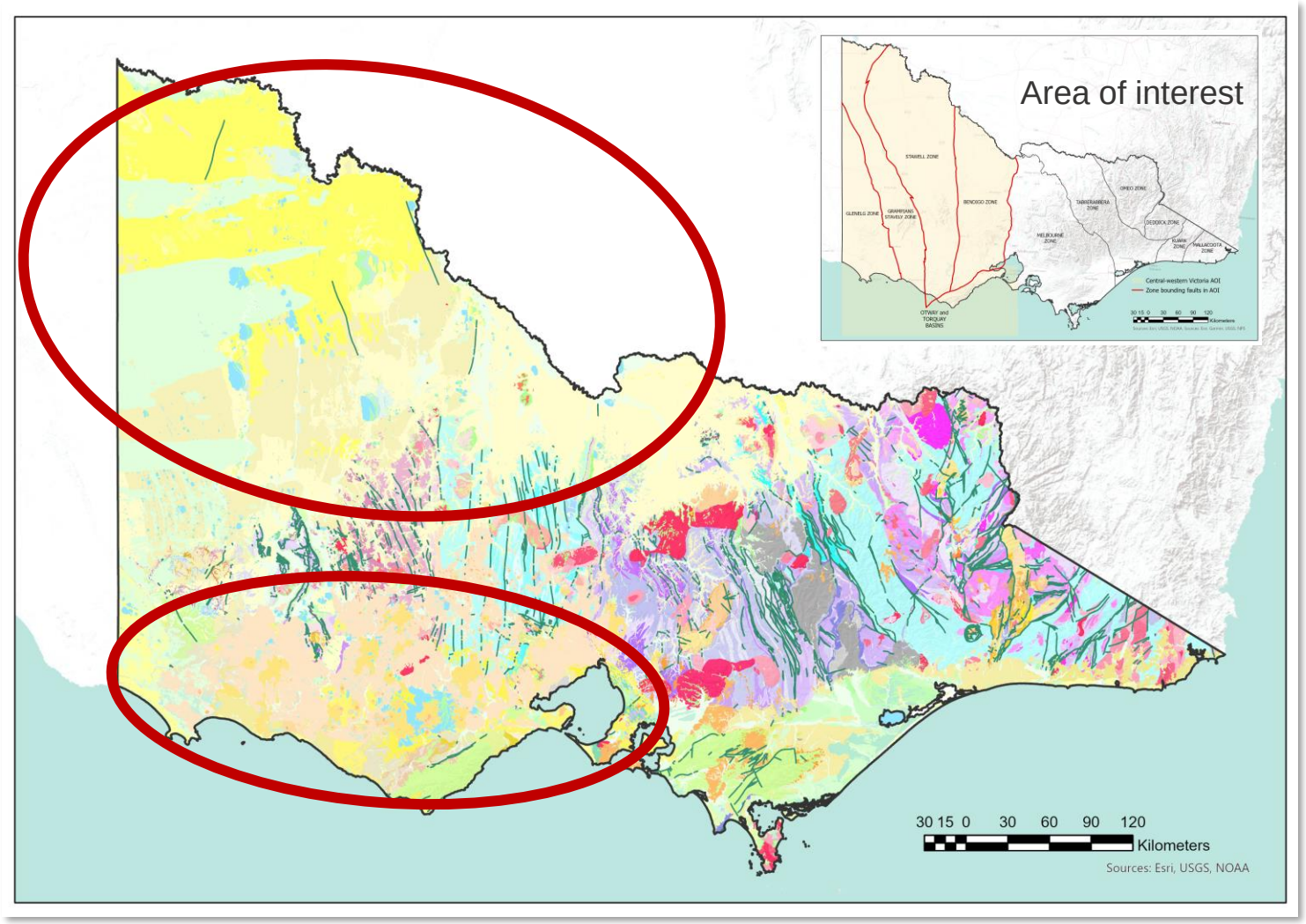
GEOLOGICAL SURVEY OF VICTORIA

Legacy mapping

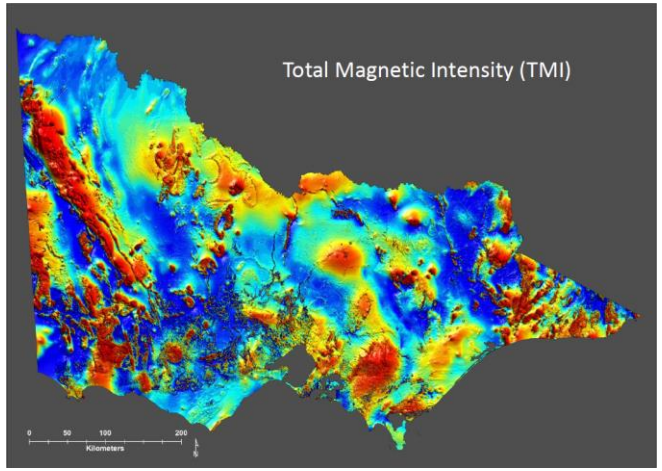
1:250k Seamless Geology coalesced over 150 years of legacy GSV mapping of exposed Paleozoic basement (Welch et al., 2011).

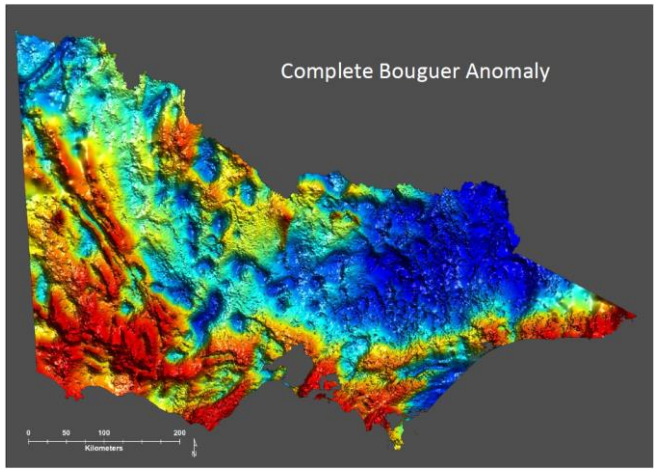
Geophysical data is crucial to interpreting Paleozoic basement beneath large swaths of younger cover.

- Additional datasets:
  - Drilling
  - Petrophysics
  - Geochronology
  - Geochemistry



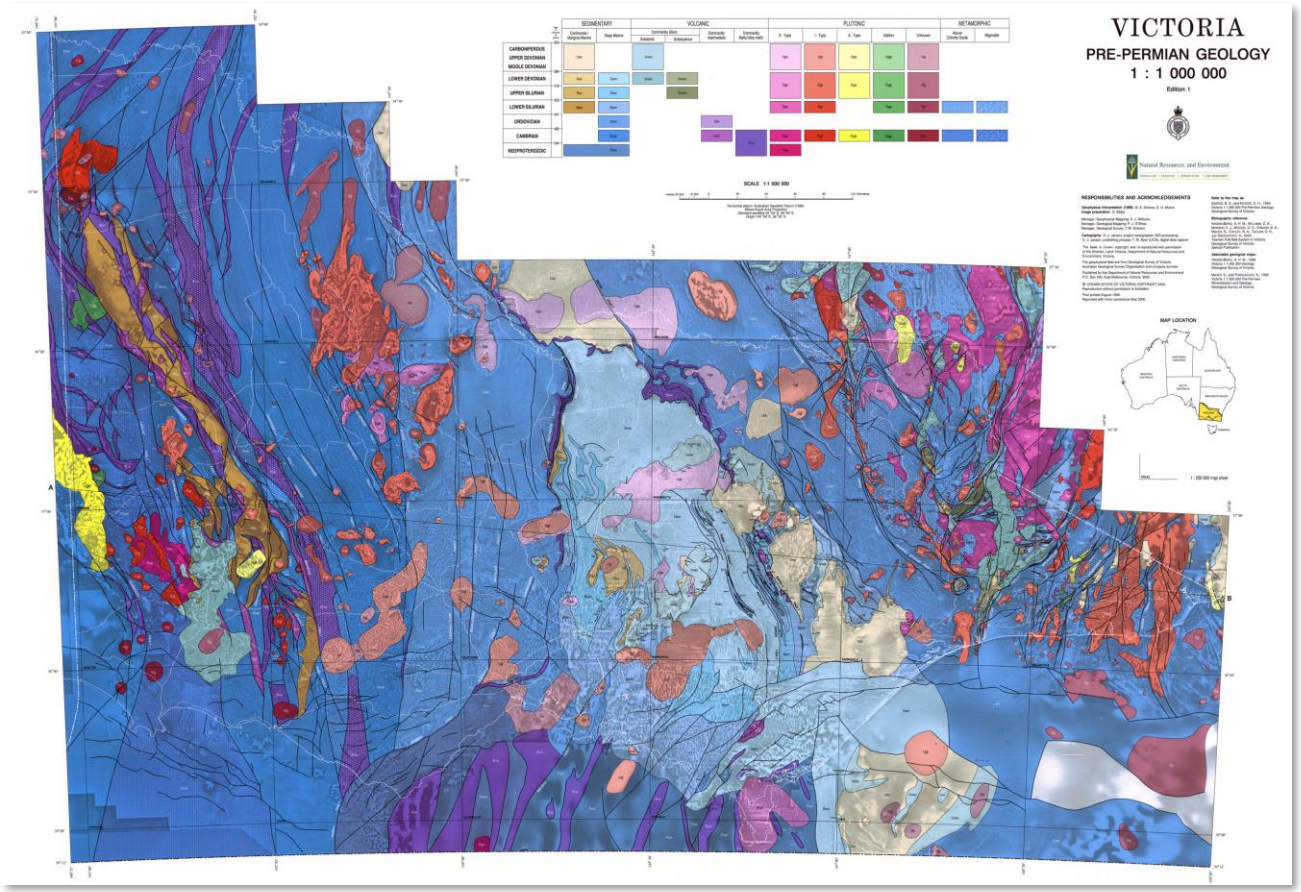
Legacy interpretations





1:1M Pre-Permian Geology (1999) - last published regional fault interpretation

Used newly acquired VIMP geophysical datasets

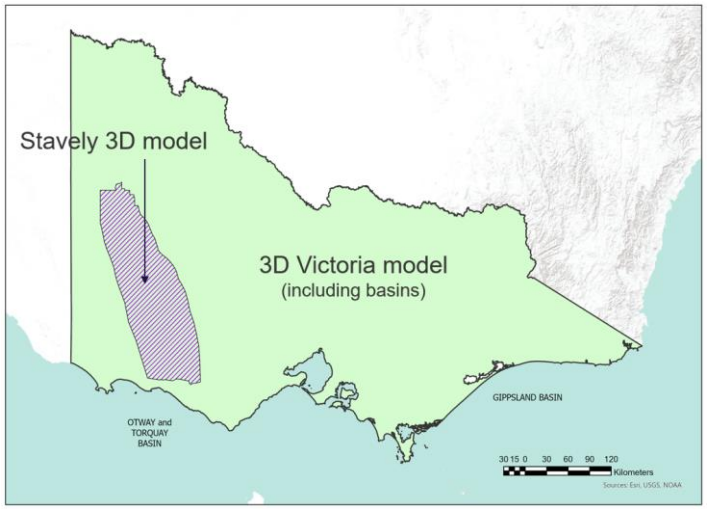


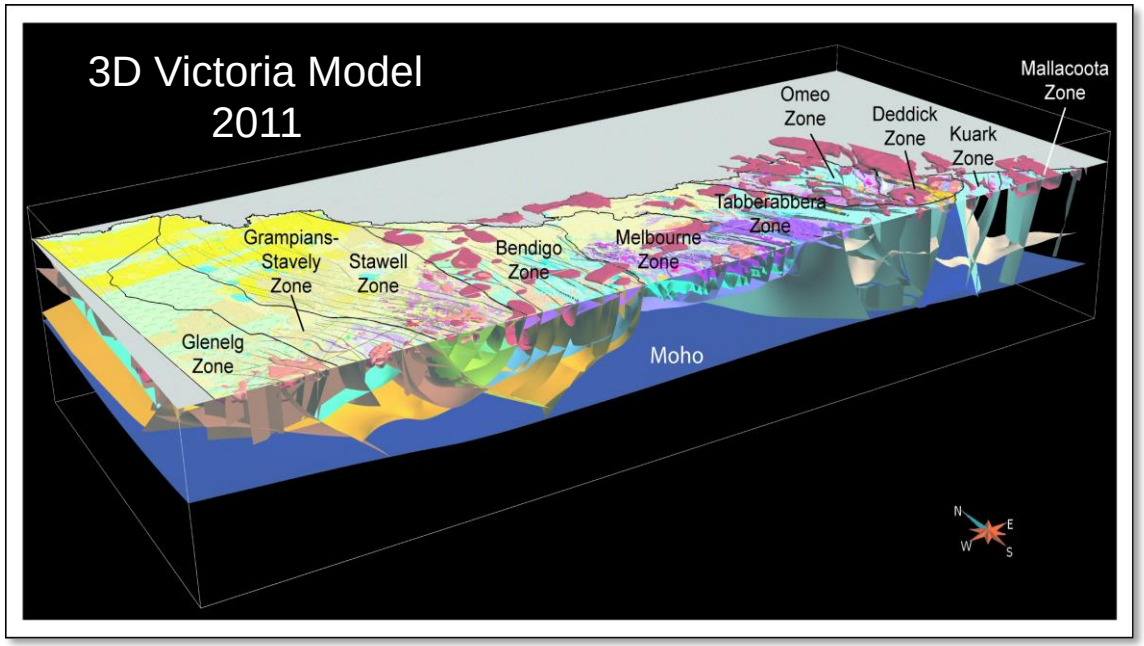
Simons & Moore, 1999

3D modelling projects

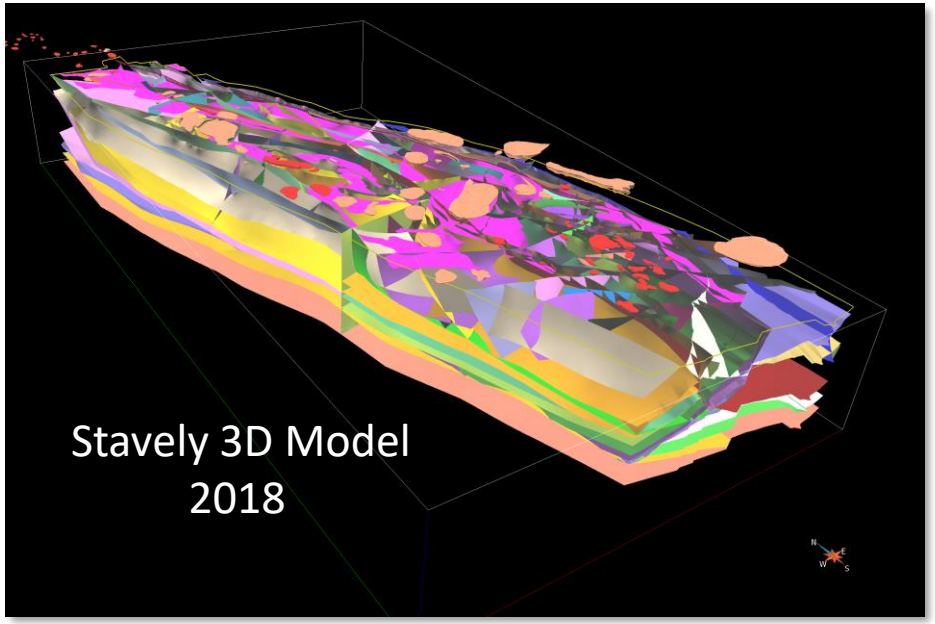
3D geological model development required understanding of structural geometries and kinematics, and geological unit distributions in three dimensions.

- New enhancement and analysis of potential field data undertaken





Rawling et al., 2011



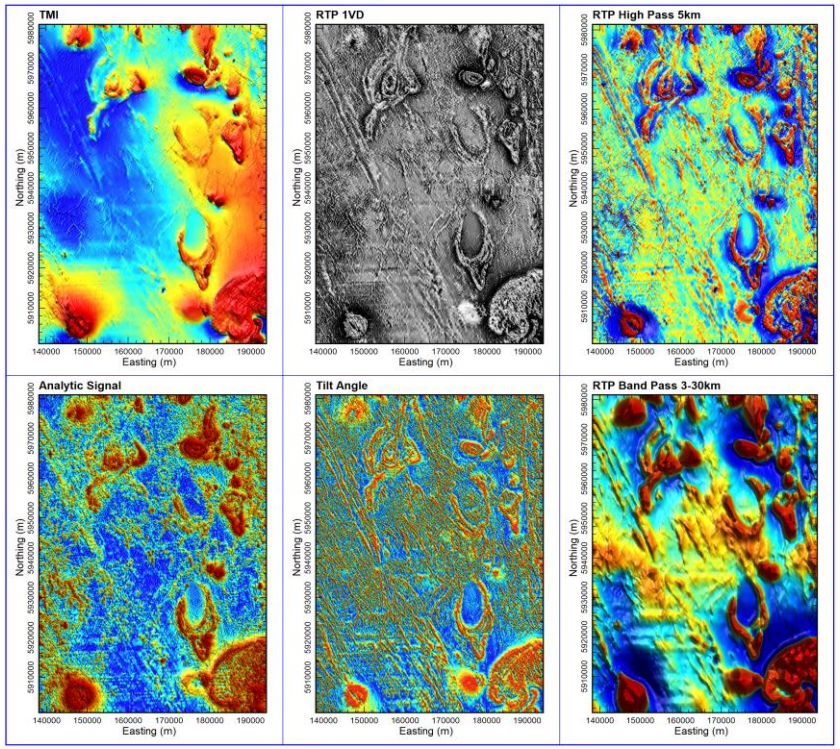
http://earthresources.efirst.com.au/product.asp?pID=1159&cID=64

Cayley et al., 2018

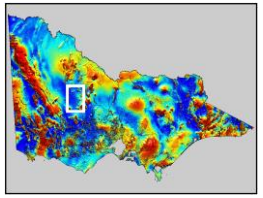
Potential field data : filtering and enhancement

Provides insight into physical rock property (~ lithology) distribution within the crust and more detail about the positions and geometries of structural features.

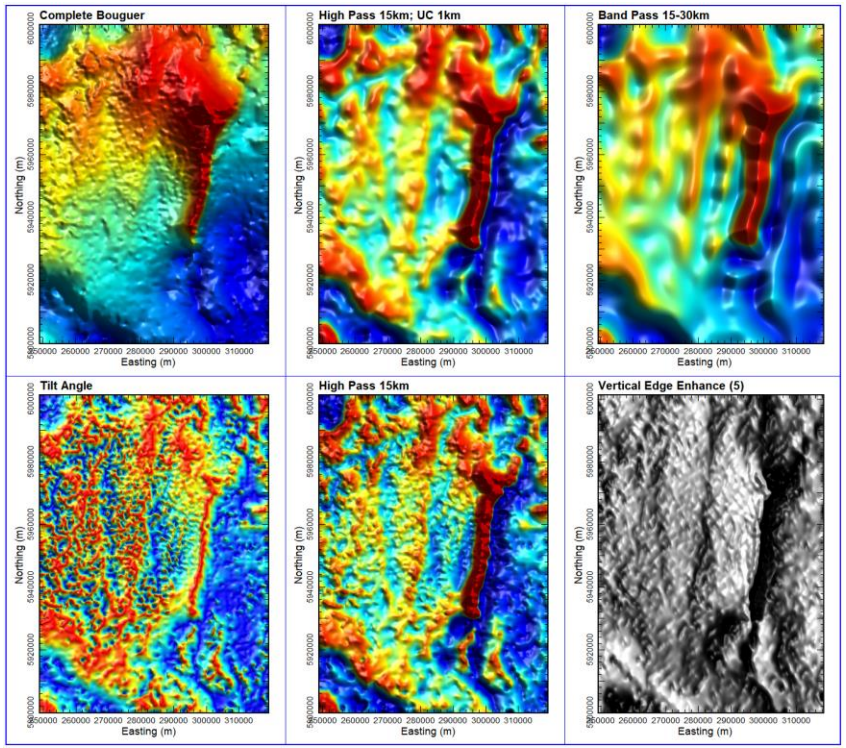
Examples of magnetic filters – Stawell Zone

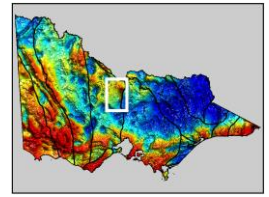


- Vertical derivatives
- Wavelength filters
- Tilt-angle filter
- Analytic signal filter
- Continuation filters
- Edge detection filters



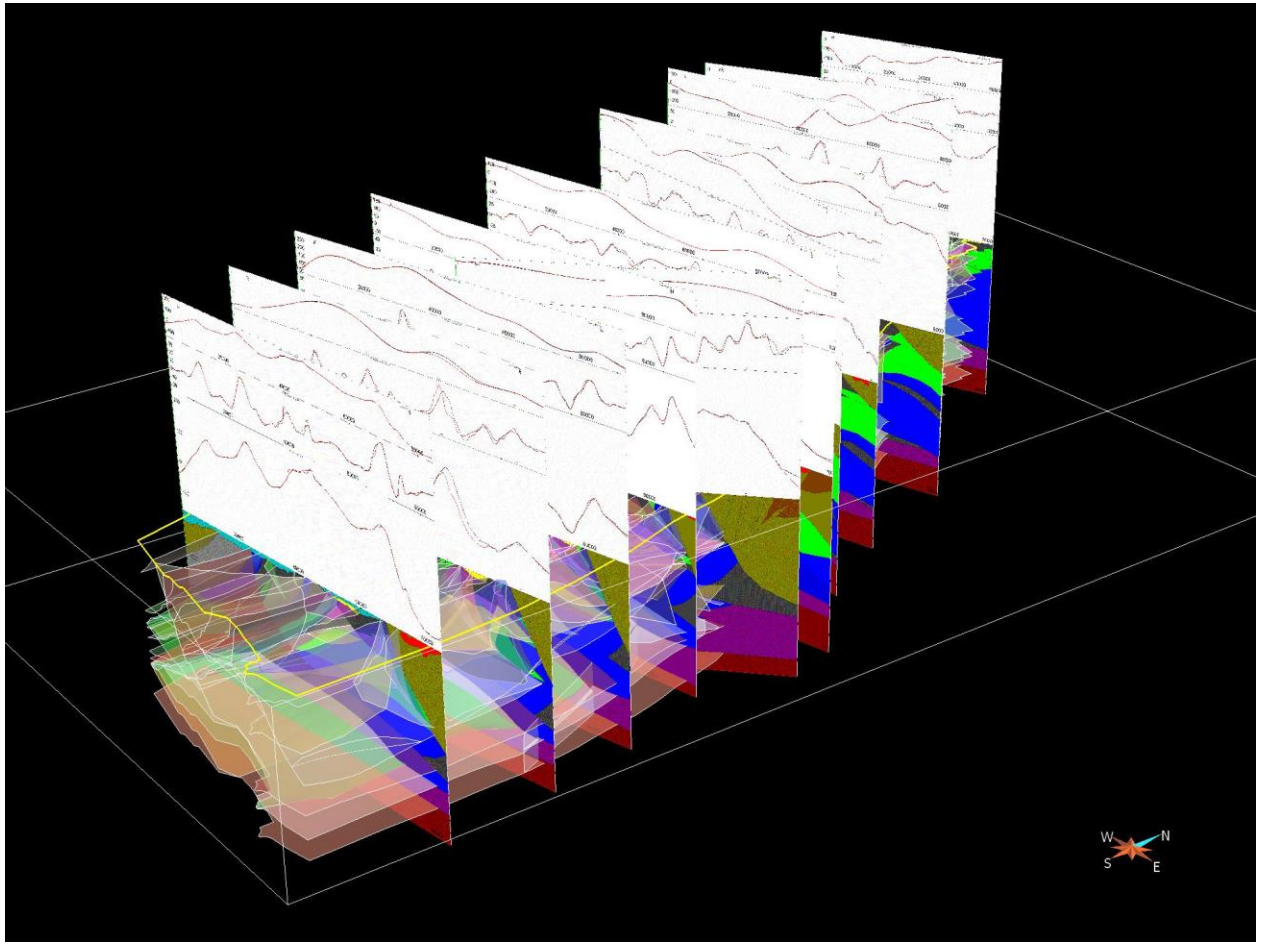
Examples of gravity filters – Bendigo Zone

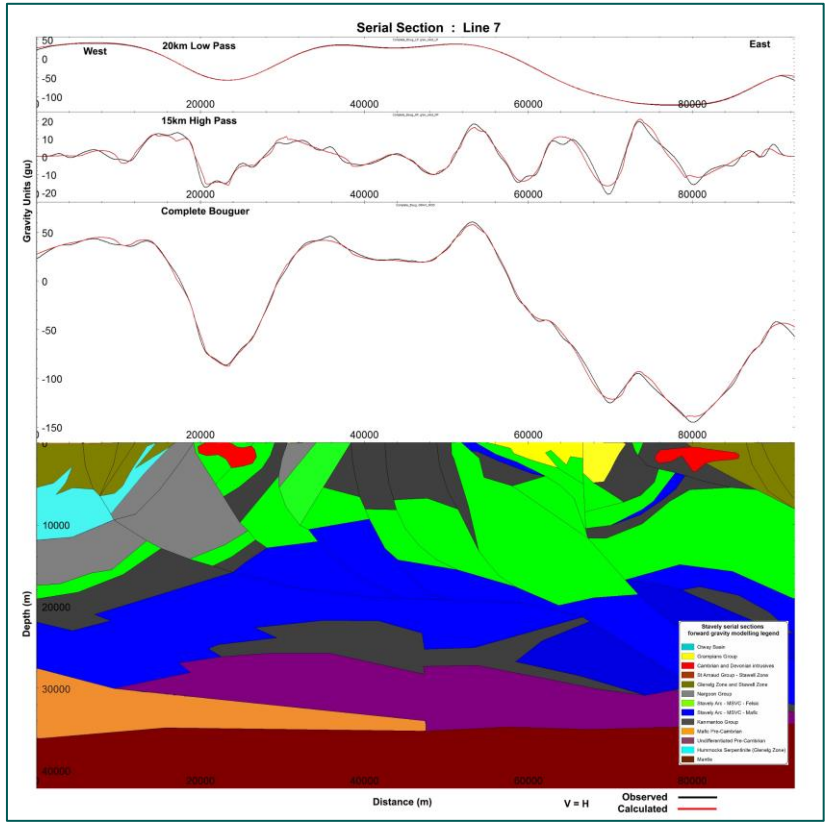




Potential field data : forward modelling

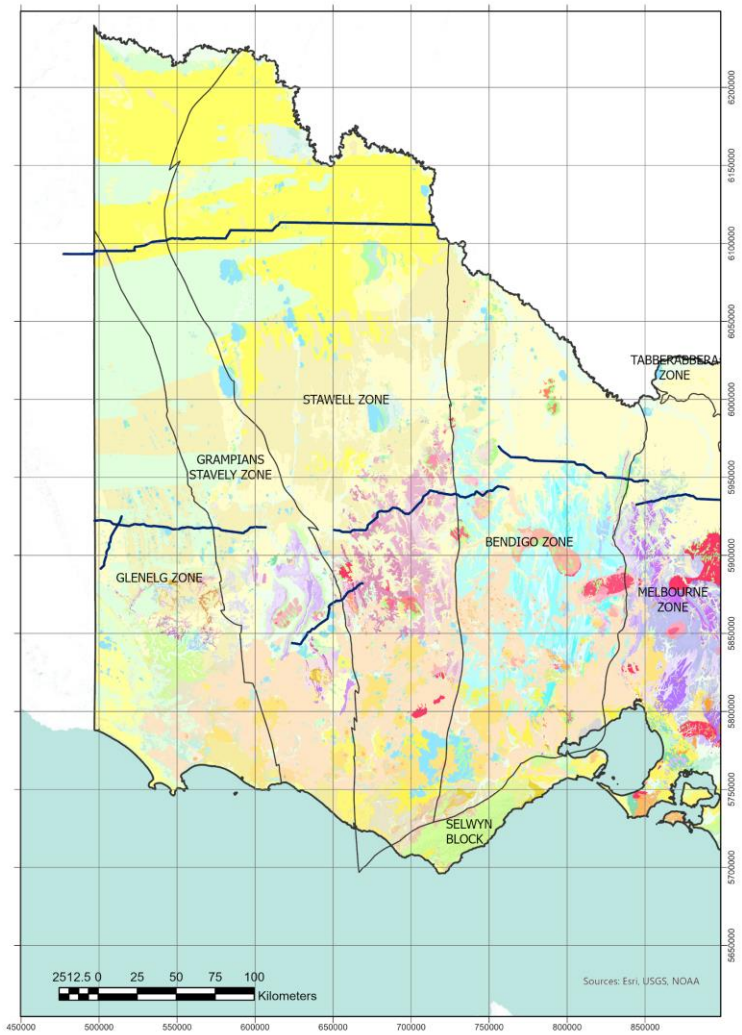
Serial section forward models - Stavely 3D geological model.





Cayley, McLean, Skladzien, Cairns, 2018: Stavely Project Report 3

Seismic reflection transects - control in third dimension



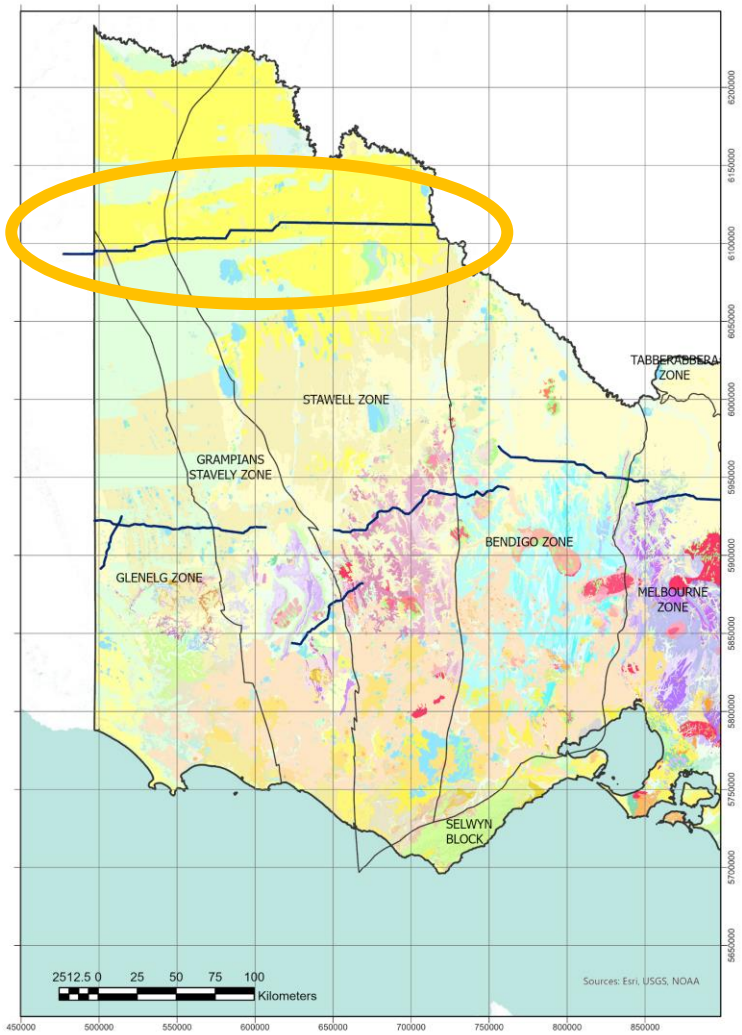
- 2006 Central Victoria Seismic Transect
- 2009 Southern Delamerian Seismic Survey
- 2022 Darling-Curnamona-Delamerian (DCD) 2D Seismic Survey

Source: Geoscience Australia portal
https://portal.ga.gov.au/3d/restore/9c6448db-418f-400b-809c-82aeafadc325

AuScope

Australian Government
Geoscience Australia

Seismic reflection transects - control in third dimension



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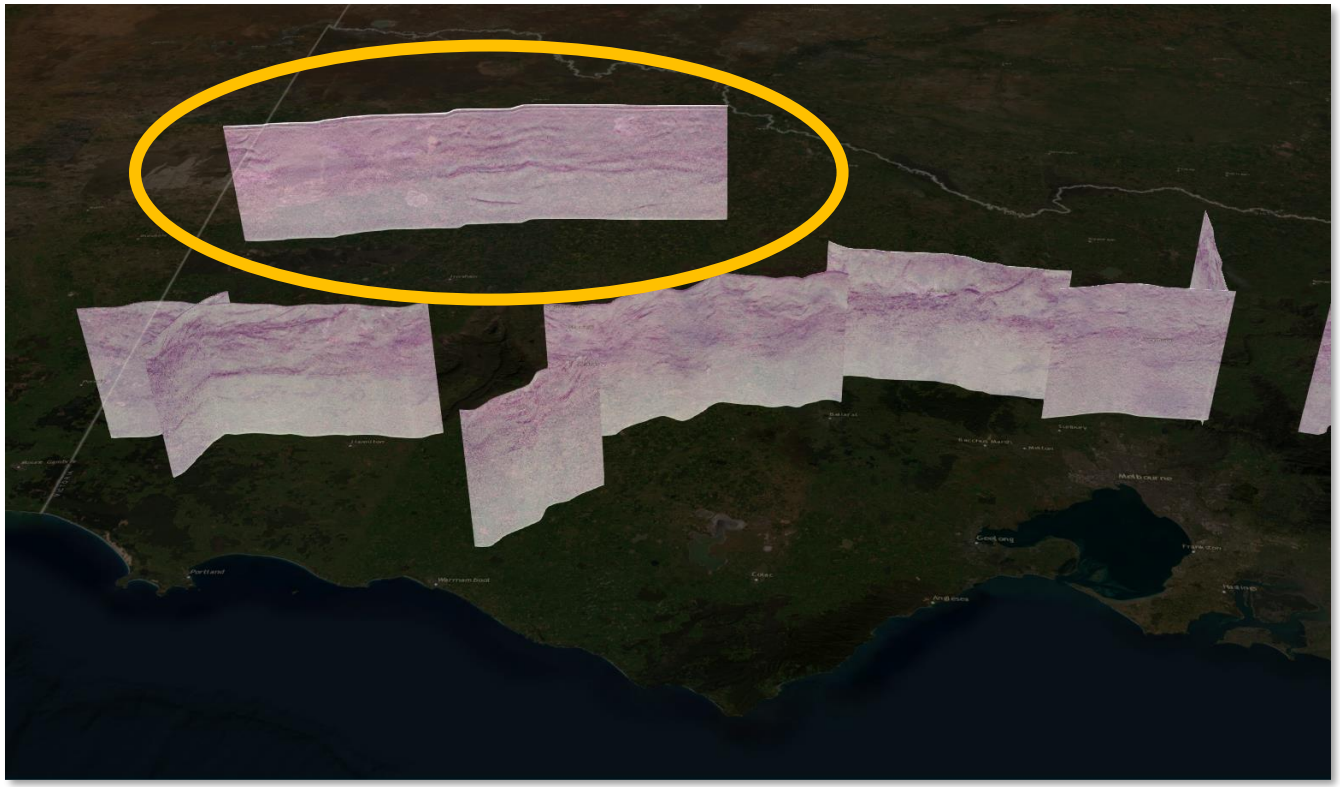


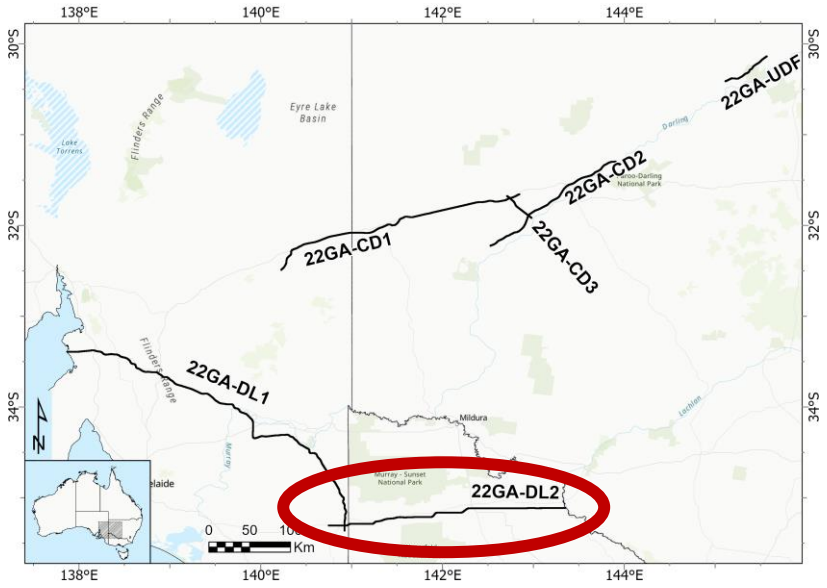
AuScope

Australian Government
Geoscience Australia

Source: Geoscience Australia portal
https://portal.ga.gov.au/3d/restore/9c6448db-418f-400b-809c-82aeafadc325

2022 Northwest Victoria DCD 2D Reflection Seismic Survey

- 2022 Darling-Curnamona-Delamerian (DCD) 2D Seismic Survey (part of GA's EFTF program)
- 5 deep seismic reflection lines totalling 1256 km
- Victorian GA22-DL2 line 249 km in length



Line GA22-DL2 acquisition

L213 Darling-Curnamona-Delamerian (DCD) 2D Seismic Survey
https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/147423

Australian Government
Geoscience Australia

2022 Northwest Victoria DCD 2D Reflection Seismic Survey

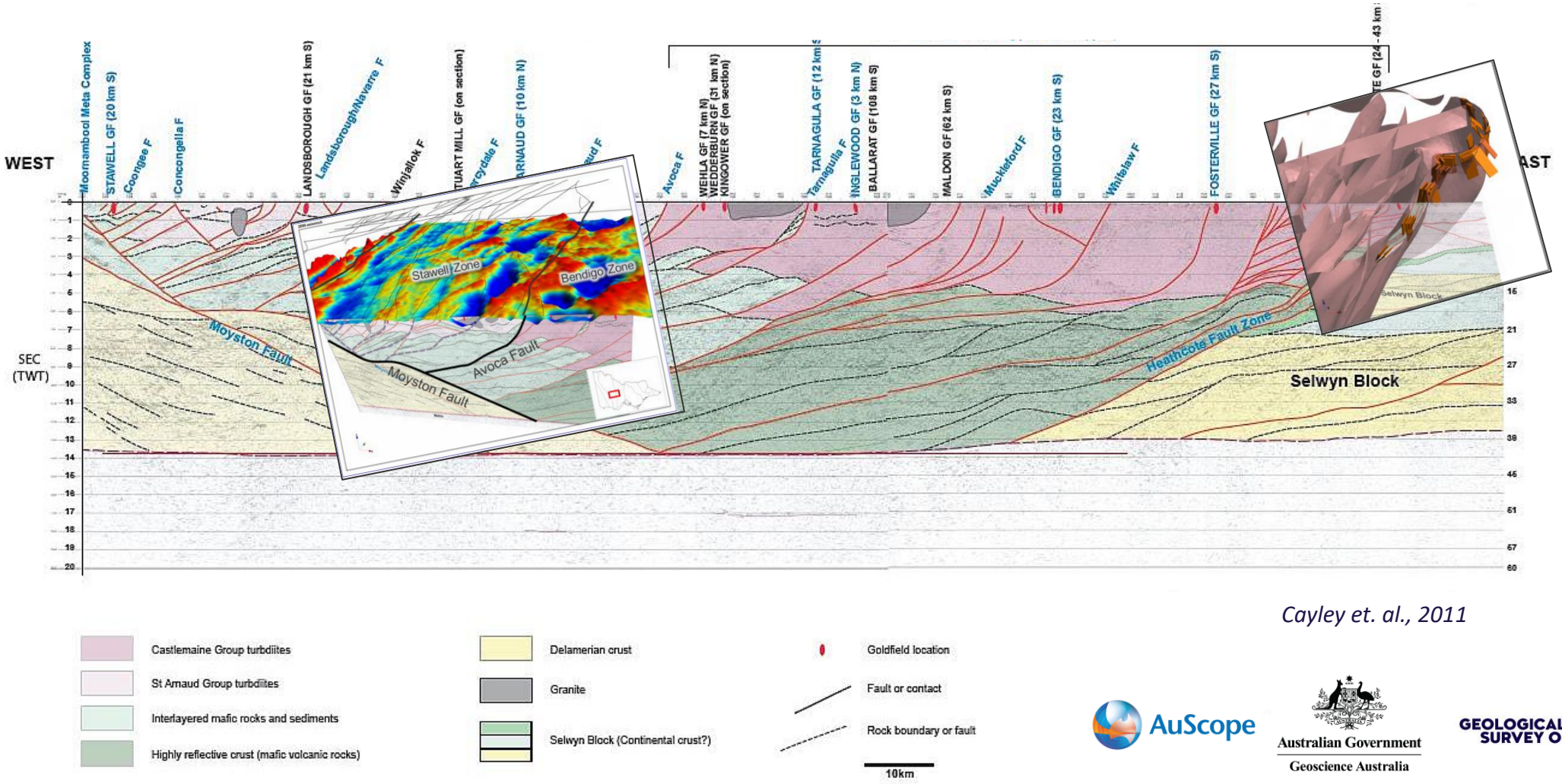
- Source array: 3 x 30 tonne vibroseis trucks
- Receiver array: 16 km symmetrical geophone (node) spread
- 20s record length
- 40 m vibe point distance
- 4 m node spacing

Line GA22-DL2 acquisition

L213 Darling-Curnamona-Delamerian (DCD) 2D Seismic Survey
https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/147423

Australian Government
Geoscience Australia

2006 seismic reflection transect - control in third dimension



Cayley et. al., 2011

AuScope

Australian Government
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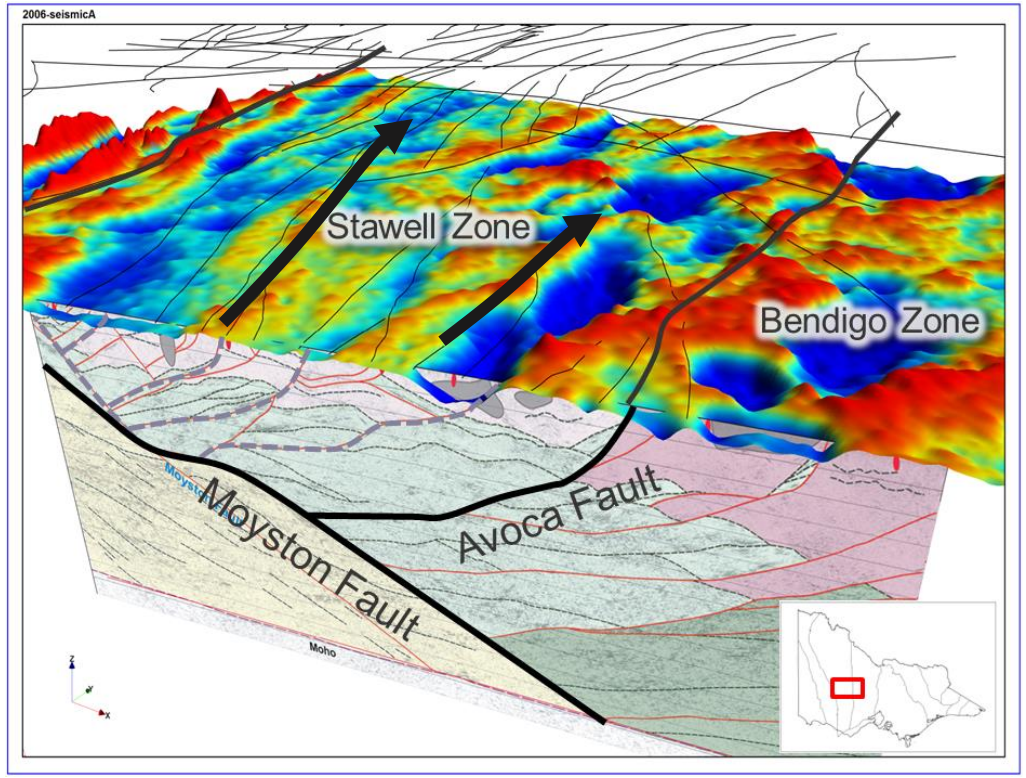
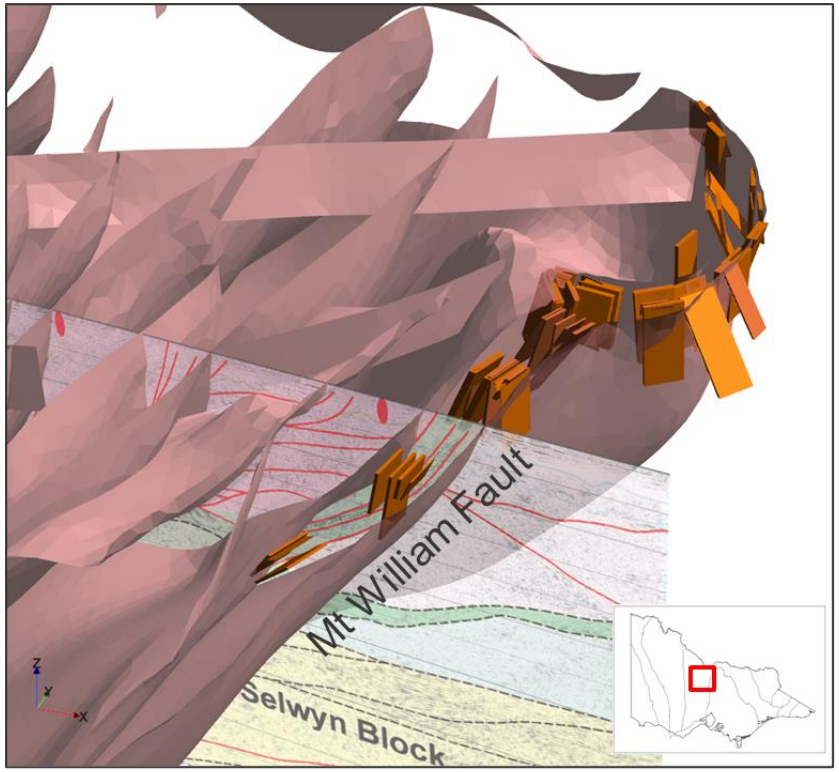
GEOLOGICAL SURVEY OF VICTORIA

Seismic reflection transects - control in third dimension

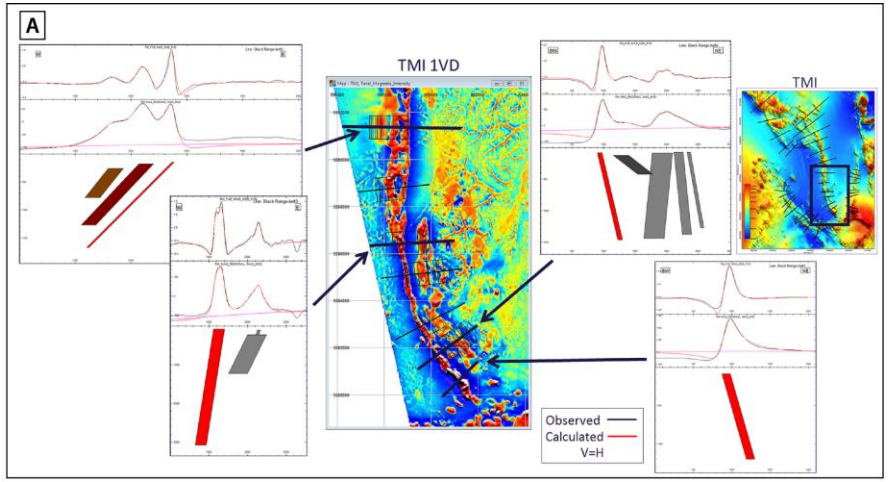


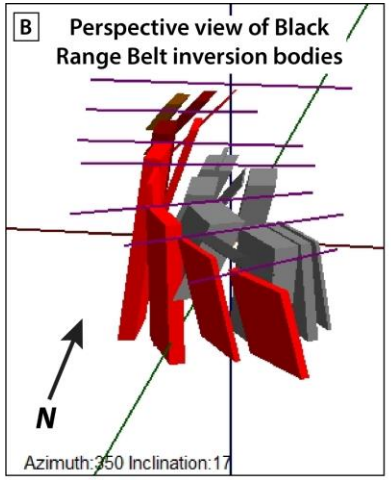
Seismic interpretation correlated with surface mapping and gravity data to interpret structures away from regions of geological control.

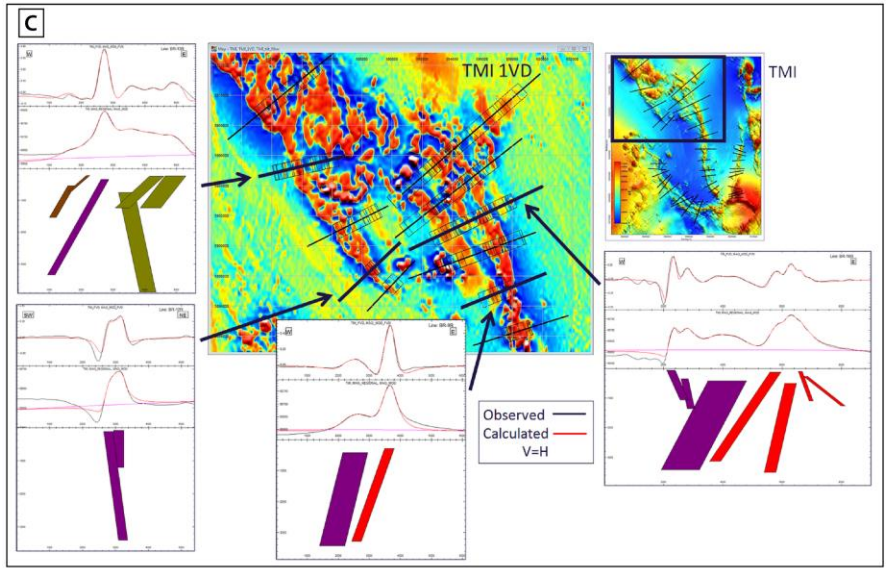
3D Victoria model fault surfaces and magnetic inversion dip model bodies.

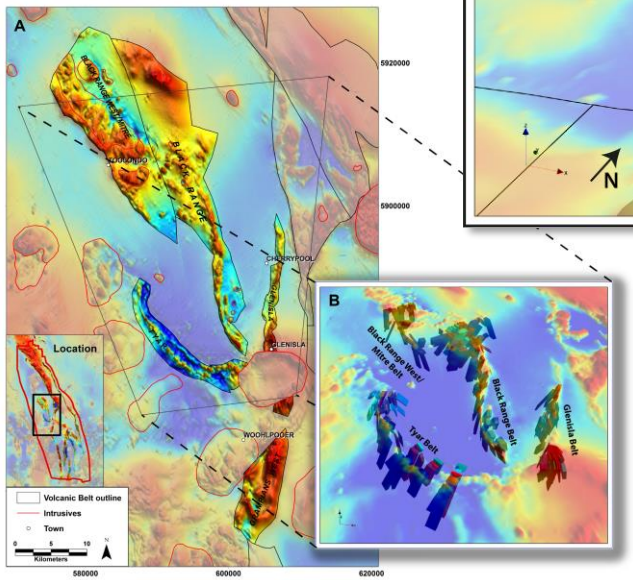


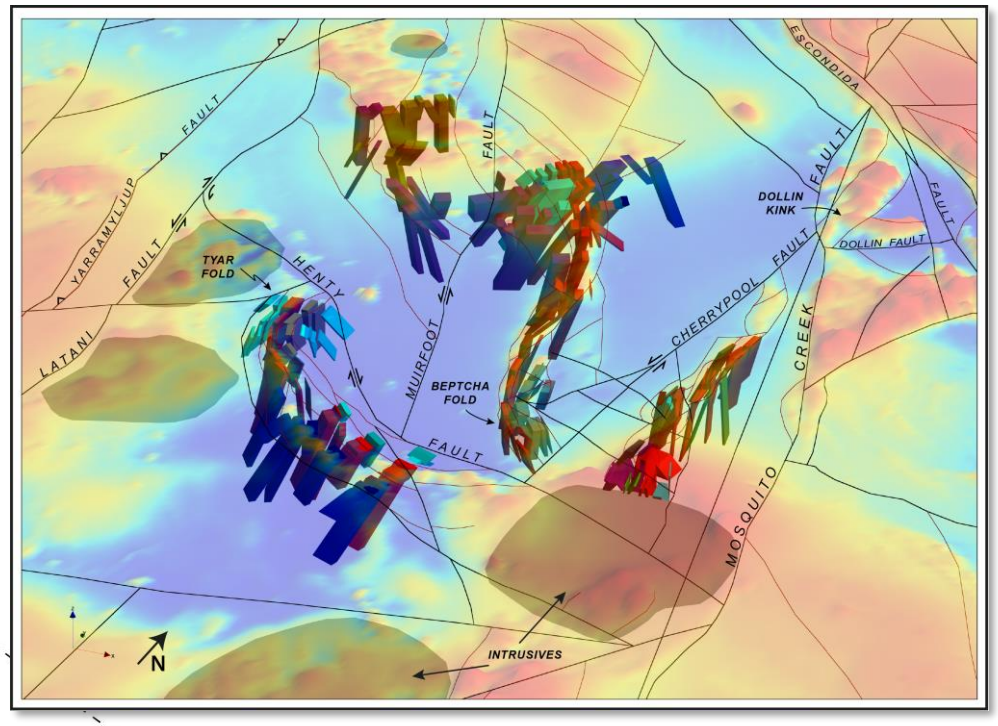
Magnetic inversion dip modelling







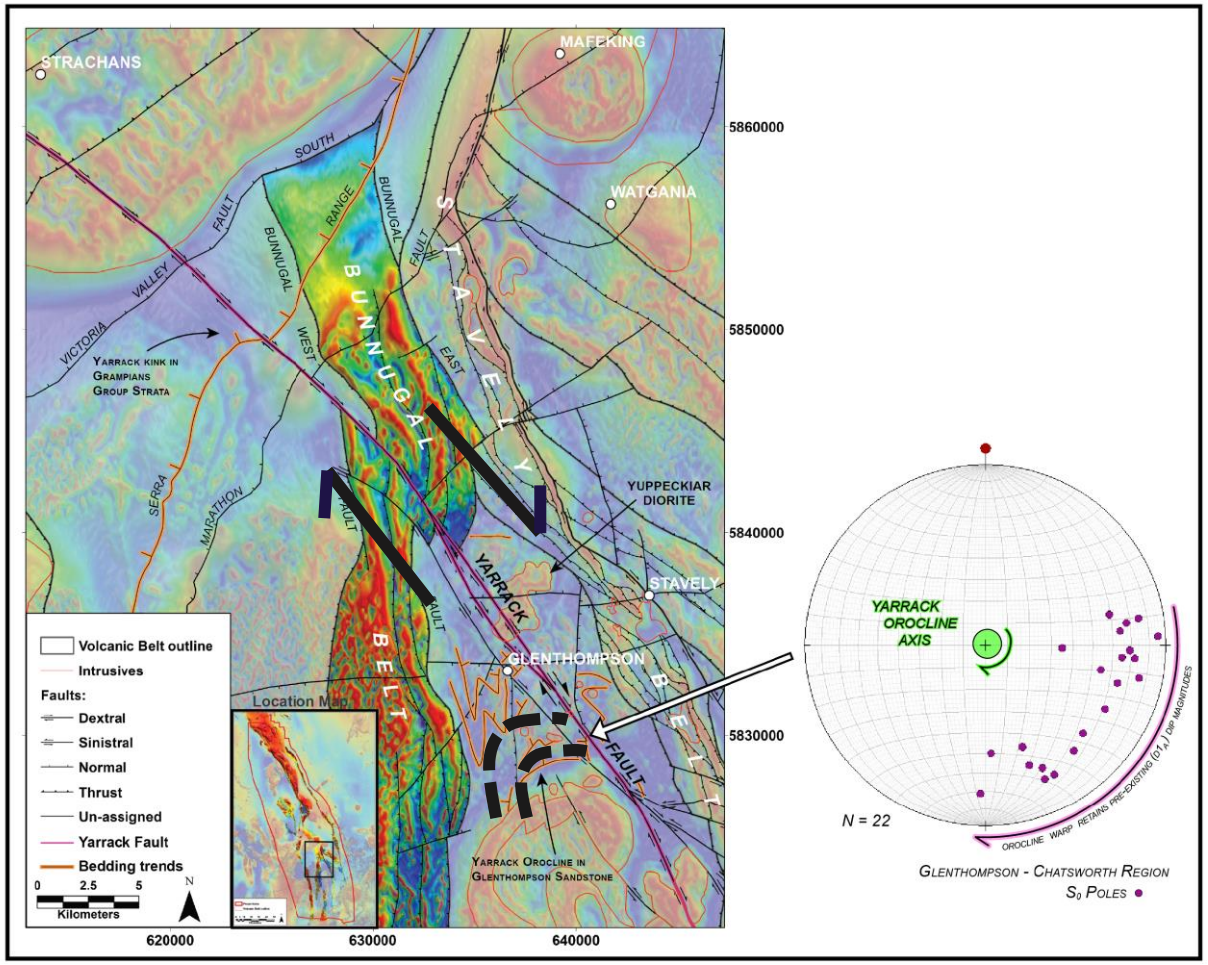




Magnetic volcanic unit geometries infer the dips of bounding Cambrian thrust faults.

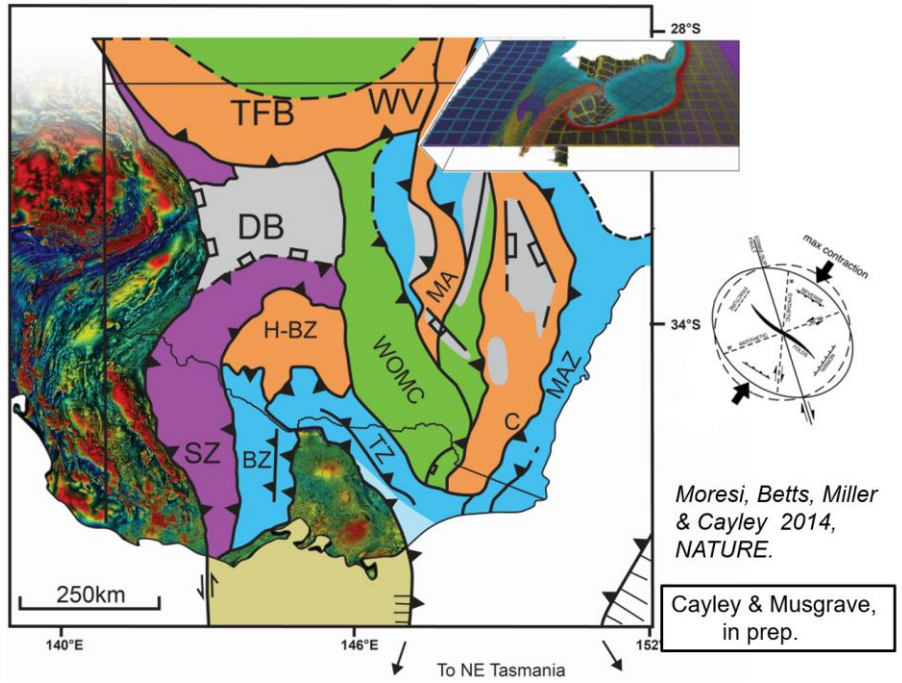
Cayley, McLean, Skladzien, Cairns, 2018: Stavely Project Report 3

Geodynamic context



Cayley, McLean, Skladzien, Cairns, 2018: Stavely Project Report 3

Application of strain ellipse theory and overprinting relationship criteria provides a framework for interpreting fault kinematics and timing and feeds into a systems-based approach for understanding geodynamic evolution.



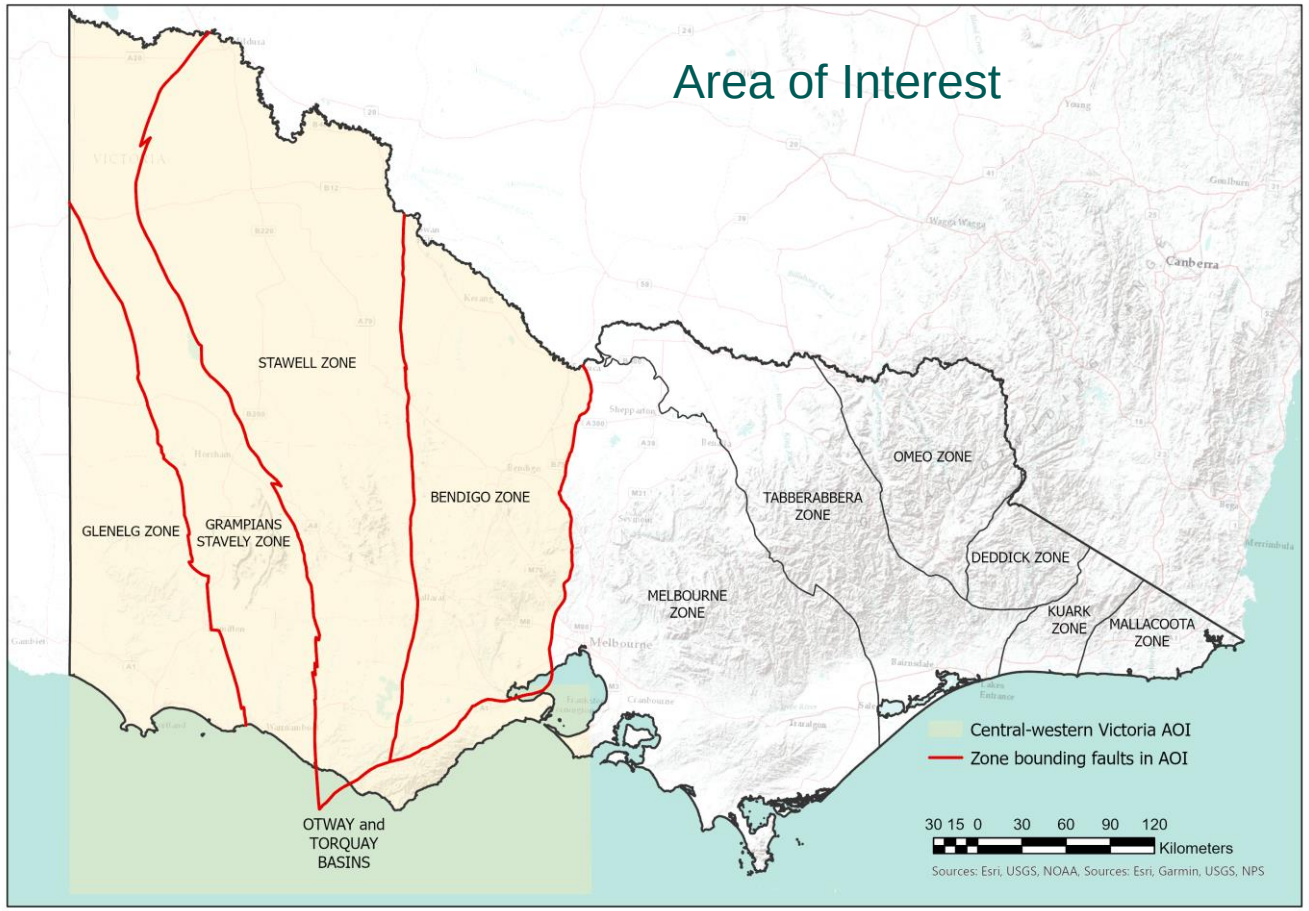
Lachlan orocline model

Outline

- Background – legacy mapping, 3D modelling programs and geophysical interpretation
- Central-west Victorian Regional Fault dataset
- Implications for regional prospectivity
- Data package delivery
- Take-aways

GEOLOGICAL SURVEY OF VICTORIA

Central-west Victorian Regional Faults dataset



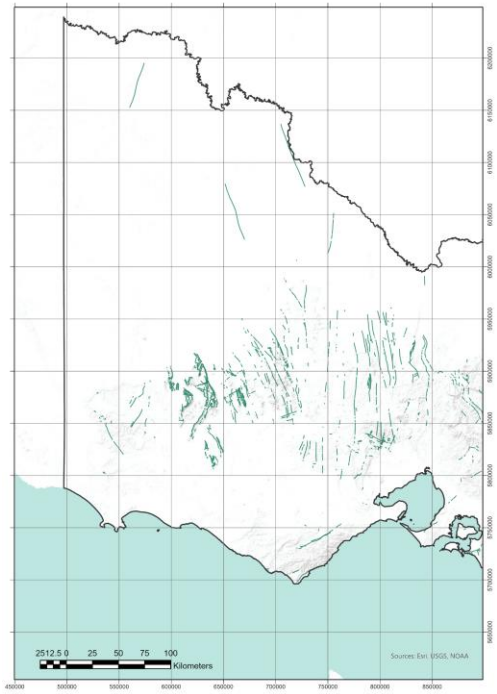
Contains a review, compilation, and update of the regional (1:250 000 to 1:1 000 000) Paleozoic basement and Mesozoic basin fault interpretation for central and western Victoria.

Motivation for creating the dataset:

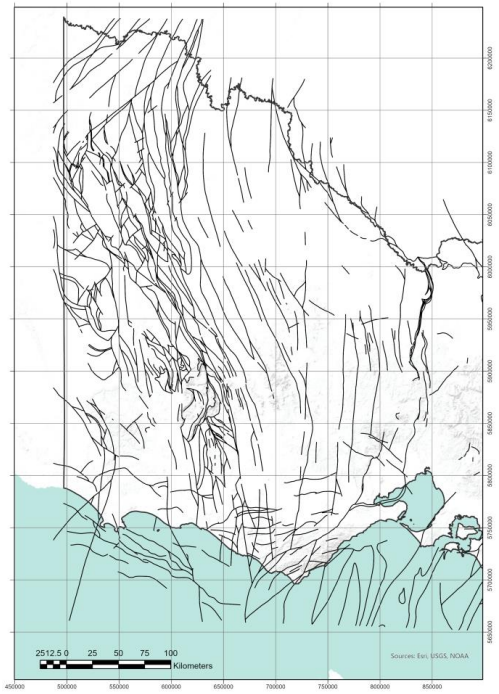
Fault interpretations from 3D modelling projects had not been formally captured or made available as 2D GIS data layers.

Expand the interpretations and geological understanding gained from 3D modelling projects (particularly Stavely 3D Project) to the broader AOI.

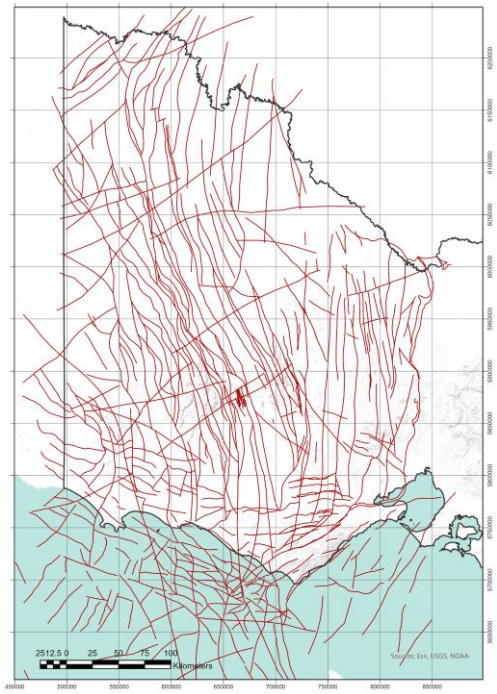
Legacy fault interpretation timeline



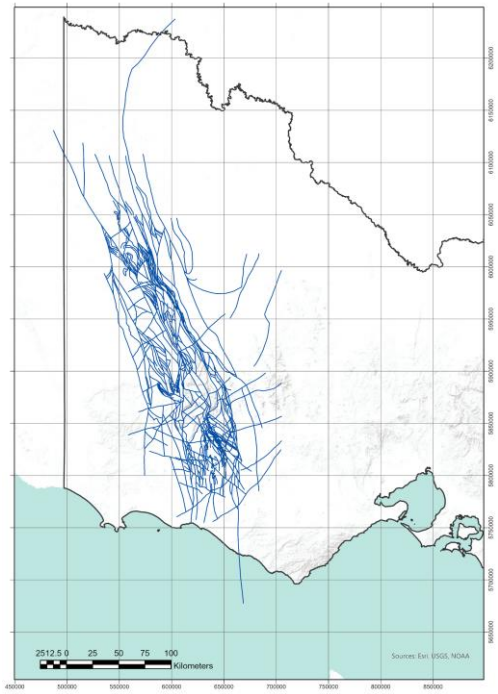
1:250k Seamless geology historical mapping (to 2011)



1M Pre-Permian (1999)



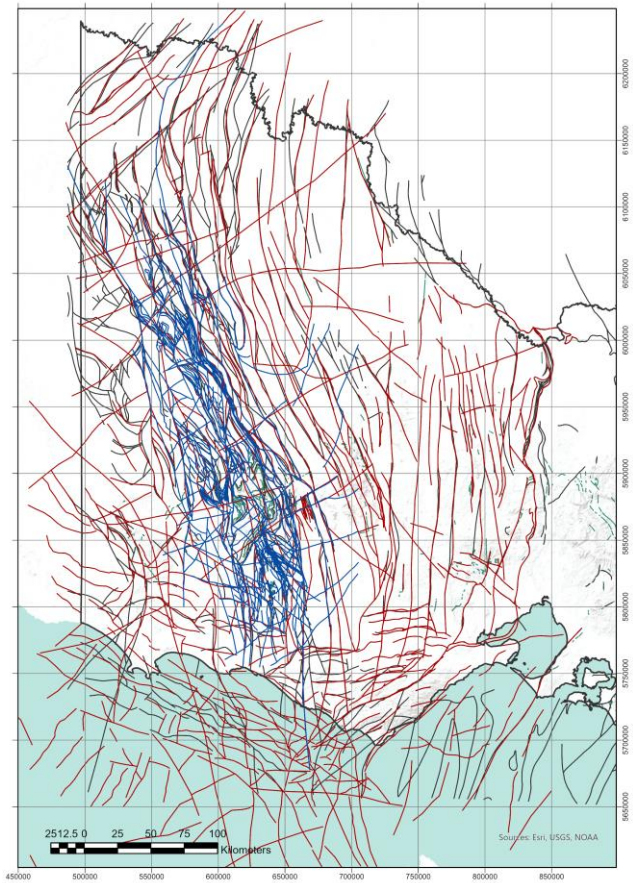
3D Victoria (2011)



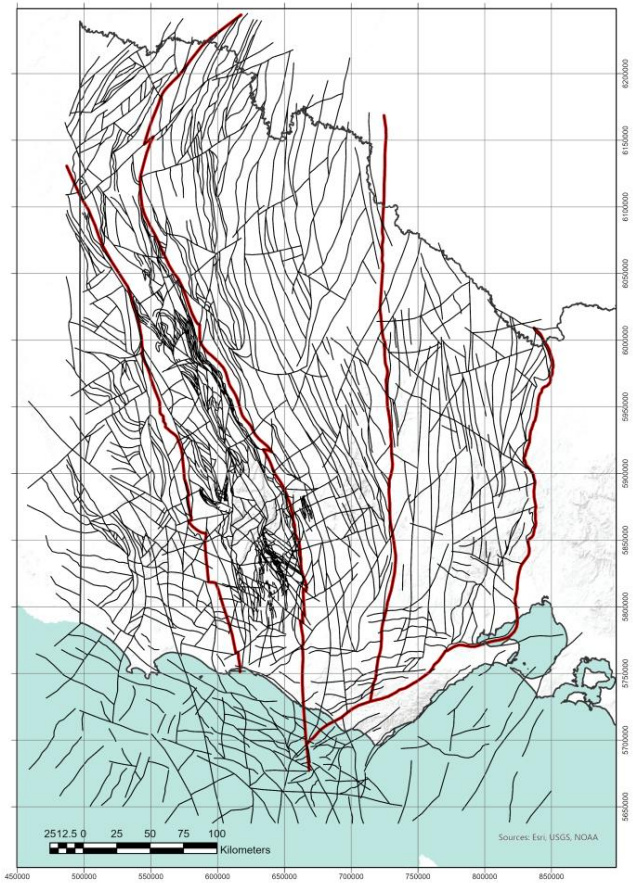
3D Stavely (2018)

Faults everywhere!

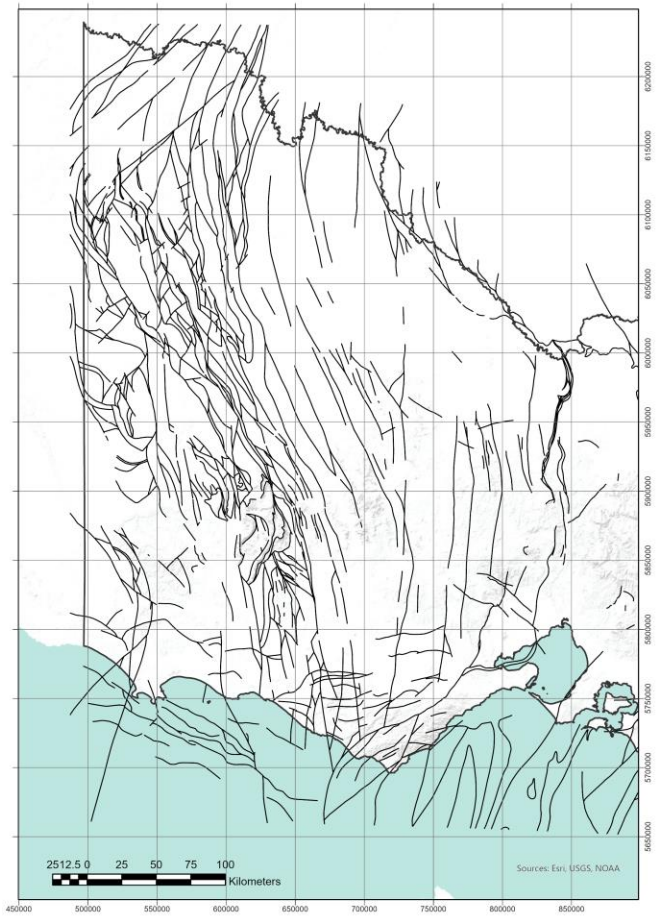
Combined legacy fault network



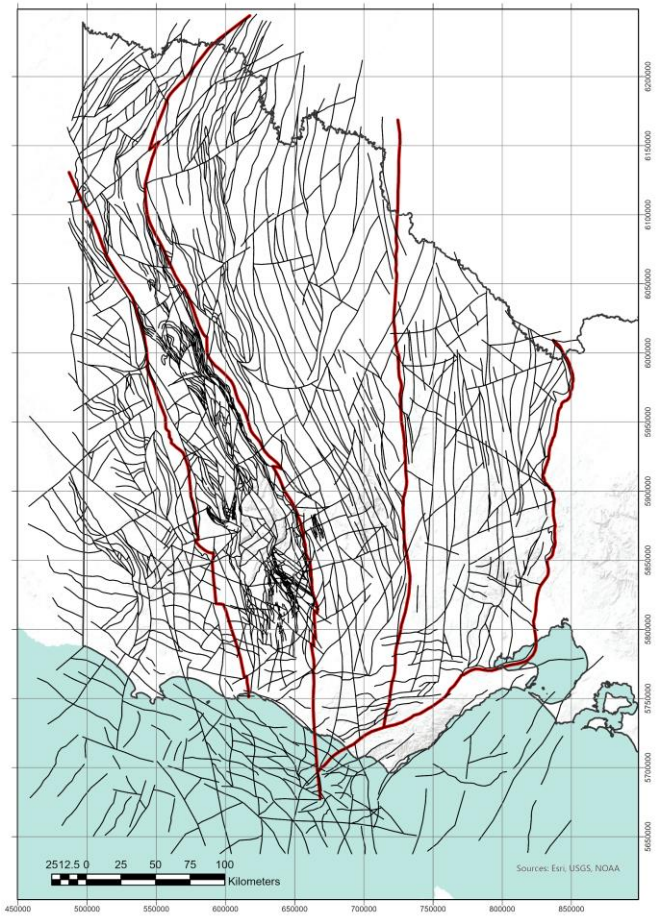
Consolidated and updated fault network



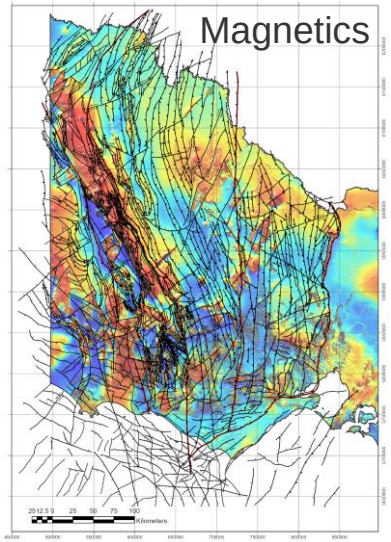
New fault network dataset includes refined 3D modelling, and significant new interpretations and, for the first time……

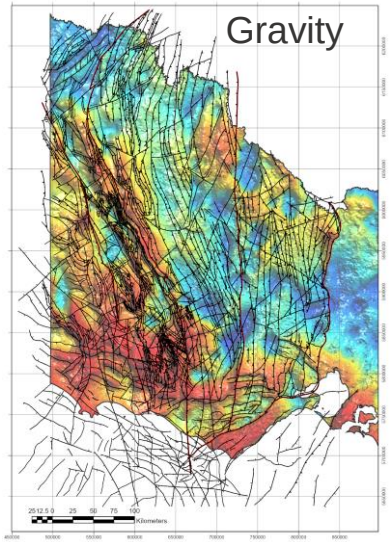


Pre-Permian Geology faults - 1999



New fault network - 2023





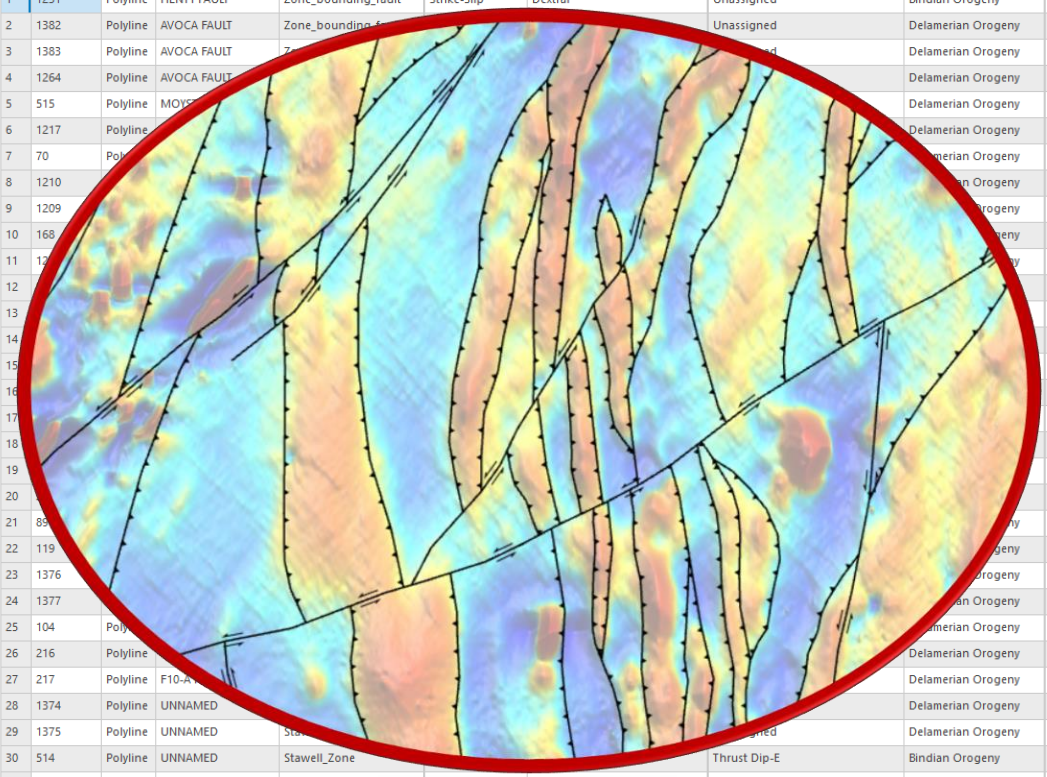
Fault metadata attribution

…contains attributes including fault geometries, kinematics and ages.

	OBJECTID *	SHAPE *	FAULT_NAME *	STRUCTURAL_ZONE_O...	FAULT_TYPE	MOVEMENT_SENSE_PRIMARY	MOVEMENT_SENSE_SECONDARY	EVENT_NAME	EVENT_AGE	INTERPRETATION_METHOD	COMMENTS	SYMBOLCODE	FAULT_SIGNIFICANCE	Shape_Length
1	1251	Polyline	HENTY FAULT	Zone_bounding_fault	Strike-Slip	Dextral	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	Zone boundary	10690	Major	49122.342552
2	1382	Polyline	AVOCA FAULT	Zone_bounding_fault	Thrust	Dip-W	Unassigned	Delamerian Orogeny	Cambrian	Magnetics; combined geoph...	Updated Avoca Fault interpretation	5405	Major	37213.438522
3	1383	Polyline	AVOCA FAULT	Zone_bounding_fault	Thrust	Dip-W	Unassigned	Delamerian Orogeny	Cambrian	Combined geophysics; previ...	Updated Avoca Fault interpretation	5405	Major	90365.940381
4	1264	Polyline	AVOCA FAULT	Zone_bounding_fault	Thrust	Dip-W	Unassigned	Delamerian Orogeny	Cambrian	Magnetics; combined geoph...	Updated Avoca Fault	5405	Major	83577.940511
5	515	Polyline	MOYSTON FAULT	Zone_bounding_fault	Thrust	Dip-E	Strike-Slip Dextral	Delamerian Orogeny	Cambrian	Seismic; combined geophysics	Update from 22GA-DL2 seismic	5405	Major	153540.122408
6	1217	Polyline	MOYSTON FAULT	Zone_bounding_fault	Thrust	Dip-E	Strike-Slip Sinistral	Delamerian Orogeny	Cambrian	Combined geophysics	Update from 22GA-DL2 seismic	5405	Major	124398.323666
7	70	Polyline	GOLDEN JACKET FA...	Stawell_Zone	Thrust	Dip-W	Strike-Slip Sinistral	Delamerian Orogeny	Cambrian	Previous mapping; combined...	Siluro-Devonian transtensional sinistral	5405	Other	40818.763084
8	1210	Polyline	UNNAMED	Stawell_Zone	Thrust	Dip-E	Unassigned	Delamerian Orogeny	Cambrian	Combined geophysics	Rotated fault segment	5405	Other	19748.039441
9	1209	Polyline	PLEASANT CREEK F...	Stawell_Zone	Thrust	Dip-W	Unassigned	Delamerian Orogeny	Cambrian	Magnetics	Rotated fault segment	5405	Major	26303.491268
10	168	Polyline	UNNAMED	Stawell_Zone	Thrust	Dip-E	Strike-Slip Sinistral	Delamerian Orogeny	Cambrian	Magnetics; combined geoph...	Reactivation by sinistral fault to south	5405	Other	36764.692352
11	1236	Polyline	UNNAMED	Stawell_Zone	Thrust	Dip-E	Strike-Slip Sinistral	Delamerian Orogeny	Cambrian	Magnetics; combined geoph...	Reactivation by sinistral fault to south	5405	Other	2871.913415
12	864	Polyline	WACKADO FAULT	Glenelg_Zone	Unassigned	Unassigned	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	14347.84817
13	865	Polyline	UNNAMED	Glenelg_Zone	Unassigned	Unassigned	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	22632.903738
14	866	Polyline	PIGEON PONDS FA...	Glenelg_Zone	Unassigned	Unassigned	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	12755.680086
15	871	Polyline	UNNAMED	Glenelg_Zone	Unassigned	Unassigned	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	49837.568301
16	892	Polyline	UNNAMED	Glenelg_Zone	Unassigned	Unassigned	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	12094.808093
17	902	Polyline	UNNAMED	Glenelg_Zone	Unassigned	Unassigned	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	32445.97394
18	903	Polyline	UNNAMED	Glenelg_Zone	Unassigned	Unassigned	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	7231.173352
19	1199	Polyline	CROWLANDS FAULT	Stawell_Zone	Thrust	Dip-W	Unassigned	Delamerian Orogeny	Cambrian	Magnetics	Probable extension of Crowlands Fault.	5405	Other	23997.831668
20	255	Polyline	UNNAMED	Glenelg_Zone	Thrust	Dip-SW	Unassigned	Delamerian Orogeny	Cambrian	Seismic; combined geophysics	Previously Escondida Fault in 3D-VIC interpretatio...	5405	Other	124720.439088
21	89	Polyline	PERCYDALE FAULT	Stawell_Zone	Thrust	Dip-W	Unassigned	Delamerian Orogeny	Cambrian	Combined geophysics; previ...	Potential Tyrrell Flt equivalent?	5405	Major	159605.16024
22	119	Polyline	STAWELL FAULT	Stawell_Zone	Thrust	Dip-W	Unassigned	Delamerian Orogeny	Cambrian	Combined geophysics; previ...	Possible Stawell Fault	5405	Other	19752.616252
23	1376	Polyline	UNNAMED	Grampians_Stavely_Zone	Thrust	Dip-NW	Unassigned	Delamerian Orogeny	Cambrian	Combined geophysics	Possible Siluro-Devonian inversion - Dip-SE normal	5405	Other	50590.830374
24	1377	Polyline	UNNAMED	Grampians_Stavely_Zone	Thrust	Dip-NW	Unassigned	Delamerian Orogeny	Cambrian	Combined geophysics	Possible Siluro-Devonian inversion - Dip-SE normal	5405	Other	10069.963113
25	104	Polyline	F10-A FAULT	Stawell_Zone	Thrust	Dip-W	Unassigned	Delamerian Orogeny	Cambrian	Combined geophysics; previ...	Possible Percydale Fault continuation	5405	Other	77333.287559
26	216	Polyline	F10-A FAULT	Stawell_Zone	Thrust	Dip-W	Unassigned	Delamerian Orogeny	Cambrian	Combined geophysics; previ...	Possible Percydale Fault continuation	5405	Other	70513.102825
27	217	Polyline	F10-A FAULT	Stawell_Zone	Thrust	Dip-W	Unassigned	Delamerian Orogeny	Cambrian	Combined geophysics; previ...	Possible Percydale Fault continuation	5405	Other	33436.034637
28	1374	Polyline	UNNAMED	Stawell_Zone	Thrust	Dip-E	Unassigned	Delamerian Orogeny	Cambrian	Combined geophysics	Possible Concongella Fault continuation	5405	Major	135714.564148
29	1375	Polyline	UNNAMED	Stawell_Zone	Thrust	Dip-E	Unassigned	Delamerian Orogeny	Cambrian	Combined geophysics	Possible Concongella Fault continuation	5405	Major	119171.144083
30	514	Polyline	UNNAMED	Stawell_Zone	Strike-Slip	Sinistral	Thrust Dip-E	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	Partly former Moyston Fault trace	5301	Other	64473.68644
31	1225	Polyline	TULLYVEA FAULT	Stawell_Zone	Strike-Slip	Dextral	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	Off-sets Moyston Fault	10690	Other	24311.365169
32	749	Polyline	BABATCHIO FAULT	Grampians_Stavely_Zone	Strike-Slip	Dextral	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	Oblique slip; dextral transtensional	10690	Other	80925.285965
33	708	Polyline	MARATHON FAULT	Grampians_Stavely_Zone	Normal	Dip-NW	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	oblique slip, transtensional	5106	Other	38074.846519
34	712	Polyline	MARATHON FAULT	Grampians_Stavely_Zone	Normal	Dip-SE	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	oblique slip, transtensional	5106	Other	16107.333829
35	744	Polyline	MARATHON FAULT	Glenelg_Zone	Normal	Dip-SW	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	oblique slip, transtensional	5106	Other	20763.244923
36	745	Polyline	MARATHON FAULT	Glenelg_Zone	Normal	Dip-S	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	oblique slip, transtensional	5106	Other	33491.833248
37	1187	Polyline	MARATHON FAULT	Grampians_Stavely_Zone	Normal	Dip-S	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	oblique slip, transtensional	5106	Other	12953.42168
38	1393	Polyline	MEHUSE FAULT	Grampians_Stavely_Zone	Thrust	Dip-E	Strike-Slip Sinistral	Benamberan-Bindian...	Ordovician-Silurian	Combined geophysics; previ...	Oblique slip contractional sinistral	5405	Major	10683.568565
39	1394	Polyline	MEHUSE FAULT	Grampians_Stavely_Zone	Thrust	Dip-E	Strike-Slip Sinistral	Benamberan-Bindian...	Ordovician-Silurian	Combined geophysics; previ...	Oblique slip contractional sinistral	5405	Major	4088.411706

Fault metadata attribution

…contains attributes including fault geometries, kinematics and ages.



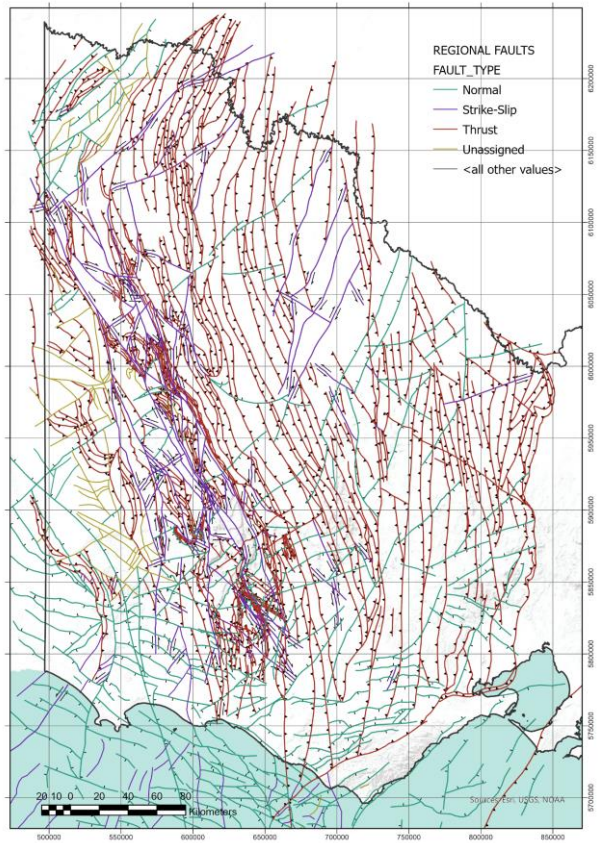
Symbology code enables fault trace symbolisation in GIS package

	OBJECTID *	SHAPE *	FAULT_NAME *	STRUCTURAL_ZONE_O...	FAULT_TYPE	MOVEMENT_SENSE_PRIMARY	MOVEMENT_SENSE_SECONDARY	EVENT_NAME	EVENT_AGE	INTERPRETATION_METHOD	COMMENTS	SYMBOLCODE	FAULT_SIGNIFICANCE	Shape_Length
1	1251	Polyline	HENTY FAULT	Zone_bounding_fault	Strike-Slip	Dextral	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	Zone boundary	10690	Major	49122.342552
2	1382	Polyline	AVOCA FAULT	Zone_bounding_f			Unassigned	Delamerian Orogeny	Cambrian	Magnetics; combined geoph...	Updated Avoca Fault interpretation	5405	Major	37213.438522
3	1383	Polyline	AVOCA FAULT	Z			d	Delamerian Orogeny	Cambrian	Combined geophysics; previ...	Updated Avoca Fault interpretation	5405	Major	90365.940381
4	1264	Polyline	AVOCA FAULT					Delamerian Orogeny	Cambrian	Magnetics; combined geoph...	Updated Avoca Fault	5405	Major	83577.940511
5	515	Polyline	MOY					Delamerian Orogeny	Cambrian	Seismic; combined geophysics	Update from 22GA-DL2 seismic	5405	Major	153540.122408
6	1217	Polyline						Delamerian Orogeny	Cambri					124398.323666
7	70	Pol						erian Orogeny	Cambri					40818.763084
8	1210							n Orogeny	Cambri					19748.039441
9	1209							rogeny	Cambri					26303.491268
10	168							geny	Cambri					36764.692352
11	12							y	Cambri					2871.913415
12									Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	14347.84817
13									Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	22632.903738
14									Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	12755.680086
15									Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	49837.568301
16									Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	12094.808093
17									Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	32445.97394
18									Siluro-Devonian	Combined geophysics	probable extensional structure	Unassigned	Other	7231.173352
19									Cambrian	Magnetics	Probable extension of Crowlands Fault.	5405	Other	23997.831668
20									Cambrian	Seismic; combined geophysics	Previously Escondida Fault in 3D-VIC interpretatio...	5405	Other	124720.439088
21	89							y	Cambrian	Combined geophysics; previ...	Potential Tyrrell Flt equivalent?	5405	Major	159605.16024
22	119							geny	Cambrian	Combined geophysics; previ...	Possible Stawell Fault	5405	Other	19752.616252
23	1376							rogeny	Cambrian	Combined geophysics	Possible Siluro-Devonian inversion - Dip-SE normal	5405	Other	50590.830374
24	1377							n Orogeny	Cambrian	Combined geophysics	Possible Siluro-Devonian inversion - Dip-SE normal	5405	Other	10069.963113
25	104	Poly						erian Orogeny	Cambrian	Combined geophysics; previ...	Possible Percydale Fault continuation	5405	Other	77333.287559
26	216	Polyline						Delamerian Orogeny	Cambrian	Combined geophysics; previ...	Possible Percydale Fault continuation	5405	Other	70513.102825
27	217	Polyline	F10-A					Delamerian Orogeny	Cambrian	Combined geophysics; previ...	Possible Percydale Fault continuation	5405	Other	33436.034637
28	1374	Polyline	UNNAMED					Delamerian Orogeny	Cambrian	Combined geophysics	Possible Concongella Fault continuation	5405	Major	135714.564148
29	1375	Polyline	UNNAMED	Sta			ned	Delamerian Orogeny	Cambrian	Combined geophysics	Possible Concongella Fault continuation	5405	Major	119171.144083
30	514	Polyline	UNNAMED	Stawell_Zone			Thrust Dip-E	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	Partly former Moyston Fault trace	5301	Other	64473.68644
31	1225	Polyline	TULLYVEA FAULT	Stawell_Zone	Strike-Slip	Dextral	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	Off-sets Moyston Fault	10690	Other	24311.365169
32	749	Polyline	BABATCHIO FAULT	Grampians_Stavely_Zone	Strike-Slip	Dextral	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	Oblique slip; dextral transtensional	10690	Other	80925.285965
33	708	Polyline	MARATHON FAULT	Grampians_Stavely_Zone	Normal	Dip-NW	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	oblique slip, transtensional	5106	Other	38074.846519
34	712	Polyline	MARATHON FAULT	Grampians_Stavely_Zone	Normal	Dip-SE	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	oblique slip, transtensional	5106	Other	16107.333829
35	744	Polyline	MARATHON FAULT	Glenelg_Zone	Normal	Dip-SW	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	oblique slip, transtensional	5106	Other	20763.244923
36	745	Polyline	MARATHON FAULT	Glenelg_Zone	Normal	Dip-S	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	oblique slip, transtensional	5106	Other	33491.833248
37	1187	Polyline	MARATHON FAULT	Grampians_Stavely_Zone	Normal	Dip-S	Unassigned	Bindian Orogeny	Siluro-Devonian	Combined geophysics; previ...	oblique slip, transtensional	5106	Other	12953.42168
38	1393	Polyline	MEHUSE FAULT	Grampians_Stavely_Zone	Thrust	Dip-E	Strike-Slip Sinistral	Benamberan-Bindian...	Ordovician-Silurian	Combined geophysics; previ...	Oblique slip contractional sinistral	5405	Major	10683.568565
39	1394	Polyline	MEHUSE FAULT	Grampians_Stavely_Zone	Thrust	Dip-E	Strike-Slip Sinistral	Benamberan-Bindian...	Ordovician-Silurian	Combined geophysics; previ...	Oblique slip contractional sinistral	5405	Major	4088.411706

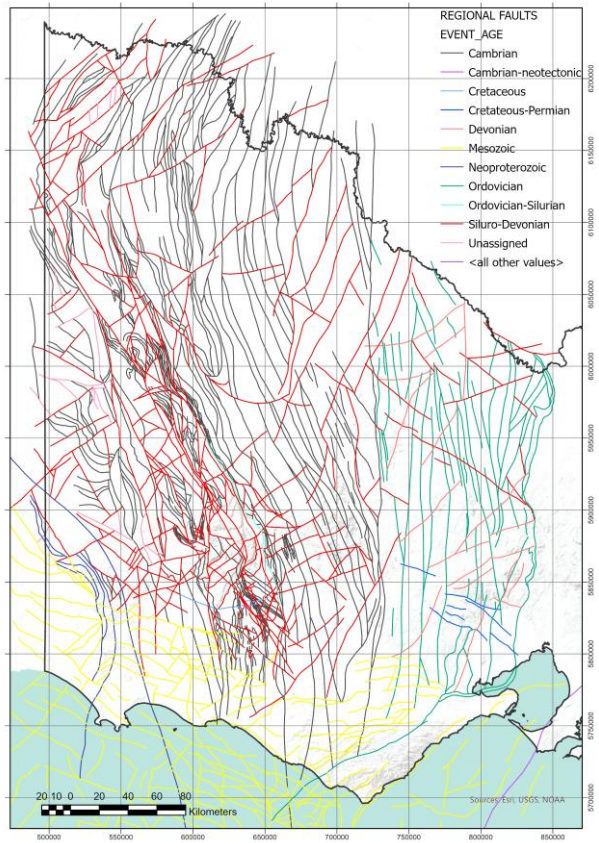
Fault metadata attribution

Metadata enables querying and display of the dataset by various attributes:

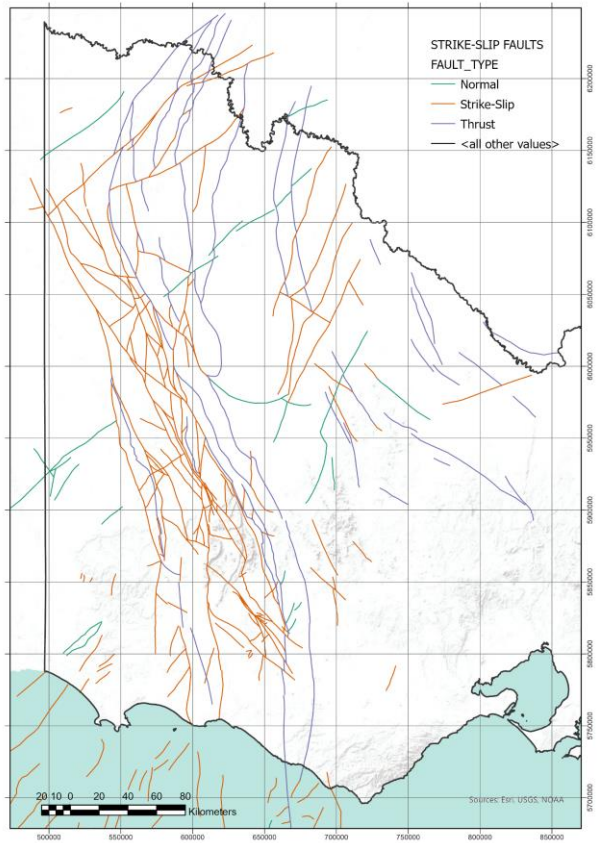
Faults by type



Faults by age



Faults with strike-slip component



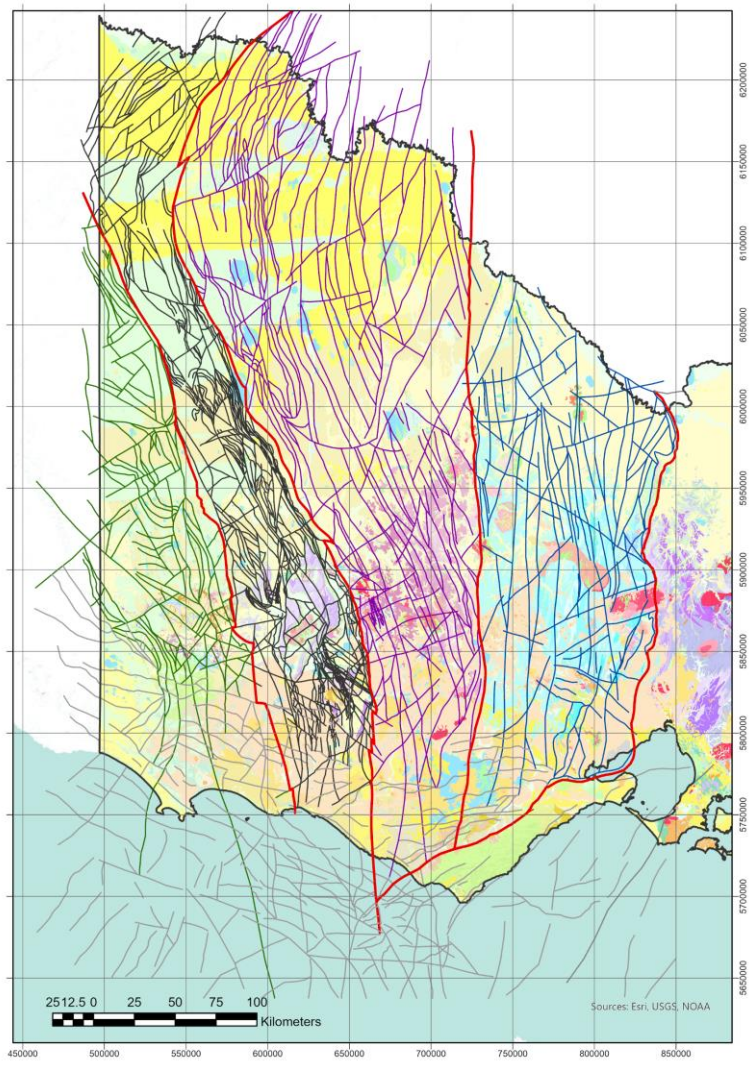
Outline

- Background – legacy mapping, 3D modelling programs and geophysical interpretation
- Central-west Victorian Regional Fault dataset
- **Implications for regional prospectivity**
- Data package delivery
- Take-aways

GEOLOGICAL SURVEY OF VICTORIA

Regional prospectivity implications

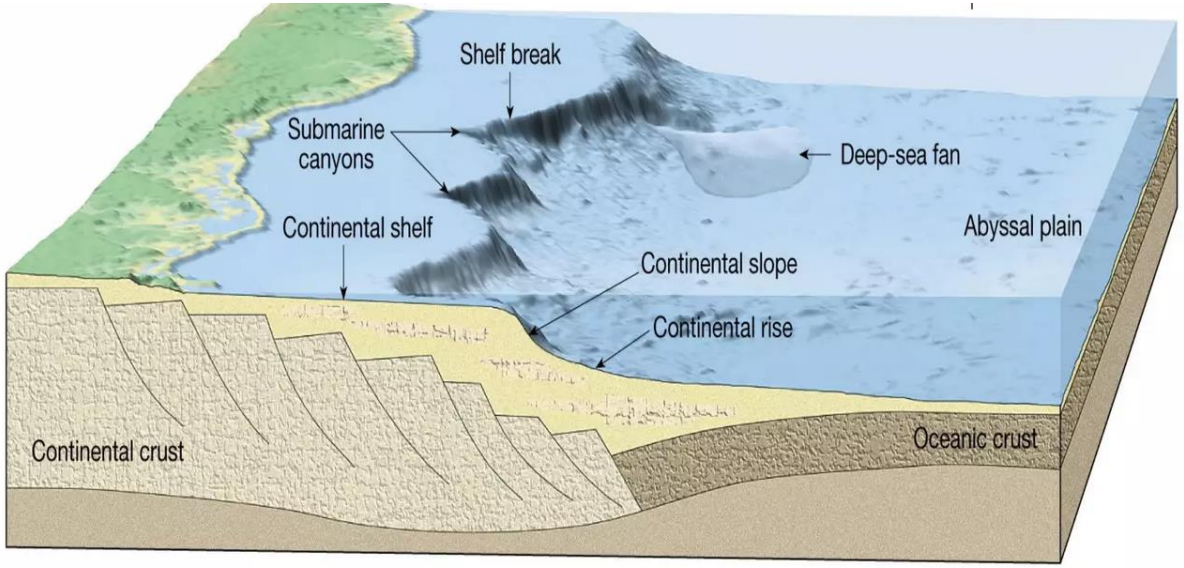
The new dataset has important implications for the understanding of earth resources prospectivity within a systematic geodynamic and tectonic context in central and western Victoria.

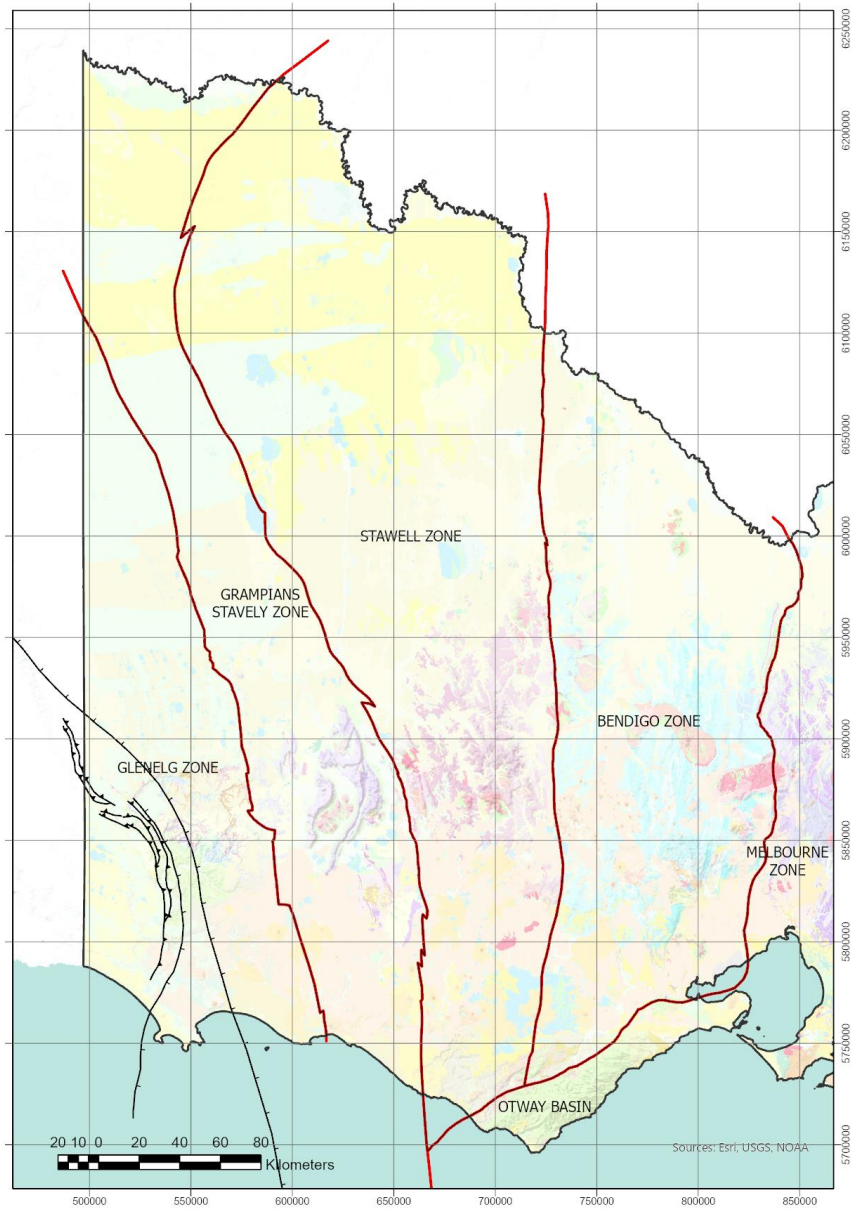


Faults coloured by structural zone

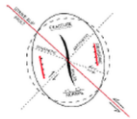
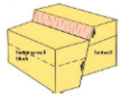
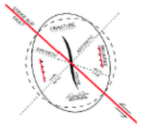
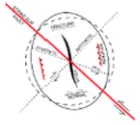
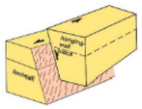
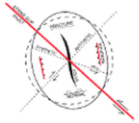
Deformation event Neoproterozoic

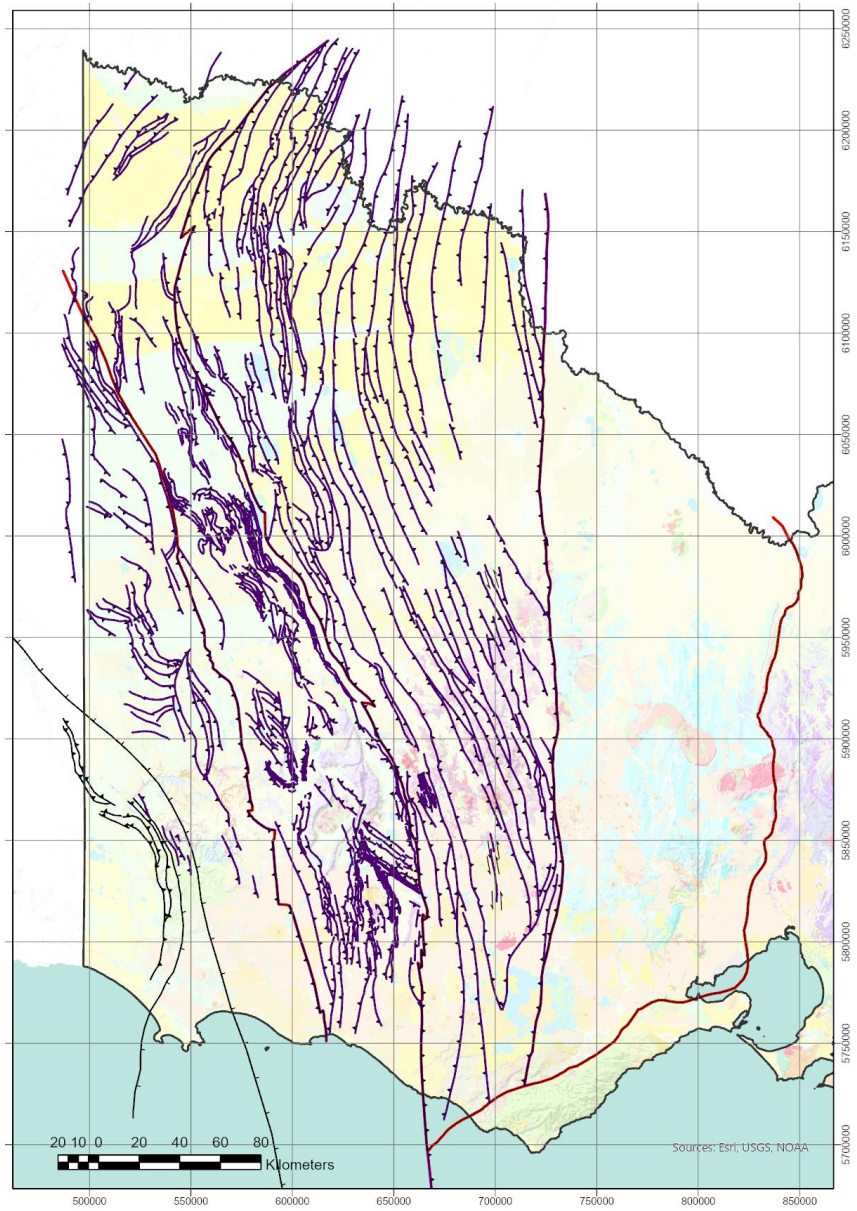
Gondwana passive margin





Deformation event Delamerian Orogeny

Deformation event (equivalent)	Timing	Mineralisation type	Dominant stress regime	Dominant structural orientation	Dominant structures	Strain ellipse	Magmatism
D1a (Delamerian)	Mid-Late Cambrian	VHMS	sinistral transpression 	north-south	north-south striking thrust faulting		syn-arc
D1b (Delamerian)	Late Cambrian	Porphyry Epithermal	sinistral transtension 	north-south	northerly trending extensional structures; re-activated D1a structures and rift complexes		syn-arc transtensional decompression melts including Bushy Creek Suite and Thursdays Gossan porphyry: circular to north-south trending elongated intrusive orientations
D2 (Benambran)	Late Ordovician – Late Silurian	Orogenic gold (east of Moyston Fault)	sinistral transpression 	north-south	basin formation associated with reverse re-activation of the Moyston Fault: Grampians Basin		
D3 (Early Bindian)	Late Silurian-Early Devonian		sinistral transpression 	northwest-southeast	thrust and large amplitude folds (Wartook, Geerak and Willaura synclines) in Gampians Group		
D4 (Late Bindian)	Early Devonian	Intrusive related gold and base metals	dextral transtension 	northwest-southeast	strike-slip faults north-south extensional structures		transtensional decompression melts: northeast to southwest trending intrusive orientations Rocklands Volcanic Group eruption
D5 (Tabberrabberan)	Middle Devonian		transpression 	northwest-southeast	Sinistral re-activation of faults such as Mosquito Creek Fault and Golton Fault; jointing of Early Devonian granites		



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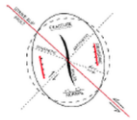
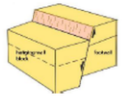
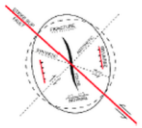
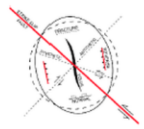
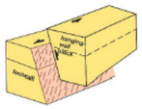
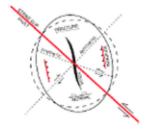
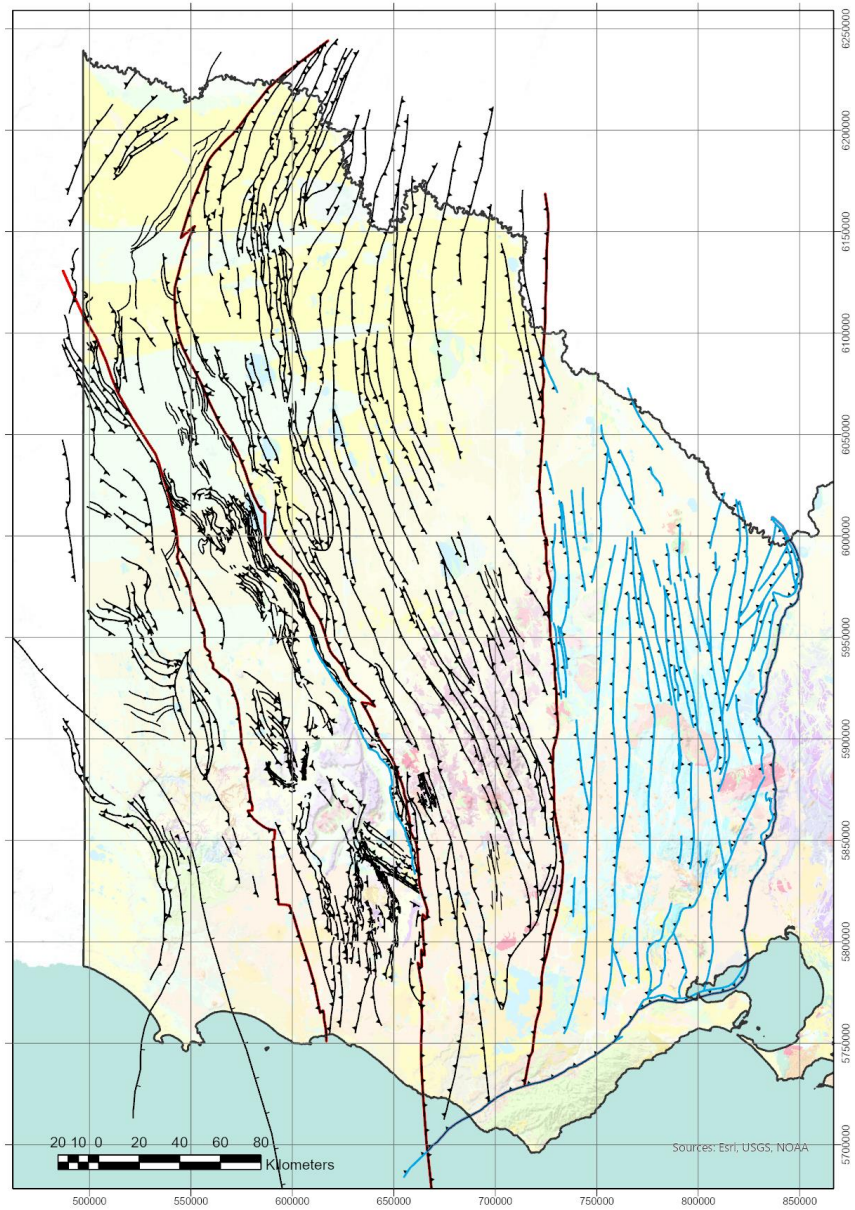
Deformation event Benamberan Orogeny

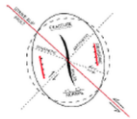
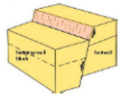
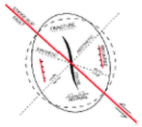
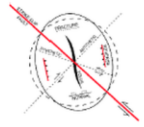
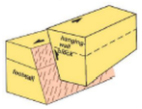
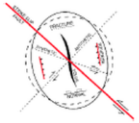
(including Cambrian structures re-activated west of Avoca Fault)

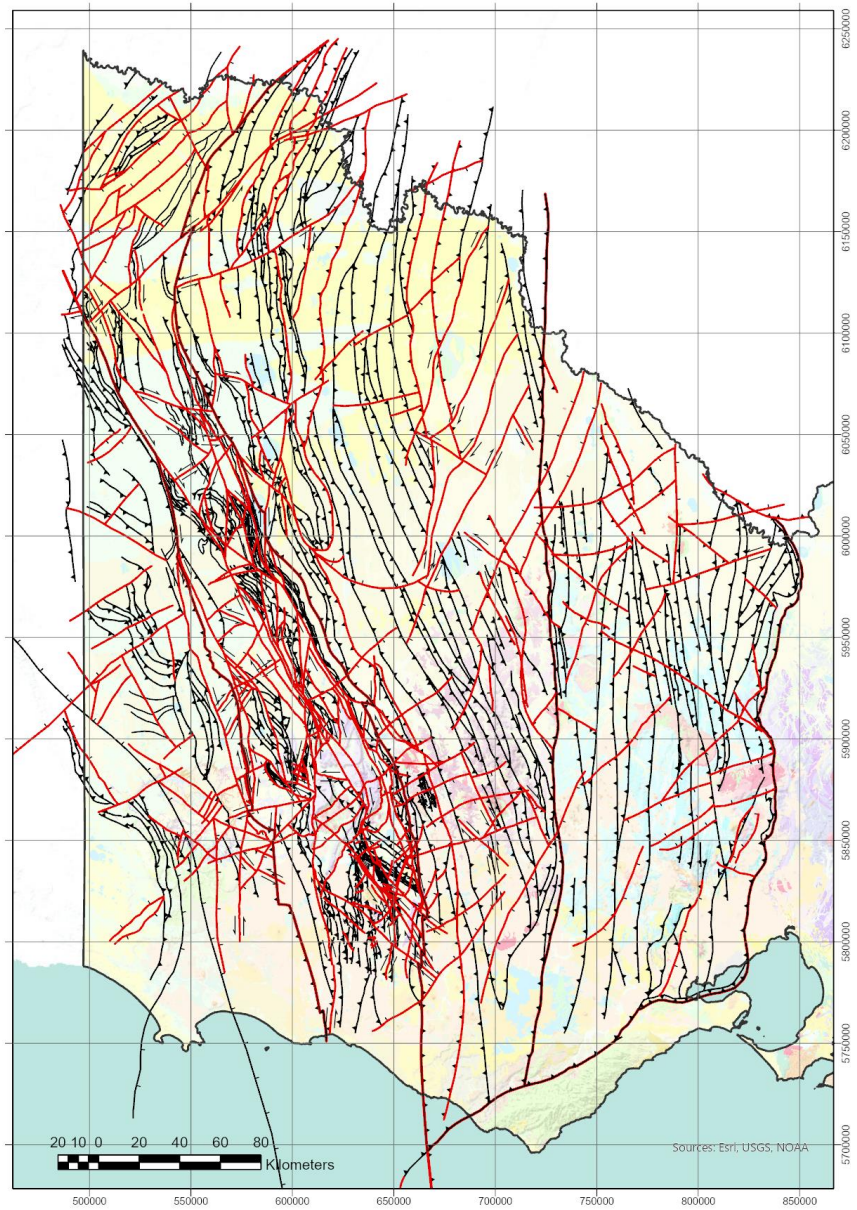
Deformation event (equivalent)	Timing	Mineralisation type	Dominant stress regime	Dominant structural orientation	Dominant structures	Strain ellipse	Magmatism
D1a (Delamerian)	Mid-Late Cambrian	VHMS	sinistral transpression 	north-south	north-south striking thrust faulting		syn-arc
D1b (Delamerian)	Late Cambrian	Porphyry Epithermal	sinistral transtension 	north-south	northerly trending extensional structures; re-activated D1a structures and rift complexes		syn-arc transtensional decompression melts including Bushy Creek Suite and Thursdays Gossan porphyry: circular to north-south trending elongated intrusive orientations
D2 (Benambran)	Late Ordovician – Late Silurian	Orogenic gold (east of Moyston Fault)	sinistral transpression 	north-south	basin formation associated with reverse re-activation of the Moyston Fault: Grampians Basin		
D3 (Early Bindian)	Late Silurian-Early Devonian		sinistral transpression 	northwest-southeast	thrust and large amplitude folds (Wartook, Geerak and Willaura synclines) in Gampians Group		
D4 (Late Bindian)	Early Devonian	Intrusive related gold and base metals	dextral transtension 	northwest-southeast	strike-slip faults north-south extensional structures		transtensional decompression melts: northeast to southwest trending intrusive orientations Rocklands Volcanic Group eruption
D5 (Tabberrabberan)	Middle Devonian		transpression 	northwest-southeast	Sinistral re-activation of faults such as Mosquito Creek Fault and Golton Fault; jointing of Early Devonian granites		



Cayley, McLean, Skladzien, Cairns, 2018: Stavely Project Report 3

Deformation event Bindian Orogeny

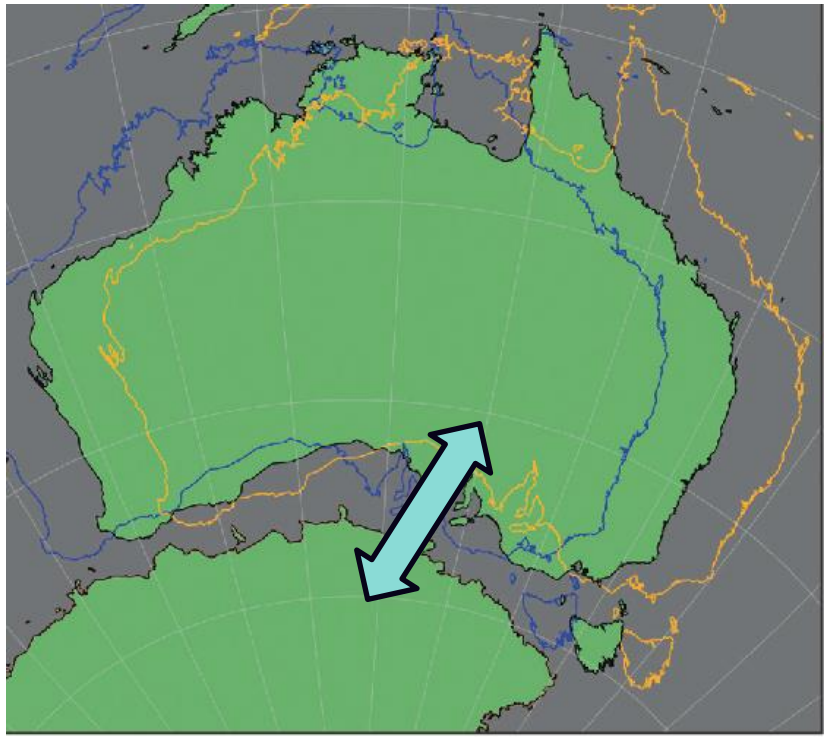
Deformation event (equivalent)	Timing	Mineralisation type	Dominant stress regime	Dominant structural orientation	Dominant structures	Strain ellipse	Magmatism
D1a (Delamerian)	Mid-Late Cambrian	VHMS	sinistral transpression 	north-south	north-south striking thrust faulting		syn-arc
D1b (Delamerian)	Late Cambrian	Porphyry Epithermal	sinistral transtension 	north-south	northerly trending extensional structures; re-activated D1a structures and rift complexes		syn-arc transtensional decompression melts including Bushy Creek Suite and Thursdays Gossan porphyry: circular to north-south trending elongated intrusive orientations
D2 (Benambran)	Late Ordovician – Late Silurian	Orogenic gold (east of Moyston Fault)	sinistral transpression 	north-south	basin formation associated with reverse re-activation of the Moyston Fault: Grampians Basin		
D3 (Early Bindian)	Late Silurian-Early Devonian		sinistral transpression 	northwest-southeast	thrust and large amplitude folds (Wartook, Geerak and Willaura synclines) in Gampians Group		
D4 (Late Bindian)	Early Devonian	Intrusive related gold and base metals	dextral transtension 	northwest-southeast	strike-slip faults north-south extensional structures		transtensional decompression melts: northeast to southwest trending intrusive orientations Rocklands Volcanic Group eruption
D5 (Tabberrabberan)	Middle Devonian		transpression 	northwest-southeast	Sinistral re-activation of faults such as Mosquito Creek Fault and Golton Fault; jointing of Early Devonian granites		



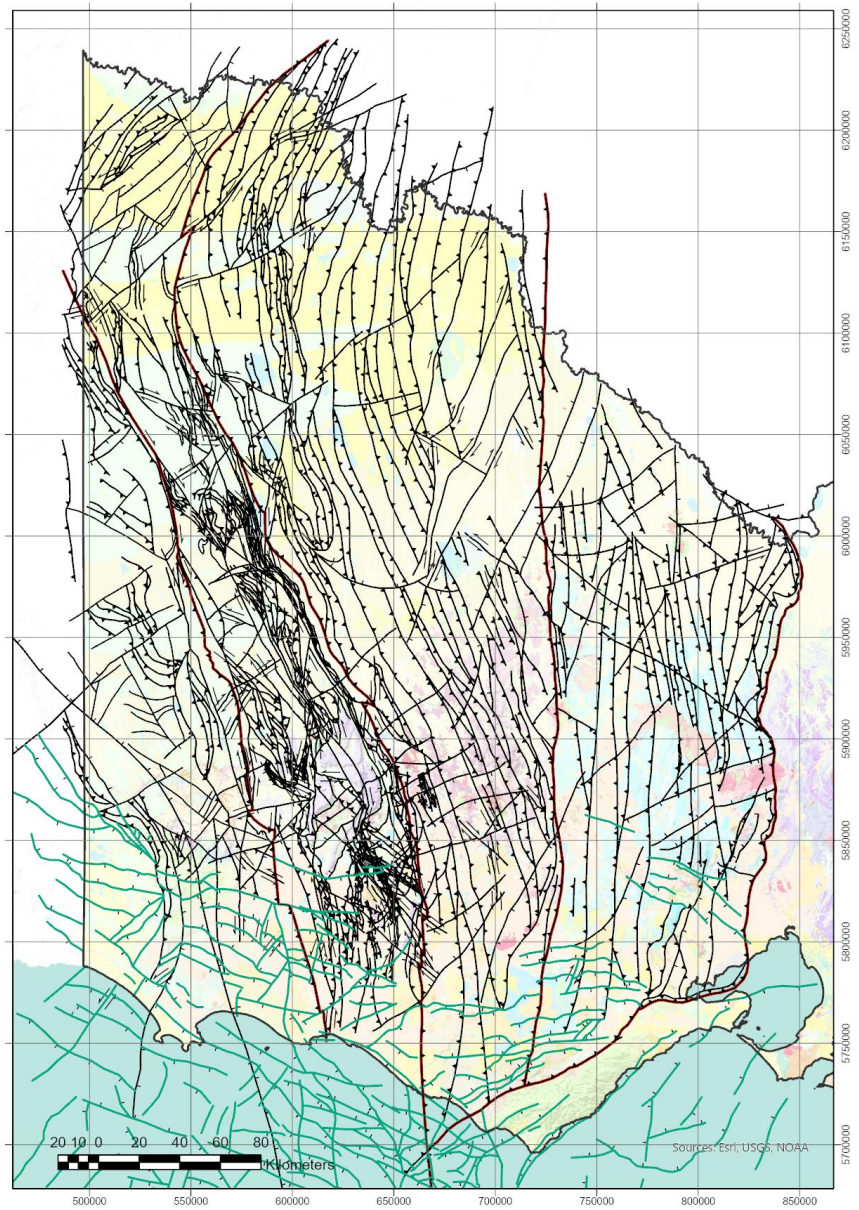
Cayley, McLean, Skladzien, Cairns, 2018: Stavely Project Report 3

Deformation event Mesozoic

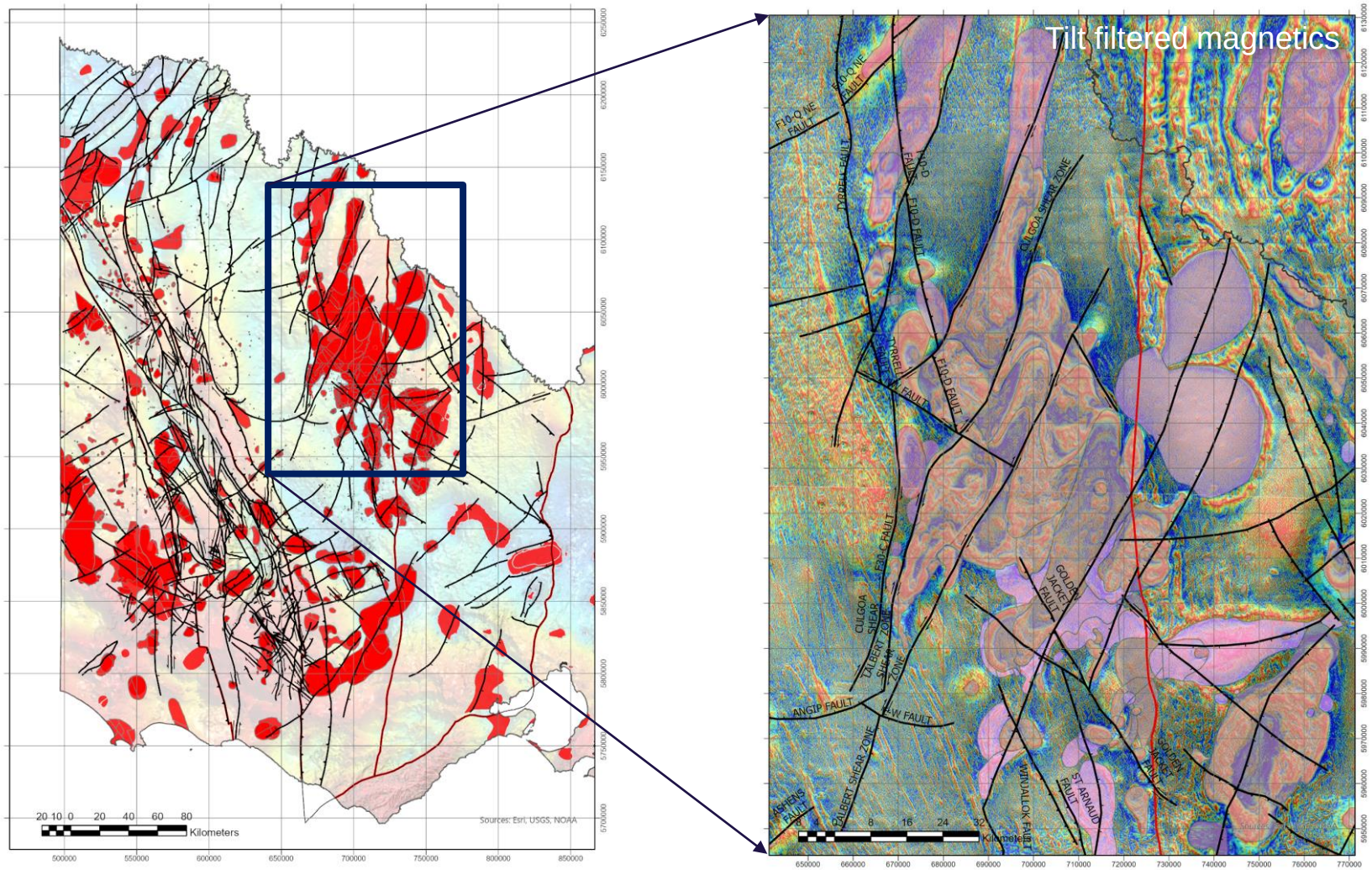
Potential Otway Basin geothermal and hydrogen storage implications



After Williams, Simon E. et al., 2012



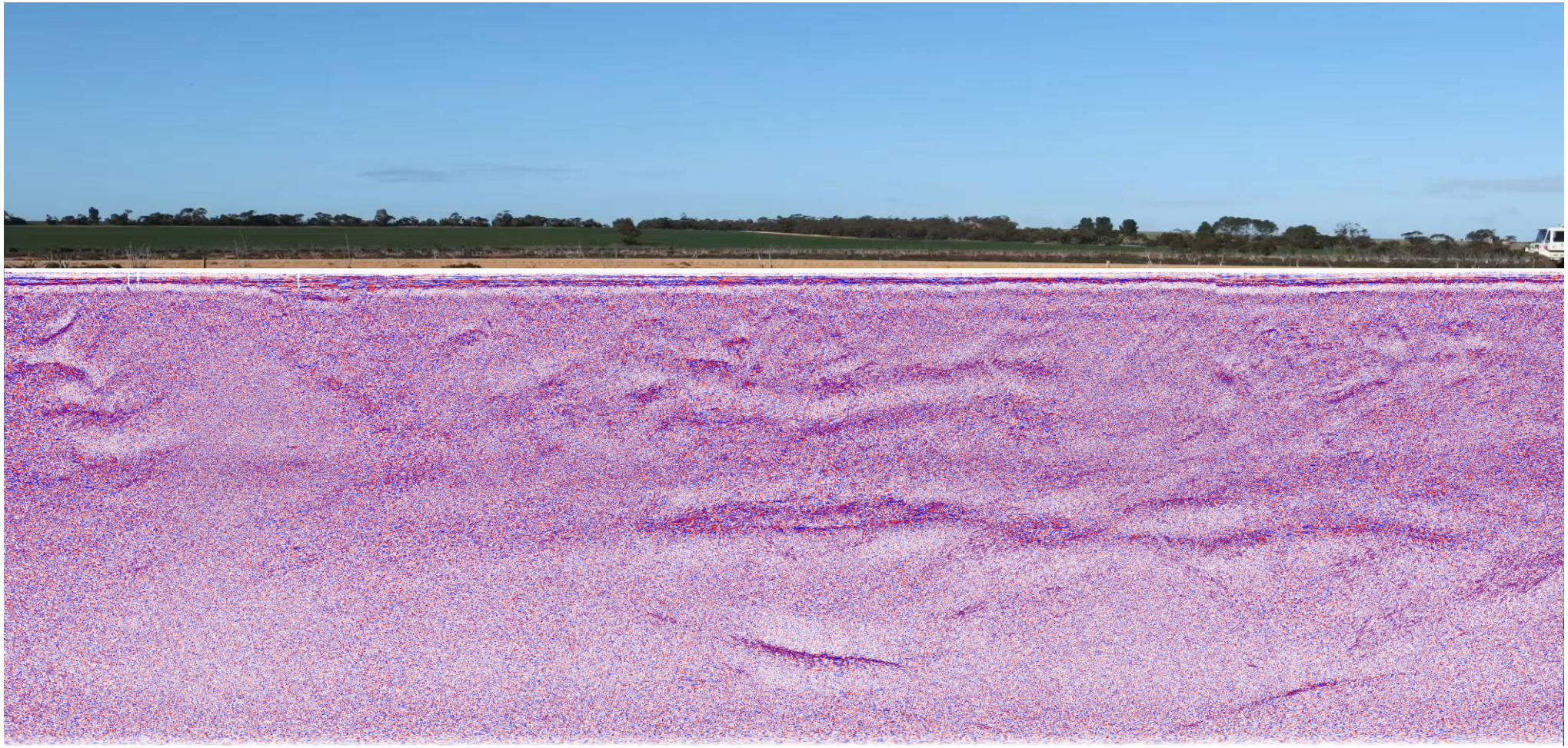
Siluro-Devonian (Bindian ~395-420Ma) structures



- Important for understanding intrusion emplacement and deformation during decompressive melting (~395-410Ma)
- Implications for IRG, base metals and Critical Minerals
- Intrusion shapes and orientation provide insight into differentiating between Cambrian vs Devonian ages in the Stavely Arc terrain > Cu porphyry exploration
- Implications for (scale independent) post mineralisation deformation

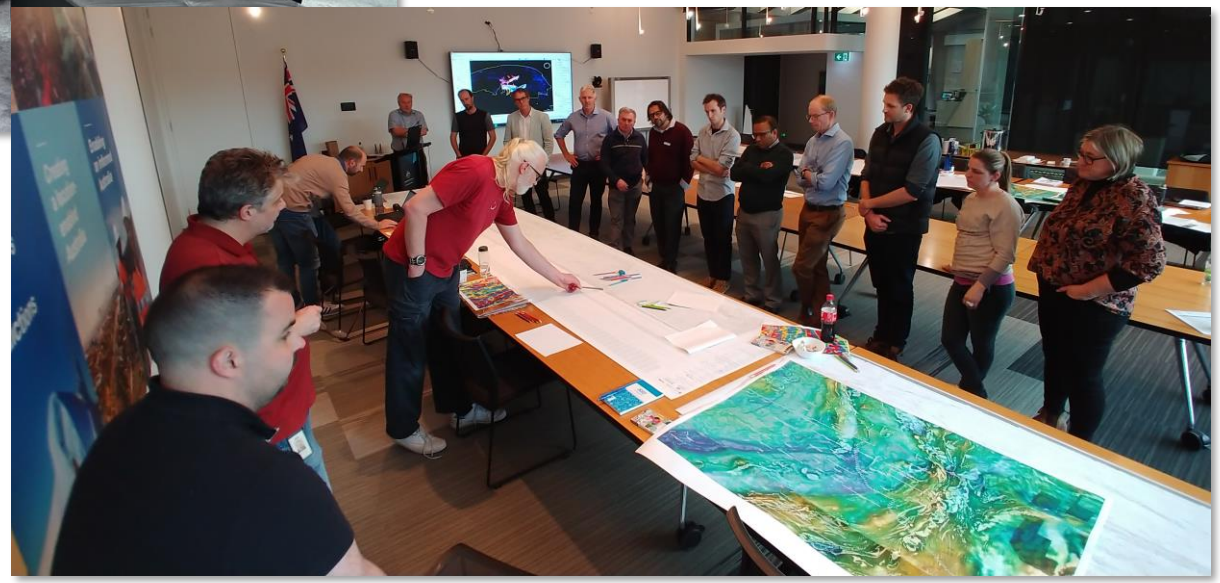
Preliminary results from the 2022 Northwest Victoria DCD 2D Reflection Seismic Survey – Line GA22-DL2

DCD 2D Reflection Seismic Survey – Line GA22-DL2



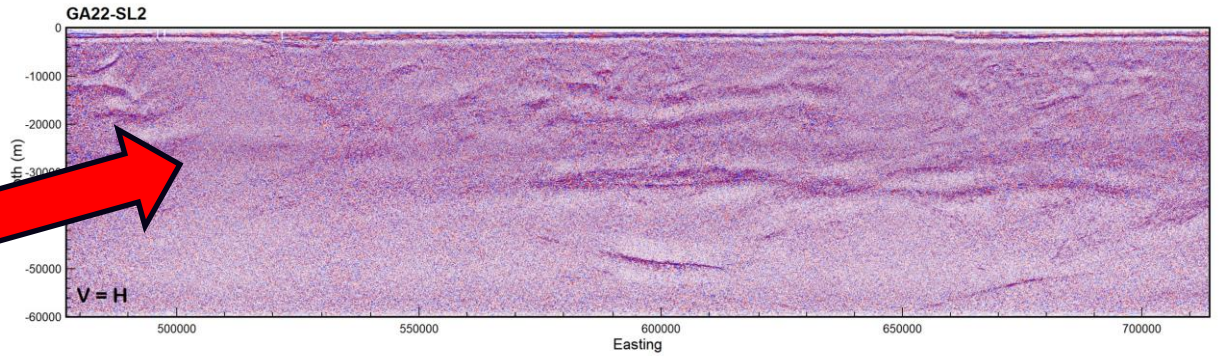
2022 DCD 2D Seismic Survey
Preliminary interpretation workshop

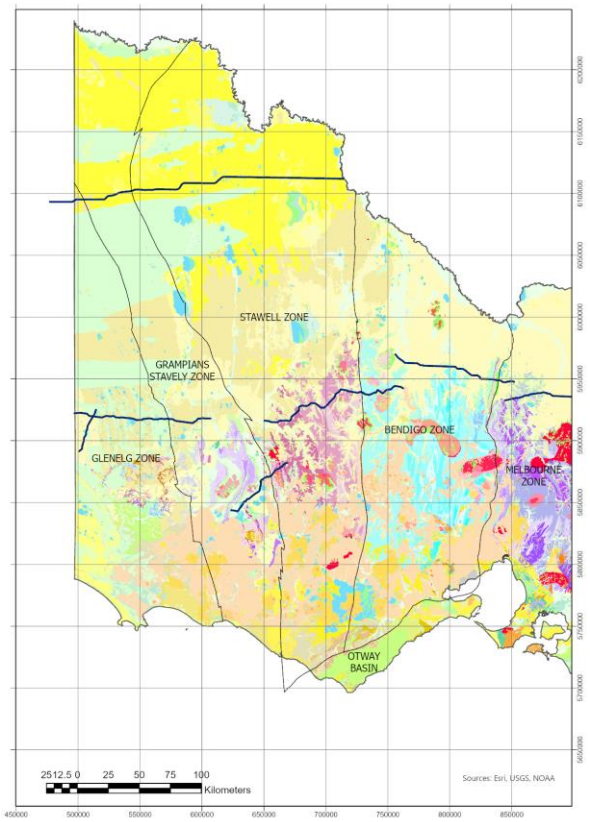
August 2023 at Geoscience Australia



Preliminary interpretation GA22-DL2

- Line GA22-DL2 located entirely over Murray Basin cover
- Bedrock exposure and seismic lines in the south provide control and inform interpretation





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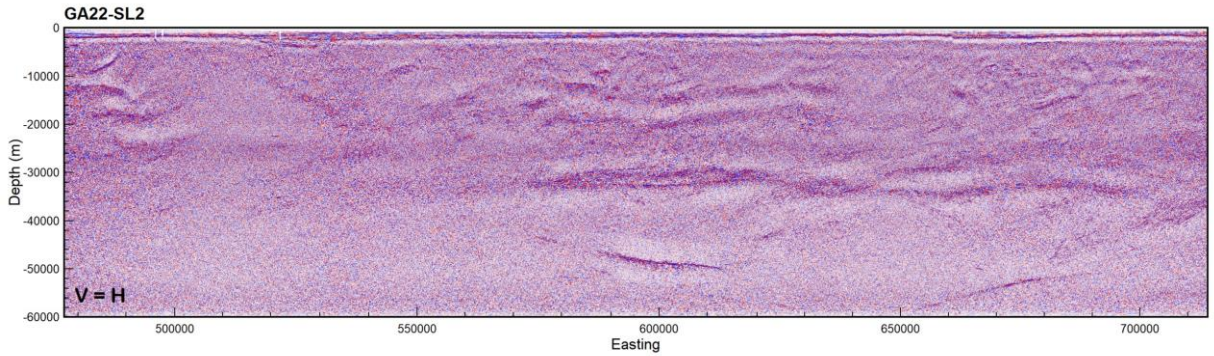

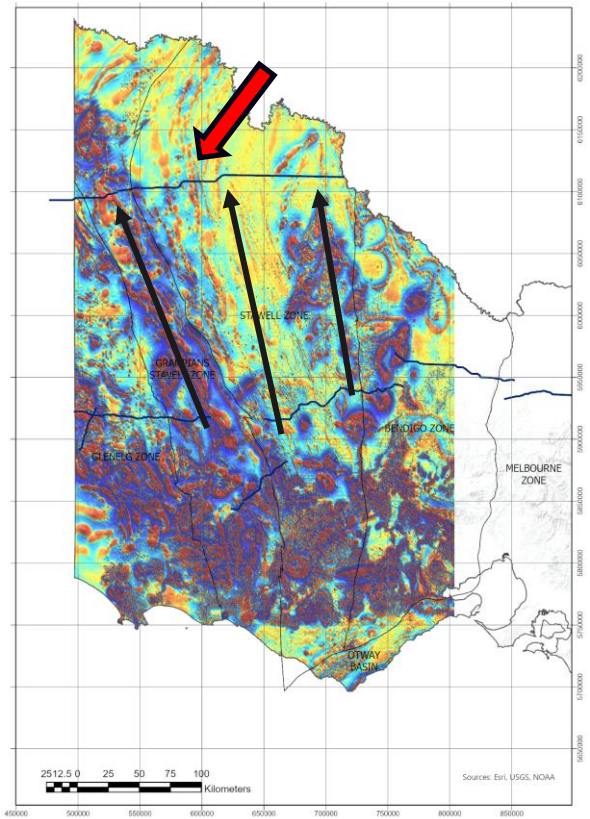

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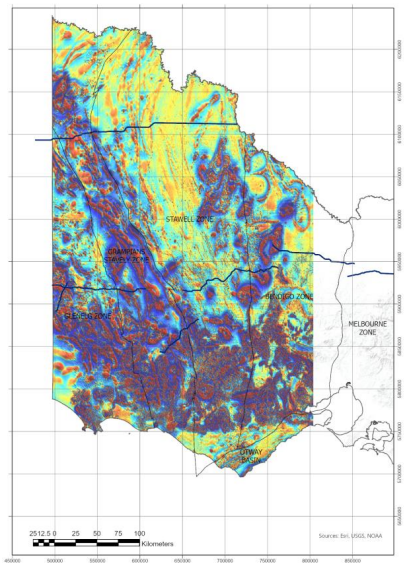
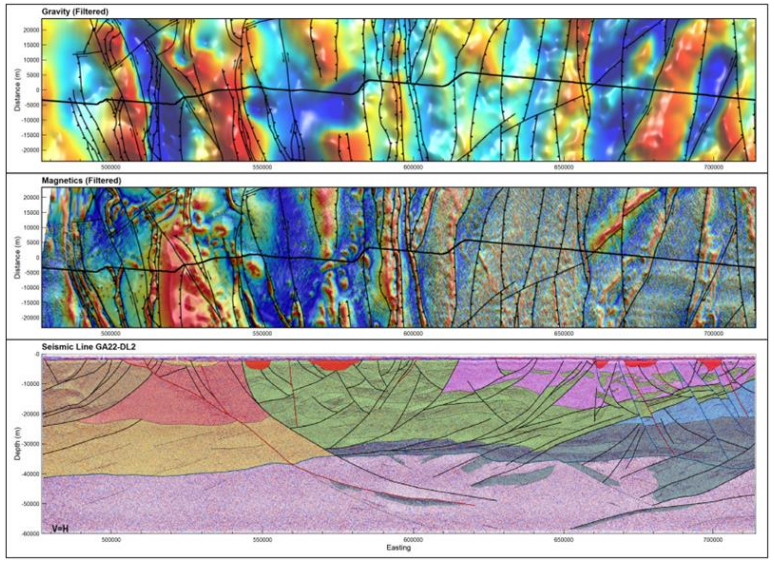
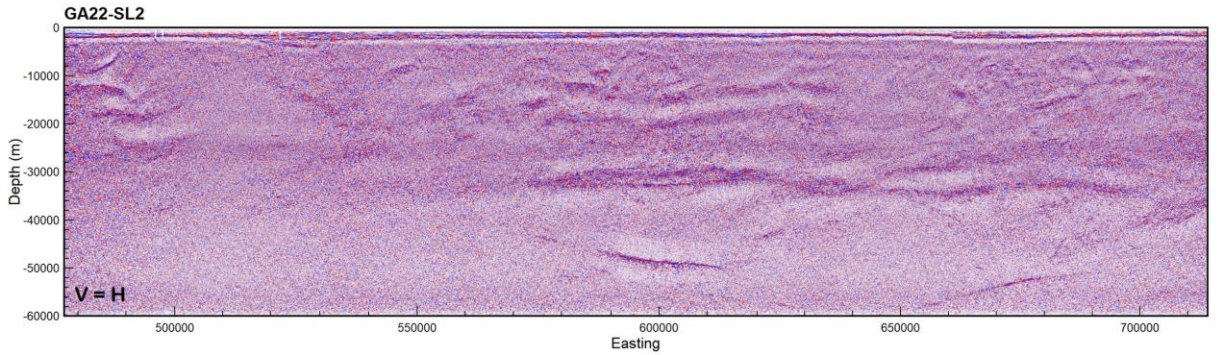
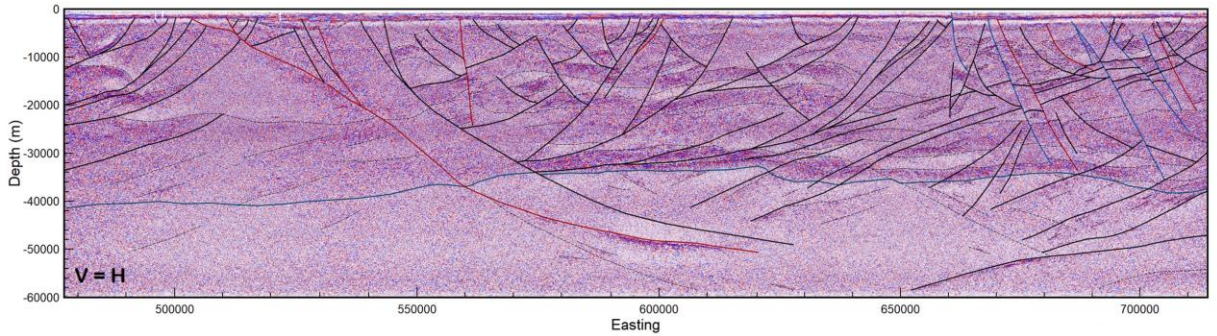
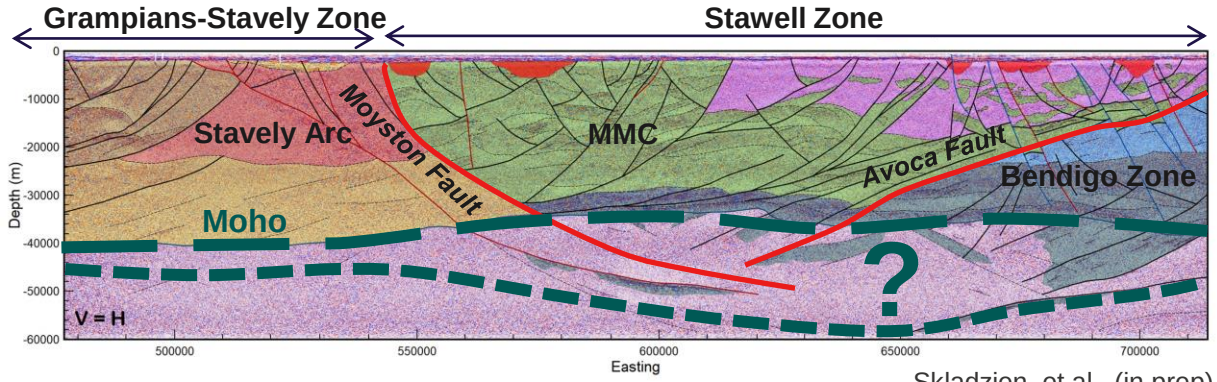










Fault - thrust
Fault - normal
Fault - strike-slip
Moho
Formline/litho boundary

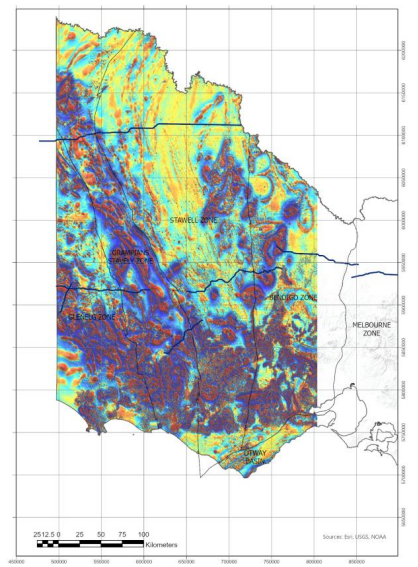
Netherby Trough
Granite
Castlemaine Group turbidites
St Arnaud Group turbidites
Interlayered mafic volcanics and sediments

Mafic volcanics
Stavely Arc
Delamerian back-arc
Delamerian crust

Skladzien, et al., (in prep)

Preliminary interpretation GA22-D

- Line GA22-DL2 l
- Bedrock exposur
  control and inforn



Fault - thrust
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St Arnaud Group turbidites
Interlayered mafic volcanics and sediments
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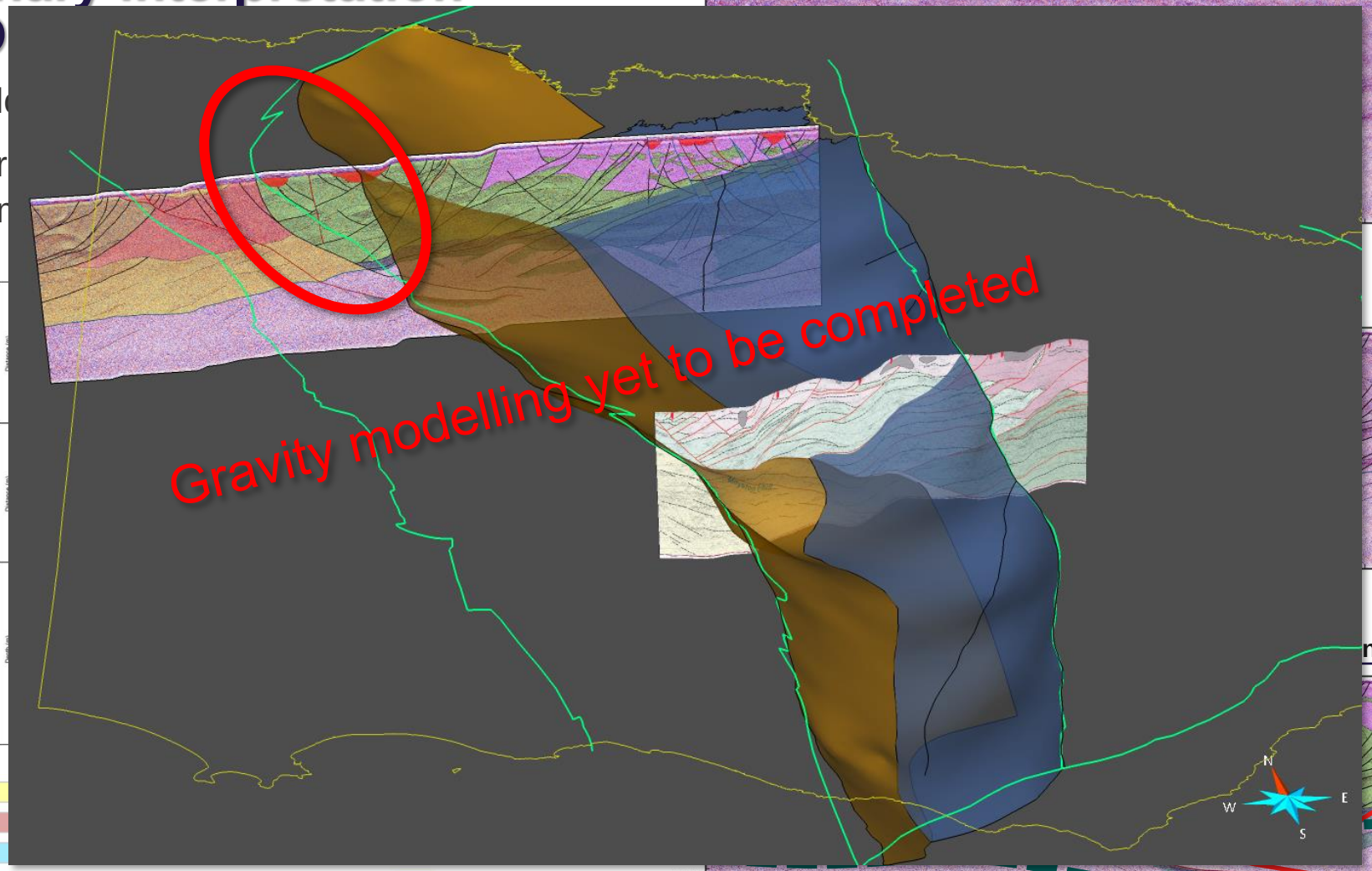
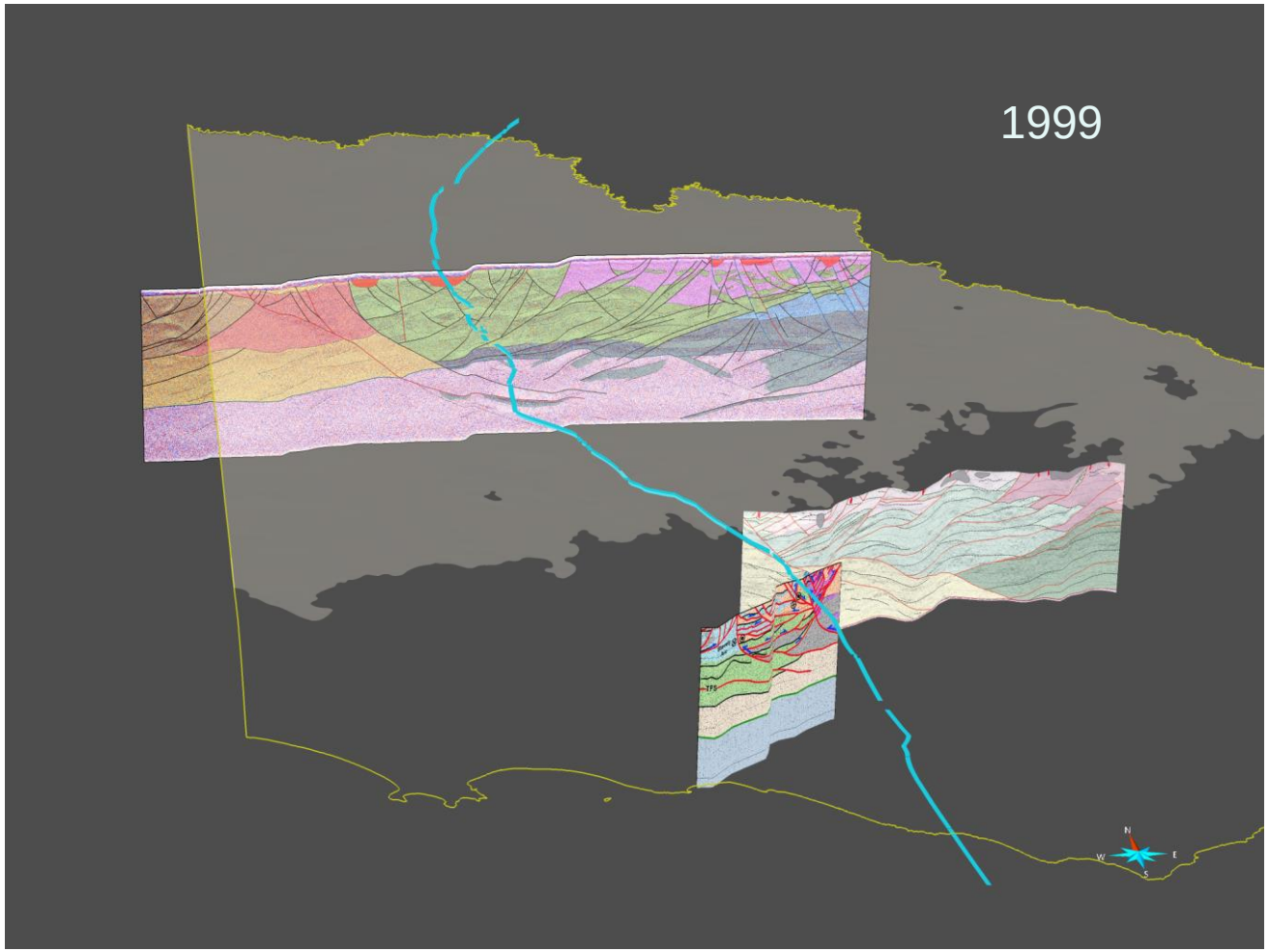
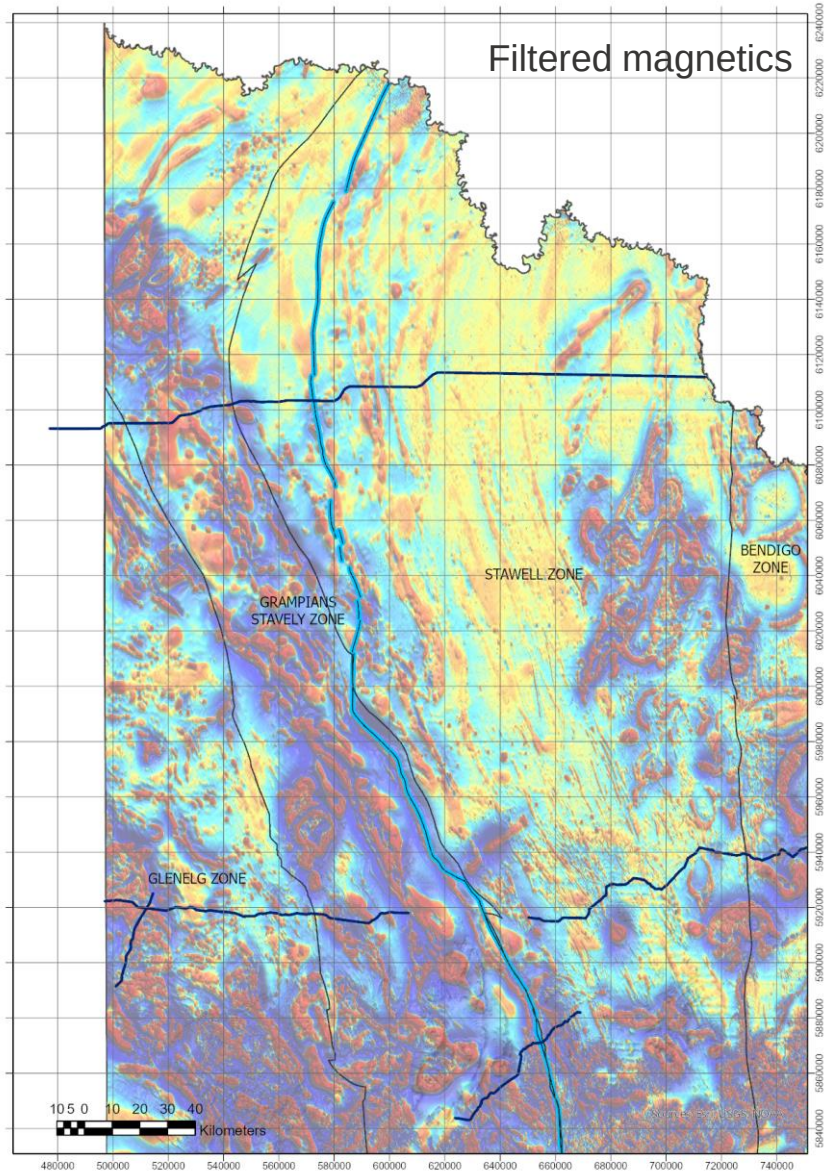


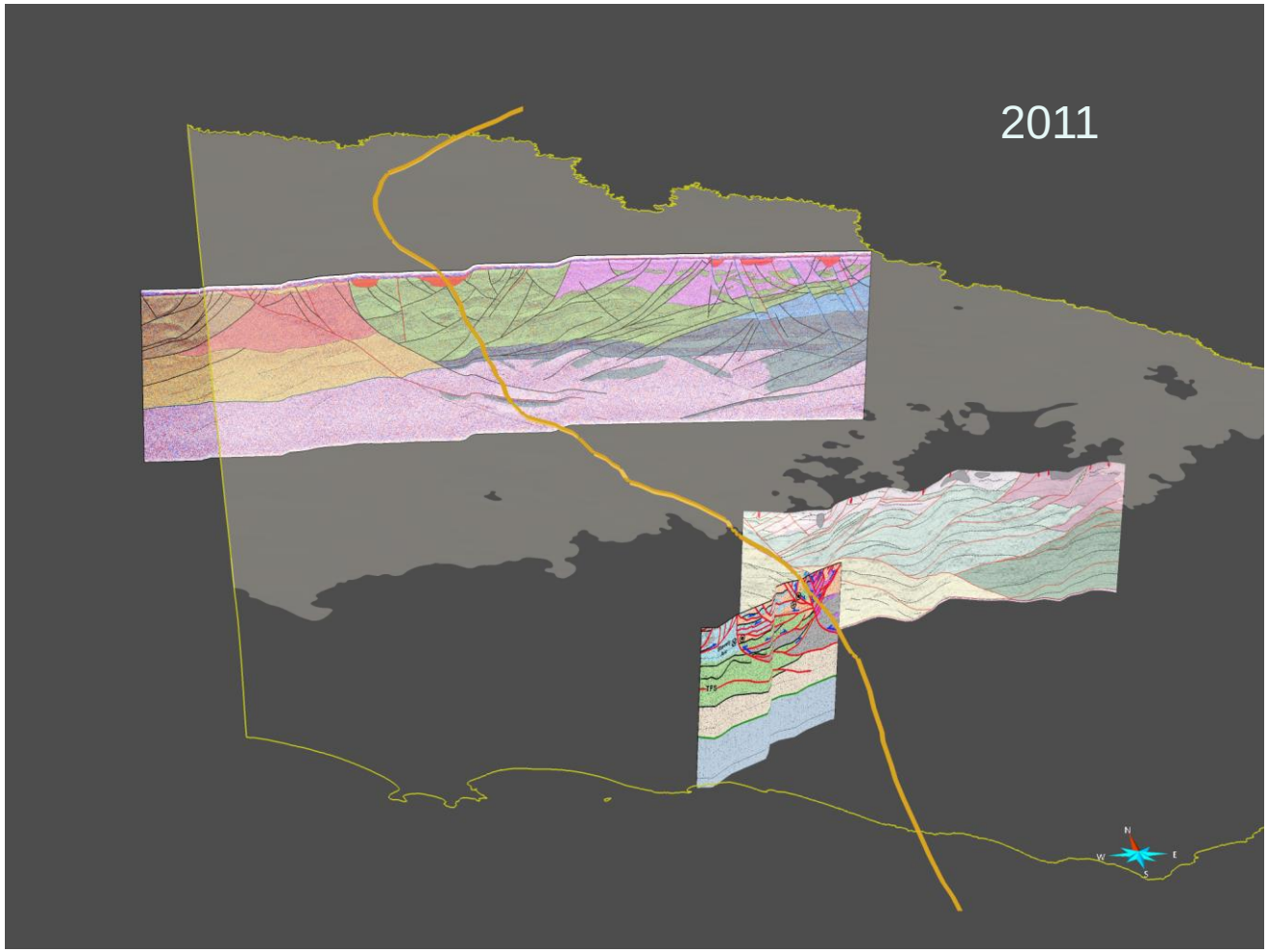
Skladzien, et al., (in prep)

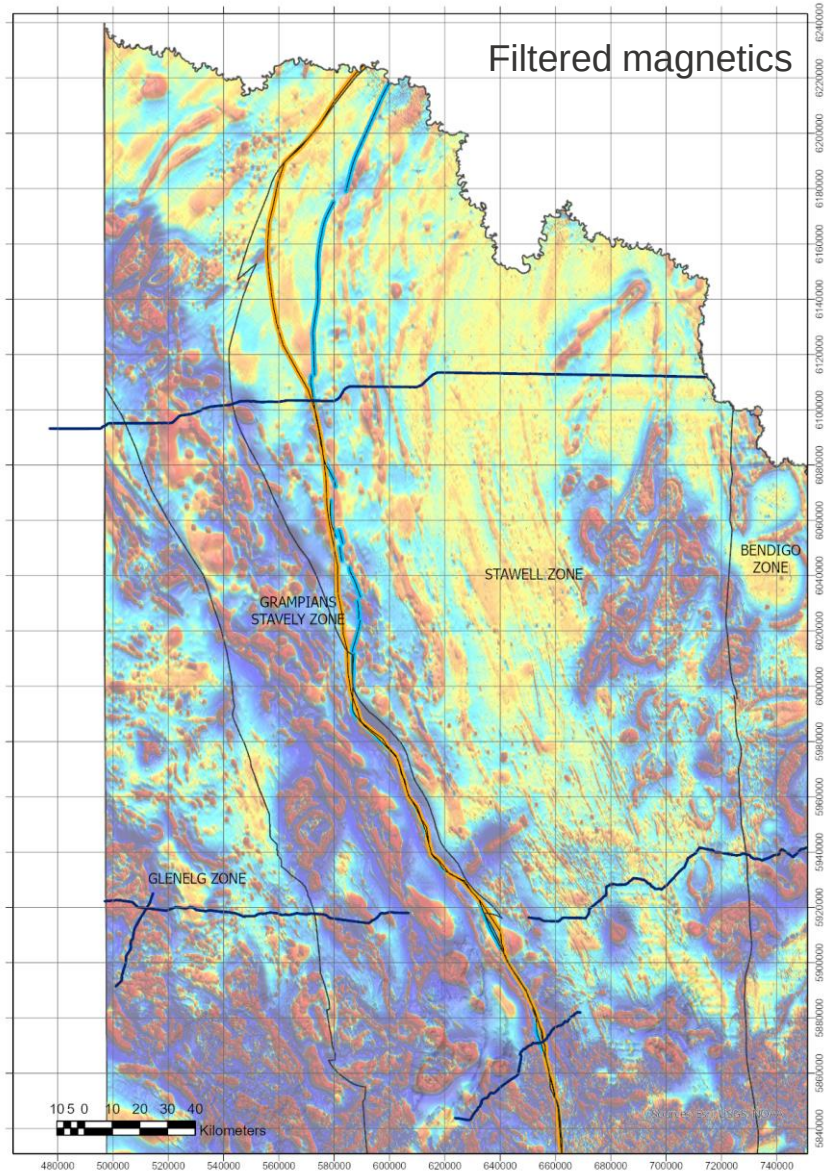
Moyston Fault position – 1:1M Pre-Permian



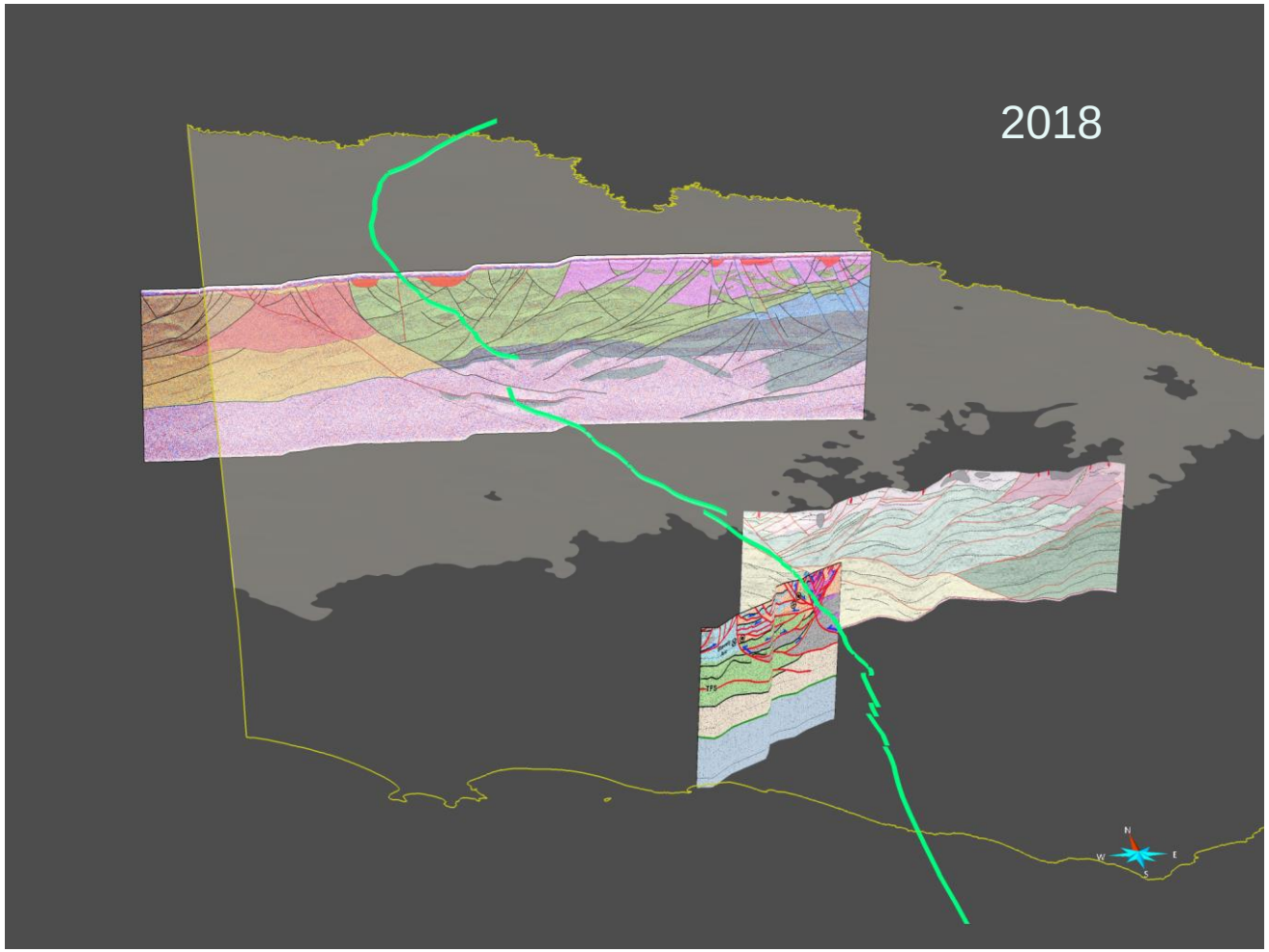


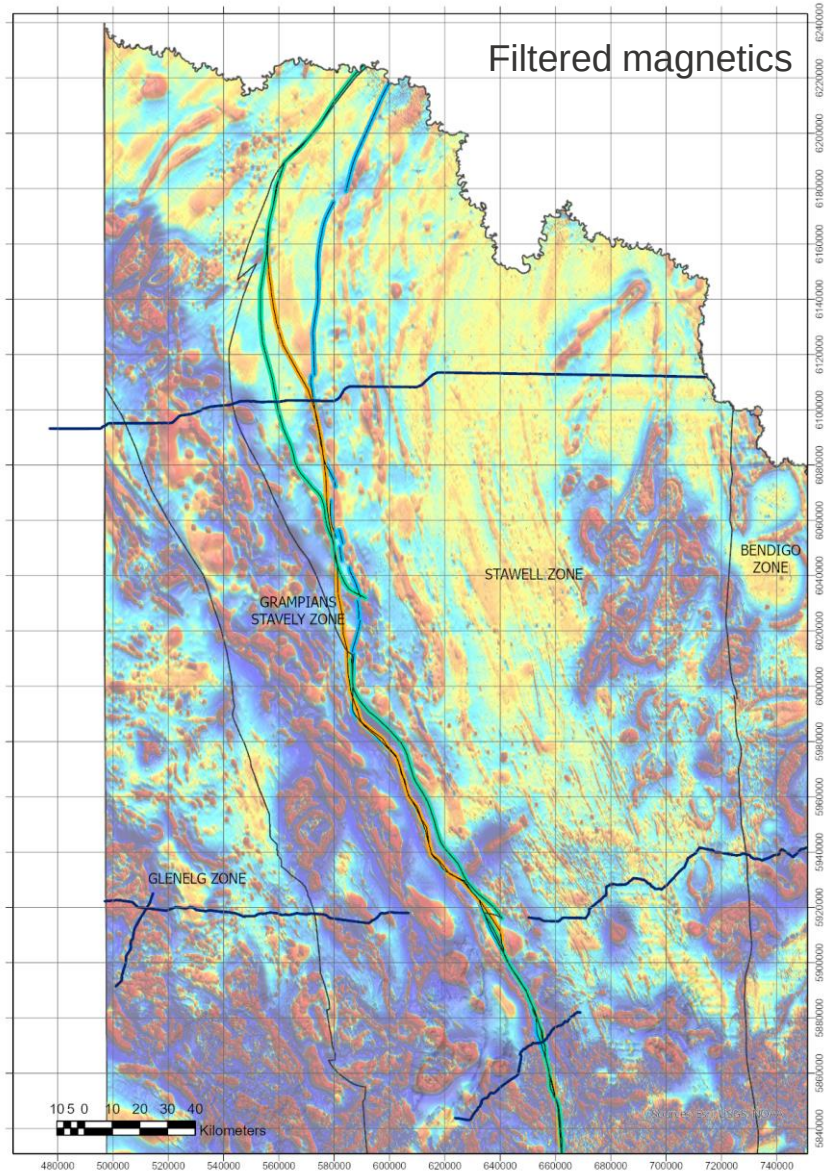
Moyston Fault position – 3D Victoria Model



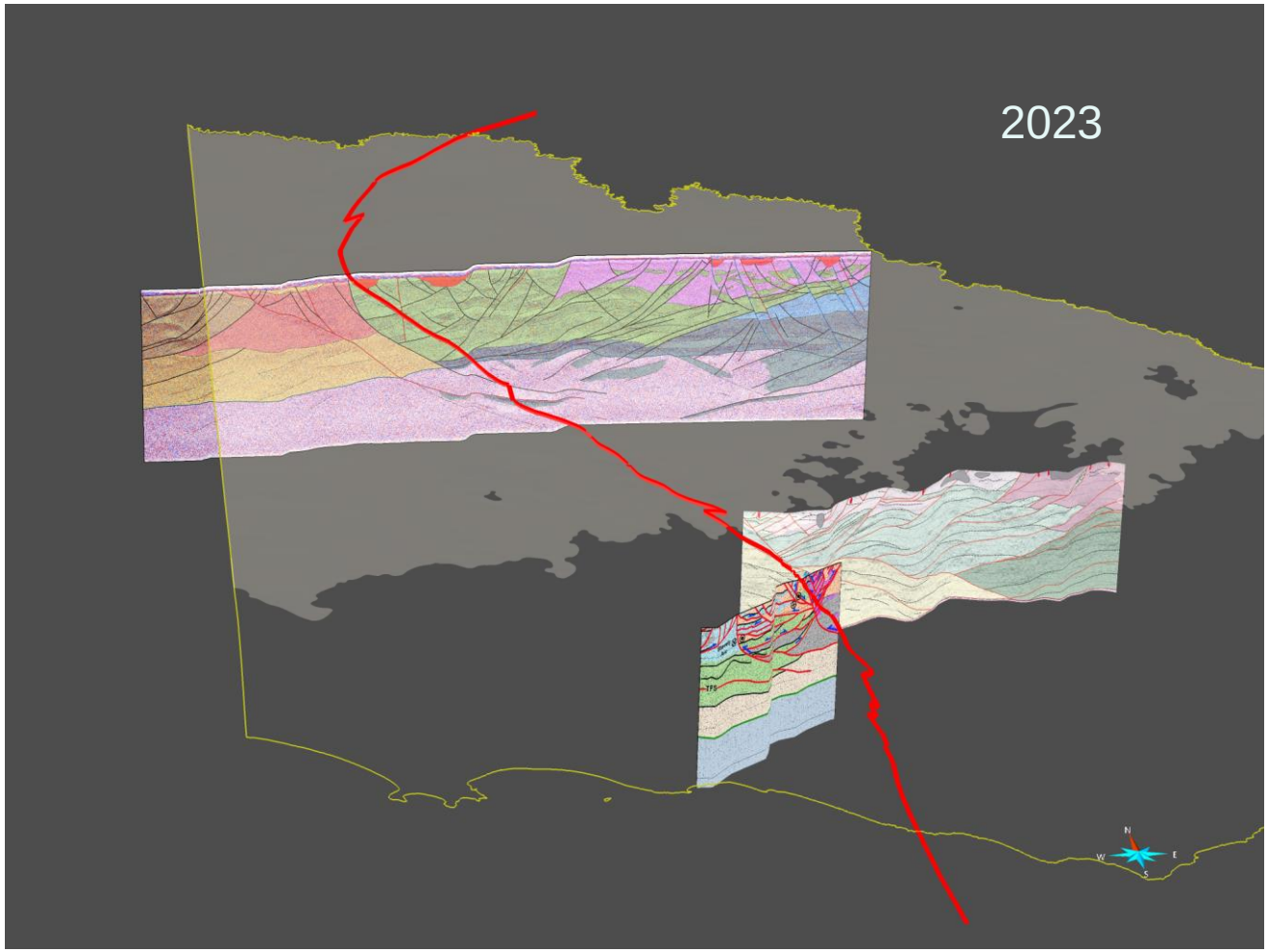


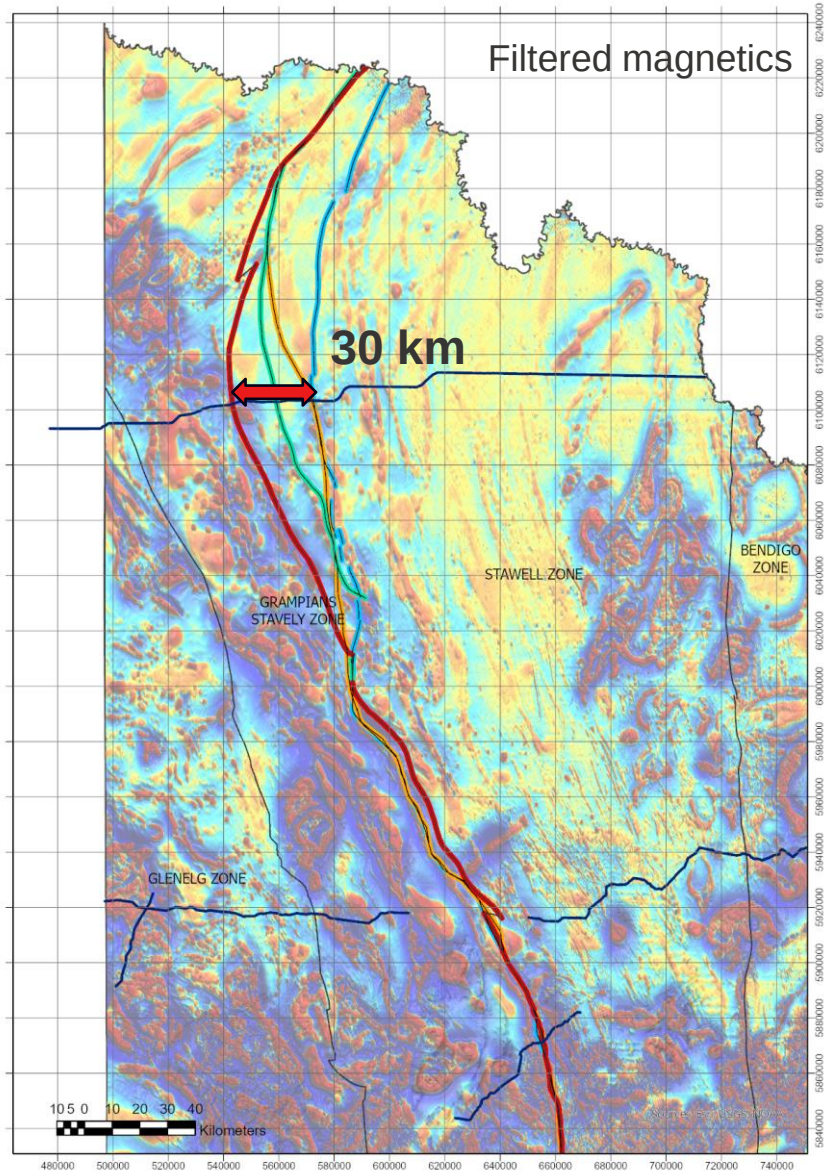
Moyston Fault position – 3D Stavely Model





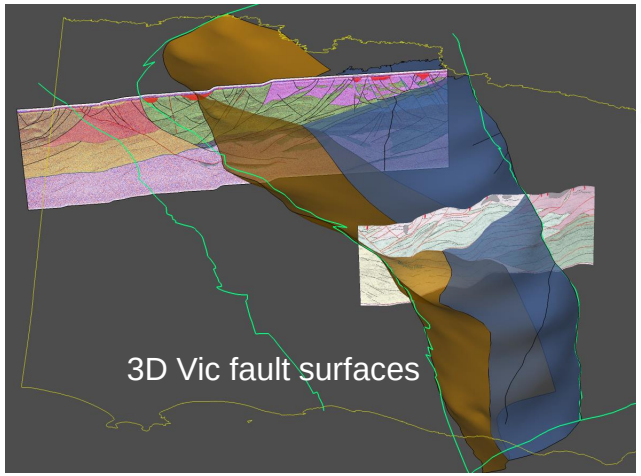
Moyston Fault position – Latest

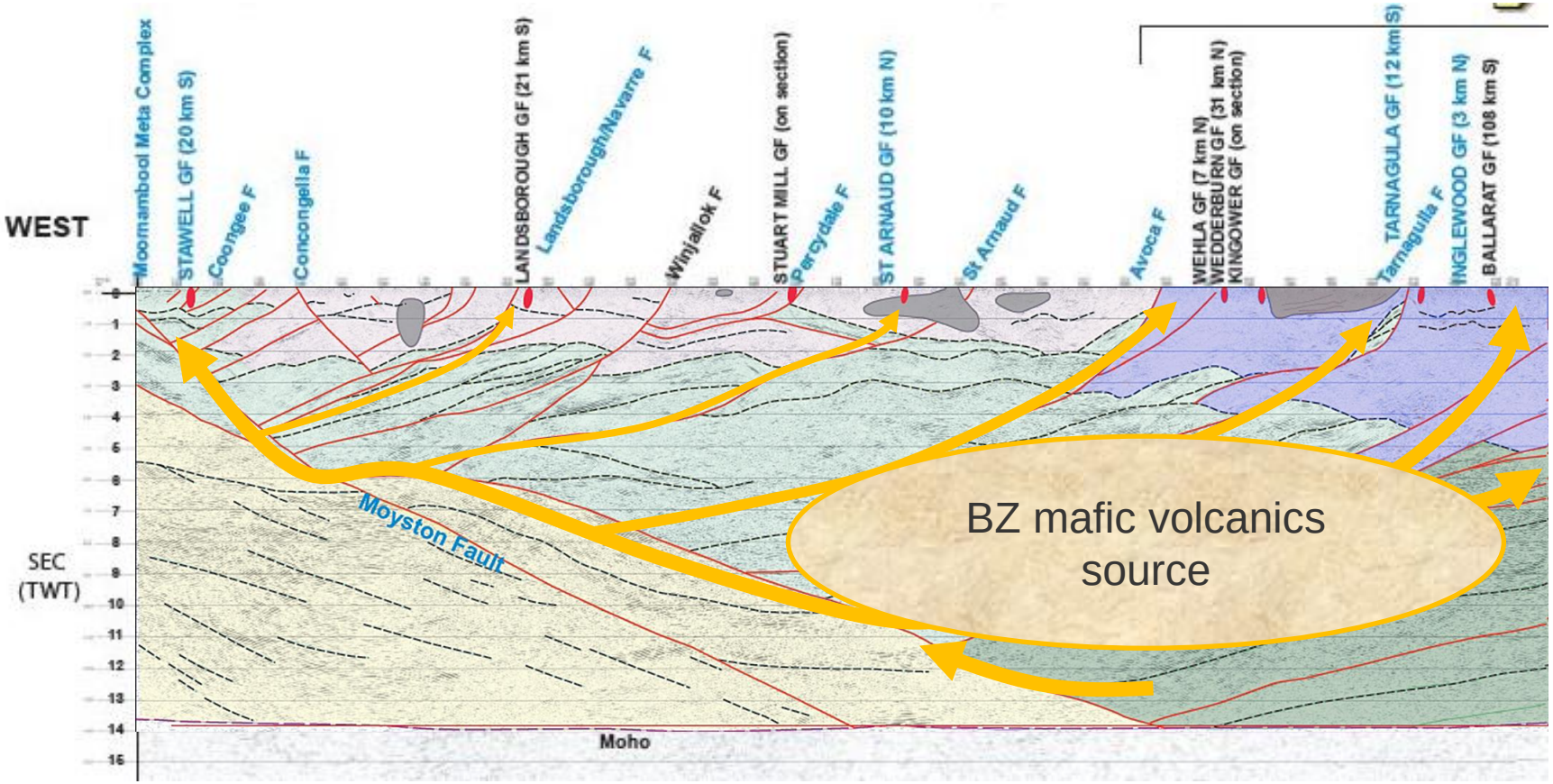




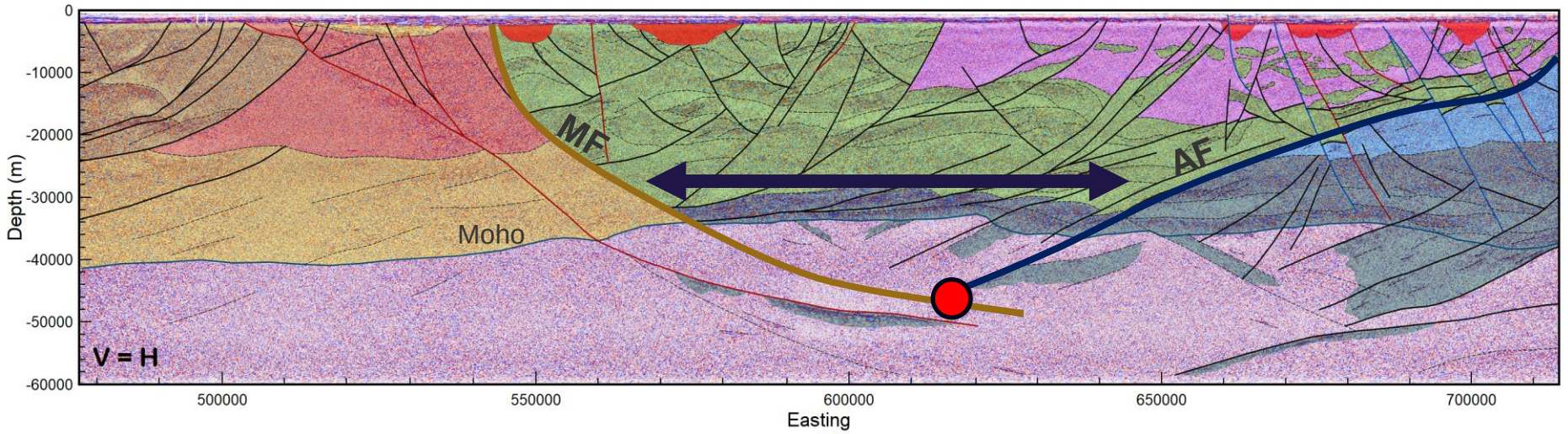
Northern Stawell Zone orogenic gold

Major reverse faults tapping mid-lower crust Bendigo Zone mafic volcanic source provide hydrothermal fluid conduits transporting gold bearing fluids into upper crust.

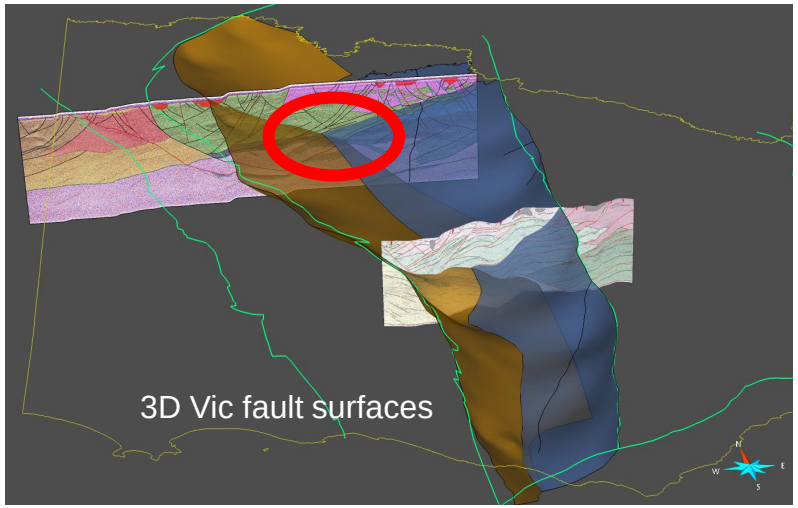




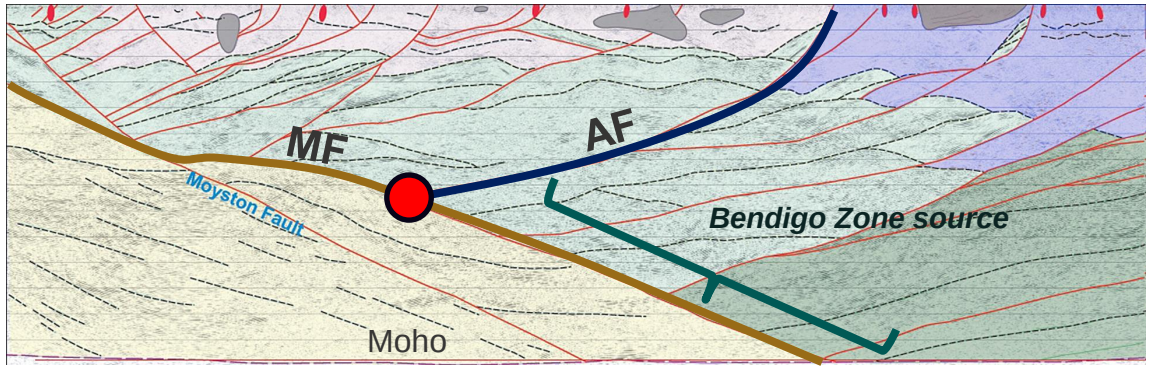
Northern Stawell Zone orogenic gold

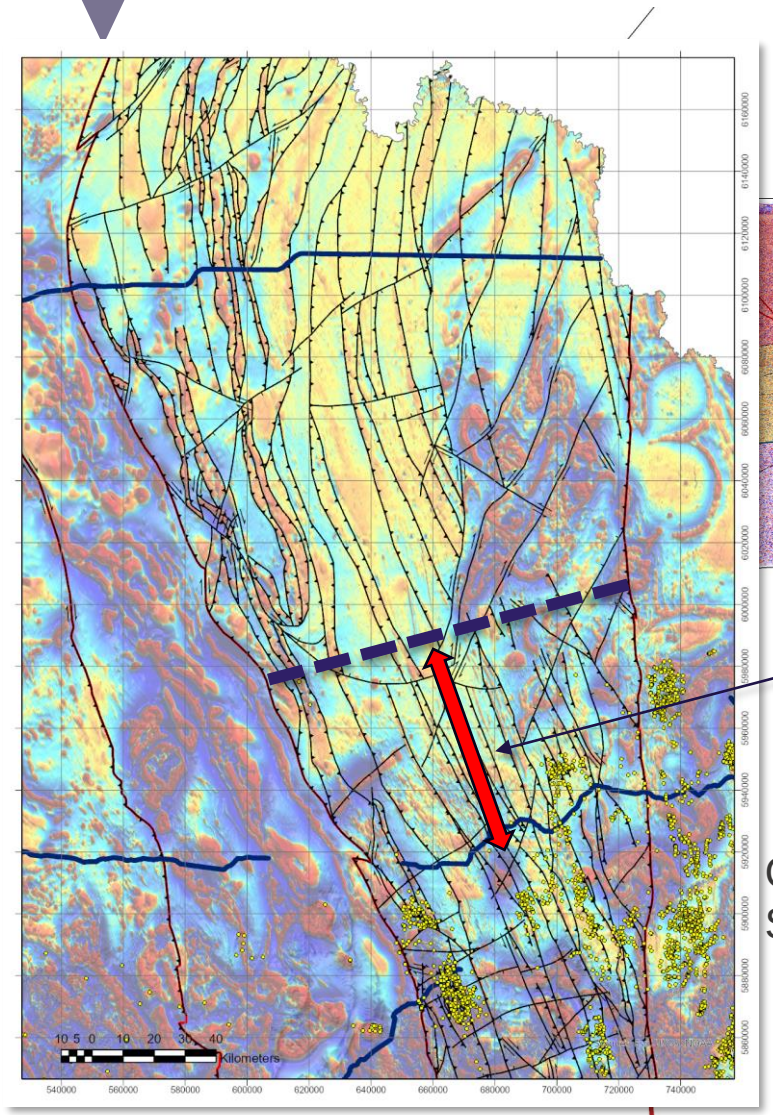


Northern Stawell Zone



Southern Stawell Zone





Stawell Zone

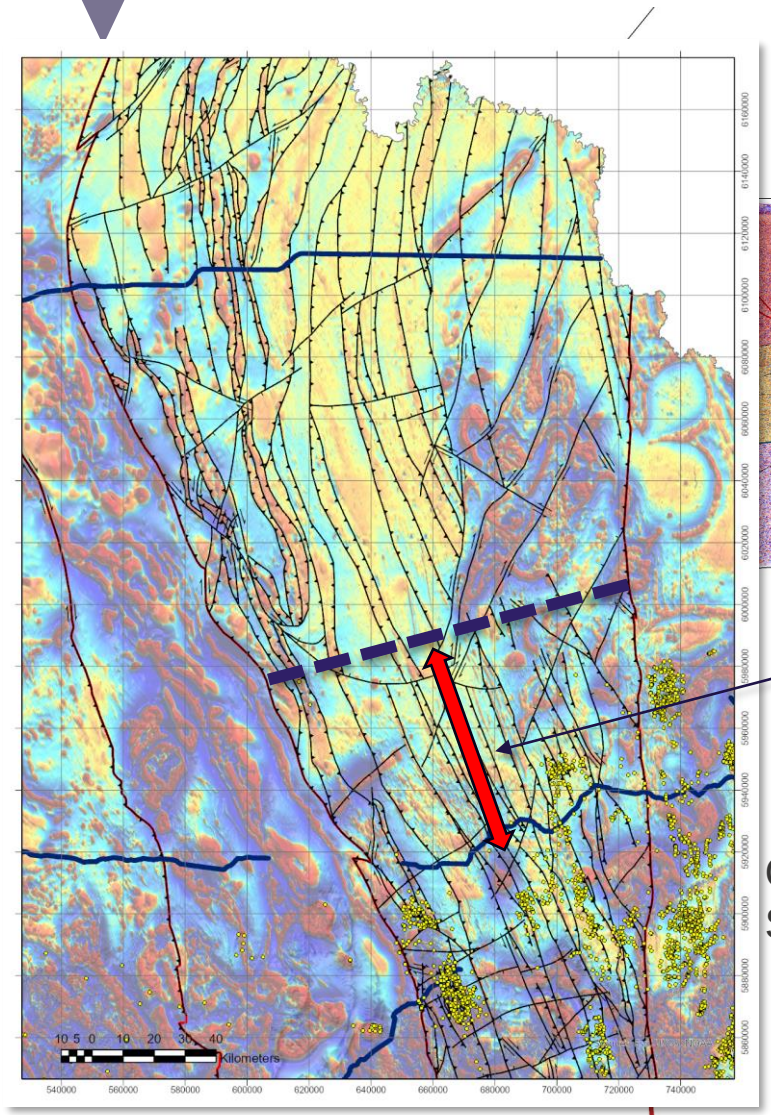
Bendigo Zone

Position where Moyston and Avoca faults intersect at depth of Moho

~70 km

Grampians-Stavely Zone

Moyston Fault



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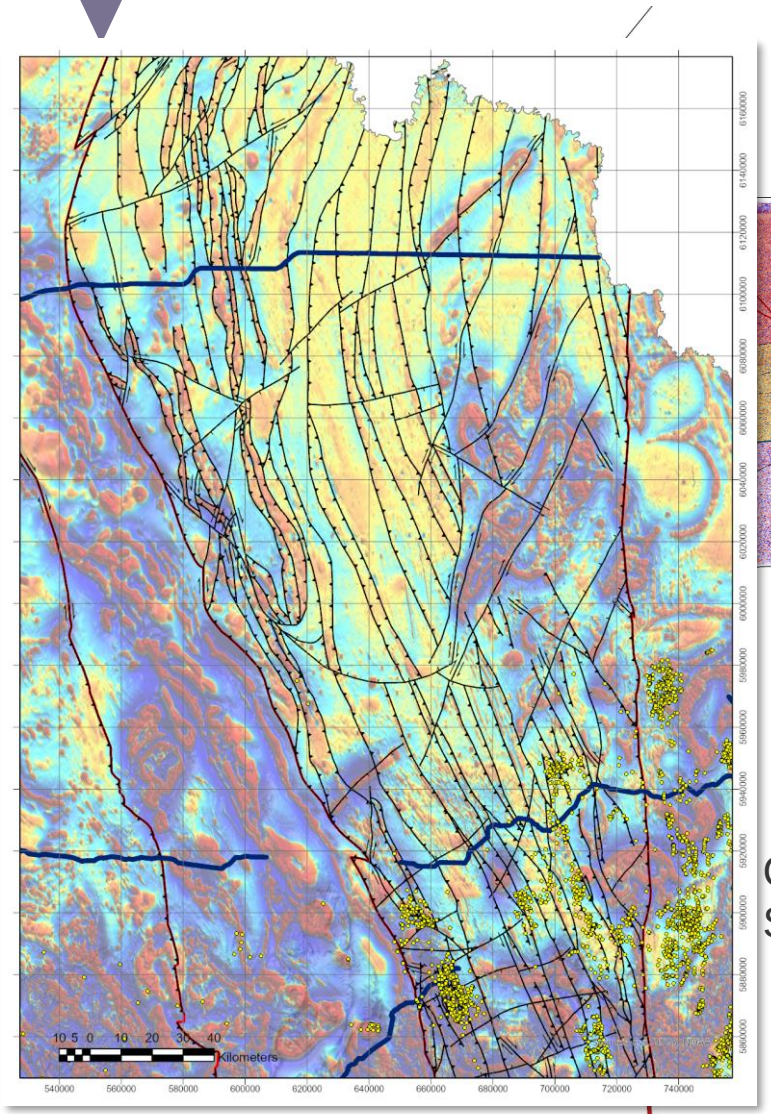
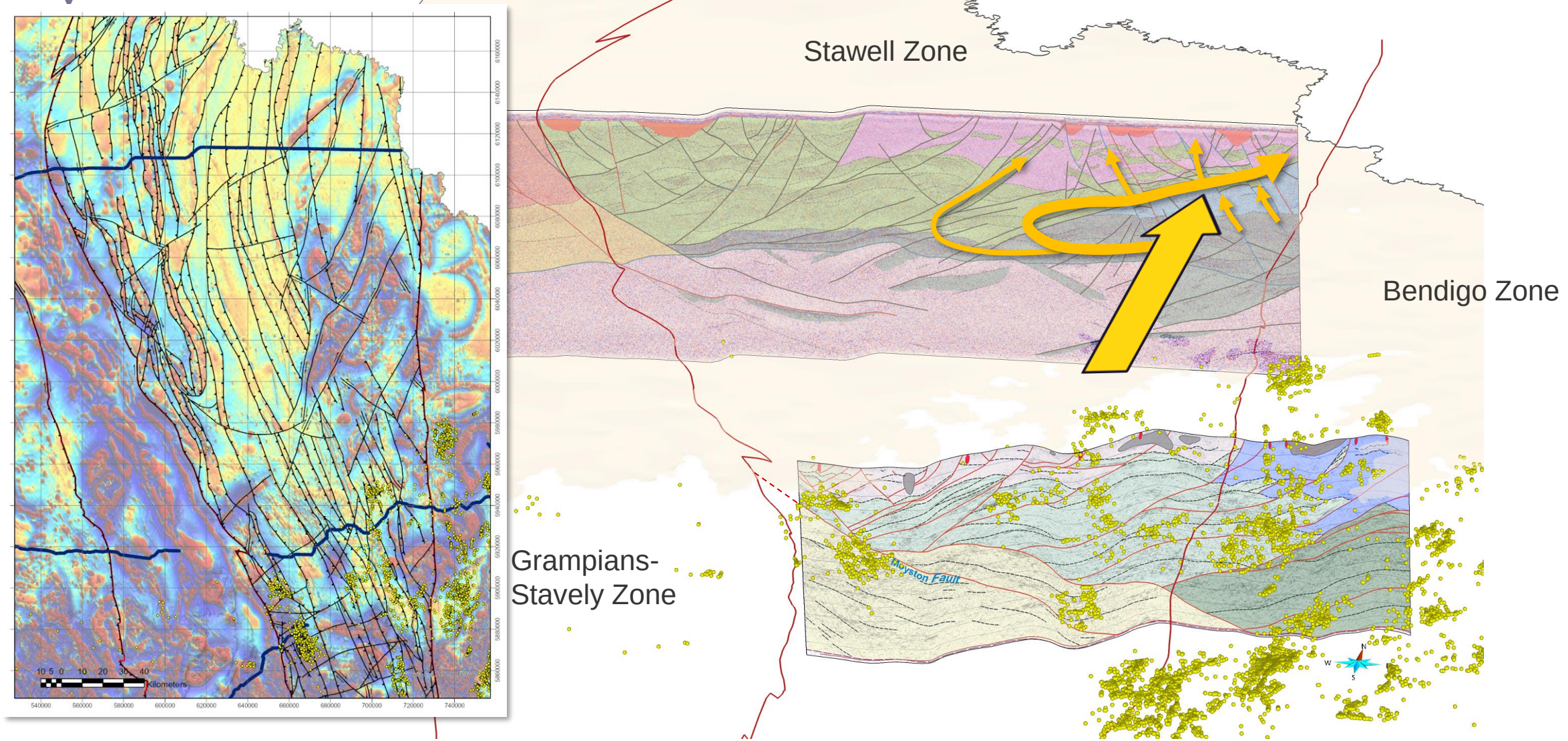


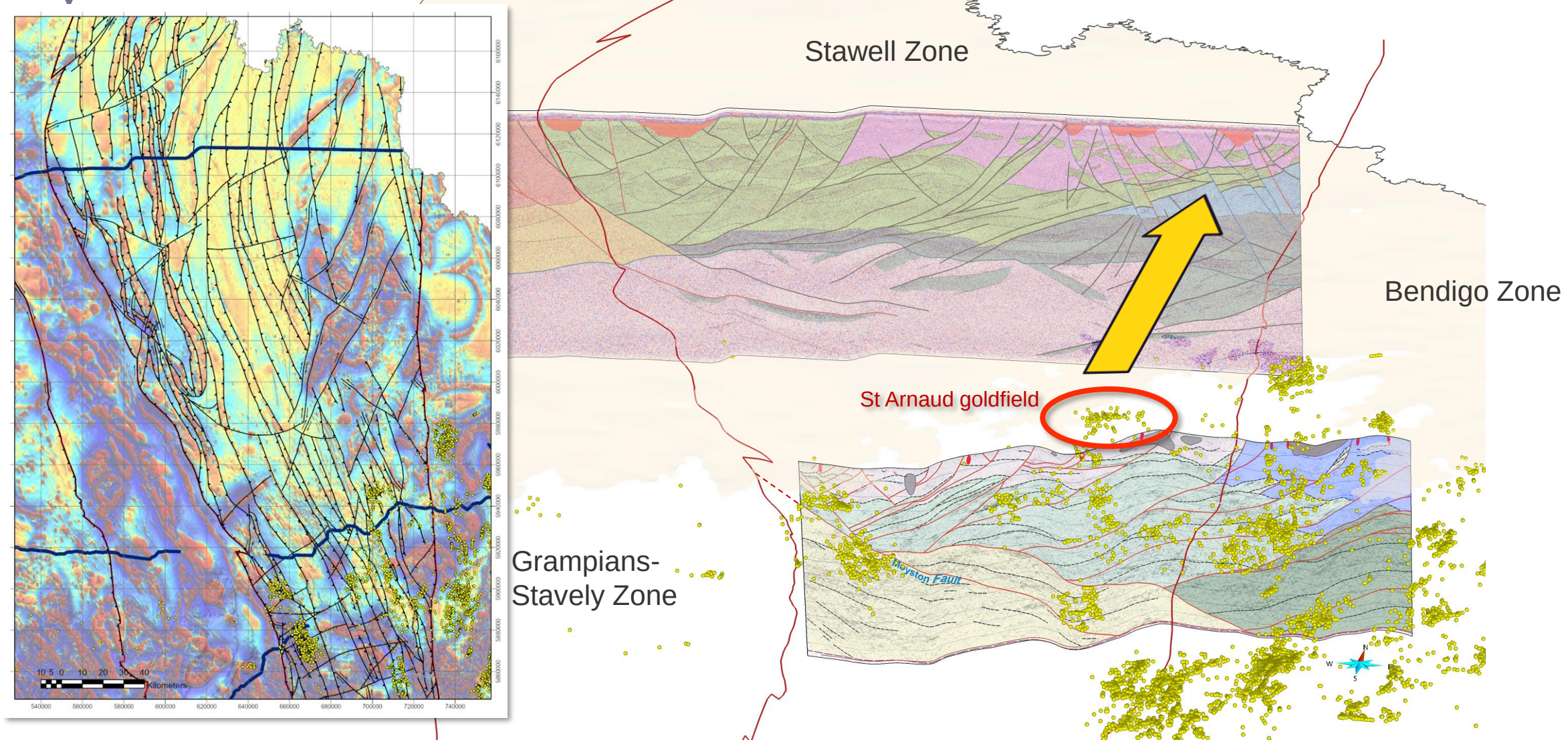
Stawell Zone

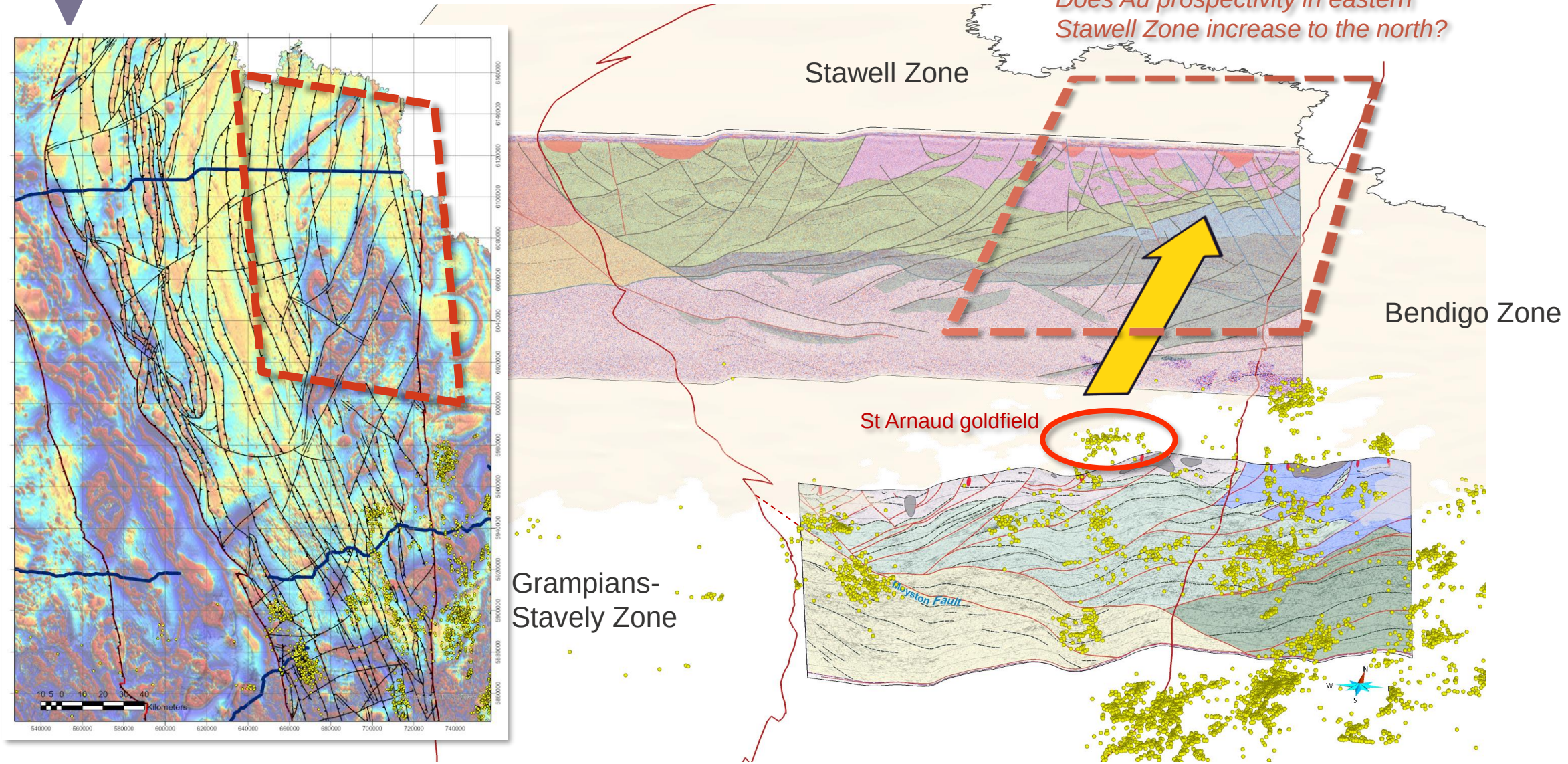
Bendigo Zone

Grampians-
Stavely Zone

Moyston Fault


Stawell Zone
Bendigo Zone
Grampians-
Stavely Zone
Moyston Fault
10 5 0 10 20 30 40
kilometers
540000 560000 580000 600000 620000 640000 660000 680000 700000 720000 740000


Stawell Zone
Bendigo Zone
St Arnaud goldfield
Grampians-
Stavely Zone
Moyston Fault
10 5 0 10 20 30 40
kilometers
540000
560000
580000
600000
620000
640000
660000
680000
700000
720000
740000


Does Au prospectivity in eastern Stawell Zone increase to the north?
Stawell Zone
Bendigo Zone
St Arnaud goldfield
Grampians-Stavely Zone
Moyston Fault
10 5 0 10 20 30 40
kilometers

Wider and thicker Moornambool Metamorphic Complex (accretionary wedge)

Stawell Zone

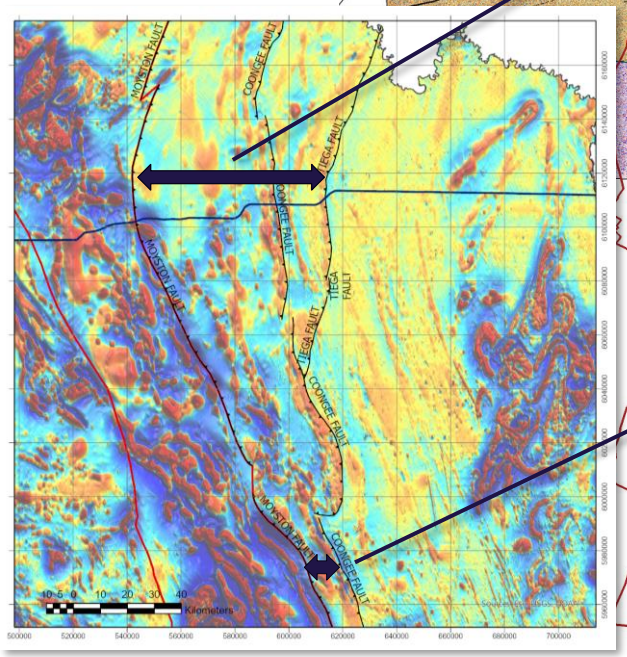
Stawell Zone wider in the north

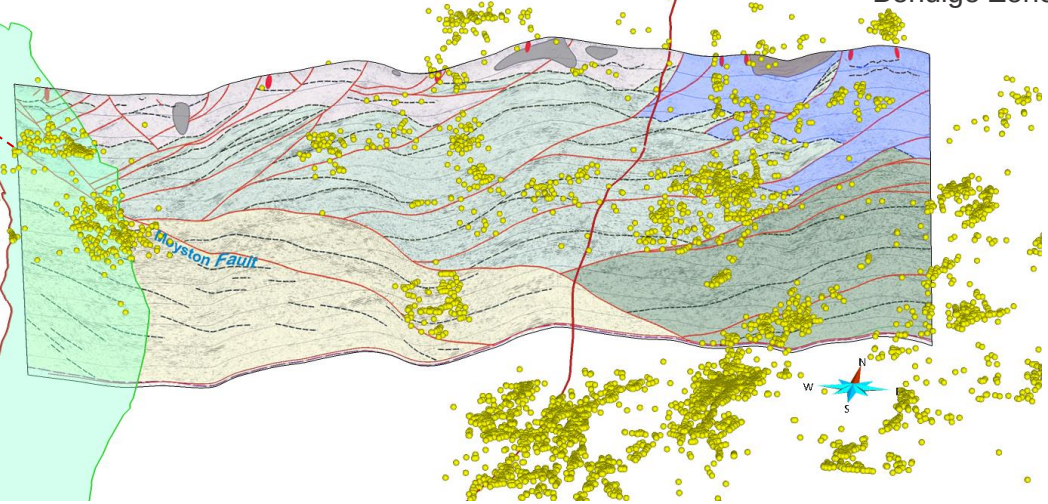
Cambrian mafic volcanics Au source?

Bendigo Zone

Stawell Zone piggy-backed over Bendigo Zone in the south

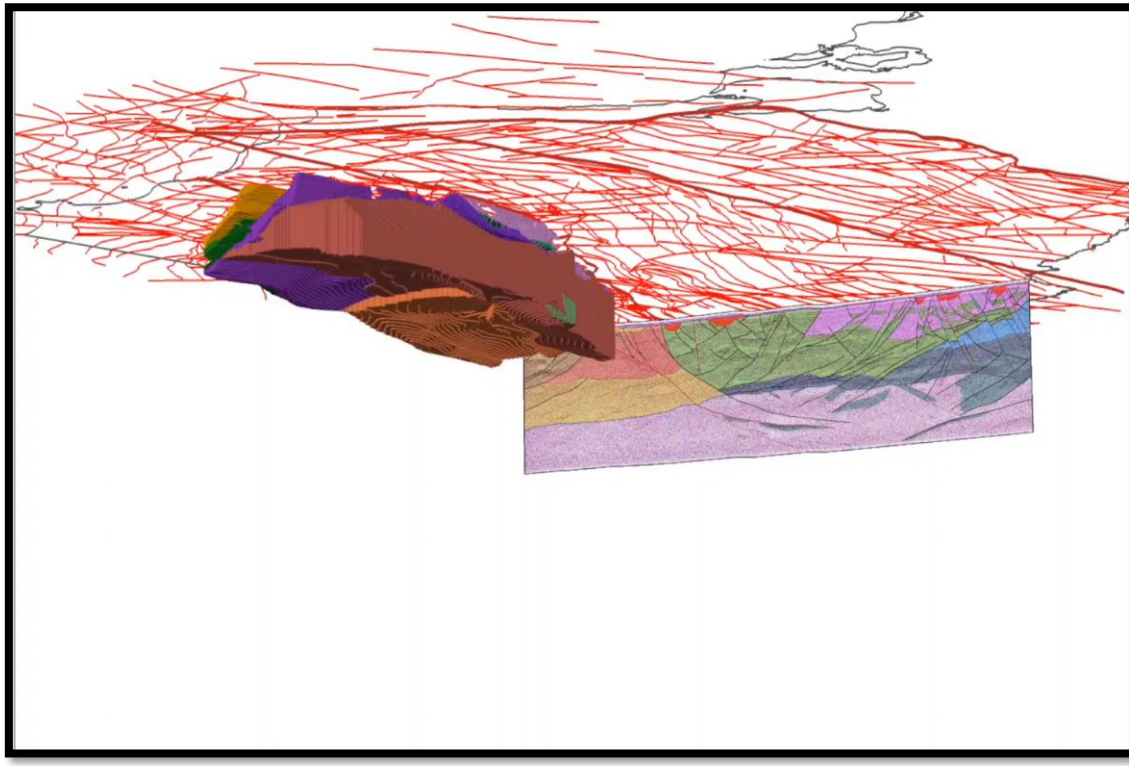
Grampians-Stavely Zone

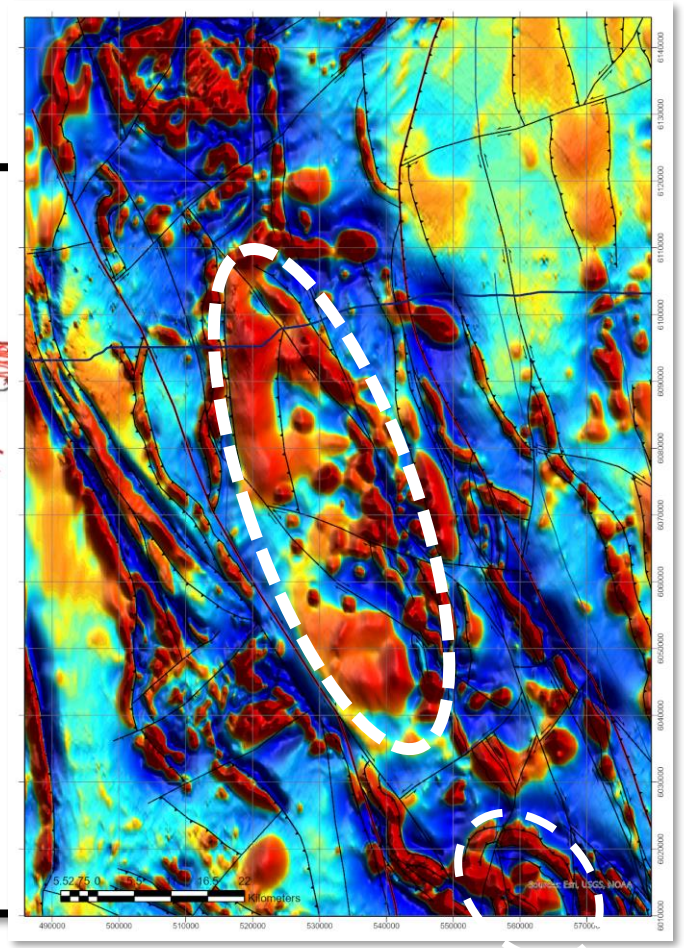


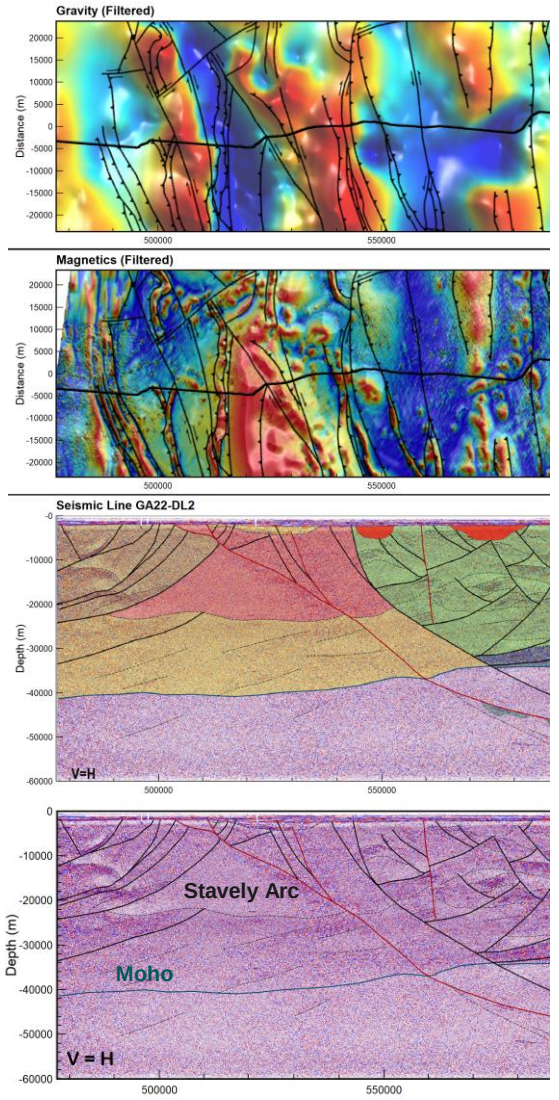


Northern Stavely Arc

- Re-interpretation of northerly Stavely Arc structures extended from Stavely 3D model
- Possible in-situ volcanic edifices imaged in new seismic – bland seismic character
- Inform and constrain potential Cu porphyry and VHMS prospectivity







Outline

- Background – legacy mapping, 3D modelling programs and geophysical interpretation
- Central-west Victorian Regional Fault dataset
- Implications for regional prospectivity
- Data package delivery
- Take-aways

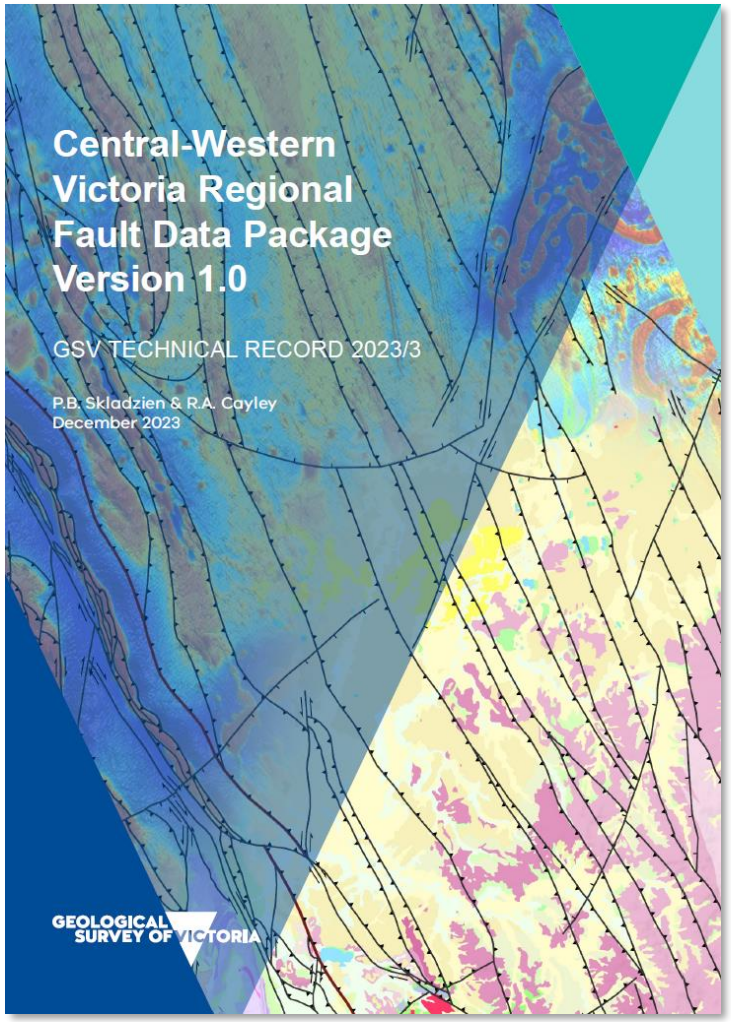
GEOLOGICAL SURVEY OF VICTORIA

Data package delivery

GSV Technical Record (2023/3)

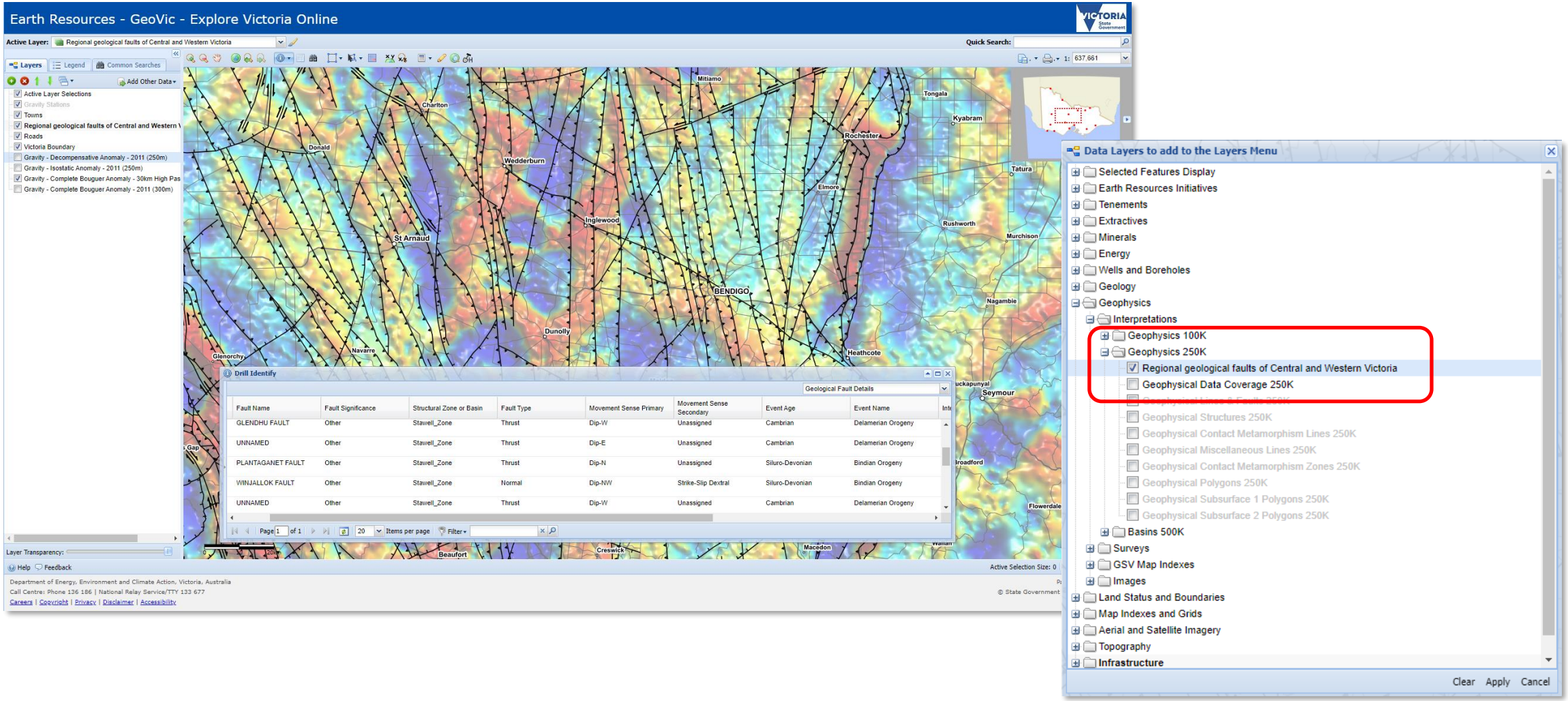
Digital fault data is provided in the following formats:

- ESRI shapefile
- ESRI geodatabase (gdb)
- ESRI layer (lyr, lyrx)
- ArcGIS Pro project

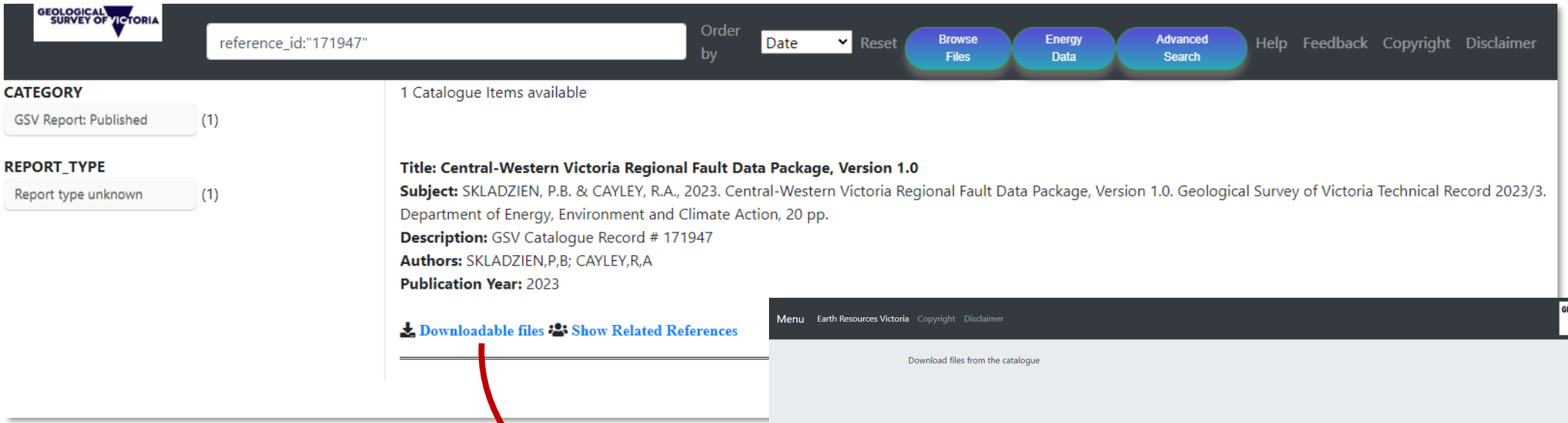


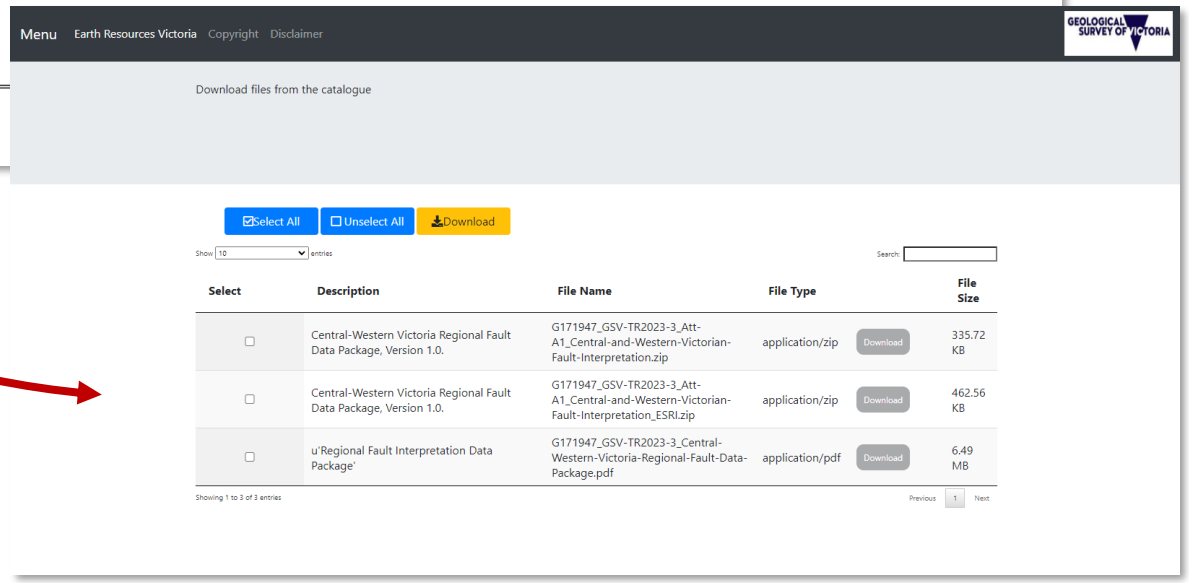
http://earthresources.efirst.com.au/product.asp?pID=1339&cID=37

Data package delivery – visualise in GeoVic



Data package delivery – GSV Catalogue (Search Assistant)





https://gsv.vic.gov.au/searchAssistant/document.php?q=parent_id:171947

Take-aways

- Consolidated and updated fault network interpretation builds upon legacy interpretations within a systems-based geodynamic framework
- Previously unavailable 3D modelling interpretations are captured and made accessible in 2D GIS format
- New seismic reflection data provides additional constraints in north-west Victoria
- The dataset delivers important regional prospectivity implications

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