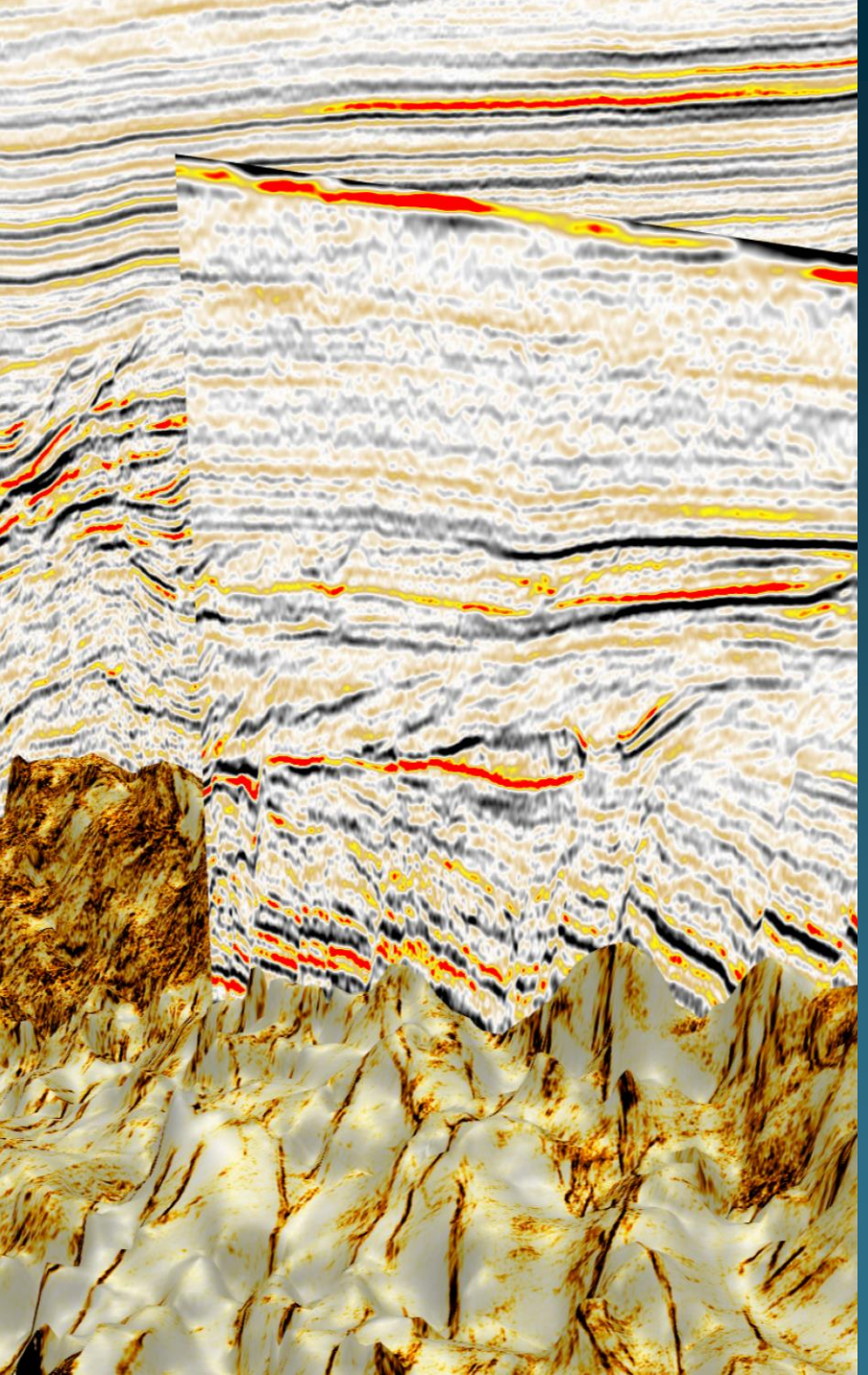


Australian Government
Geoscience Australia

Post-stack 3D merging to fast-track regional interpretation

Offshore Otway Basin case study

Merrie-Ellen Gunning | Director Offshore Energy Systems

© Commonwealth of Australia (Geoscience Australia) 2024

Acknowledgement of Country

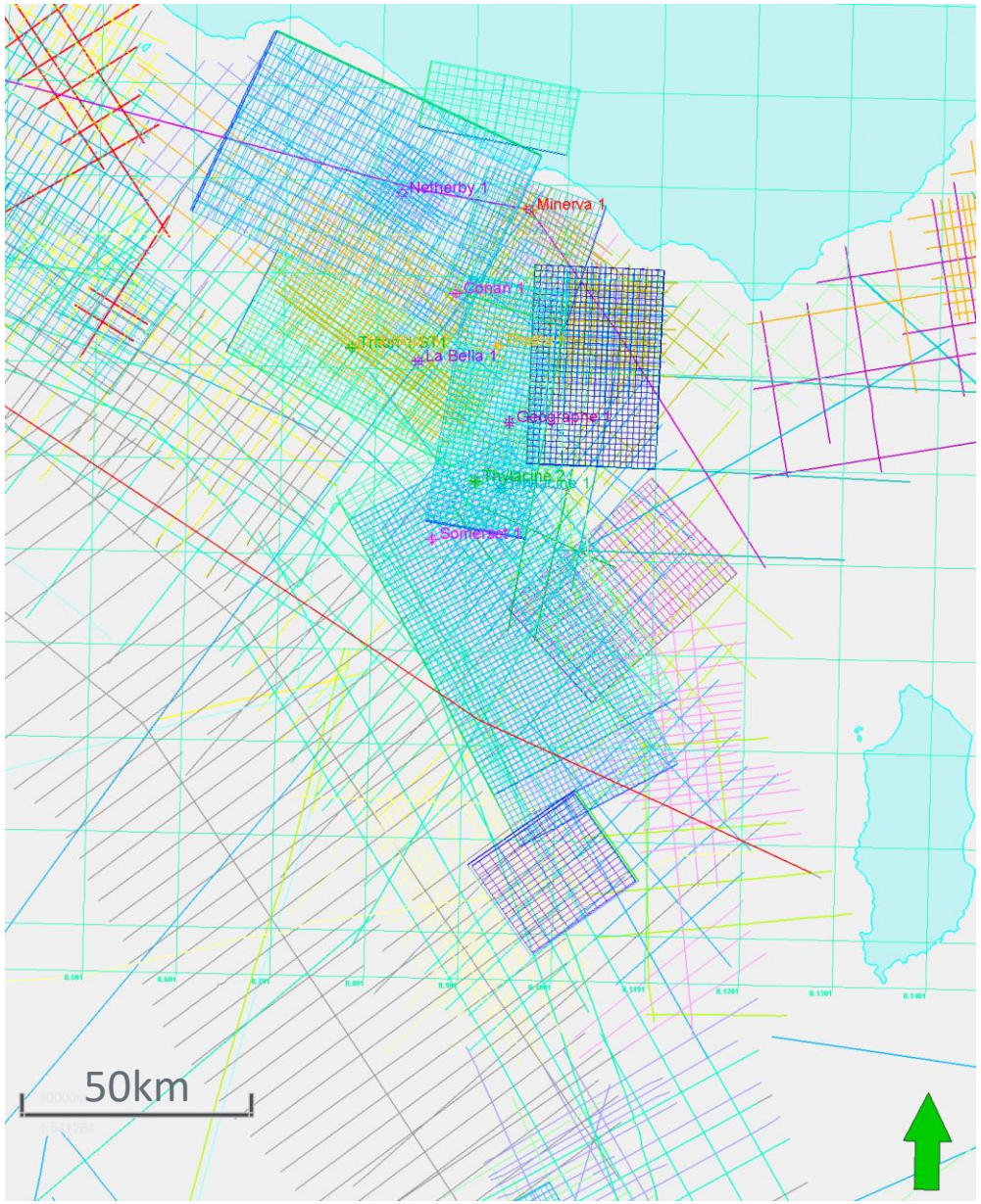
Geoscience Australia acknowledges the traditional owners and custodians of Country throughout Australia and acknowledges their continuing connection to land, waters and community. We pay our respects to the people, the cultures and the elders past and present.

Image: Caterpillar Tracks: Artwork by Roseanne Kemarre Ellis on Geoscience Australia's Alice Springs antenna

© Commonwealth of Australia (Geoscience Australia) 2024

Setting

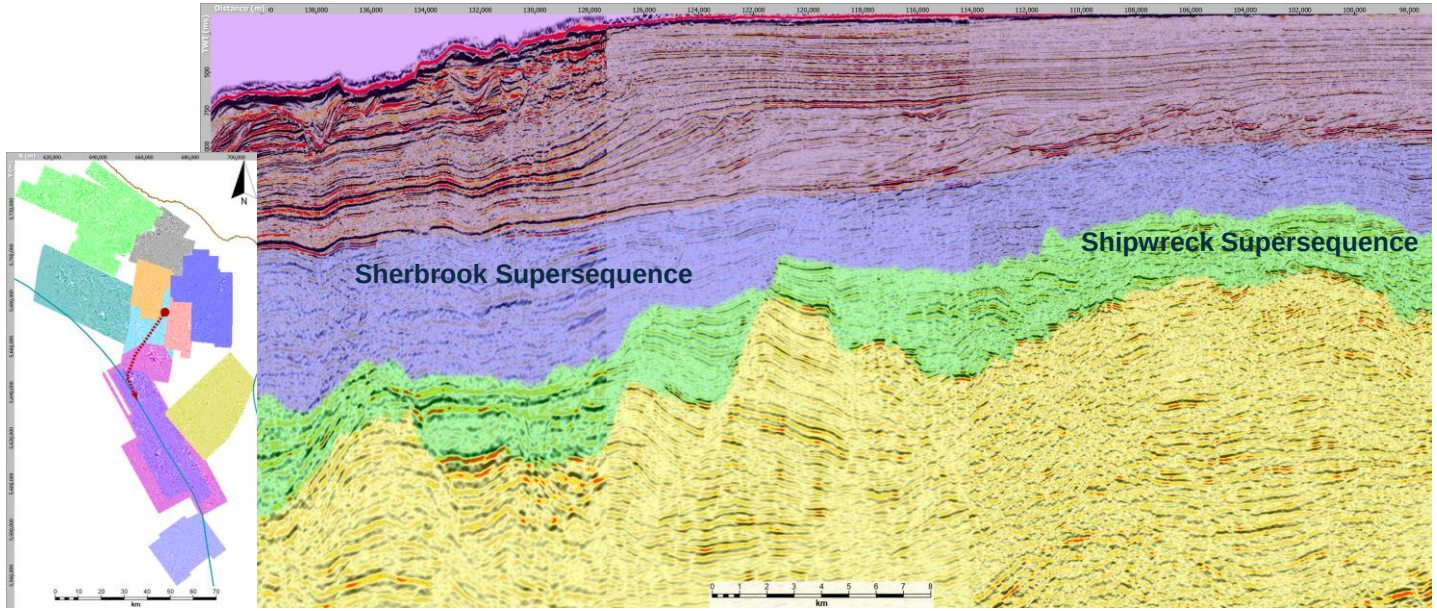
- Multiple surveys, orientation, imaging, previous merges.
- Regional – predominantly 2D - mapping project

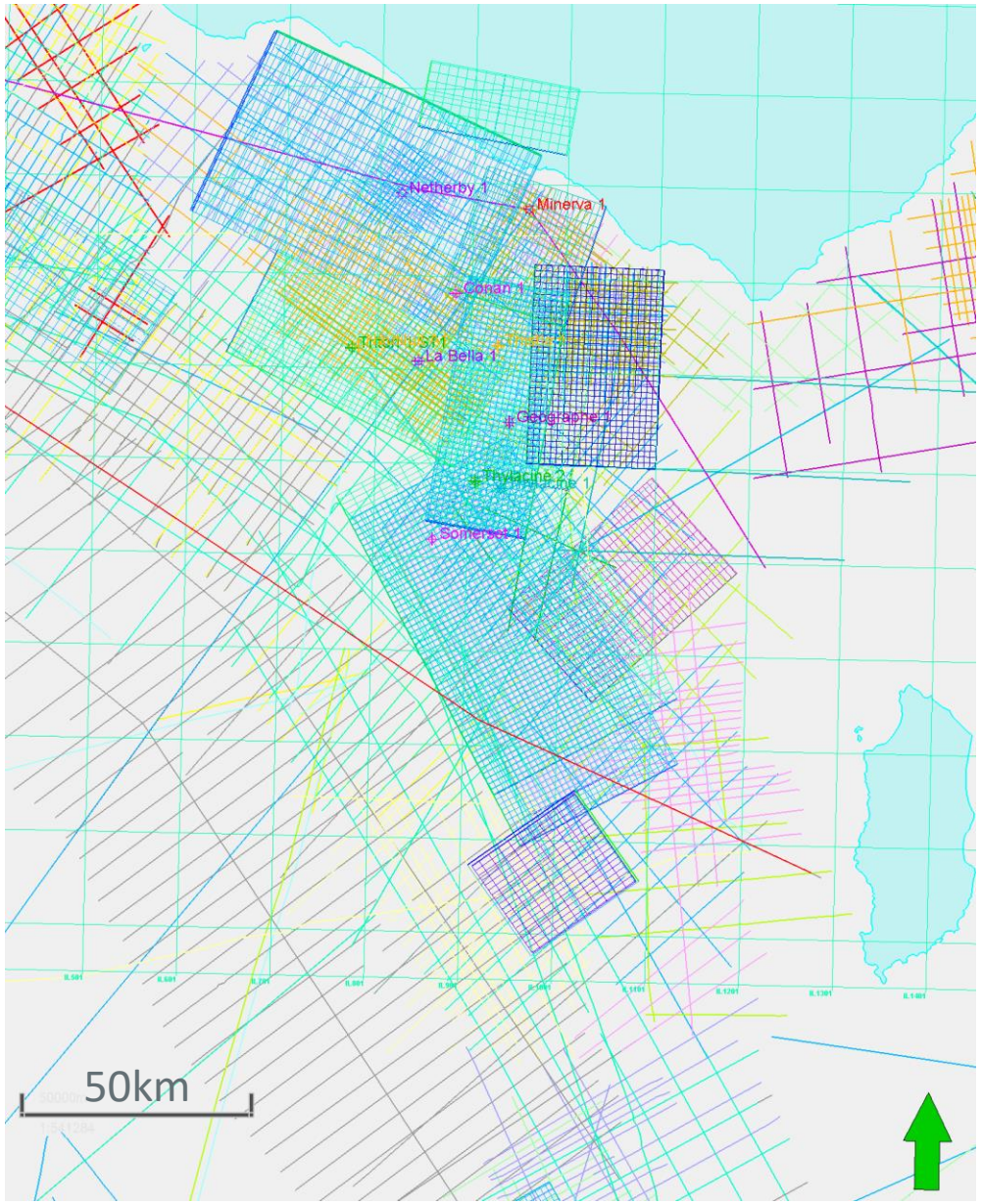


© Commonwealth of Australia (Geoscience Australia) 2024

Setting

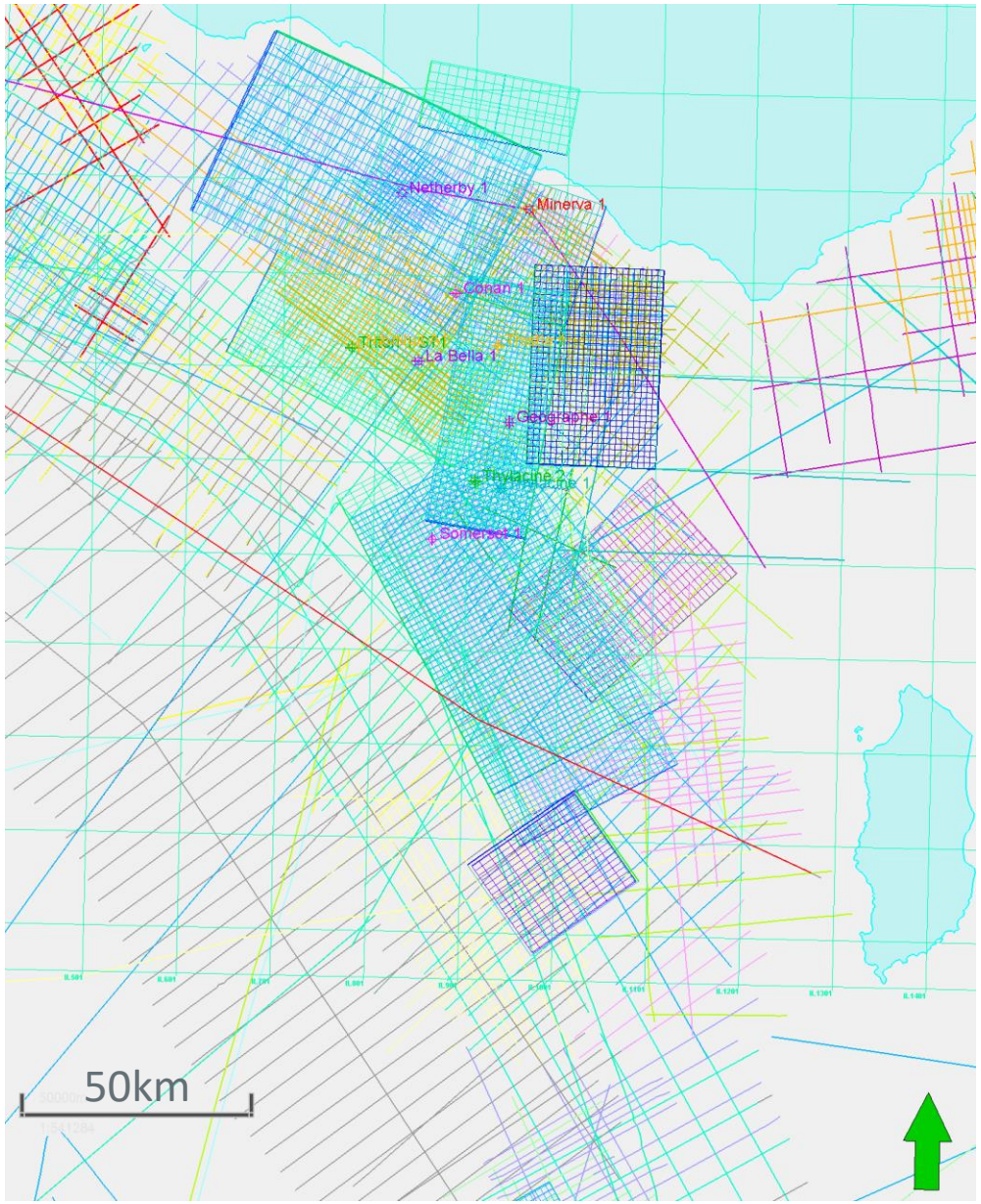
- Multiple surveys, orientation, imaging, previous merges.
- Regional – predominantly 2D - mapping project
- Integrating interpretation across the region – focus on the upper Cretaceous (Sherbrook and Shipwreck supersequences)





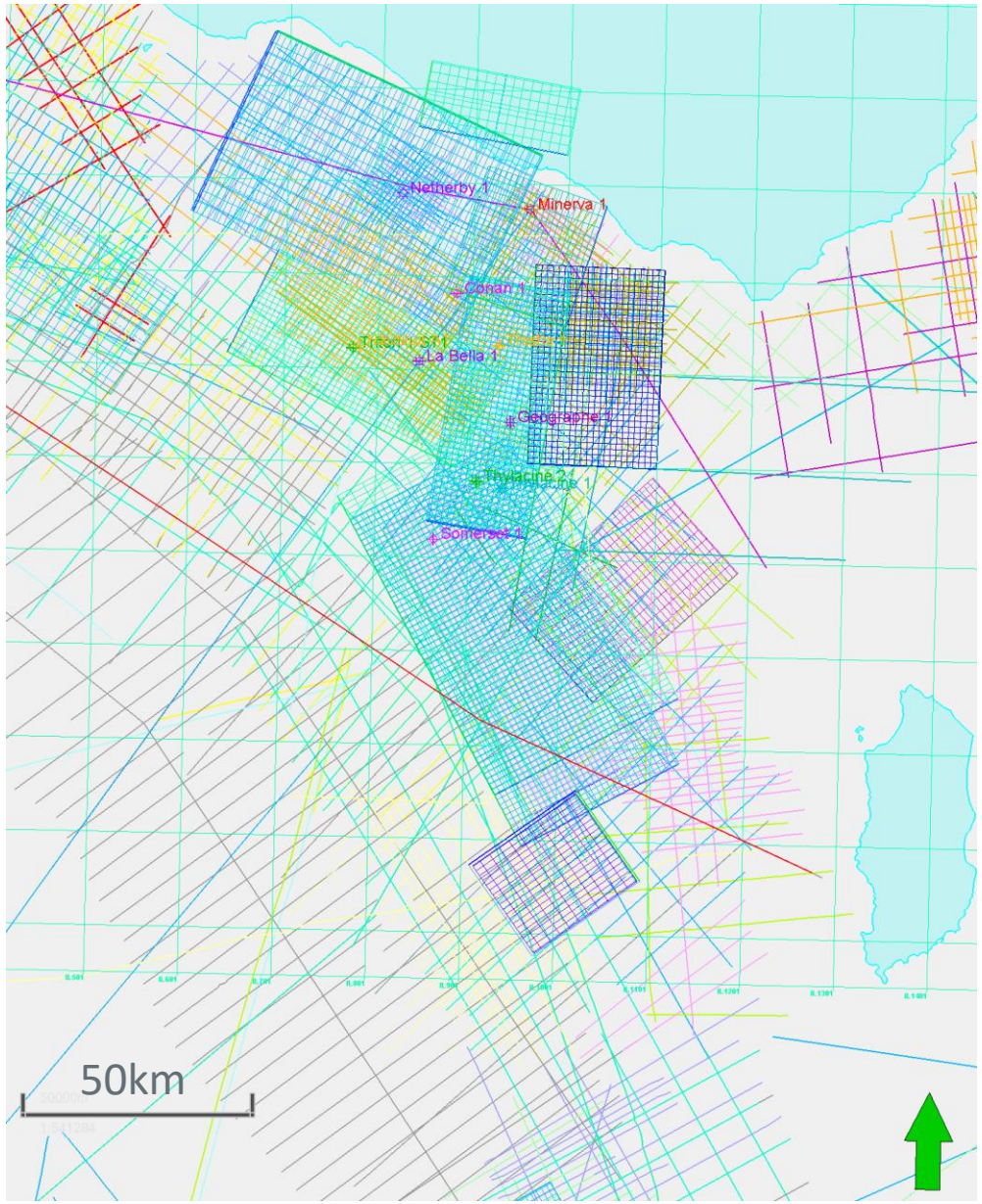
© Commonwealth of Australia (Geoscience Australia) 2024

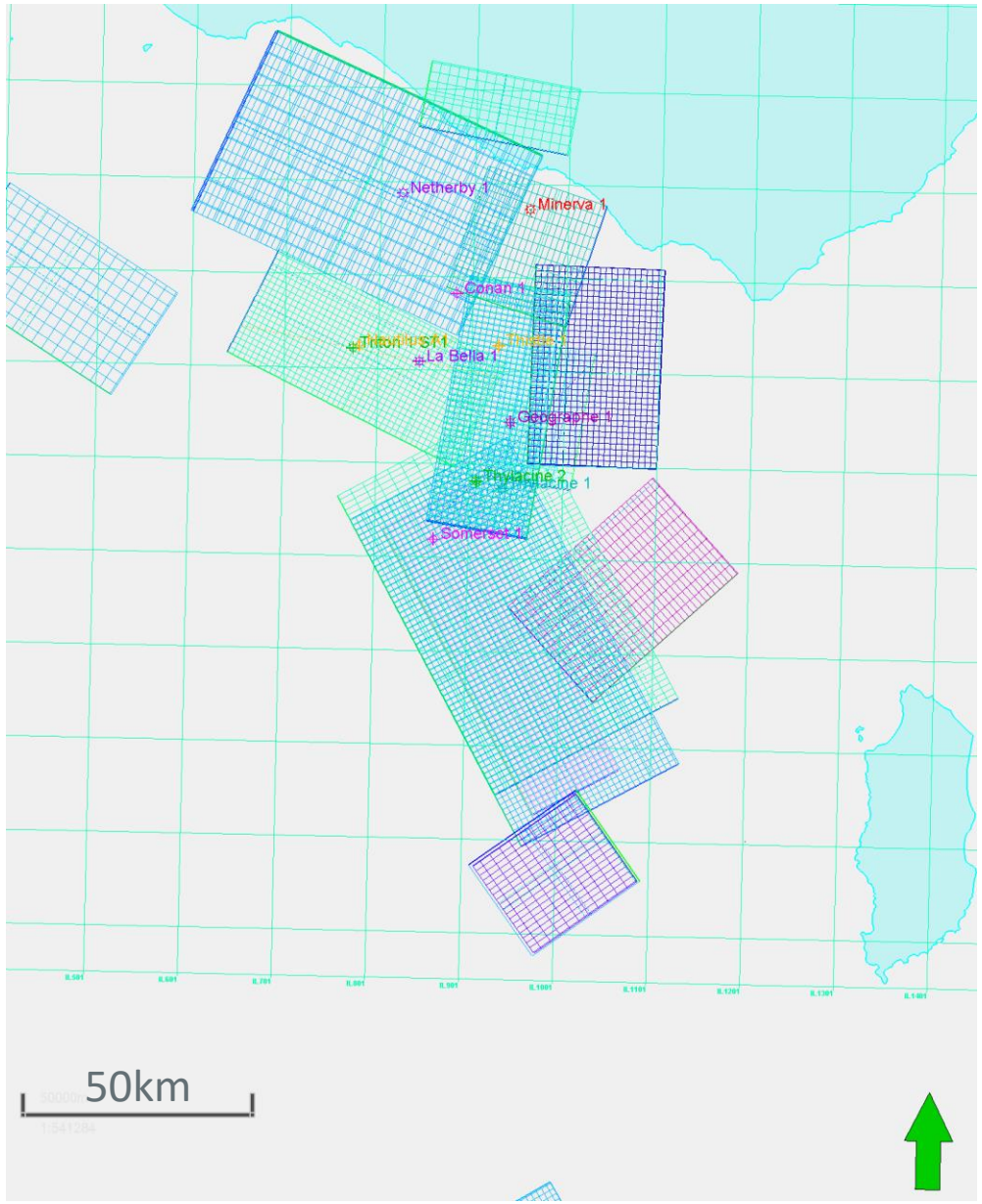
Setting



© Commonwealth of Australia (Geoscience Australia) 2024

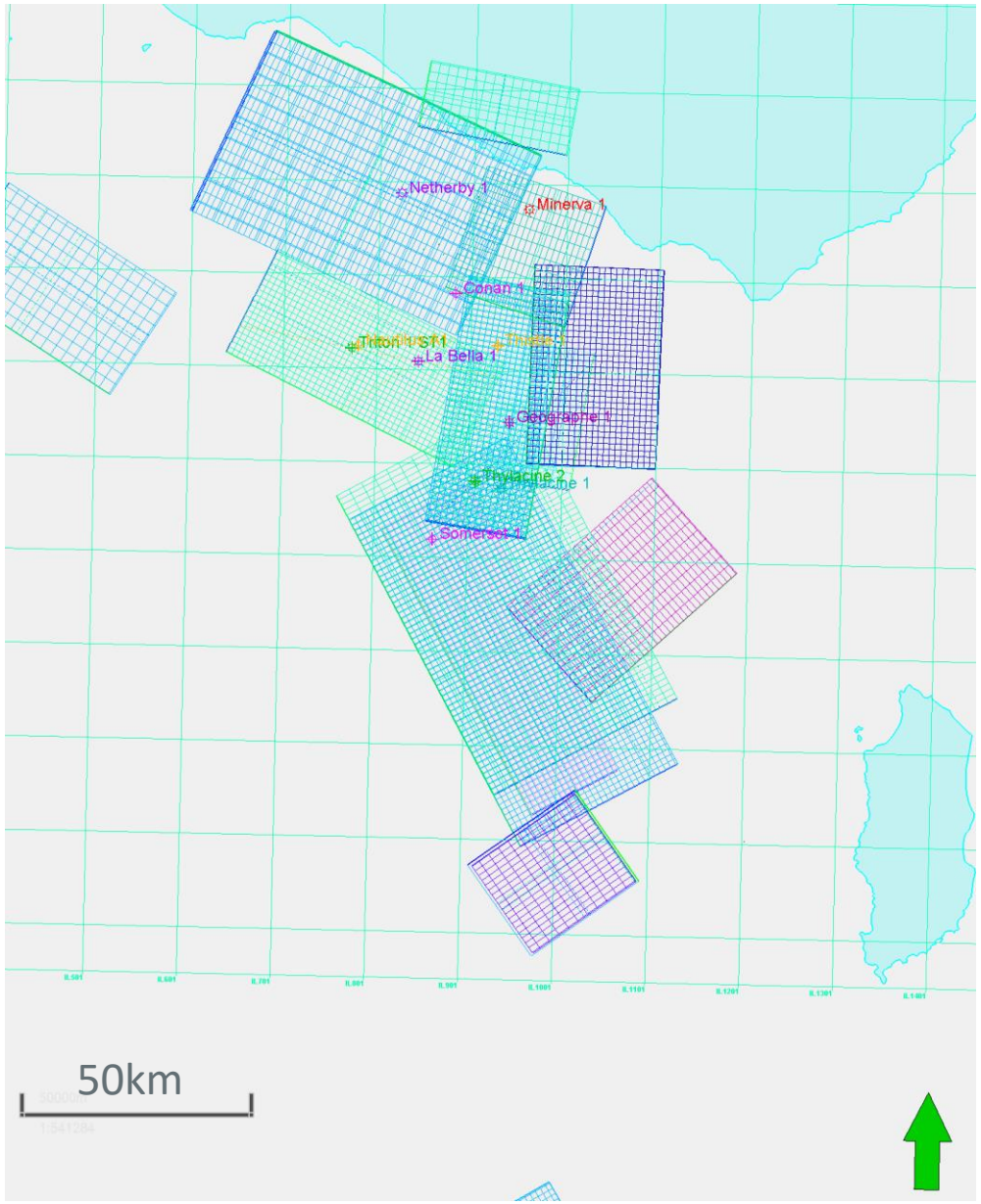
Setting

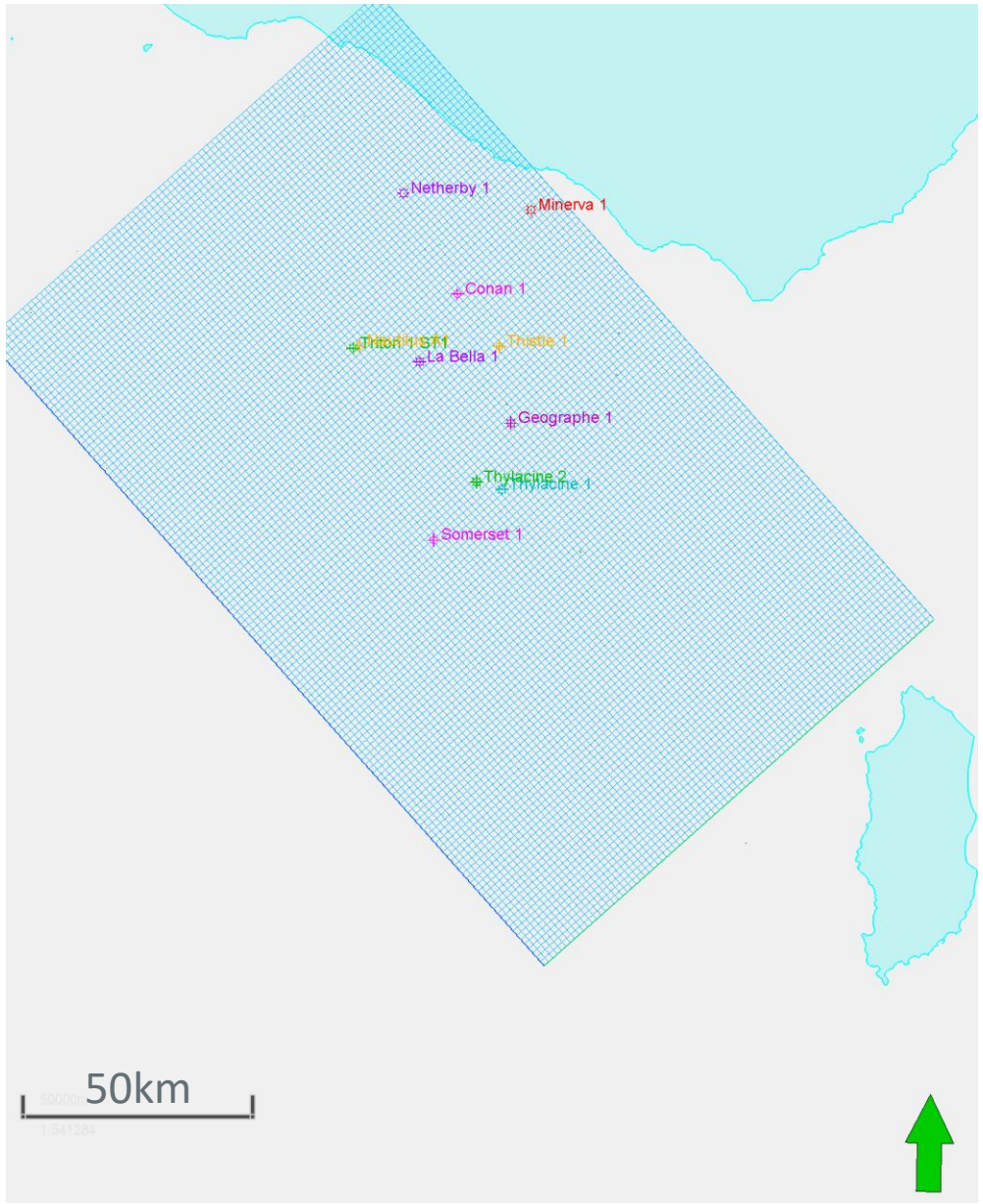




© Commonwealth of Australia (Geoscience Australia) 2024

Setting





© Commonwealth of Australia (Geoscience Australia) 2024

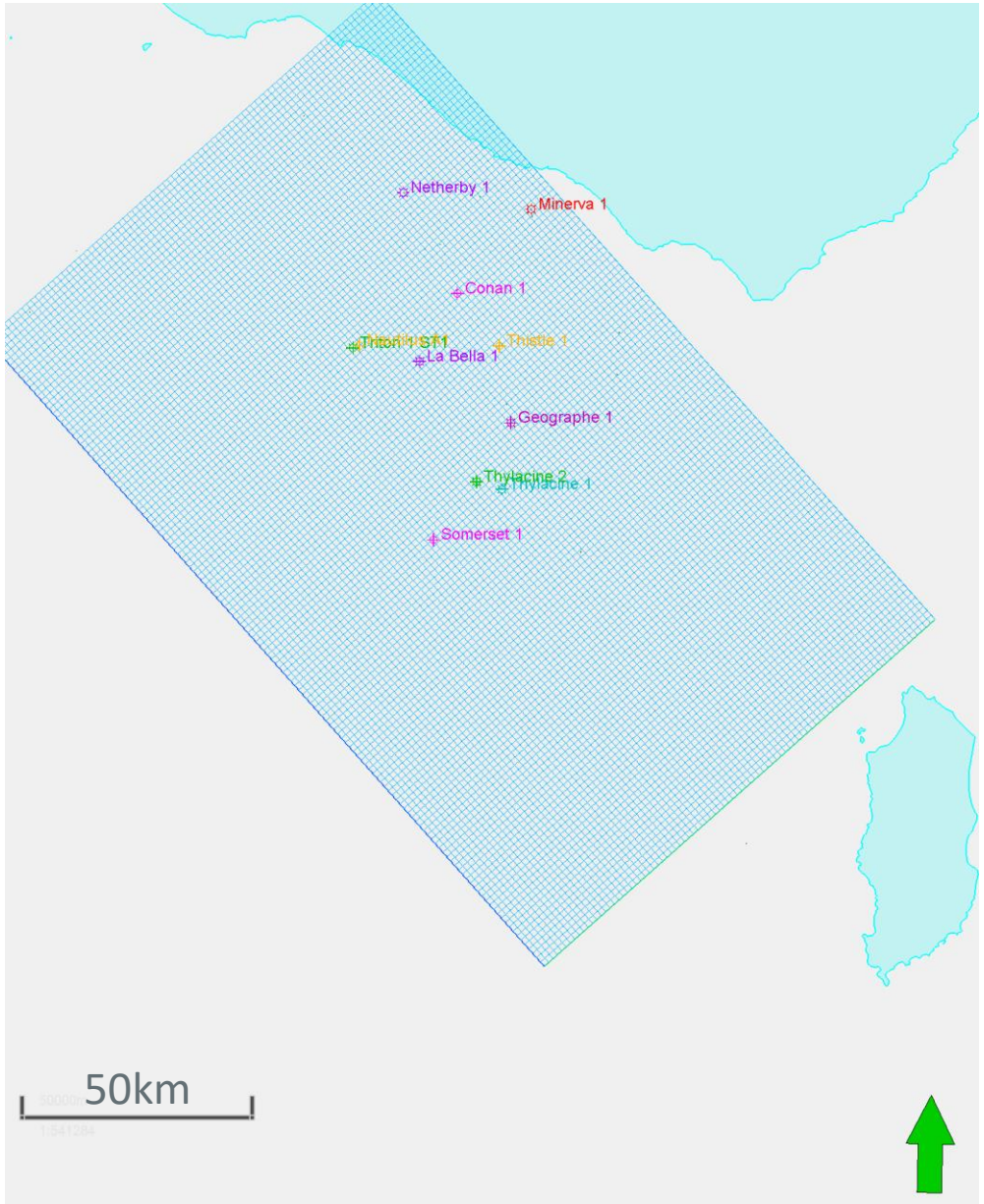
Purpose

Reasons for post-stack merge (rather than a pre-stack)

- Time
- Money
- But mostly time.

- This case was to produce a regularised and seamless single 3D dataset of the highest possible quality, for the offshore Otway Basin, within two-months.

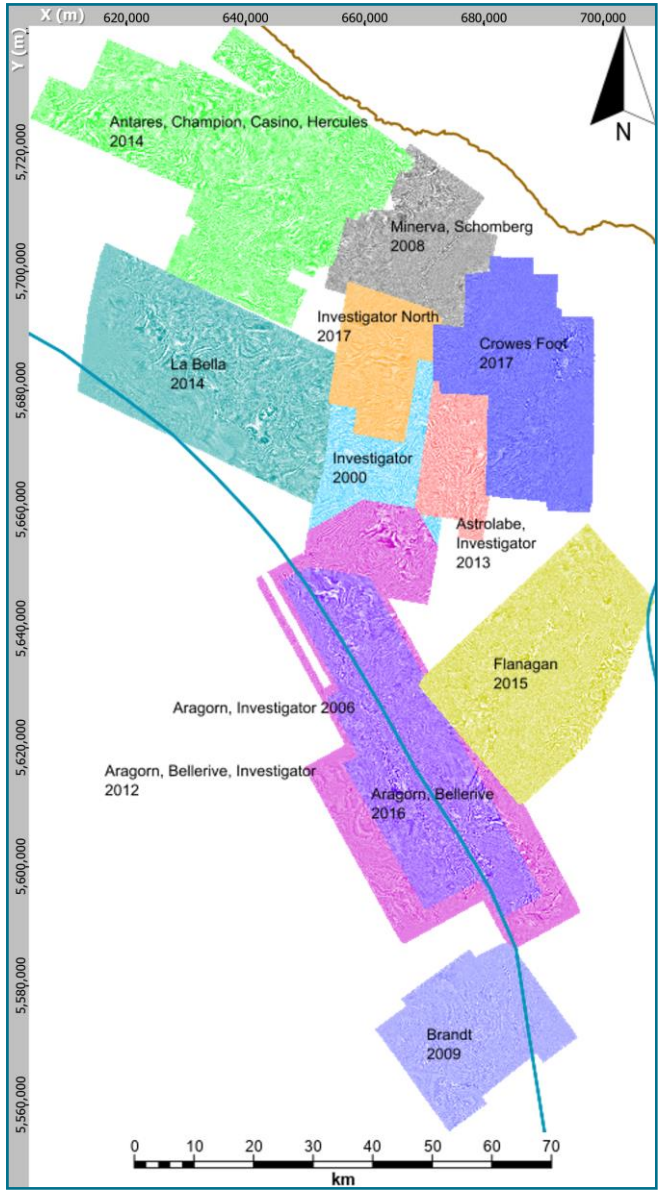
- Input volumes (12 volumes, 14 surveys) totalling 8,092 km^2 were post-stack merged and processed to produce a continuous and consistent volume, enabling more efficient and effective interpretation of the region.



© Commonwealth of Australia (Geoscience Australia) 2024

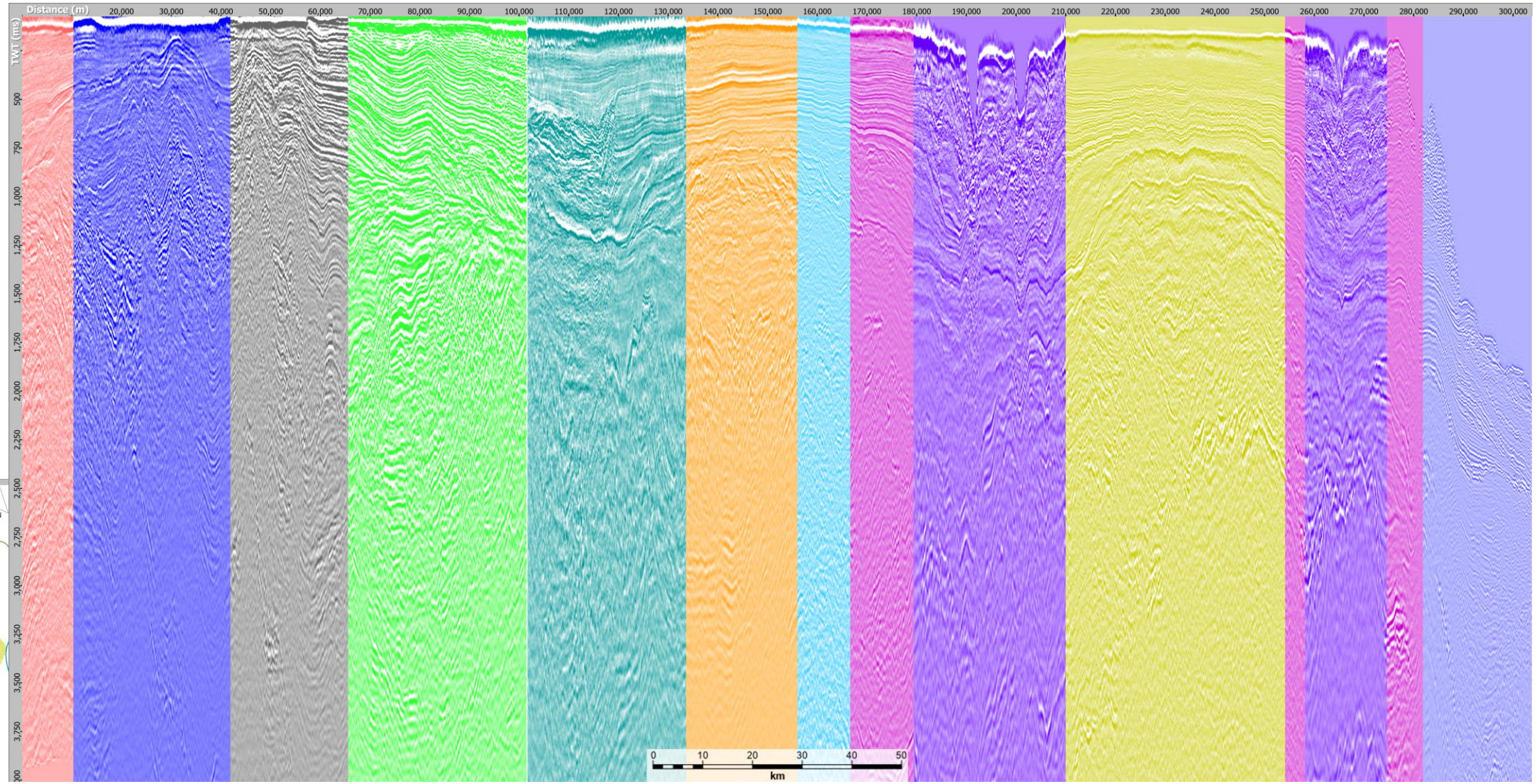
Inputs

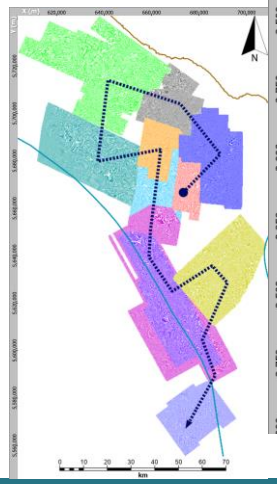
Volume	Survey(s)	Data type	Angle range	Contractor	Year processed	Input Area (sqkm)
1	Antares, Champion, Casino, Hercules	PSDM stack	0-35°	CGG	2014	1555
2	Astrolabe, Investigator	PSDM stack	3-35°	CGG	2013	506
3	Aragorn, Bellerive, Investigator	PSDM stack	unknown	DUG	2012	1865
4	Aragorn, Bellerive	QKDM stack	5-35°	SLB	2016	1154
5	Aragorn, Investigator	PreSTM Stack	Full offset	PGS	2006	1409
6	Brandt	PSDM stack	5-35°	CGG	2009	608
7	Crowes Foot	QKDM stack	5-35°	SLB	2017	877
8	Flanagan	PSTM stack	2-30°	DUG	2015	974
9	Investigator	Post-stack OMEGA-X migration	Full offset	Veritas DGC	2000	1047
10	Investigator North	QKDM stack	5-35°	SLB	2017	334
11	La Bella	PSTM stack	0-30°	CGG	2014	1333
12	Minerva, Schomberg	PSTM stack	3-40°	Fugro	2008	552



© Commonwealth of Australia (Geoscience Australia) 2024

Inputs





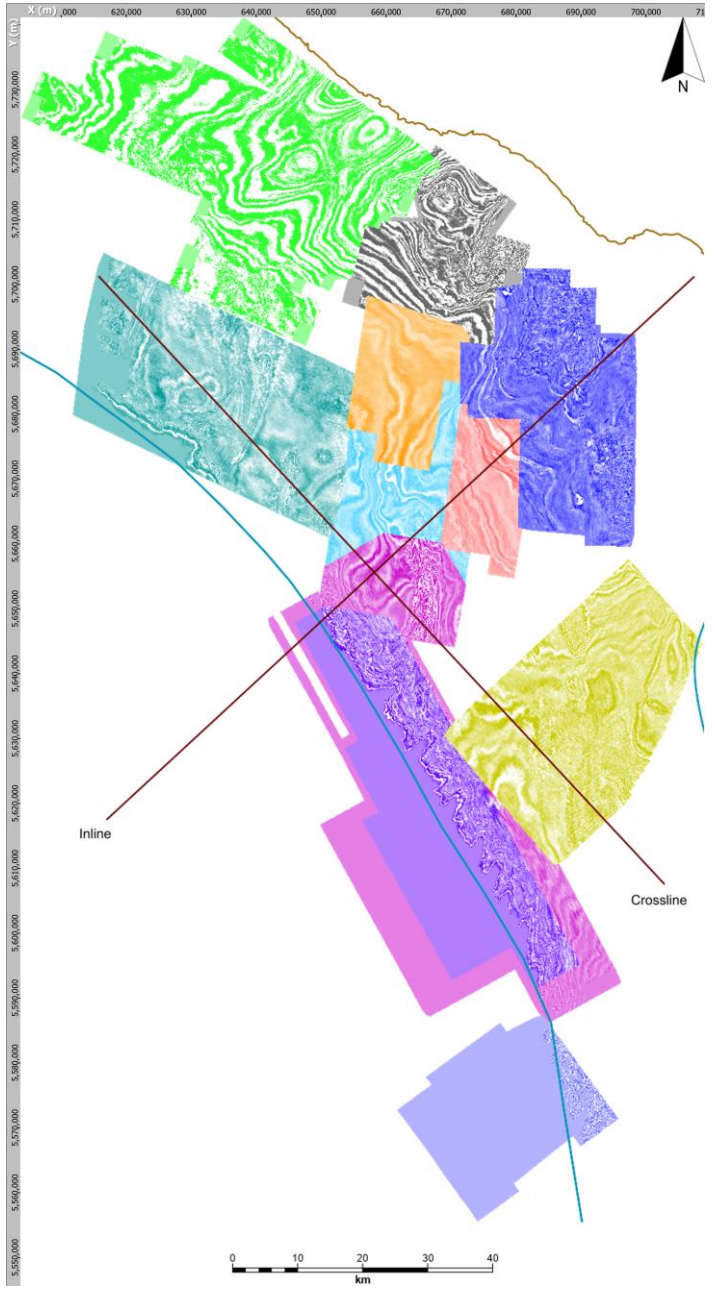
© Commonwealth of Australia (Geoscience Australia) 2024

Processing

- Reformat to internal format from SEGY
- Back-off legacy residual gain correction
- Resample to 4 ms (where required)
- **Survey regularisation & interpolation**
- Survey Matching (bulk amplitude, timing and phase)
- Time variant spectral & amplitude matching
- Survey merging
- Random noise attenuation (3D Cadzow)
- Lateral amplitude scaling
- Acquisition footprint attenuation
- Spectral Broadening
- Residual gain correction
- Water bottom mute
- Output final SEGY

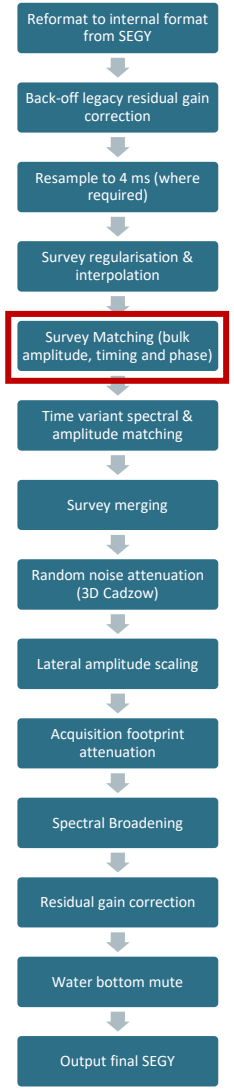
Survey Regularisation and Interpolation

Common grid – orientated to structure



© Commonwealth of Australia (Geoscience Australia) 2024

Processing



Survey matching – amplitude, phase, time

using DUG's mis-tie analysis algorithm
Water bottom+250ms to Water bottom+2500ms

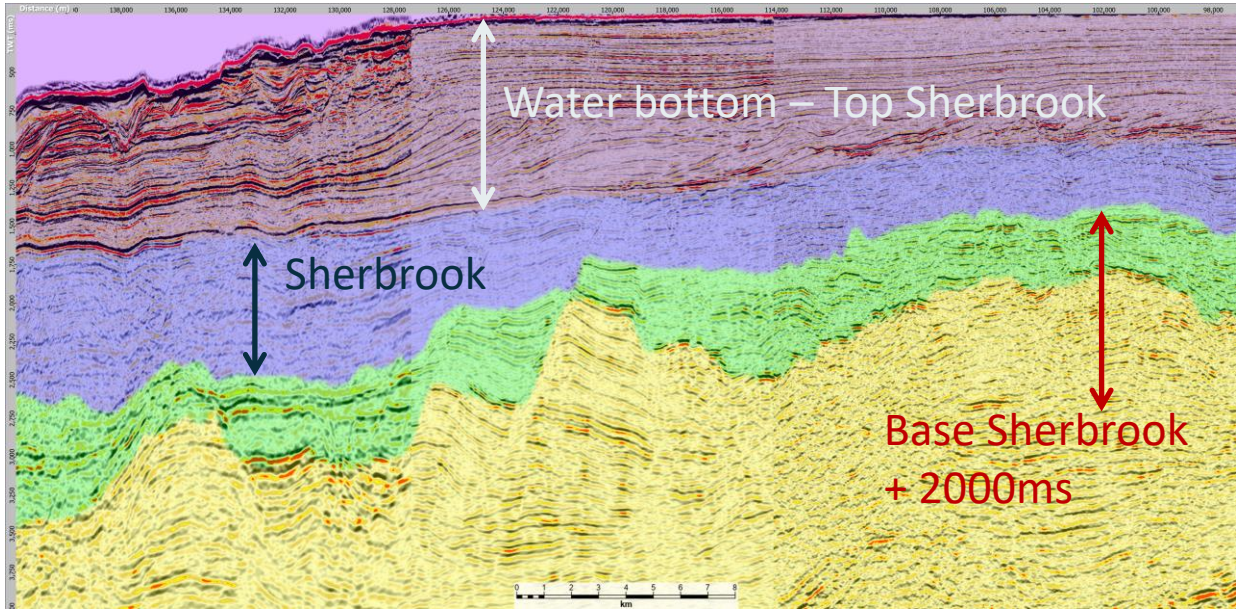
Survey(s)	Time shift	Phase shift	Amplitude scaling
Investigator North	Reference survey		
Antares, Champion, Casino, Hercules	3.47ms	57.16°	1.151x10-5
La Bella	4.48ms	62.36°	2.254x10-8
Minerva, Schomberg	8.55ms	27.56°	8.16x10-4
Investigator	3.52ms	27.39°	0.826
Crowes Foot	4.49ms	42.45°	1.3154
Astrolabe, Investigator	6.53ms	67.87°	1.571x10-5
Aragorn, Bellerive	3.4ms	22.35°	5.425x10-4
Aragorn, Bellerive, Investigator	12.48ms	17.39°	5.942x10-4
Flanagan	6.53ms	57.85°	8.532x10-4
Brandt	20ms	42.84°	1.544x10-5

© Commonwealth of Australia (Geoscience Australia) 2024

Processing

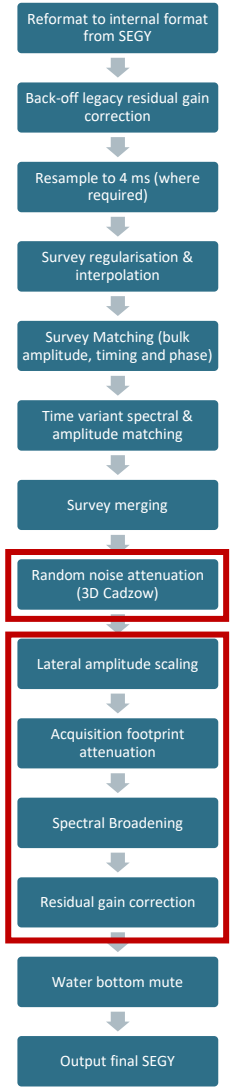
- Reformat to internal format from SEGY
- Back-off legacy residual gain correction
- Resample to 4 ms (where required)
- Survey regularisation & interpolation
- Survey Matching (bulk amplitude, timing and phase)
- **Time variant spectral & amplitude matching**
- Survey merging
- Random noise attenuation (3D Cadzow)
- Lateral amplitude scaling
- Acquisition footprint attenuation
- Spectral Broadening
- Residual gain correction
- Water bottom mute
- Output final SEGY

Spectral matching



© Commonwealth of Australia (Geoscience Australia) 2024

Processing



Random Noise Attenuation

Cadzow time-varying approach

2 windows

Water bottom +400ms – T1

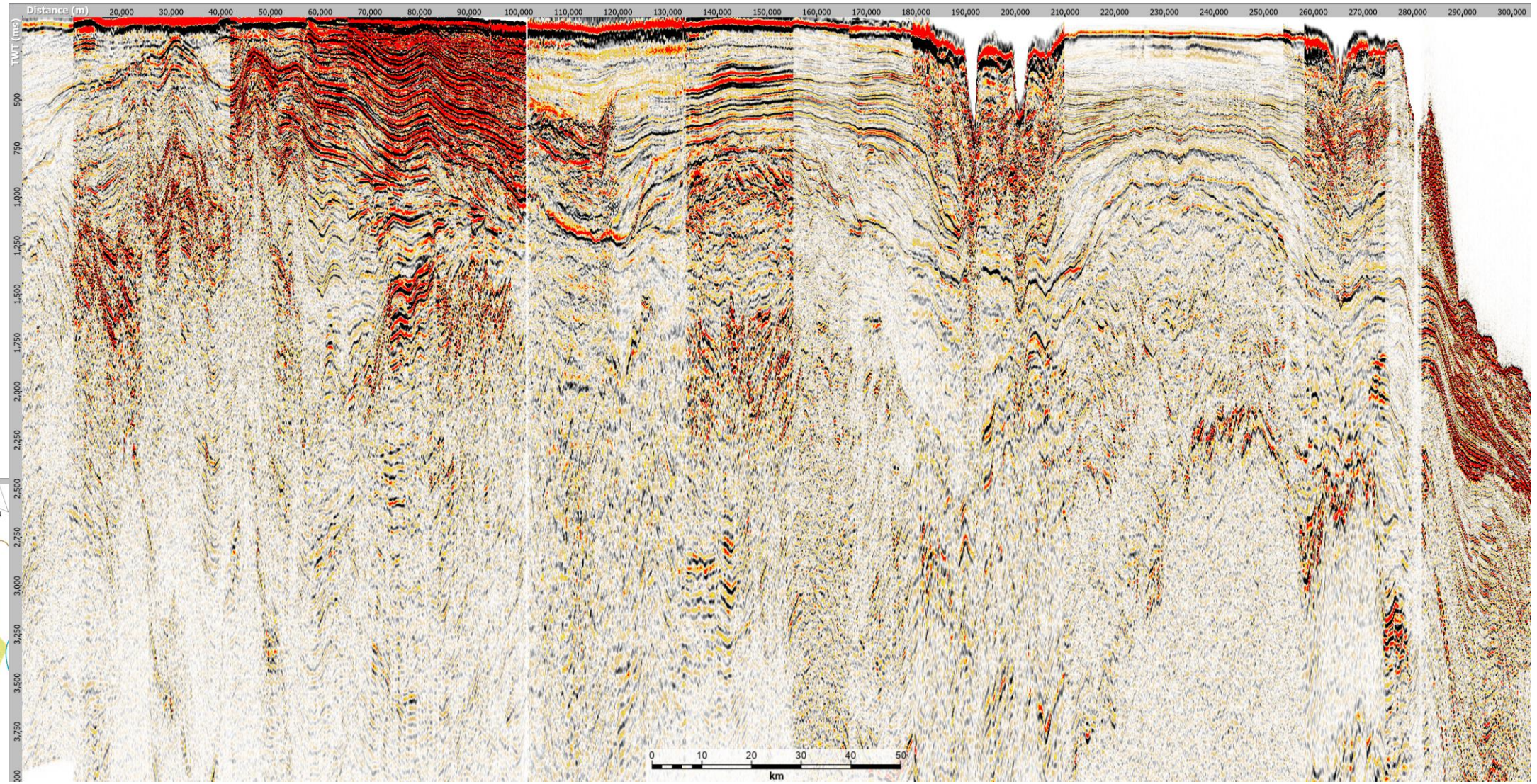
T1 – end of trace

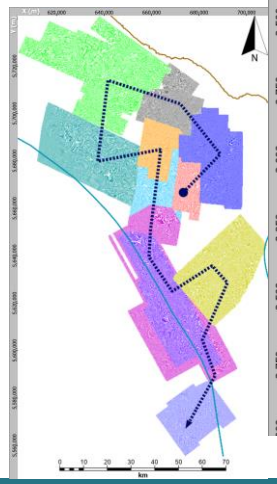
Other post merge enhancements

improved interpretability

© Commonwealth of Australia (Geoscience Australia) 2024

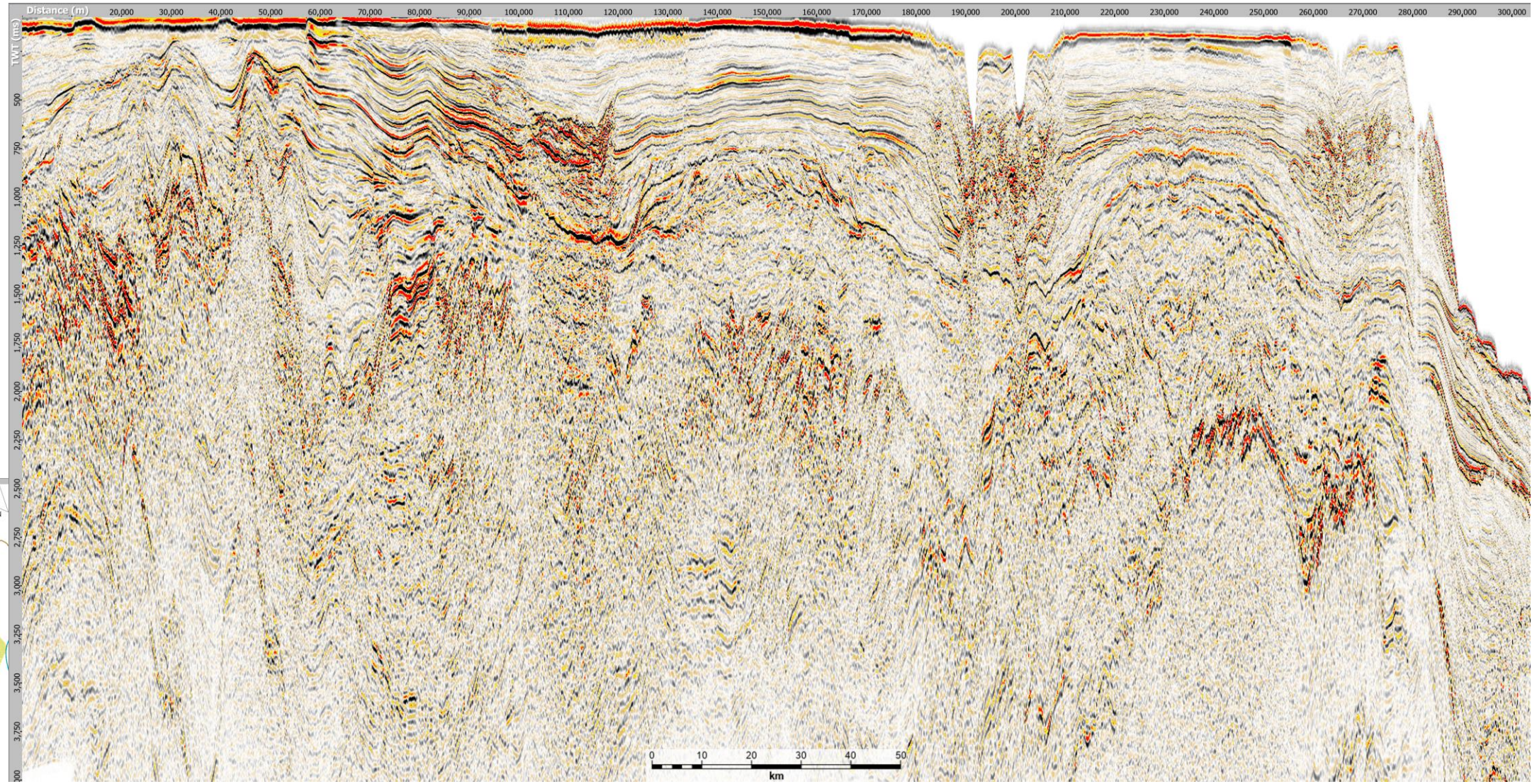
Inputs

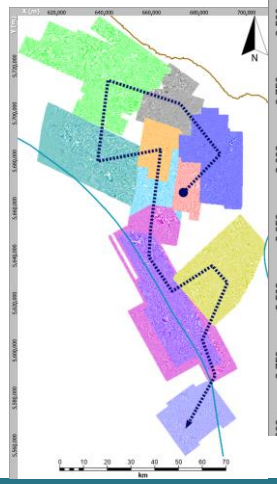




© Commonwealth of Australia (Geoscience Australia) 2024

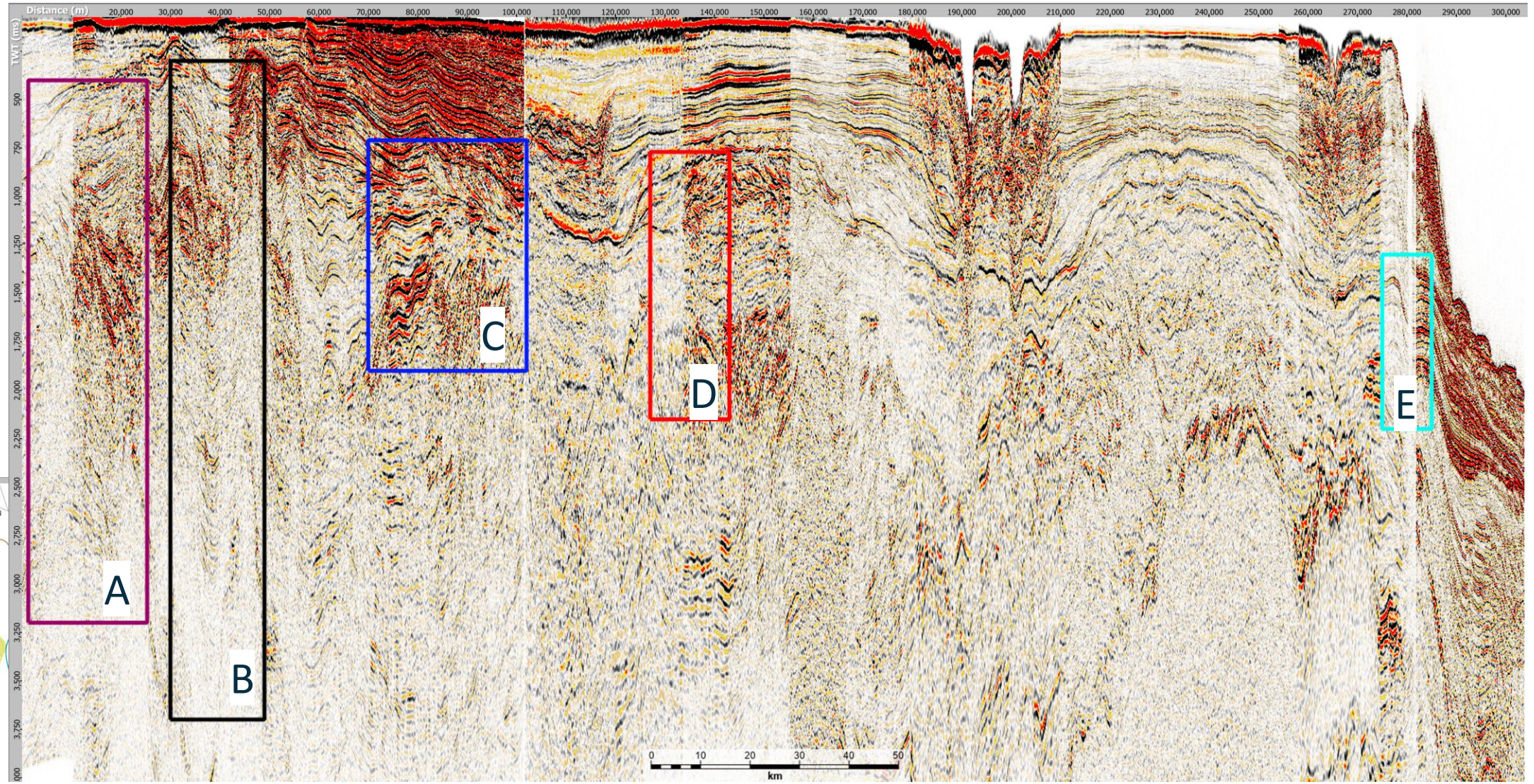
Output





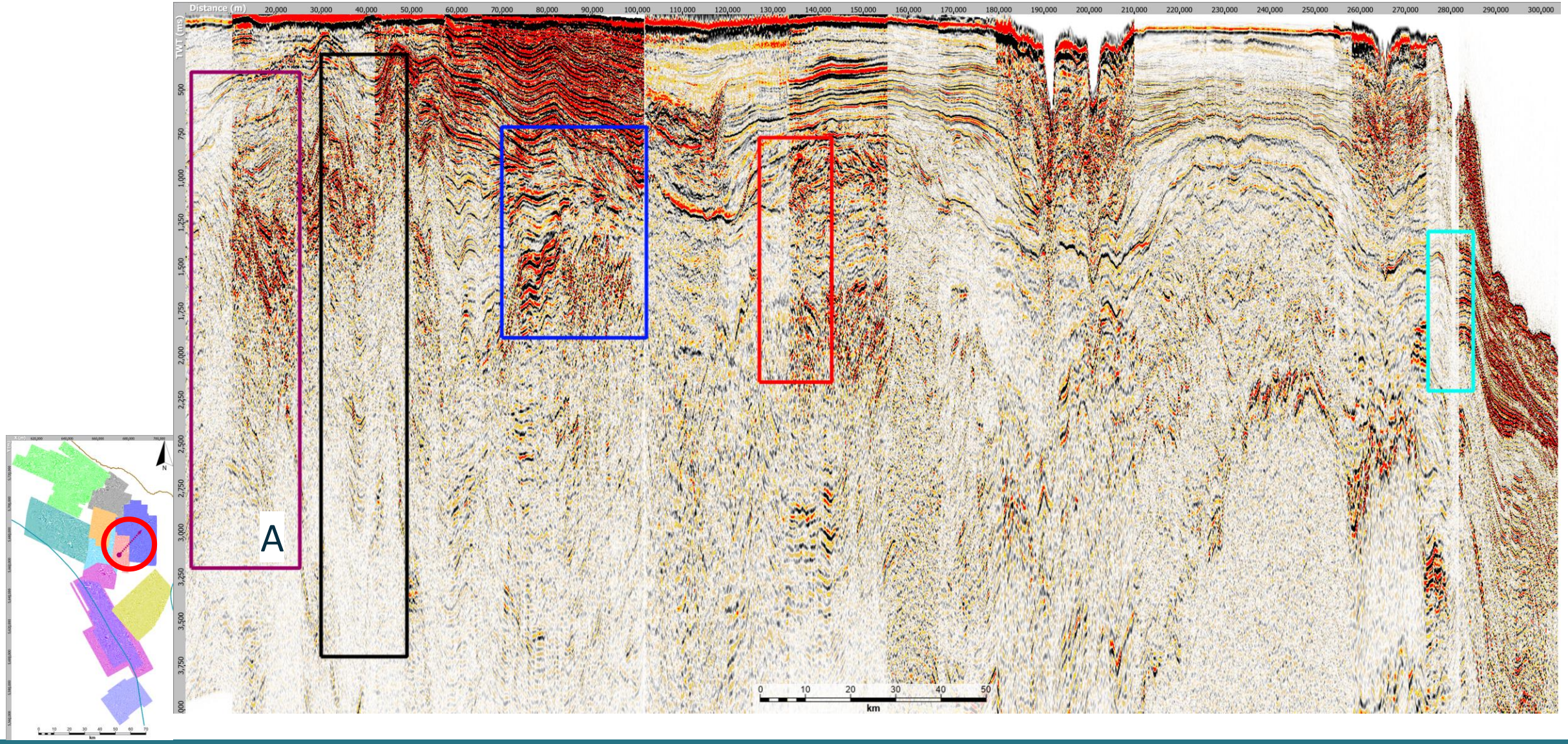
© Commonwealth of Australia (Geoscience Australia) 2024

Results



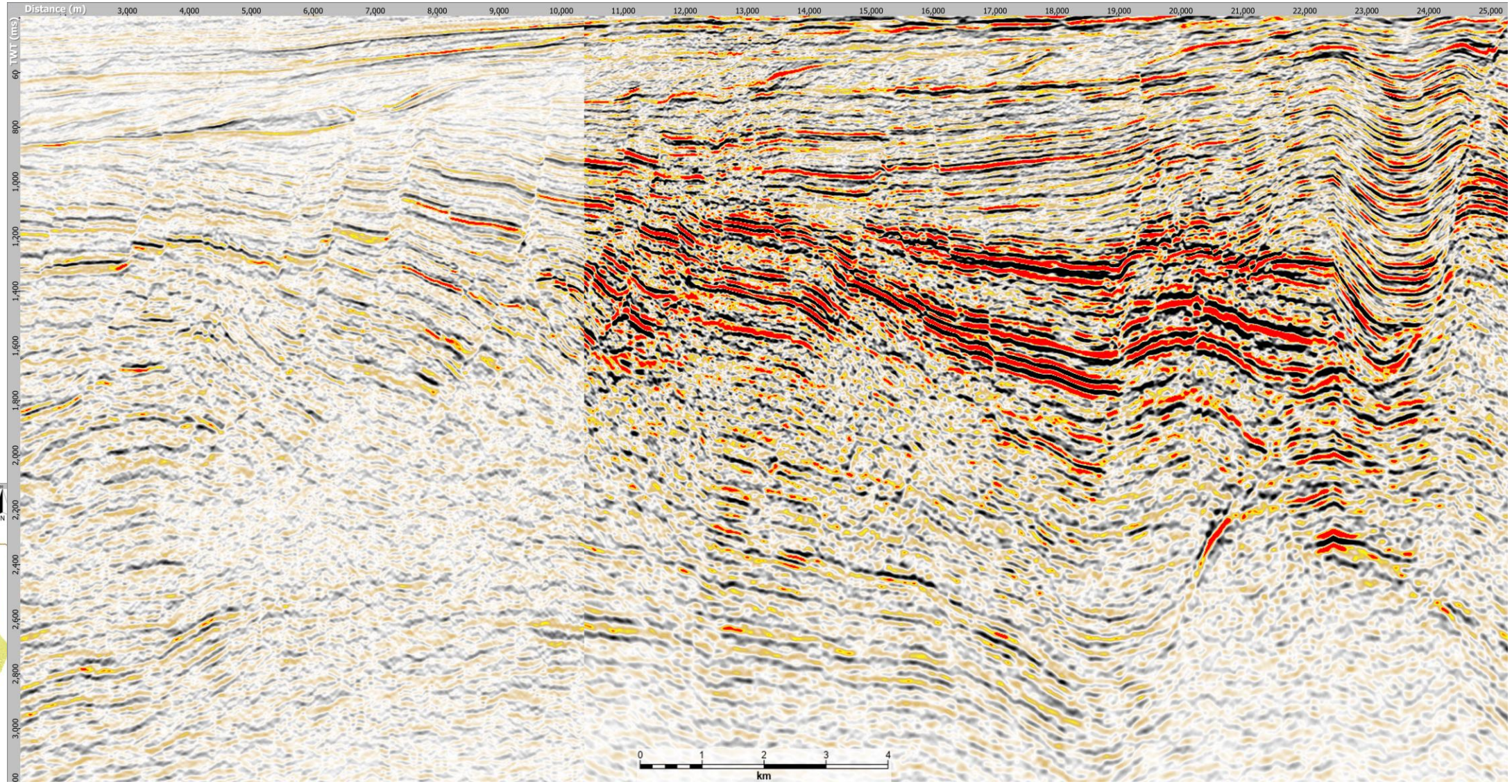
© Commonwealth of Australia (Geoscience Australia) 2024

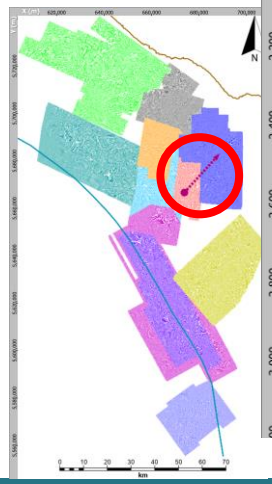
A



© Commonwealth of Australia (Geoscience Australia) 2024

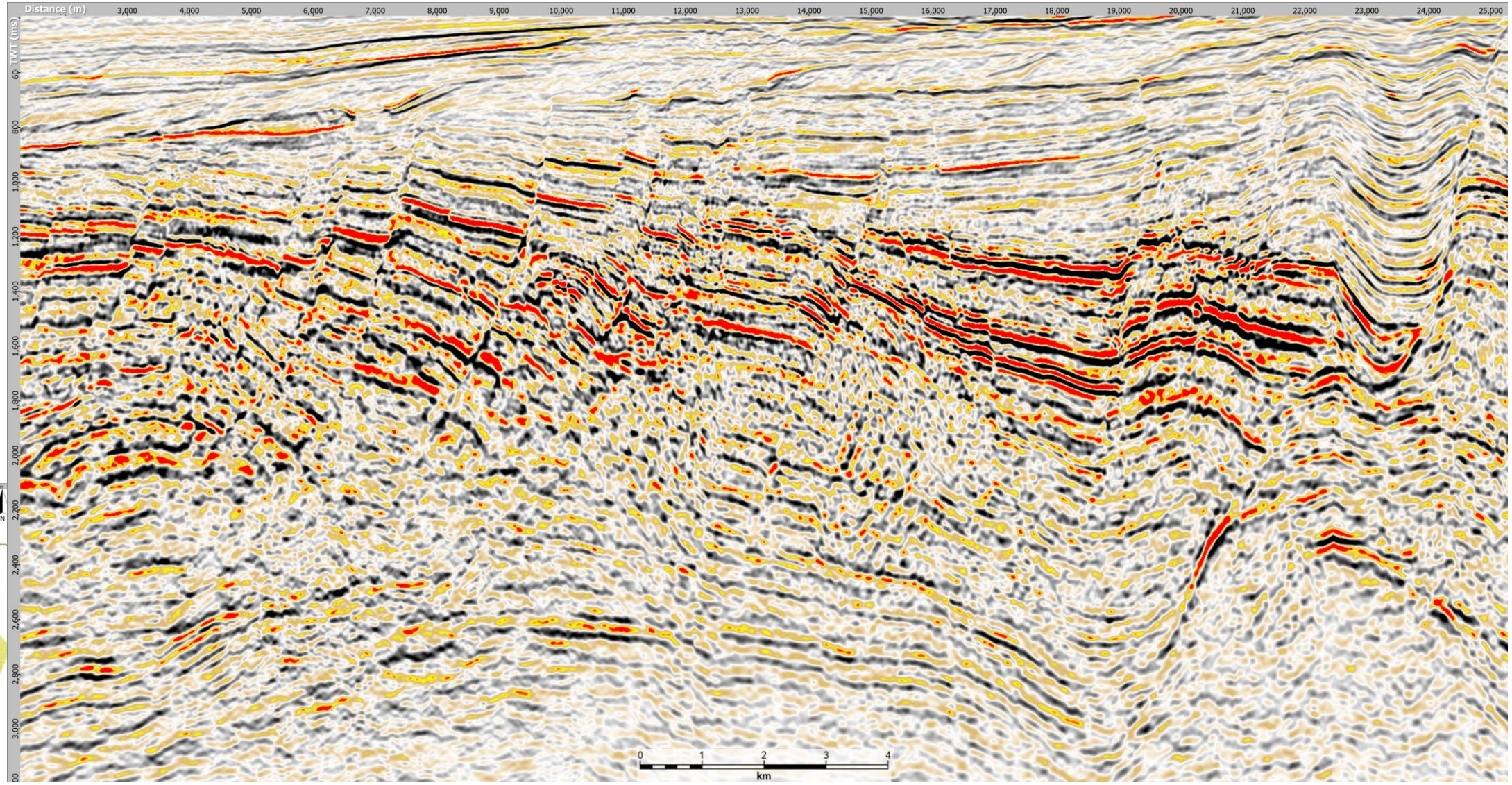
A - Input

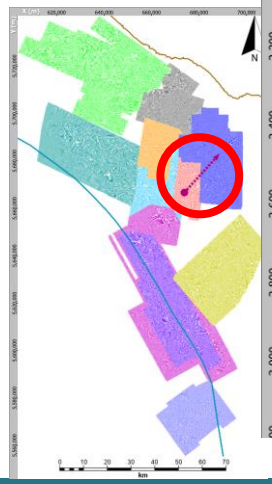




© Commonwealth of Australia (Geoscience Australia) 2024

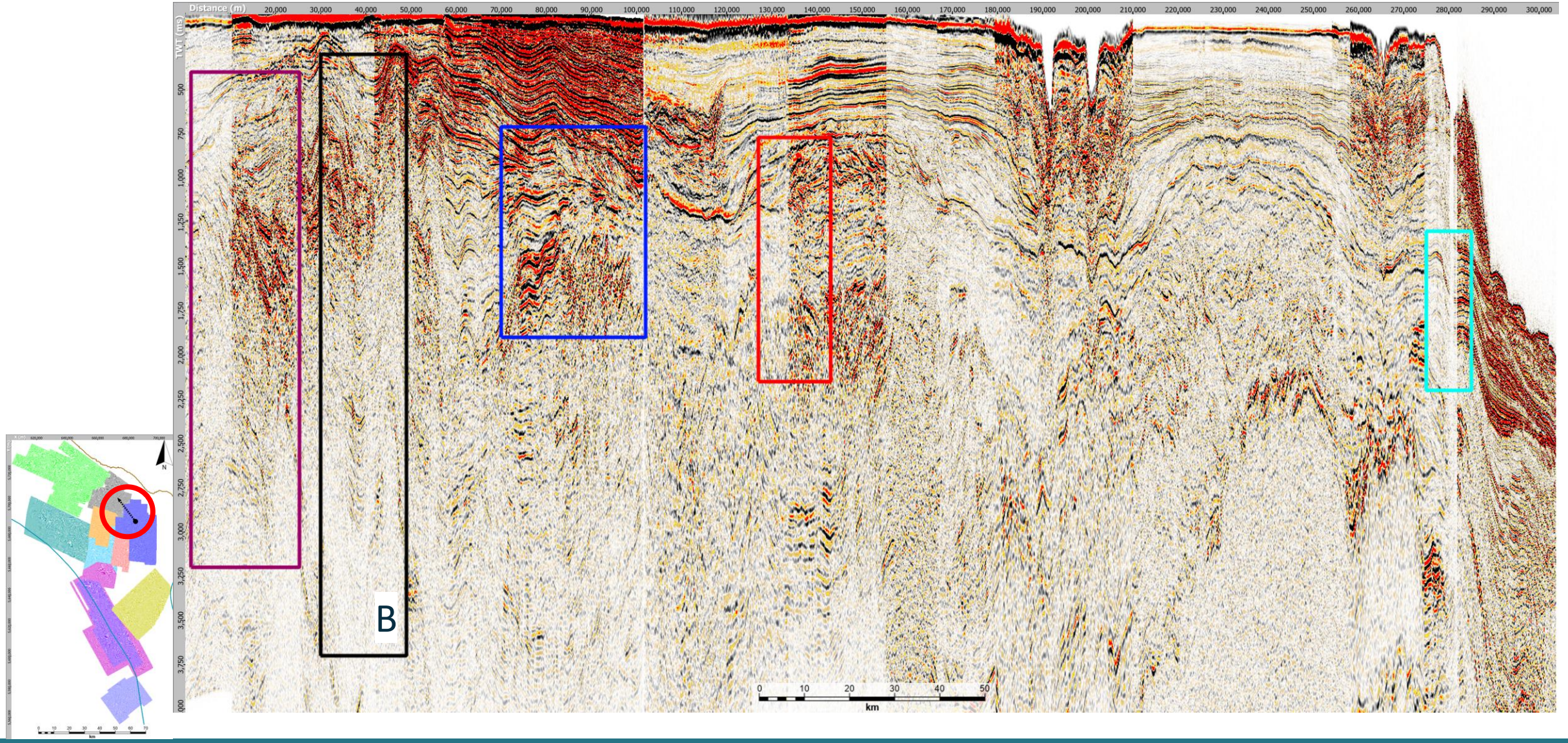
A - Final





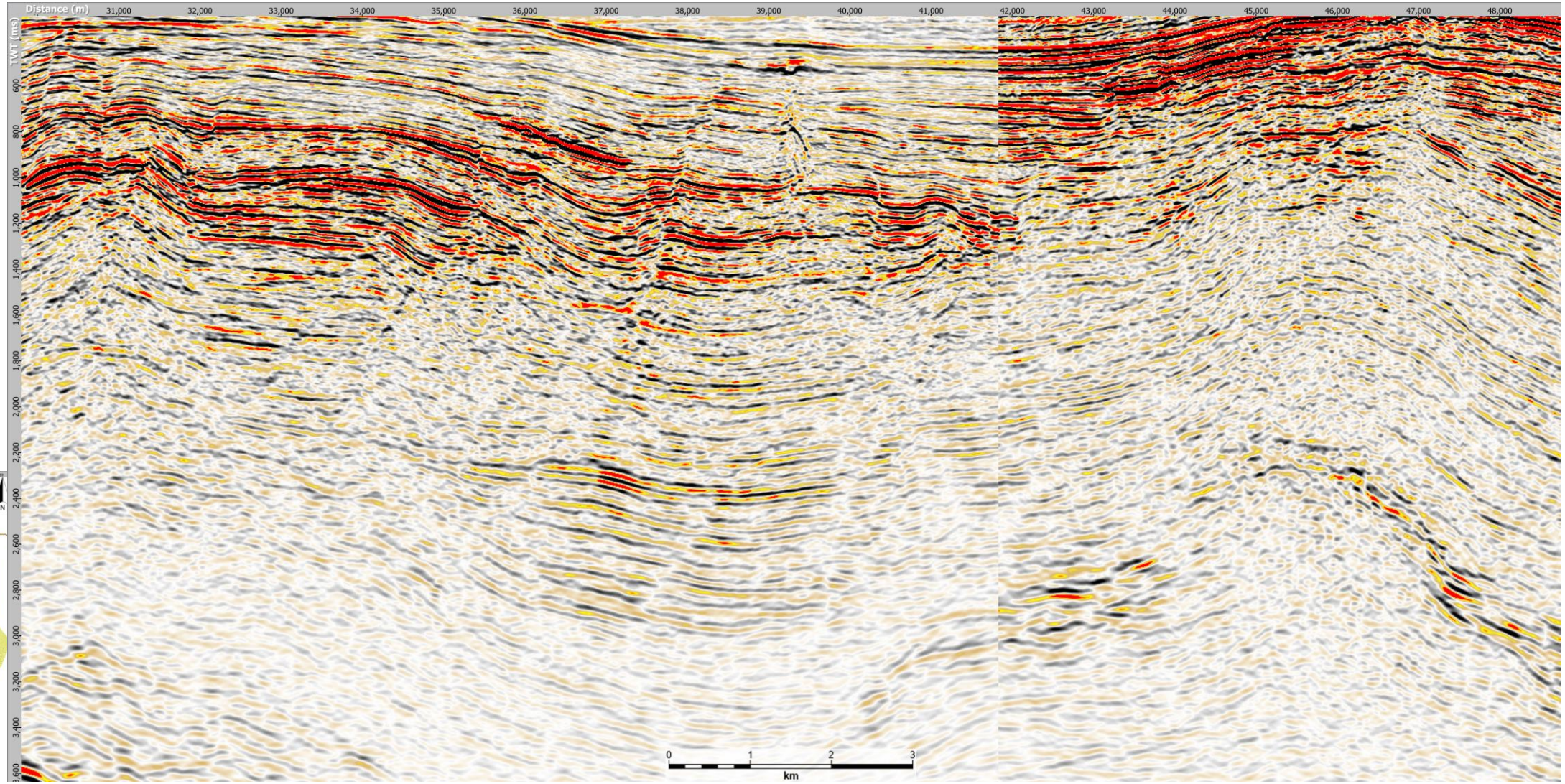
© Commonwealth of Australia (Geoscience Australia) 2024

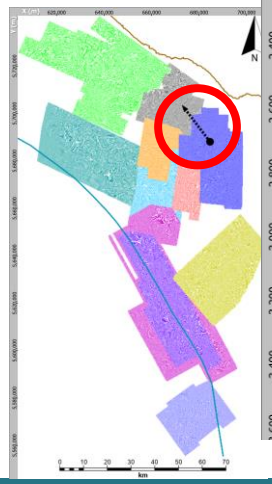
B



© Commonwealth of Australia (Geoscience Australia) 2024

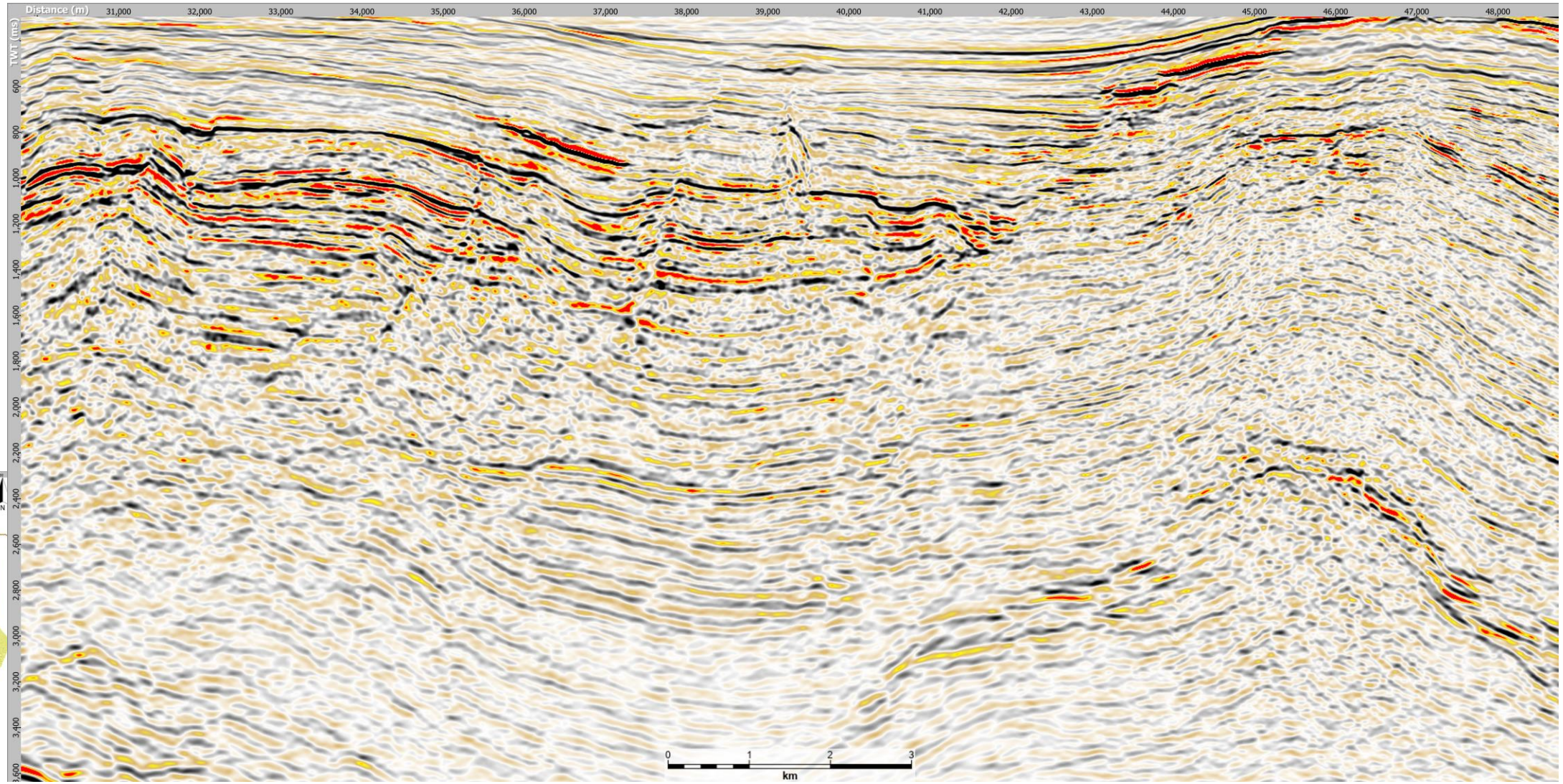
B - Input

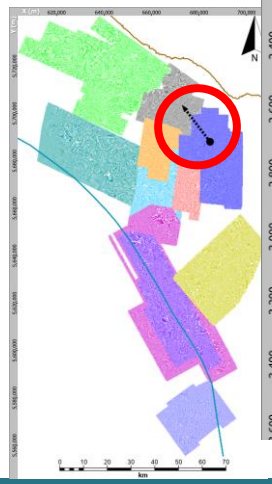




© Commonwealth of Australia (Geoscience Australia) 2024

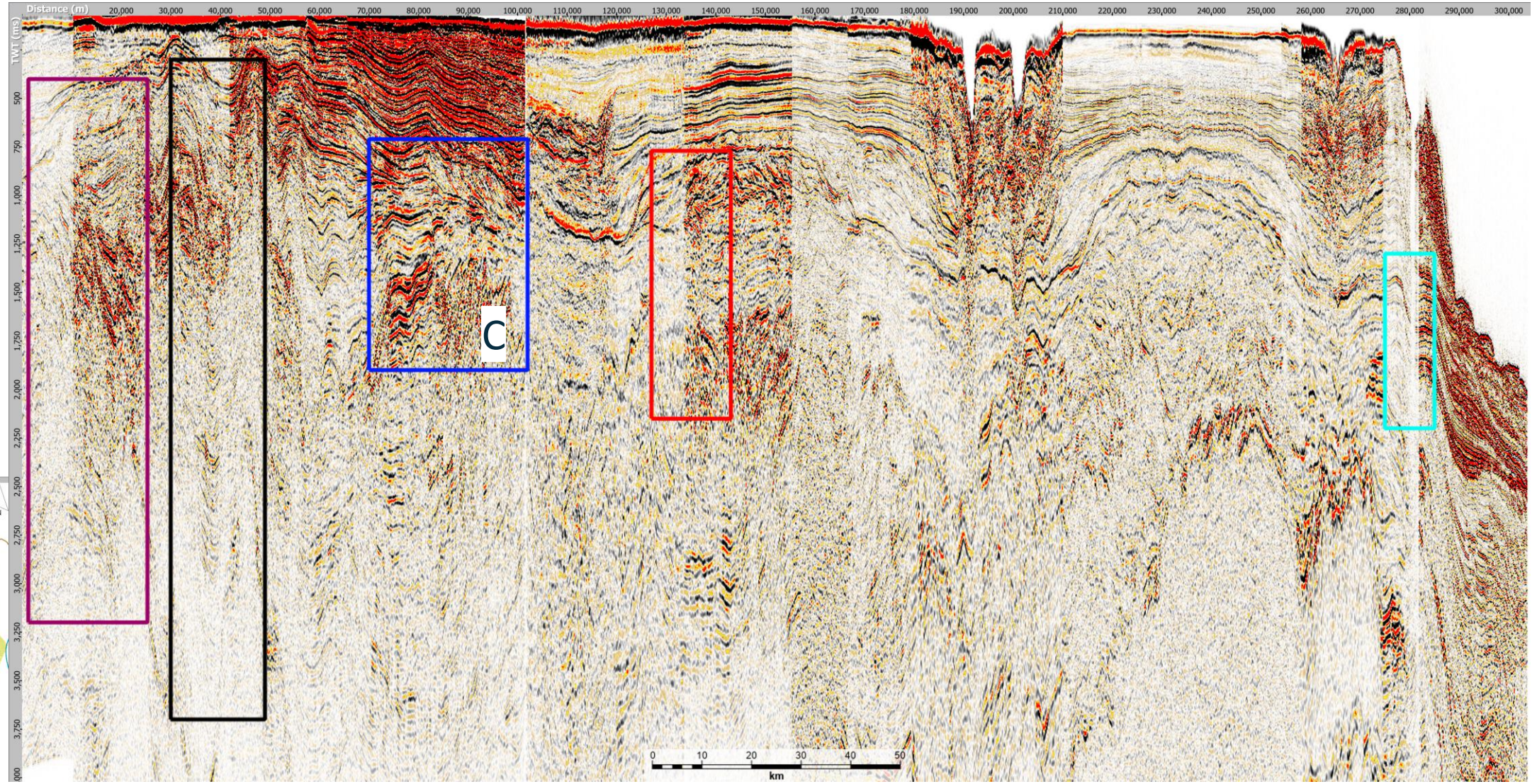
B - Final





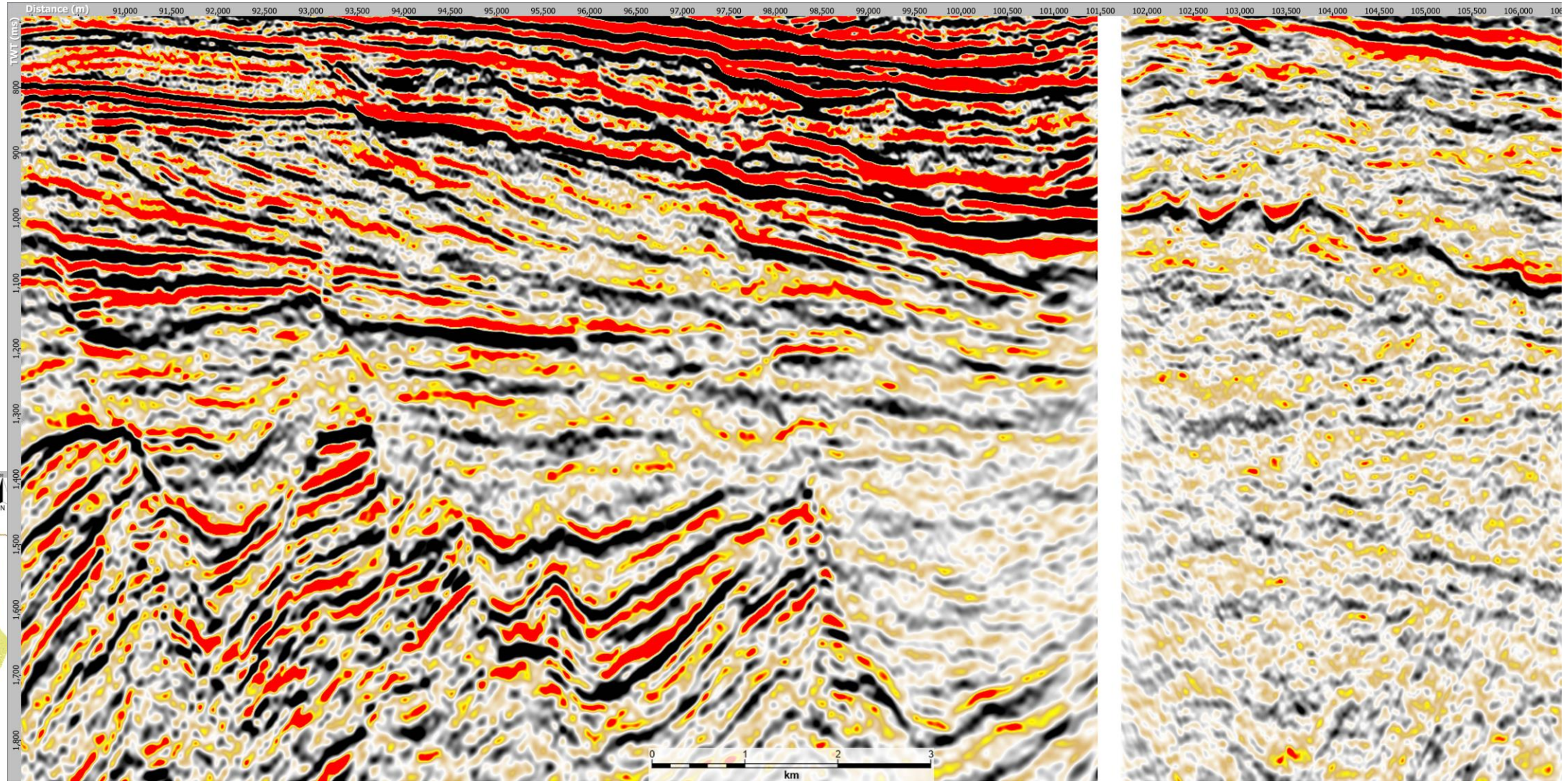
© Commonwealth of Australia (Geoscience Australia) 2024

C



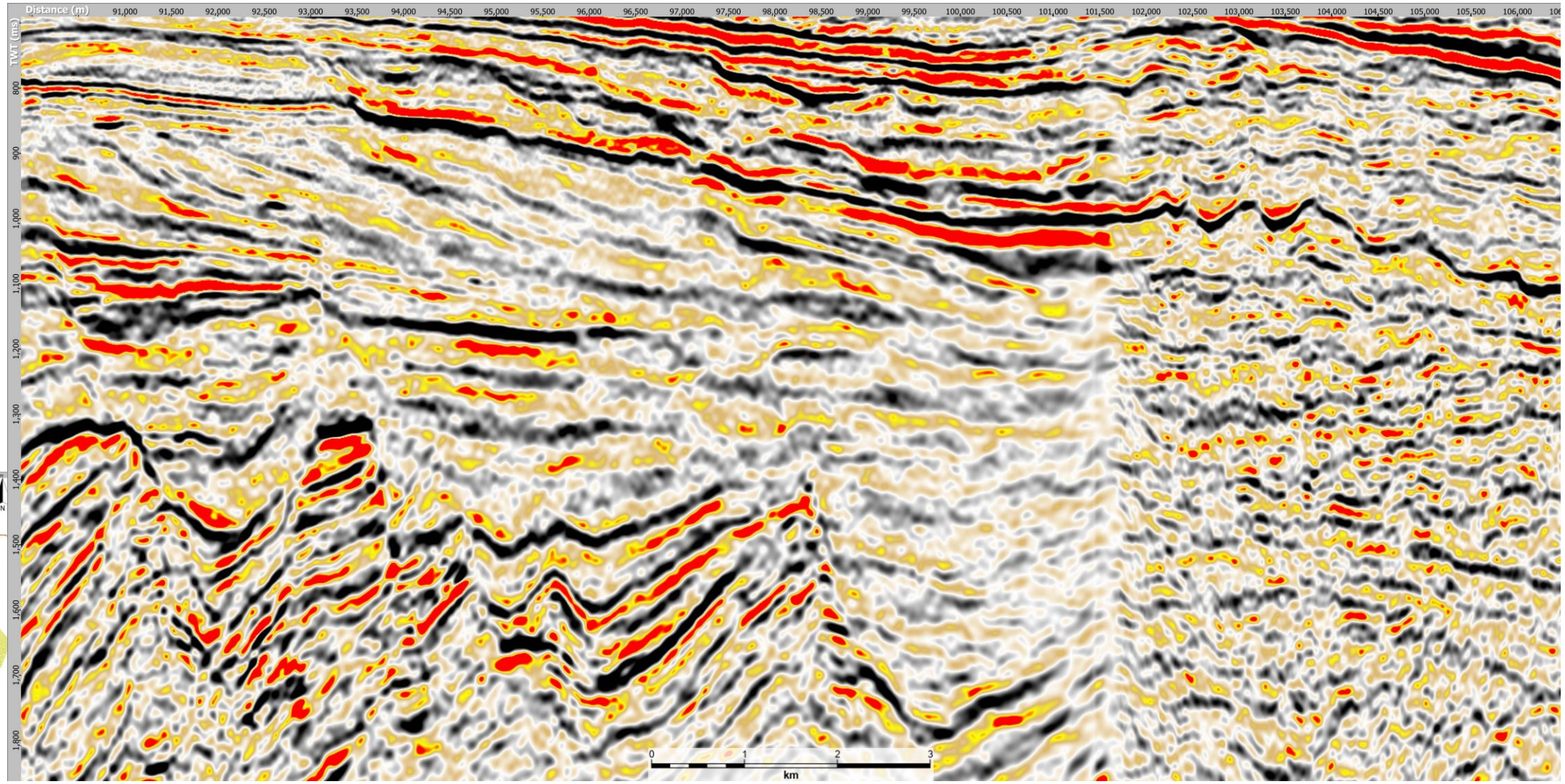
© Commonwealth of Australia (Geoscience Australia) 2024

C - Input



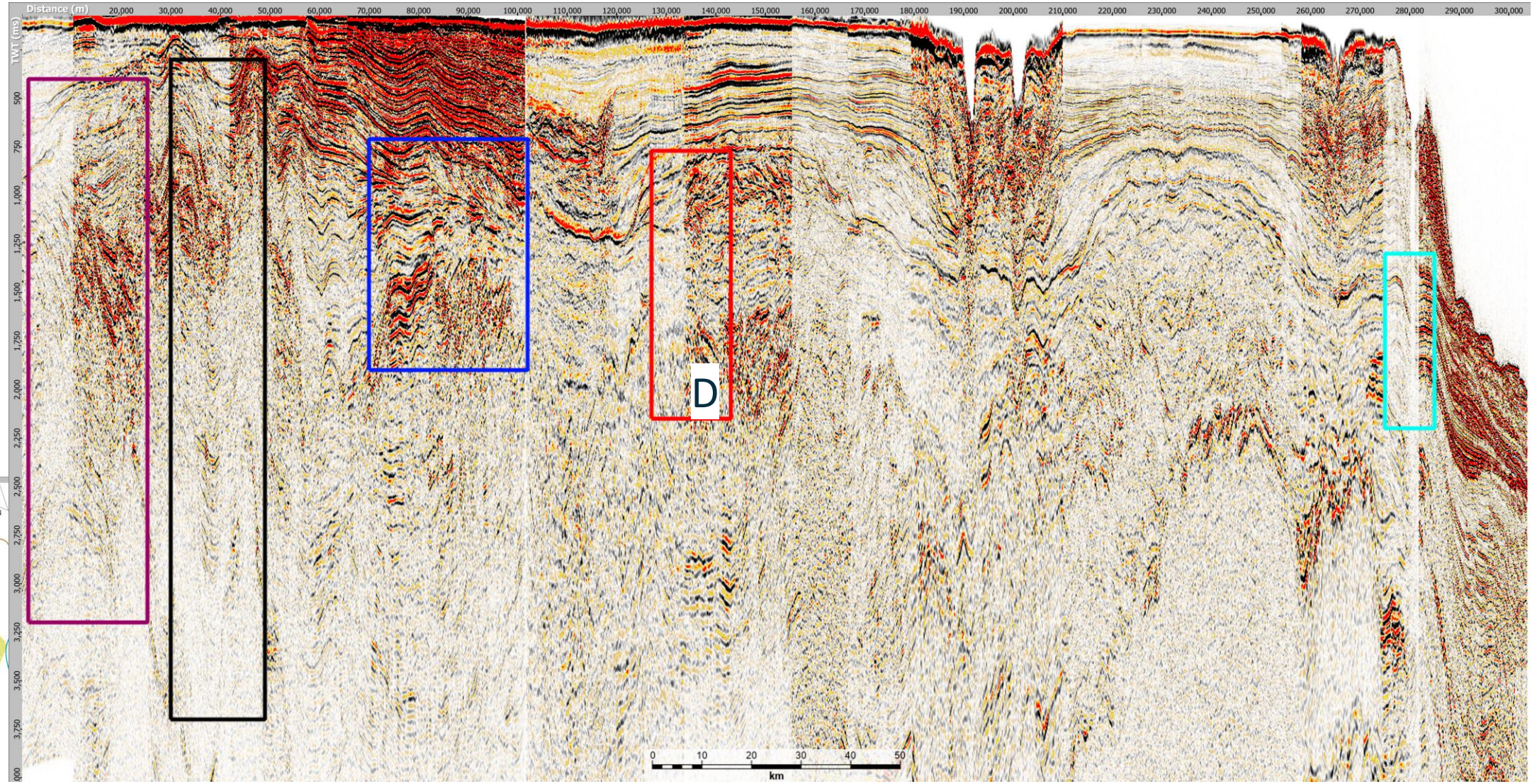
© Commonwealth of Australia (Geoscience Australia) 2024

C - Final



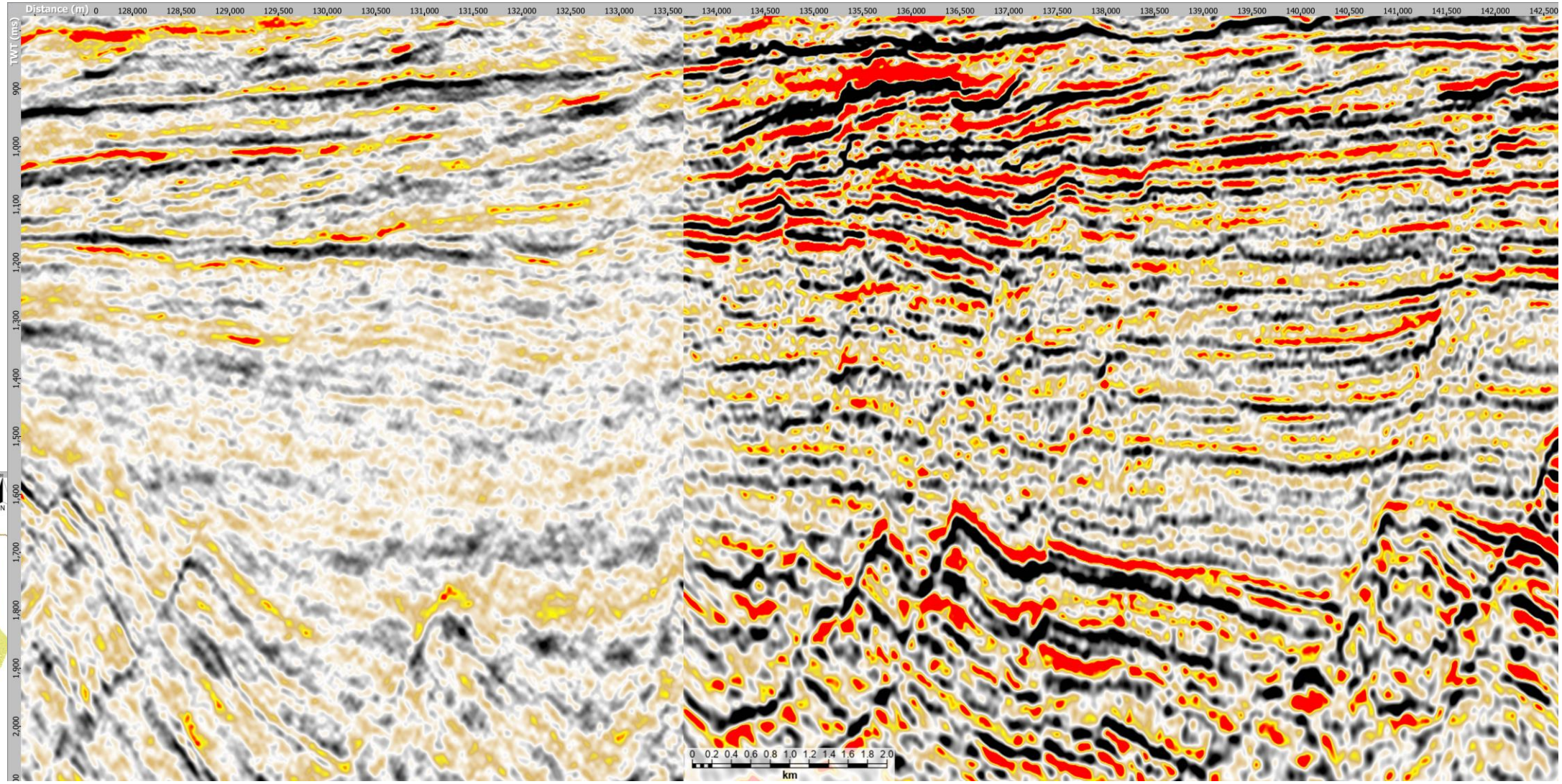
© Commonwealth of Australia (Geoscience Australia) 2024

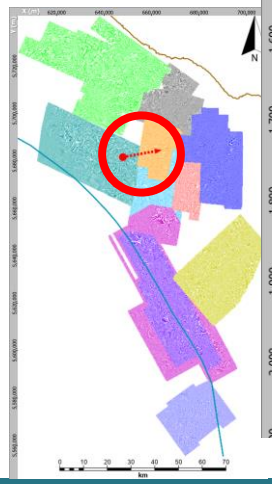
D



© Commonwealth of Australia (Geoscience Australia) 2024

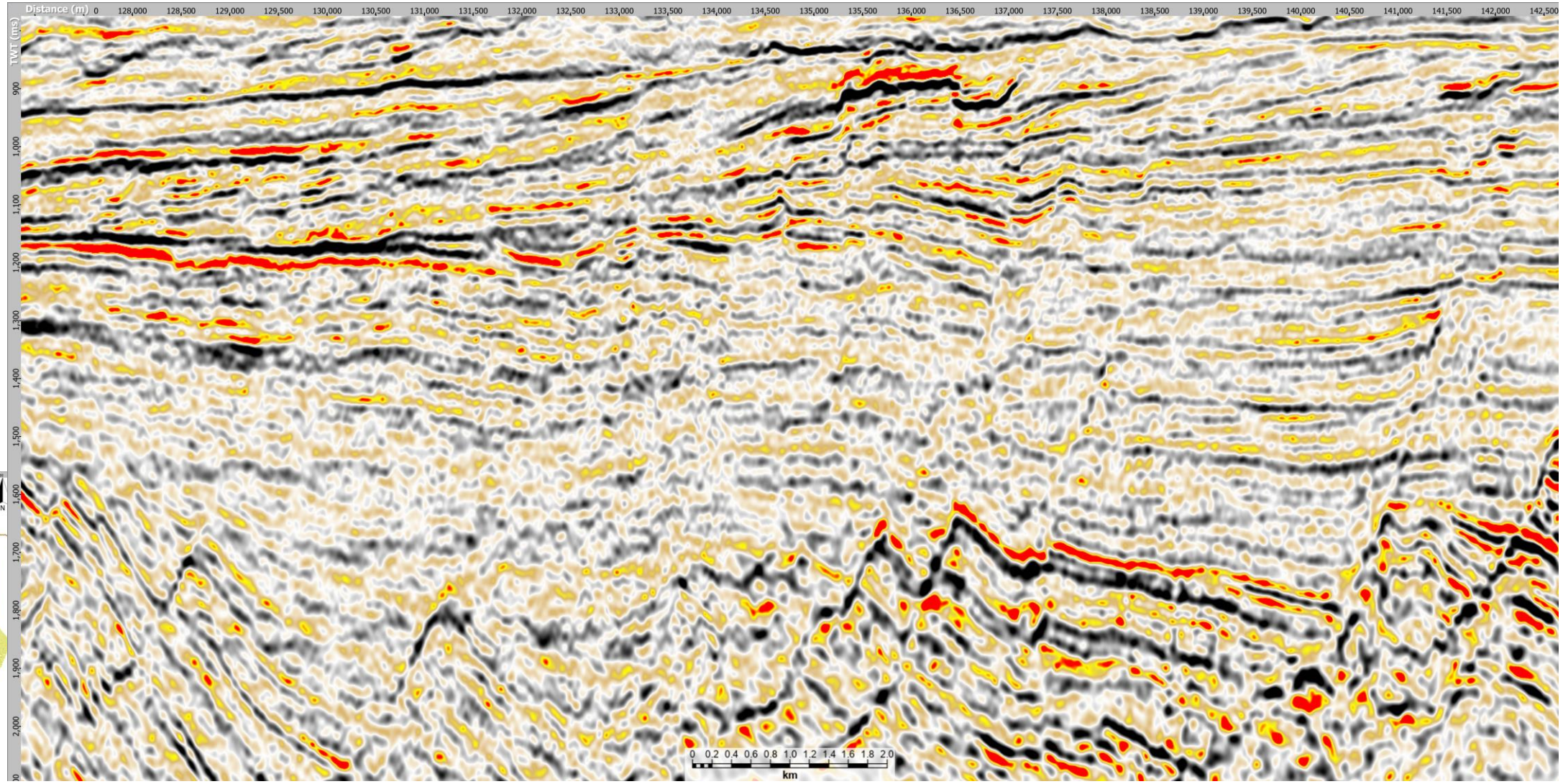
D - Input

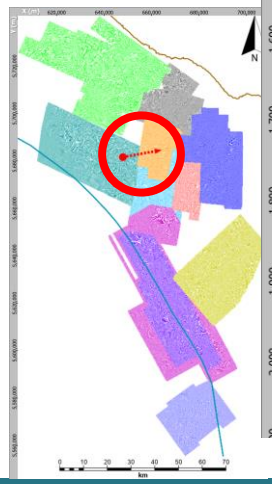




© Commonwealth of Australia (Geoscience Australia) 2024

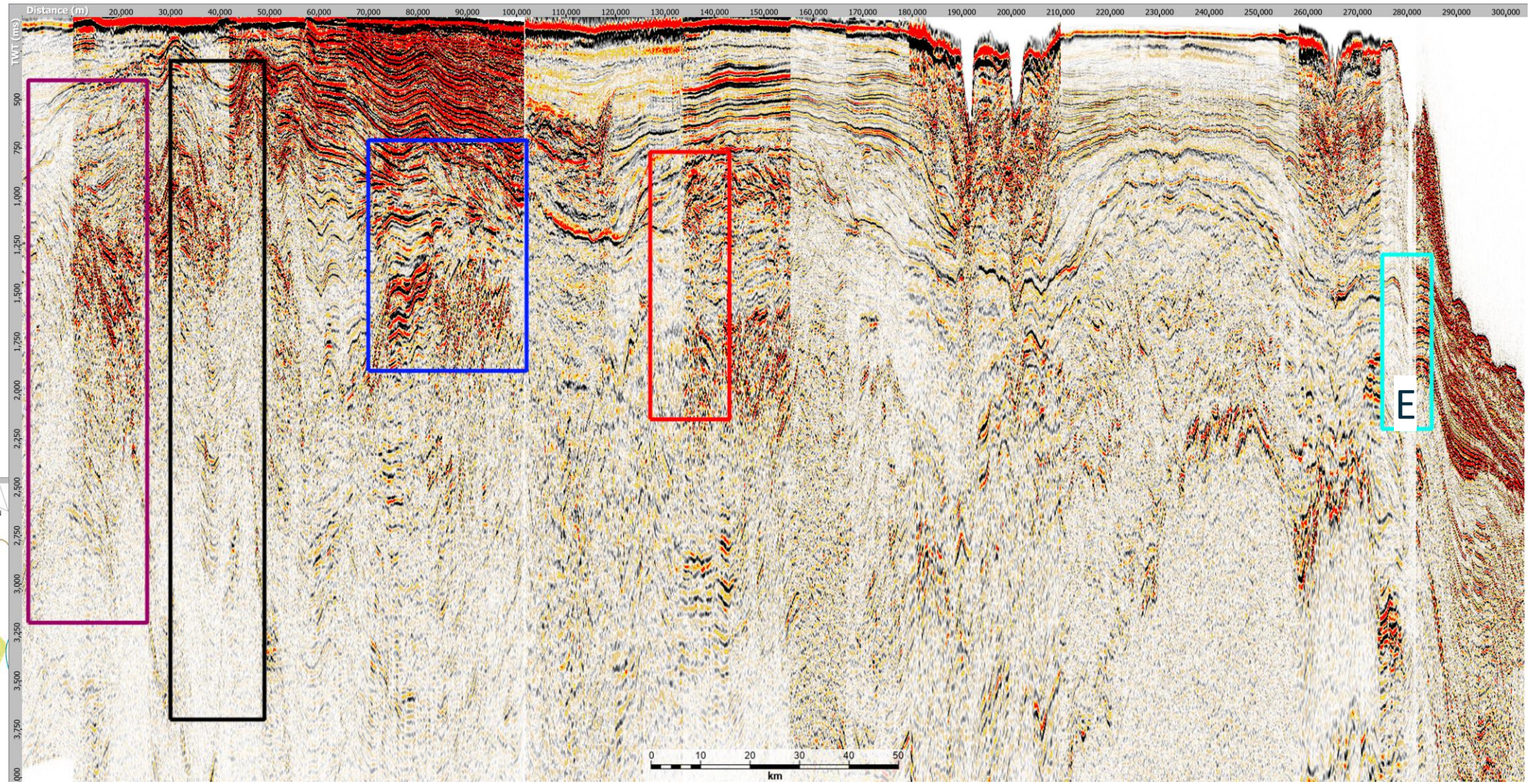
D - Final





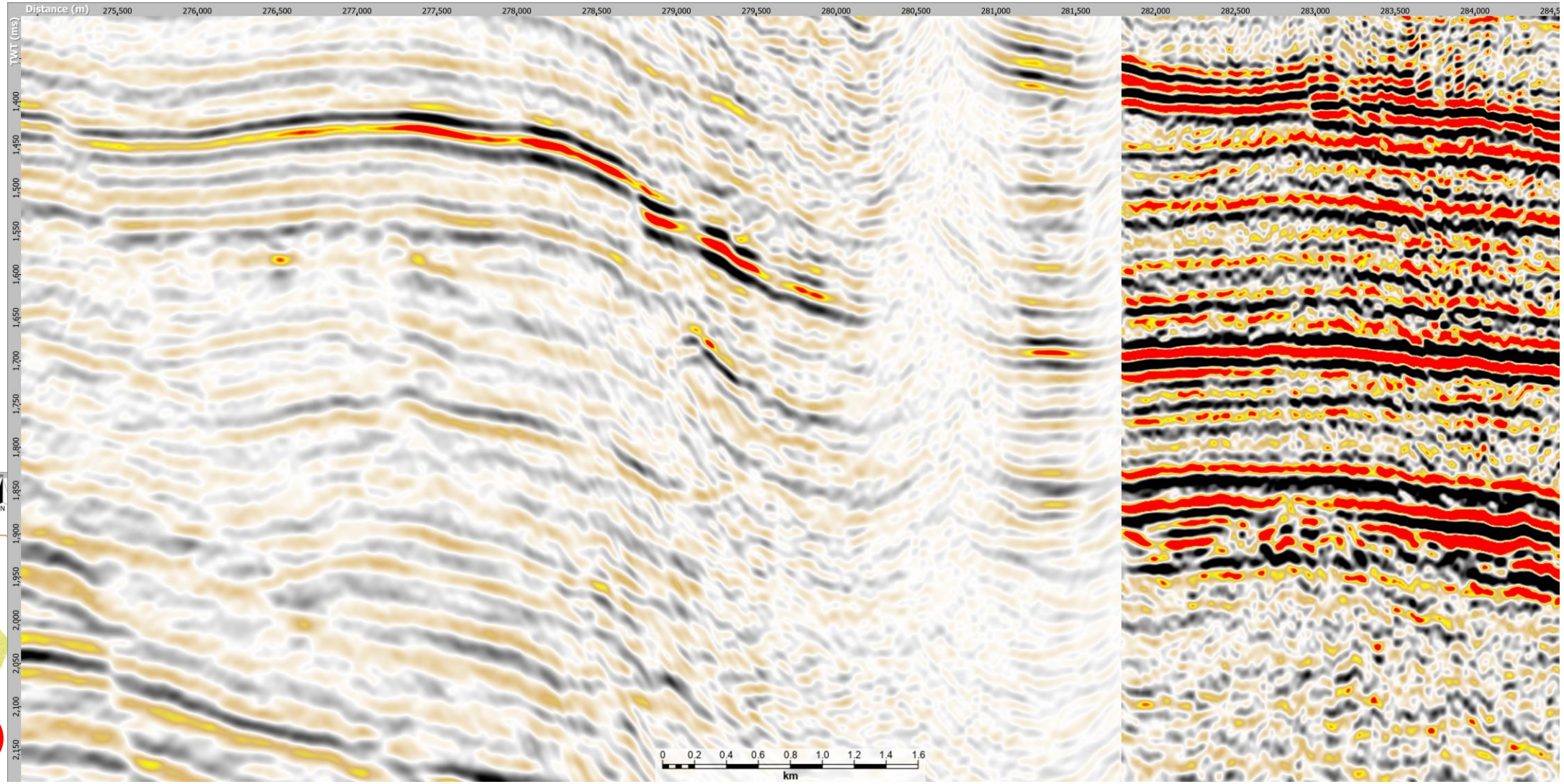
© Commonwealth of Australia (Geoscience Australia) 2024

E



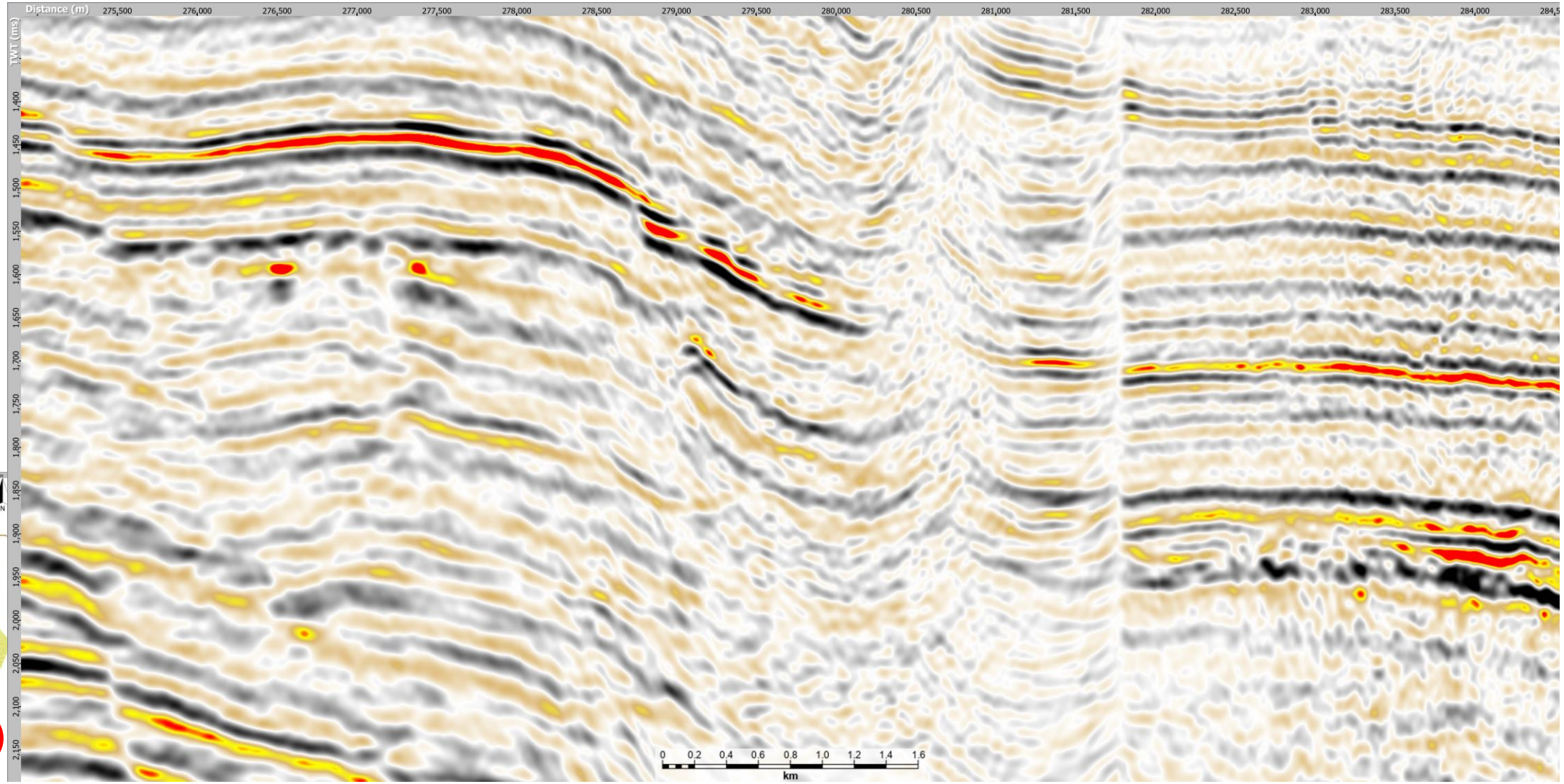
© Commonwealth of Australia (Geoscience Australia) 2024

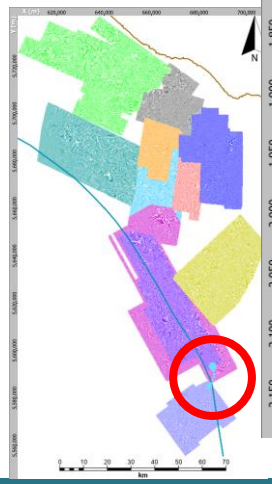
E - Input



© Commonwealth of Australia (Geoscience Australia) 2024

E - Final

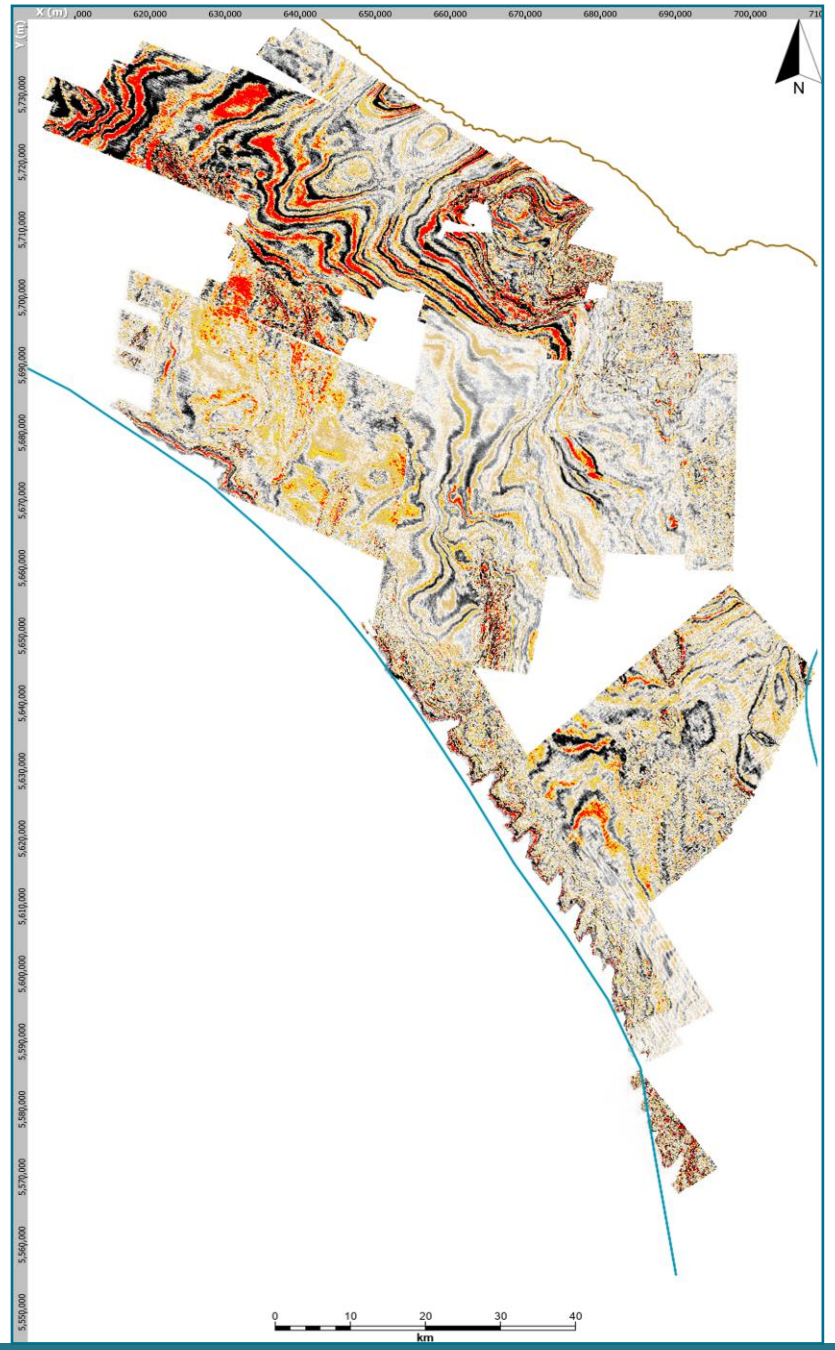




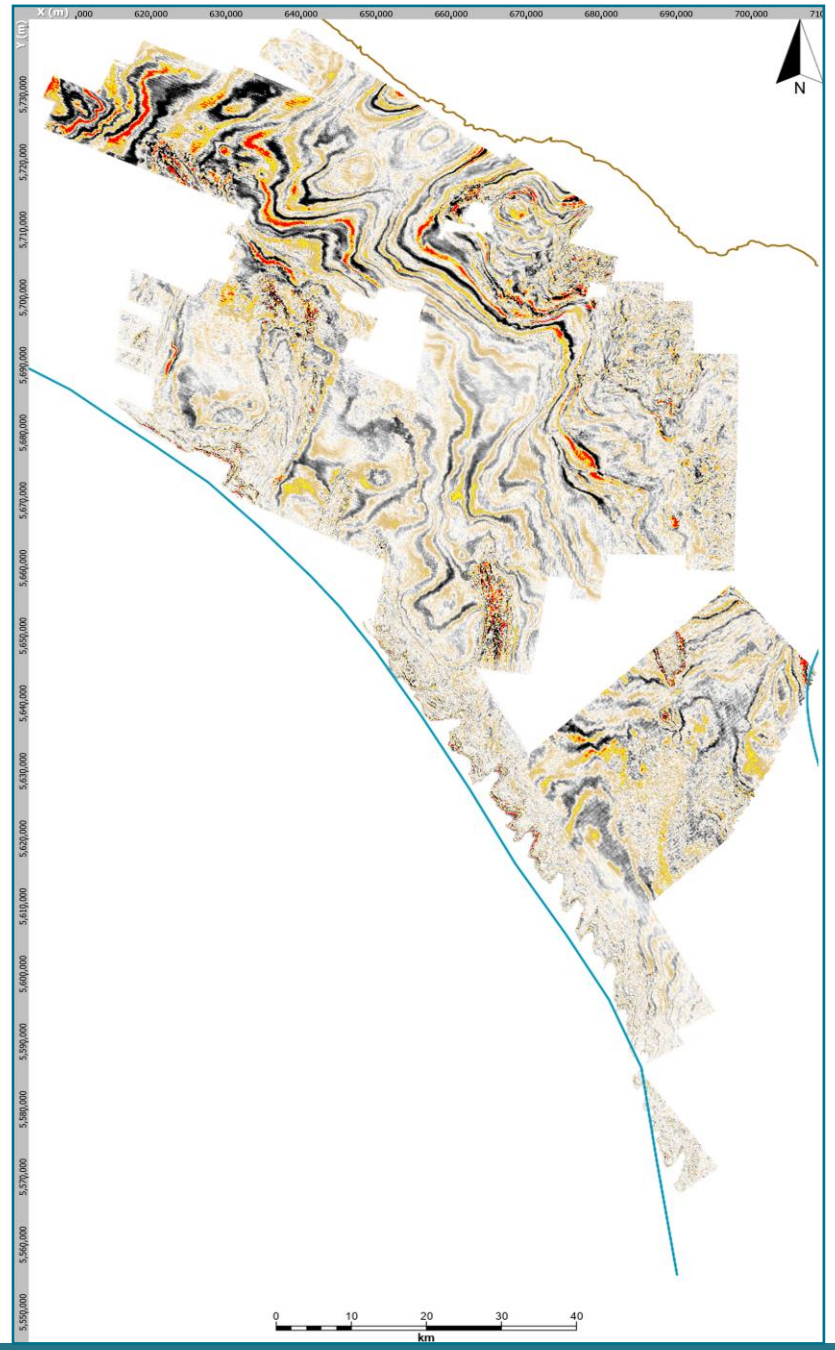
© Commonwealth of Australia (Geoscience Australia) 2024

Input

500ms



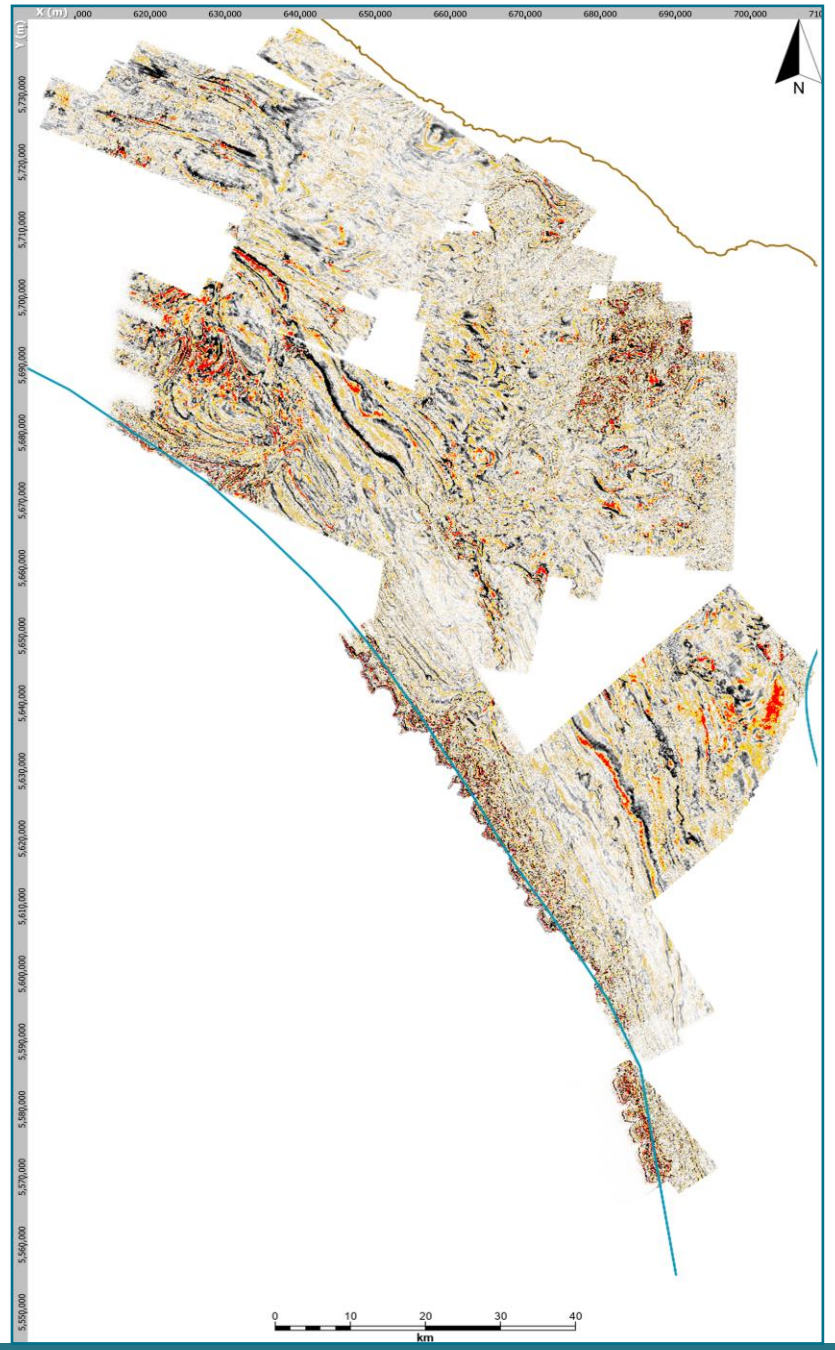
Final



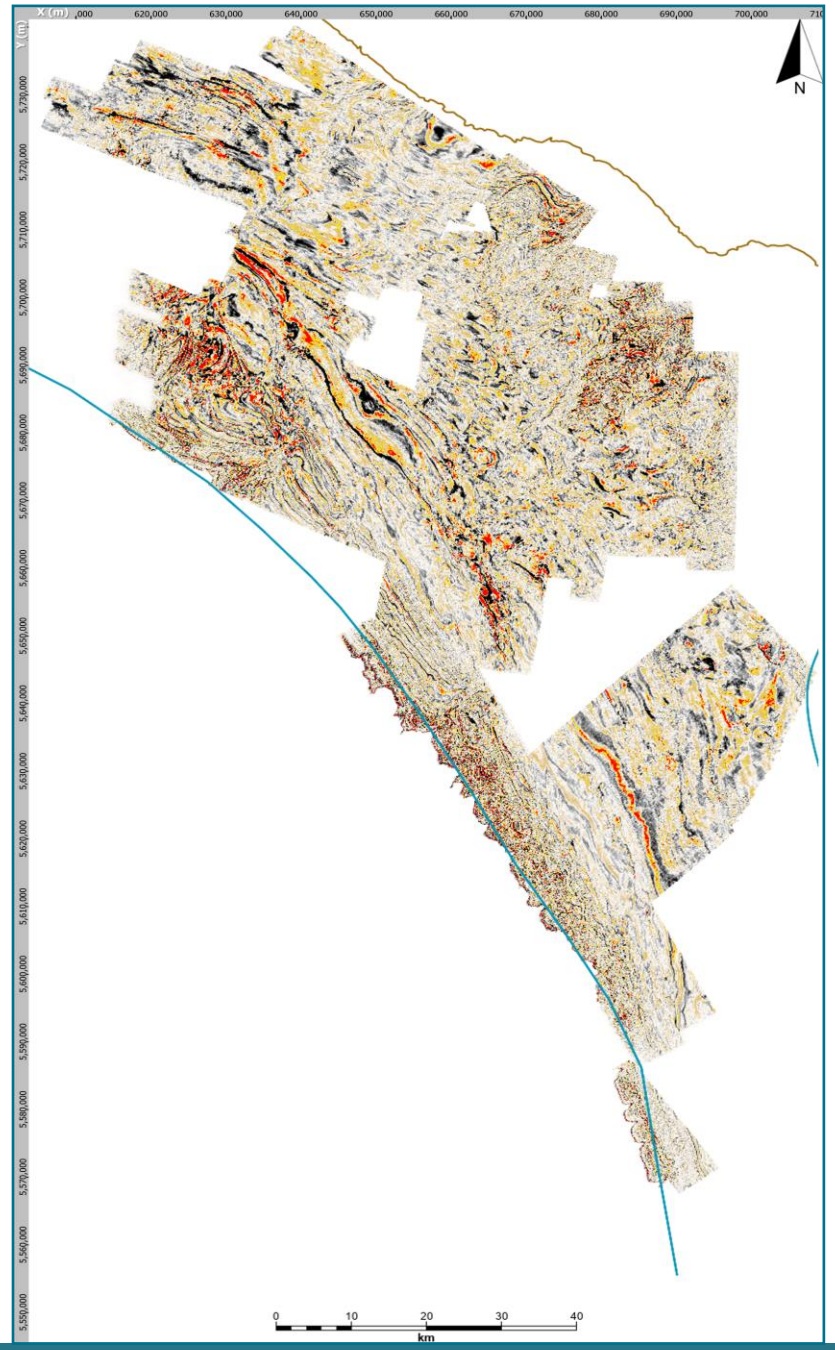
© Commonwealth of Australia (Geoscience Australia) 2024

Input

1000ms



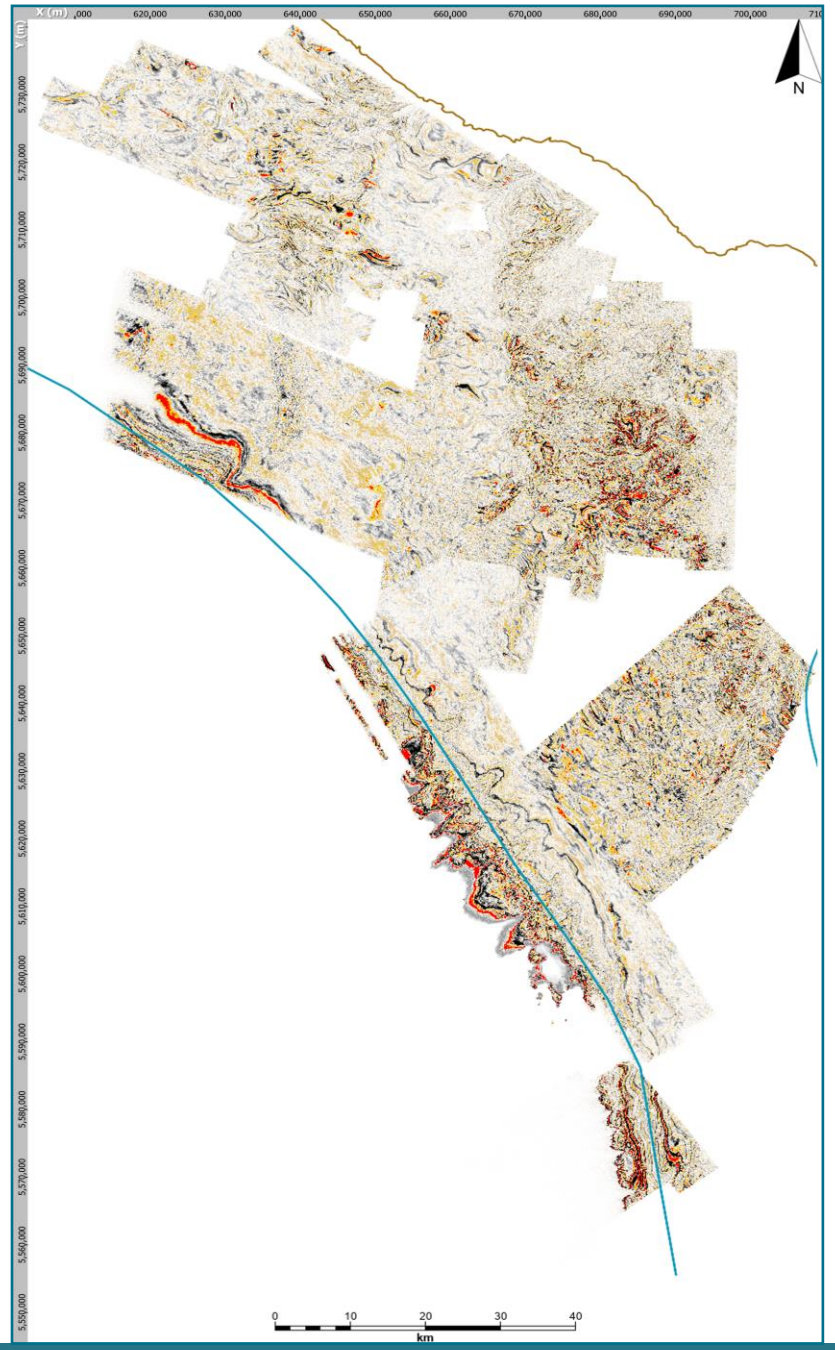
Final



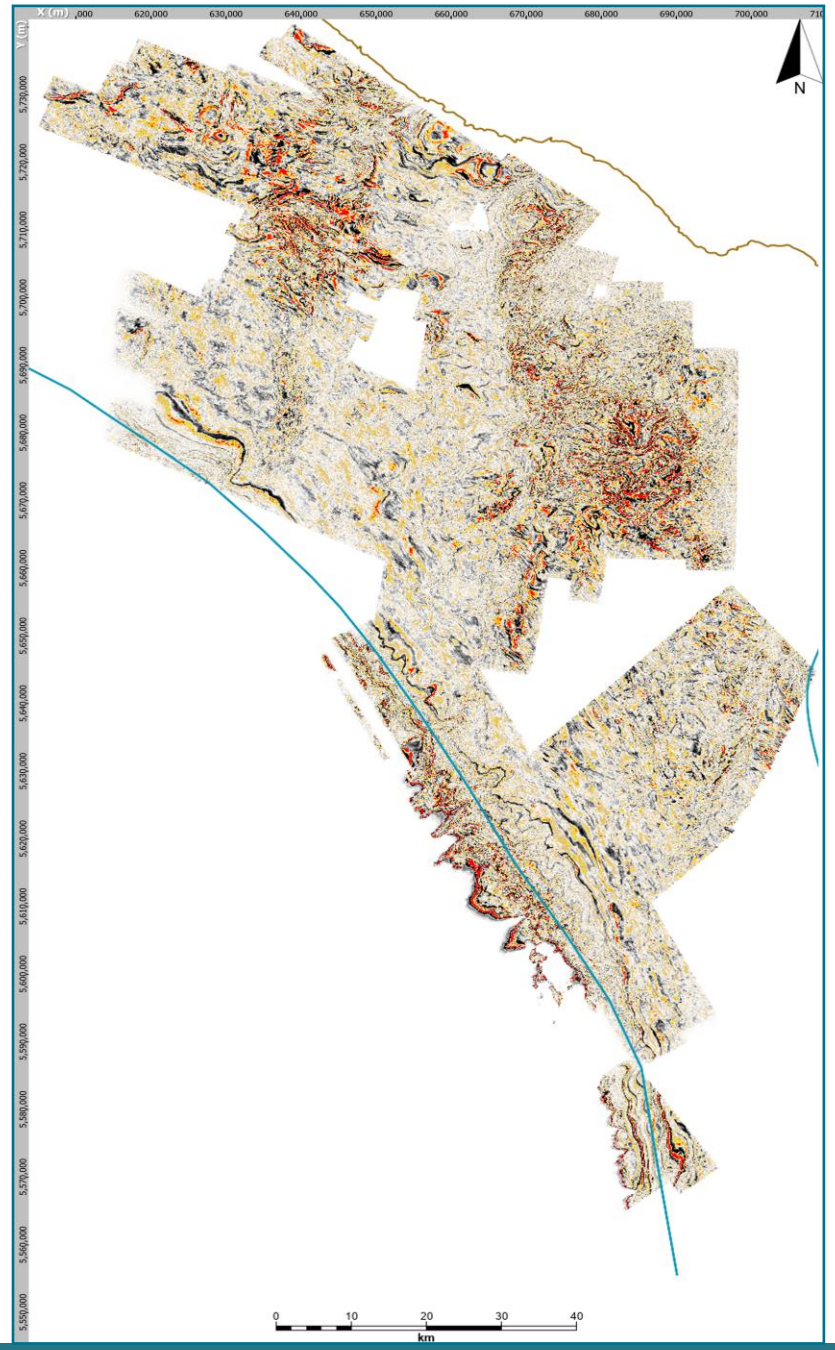
© Commonwealth of Australia (Geoscience Australia) 2024

Input

1500ms



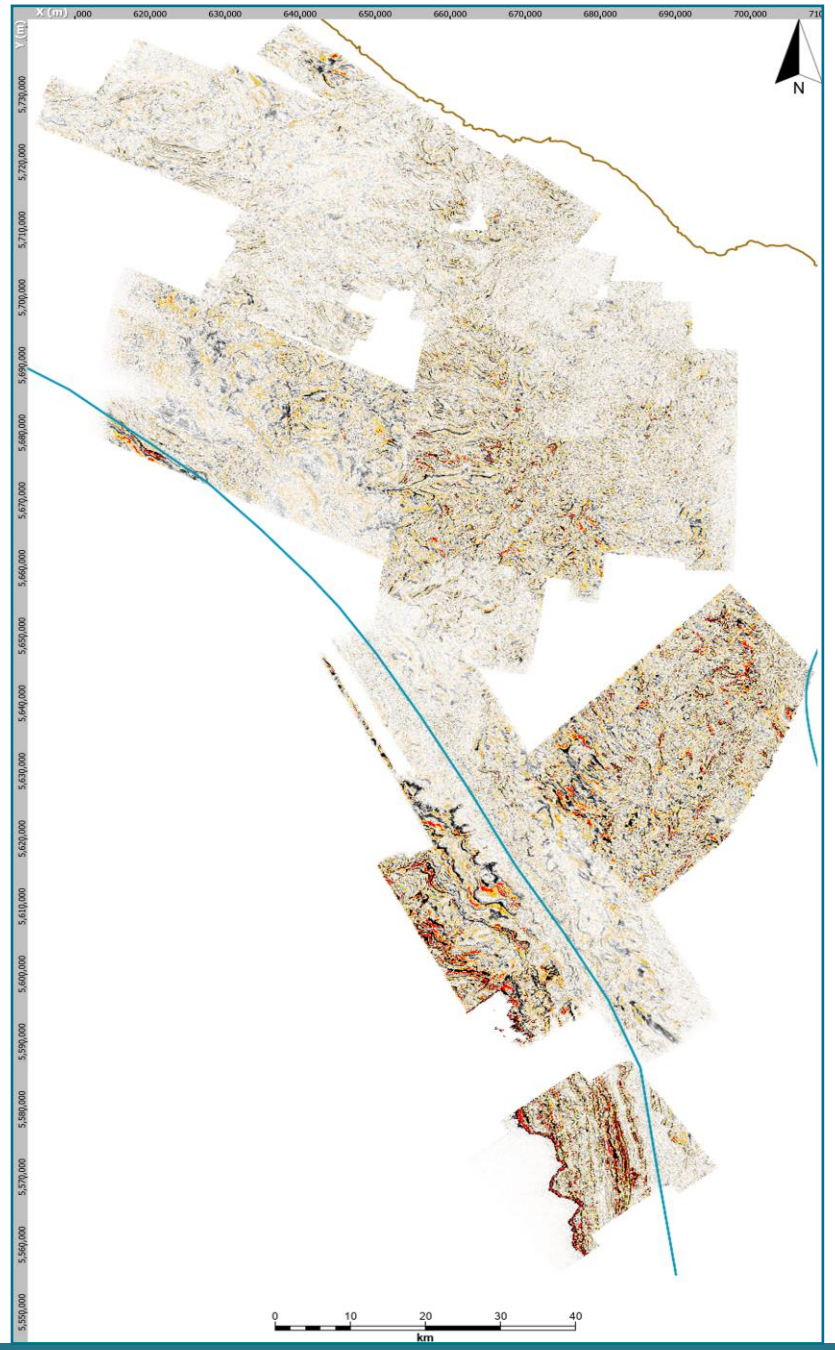
Final



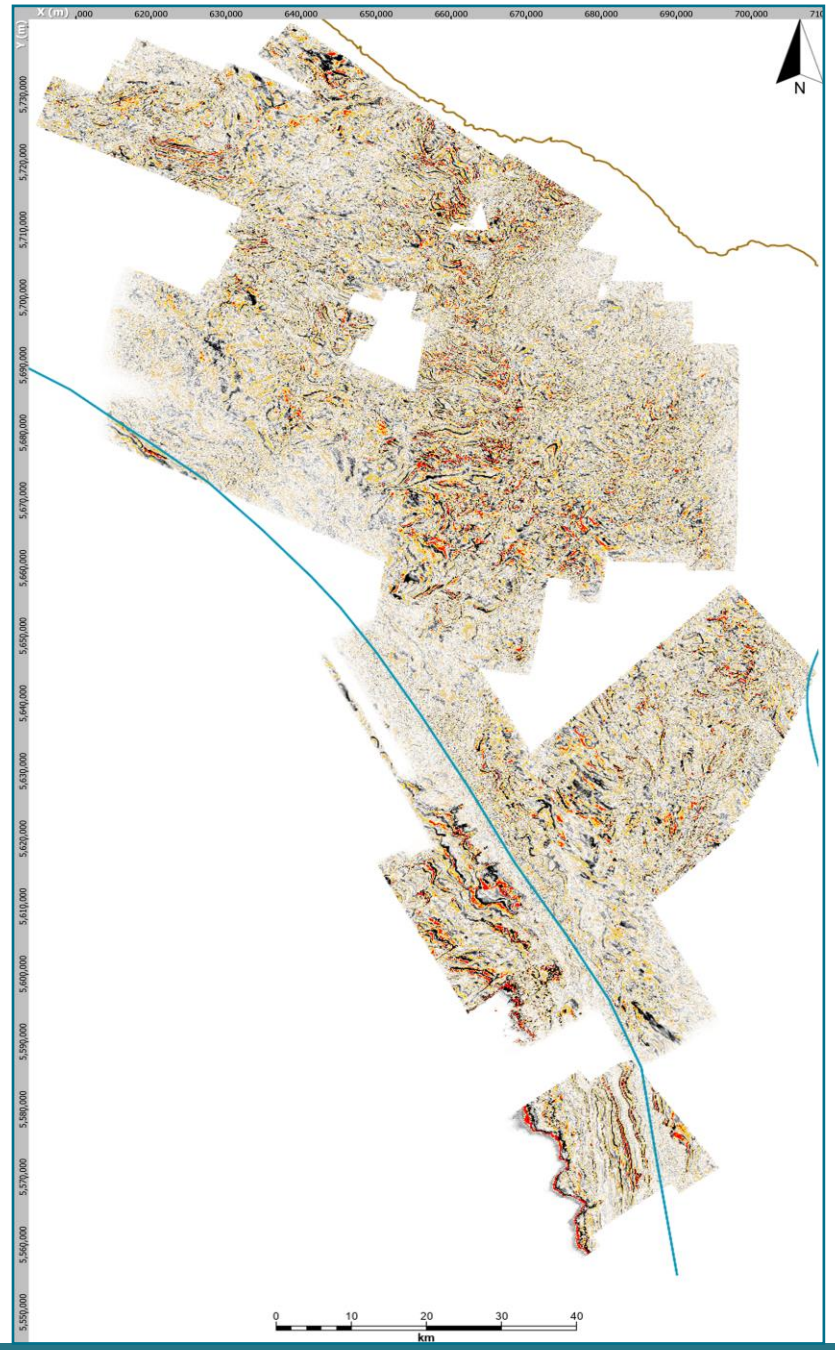
© Commonwealth of Australia (Geoscience Australia) 2024

Input

2000ms



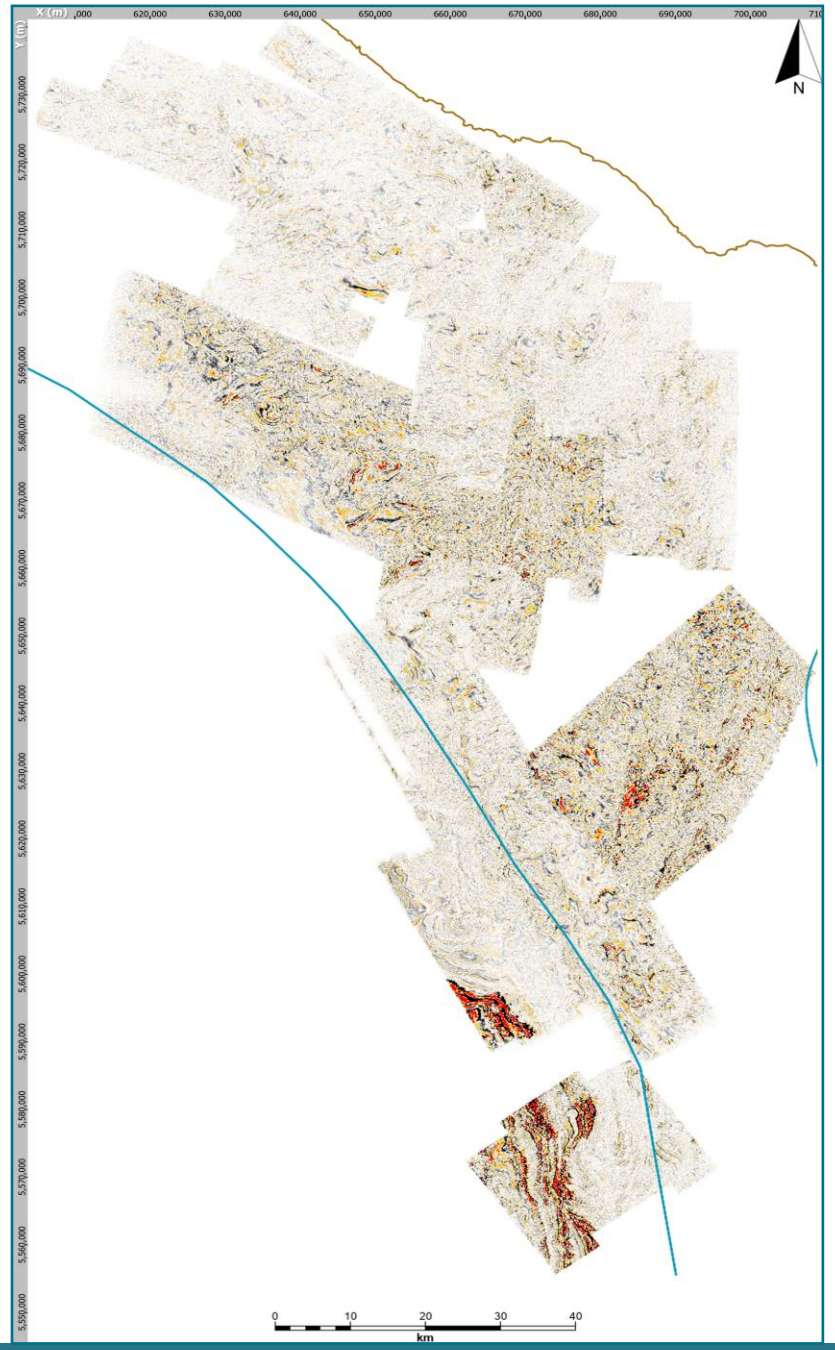
Final



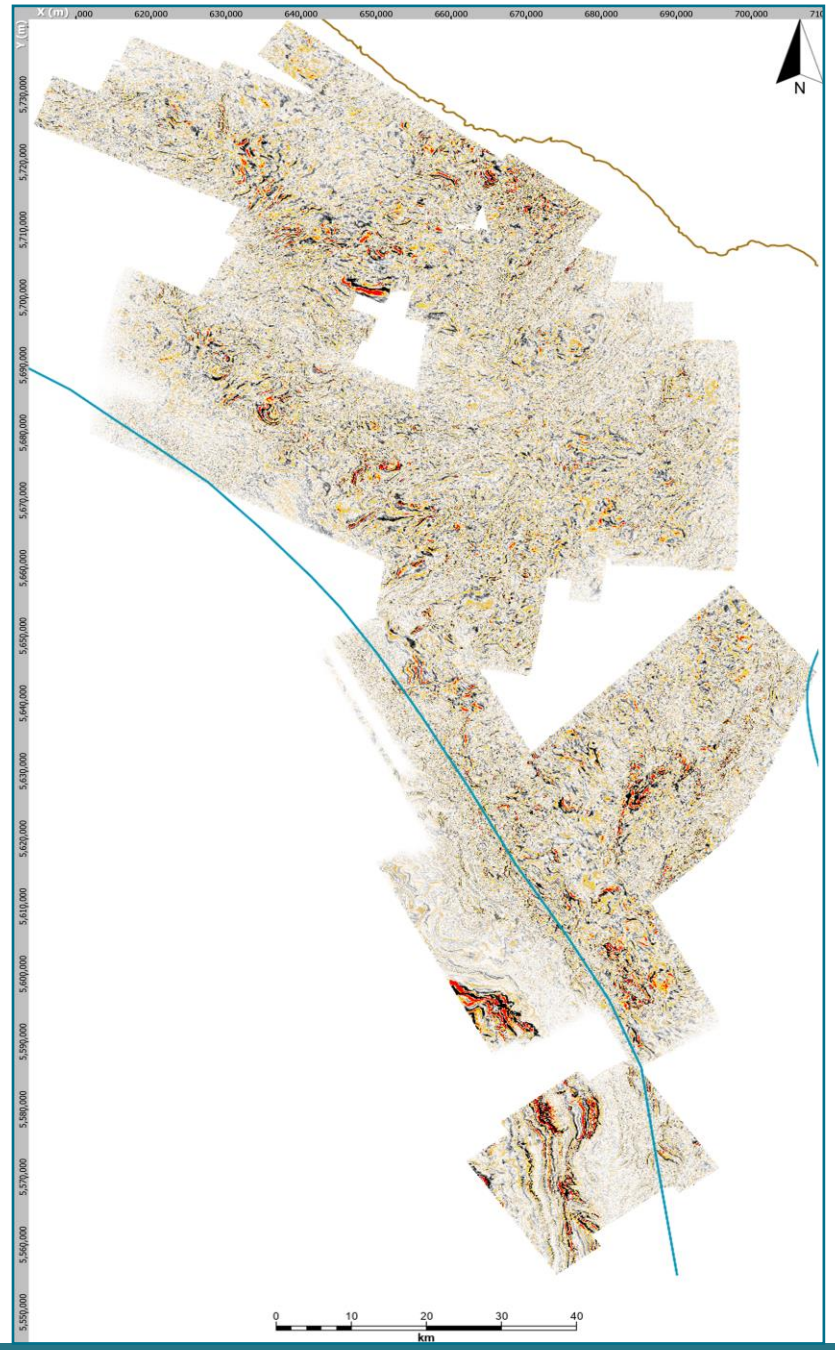
© Commonwealth of Australia (Geoscience Australia) 2024

Input

2500ms



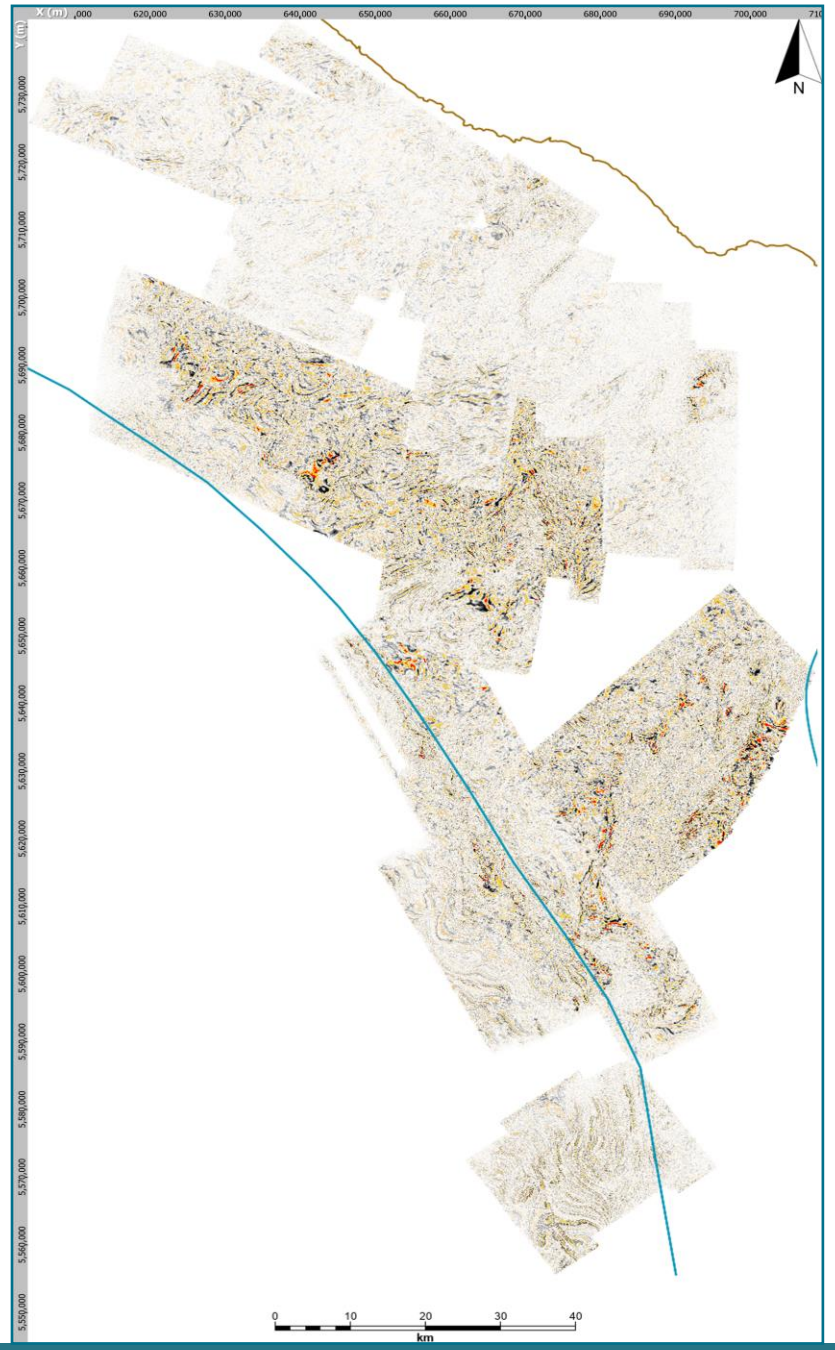
Final



© Commonwealth of Australia (Geoscience Australia) 2024

Input

3000ms

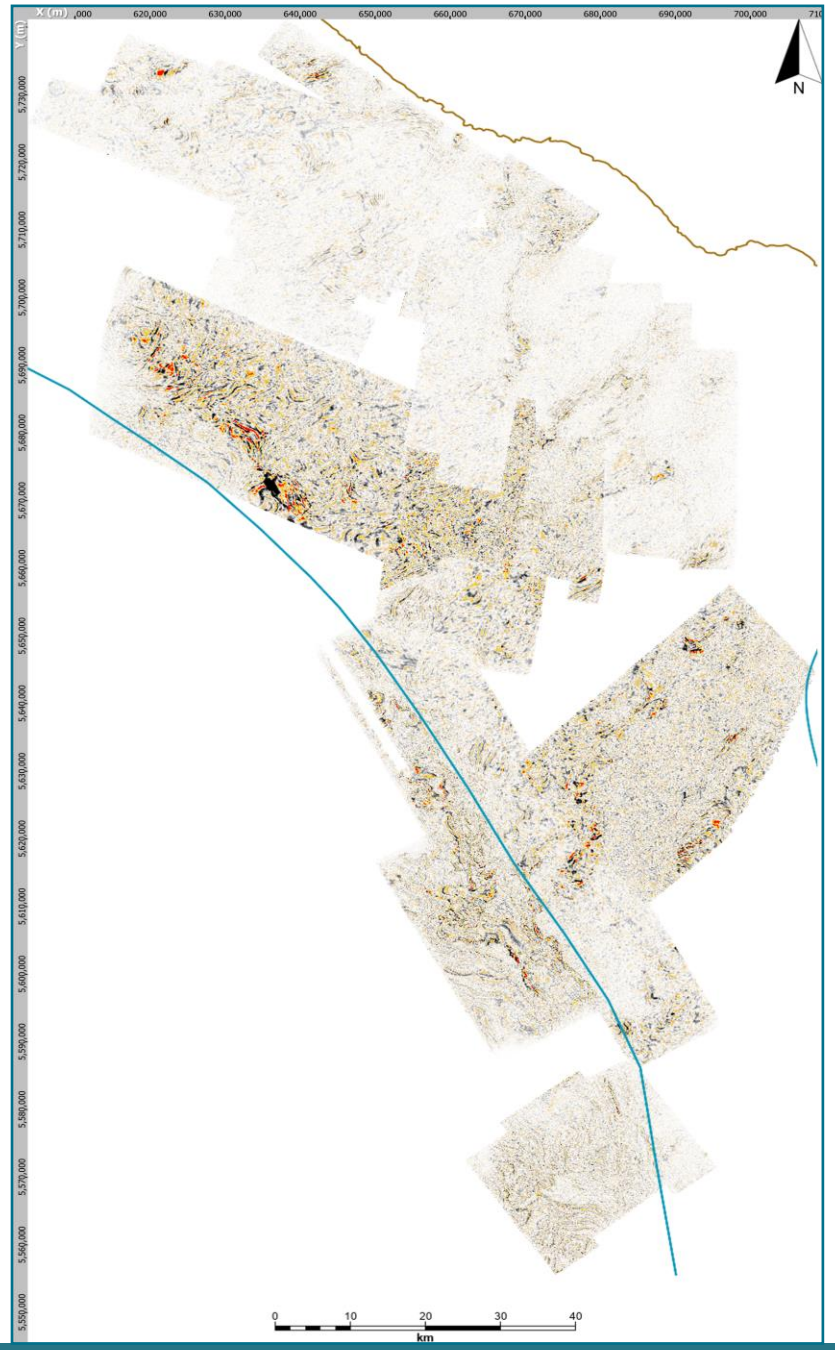


Final

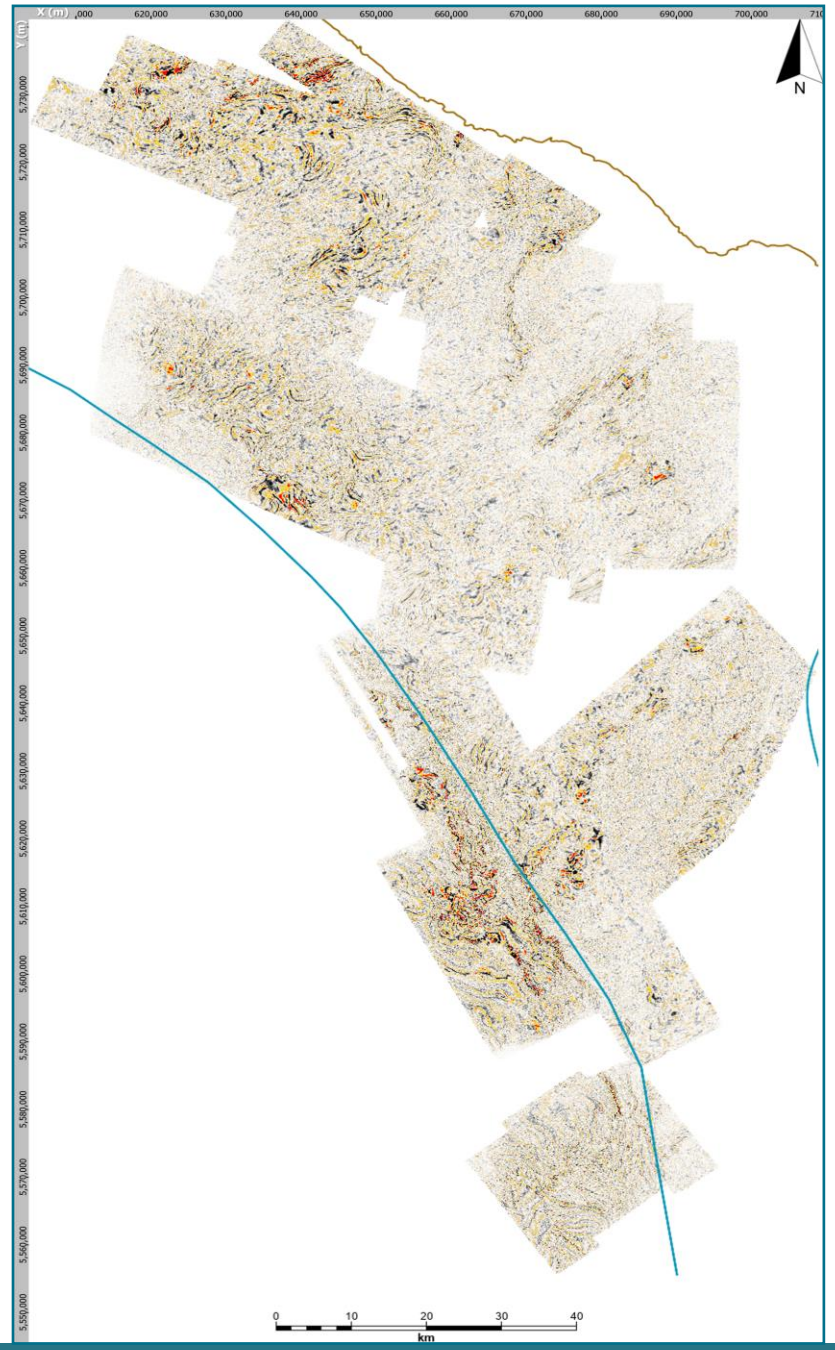
© Commonwealth of Australia (Geoscience Australia) 2024

Input

3500ms



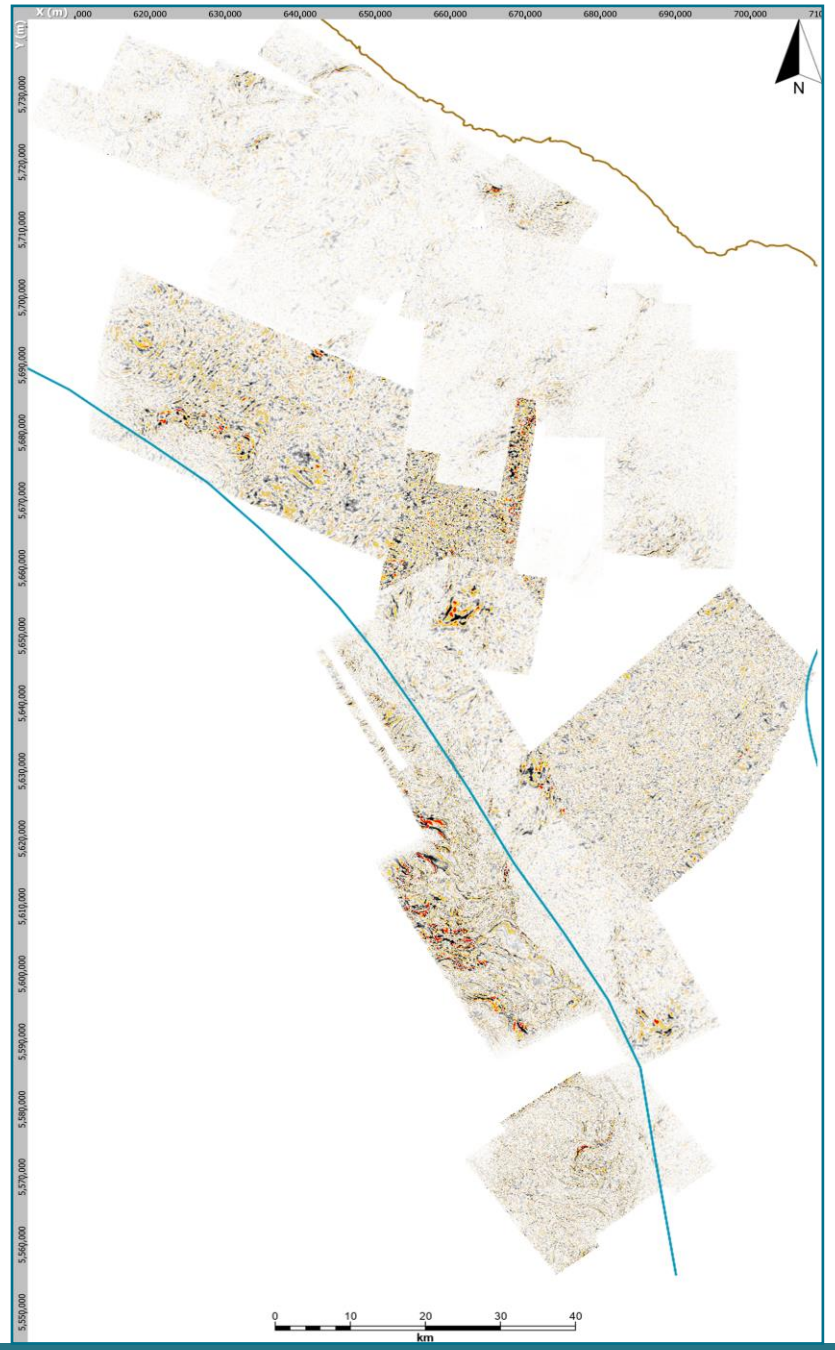
Final



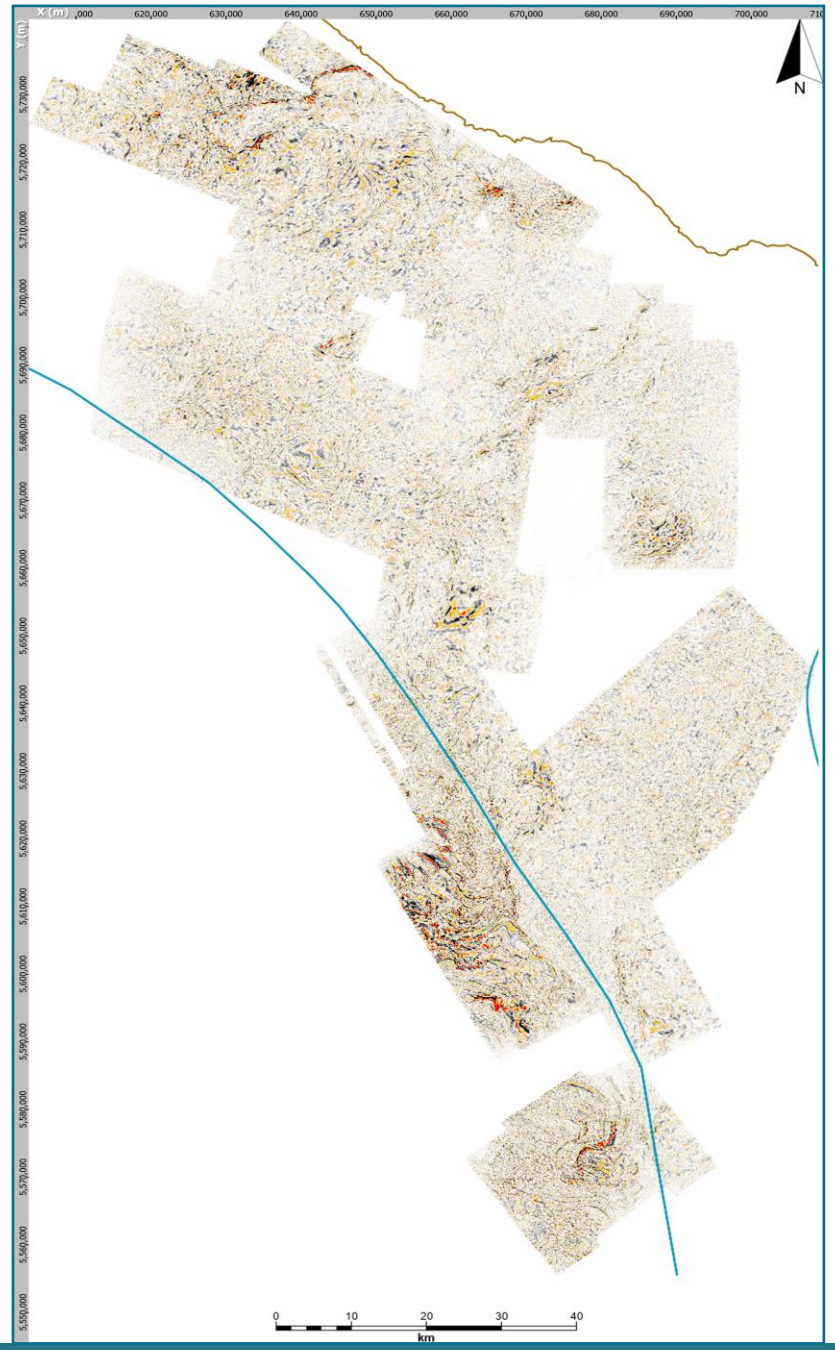
© Commonwealth of Australia (Geoscience Australia) 2024

Input

4000ms



Final



© Commonwealth of Australia (Geoscience Australia) 2024

Conclusions

The resultant volume enables;

- more continuous tracking of events using auto trackers, including waveform picking
- production of normalised amplitude maps and extraction of seismic attributes to map extents of geological features across survey boundaries
- faster interpretation of structure and events using contiguous time slices and generation of similarity/variance attributes
- better delineation of structure through better imaging of fault blocks and readily recognising changes in fault trend
- Improved work processes including loading, data management, surface generation…

© Commonwealth of Australia (Geoscience Australia) 2024

When should you do a post-stack 3D merge?

Technical

Contiguous/abutting 3D's with variable;

- orientation
- imaging

When constrained by

- Time
- Money
- Access to field data

such that a pre-stack option is not feasible

When pre-stack reprocessing

To provide an 'early' product in parallel

- Where sufficient time and money are available
  - Fast track interpretation
  - Improved model building
  - Targeting issues e.g. de-multiples, velocity problems, noise

© Commonwealth of Australia (Geoscience Australia) 2024

Appreciation

Co-authors

Scott Wilkinson[B], *Pei-Fei Chau*[B], *Cameron Mitchell*[A] *and Jennifer Badry*[B].

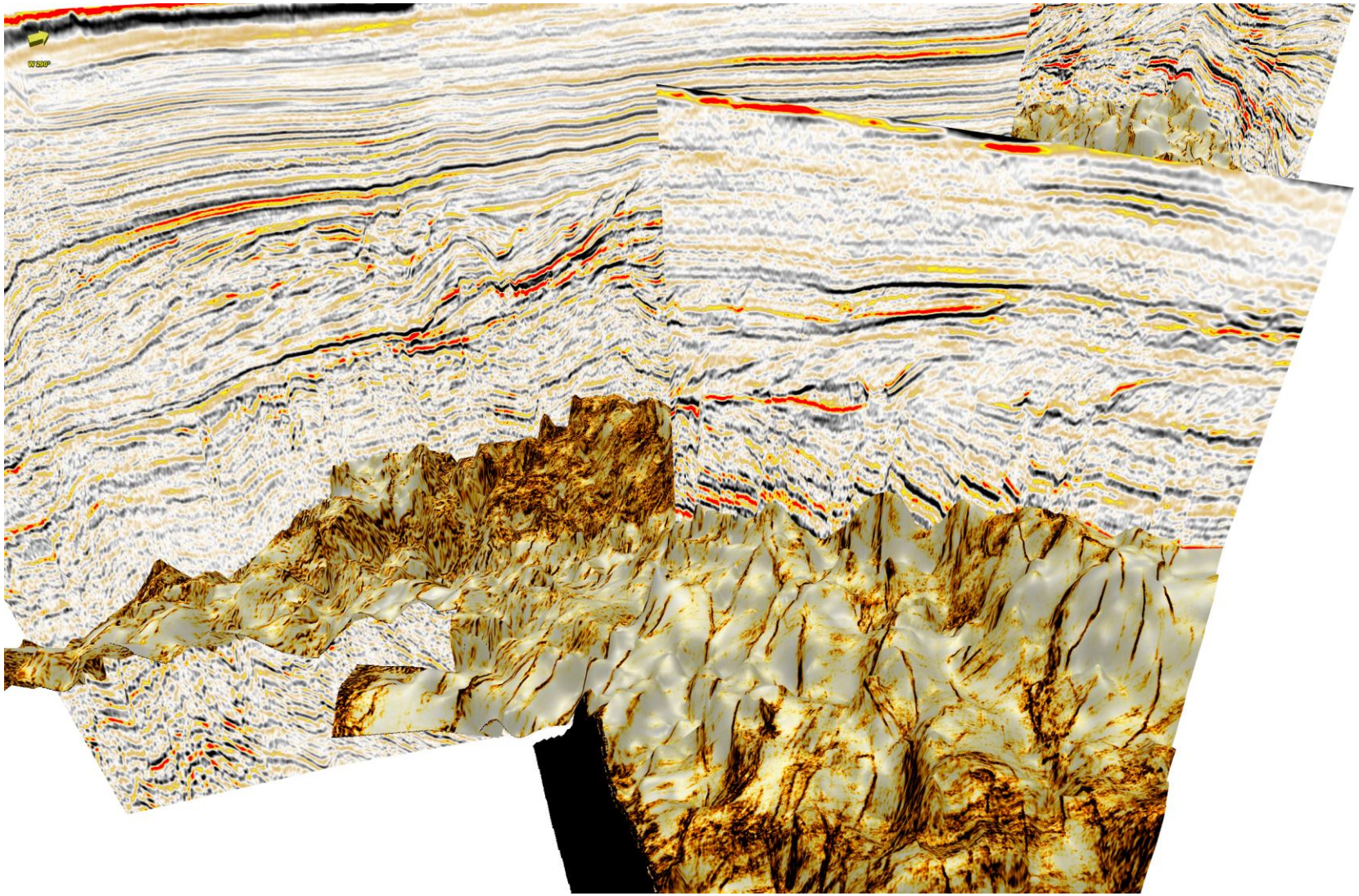
A. Geoscience Australia

B. DUG Technology Ltd

- The team at DUG
- The Repository Team
- The reviewers Donna Cathro and Yvette PoudjomDjomani
- The contracts team at Geoscience Australia
- Chris Evenden
- The Offshore Energy Systems team

© Commonwealth of Australia (Geoscience Australia) 2024

Questions



Australian Government
Geoscience Australia

Further information

The data is available for download (up to 54 Gb each) via NOPIMS (nopims.gov.au) as 11 separate files and volumes (final), or as single volumes (raw and final) from ausgeodata@ga.gov.au.

Reprocessing Id ENO0810804.

© Commonwealth of Australia (Geoscience Australia) 2024