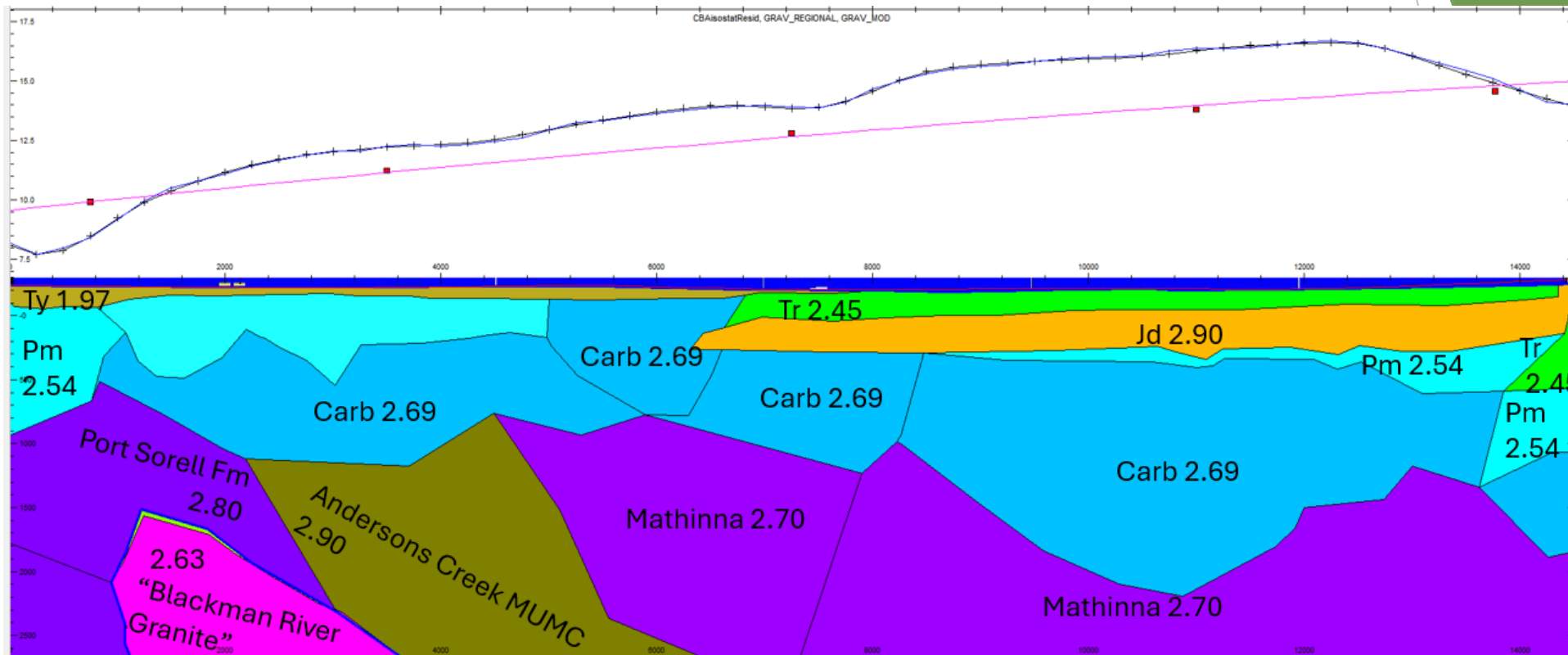




Est. 1980

Solution Energy: Lemont gravity modelling



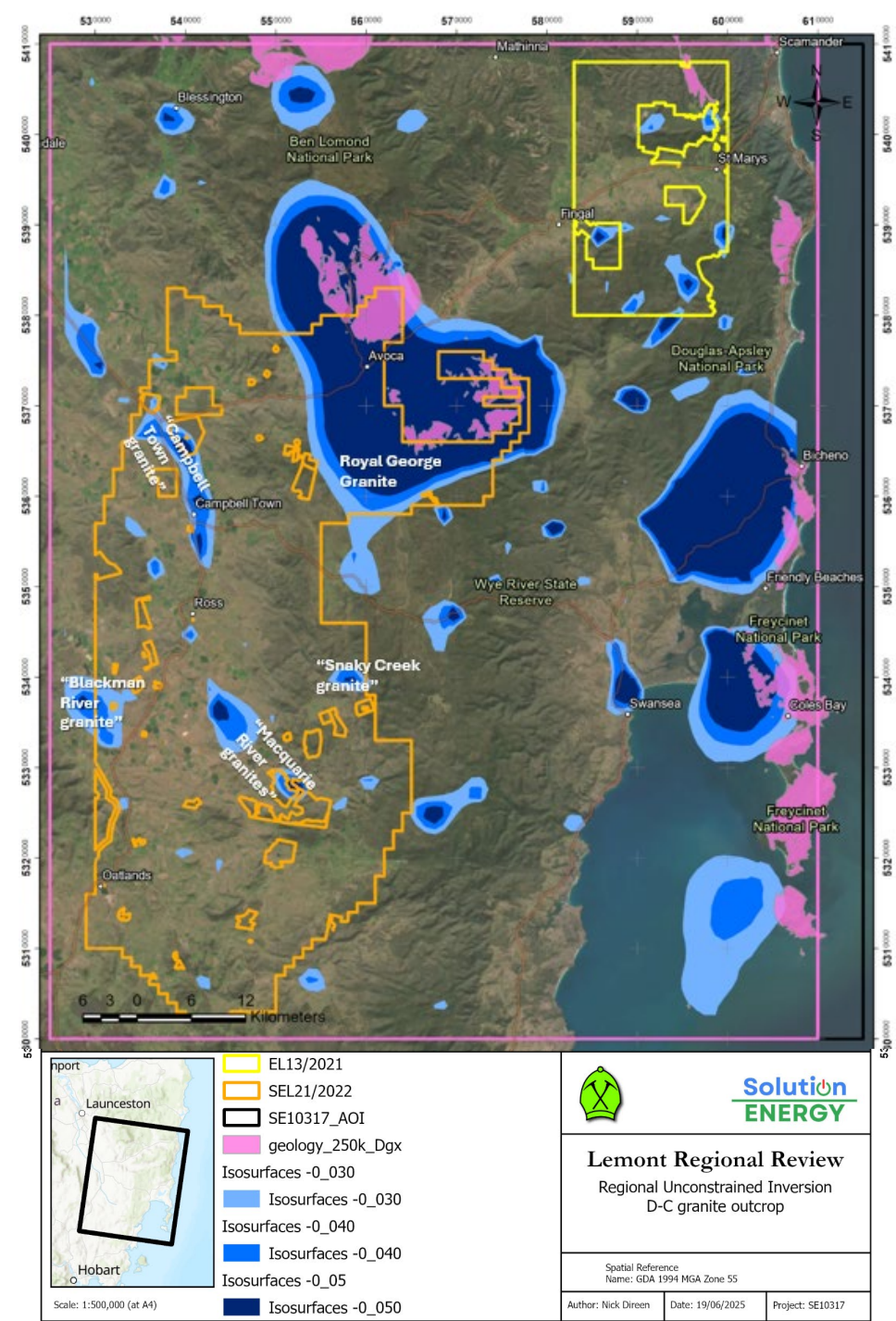
Nick Direen
Mitre Geophysics P/L

21 August 2025



Rationale

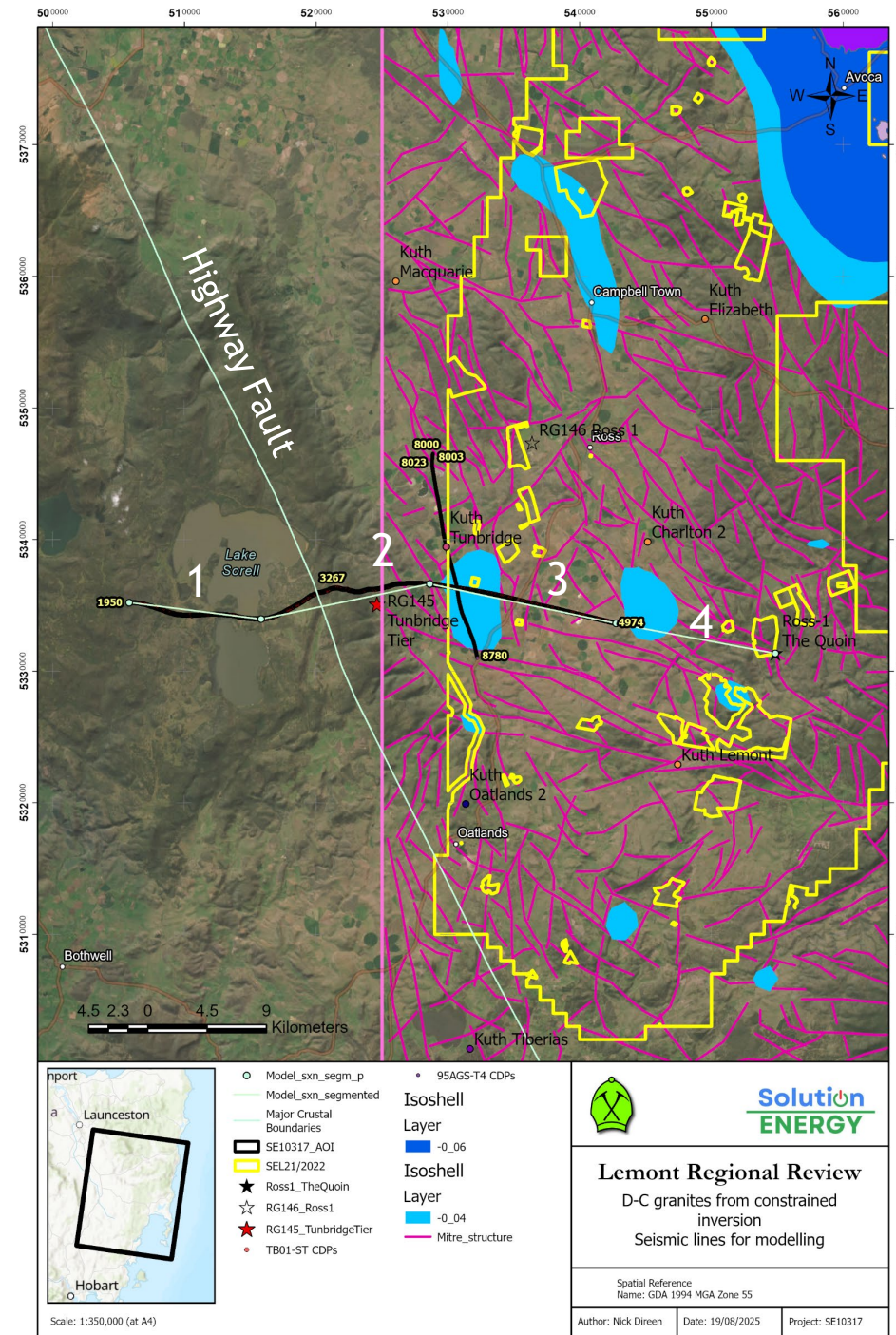
- ▶ Earlier work by Mitre (Direen, 2025) found very little evidence to support the existence of a major Devonian granitoid batholith margin passing through the Lemont tenement area, as had been proposed earlier by Leaman, (2007; 2010; 2012), and used in the conceptual heat flow targeting for Lemont (Lewis, 2005).
- ▶ Further assessment by Mitre (Direen and Campbell, 2025) using isostatic residual Bouguer gravity anomalies found supporting evidence for isolated, smaller volume low density bodies, that could be interpreted as granites in and around the Lemont AOI, shown in the map at right.
- ▶ One of these features, informally named the "Blackman River granite" intersected seismic reflection line TB01-ST which was previously interpreted by Mitre (Direen, 2025), who recommended further 2.5D model testing of the feature.
- ▶ This work is described here, along with a full 2.5D gravity model of the extent of TB01-ST in four segments, including an extension to the Ross 1-The Quoin deep stratigraphic drillhole (Clarke and Farmer, 1983), for further constraint; and a 2.5D forward model of the intersecting seismic reflection line 95AGS-T4.



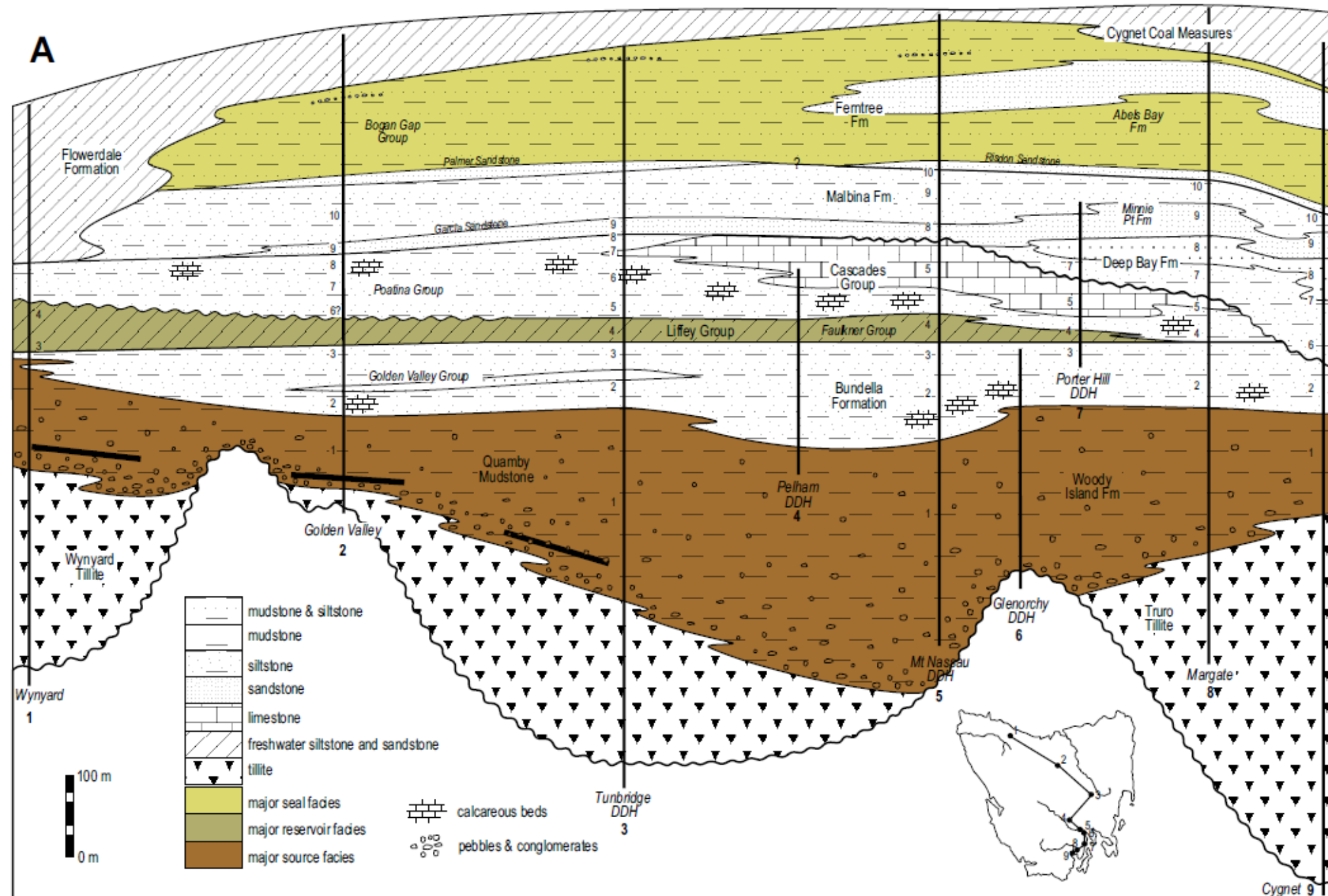


Project Location

- ▶ Location of the model sections is shown in the map at right.
- ▶ Line TB01-ST has a significant crooked-line geometry and has been split into 3 segments (1-3 at right) for geometrically valid 2.5D modelling. A fourth segment, 4 at right, as added at the eastern end of the line to tie the line to the stratigraphic drillhole Ross 1 the Quoin.
- ▶ Line 95AGS-T4 was modelled as a single 2.5D line, but this line trends obliquely to mapped structure (pink traces at right) and stratigraphy, making it difficult to resolve geometry correctly.



A



Both seismic lines contain considerable interpreted thicknesses of Tasmania Basin Paleozoic stratigraphy (Direen, 2025) above the Proterozoic-Palaeozoic basement deformed by the Tabberabberan Orogeny.

The internal stratigraphy of the Permian section of the Tasmania Basin (Lower Parmeener Supergroup) is shown at left from Reid (2004).

The upper Parmeener Supergroup (Triassic) has not been split.



Petrophysics

- ▶ Rock properties assigned to the modelled units largely follow the values found in Leaman (2012), see table at right.
- ▶ Where these values seriously conflicted with the model fit - for example in the case of denser Permian-Carboniferous limestone and tillite units that Leaman did not split out separately, or variants within the Jurassic dolerites, further information was gleaned from other sources such as Leaman (1973), Clarke and Farmer (1983), Rast (2009) and Zengerer (1999).

Table of rock properties

Density is expressed as a contrast with background and reduction density of 2.67 t/m³.

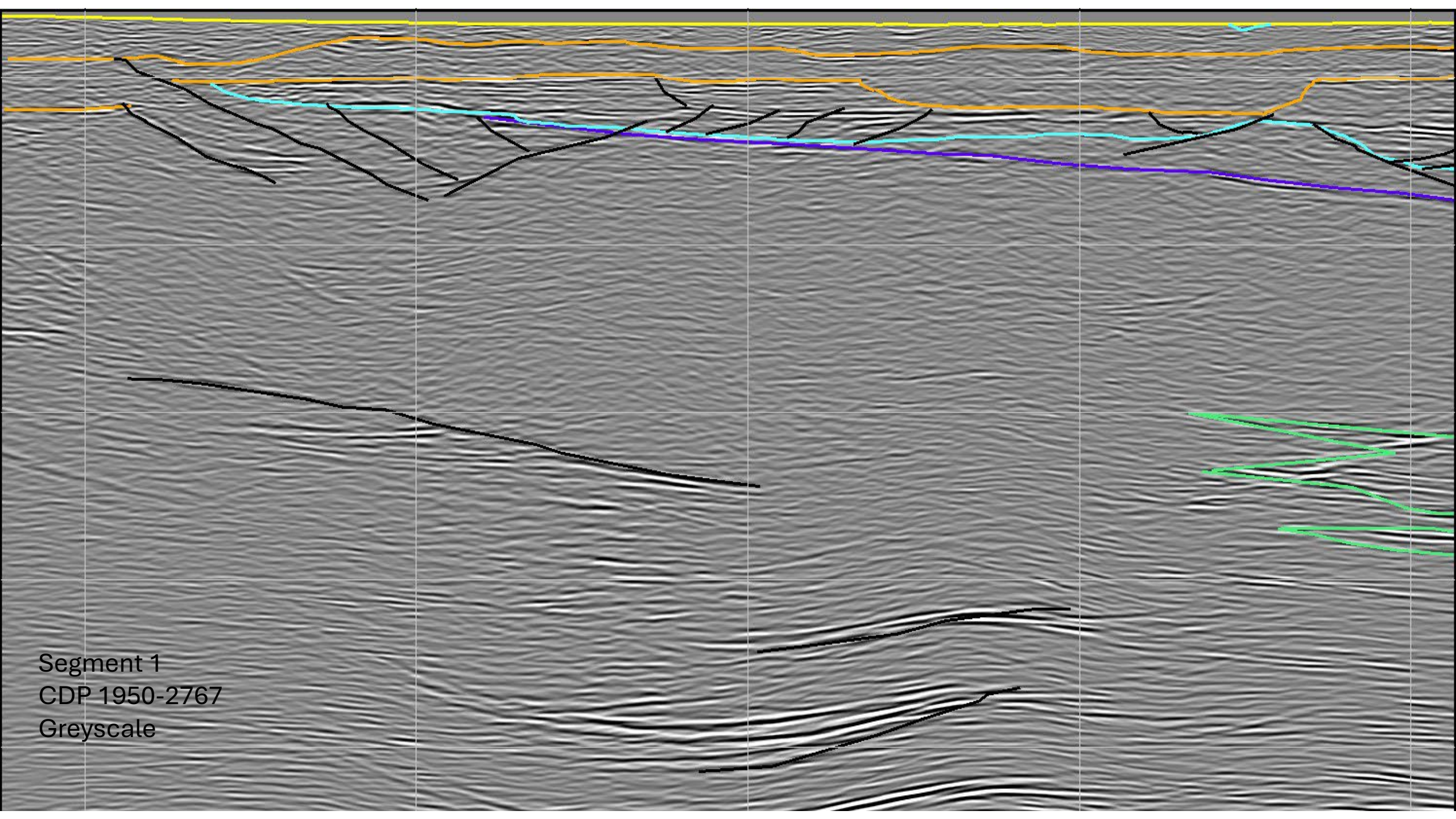
Age and unit	Density g/cc, t/m ³	Susceptibility cgs	Susceptibility SI
Quaternary	-1.2	0	
Tertiary			
Sediments	-0.7	0	
Basalt	0.23	>0.001	>0.01
Jurassic dolerite	0.23	>0.004	>0.05
Triassic	-0.22	0	
Permian	-0.13	0	
Devonian			
Granite	-0.05–0.07	0	
Granodiorite	0.03	~0.0002	~0.0025
St Marys porphyrite	-0.02–0.03	0	
Siluro-Devonian			
Western Tasmania	-0.1	0	
Mathinna Supergroup	-0.07–+0.1 (0.07–0.09)	0–0.0005	<0.006
Ordovician			
Gordon Group	0.07	0	
Denison Group	-0.07	0	
Cambrian			
Tyndall/Yolande groups	0.05–0.07	0.0002	0.0025
Dundas Group style	0.05–0.07	<0.0002	<0.0025
Sundry variations	var	var	
Andesites	0.1–0.15	>0.0002	>0.0025
Central volcanics	0.06–0.08	~0.0002	~0.0025
Porphyry	-0.03<0.05	<0.0002	<0.0025
Granite	-0.05/0.02	>0.0005	>0.006
Ultramafic rocks	var	>0.01	>0.12
Que style basalts	0.1–0.2	>0.0003	>0.0035
(note many Cambrian units exhibit variations in properties locally when altered)			
Precambrian/Eocambrian			
Crimson Creek Formation	>0.1	>0.001	>0.01
Success Creek Formation	>0.07		0
Lineament rocks (variants occur)	>0.1	>0.0002	>0.0025
Oonah/Burnie Formation	0.08	<0.0005	<0.006
Forth Complex	0.1	0	var
Tyennan/Badger/Rocky Cape	0	0	



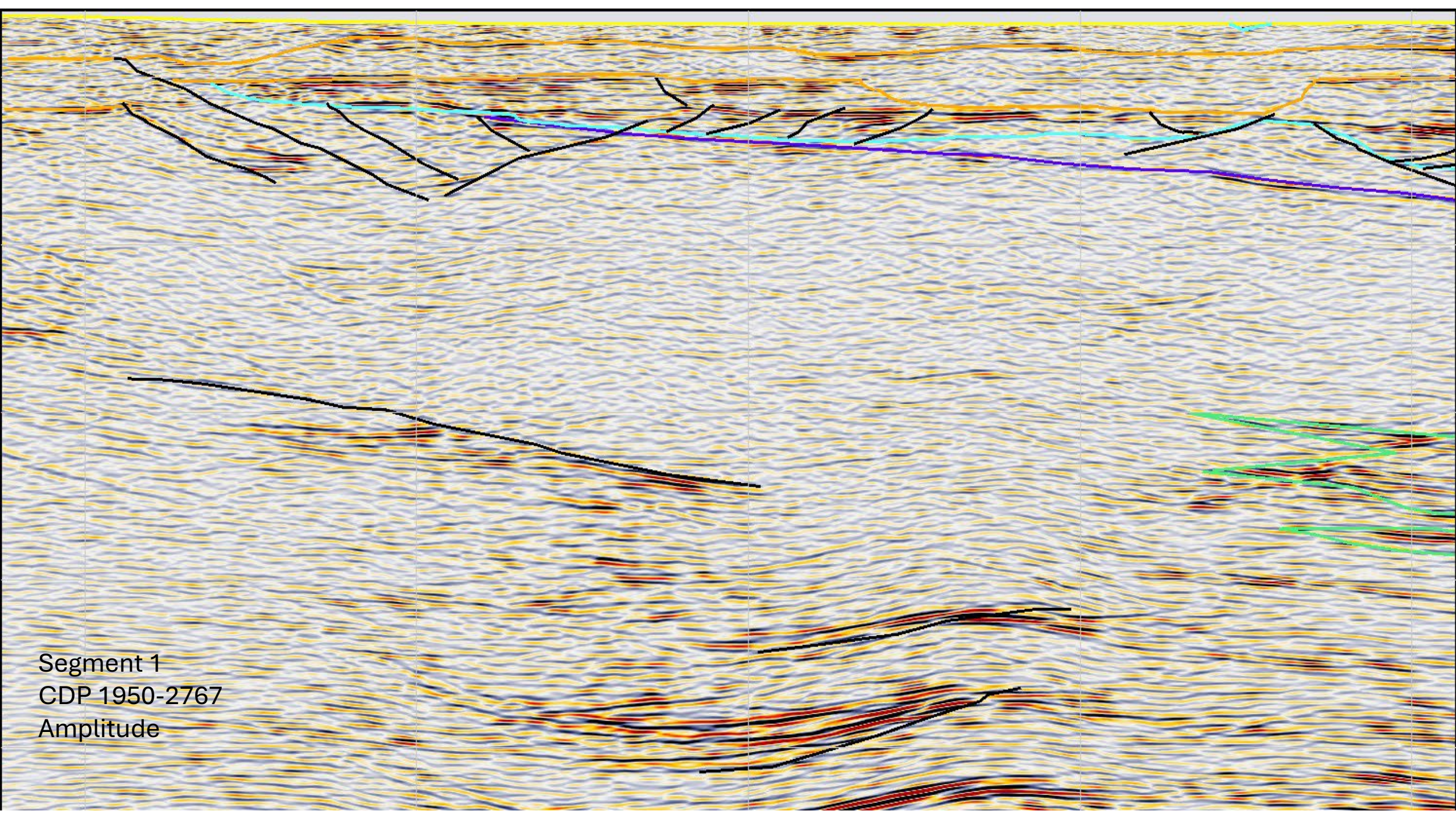
Segment 1 Geology



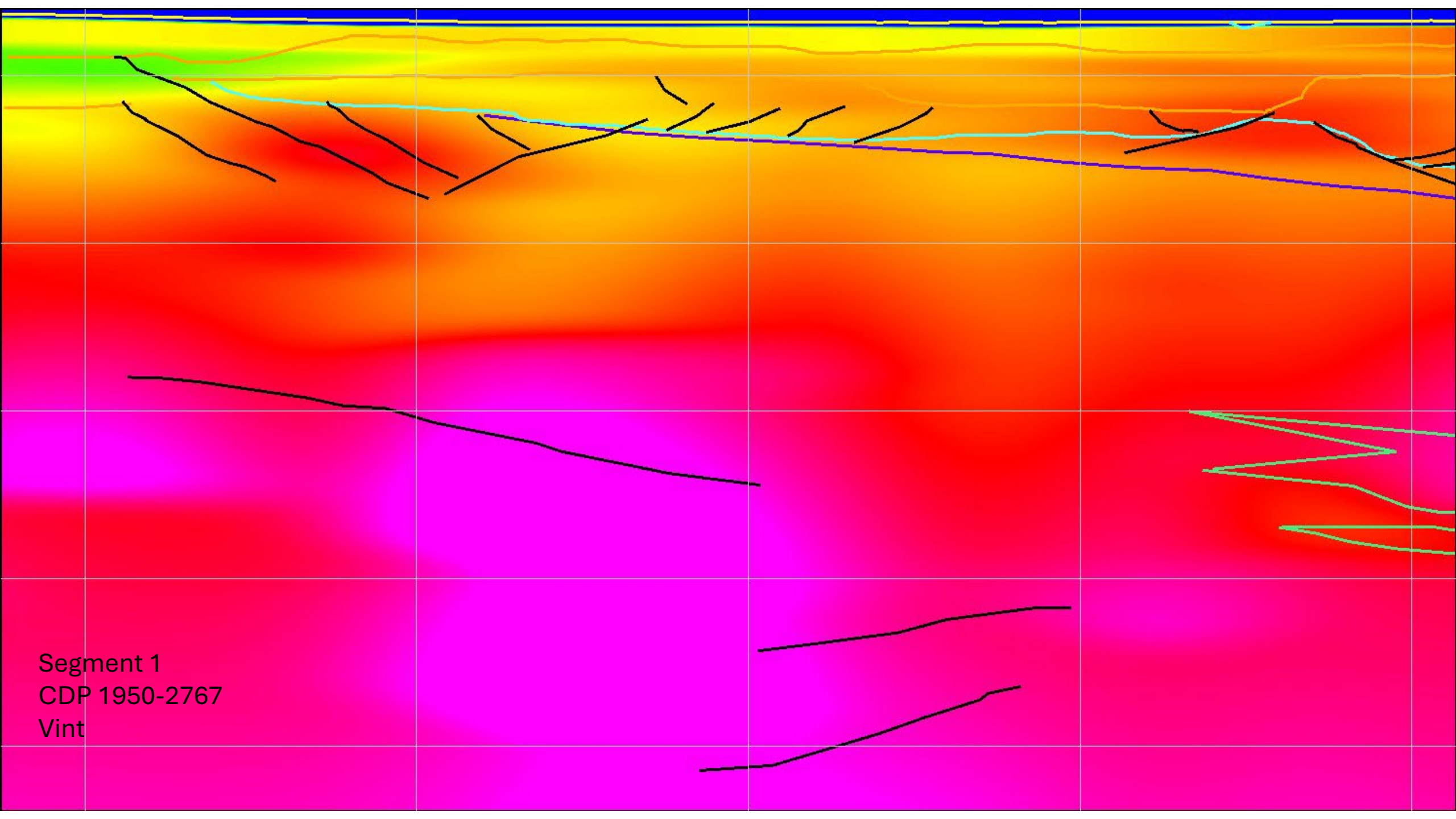
- ▶ Most exposure is a ~flat sheet of Jurassic dolerite
- ▶ Underlain by Permian glaciomarine sequence (circled)
- ▶ Thin, discontinuous veneer of Qa, Qh - unconsolidated alluvial & lacustrine deposits
- ▶ Minor Tertiary basalt centres (Tb)



Segment 1
CDP 1950-2767
Greyscale



Segment 1
CDP 1950-2767
Amplitude

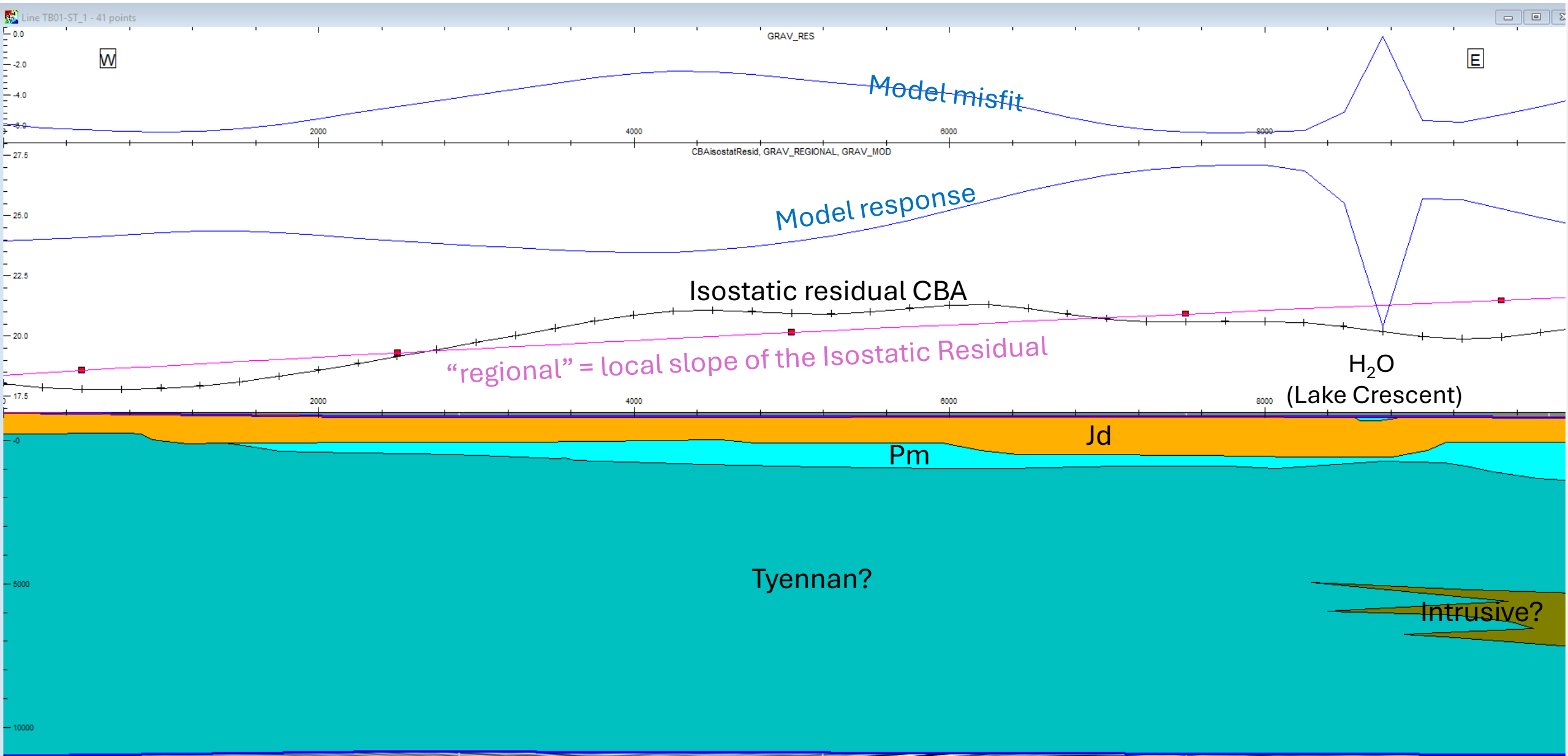


Segment 1
CDP 1950-2767
Vint

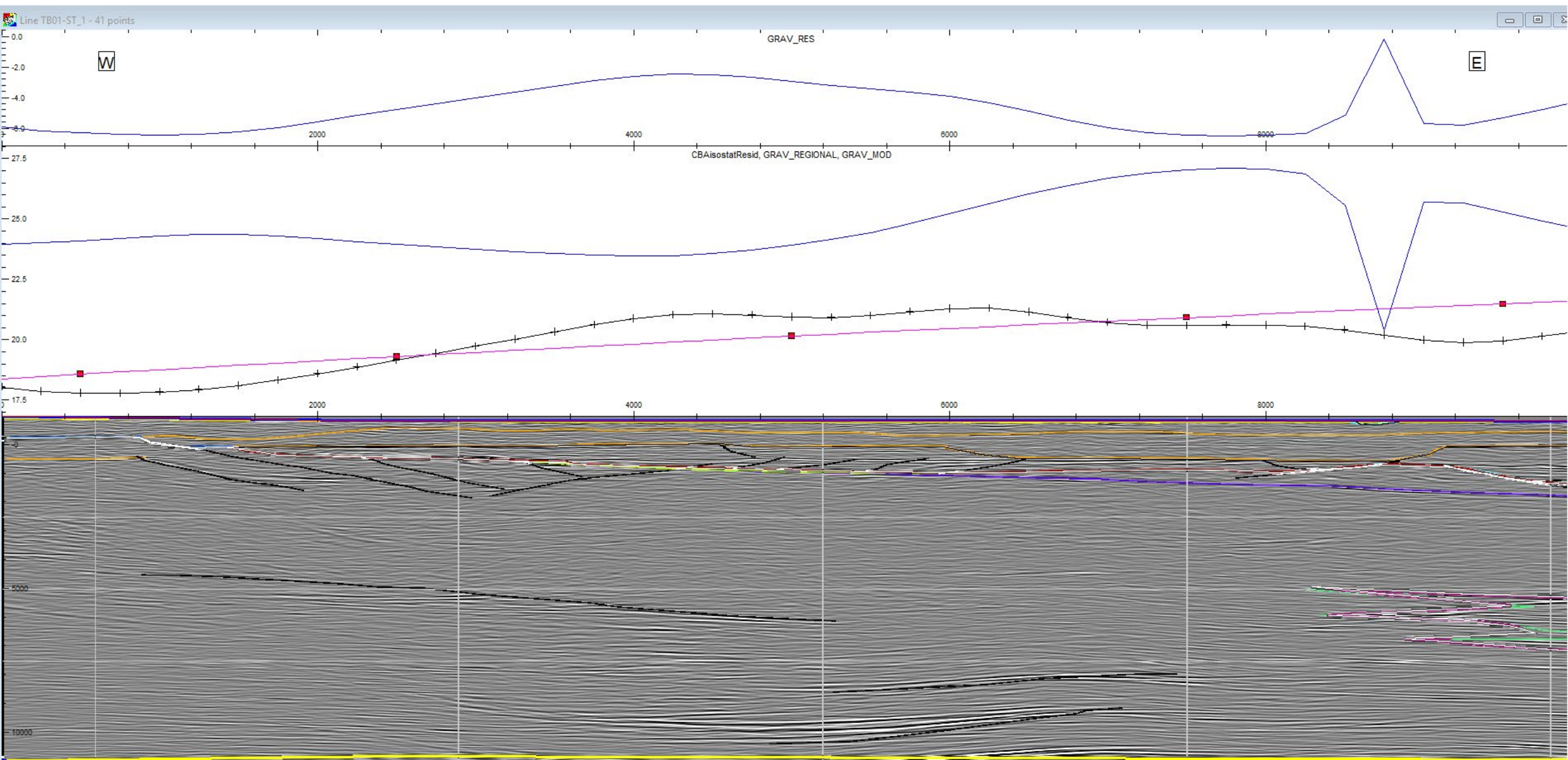
Lemont Gravity modelling

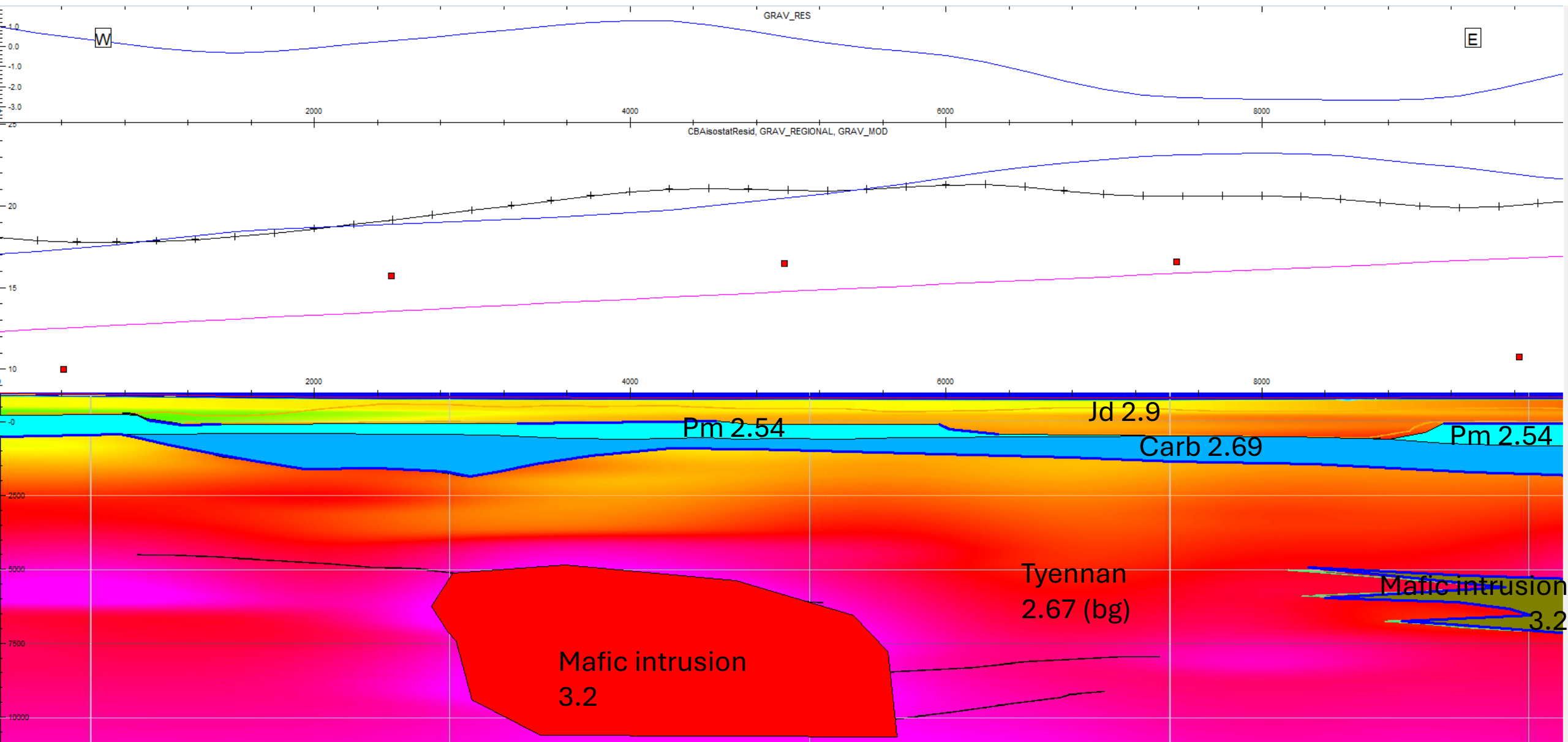
Seismic interp

TB-ST1 Segment 1 – Initial Model

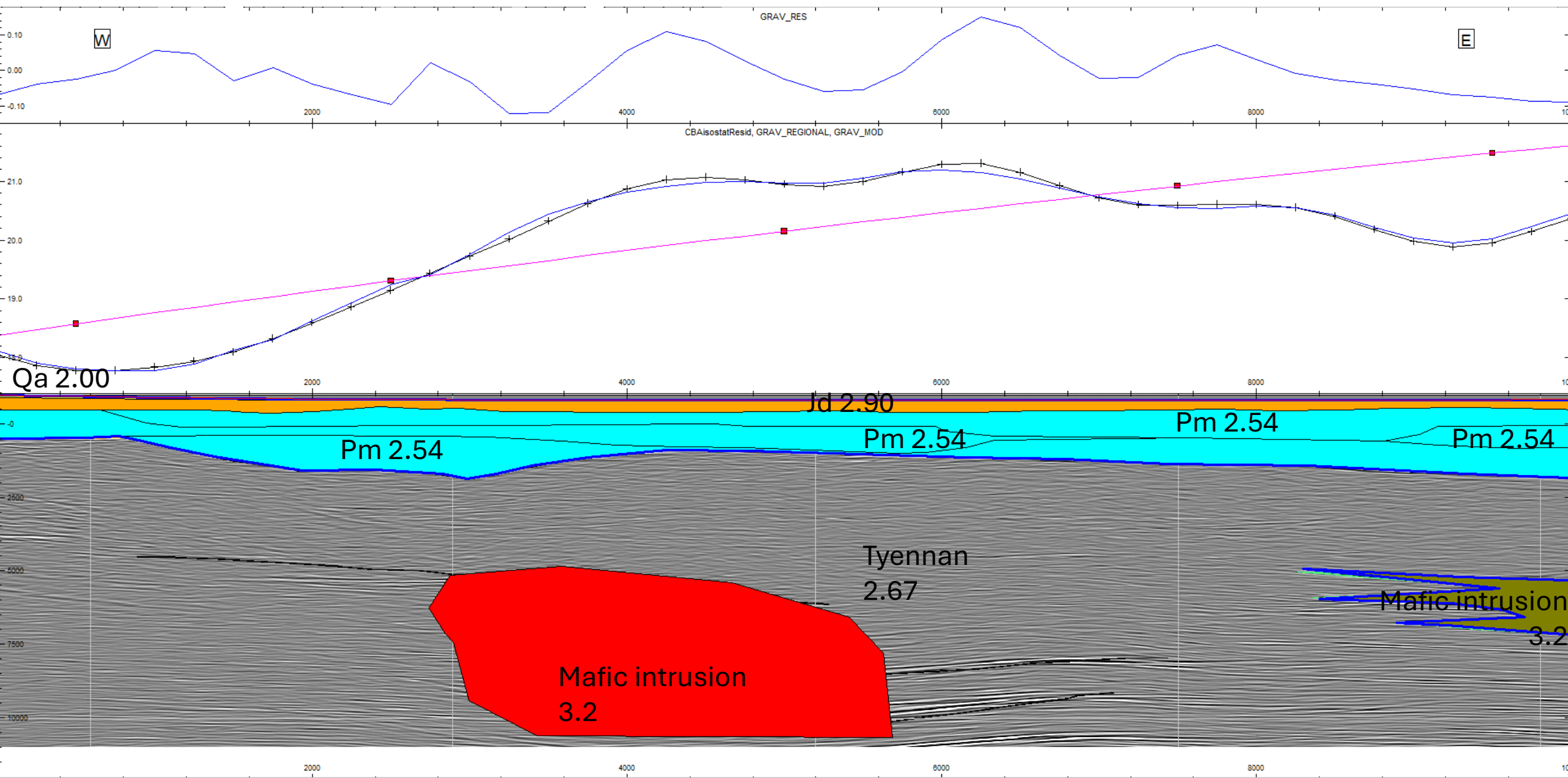


Lemont Gravity modelling
Seismic interp
TB-ST1 Segment 1

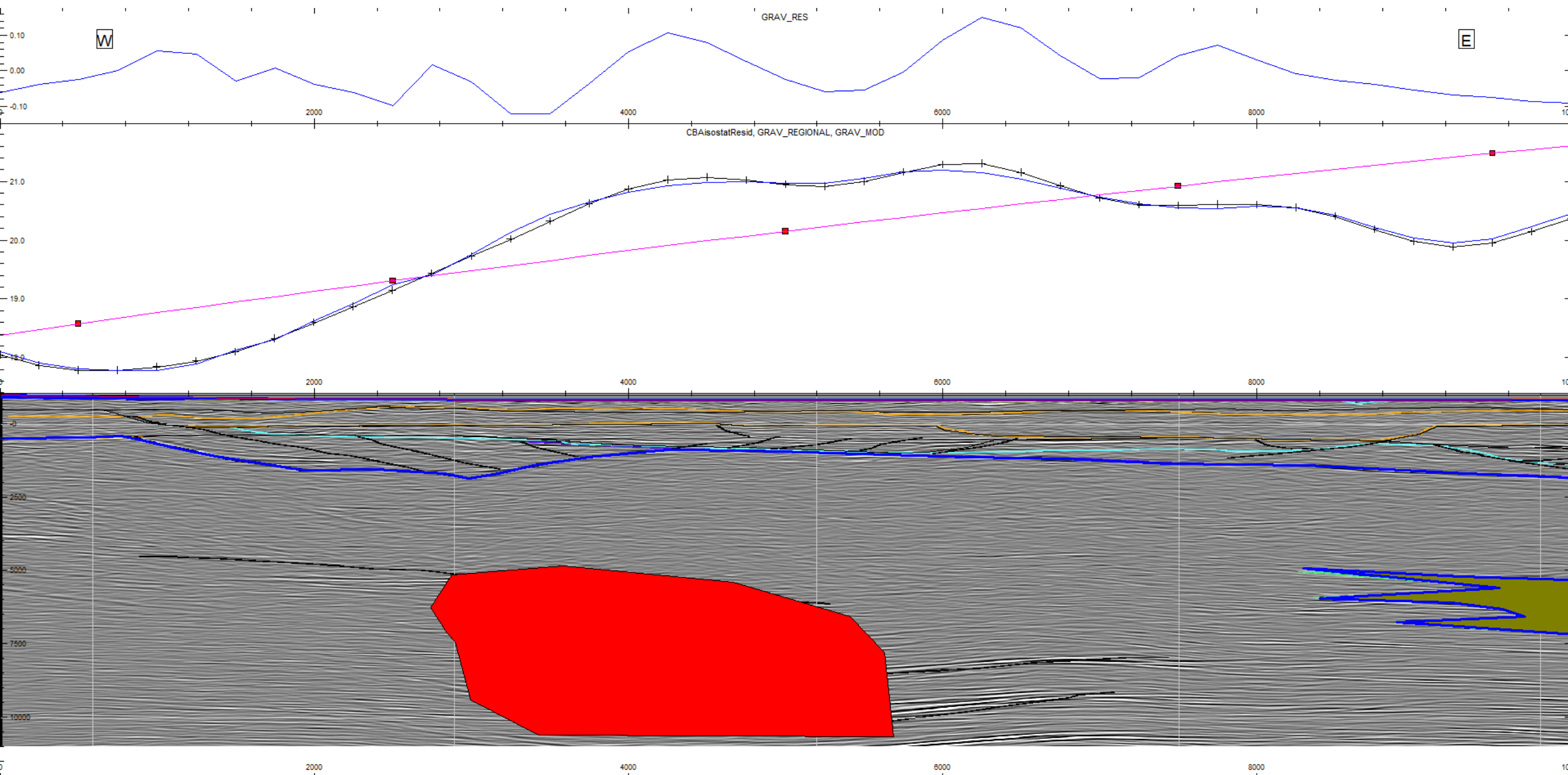




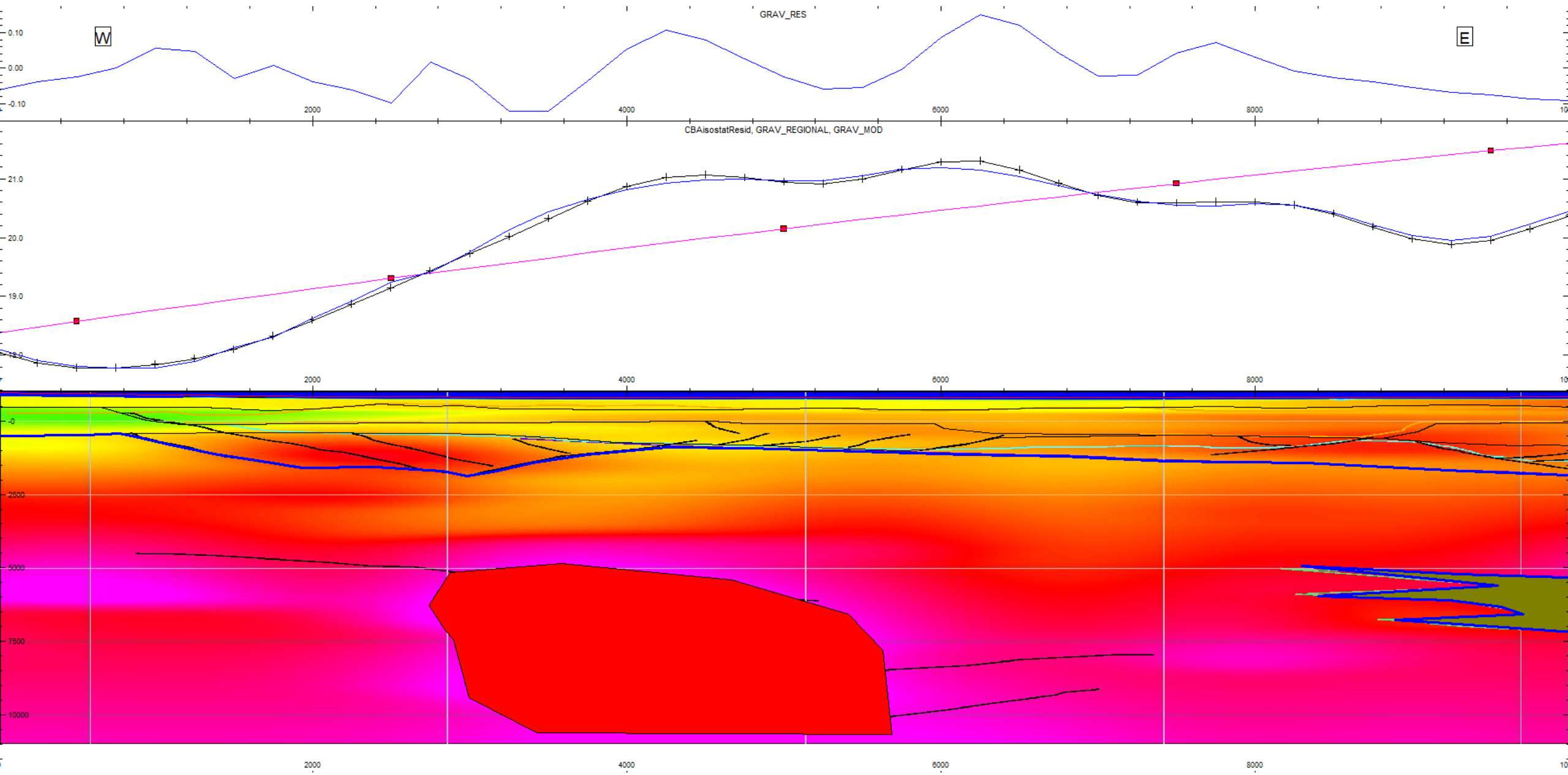
Segment 1 vb



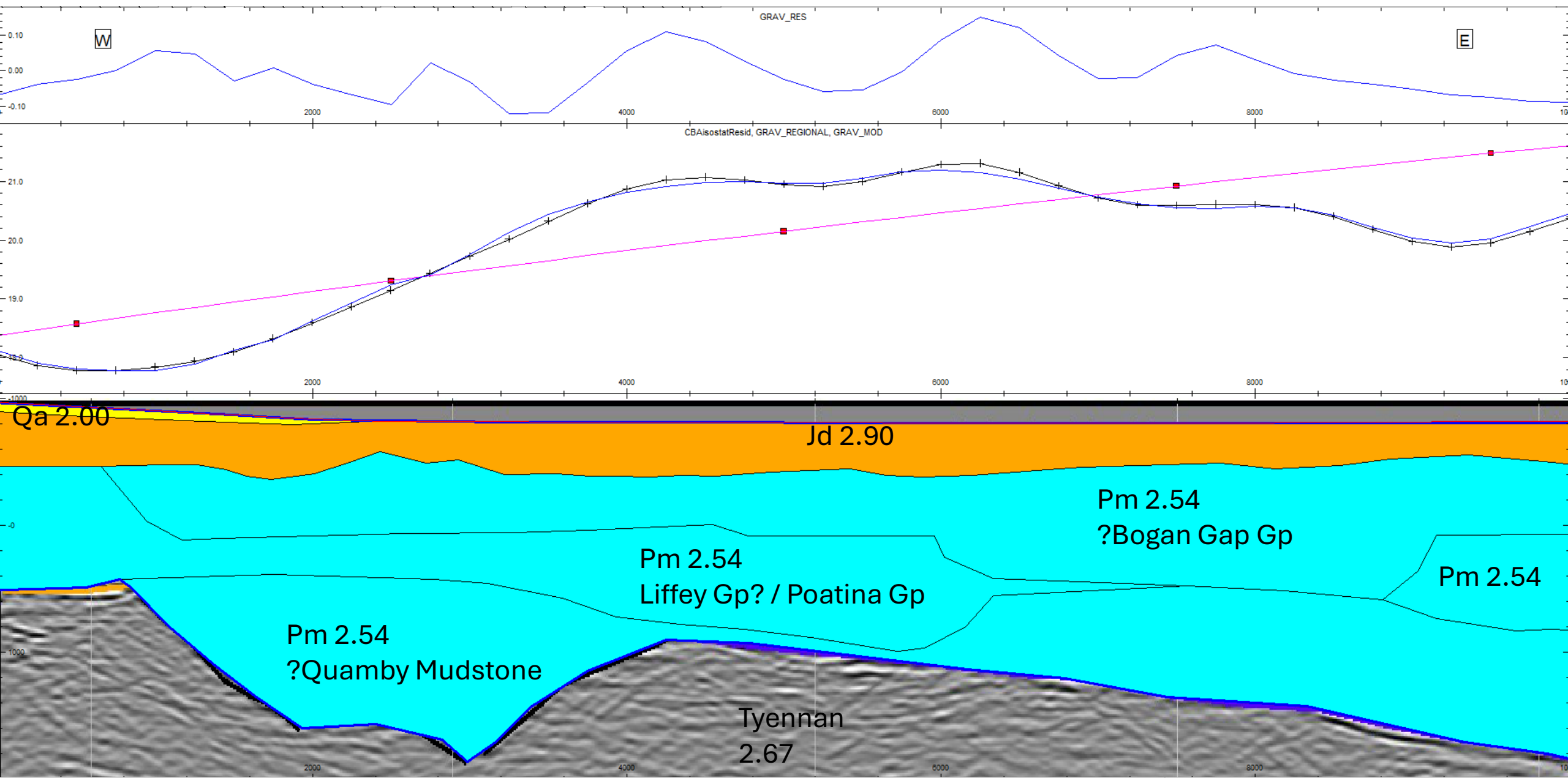
Segment 1 v "d" "final" model



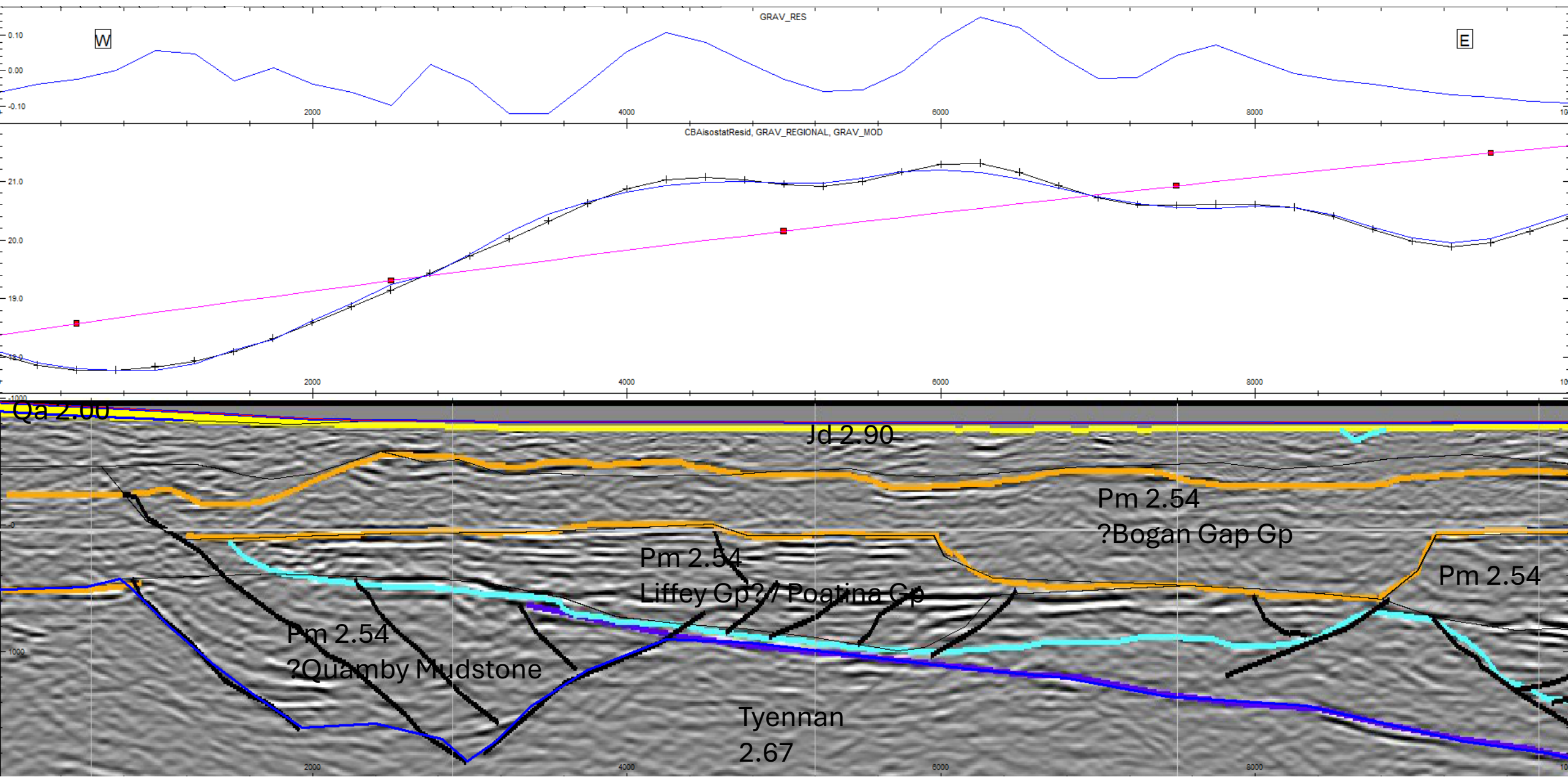
Segment 1 Seismic greyscale v. "d"



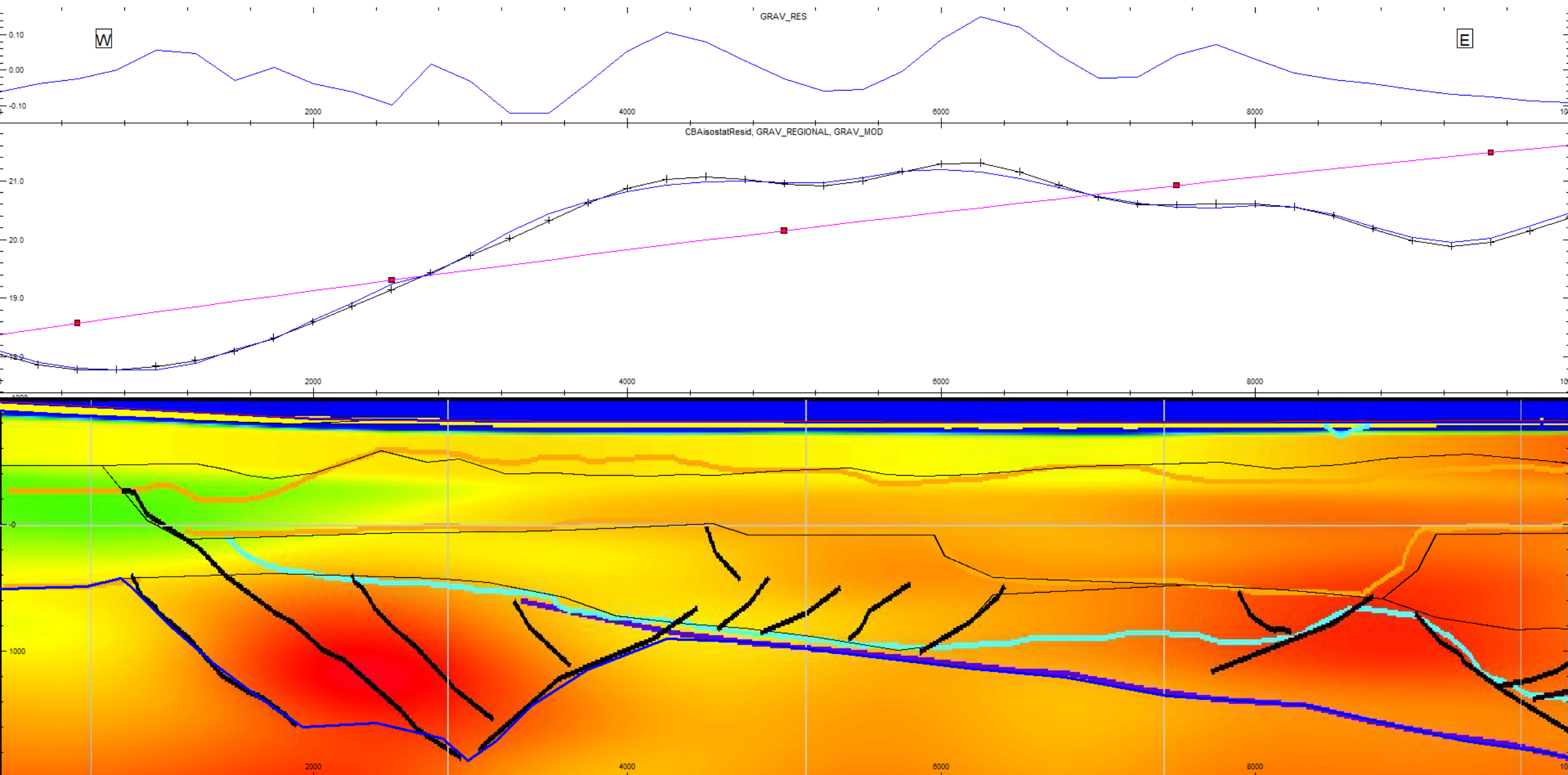
Segment 1 v. "d" Seismic Vint



Segment 1 v. "d" "final", top 3000m



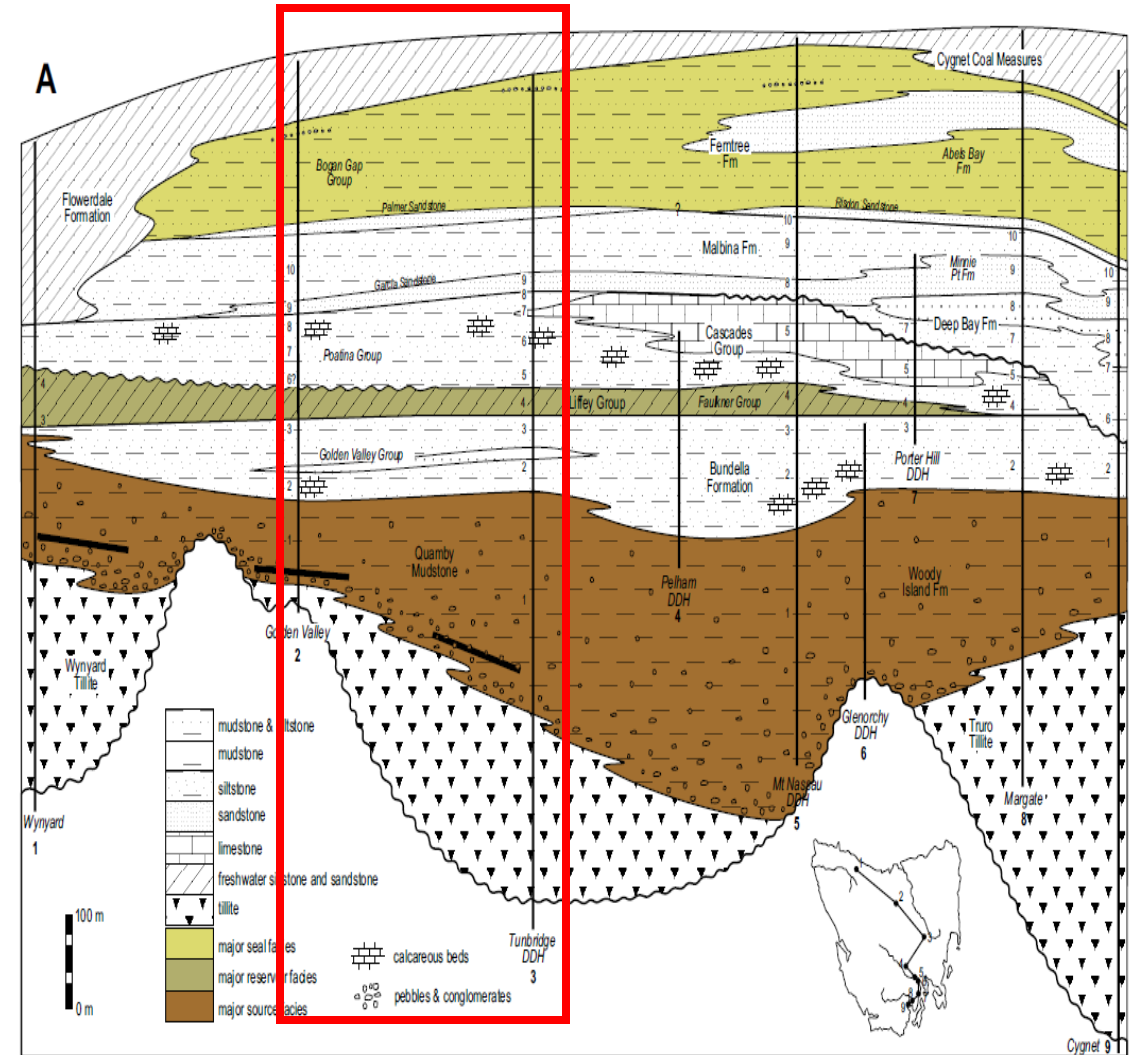
Segment 1 v. "d" Seismic greyscale, top 3000m



Segment 1 v. "d" Seismic Vint, top 3000m

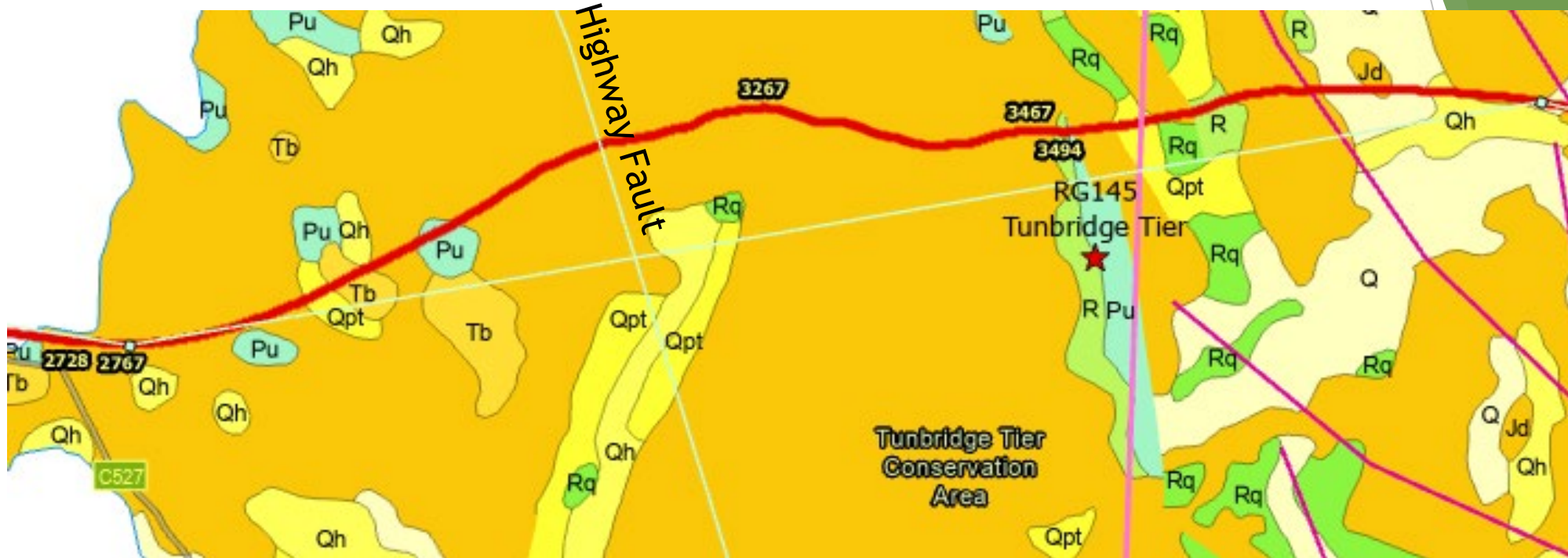
Segment 1 Commentary:

- After the Qa/Jd contact near Lake Sorell ($\Delta\rho$ 0.9 g/cc), the shape of the isostatic residual Bouguer anomaly is most sensitive to the lower contact of the Jd on the Parmeener SGp (Bogan Gap Gp?) ($\Delta\rho$ 0.46)
- This pick differs from the original lower Jd surface picked from the seismic which was a bright transgressive reflector. As such, the presence of a double thickness of Jurassic dolerite sheets is not supported by the gravity.
- Instead, this reflector probably represents an internal Tasmania Basin contact between Bogan Gap Gp (mudstones) with underlying carbonate rich Poatina Gp.
- The dense Wynyard Tillite / Stockers Tillite is absent or thin in this section, with the lower unreflective low density Permian unit (Quamby Mudstone?) resting directly on interpreted Tyennan basement.
- The Permian section is therefore up to 2km thick on this part of the line, with what appears to be a Pm rift depocenter in the west.
- No low density Triassic section is required in this section of the line to match the gravity.

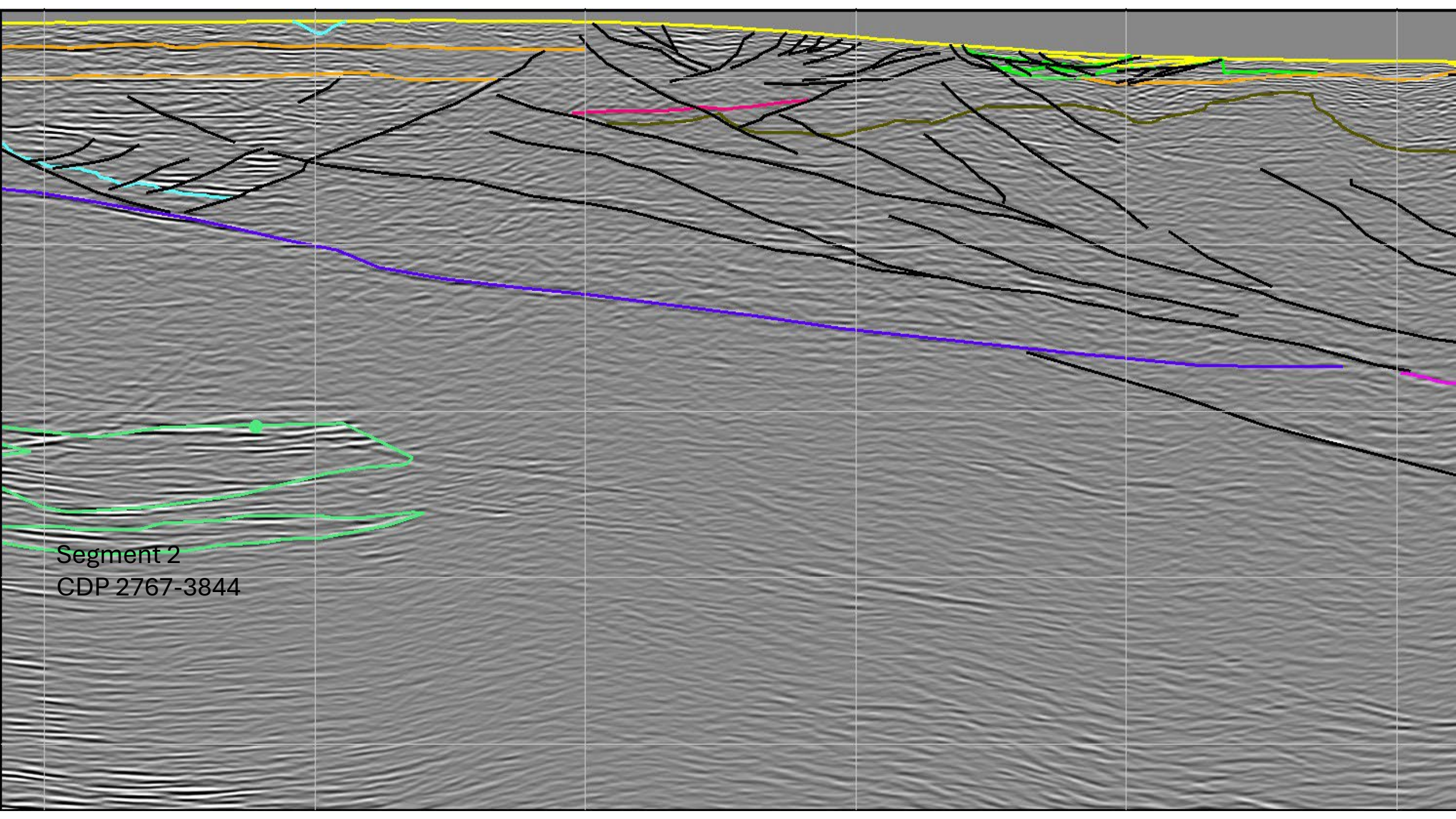




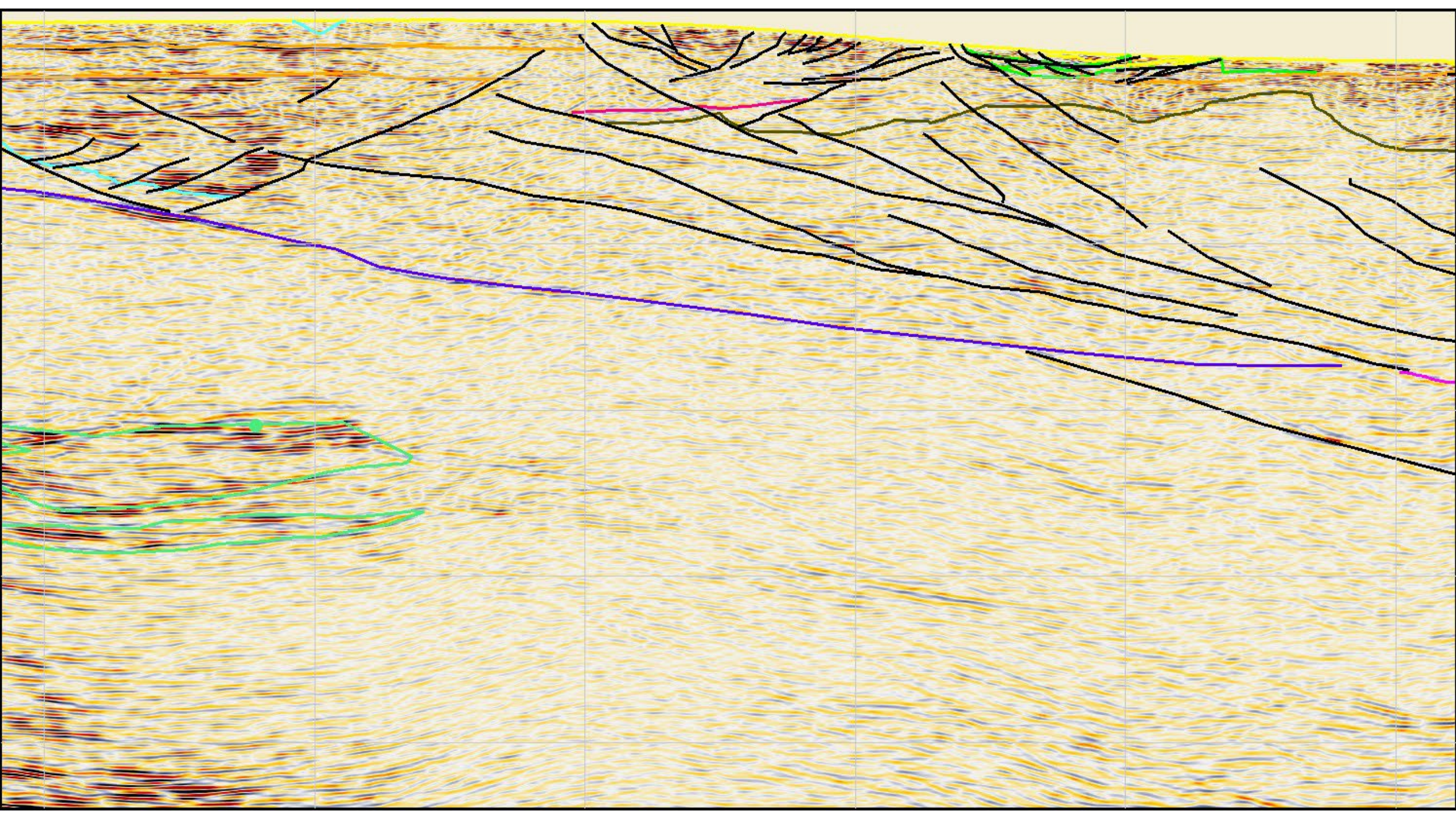
Segment 2 Geology

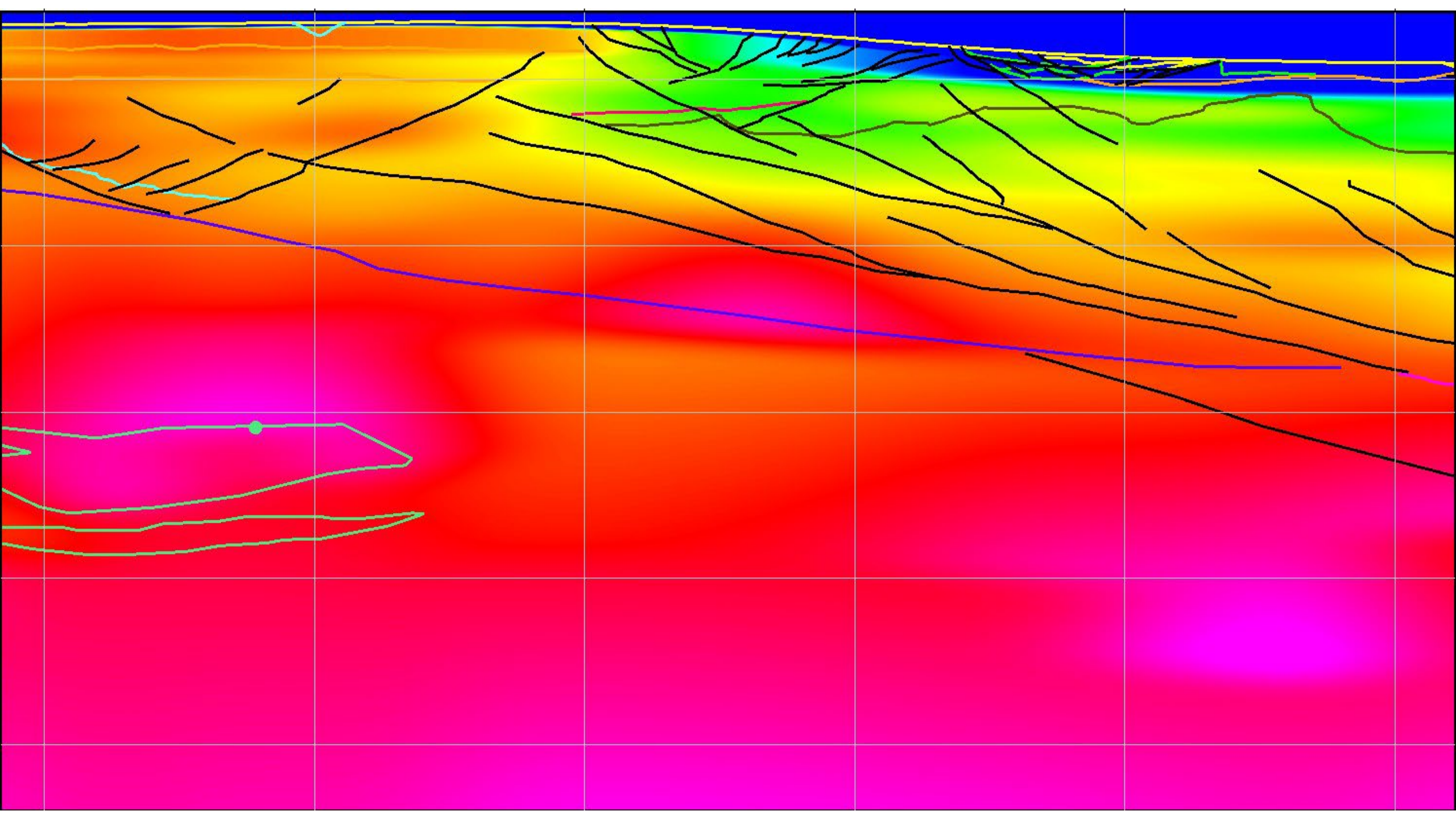


- ▶ Most exposure is a ~flat sheet of Jurassic dolerite, faulted near the Tiers
- ▶ Underlain by Permian glaciomarine sequence, and Triassic (R) near Tunbridge Tier
- ▶ Thin, discontinuous veneer of Qa, Qh - unconsolidated alluvial & lacustrine deposits, and Qpt (Talus)
- ▶ Tertiary basalt centres (Tb)
- ▶ Significant faulting in eastern quarter of line segment



Segment 2
CDP 2767-3844

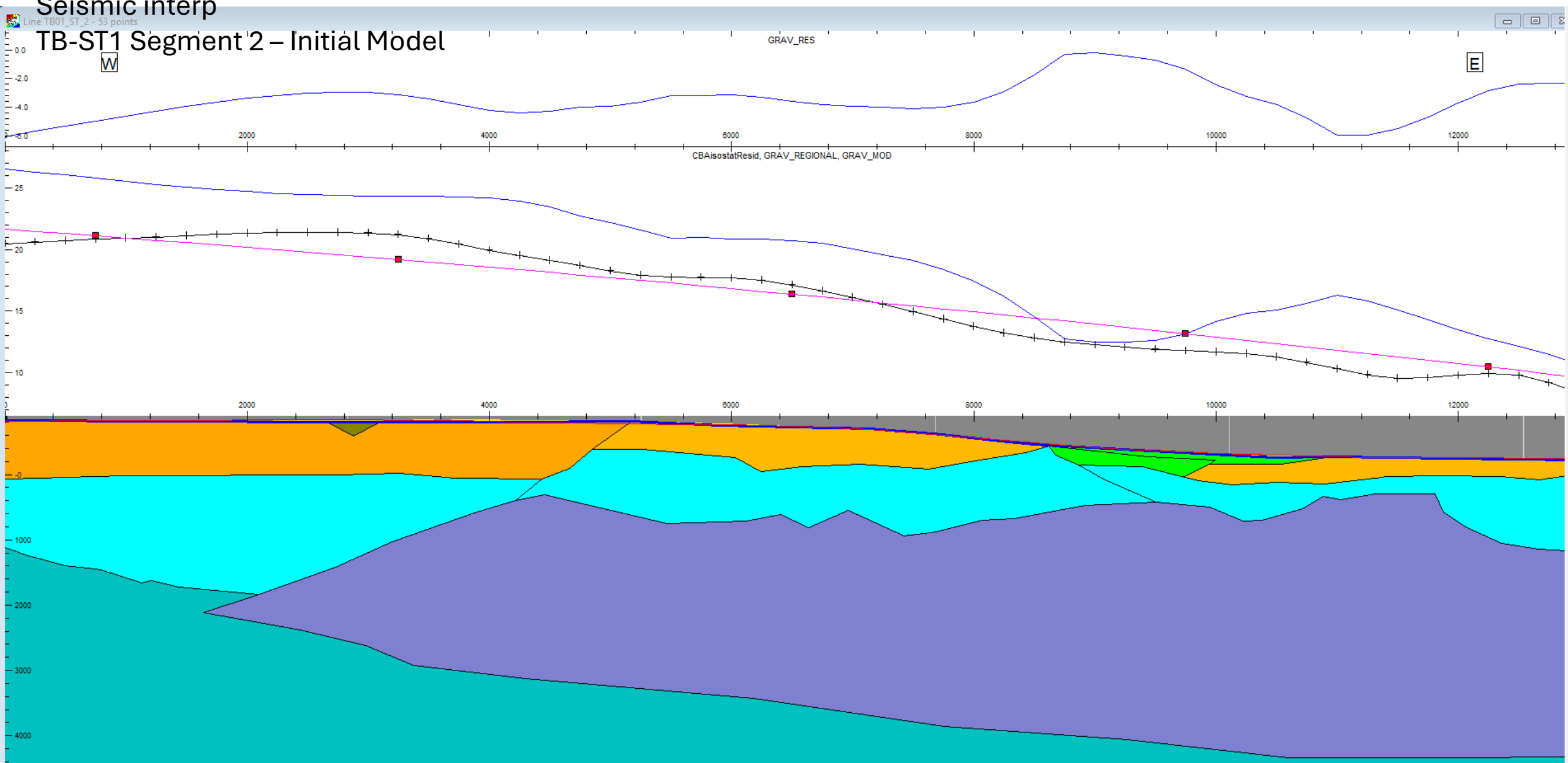


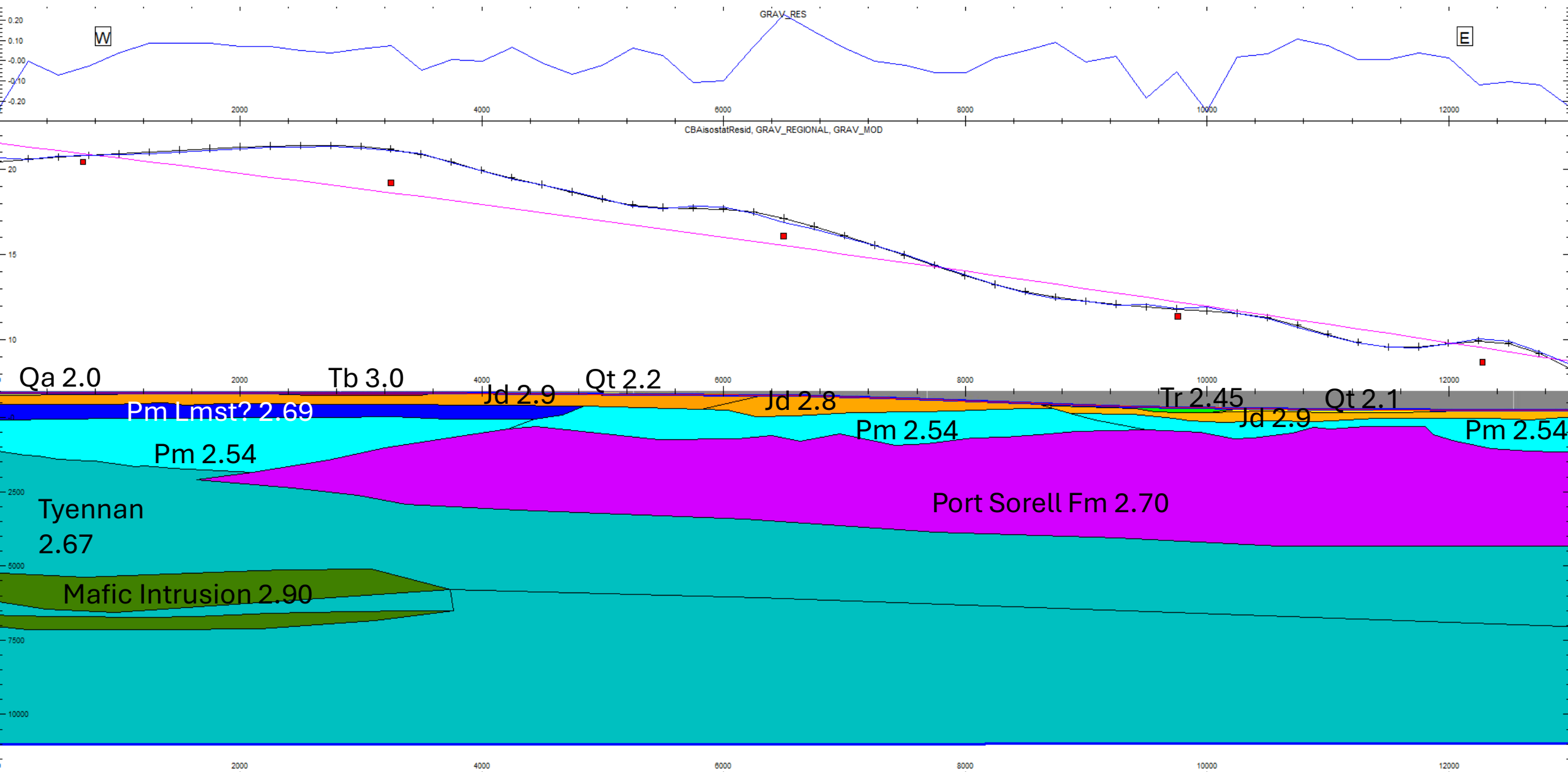


Lemont Gravity modelling

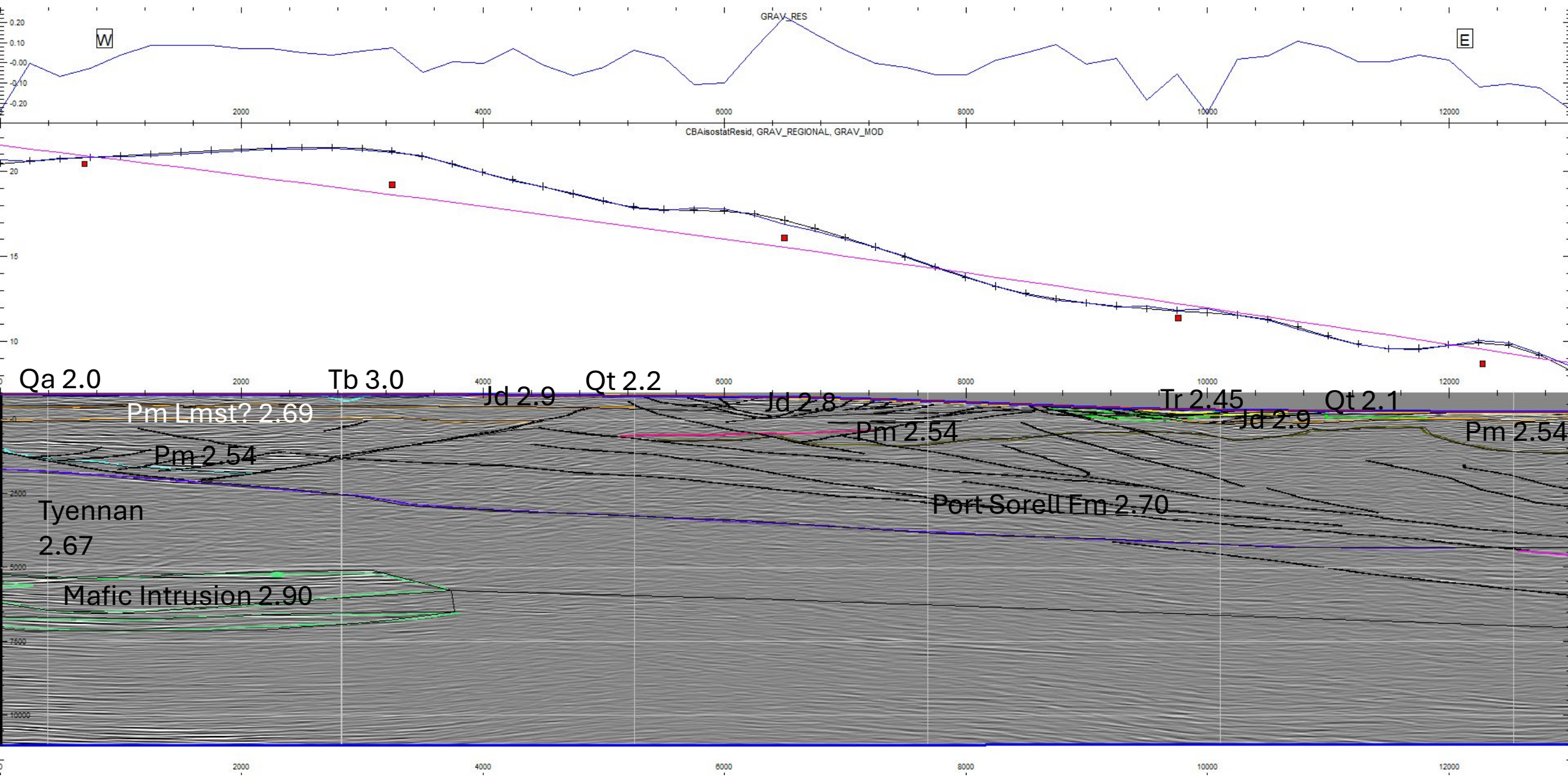
Seismic interp

TB-ST1 Segment 2 – Initial Model

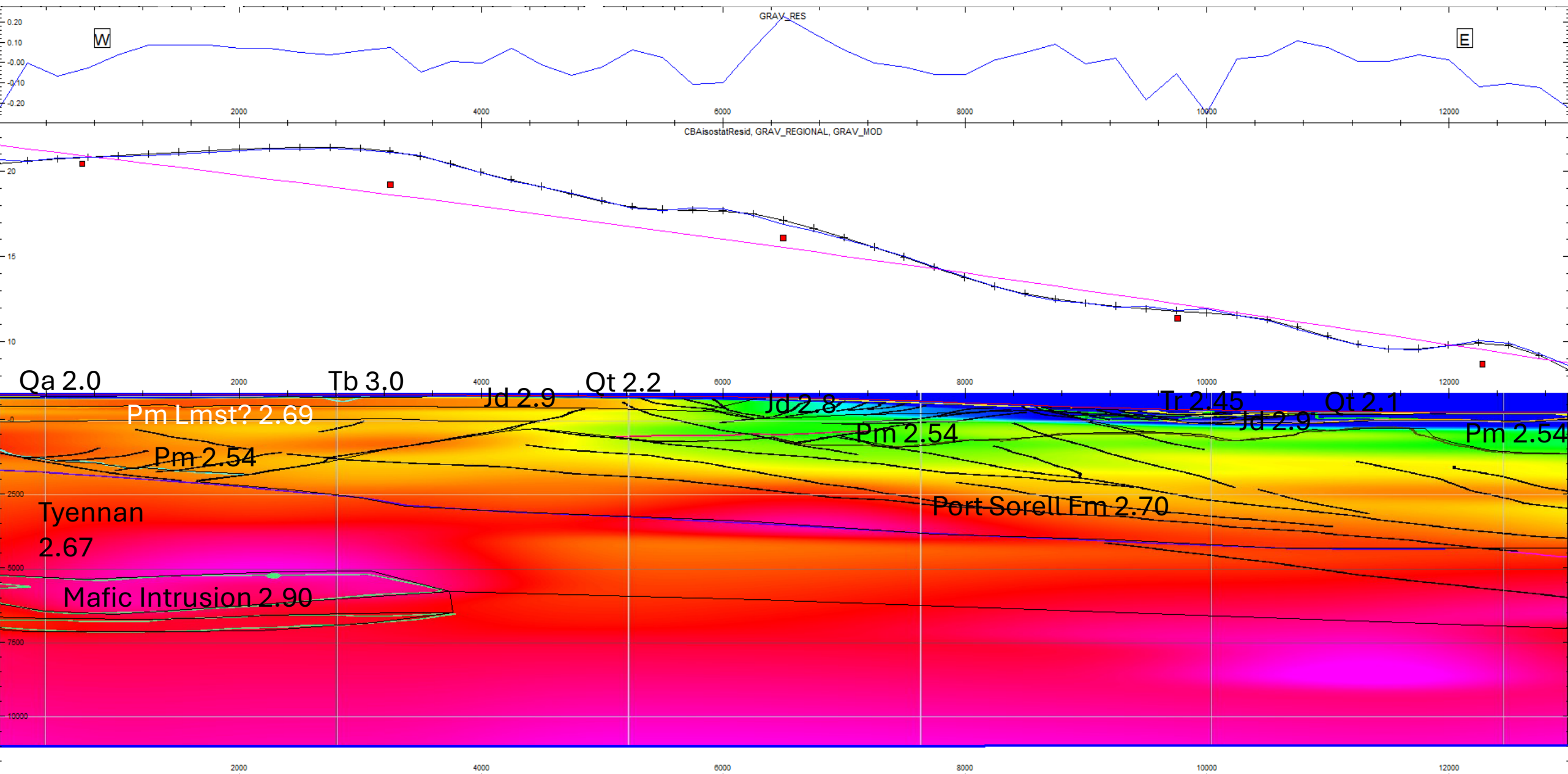




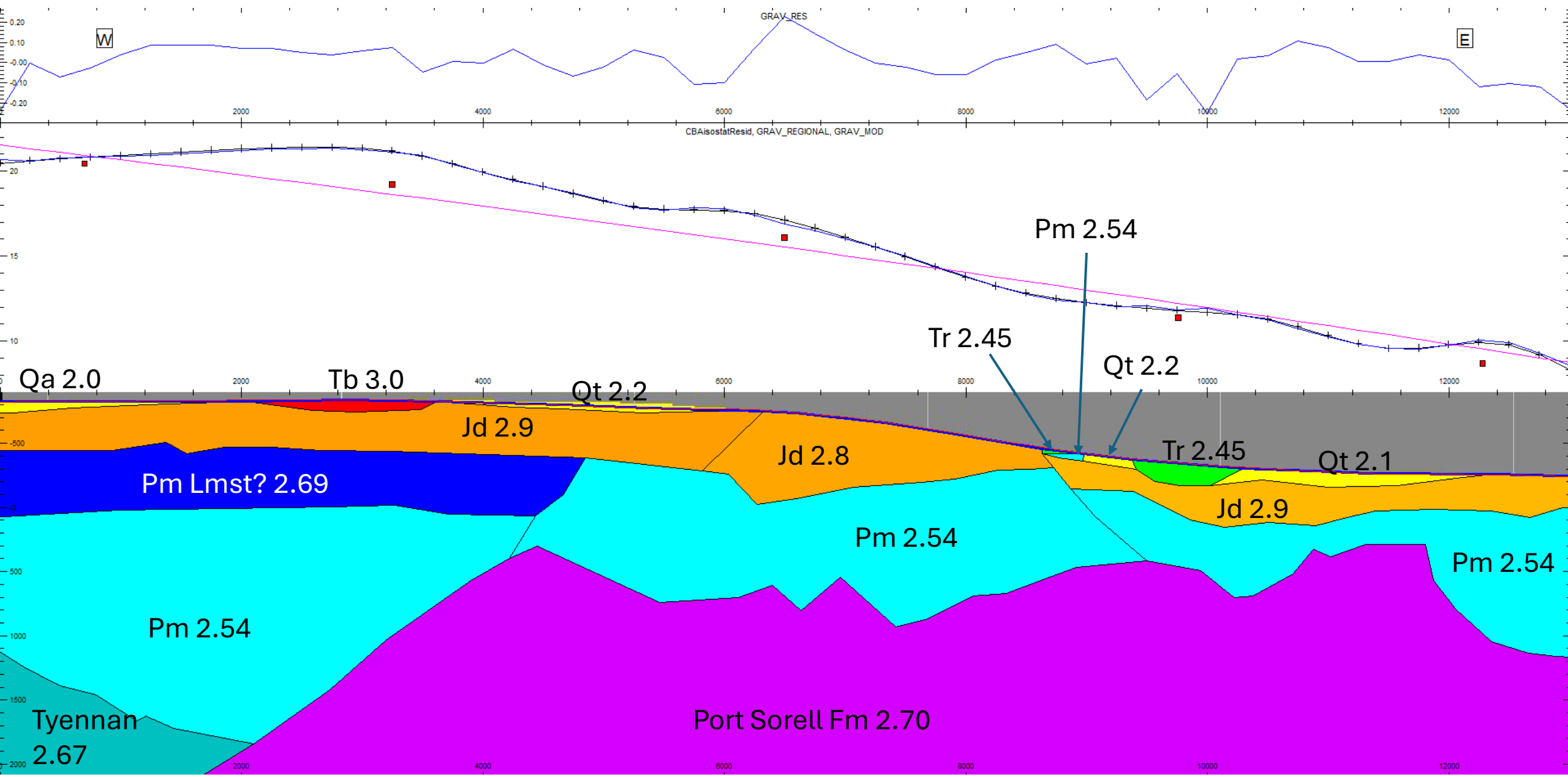
Segment 2 v4 "final"



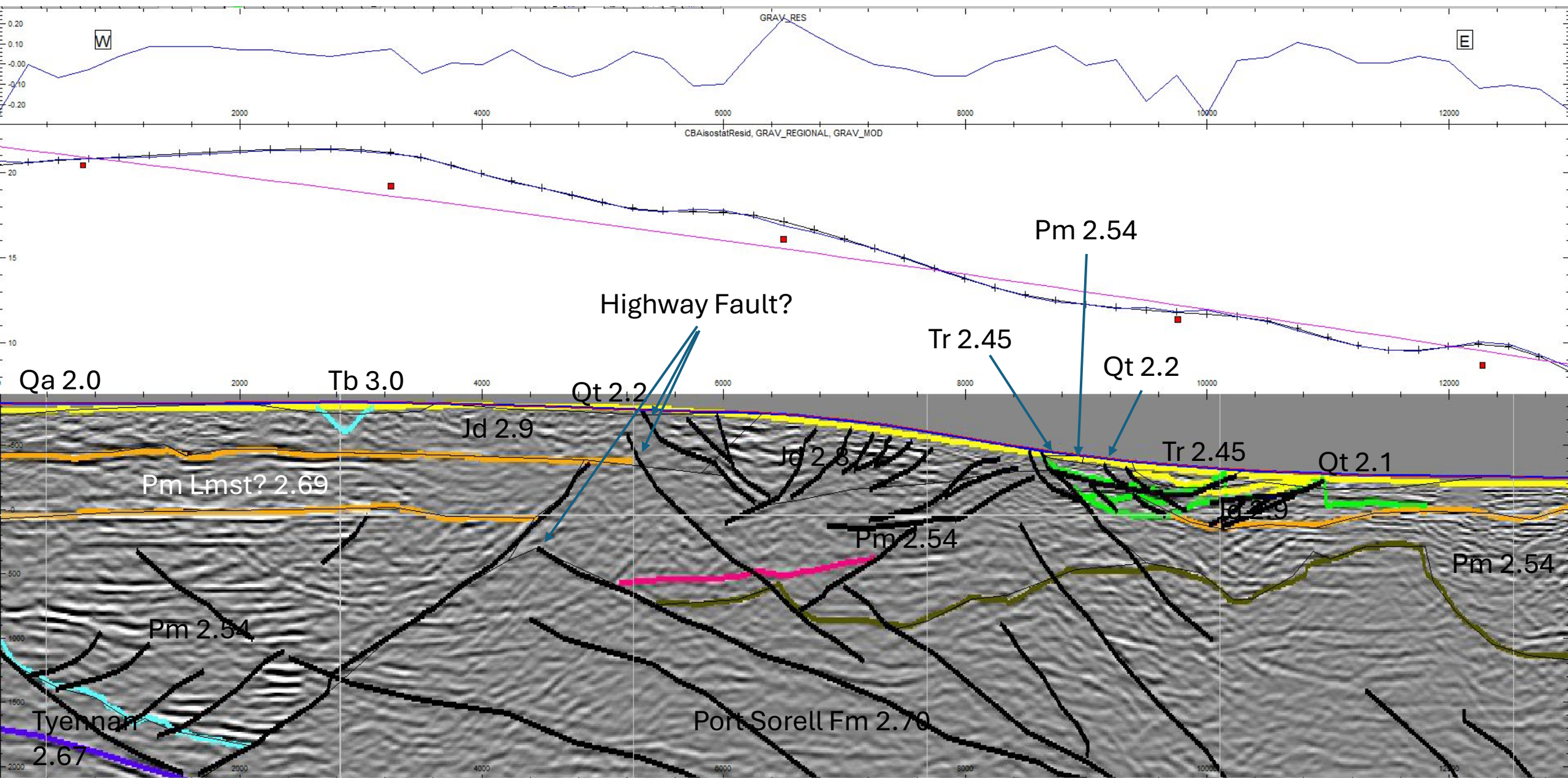
Segment 2 v4 "final", greyscale seismic



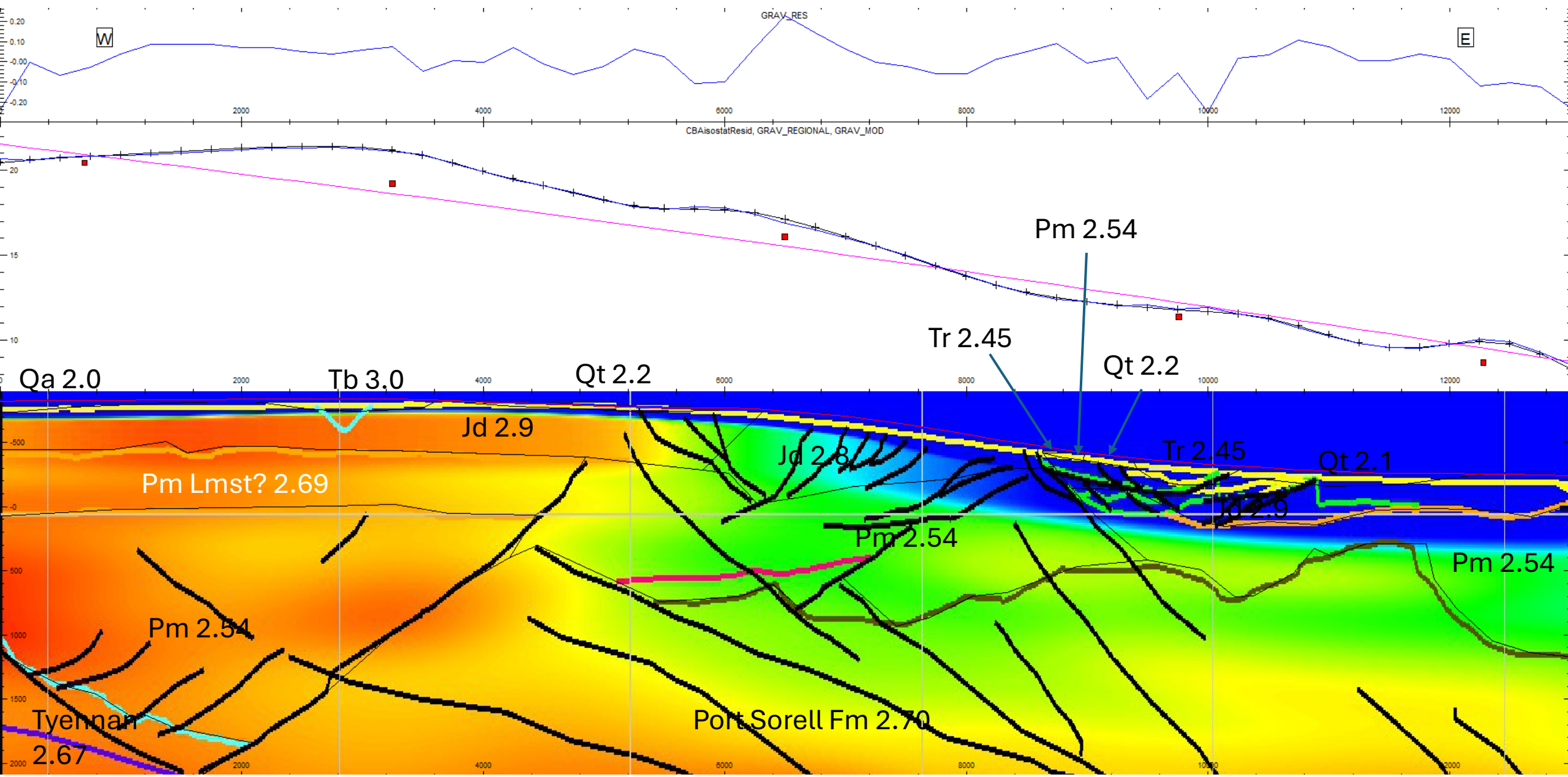
Segment 2 v4 “final” seismic Vint



Segment 2 v4 "final", top 3000m



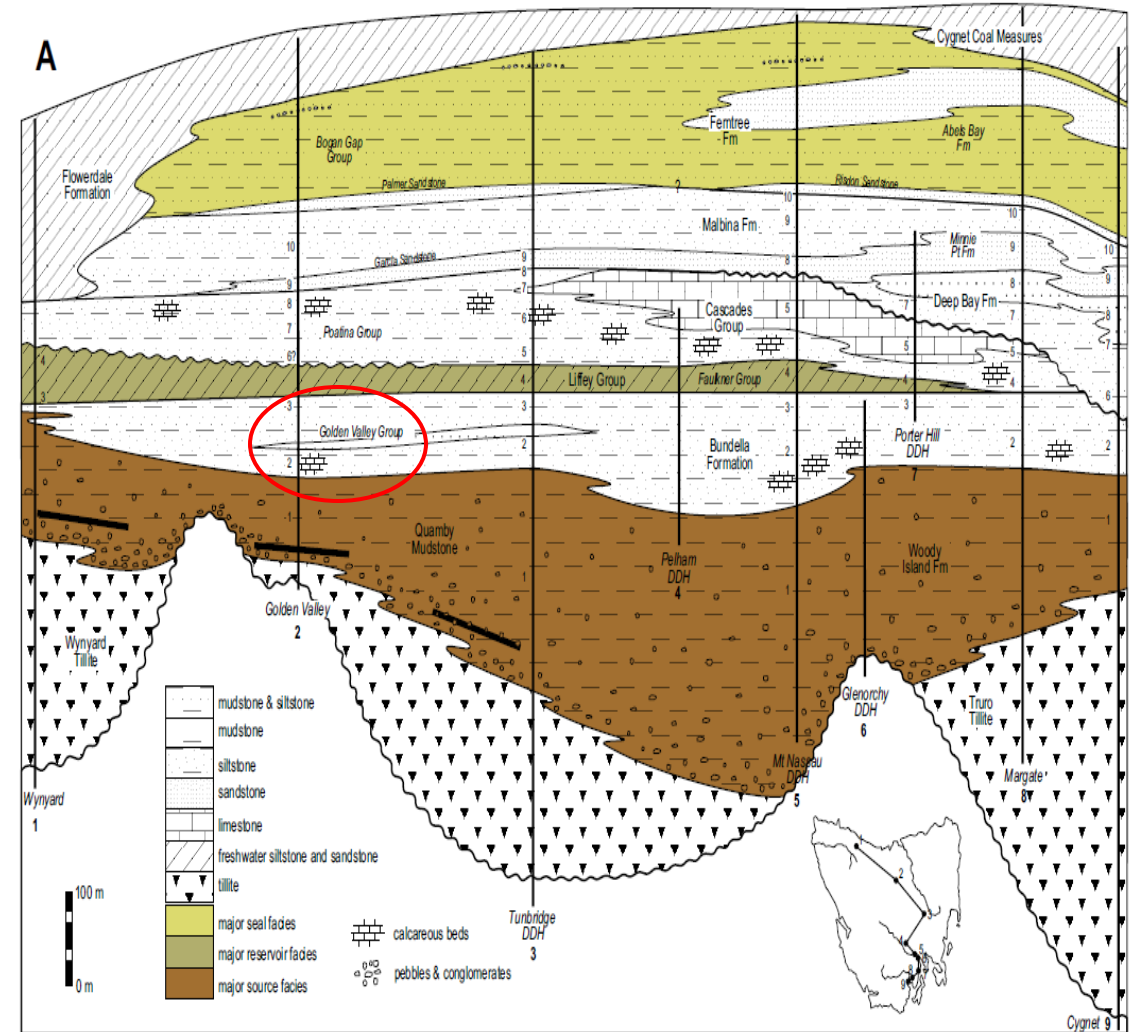
Segment 2 v4 "final", top 3000m, greyscale seismic



Segment 2 v4 "final", top 3000m, Vint seismic

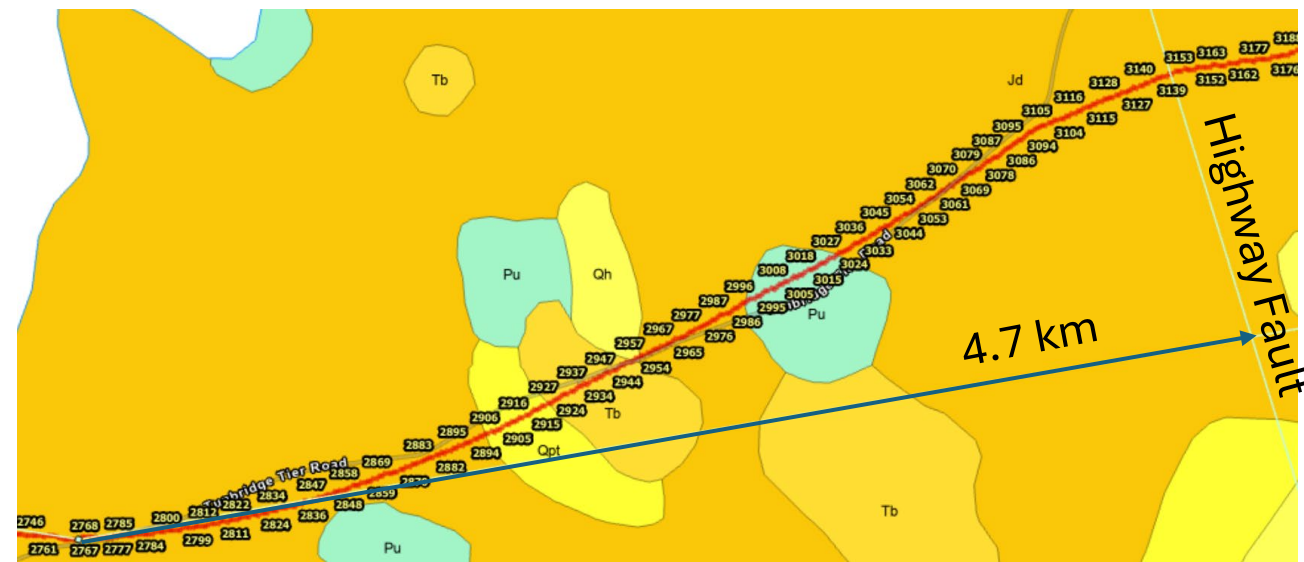
Segment 2 Commentary:

- Significant Tertiary basalt volcanic centre 2-3.6 km along line associated with surface outcrops.
- Veneers of Qa / Qt have enough depth to affect gravity signal
- Fault complex around Tiers escarpment has extensional geometries for Tr and Pm detached blocks.
- Jd under Tiers slightly lower density – more faulted / fractured / weathered?
- Three significant deep fault-controlled graben filled with Pm sedimentary rocks below Jd.
- Western most graben requires a denser layer at top: wrong geometry (tabular) for Carboniferous tillite (rift fill); likely to be Pm limestone of the carbonate rich Golden Valley Group (Clarke, 1968) (circled on diagram).
- This western graben marks an extensionally reactivated major basement contact between Tyennan lower density basement (to the west) and higher density Port Sorell Fm (to the east).
- The “Highway Fault” is mapped by MRT at a position 4.69km from the western end of this segment. No fault is observed at surface in the seismic at this position,

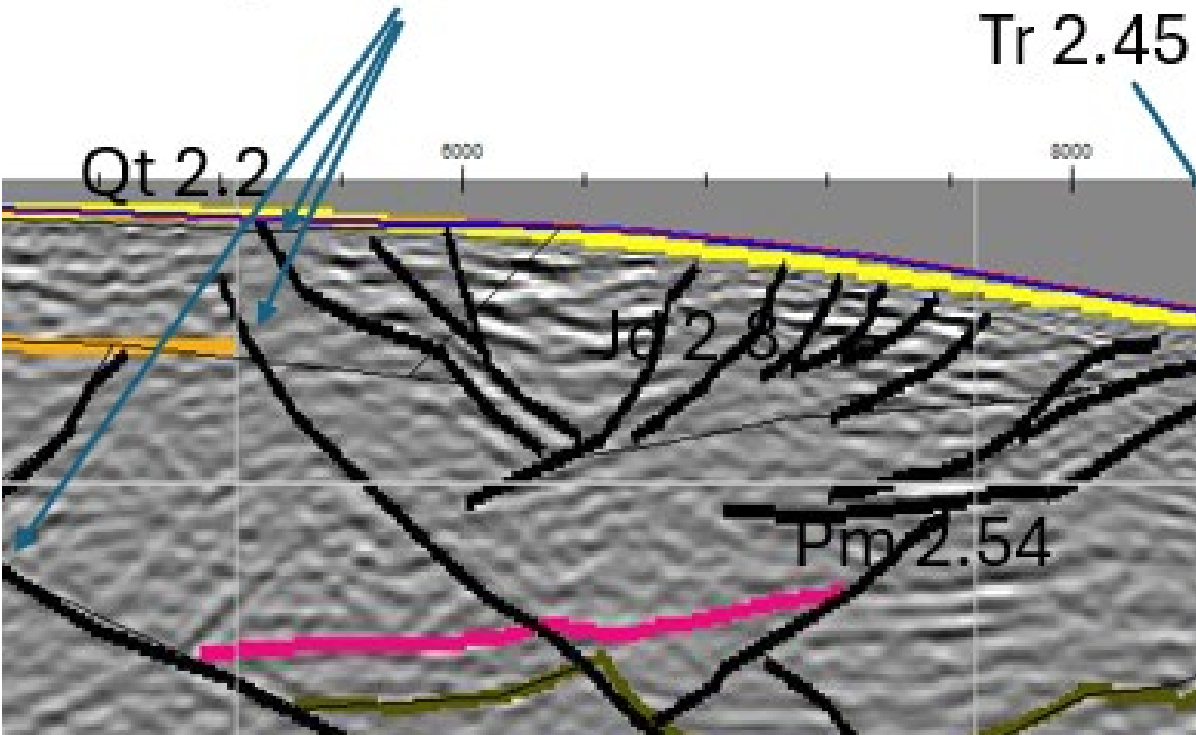


Notes on the “Highway Fault”:

- The “Highway Fault” is mapped by MRT at a position 4.69km from the western end of this segment. No fault is observed at surface in the seismic at this position.
- A fault that daylights at about 5.2km from the start of line is the western edge of a negative flower structure, entirely within Jd.
- A negative flower structure implies strong post Jurassic strike slip motion on the structure.
- This shallow complex fault zone may root into an older blind Permian rift fault closer to the mapped position of the Highway Fault but the geometries are unclear.

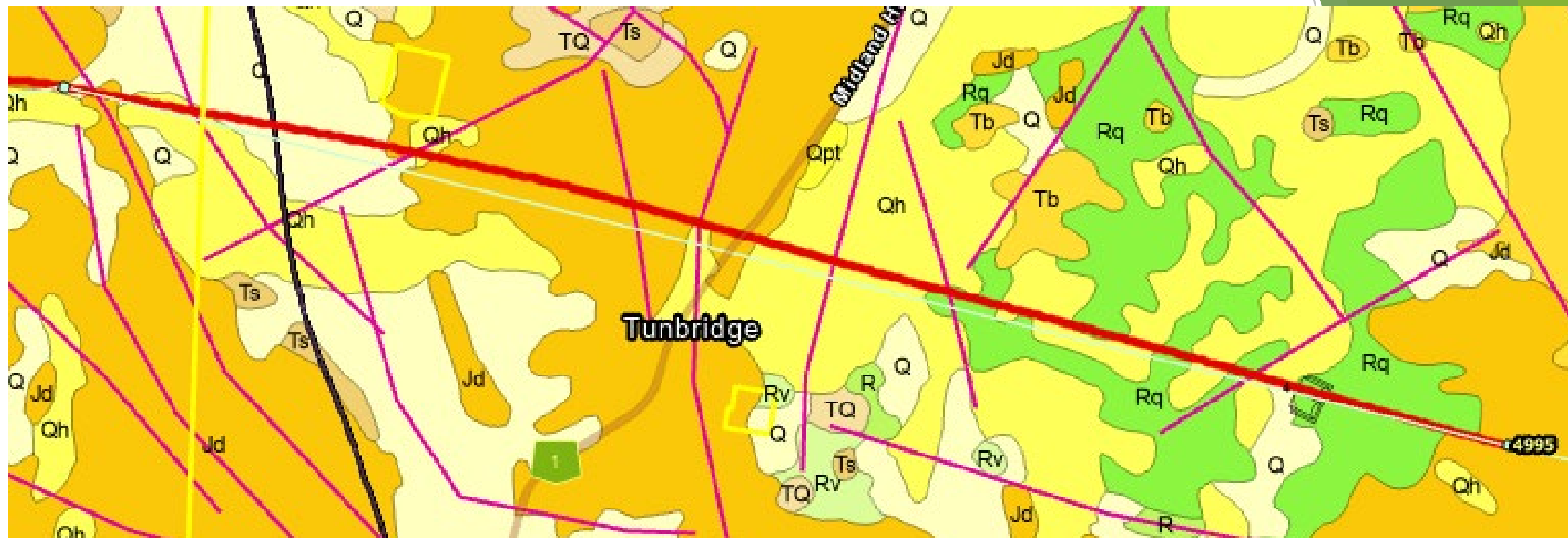


Highway Fault?

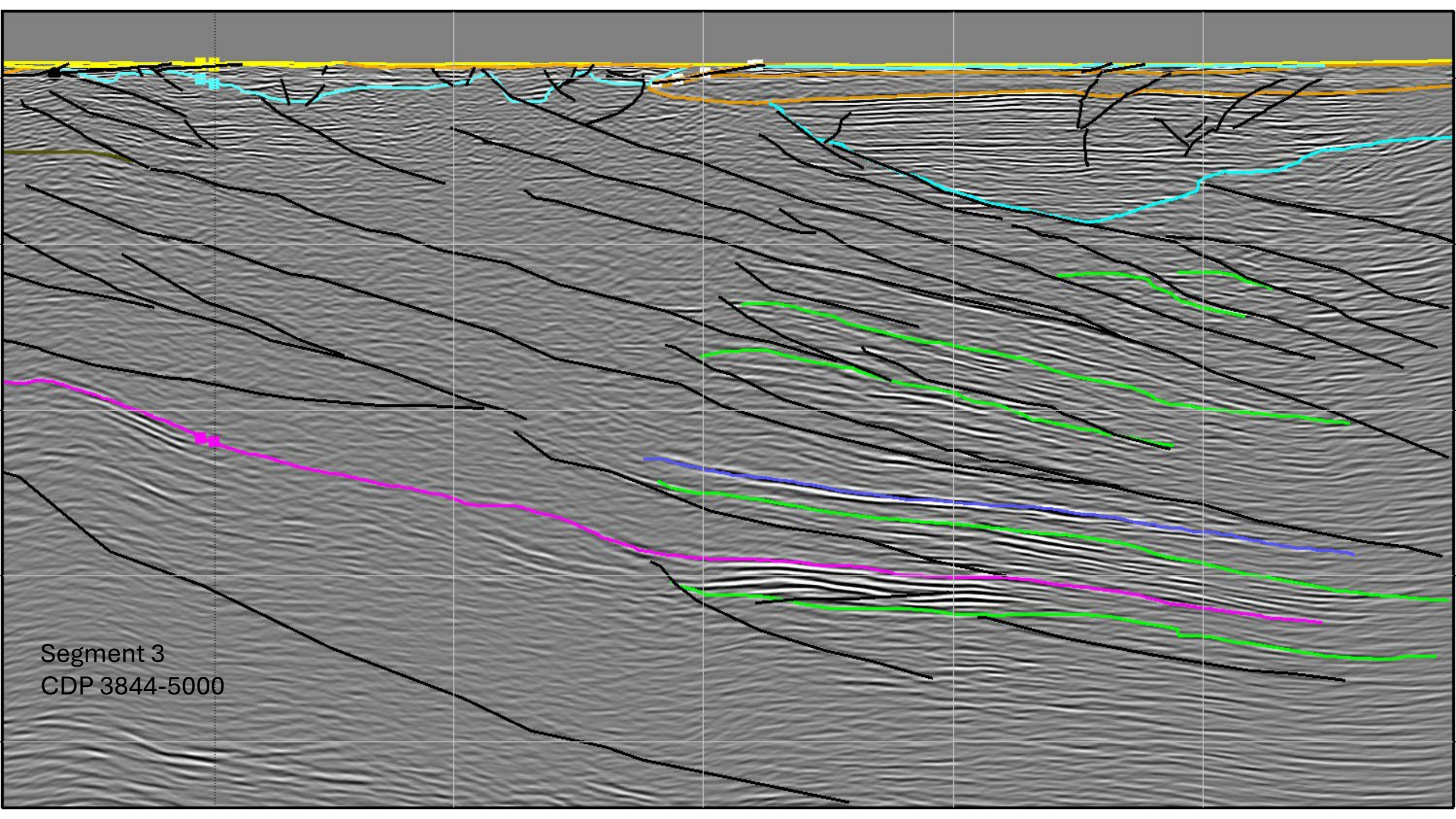


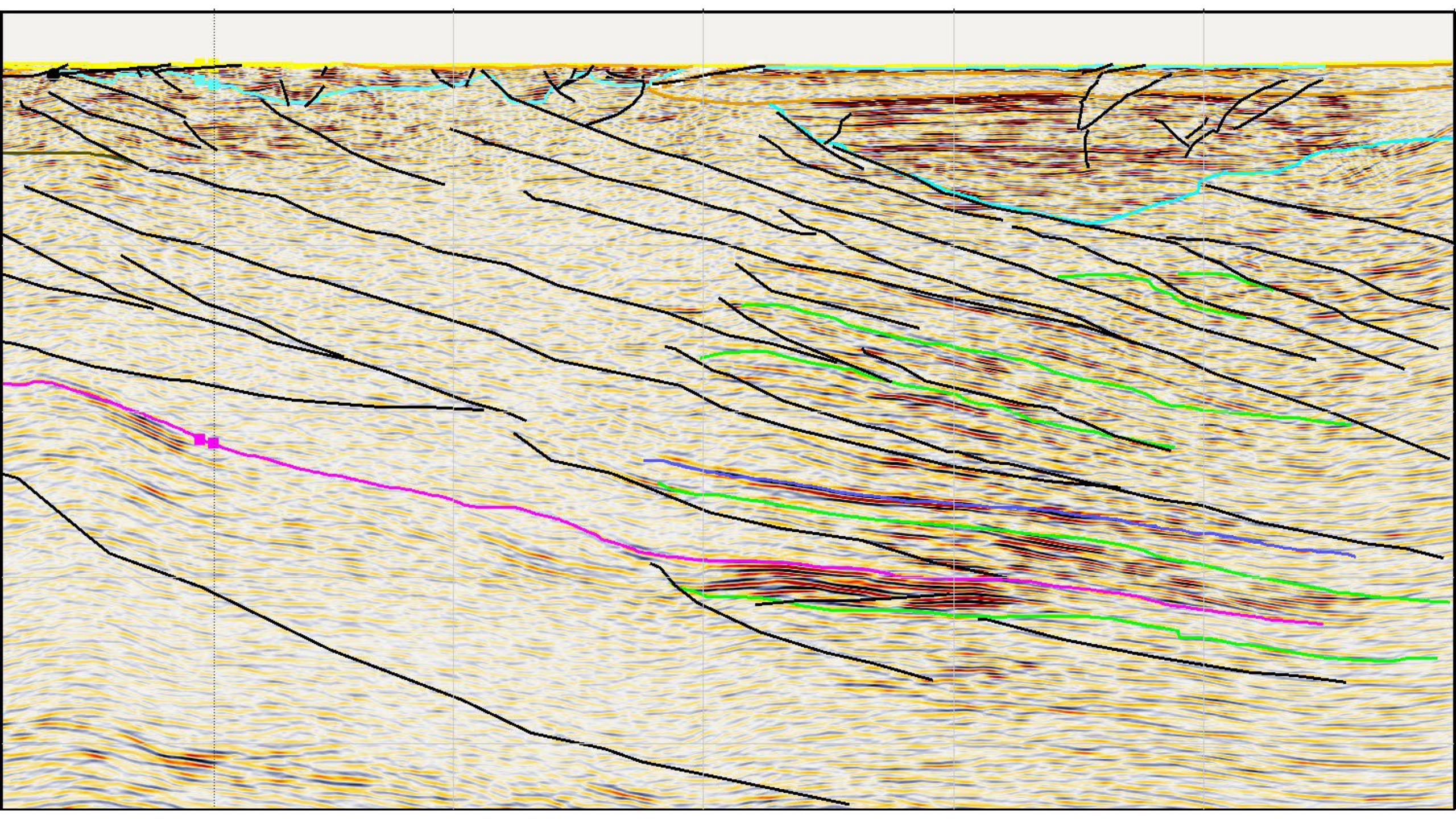


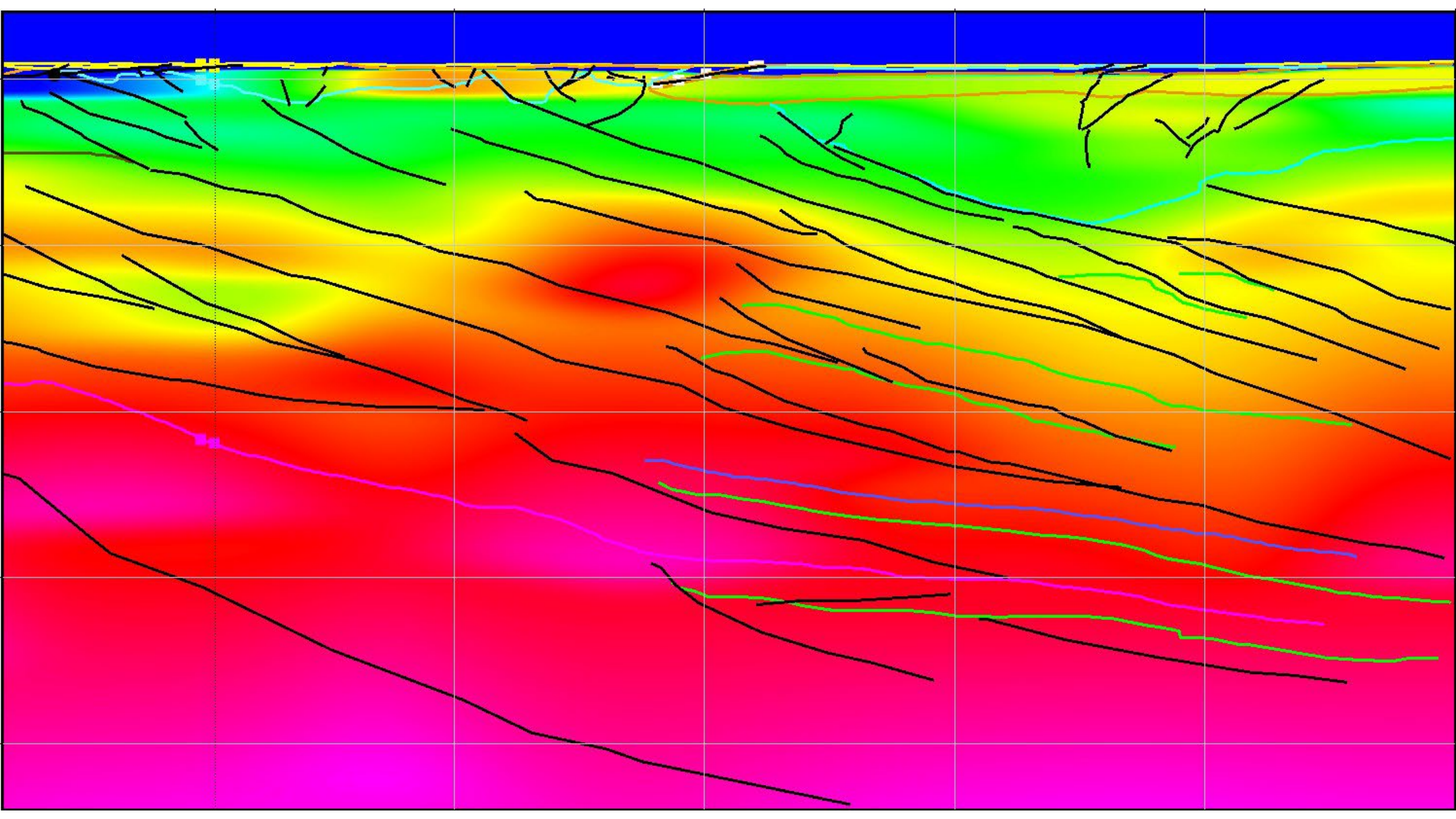
Segment 3 Geology

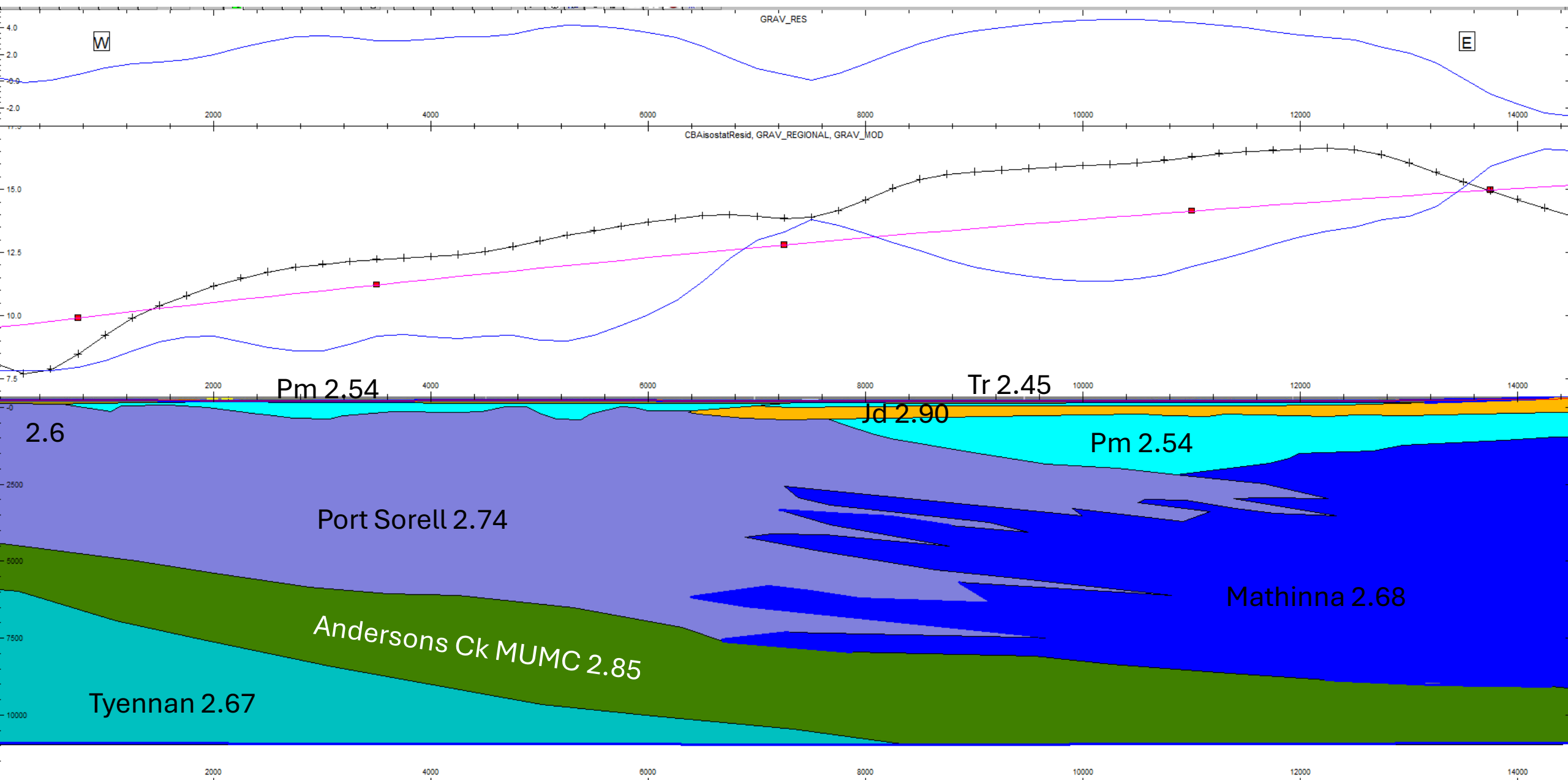


- ▶ Jurassic dolerite, faulted near the Tiers
- ▶ Tertiary sediment fill at foot of Tiers, west of Tunbridge + veneer of Qa, Qh - unconsolidated alluvial & lacustrine deposits
- ▶ Faulted Triassic quartz sandstones (Upper Parmeener Supergroup) (Rq) east of Tunbridge
- ▶ Jd at end of line

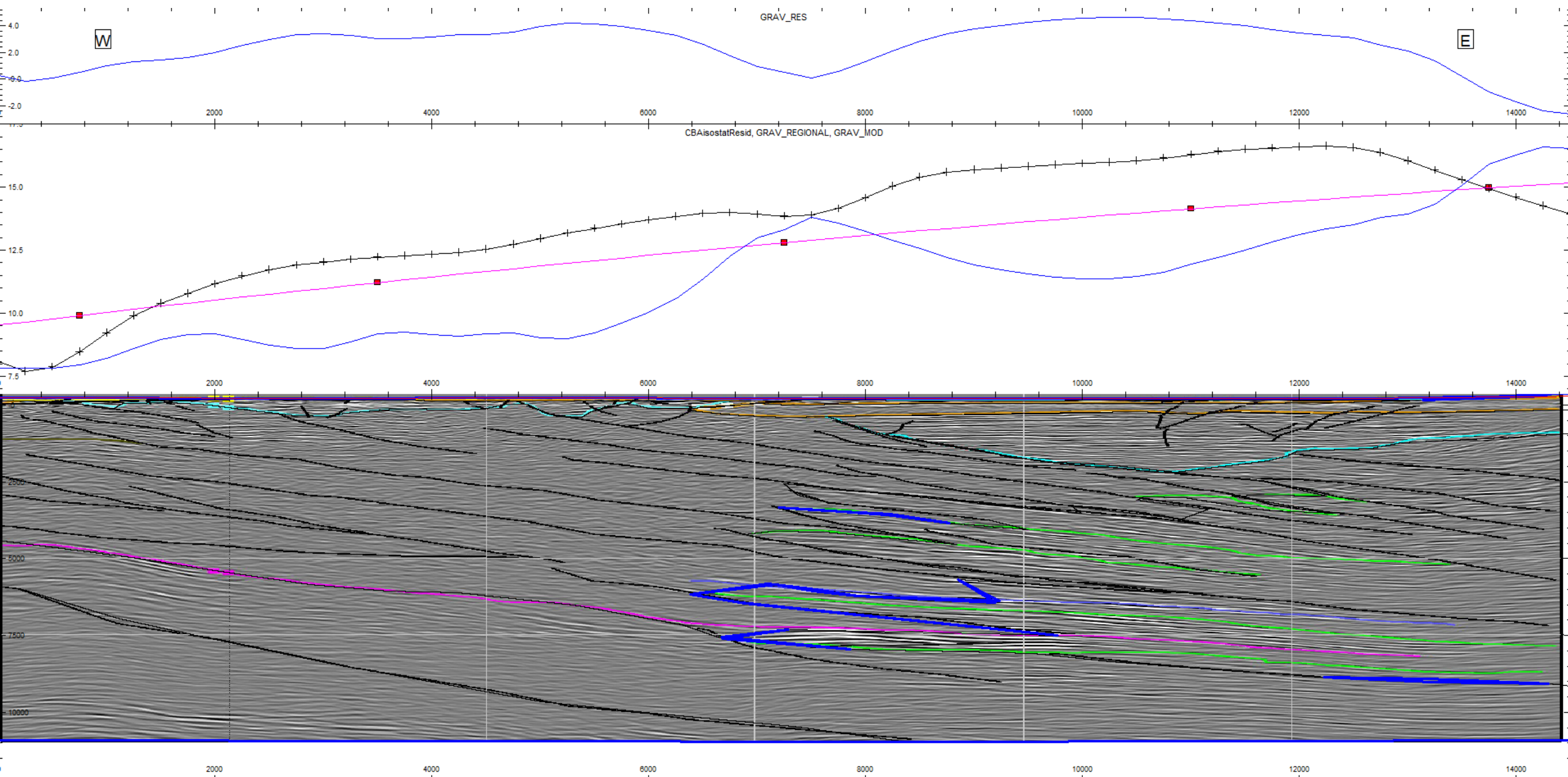








TB-ST1 Segment 3 – Initial Model, based on seismic interpretation of Direen (2025)



Poor fit requires revision of identity and geometry of some blocks

Nb = Neoproterozoic Badger Head Block
Cp = Cambrian Port Sorell Formation
Cu = Cambrian ultramafics
Cb = Cambrian Blyth Creek Formation
Cv = Cambrian volcanics
Oc = Ordovician Cabbage Tree Formation / Frankford Formation undifferentiated
Os = Ordovician Supply River Sandstone / Eaglehawk Gully Formation
Og = Ordovician Flowery Gully Limestone
Dc = Devonian Corn Hill Beds
Pm = Permian sedimentary rocks
Ts = Triassic sedimentary rocks
Jd = Jurassic dolerite
Tb = Tertiary basalt
Ti = Tertiary ironstone
Q = Quaternary alluvium

Rock Unit	Density Range t/m ³	Mean t/m ³	Median t/m ³	Mag. Susc. Range SI*10 ⁻³	Mean SI*10 ⁻³	Median SI*10 ⁻³
Anderson's Creek Ultramafic Complex (ACUC)	2.0-3.1	2.49	2.36	5-150	65	59
Port Sorell Formation (PSF)	2.3-3.0	2.70	2.72	0.01-1.42	0.44	0.48
Badger Head Formation (BHF)	2.6-2.7	2.67	2.67	0.08-0.17	0.13	0.13
Denison Group (DG)	2.5-2.9	2.71	2.72	0.03-5	0.54	0.15
Grubb Shale, Corn Hill Beds (GS+CHB)	2.5-2.8	2.65	2.65	0.05-0.27	0.17	0.17
Blyth Creek Formation	2.5-3.0	2.78	2.8	0.02-21	0.23*	0.22*
Flowery Gully Limestone (FGL)	2.6-2.8	2.74	2.74	0.02-0.04	0.03	-
Permian sandstone & siltstone (PERM)	2.4-2.6	2.52	-	0.04-0.05	0.04	-

* Not including volcanics and occasional serpentinite

Figure 4.1 Density and Magnetic Susceptibility of West Tamar lithologies

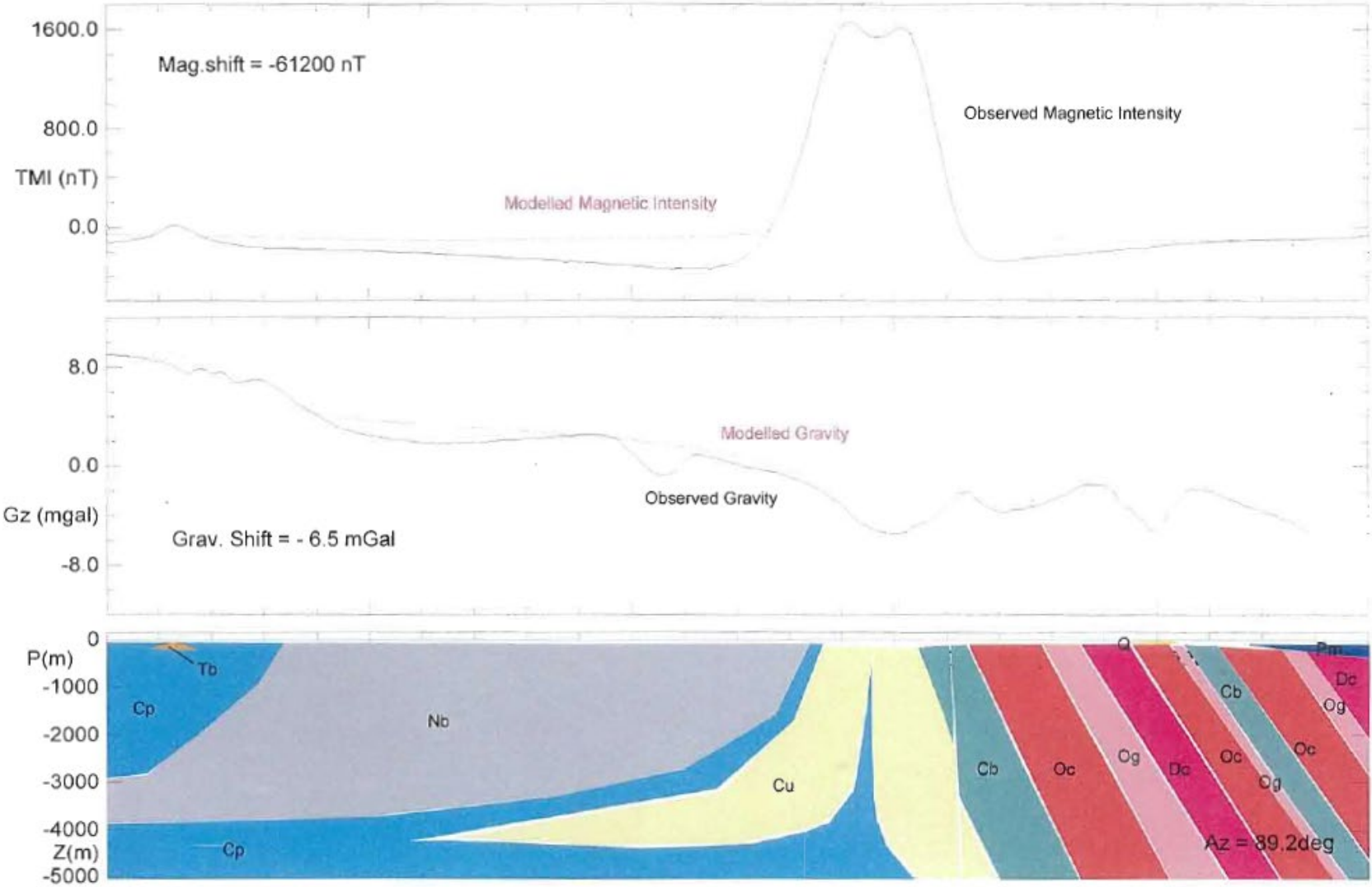
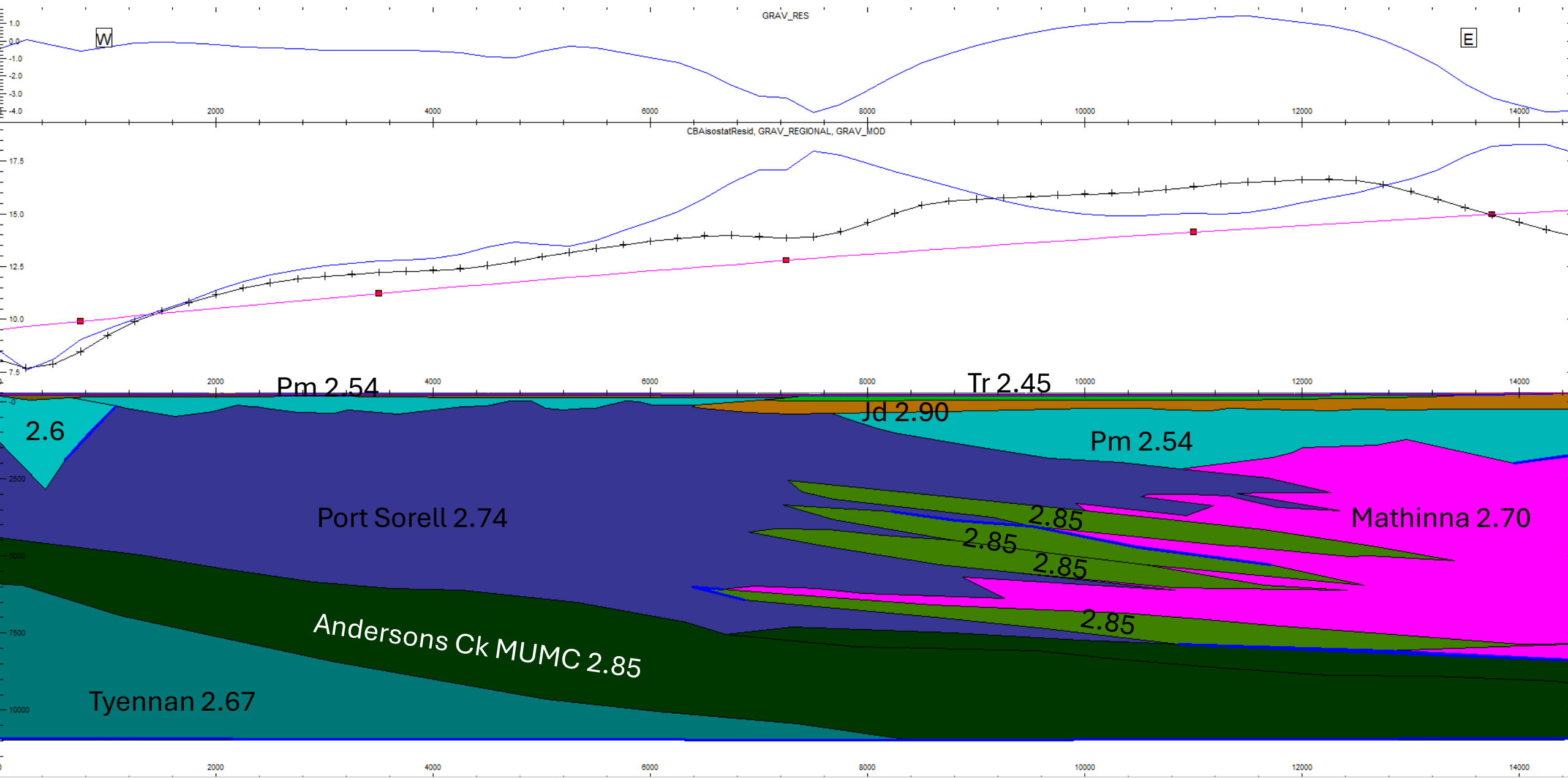
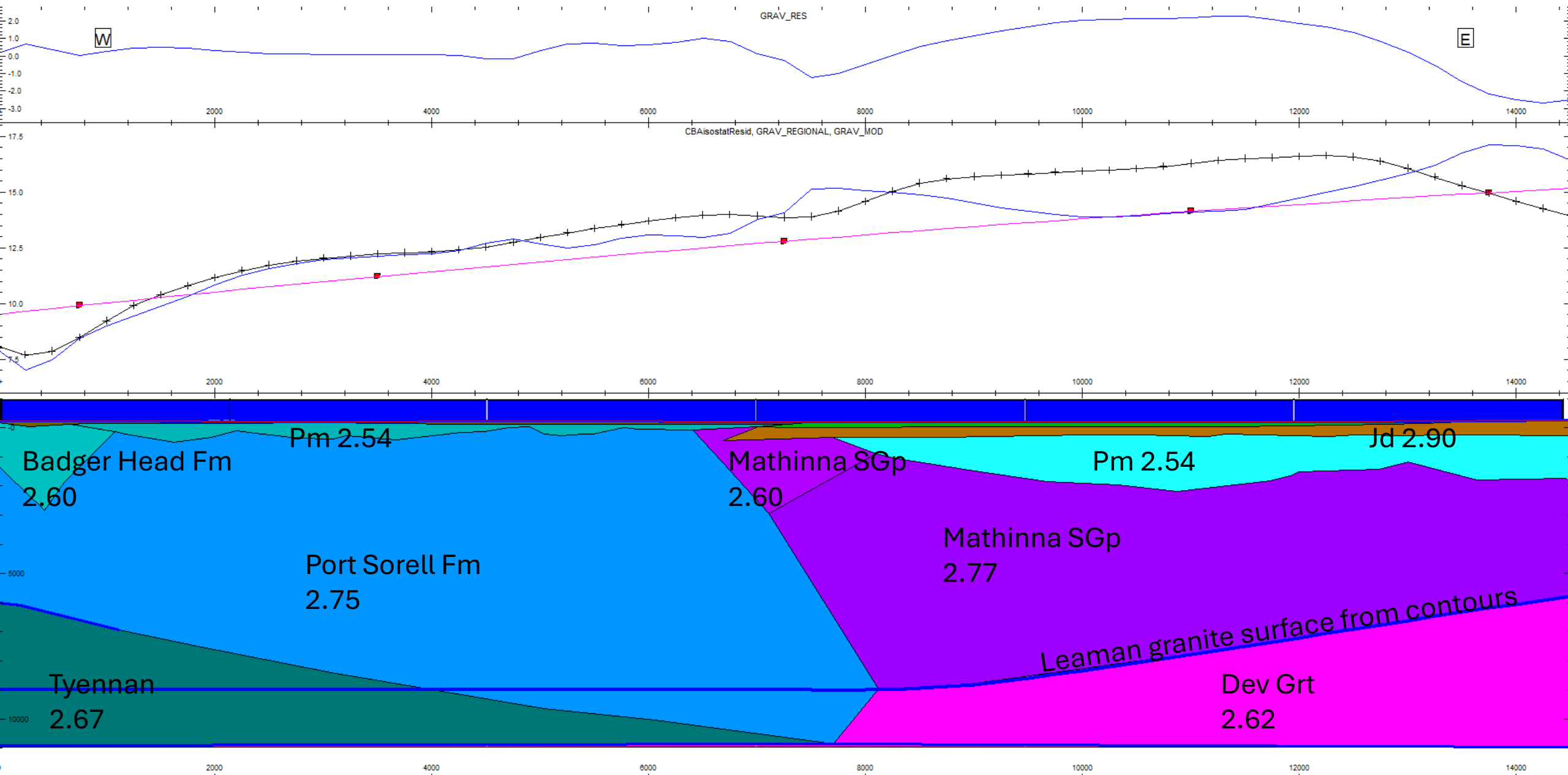


Figure 6.2. Section 2 Modelled Gravity and Magnetics, West Tamar District

Density control for underlying basement units has been derived from a database compiled near Beaconsfield by Zengerer (1999).

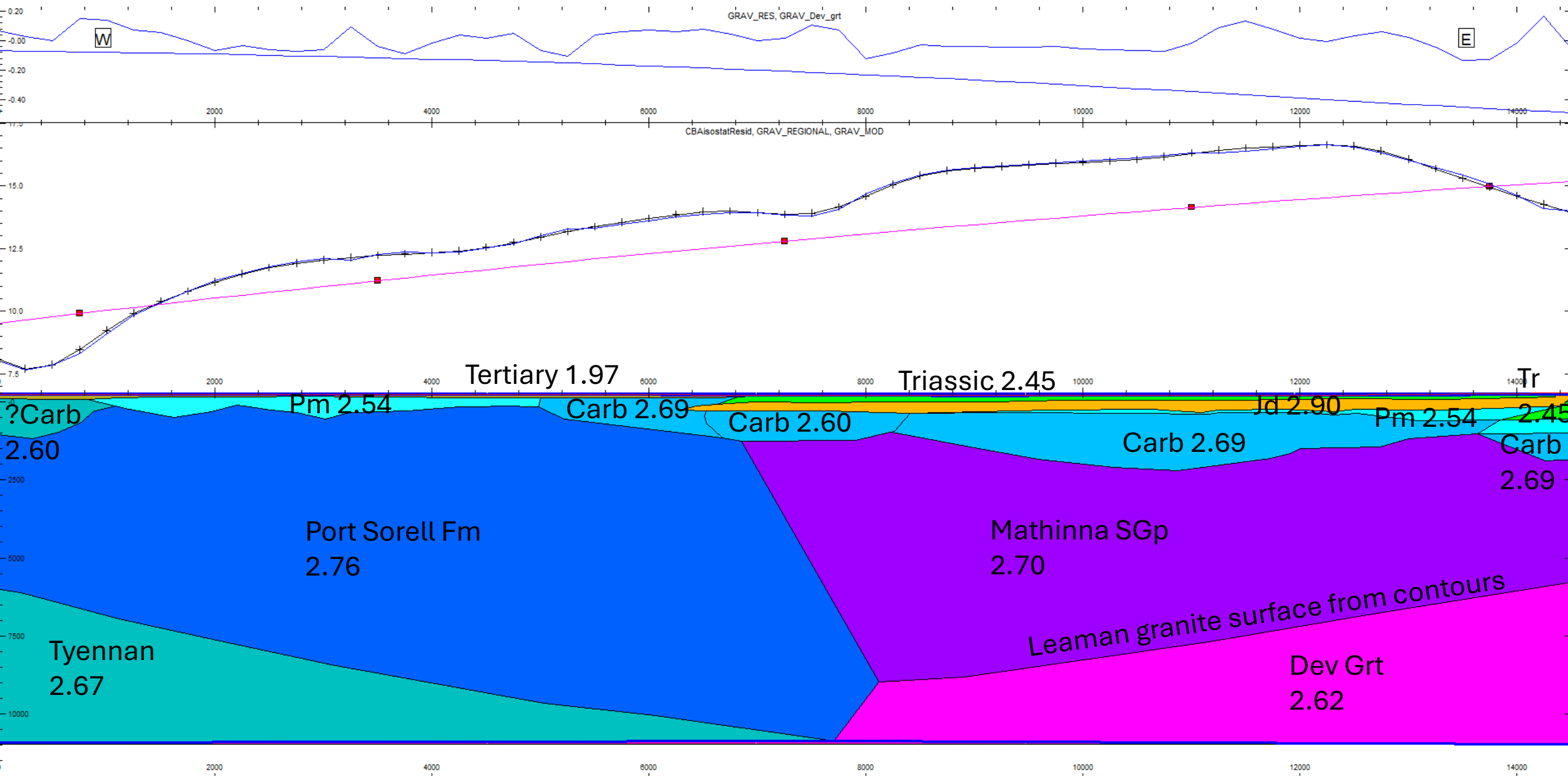


TB-ST1 Segment 3 – Revised Model v2

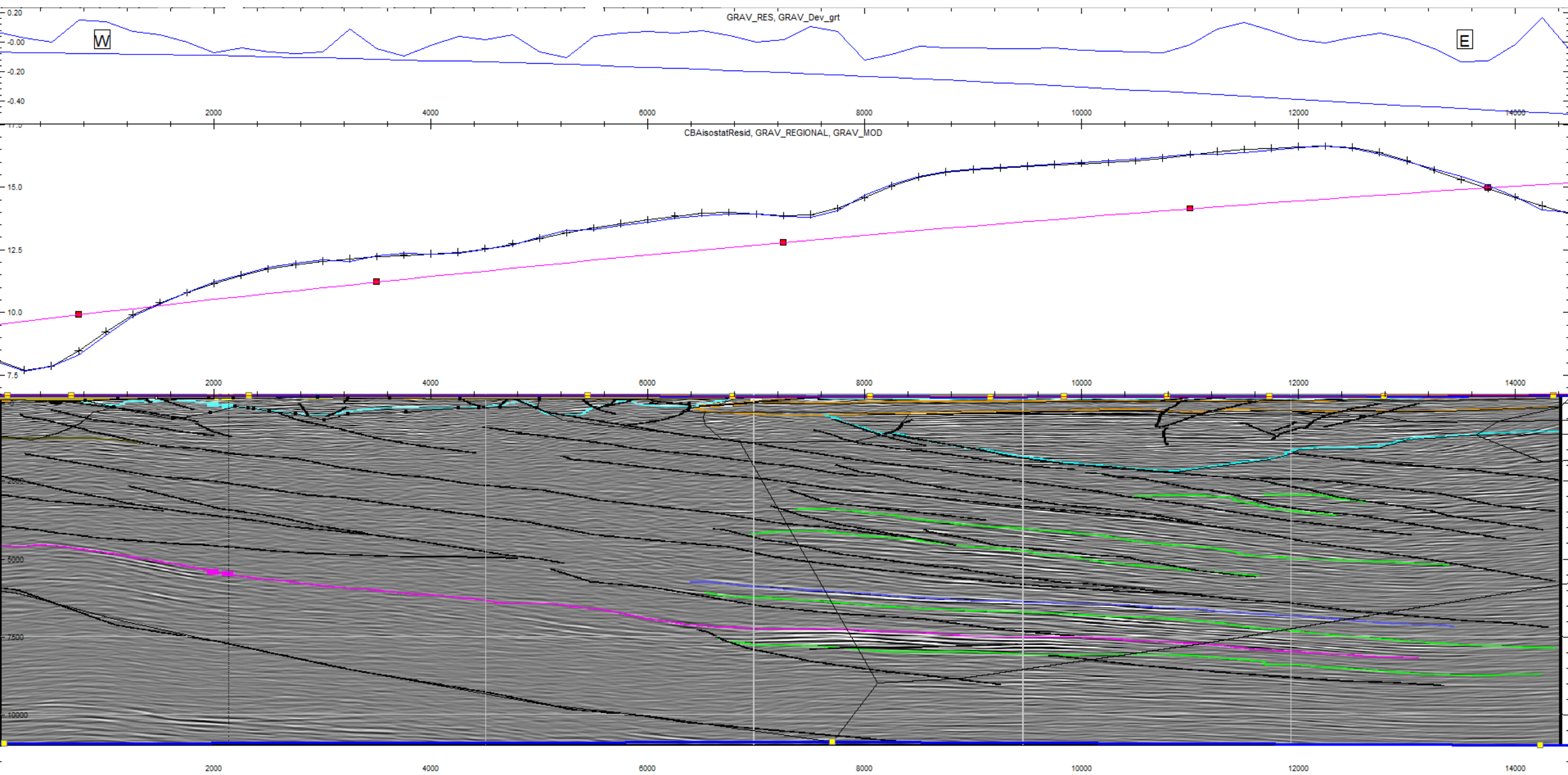


Note: discussion with RFB in late July re density of Stockers Tillite, which has a lot of carbonate matrix; density could be going up to 2.70 g/cc

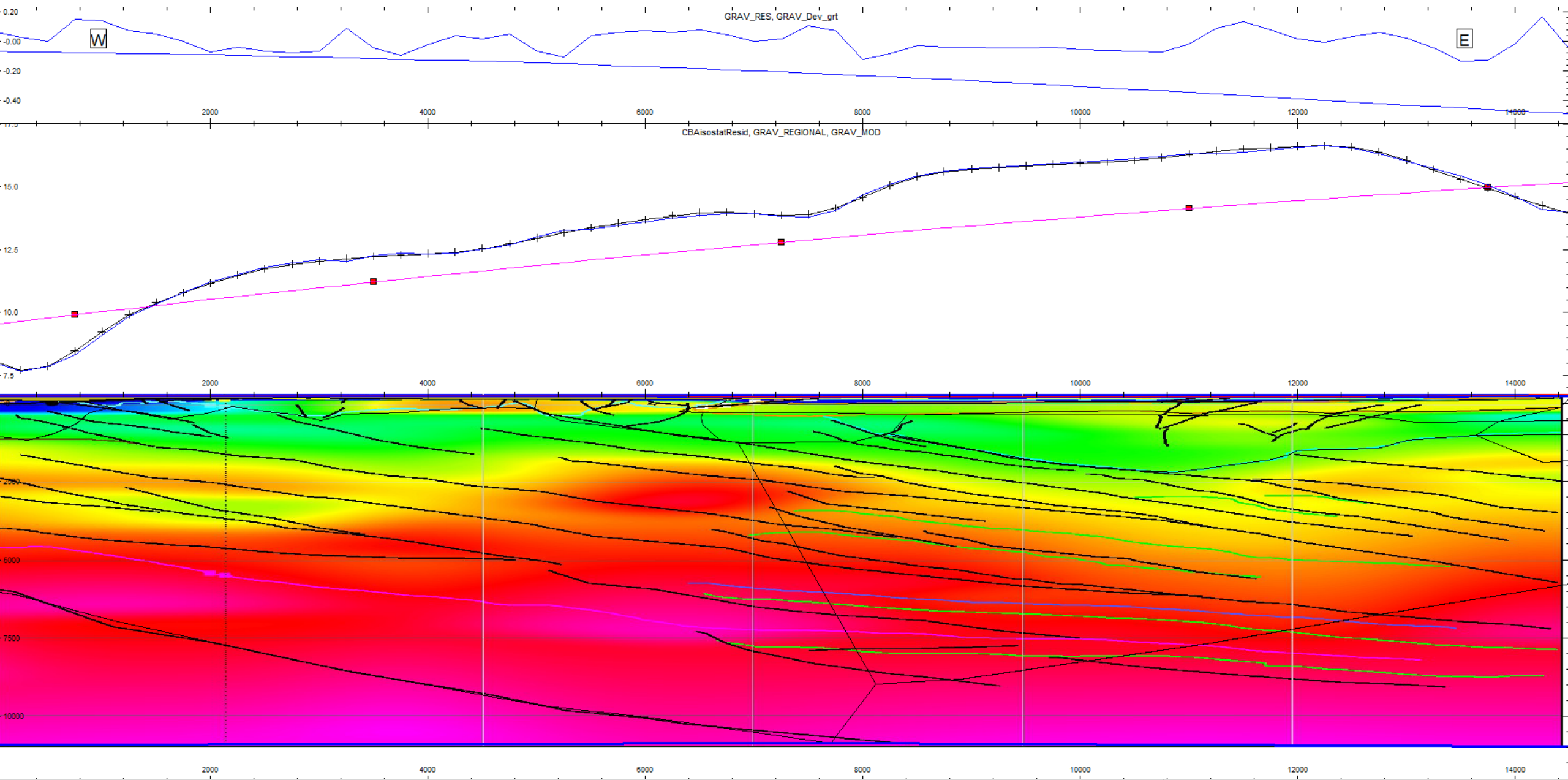
2.69 g/cc seems to work ok – Rast 2009 Hons thesis measured densities this high in RG145, and up to 2.73 and 2.76 in Ross 1



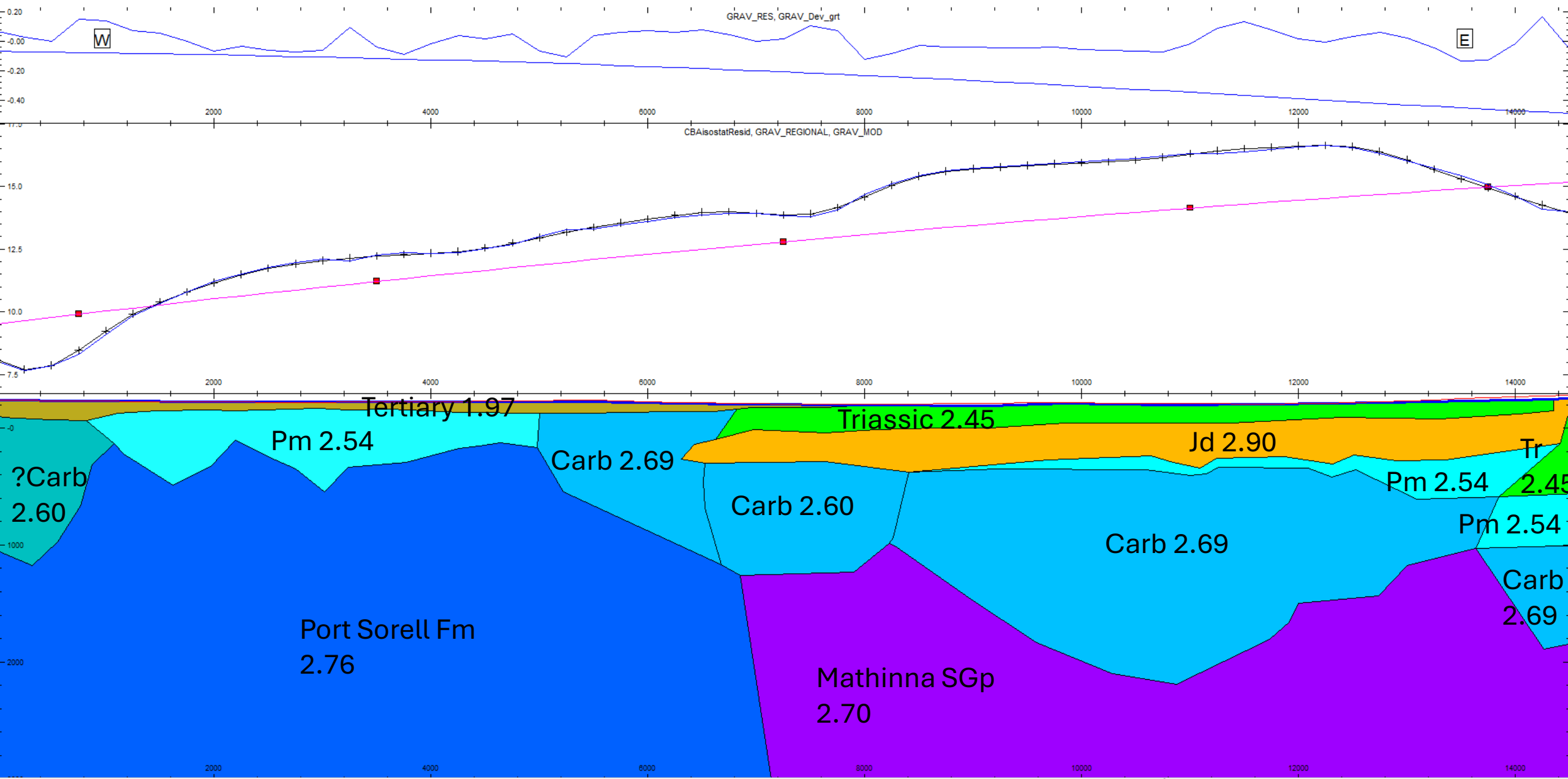
Model Segment 3, fit using extensive higher density Pm units



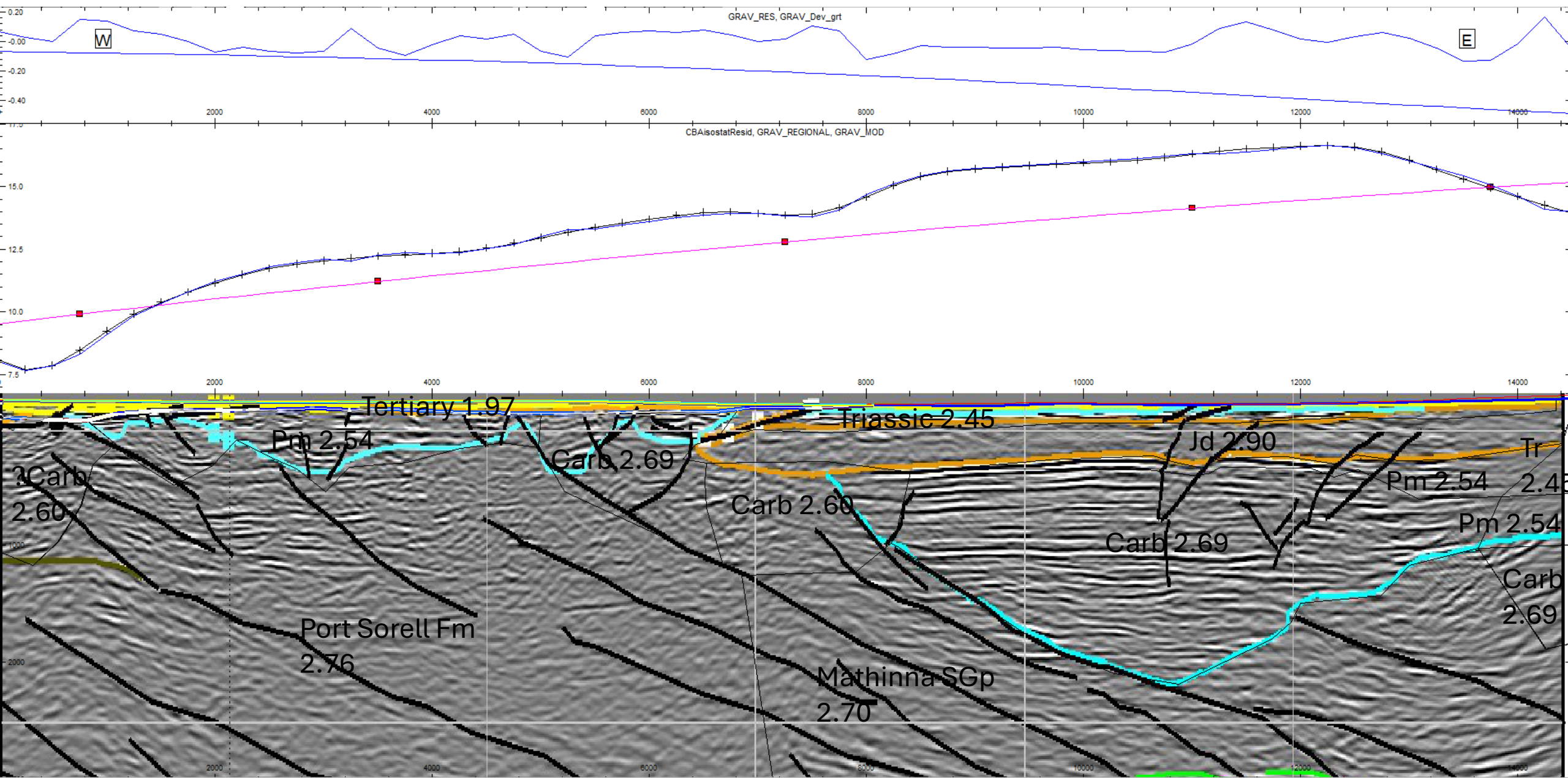
Model Segment 3, fit using extensive higher density on greyscale seismic



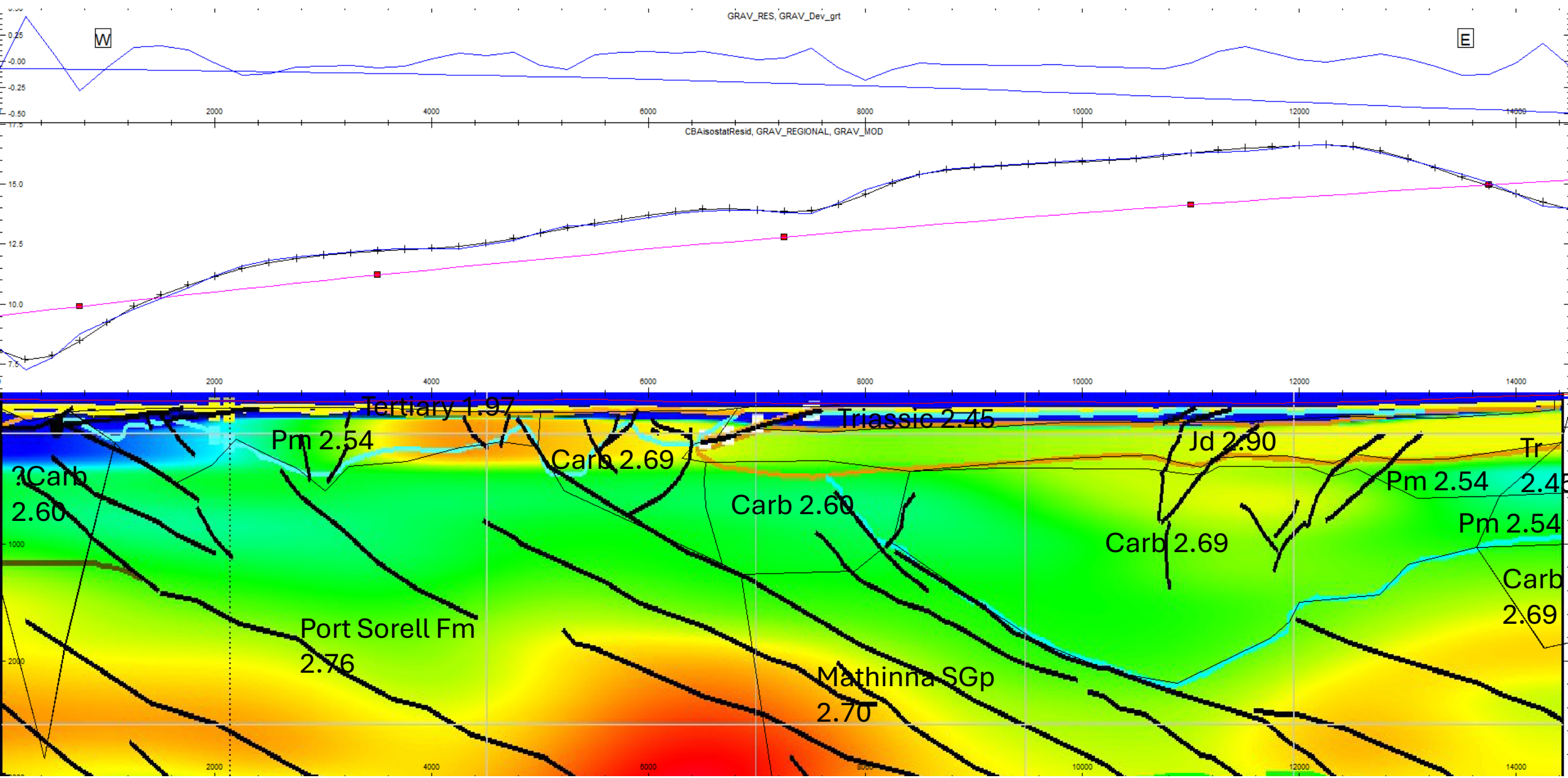
Model Segment 3, fit using extensive higher density on Vint



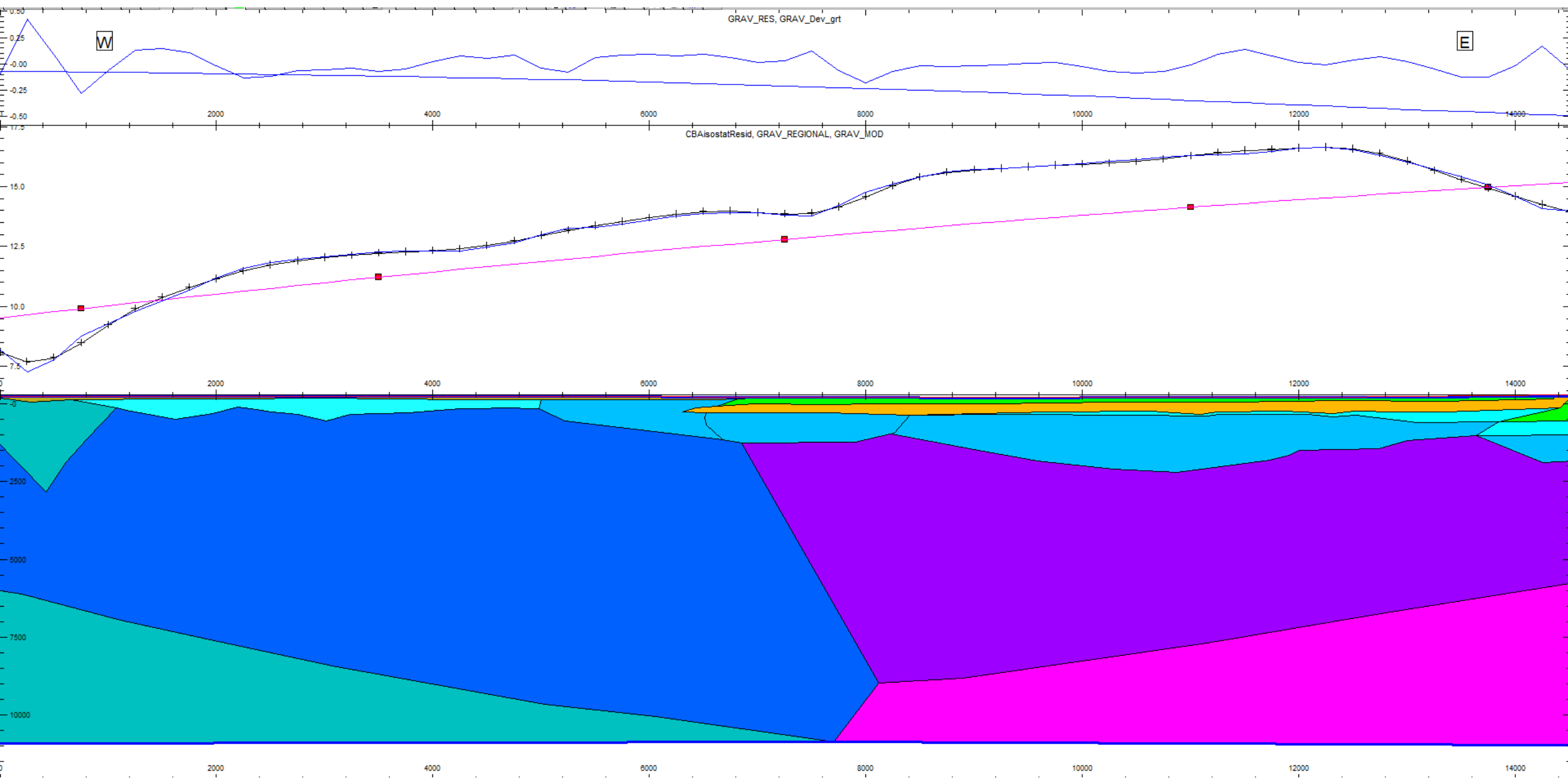
Model Segment 3, fit using extensive higher density Pm units top 3000m detail



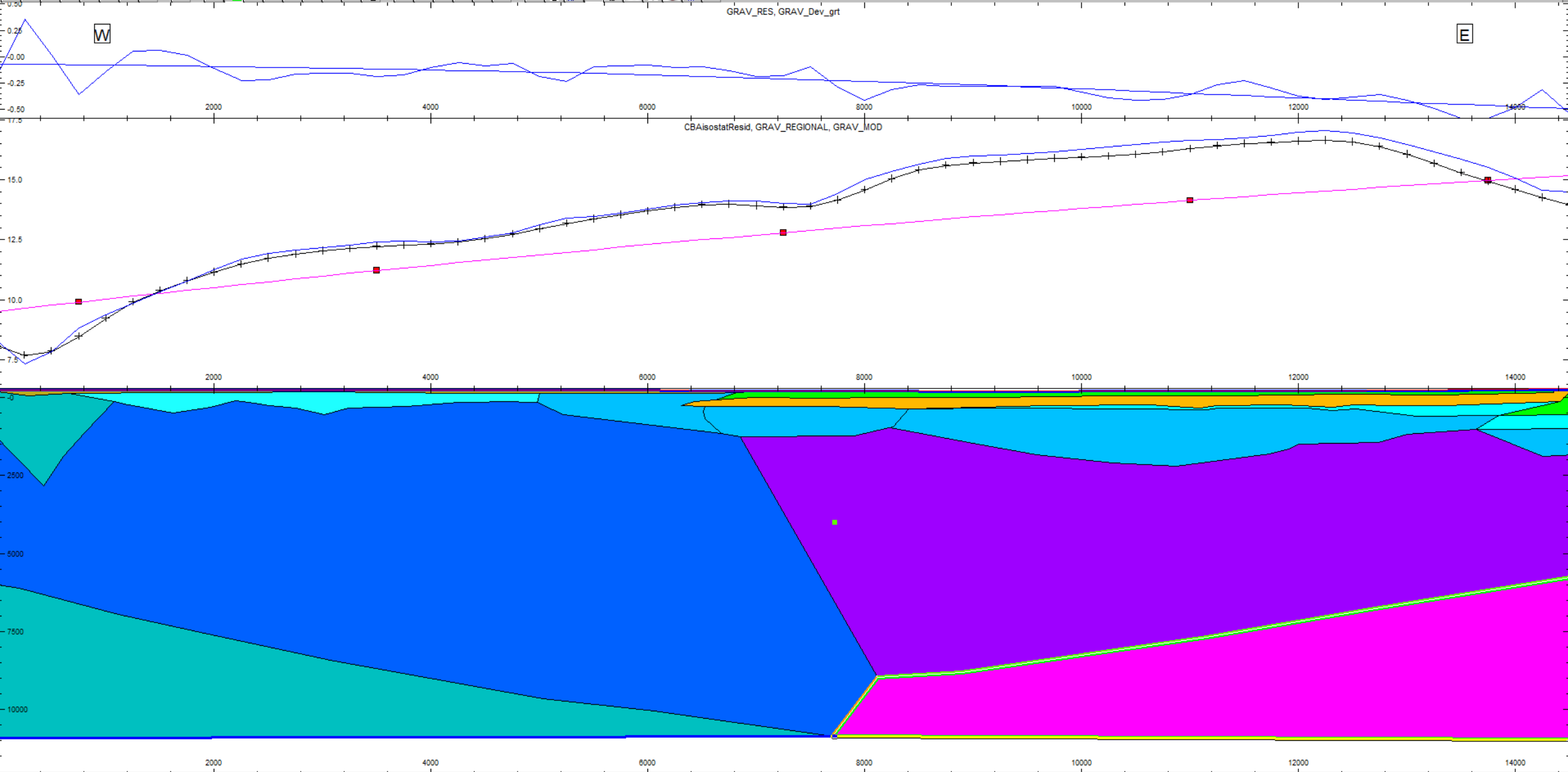
Model Segment 3, fit using extensive higher density Pm units top 3000m detail on seismic greyscale



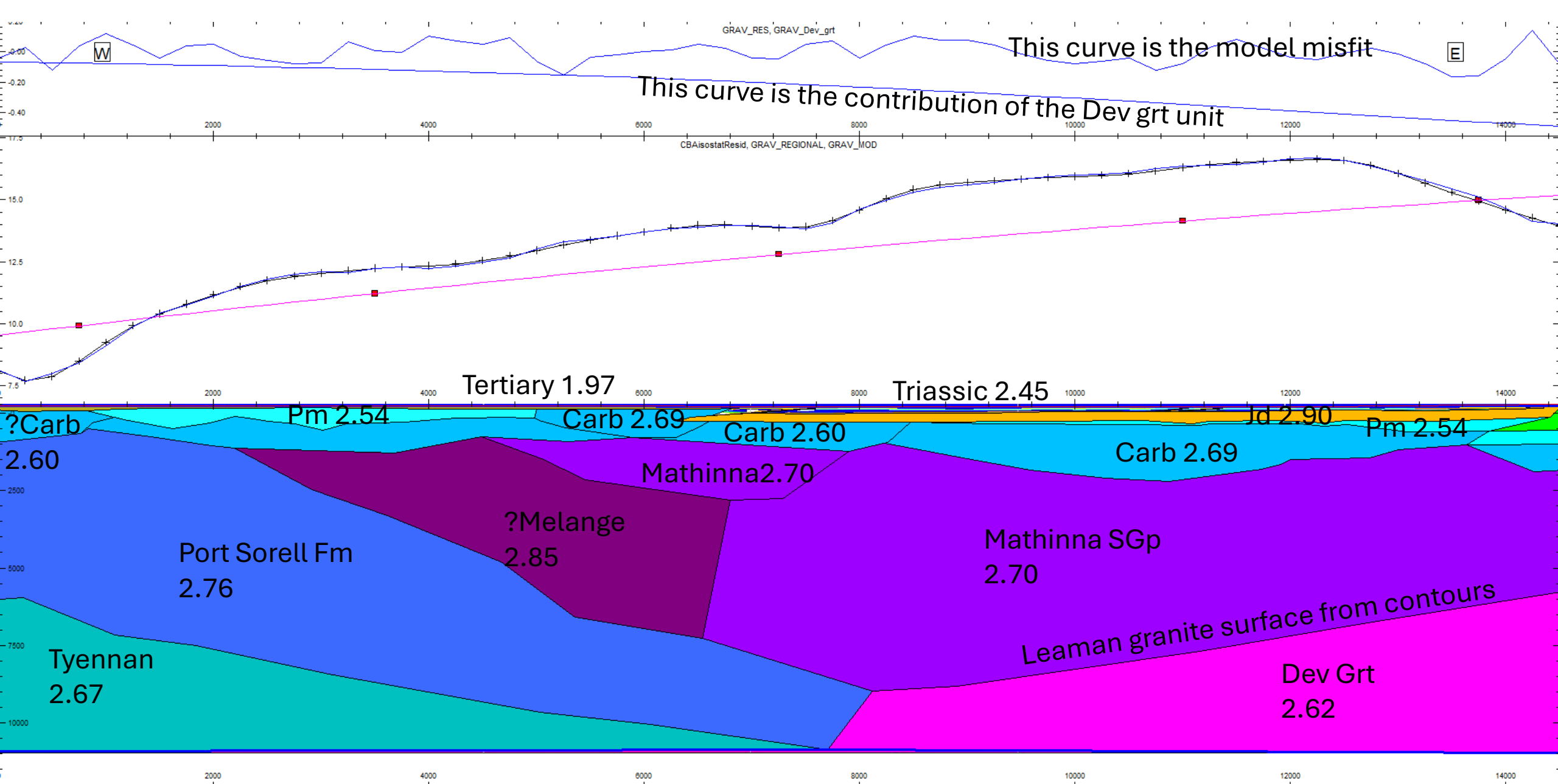
Model Segment 3, fit using extensive higher density Pm units top 3000m detail on seismic Vint



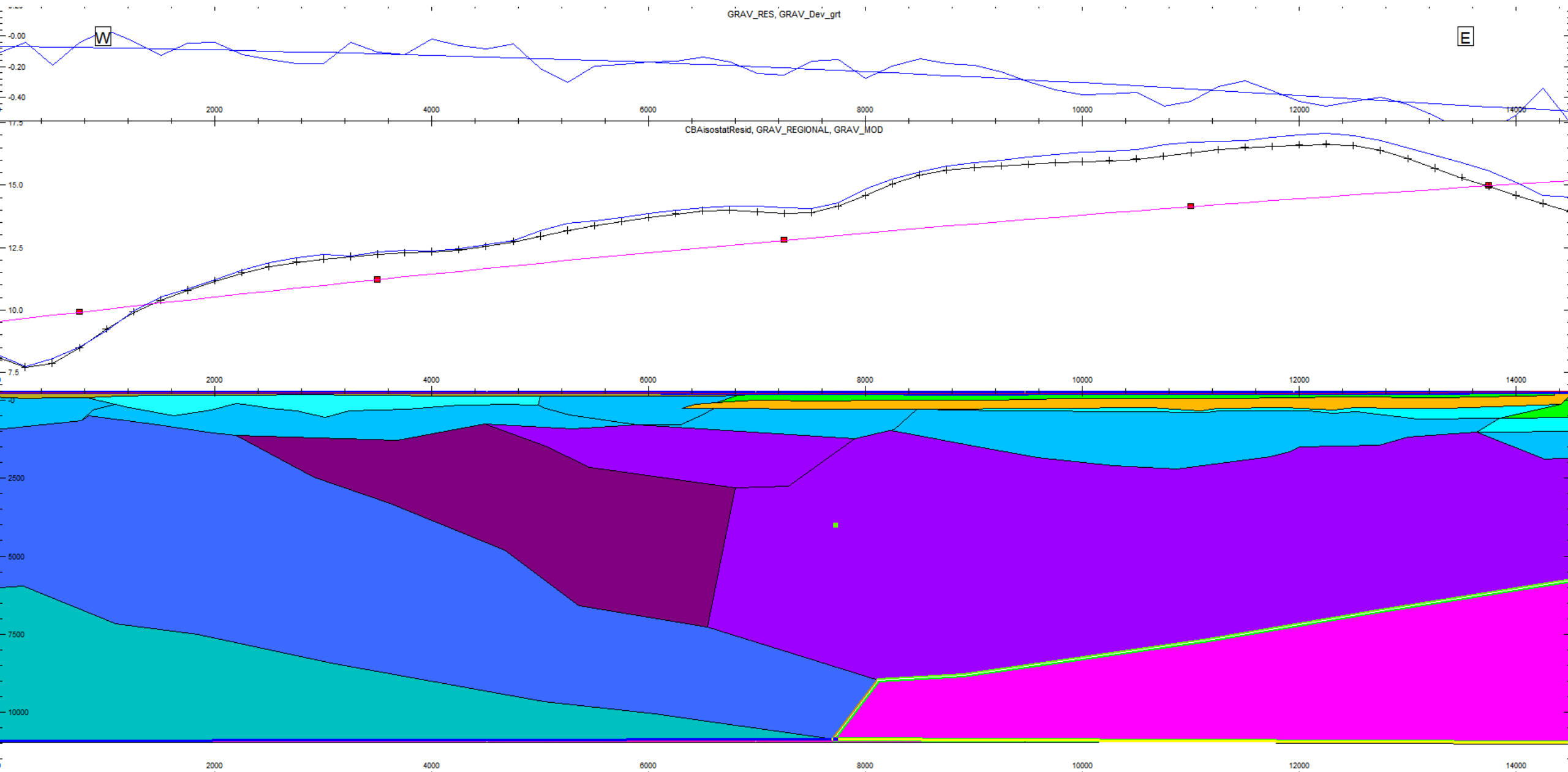
Same model as above, but with granite contribution to the model response shown top panel



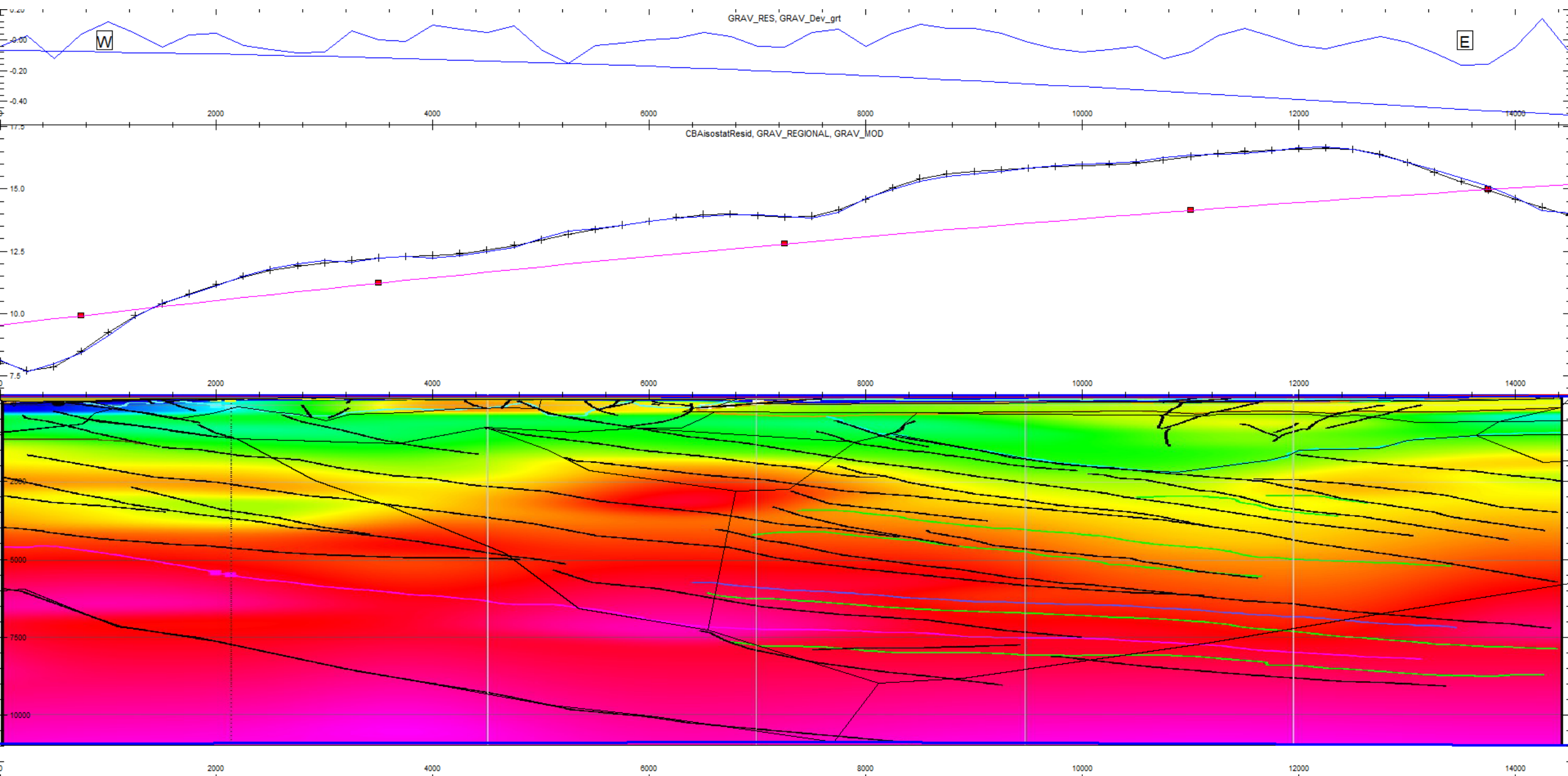
Same model as above, but with granite inactive i.e. not contributing to the model response



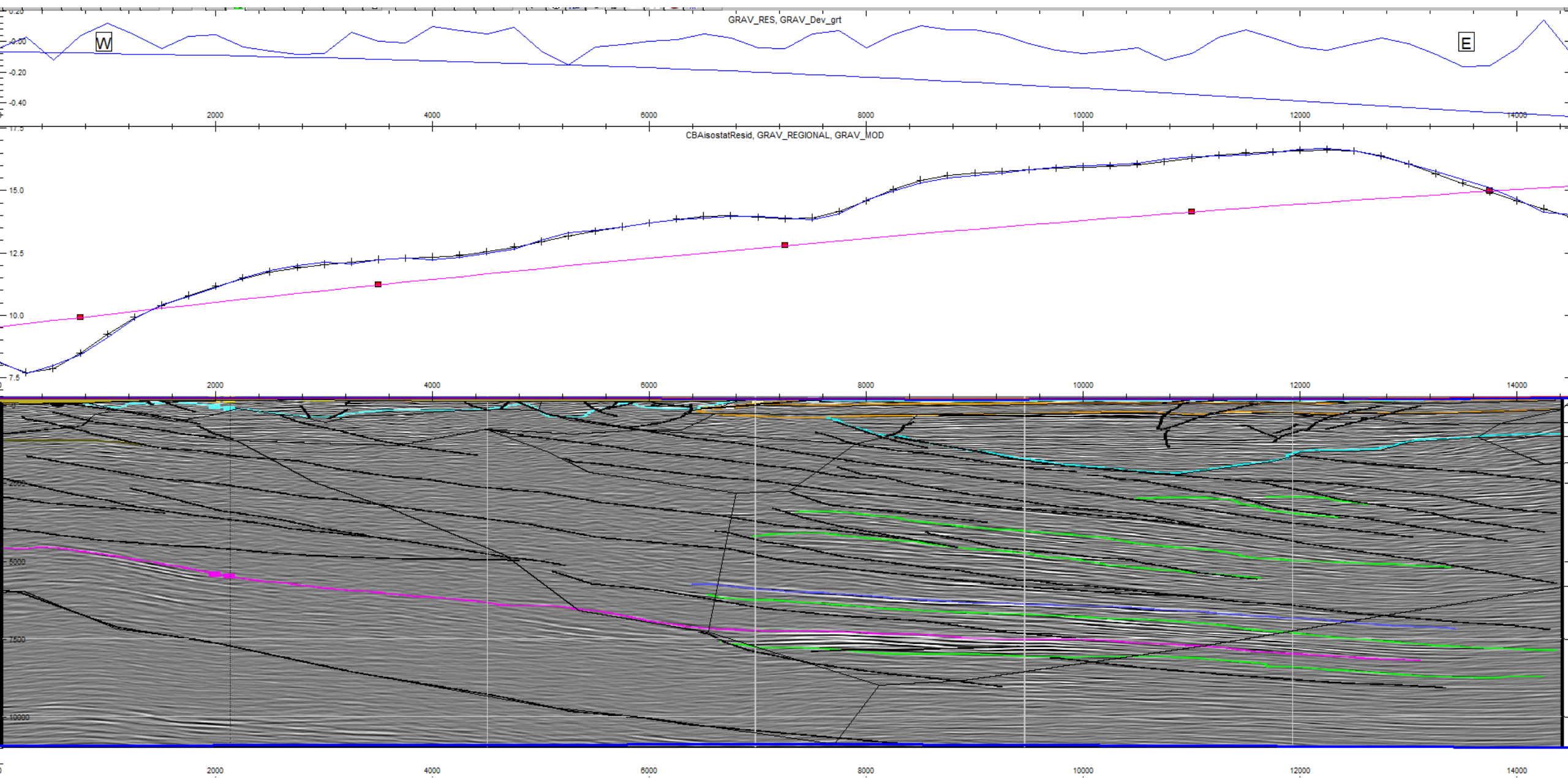
Segment 3 Model v. "i". The inclusion of the Devonian Granite batholith adds a subtle regional slope of ~0.02 mGal



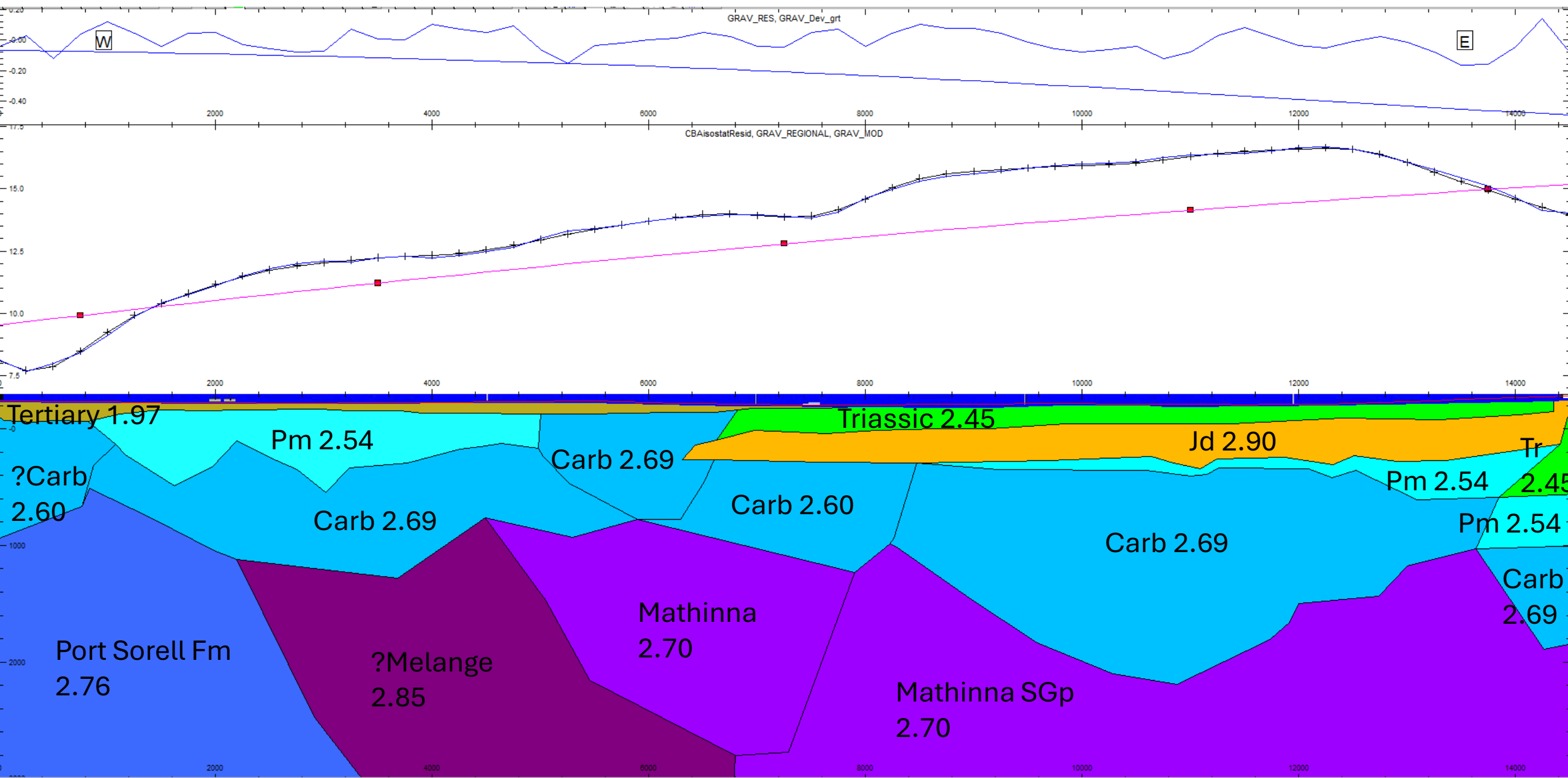
Segment 3 Model v. “i” with Dev grt body made inactive. This results in a mac misfit of 0.4 mGal at the eastern end of the model



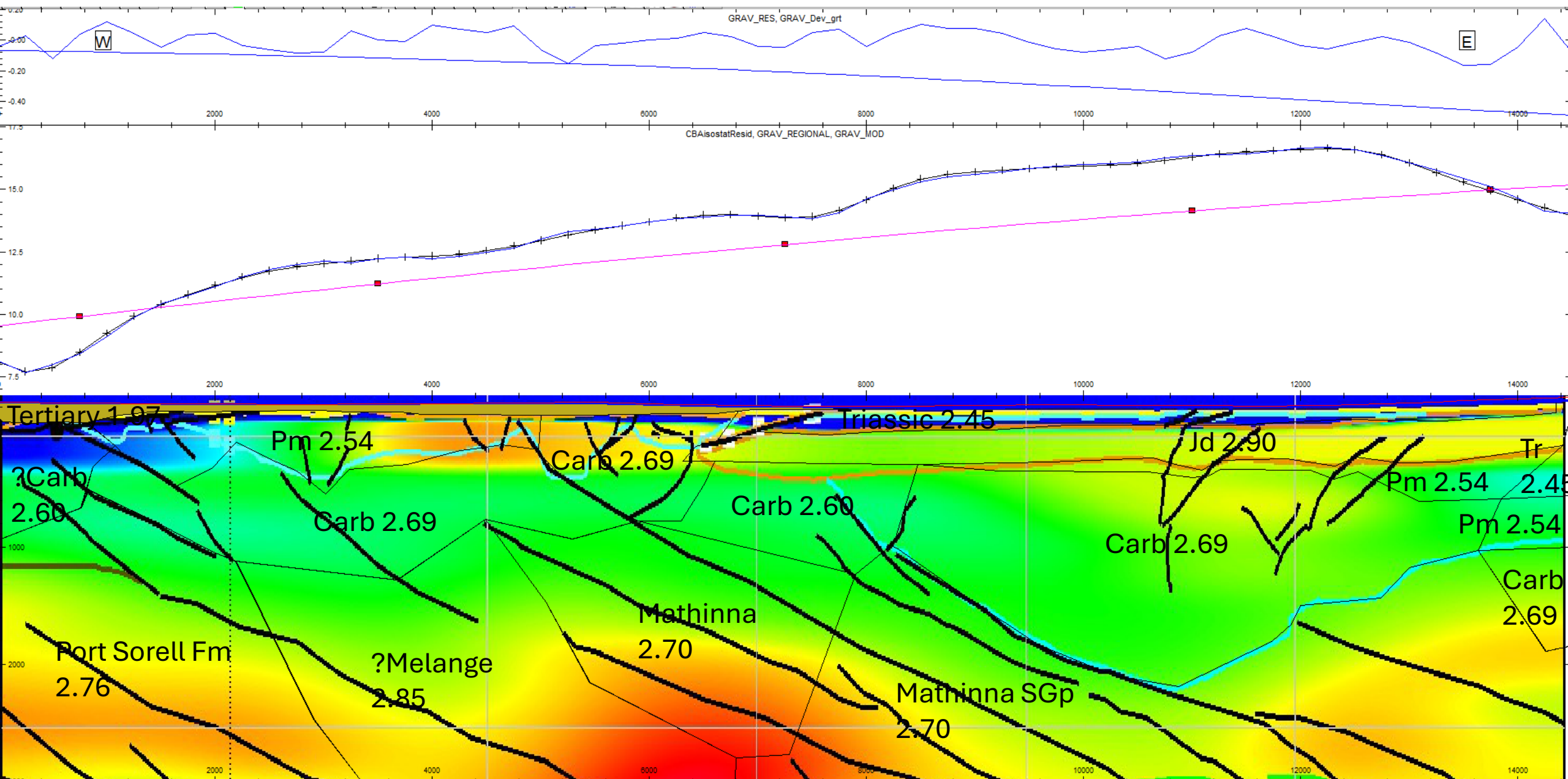
Same model as above, seismic Vint



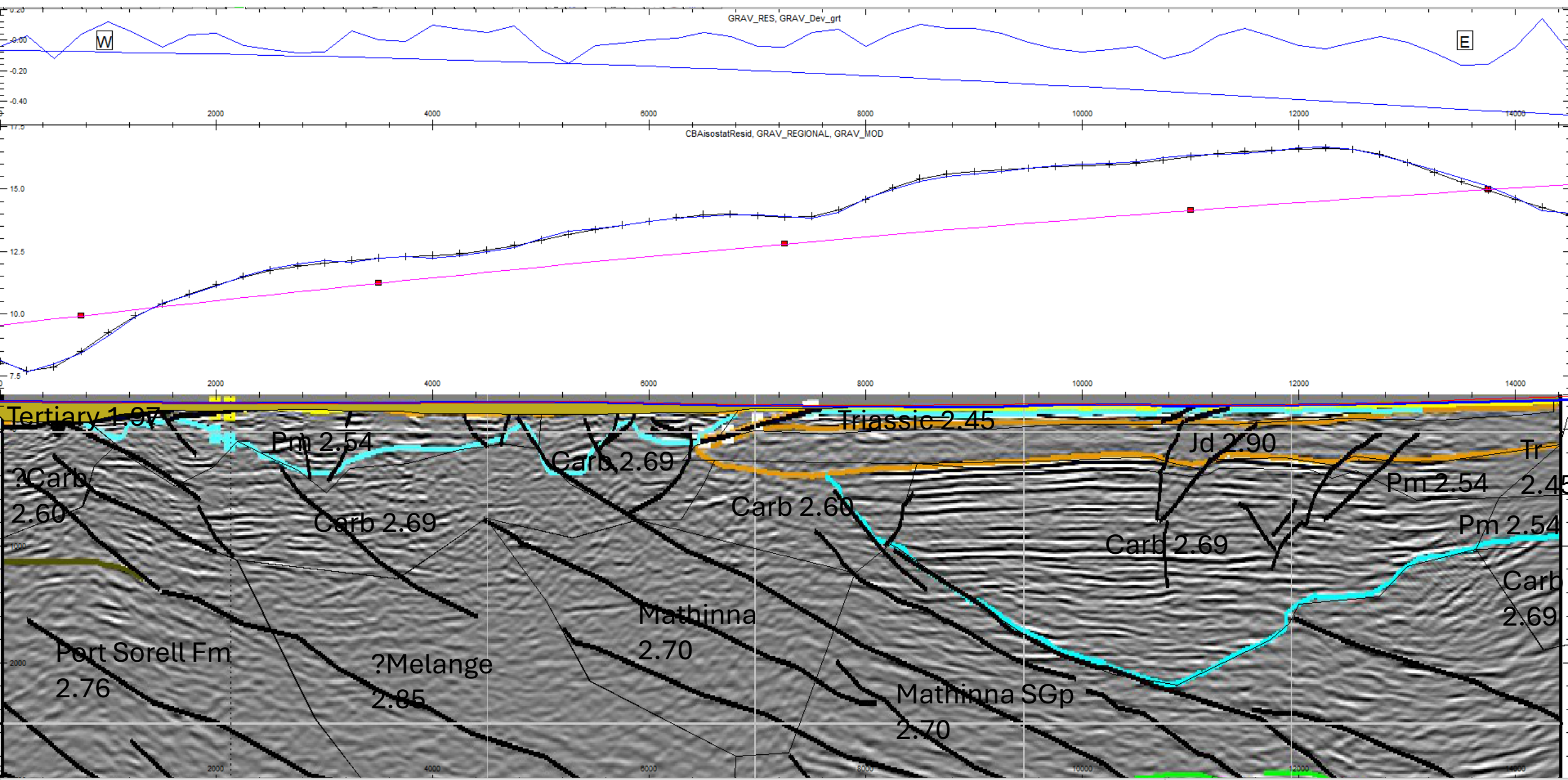
Same model as above, seismic greyscale



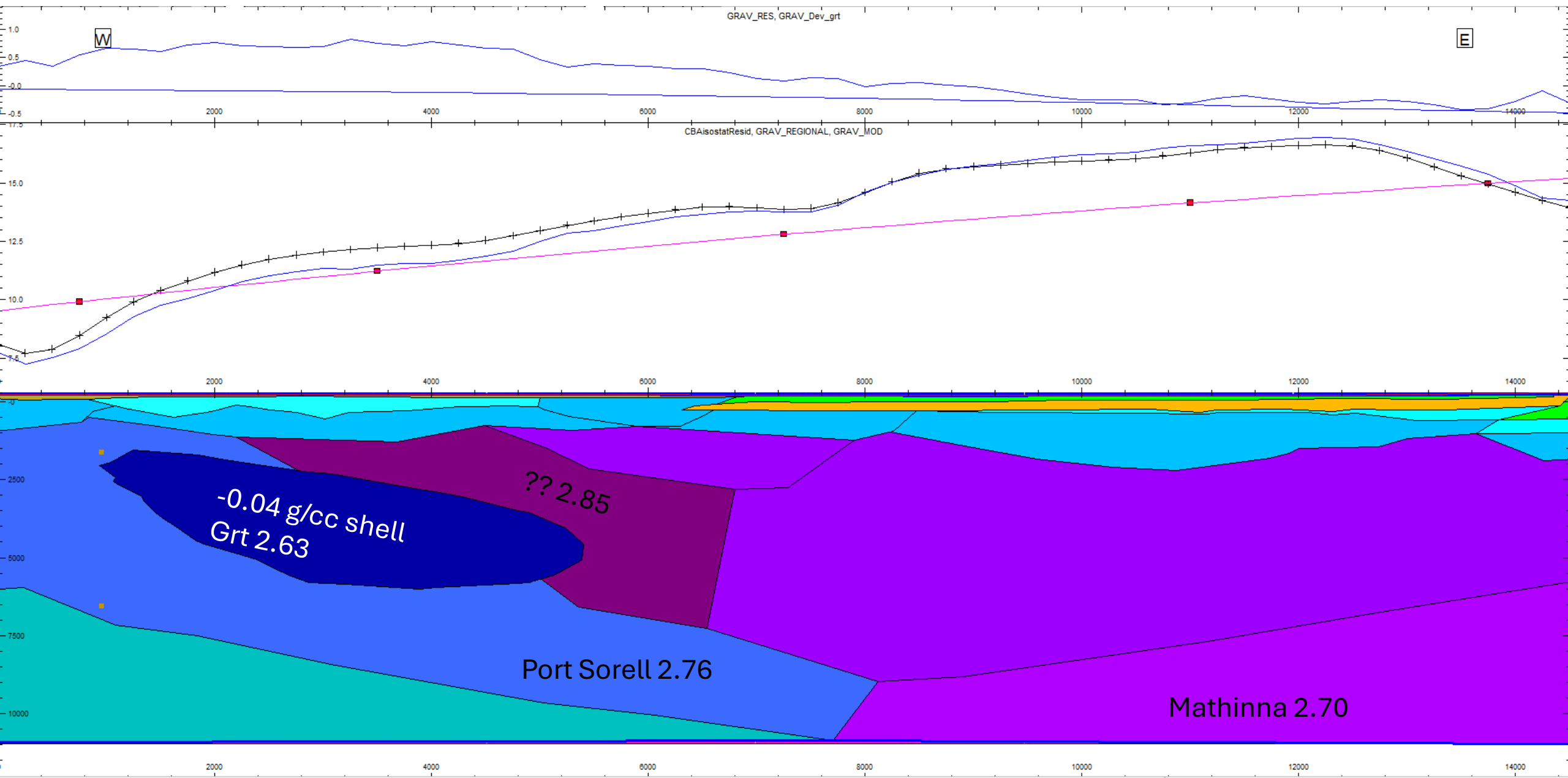
Segment 3 Model v. "i", details upper 3000m



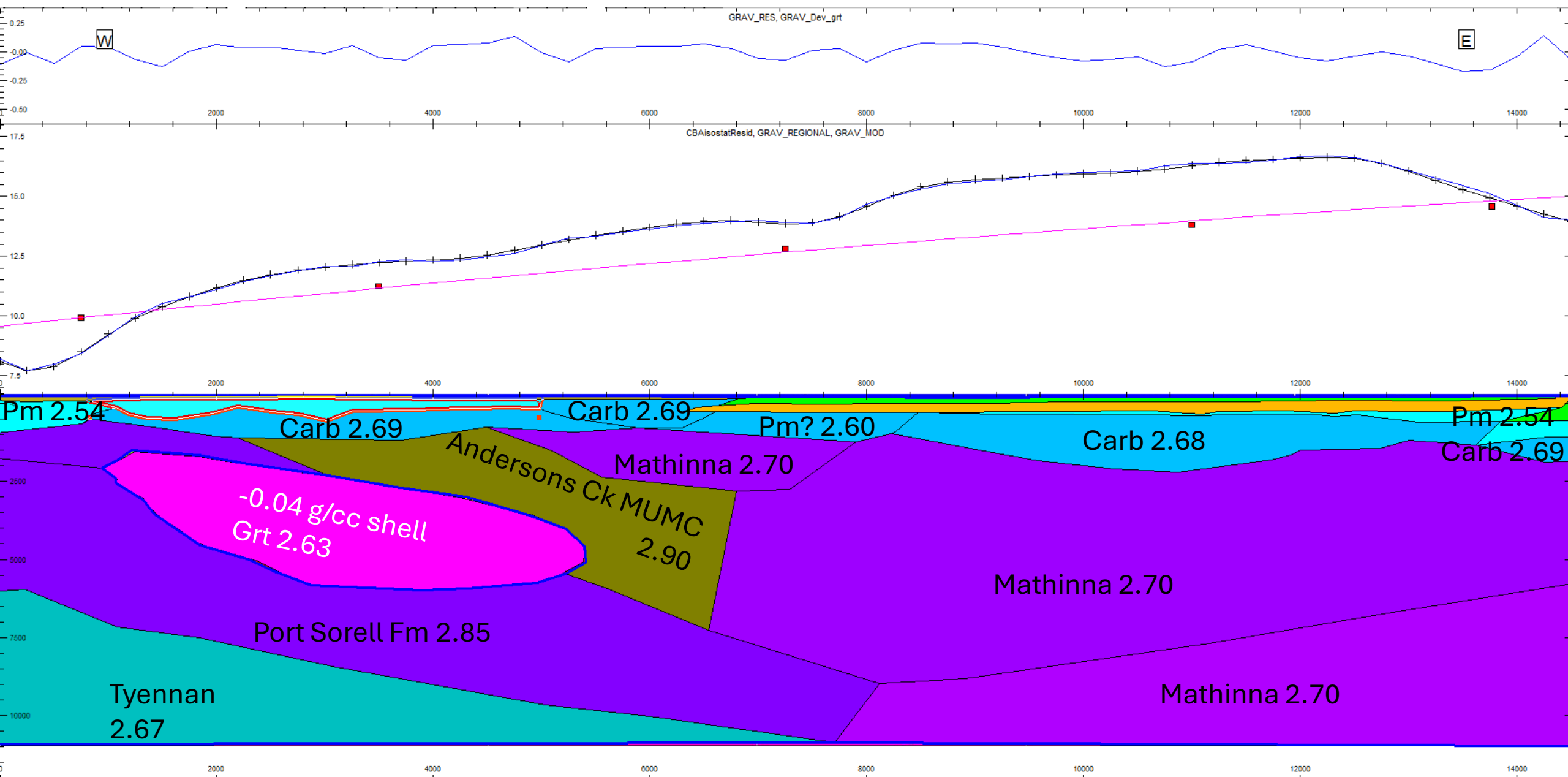
Segment 3 Model v. "i", details upper 3000m, seismic Vint



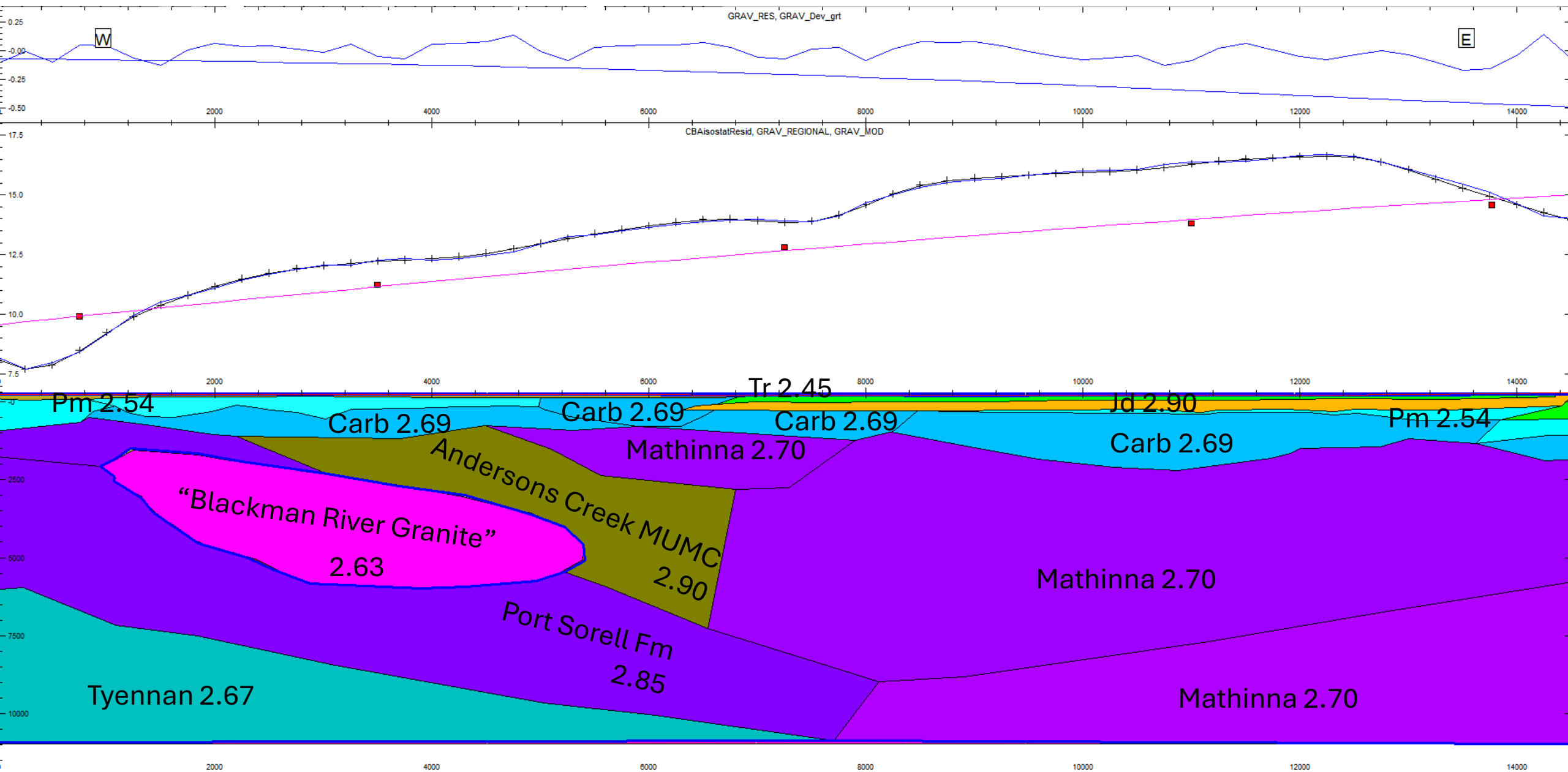
Segment 3 Model v. "i", details upper 3000m, seismic greyscale



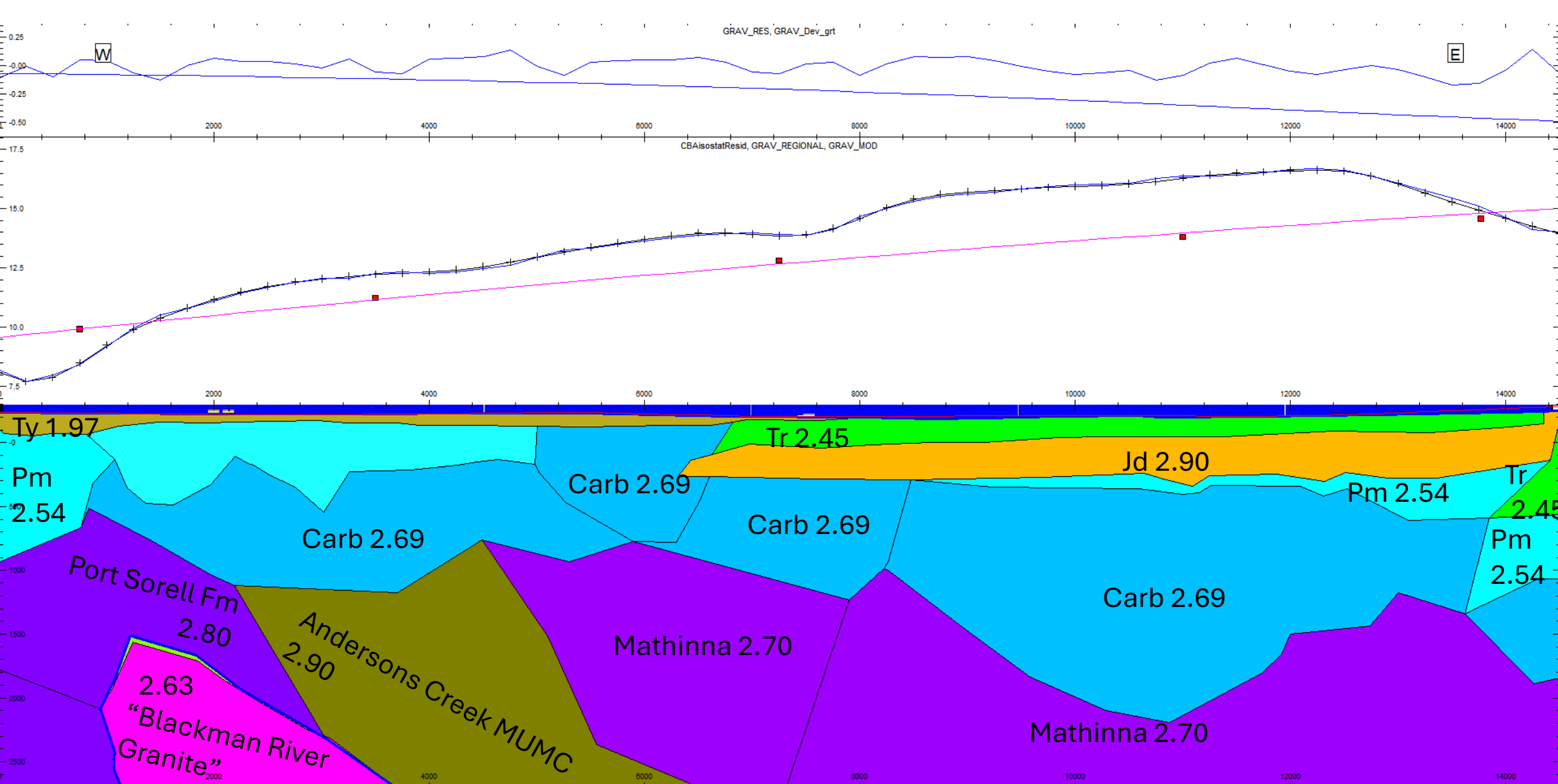
Regional Constrained inversion granite added, no adjustments



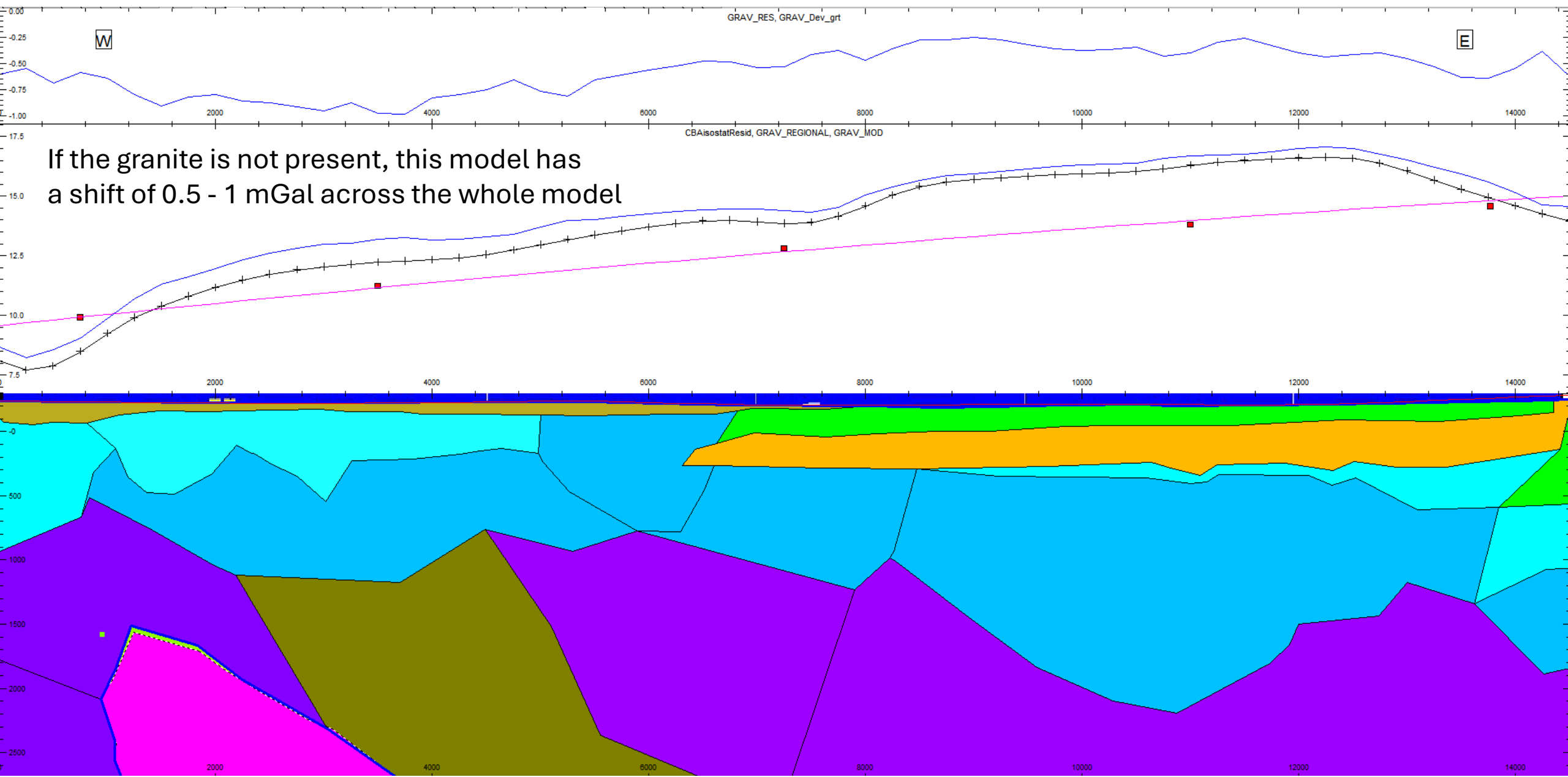
Regional Constrained inversion granite added, adjusted to fit



Segment 3 Model v. "k"

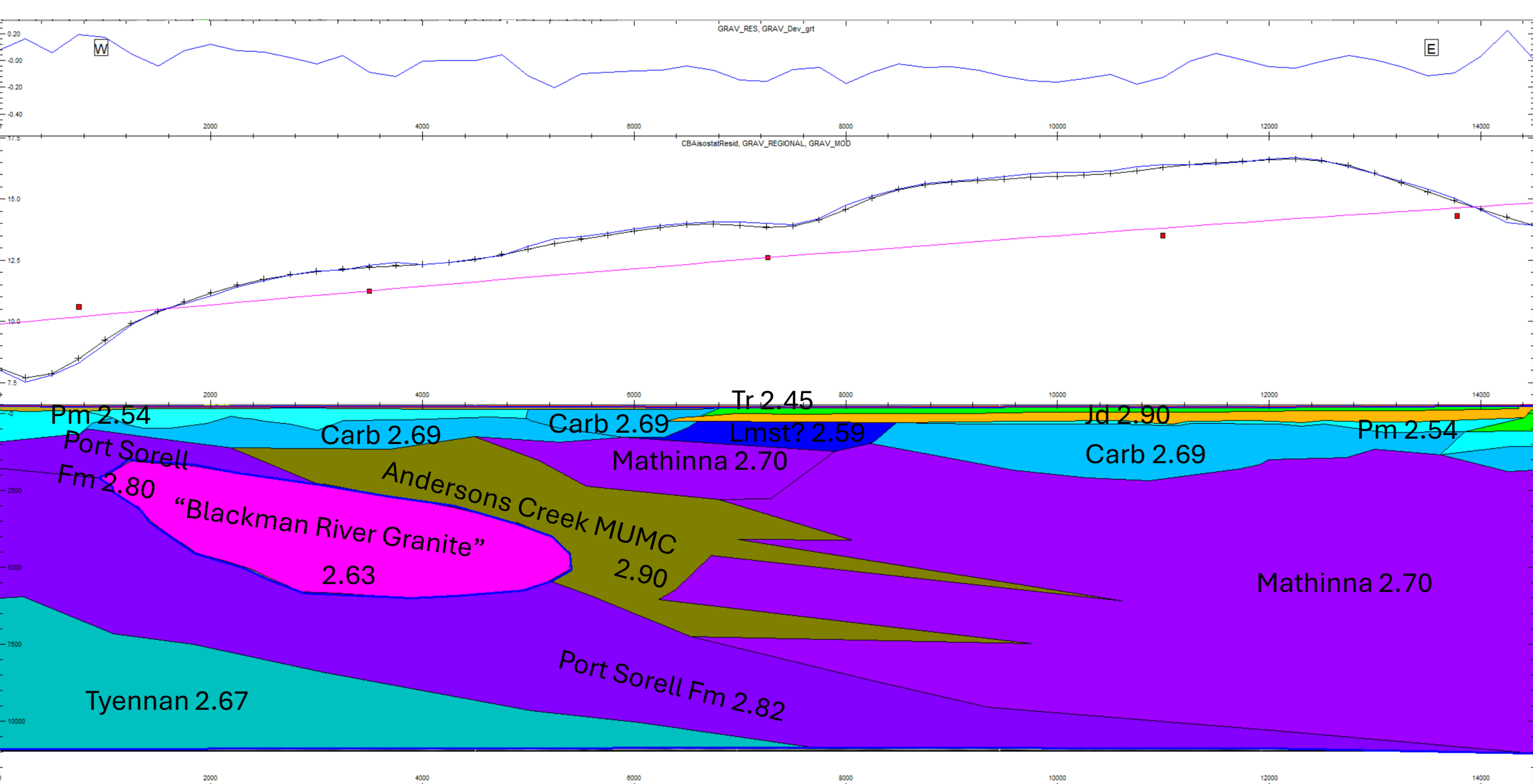


Segment 3 Model v. "k", detail upper 3000m

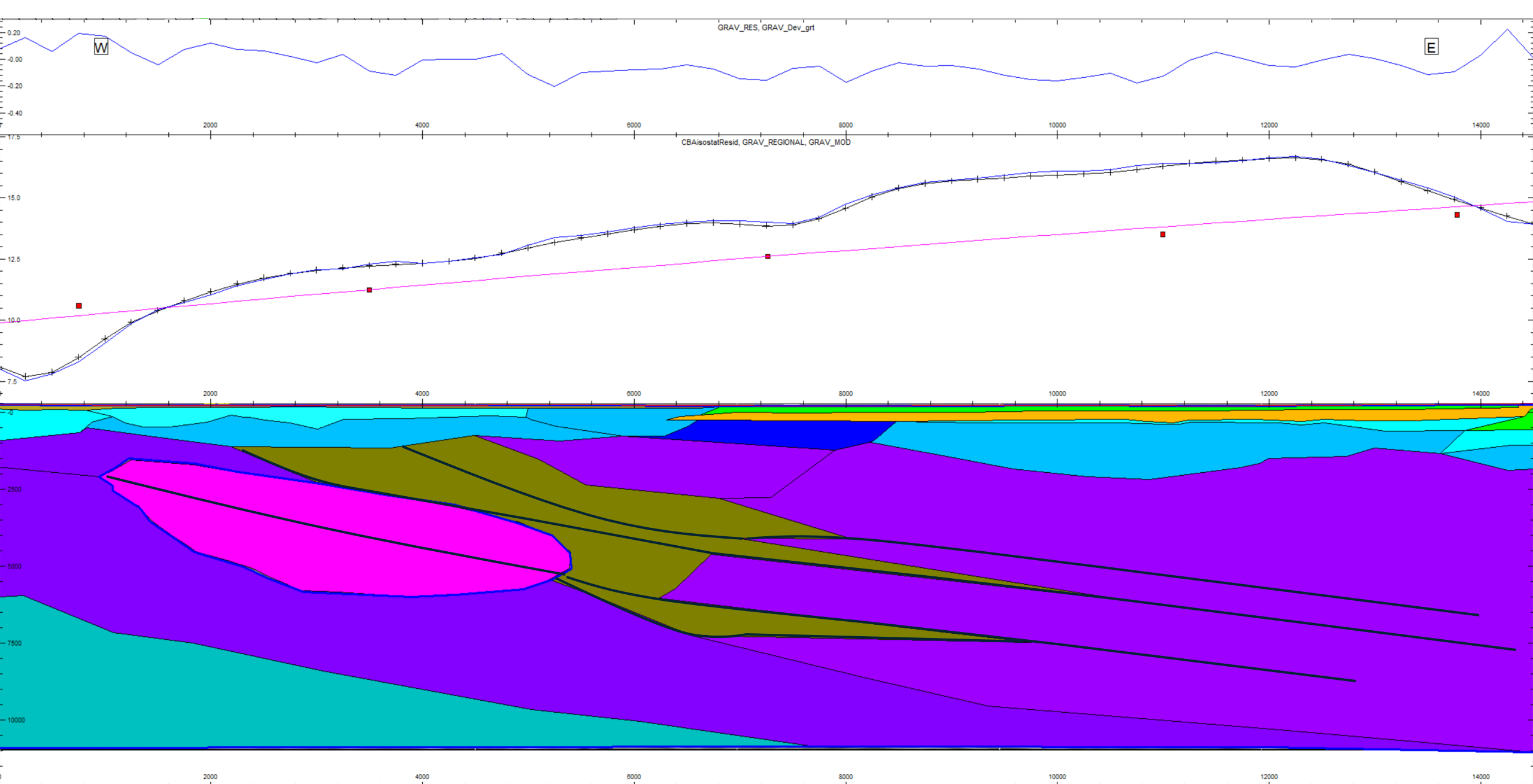


If the granite is not present, this model has a shift of 0.5 - 1 mGal across the whole model

Segment 3 Model v. "k", as per previous slide, detail upper 3000m, Macquarie River granite **inactive**



Segment 3 Model v. "l" - boundaries harmonised to seismic



Segment 3 Model v. "l" - boundaries harmonised to seismic, interpreted Devonian thrusts shown

Segment 3 Commentary:

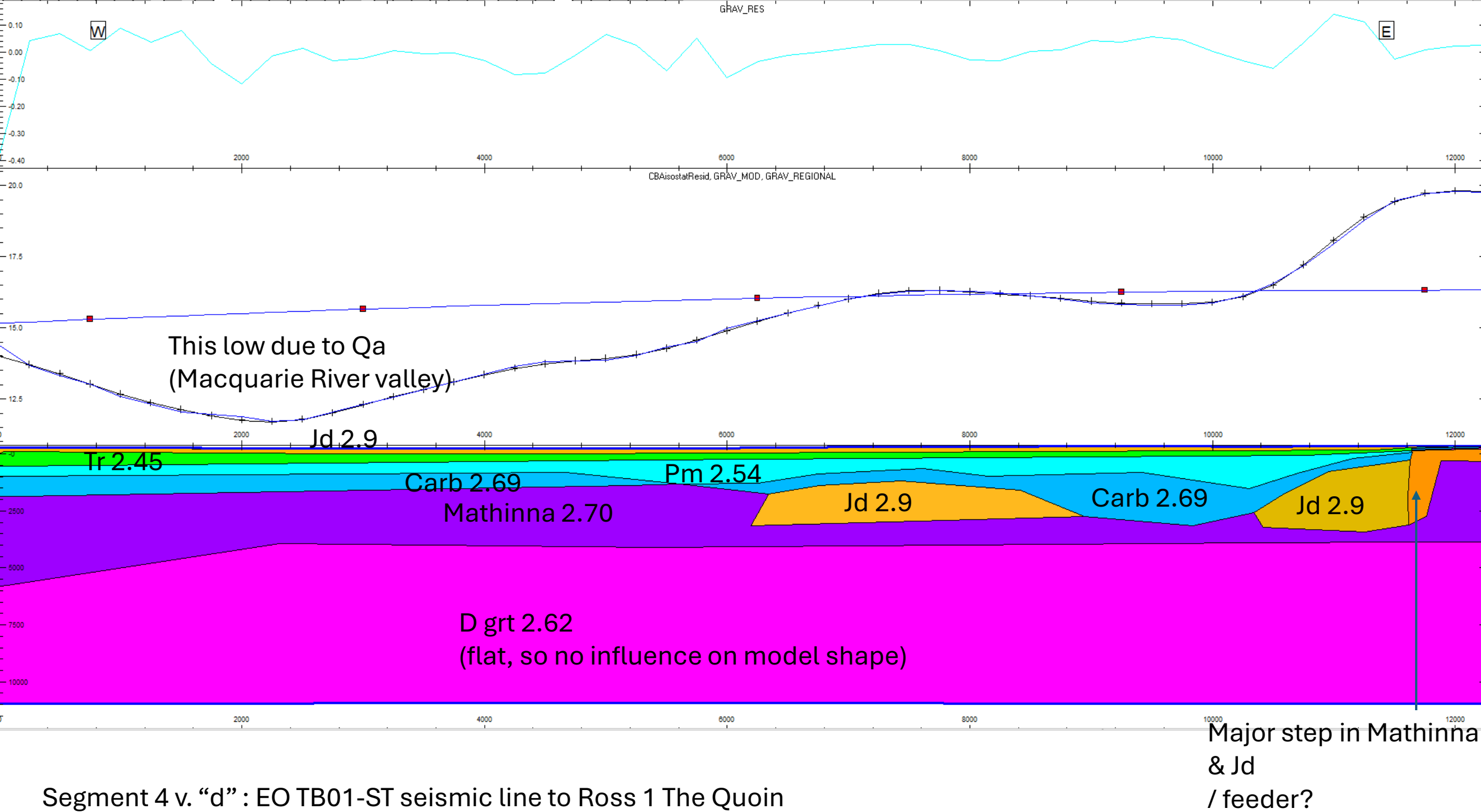
- Several different solutions were trialled, all fitting the data to the same level of fit, more or less.
- All models trialled require significant thicknesses of denser Pm sequences below the Jd. These are labelled Carboniferous, but in the shallower sections could just be carbonate rich (limestone bearing) glaciomarine sequences of the Permian Golden Valley Gp / Darlington Limestone (ASUD / (Wells, 1957; (Clarke, 1968)). The deeper incised rift fills are likely to be the Carboniferous Stockers Tillite (Wells, 1957; Reid and Burrett, 2004).
- The Triassic unit is quite thin
- A Tertiary basin unit of low density reaches up to 180m thickness
- This segment marks the lateral transition from interpreted Port Sorell Fm (higher density) in the west, through a dense unit, interpreted as melange / Andersons Creek MUMC (high density: 2.85), into the lower density (2.70) Mathinna Supergroup to the east.
- There are multiple ways to fit the geology between depths of 1500m and 10km.
- There is less compelling support for a deep, Devonian granite batholith (omitting it creates a model error of 0.4 mGal max) compared to a discrete pluton ("Blackman River Granite") whose omission creates a 0.5 to 1 mGal error in the equivalent model. However, both solutions can be fit to the data within the tolerance of the variance in the density measurements, and the uncertainty of the nature of the blocks in the deeper crust.
- The final solution (v. "m") can be reconciled with the previously interpreted seismic structure. However, the green body interpreted here as ?Anderson's Creek Ultramafic with a density of 2.90 g/cc, may in fact be more complex, and could for example contain sheets of Port Sorell Fm (max density 3.0 g/cc), Badger Head Fm (max density 2.7 g/cc), or Gordon Limestone (max density 2.92 g/cc) (Leaman, 1973; Zengerer, 1999). Resolving what is in this "Badger Head block" (as originally interpreted in the seismic: Direen, 2025) and what proportion of it is truly the Cambrian MUMC rock, will require magnetic modelling cf. (Zengerer, 1999; Roach, 1994).

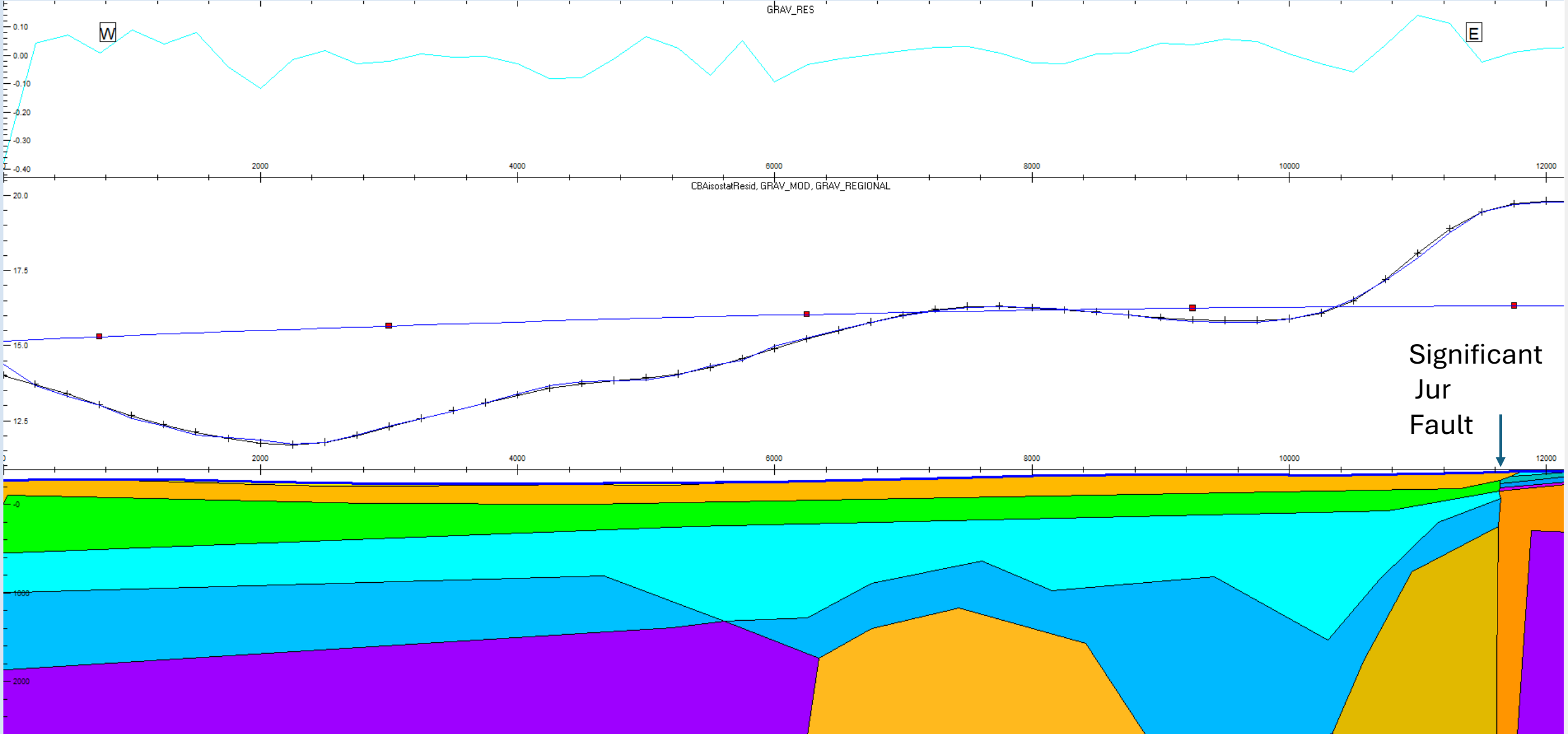


Segment 4 Geology



- ▶ Surface sheet of Jurassic dolerite, faulted in the Macquarie River corridor
- ▶ Tertiary basalt / volcanoclastics and Qa in the Macquarie River corridor
- ▶ Inlier of exposed Permian glaciomarine sequence at Ross 1 The Quoin



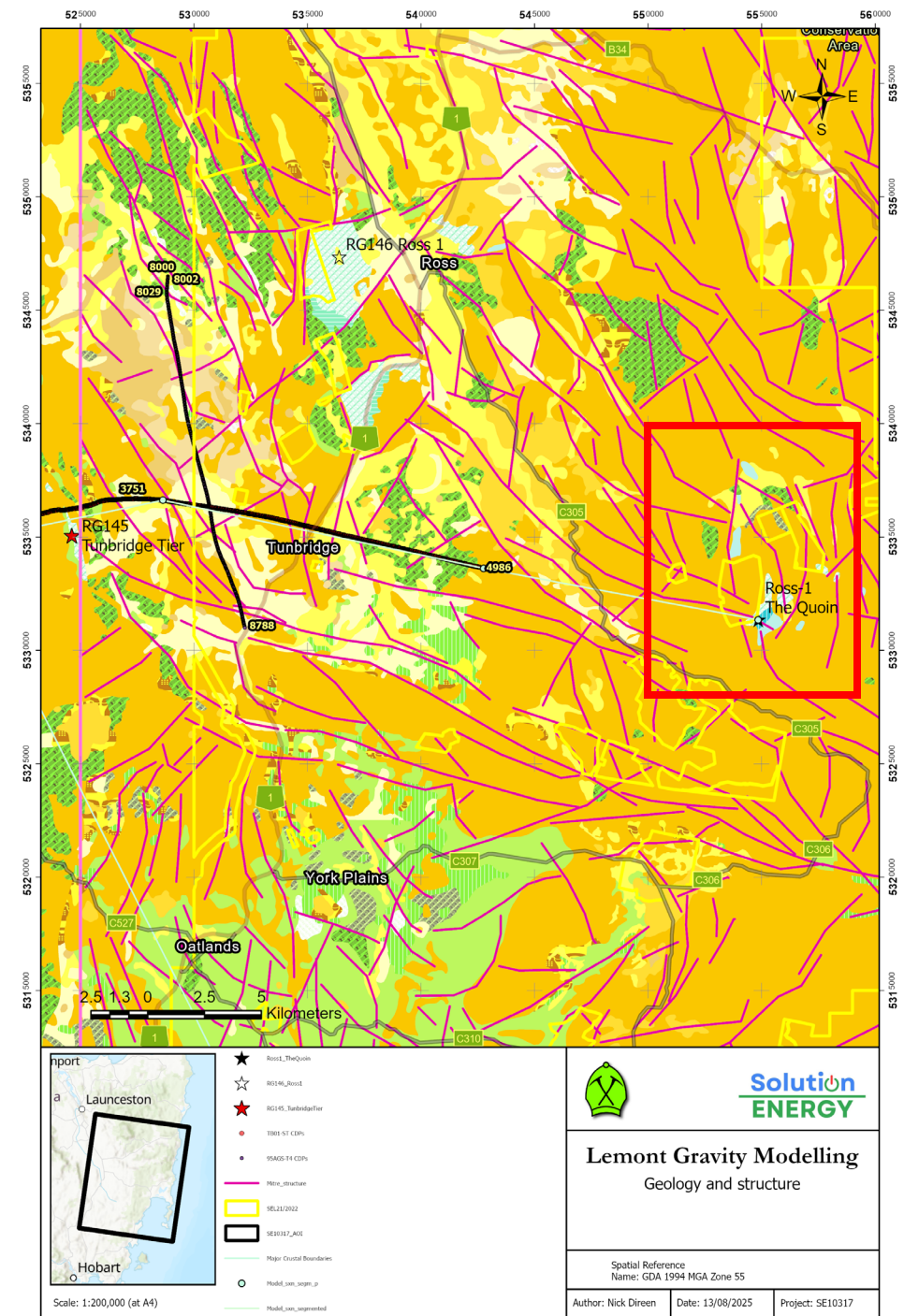


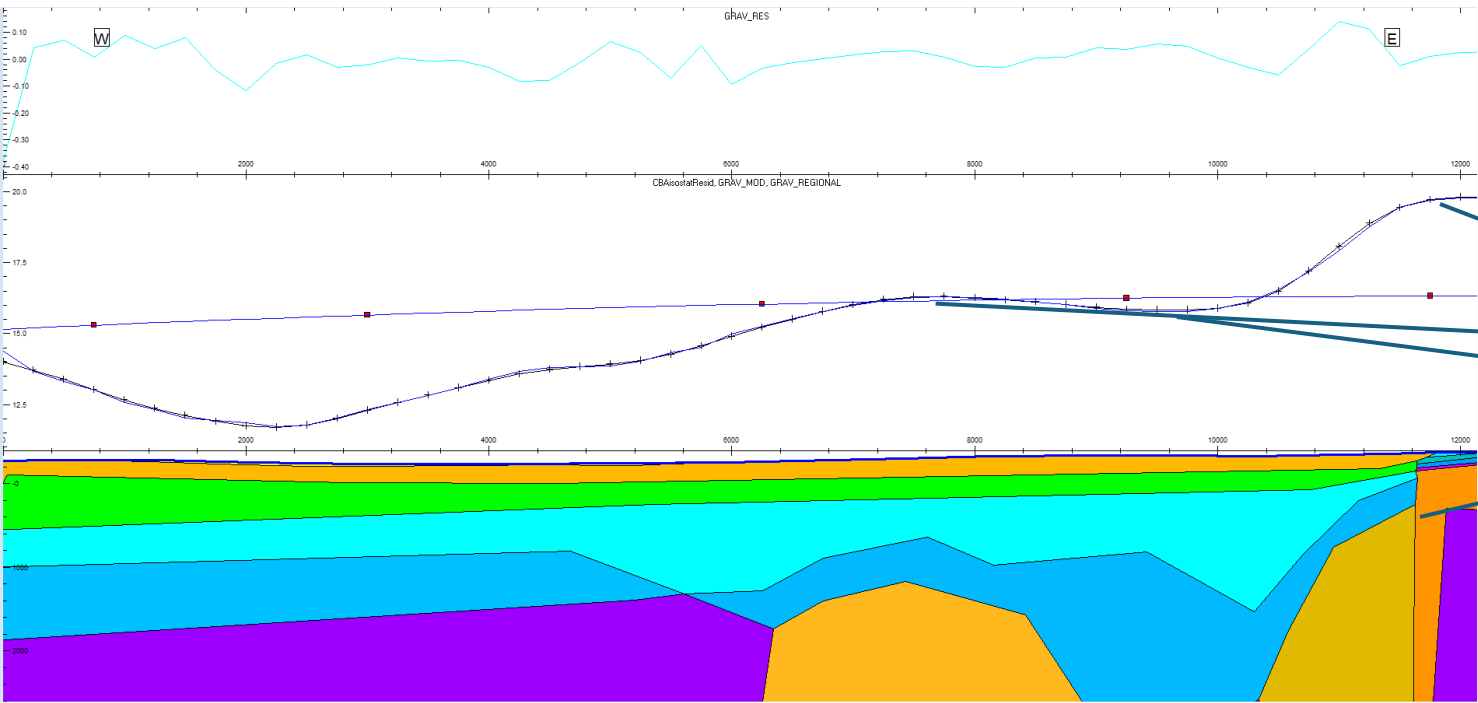
Segment 4 v. "d" : EO TB01-ST seismic line to Ross 1 The Quoin, detail top 3000m

Ross 1 The Quoin (Clarke and Farmer, 1983)

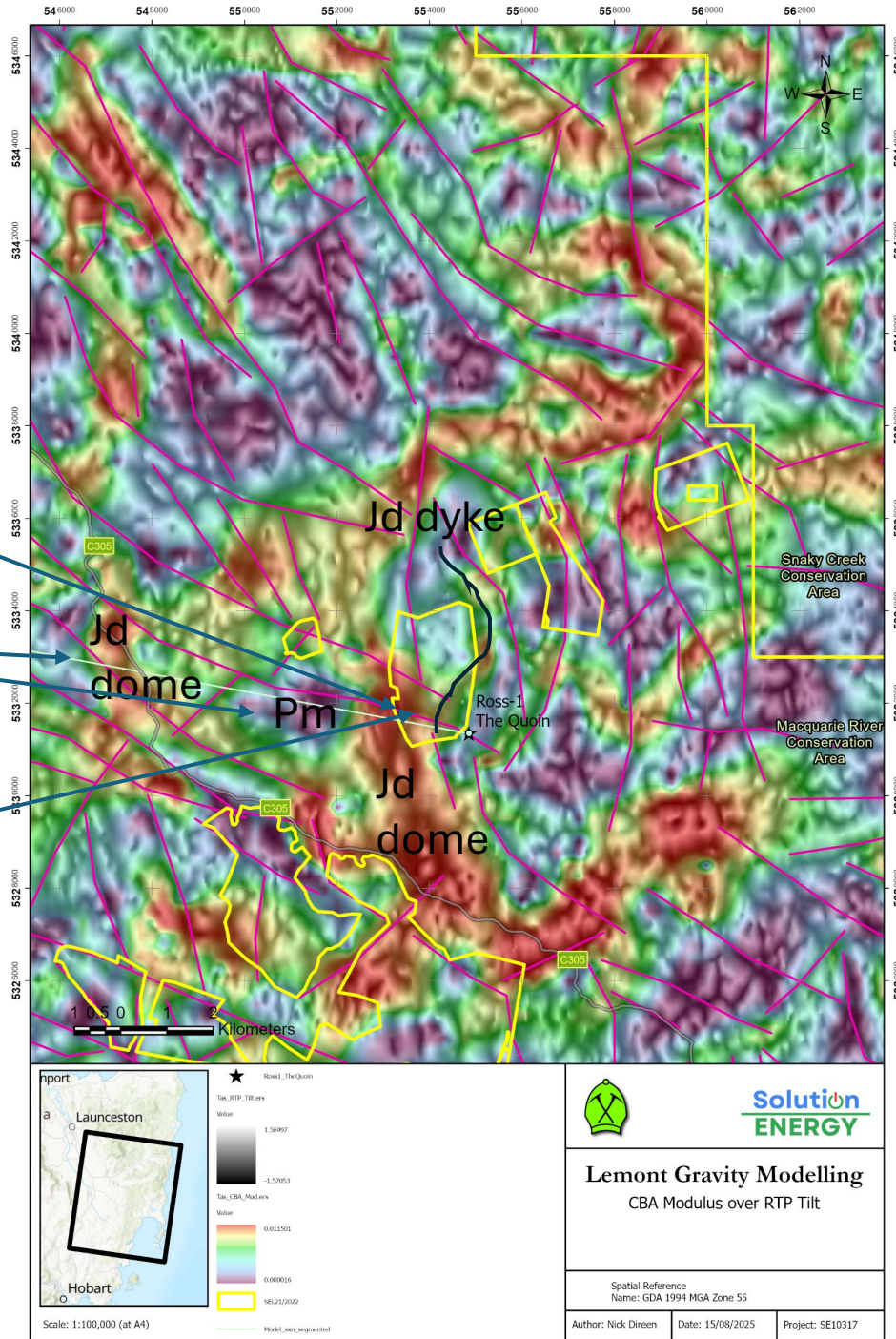
	wrt msl +ve down	Thickness	Unit
KB	-361		
	-234	127	Parmeener
	-175	59	Tillite
	-148	27	Mathinna
	323	471	Jd

Complex structural area
Popped up inlier of Tasmania Basin from beneath Jd

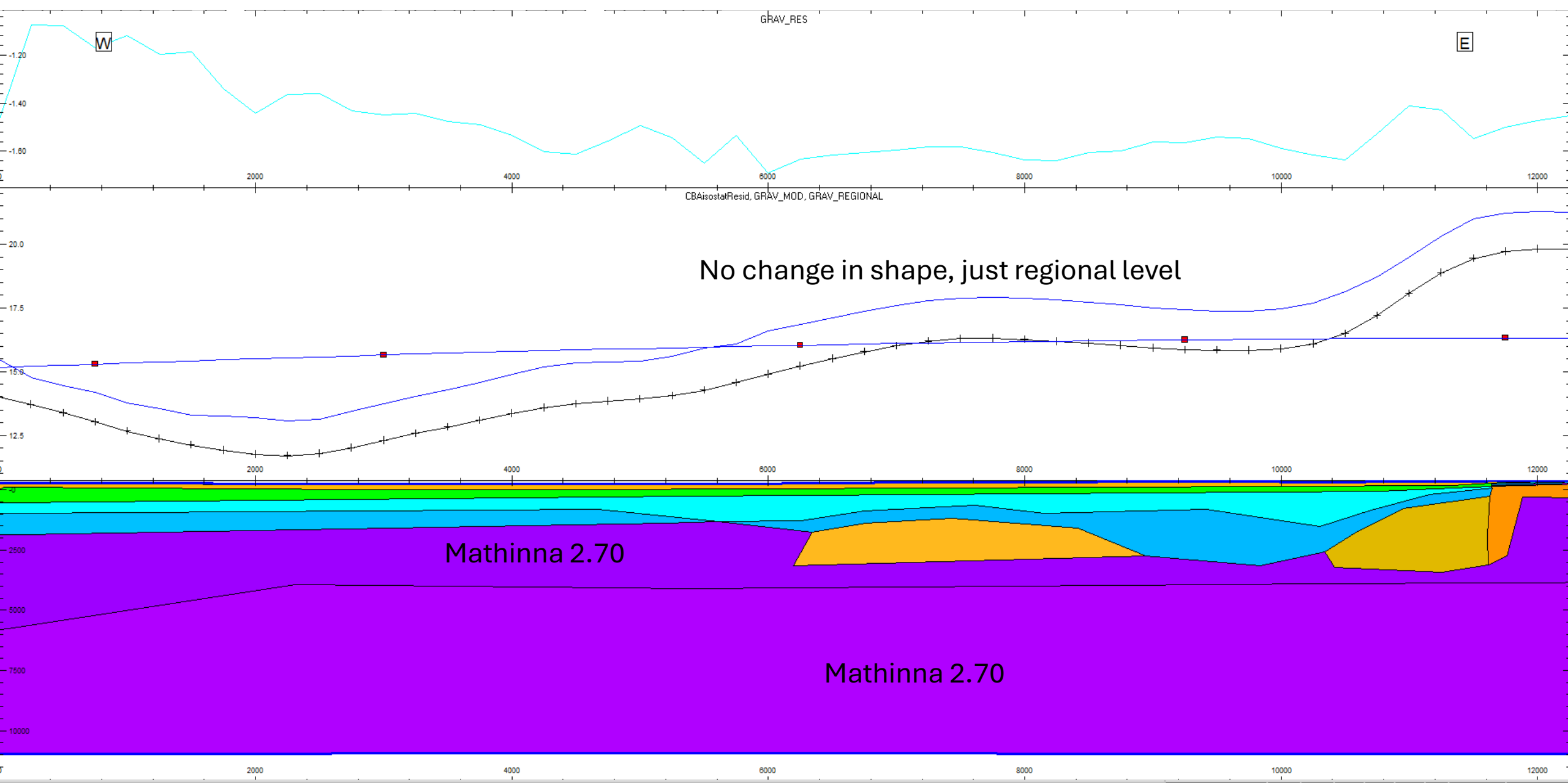


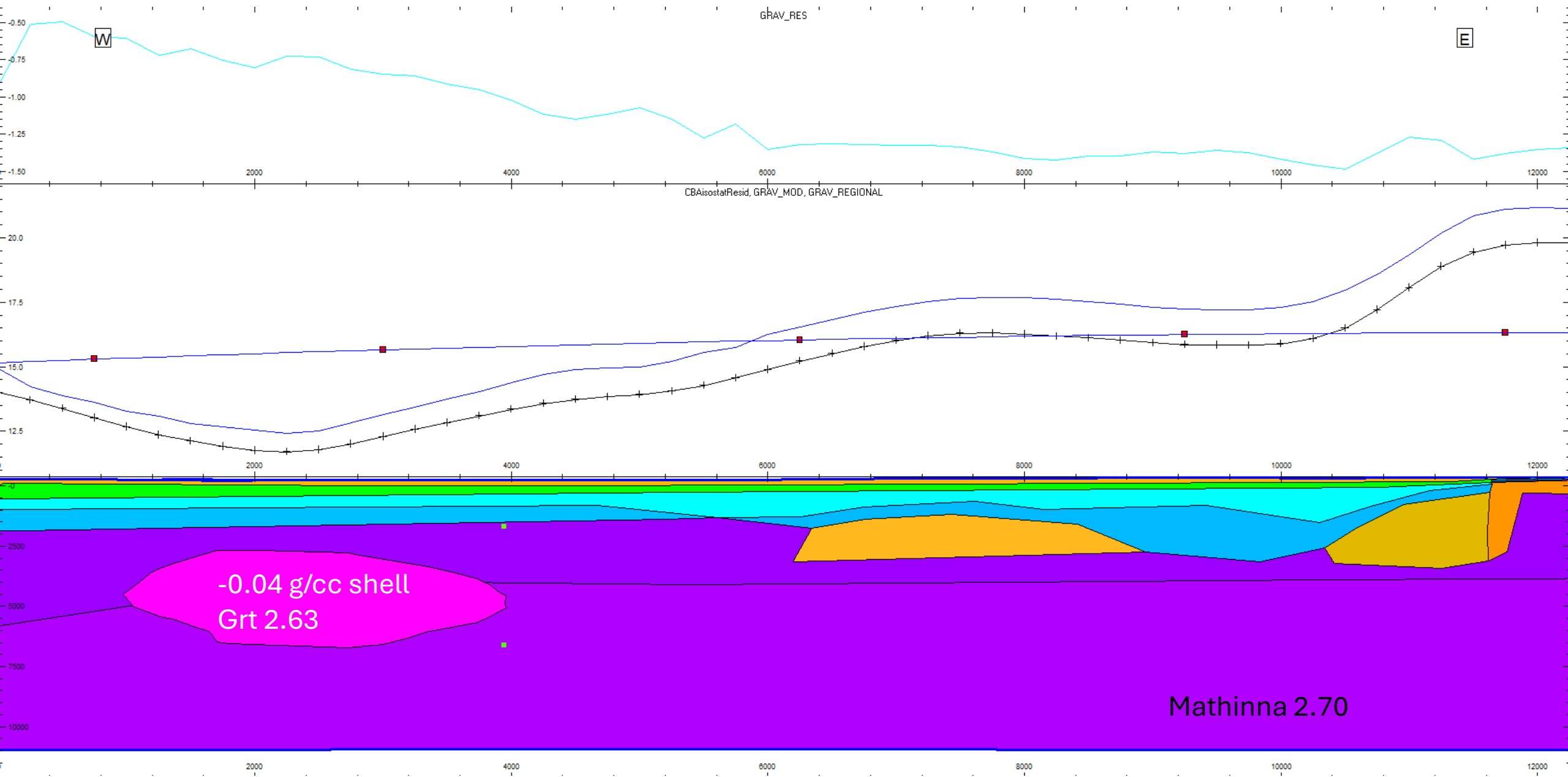


Significant
Jur
Fault

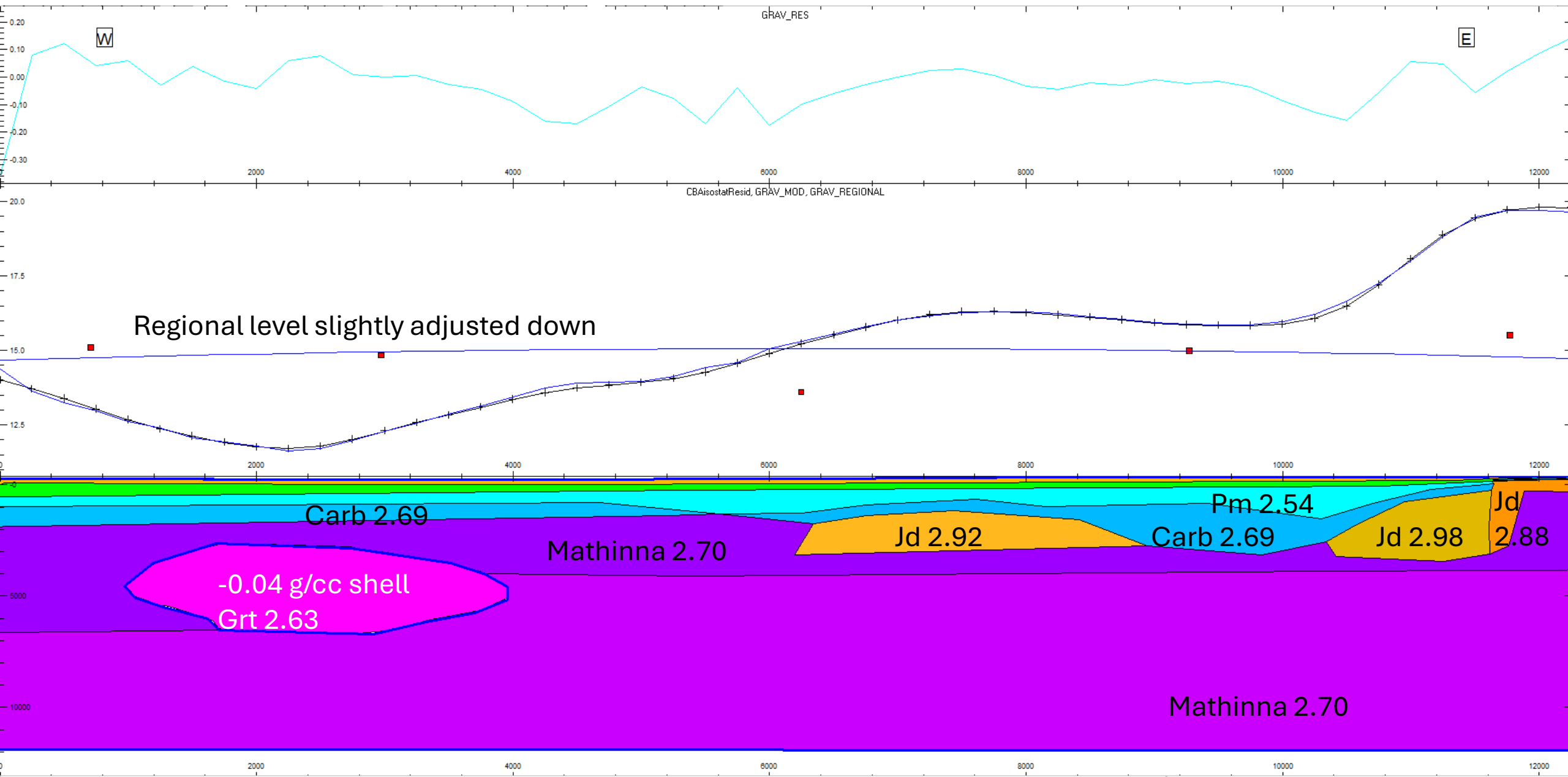


Alternate Model – Mathinna Basement





Regional Constrained inversion granite added, no adjustments



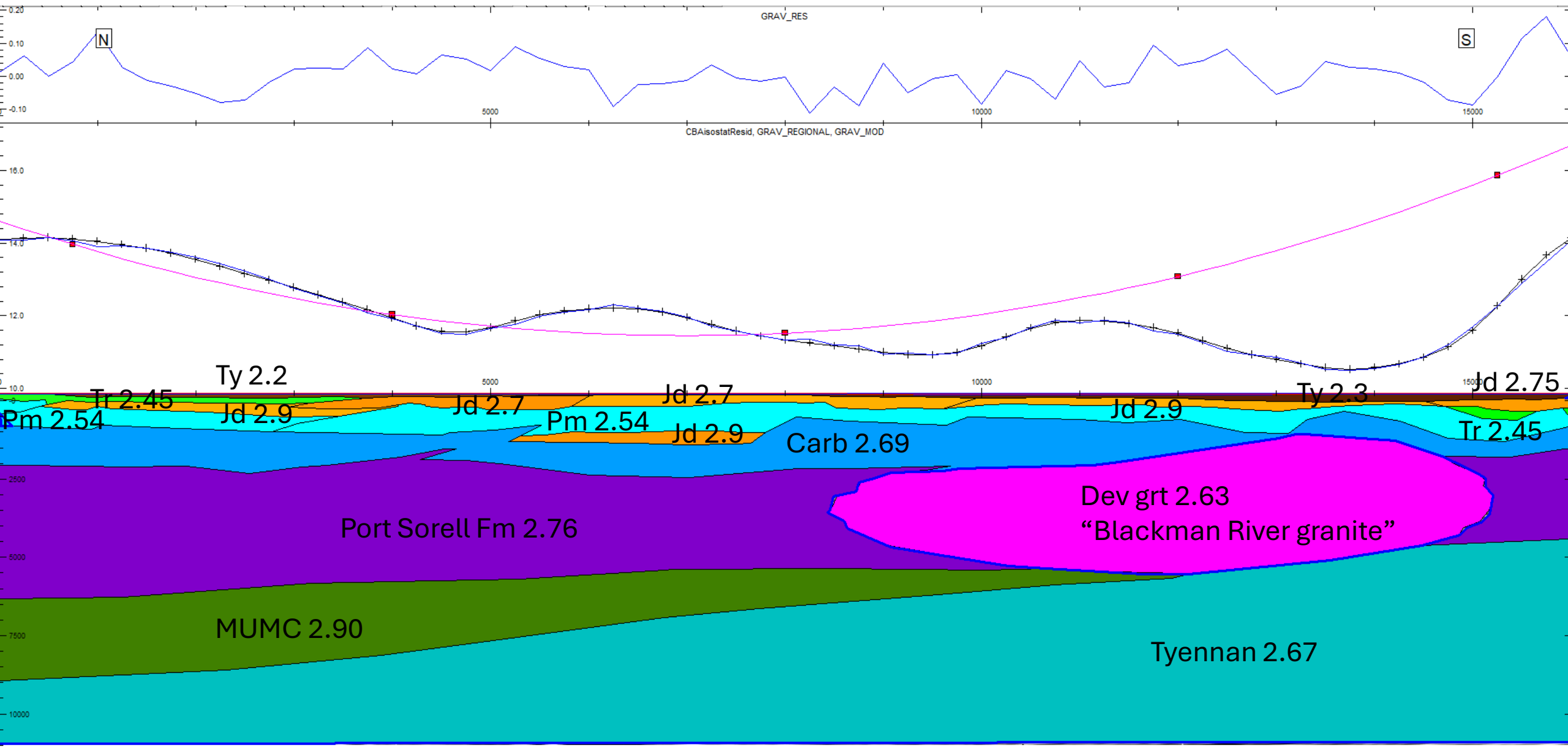
Regional Constrained inversion granite added, adjusted to fit

Segment 4 Commentary:

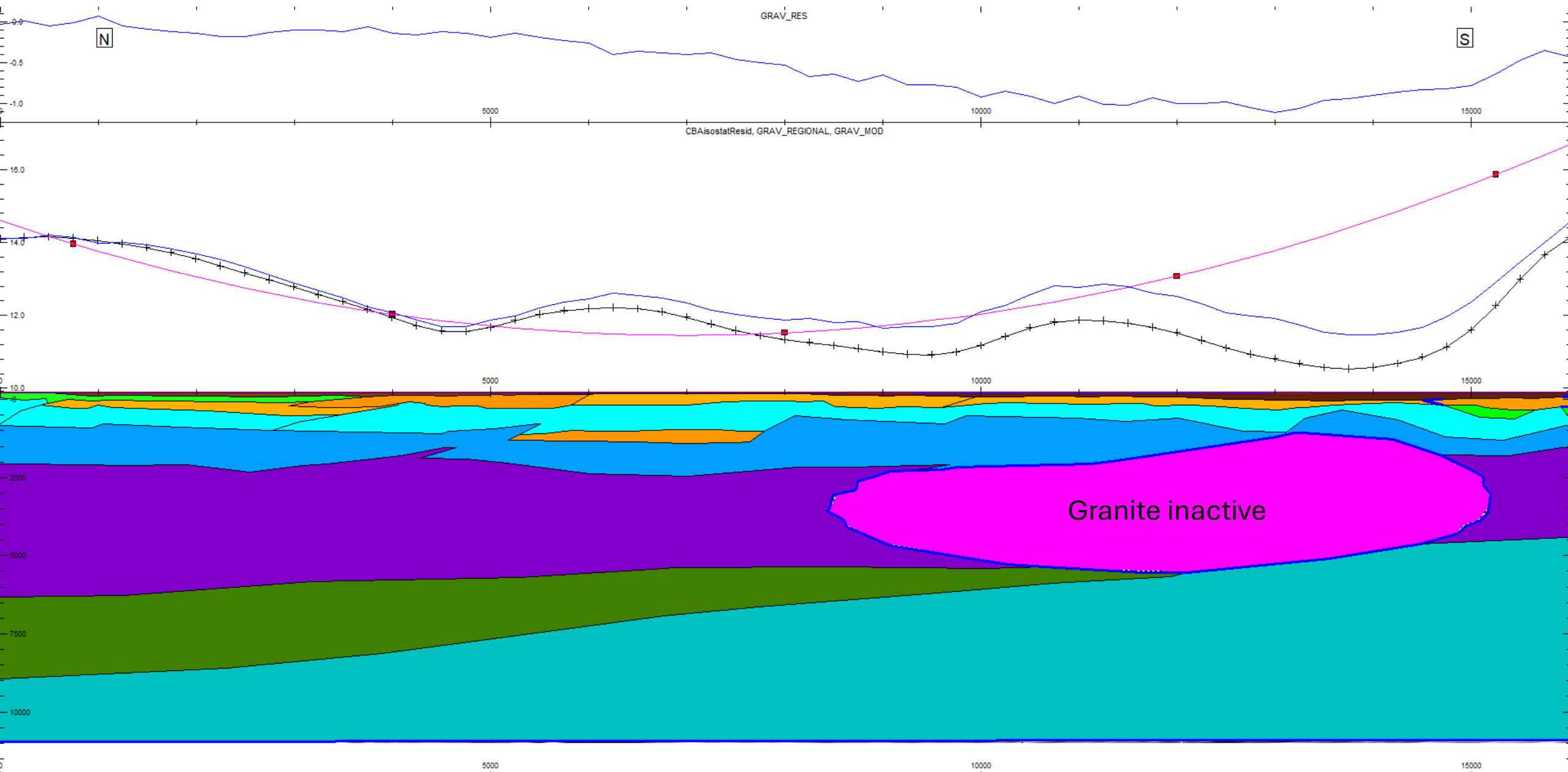
- This model is not sensitive to the presence of a Devonian Granite at depth, as its top surface would be ~flat, so it creates no gravity gradient or anomaly
- The model can be fit with or without the “Macquarie River granite” with only a slight adjustment of the regional level.
- The area around The Quoin appears to be associated with a significant regional fault and a Jurassic dolerite feeder dyke structure to depth. This feature can also be traced in the magnetics.
- Two Jurassic dolerites domes or laccoliths are required to fit the gravity data, and these correspond to magnetic high features



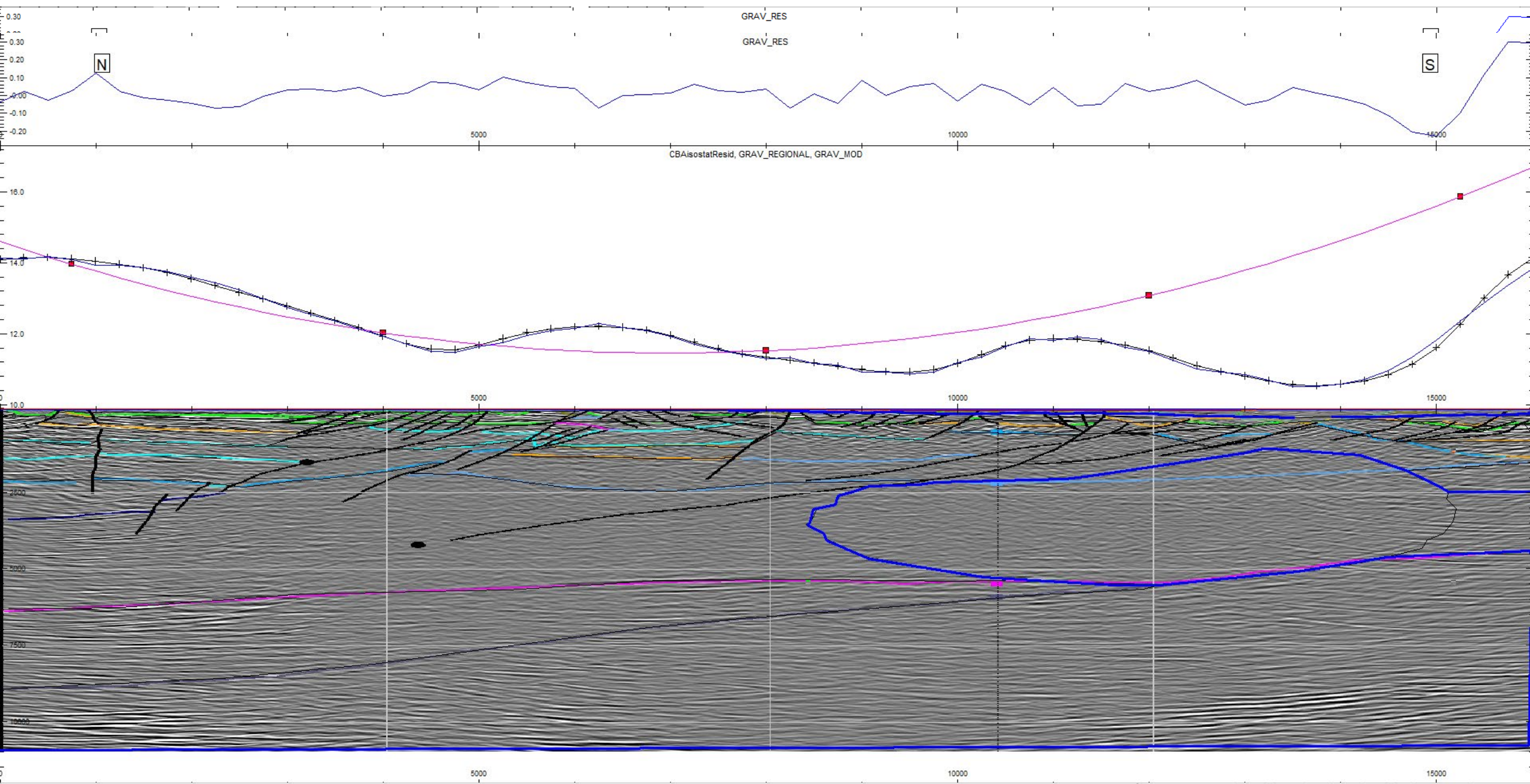
Top surface of model attempted to match to map, but the extent of Qa and Ty units appears to be inaccurate in the Macquarie River valley

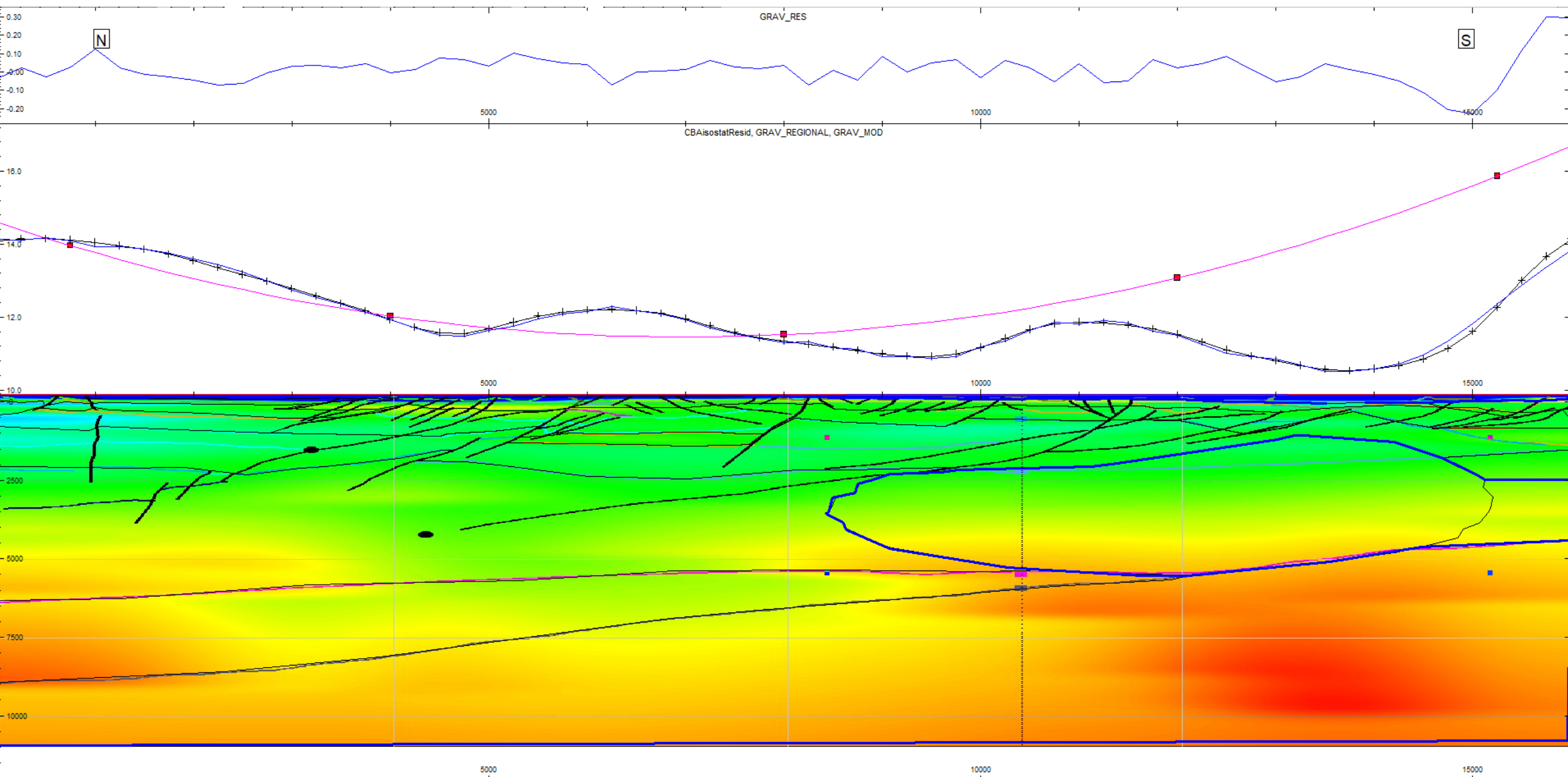


95AGS_T4: to make the model fit, there needs to be significant variance in the exposed Jd density 2.7-2.90 g/cc

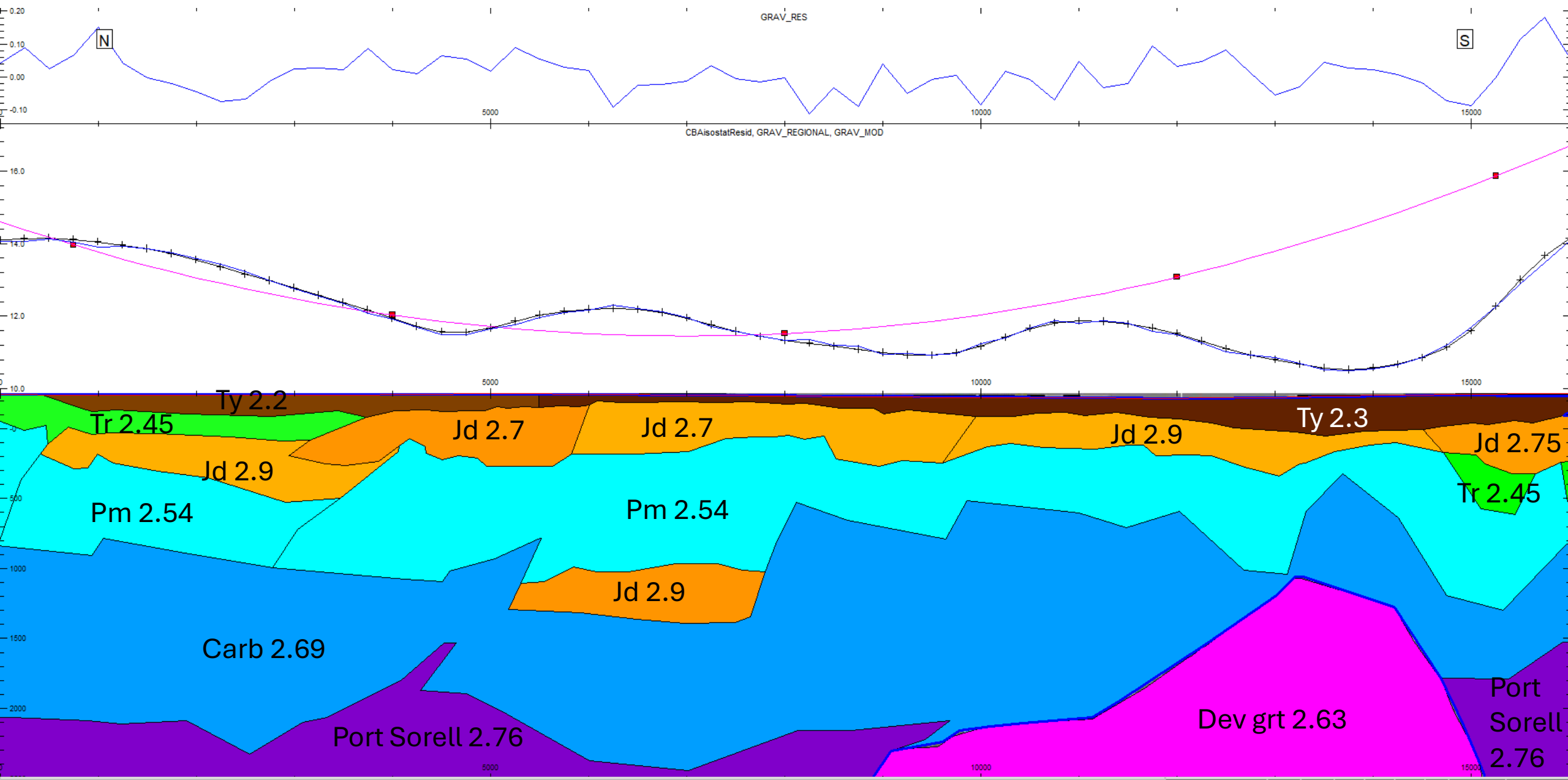


95AGS_T4, no granite contribution. Model error rises to 1 mGal if granite not present

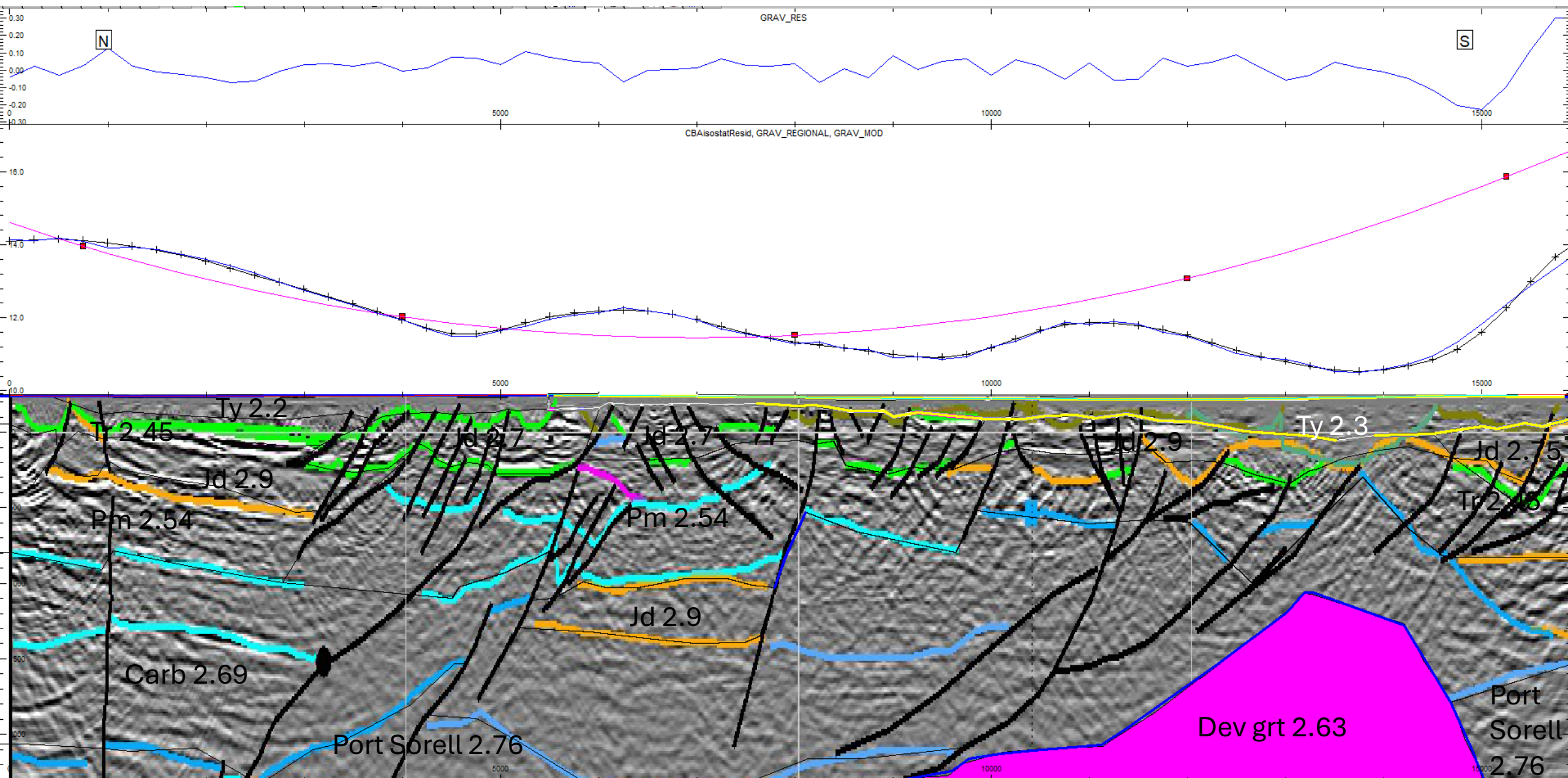




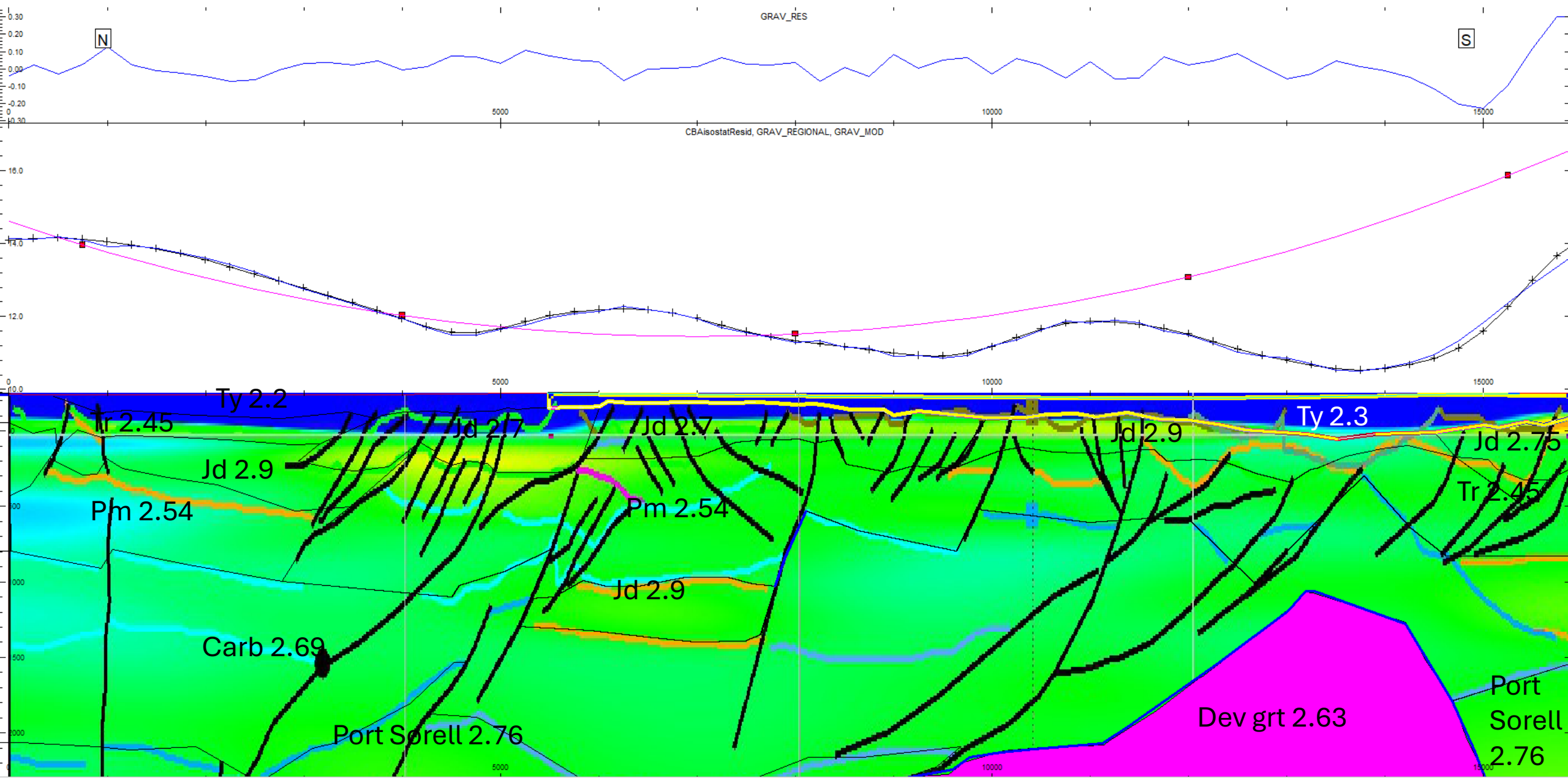
95AGS_T4 Seismic V int



95AGS_T4 details upper 3000m



95AGS_T4 details upper 3000m, seismic greyscale



95AGS_T4 details upper 3000m, seismic Vint

95AGS-T4 Commentary:

- The model strikes along the plane of a major fault system, making the geometries challenging to model.
- The geometry of the interpreted Jd is consistent with the interpretations of Leaman (1996) and Stacey (2009). However, to fit the gravity and the seismic interpretation, the Jd must not be a continuous sheet with identical properties but a series of blocks with different densities, either due to weathering and alteration, or compositions related to faulting exposure levels.
- There is also considerable variation in the thickness of the Permian if its density is kept constant.
- There is support for the “Blackman River granite” being present in this section. Omitting this low density feature creates a model error of ~1Gal.
- The support for the Blackman River granite pluton in both 95AGS-T4 and TB01-ST lines suggests that this solution is favoured over the Leaman (2012) model, based on the criteria of Leaman (1994): that is being based on two consistent interlocking models, as opposed to a single section. Further refinements might be possible in 3D, based on the adjustments made to the regional field, but in reality, this would be a time-consuming exercise, when there is already a regional 3D solution based on inversion of the whole field (Direen and Campbell, 2025), which is also consistent with outcrop and other information.

References

- Clarke, M.J., 1968. A reappraisal of a Lower Permian type section Golden Valley, Tas. Geological Survey Record, 7. TASMANIA DEPARTMENT OF MINES Hobart, 27 pp.
- Clarke, M.J. and Farmer, N., 1983. A diamond drill hole at The Quoin, south-east of Ross, Tasmania Department of Mines, Rosny.
- Direen, N., 2025. Lemont regional tectonostructural analysis from integration of gravity, magnetics and deep seismic reflection imaging, Mitre Geophysics Confidential Unpublished Report Mitre Geophysics Pty Ltd, Perth, pp. 65.
- Direen, N. and Campbell, F., 2025. Delineation of Tabberabberan granitoids in eastern Tasmania from gravity inversions., Mitre Geophysics Pty Ltd, Perth.
- Leaman, D., 1973. Applied geophysics in Tasmania: Part 1. Summary of surveys and rock properties. Exploration Geophysics, 4(3): 27-58.
- Leaman, D., 1994. Criteria for evaluation of potential field interpretations. First Break, 12(4): 181-191.
- Leaman, D. and Richardson, R., 2003. A geophysical model of the major Tasmanian granitoids. Tasmanian Geological Survey Record, 11, 2003 pp.
- Leaman, D.E., 1996. Evaluation AGSO seismic lines T4, T5 Tasmania for Great Southland Minerals Pty Ltd, Leaman Geophysics, Hobart.
- Leaman, D.E., 2007. Subsurface form of granites, eastern Tasmania. Analysis for KUTh Energy, Leaman Geophysics, Hobart.
- Leaman, D.E., 2010. Subsurface form of granites, eastern Tasmania. Preliminary Interpretation. 2010. Analysis for KUTh Energy, Leaman Geophysics, Hobart.
- Leaman, D.E., 2012. An interpretation of the granitoid rocks of eastern Tasmania, Mineral Resources Tasmania, Rosny.
- Lewis, R.J.G., 2005. Geothermal energy prospects for Tasmania, KUTh Exploration Pty Ltd,, Hobart.
- Rast, K., 2009. Thermal and petrophysical characteristics of the sedimentary overburden of radiogenic granites in eastern Tasmania to constrain conductive thermal modelling, University of Tasmania, Hobart, 69 pp.
- Reid, C. and Burrett, C., 2004. The geology and hydrocarbon potential of the glaciomarine Lower Parmeener Supergroup, Tasmania Basin. In: P.J. Boulton, D.R. Johns and S.C. Lang (Editors), Eastern Australasian Basins Symposium II. Petroleum Exploration Society of Australia Special Publication, Adelaide, South Australia, pp. 265-275.
- Roach, M., 1994. The regional geophysical setting of gold mineralisation in northeast Tasmania, University of Tasmania.
- Stacey, A.R., 2009. The structural history of Tasmania from the Devonian to the recent, University of Tasmania, Hobart, 361 pp.
- Wells, A.T., 1957. Geology of the Deloraine-Golden Valley Area, Tasmania. Museum Committee, Launceston City Council.
- Zengerer, M., 1999. Gravity and magnetics of the West Tamar District, northern Tasmania, University of Tasmania, Hobart.