Multiple Source Marine Seismic Acquisition in Australia

James Wallace, Polarcus

TECHNOLOGY SESSION

PESGB SEAPEX Asia Pacific E&P Conference
"Asia-Pacific Revisited: New Ideas, New Opportunities"
27th June Olympia, London

Outline

- Multiple Source Acquisition – Triple Source Design

- Case study: Cygnus, Polarcus MC, Vulcan sub-basin, Australia

Conventional 3D

- Dual source sequential shooting flip / flop
- Cross-line samping = ¼ of the streamer separation

Polarcus

Triple Source 3D – Enhanced Quality

- Designed to provide closer cross-line sampling and more unique ray-paths than dual sources on same streamer configurations
- Cross-line sampling = 1/6 of streamer separation

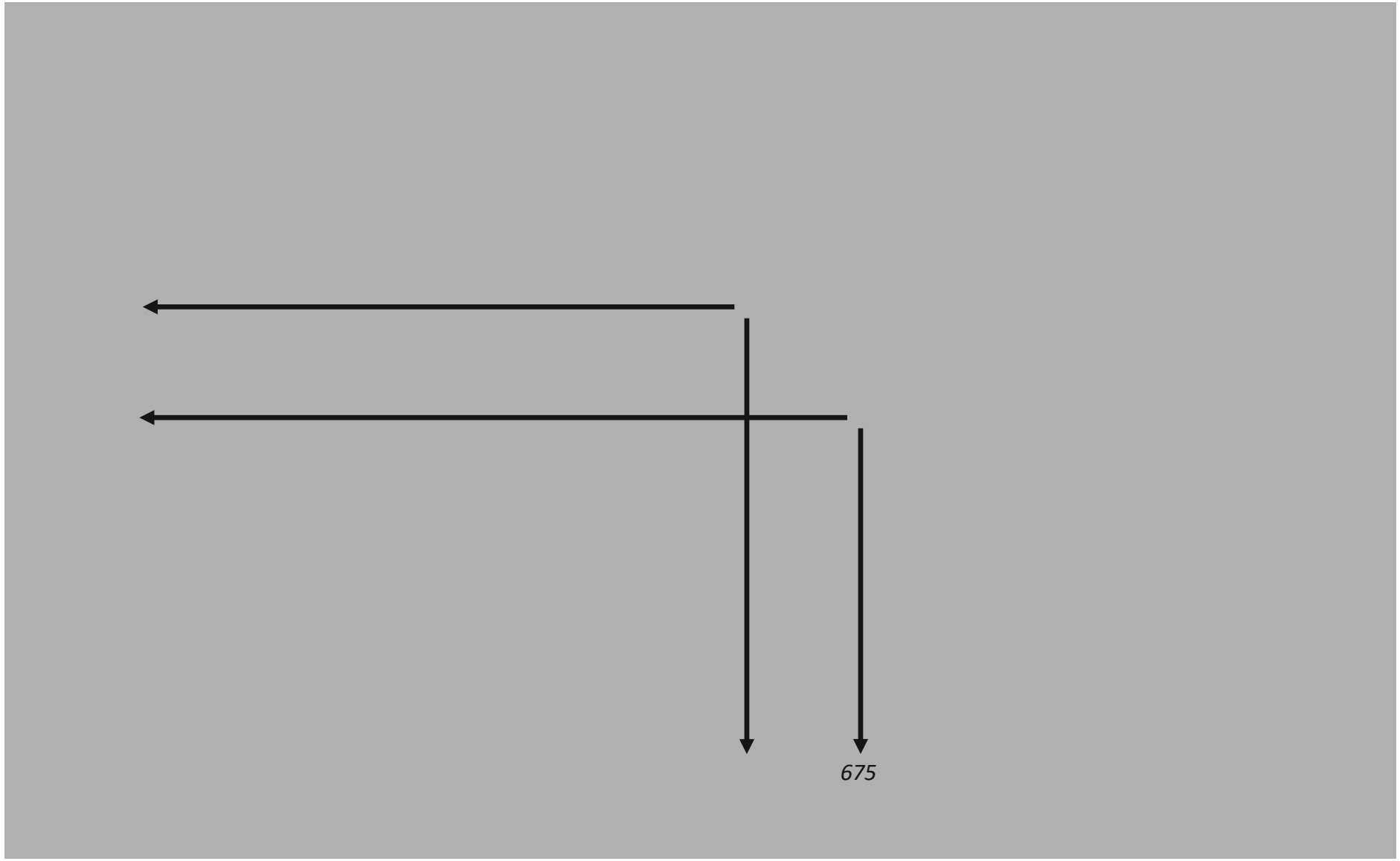
Polarcus

Triple Source 3D – Enhanced Efficiency

- Designed to provide dense cross-line spatial sampling from wide streamer configurations
- Cross-line sampling = 1/6 of streamer separation

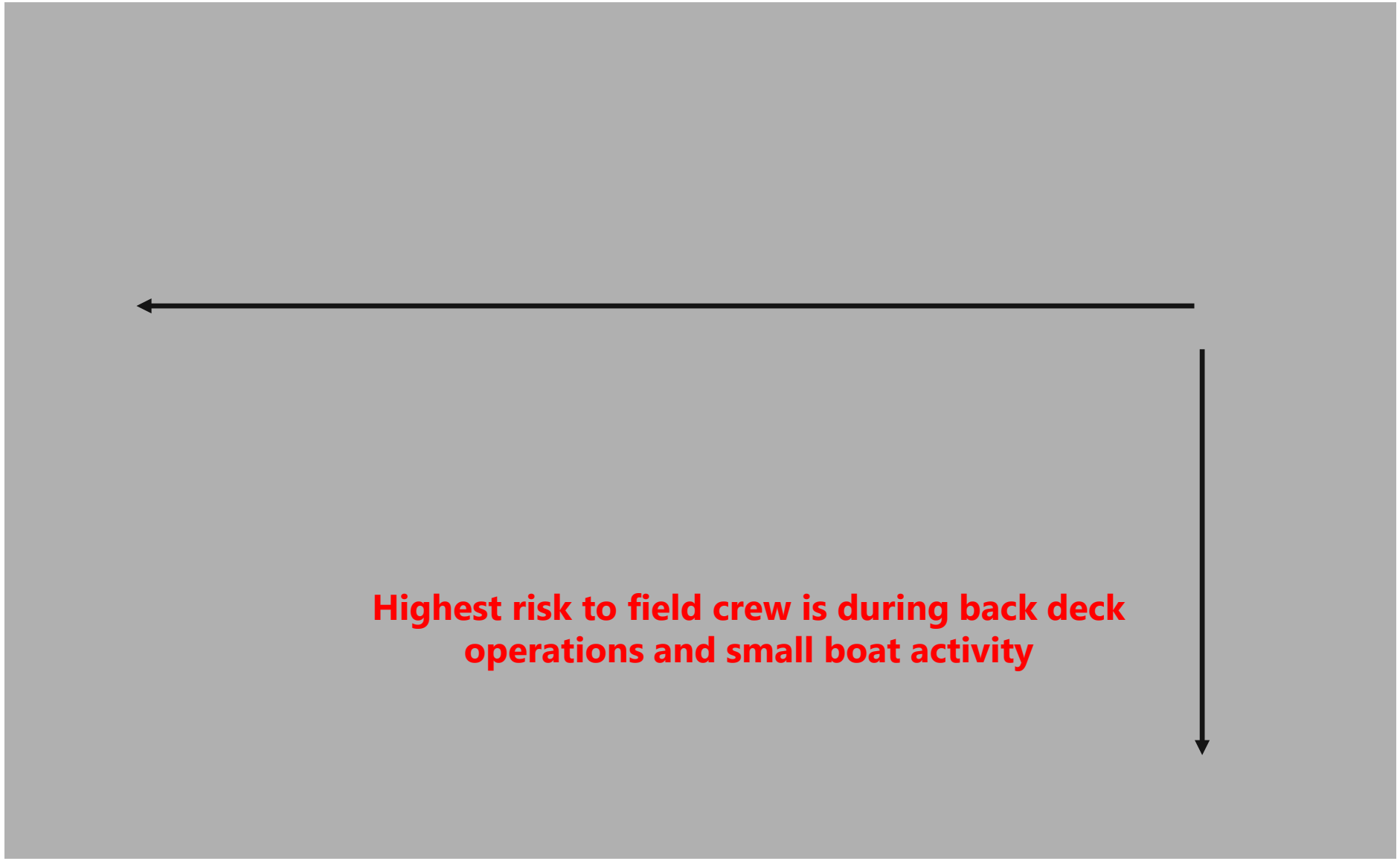
Polarcus

Multi-Source Efficiency…and Quality



Polarcus

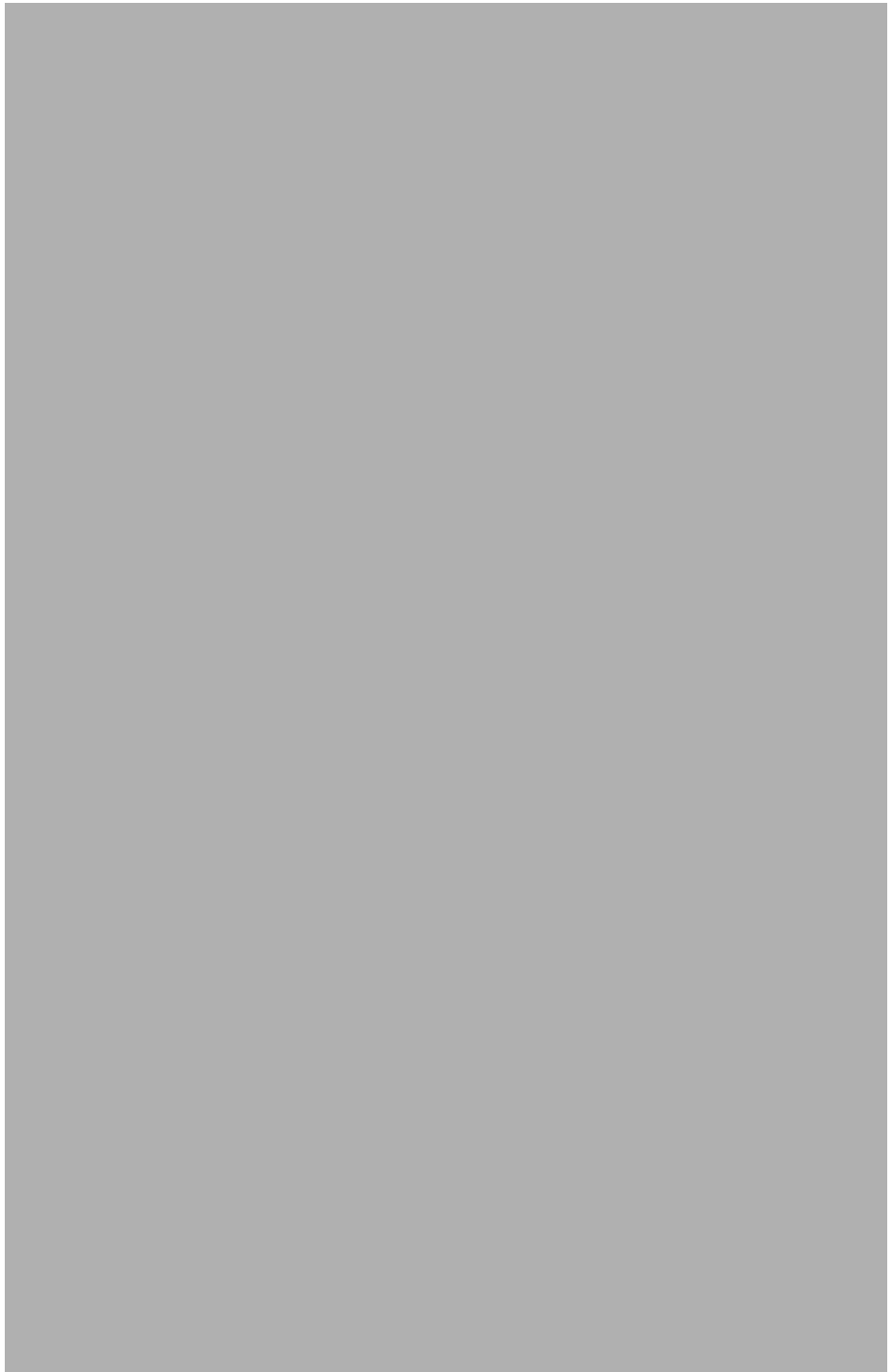
Multi-Source Efficiency…and Quality



Polarcus

Floating Debris Hazard

- Cause expensive equipment damage
- Increased small boat activity
- Too many streamers could be a show-stopper



Polarcus

Barnacles

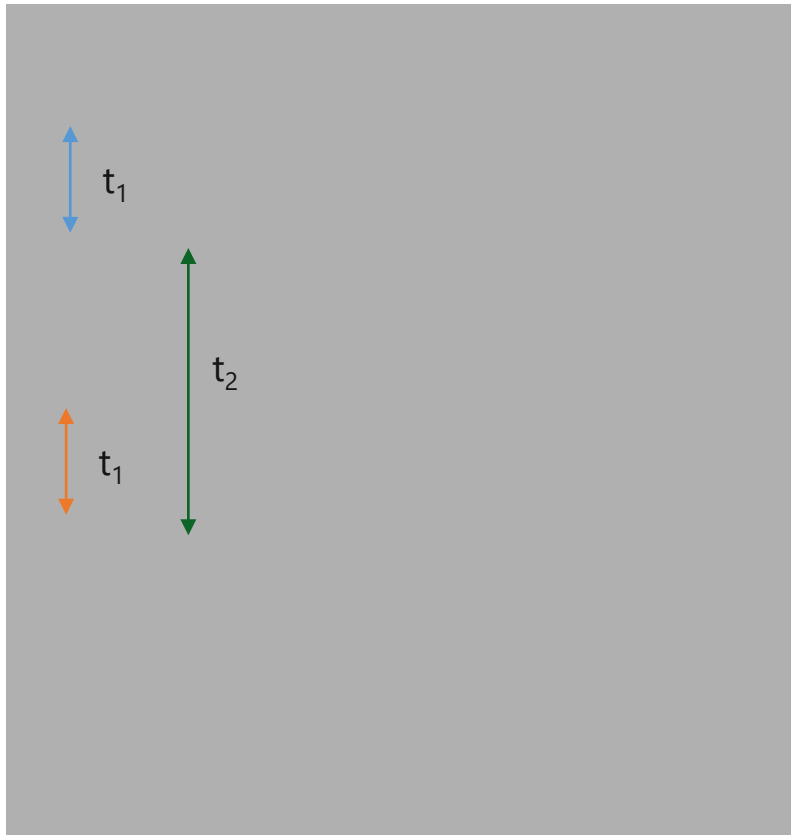
attached to in-sea equipment

- Increase drag and tensions on the streamers
- Affect spread stability and separations
- Increased small boat activity for cleaning
- Costly recoveries and deployments

Polarcus

Shotpoint Interval and Overlap

- Multiple sources takes advantage of overlapping shots
- Two main technologies: deblending and continuous recording
- Risk to quantitative interpretations methods such as AVO and inversion minimized by ensuring the blended zone is deeper than any amplitude-sensitive analysis zone.

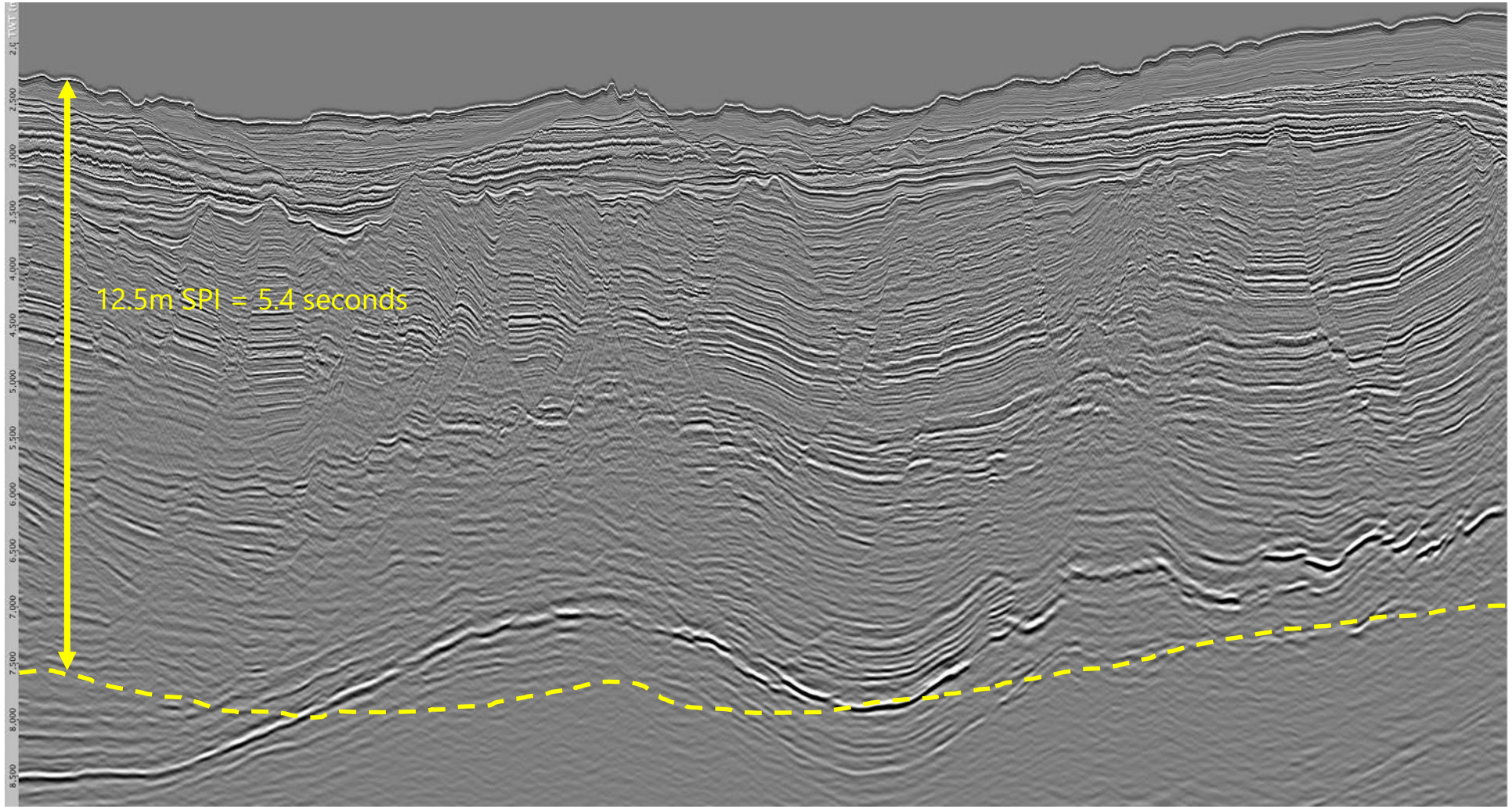


The *unblended zone* (difference in arrival time between the water bottom and next shot's water bottom) is the same as the shot interval time, stays constant from near to far offset, and not linked to water depth.

Polarcus

Deblended Migrated Section

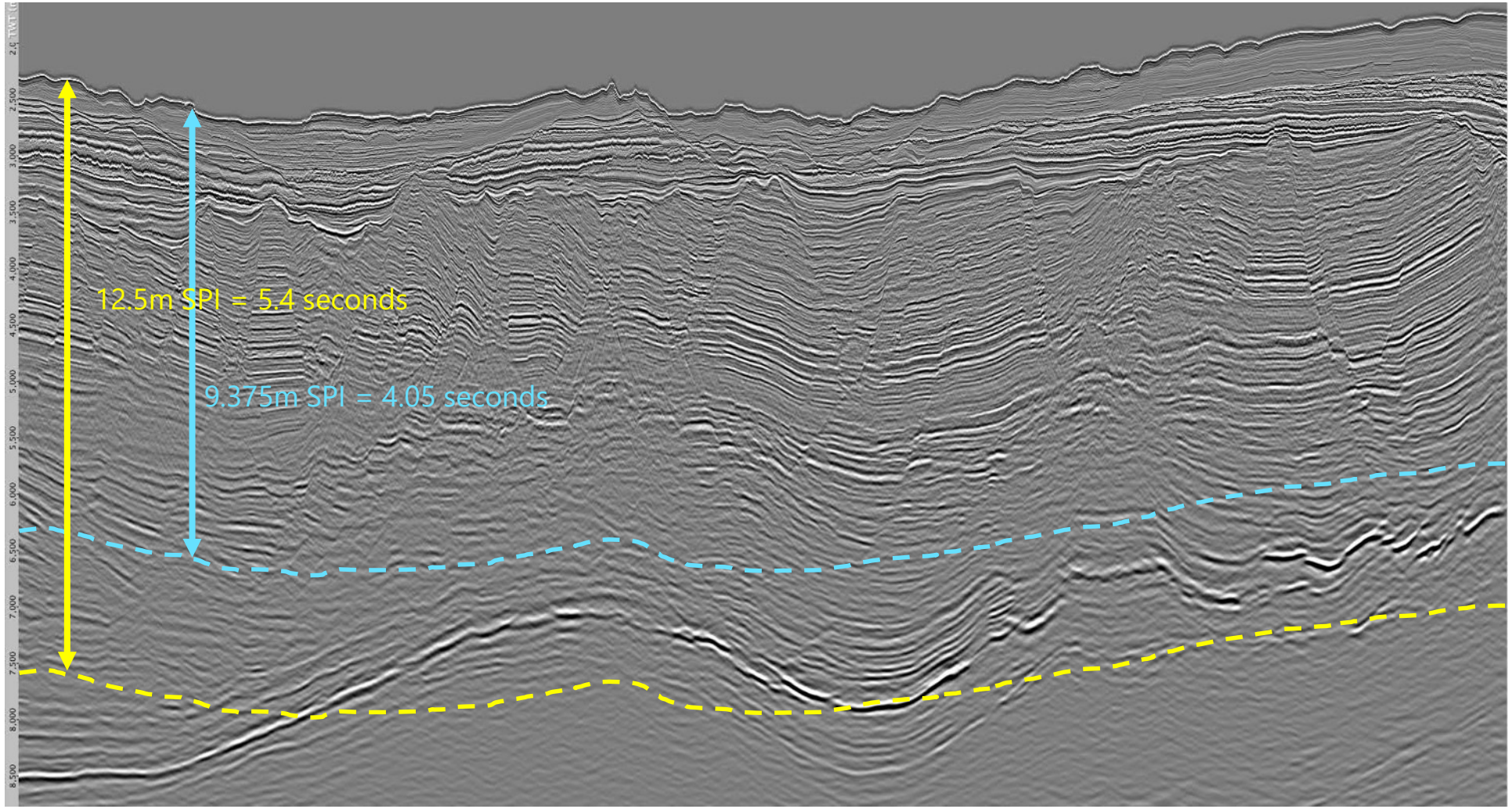
Shot Record Overlap Determined by Shot Point Interval



Polarcus

Deblended Migrated Section

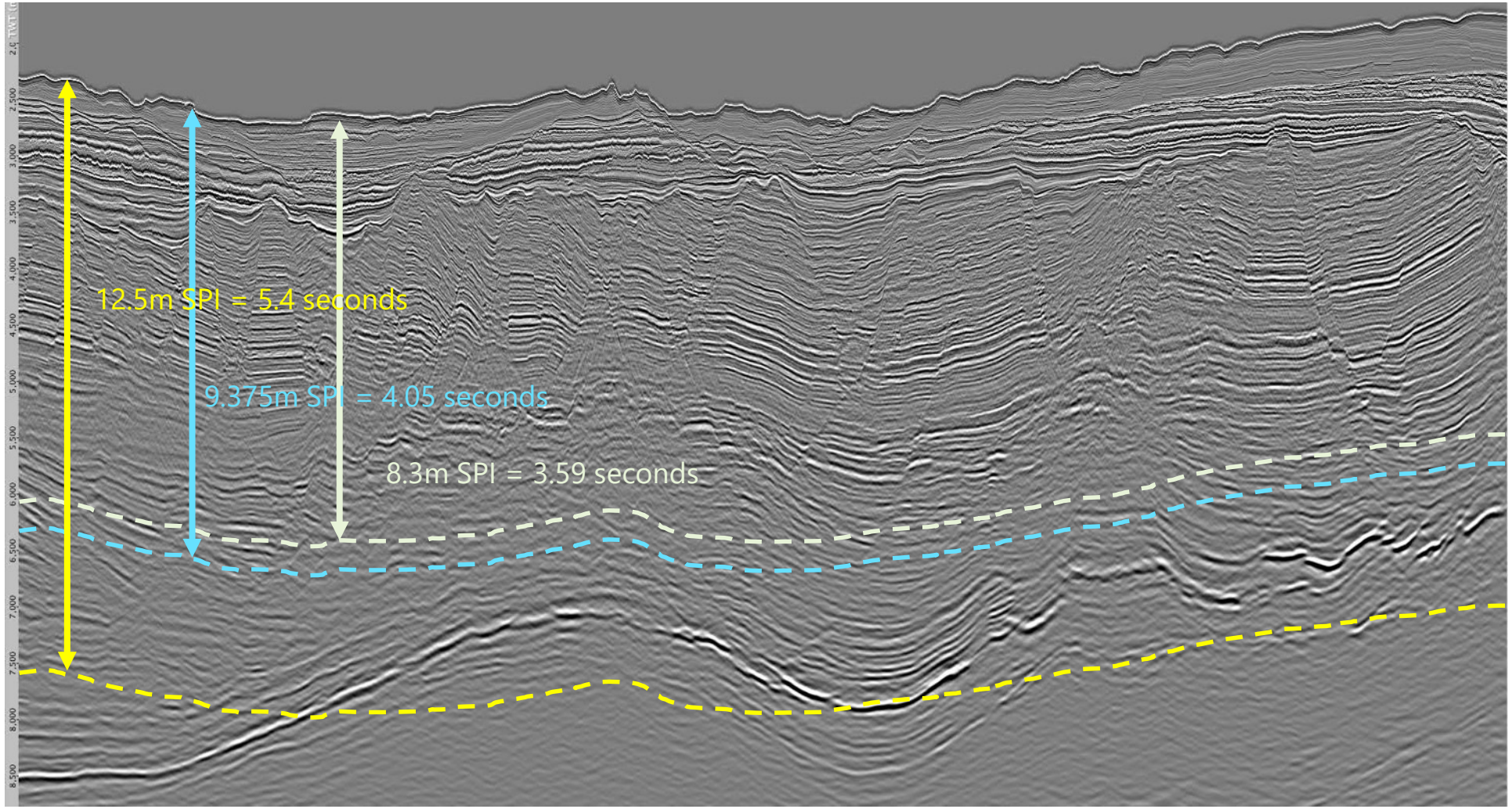
Shot Record Overlap Determined by Shot Point Interval



Polarcus

Deblended Migrated Section

Shot Record Overlap Determined by Shot Point Interval



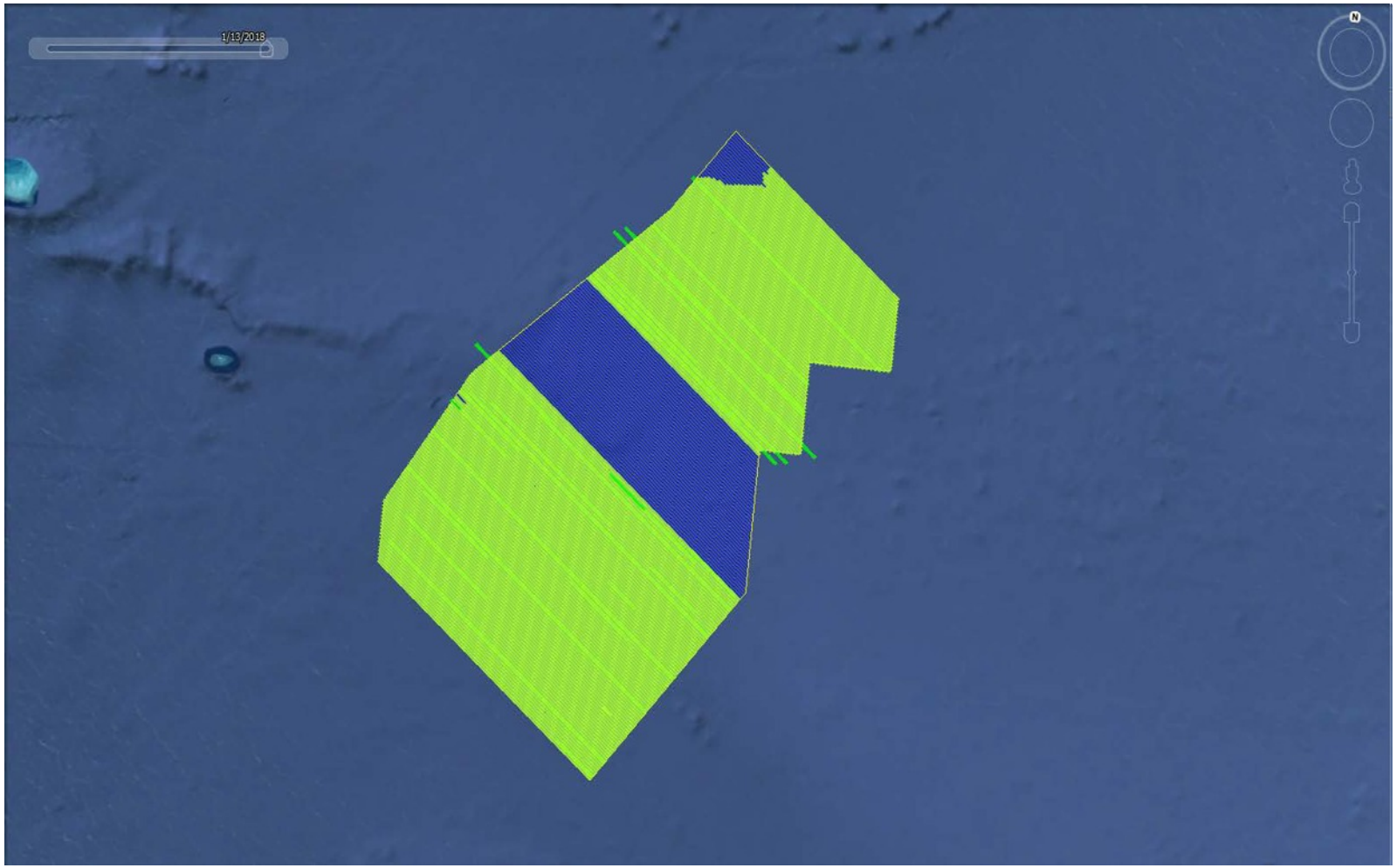
Polarcus

Case Study Cygnus 3D : Location

- Australian Northwest Shelf
- Timor Sea
- Southwest Bonaparte Basin
- Vulcan Sub-basin
- 7,200 km^2 regional survey
- World class gas province
- Significant oil sweet spots
- Exploration since early 1970s

Polarcus

Multi-Client Multi-Year
2015, 2016, 2017, 2018…and beyond



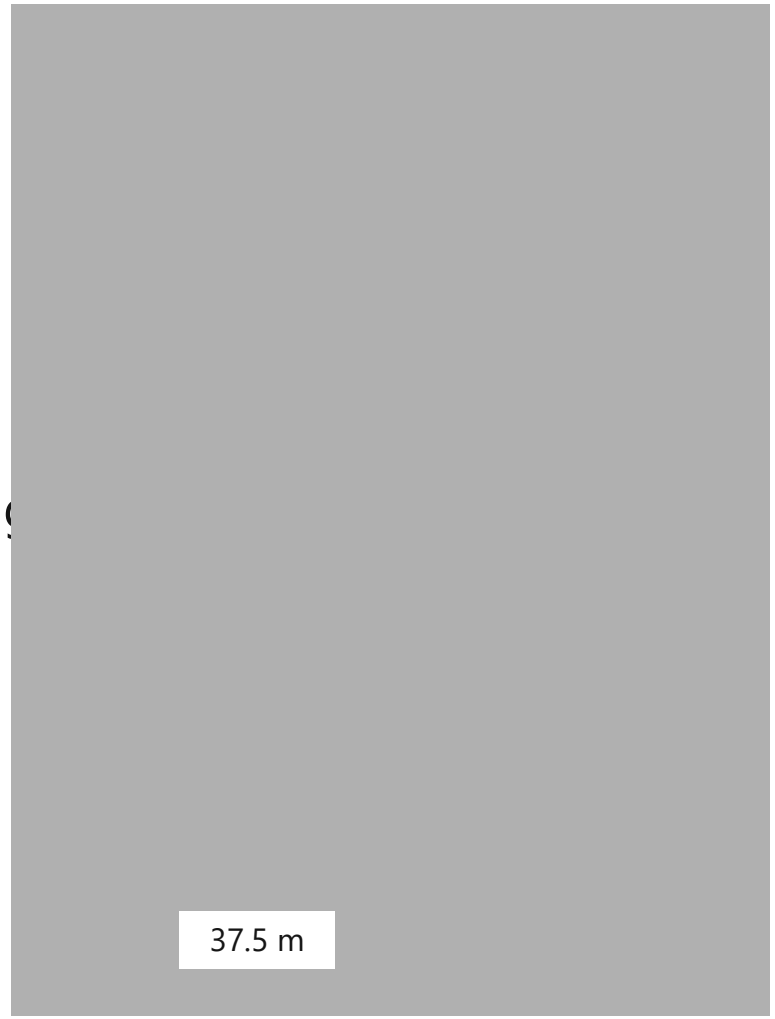
- **Phase 1** **2015-2016**
- **Phase 2** **2016**
- Phase 3 2017-2018

- Phase 1 2015-2016
- Phase 2 2016
- **Phase 3 North** **2017-2018**

Polarcus

Acquisition Parameters

- **Triple** sources 3090 in^3 arrays **6** m tow depth
- **12.5** m shot interval flip-flop-flap
- **10 x 112.5 x 8100** streamer spread **15** m flat tow depth
- **8** seconds acquisition record length – **continuous** recordin
- Preplot spacing **562.5** m
- Natural acquisition bin size **6.25 x 18.75** m
- Inline bin fold **108**
- Trace density **921600** traces / km^2



Polarcus

Challenges

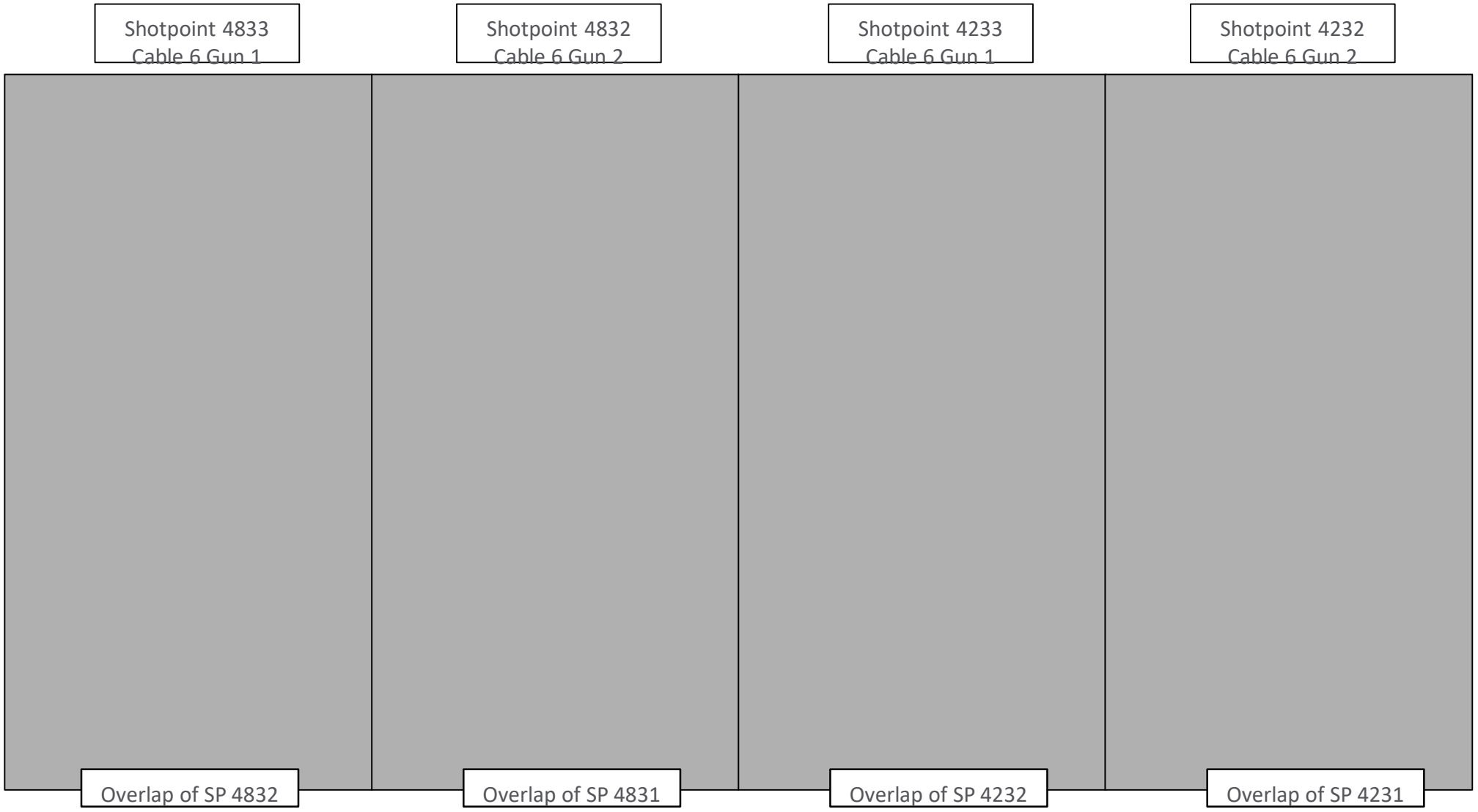
- Shallow carbonates leading to poor signal to noise ratios with limited source penetration
- Hydrocarbon Related Diagenetic Zone (HRDZ) cause amplitude anomalies and degrade stack response
- Coherent noise – complex multiples and refractions
- Faulting leading to fault shadows, poor reflectivity, shallow water multiples and ray path distortion
- Non optimal acquisition parameters of legacy datasets have not addressed these challenges

Challenges….and Solutions

- **Acquisition azimuth** - in the less efficient NW/SE dip direction, previous surveys have been NE/SW
- **Triple source** - delivering a 33% improved cross line sampling without interpolation
- **Continuous recording** - enhanced trace density, decoupling shot interval, vessel speed and record length
- **Offset** - 8100 m streamers to image the steeply-dipping horst blocks, provide far angle stack data and high quality AVO/inversion processing
- **Broadband** - notional signatures derived from NFH data, source/streamer depth ratio and DUG Broad
- **Deblending** - DUG deblend (iterative-relaxation inversion rather than a noise based deblending method used to separate blended data)
- **Demultiple** – 7 passes of demultiple including 3D SRME, shallow water demultiple, interbed multiple elimination, Tau-P and radon
- **Depth migration** – 5 iterations of tomography, 75° maximum dip and 6.5 km half aperture with data output to 14 km (suitable for regional studies)

Shot gather – Before deblend

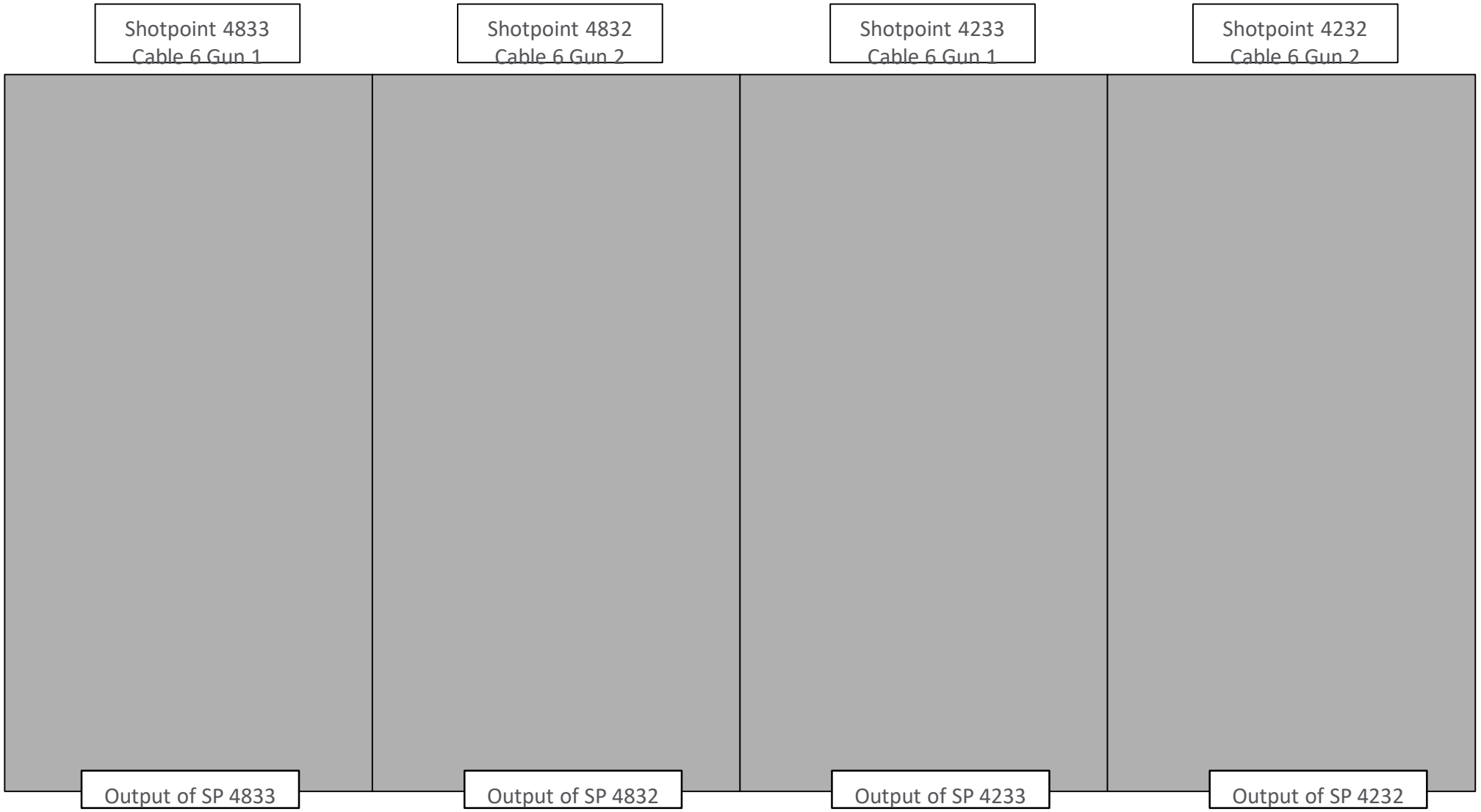
MC1502-6535P1158_cable6_gun1 & MC1502-6535P1158_cable6_gun2



Polarcus

Shot gather – After deblend

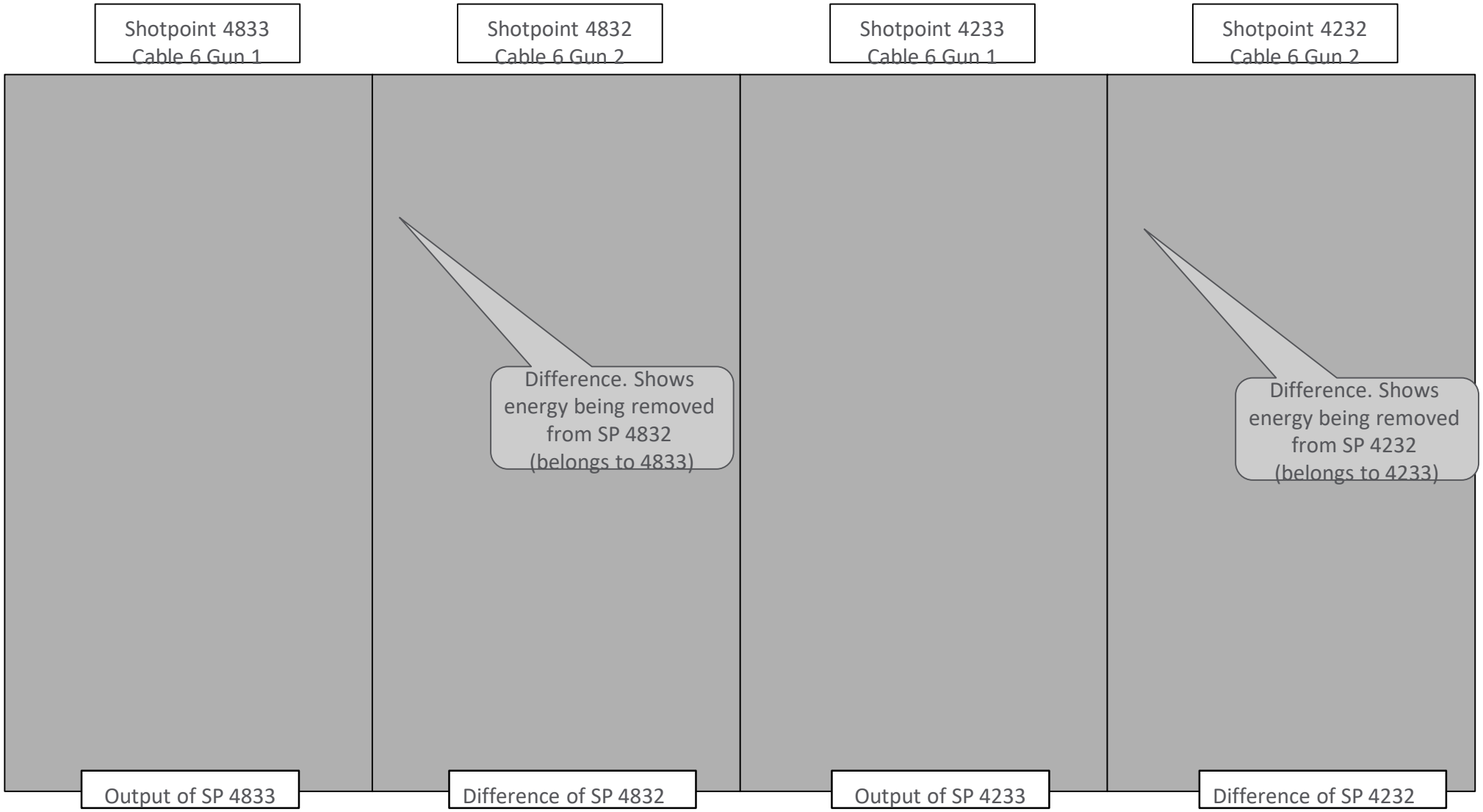
MC1502-6535P1158_cable6_gun1 & MC1502-6535P1158_cable6_gun2



Polarcus

Shot gather – Difference deblend

MC1502-6535P1158_cable6_gun1 & MC1502-6535P1158_cable6_gun2



Polarcus

Vintage and New Acquisition

Polarcus

Vintage 3D versus Cygnus 3D

Vintage MultiClient data shot in 4 phases during 1998/99 by 3 different vessels, example configuration below

- Using older acquisition technology
- Survey azimuth set to acquire in **strike** direction
- **Dual** sources 3900 in^3 arrays **5** m tow depth
- **18.75** m shot interval flip-flop
- **8 x 112.5 x 4500** streamer spread **7** m flat tow depth
- **5.5** seconds acquisition record length – **navigation-triggered** recording
- Preplot spacing **450** m
- Natural acquisition bin size **6.25 x 28.125** m
- Inline bin fold **60**
- Trace density **341333** traces / km^2

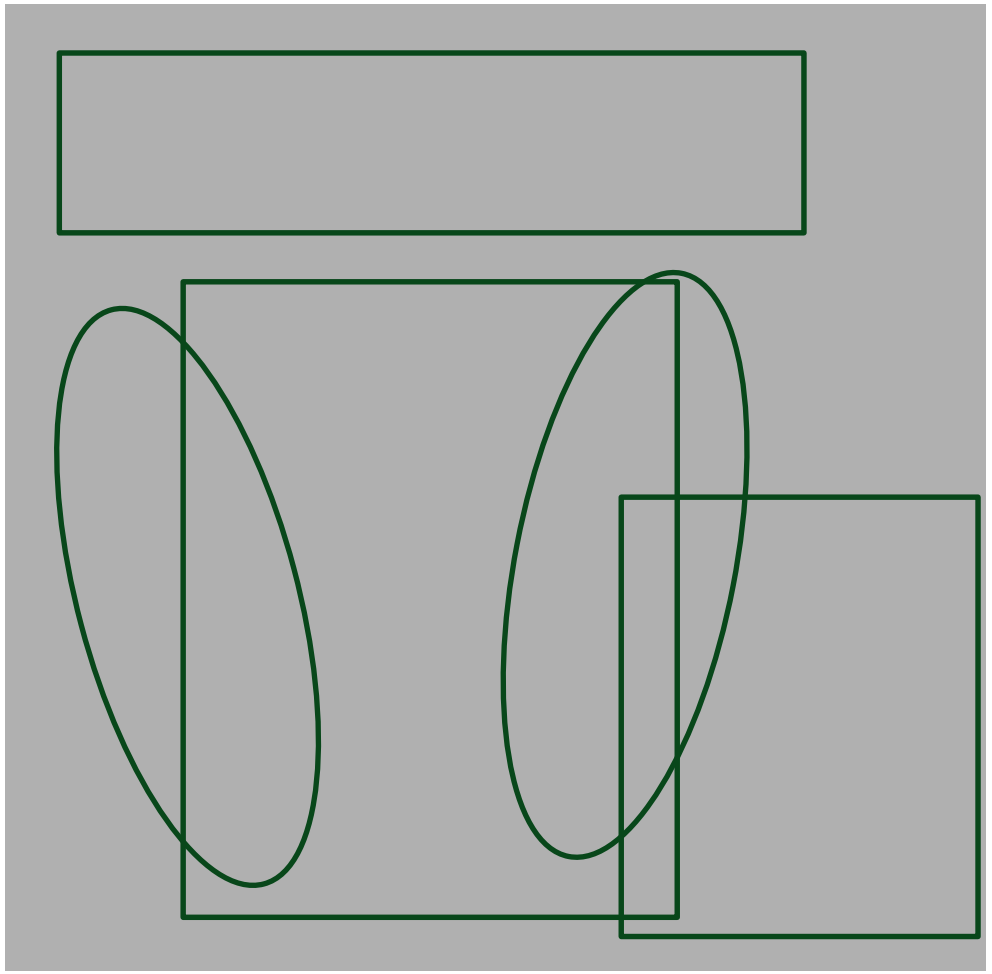
……..However!

- Same (re)processing flow
- Consistent processing team

Polarcus

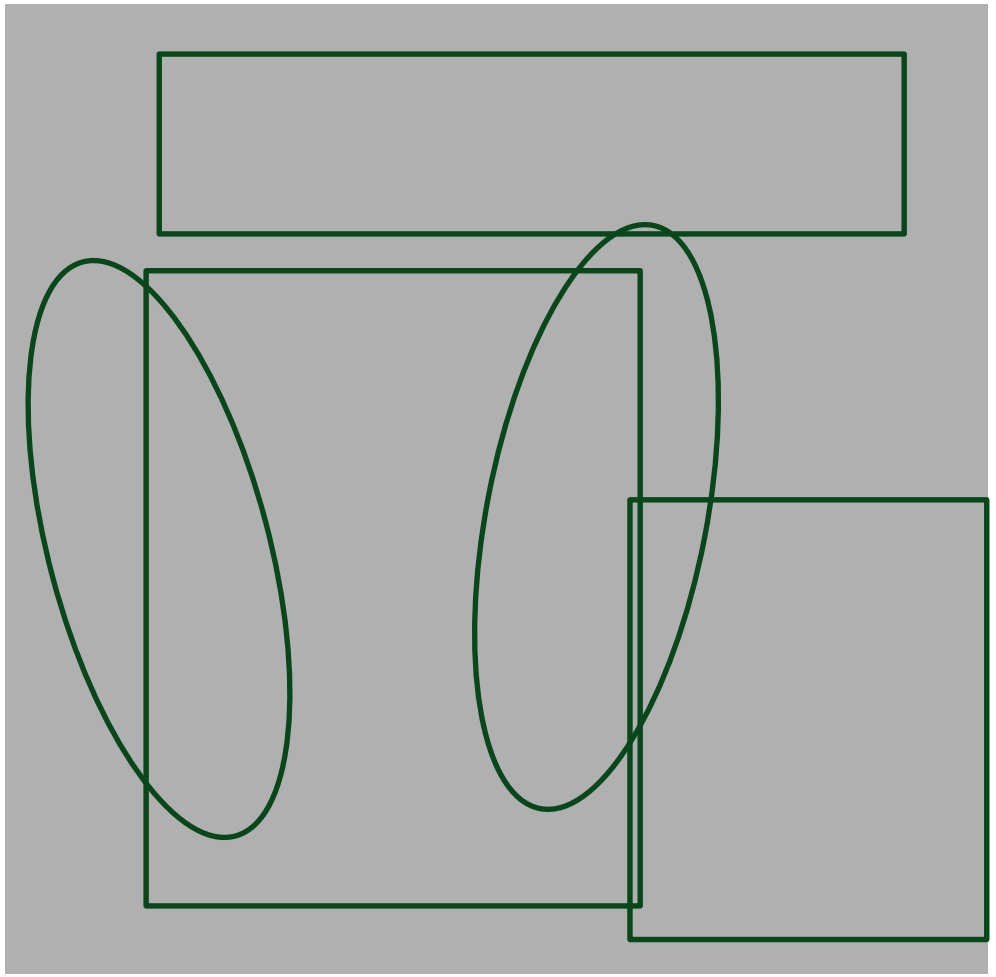
Reprocessed legacy data vs PSTM

Onnia PSTM



Onnia PSTM (DUG reprocessed same flow)

Cygnus PSTM



Cygnus PSTM (DUG processed same flow)

Polarcus

Processing: Final PreSDM

Polarcus

Far Angle Data - The Holy Grail

Cygnus 3D PSTM raw 34-46˚ far angle stack - simulated “historical” 4500 m limited offset data

Reliable data only achieved to a depth of ~3 km (in time ~2.2 s)

Cygnus 3D PSTM raw 34-46˚ far angle stack - full 8100 m offset data

8km offsets data over the important Jurassic/Triassic interval down to the top Permian in some locations ~6-7 km depth (~3.8 s in time)

Polarcus

Conclusion

The new data, allows a detailed understanding of the sedimentological and structural evolution of the Basin, better understanding of the proven plays and investigation of plays never before imaged.

Timor Sea interpreter (30 years experience):
“The PSDM imaging is superb! Undoubtedly your survey and processing has raised the seismic quality bar several notches for the basin. The fault blocks in the Swan Graben are now displayed with clarity and it is indeed a credit acquisition and the excellently deblended and demultiple broadband depth processing”

Acknowledgments

I would like to thank DownUnder Geosolutions, Spectrum and the crews of the Polarcus Naila, Pacific Protector, Mermaid Vantage and Empress for their hard work and diligence throughout these projects.