



TopSeis

– the Tailor Made Solution for Subsurface Exploration and Development in the Barents Sea

April 2017

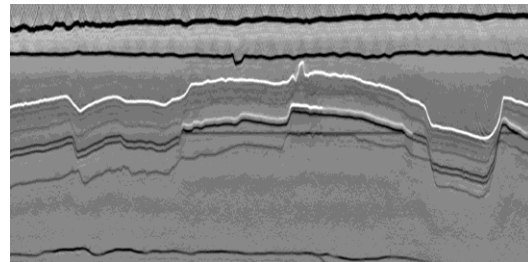
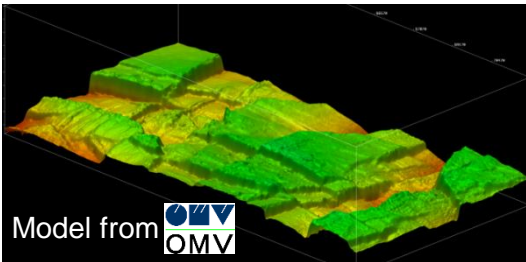
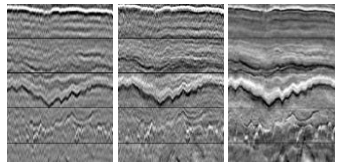
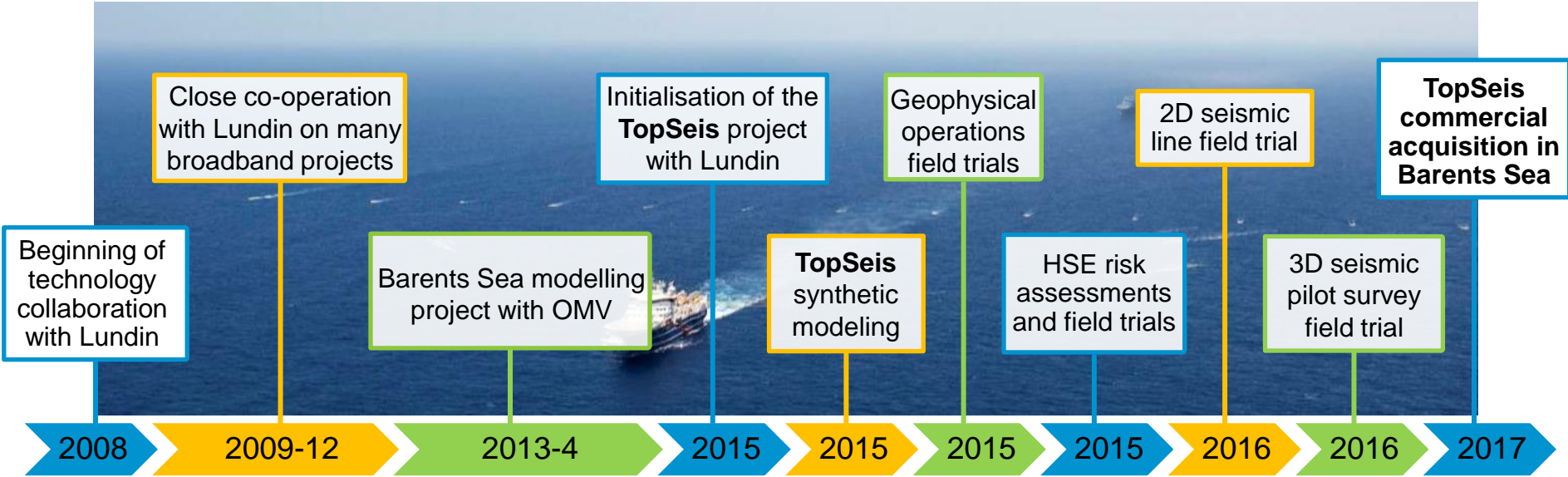
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TopSeis

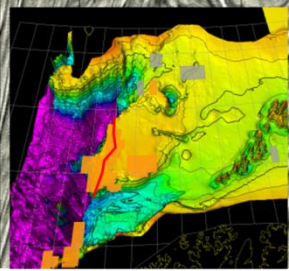
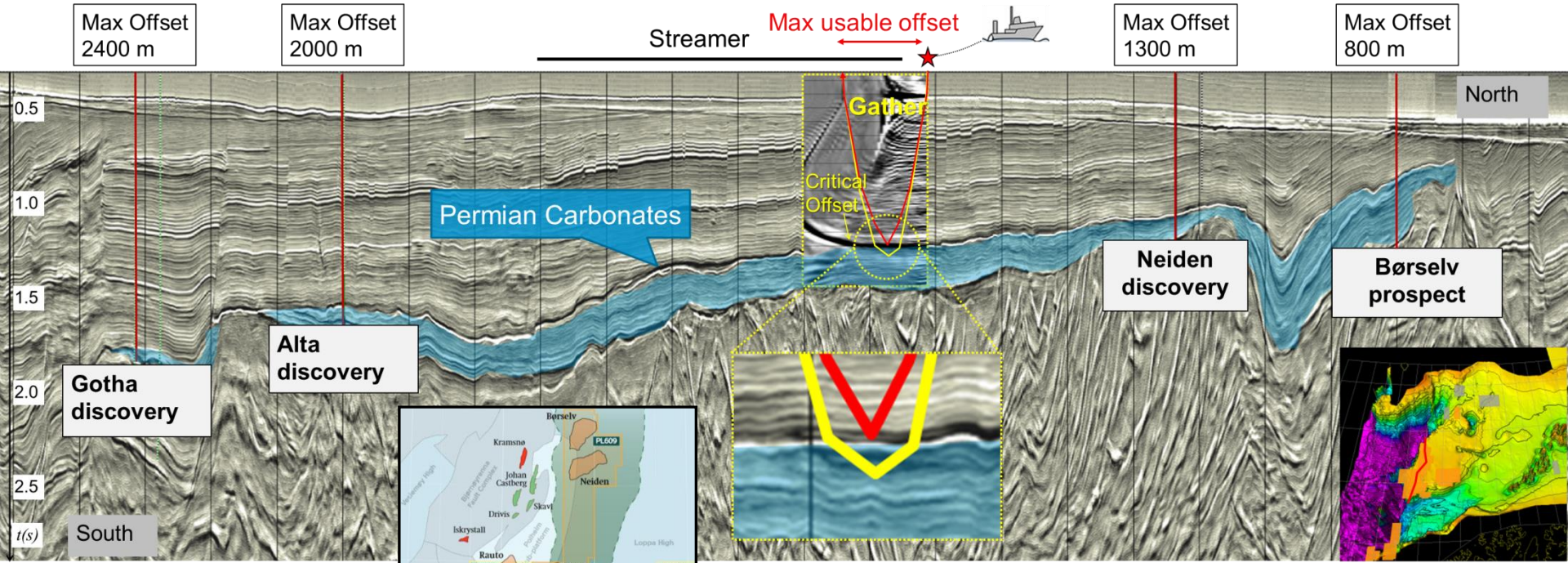


Shooting over the seismic spread

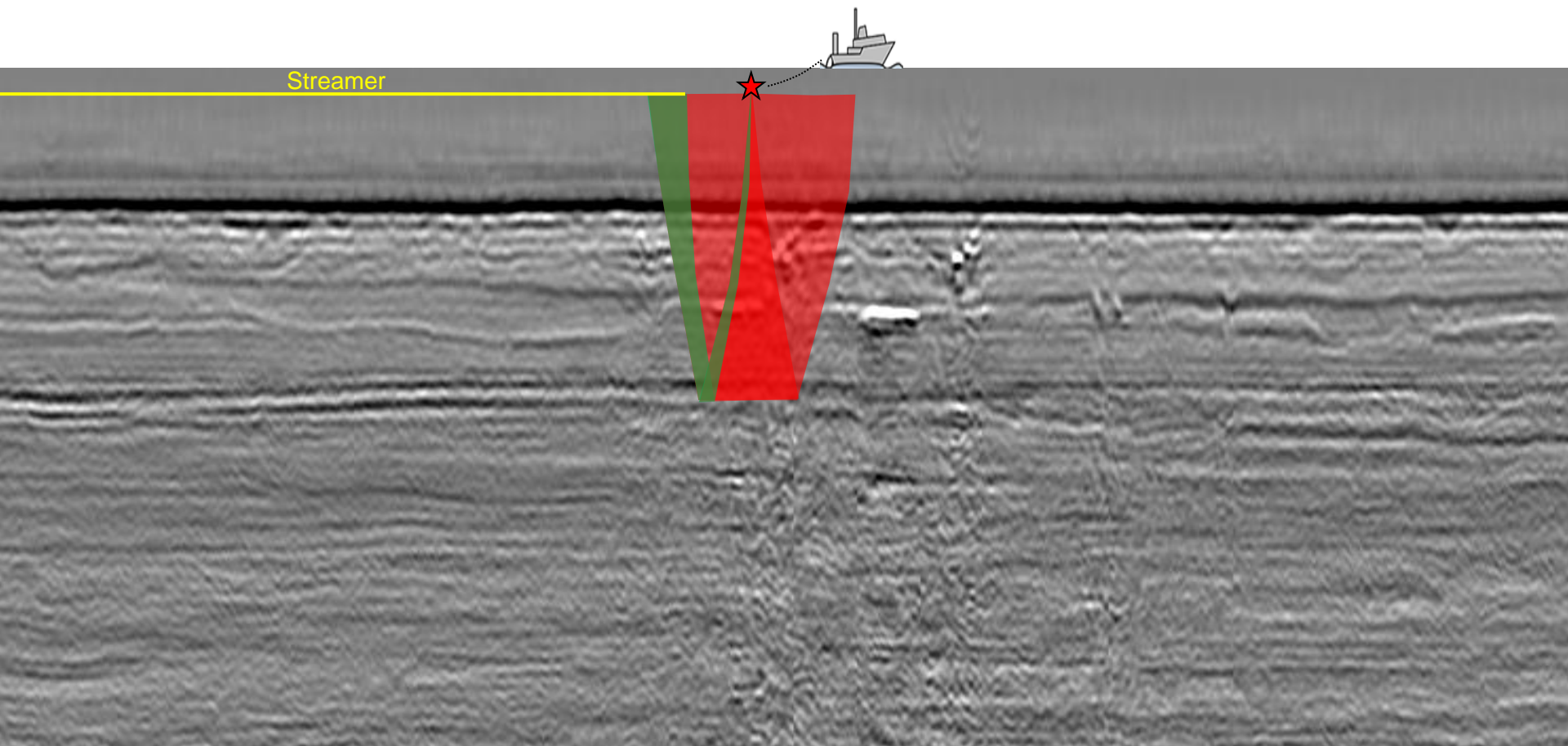




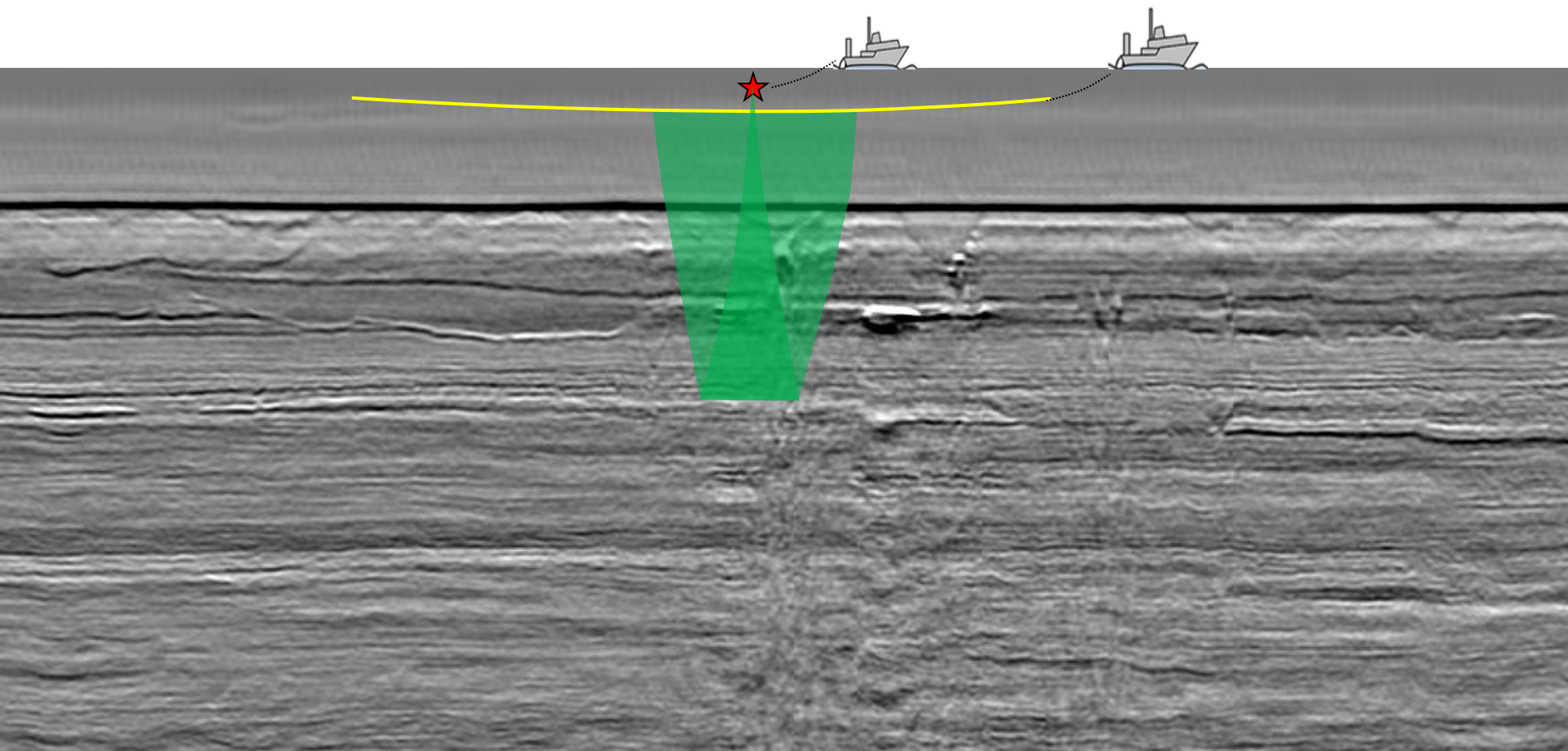
Motivation – Better imaging in the Barents Sea



Conventional acquisition: lack of near offsets

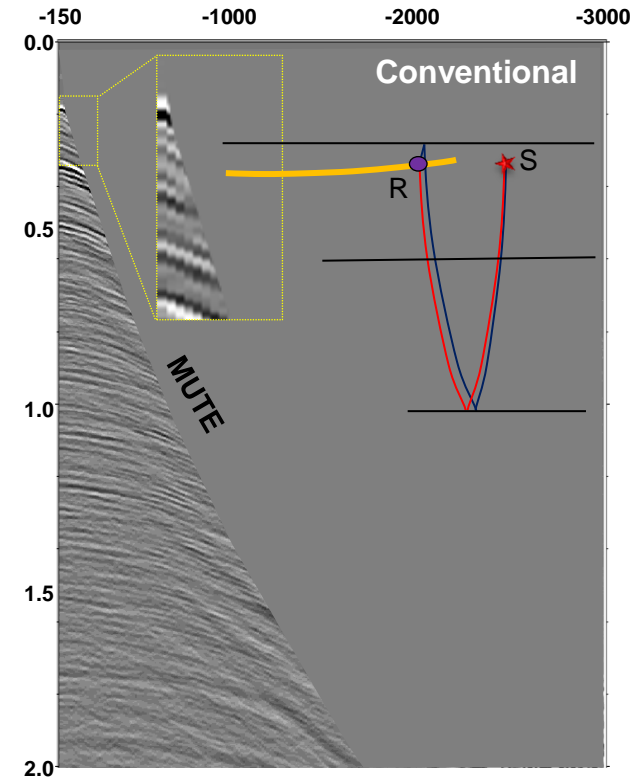
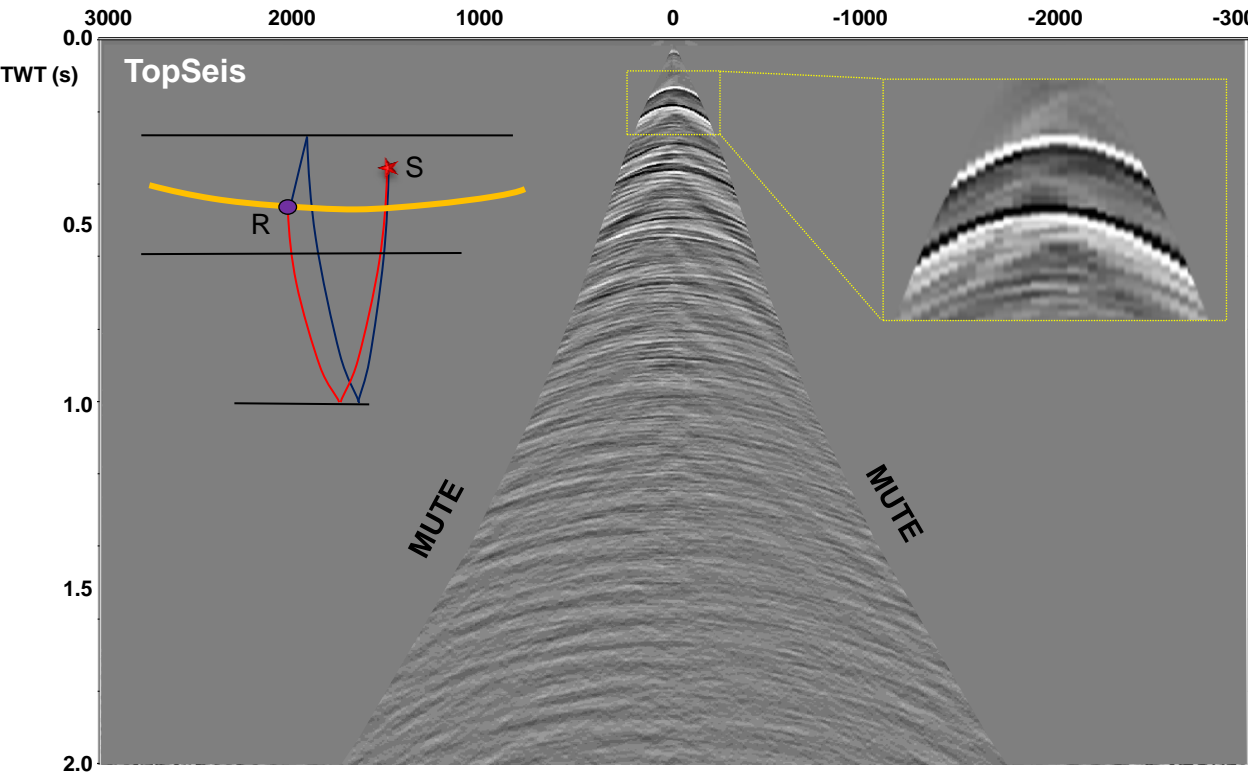
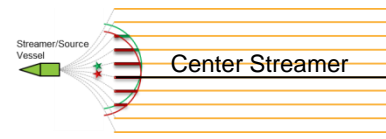
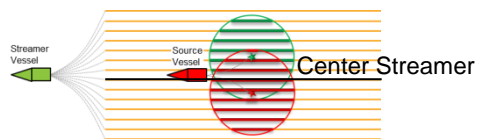


TopSeis acquisition: rich near offsets



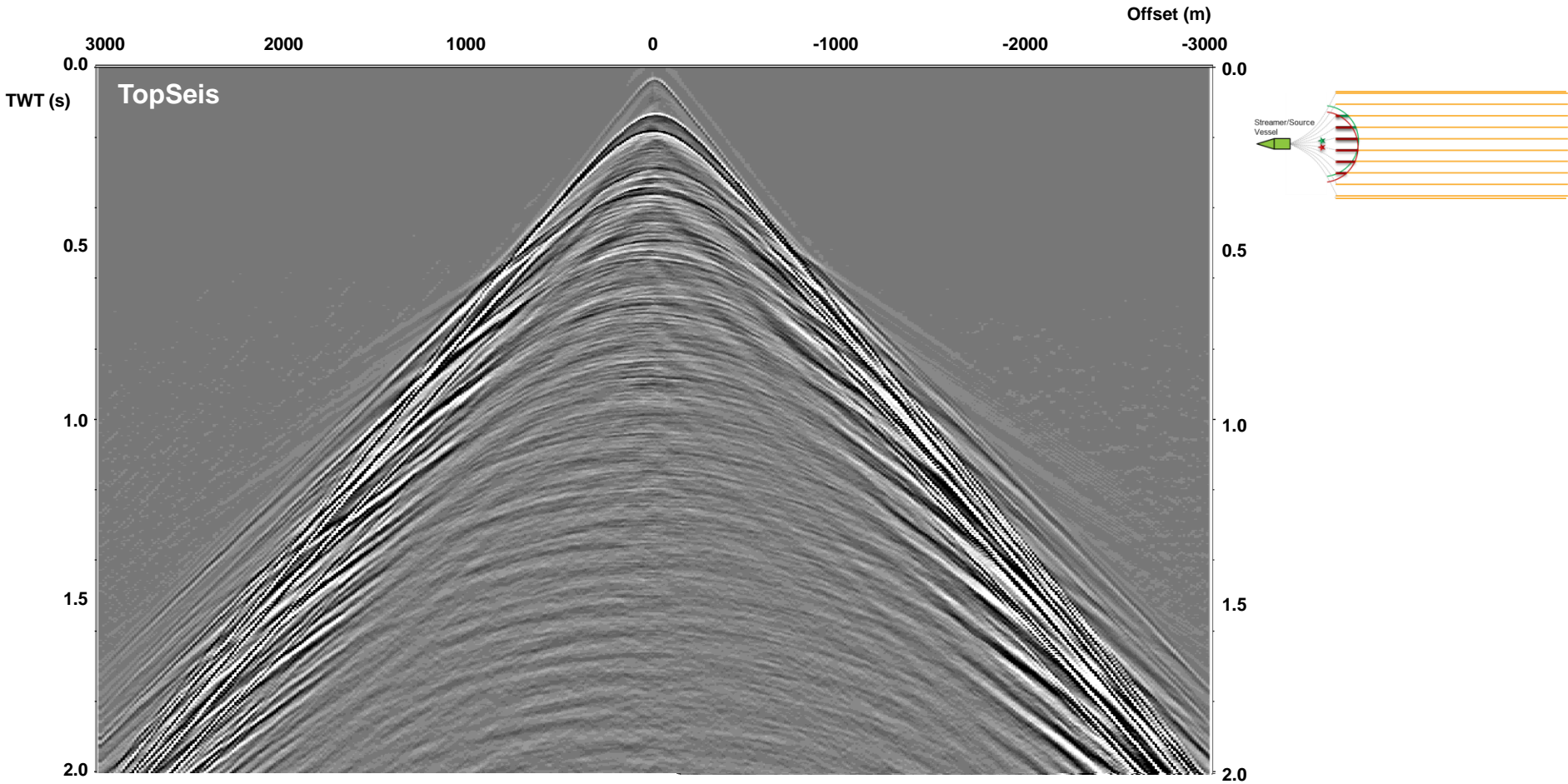


Shot Gathers – Example from Frigg Gamma field test, North Sea



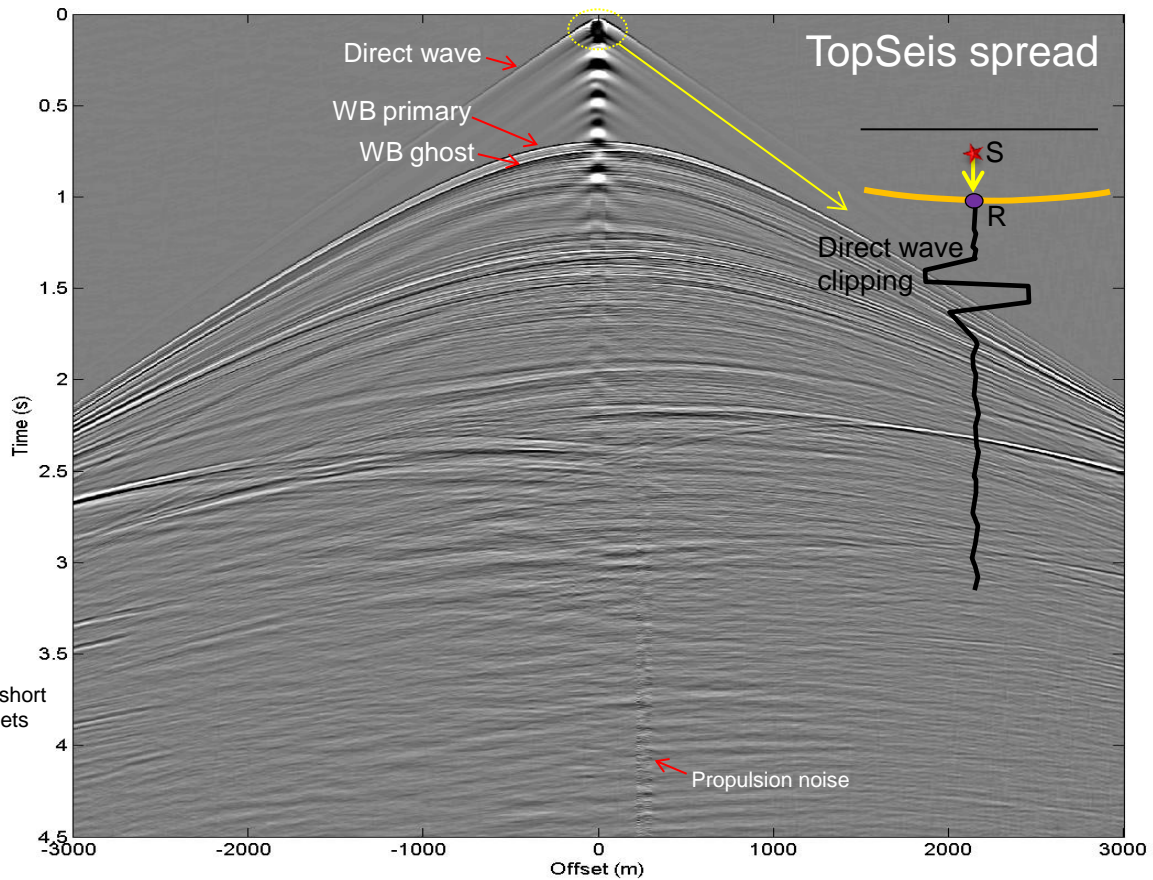
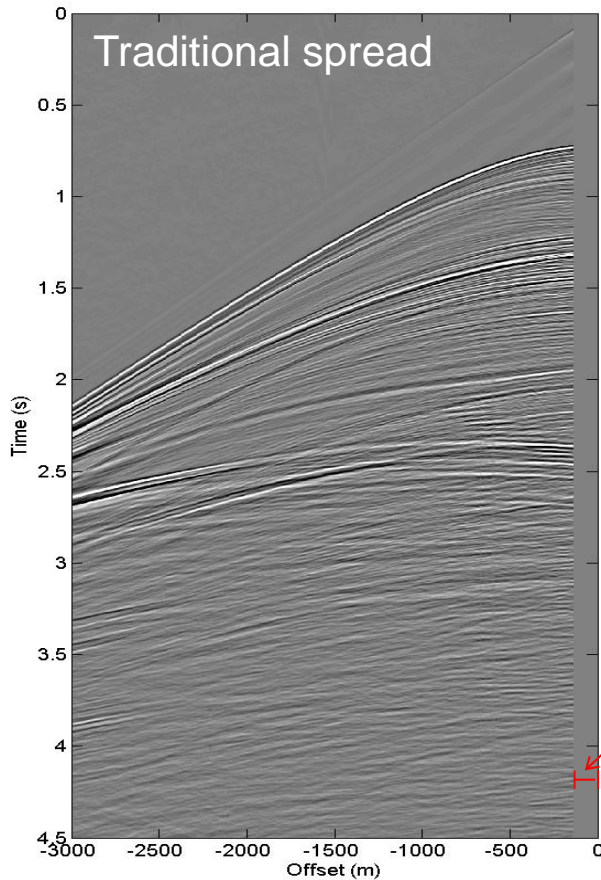


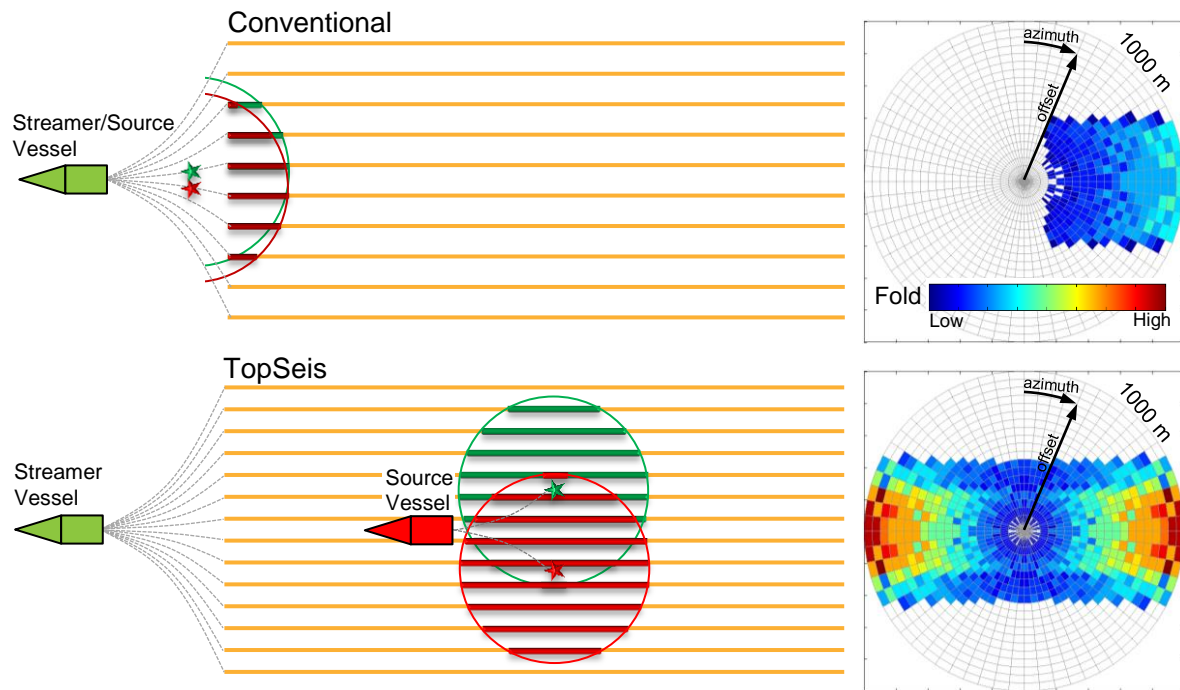
Shot Gathers – Example from Frigg Gamma field test, North Sea





Shot Gathers – Example from offshore Gabon

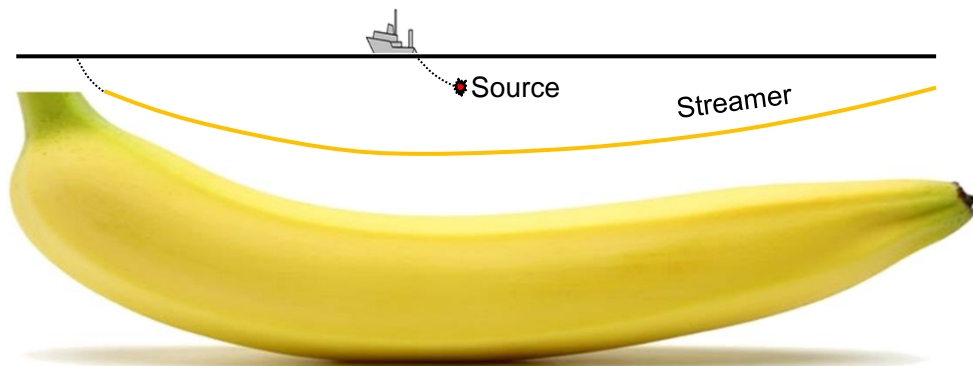
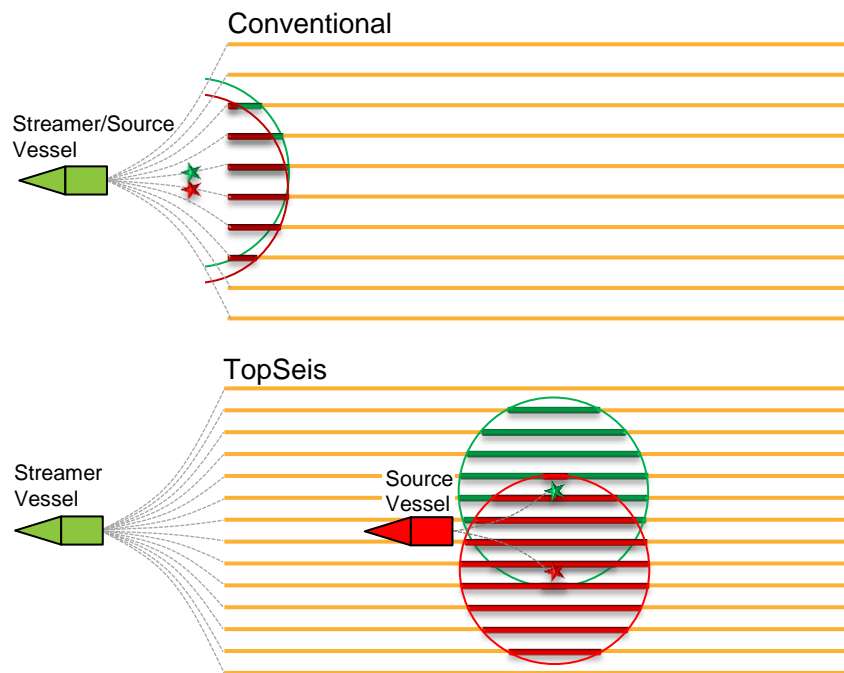




The unique source-over-spread configuration delivers:

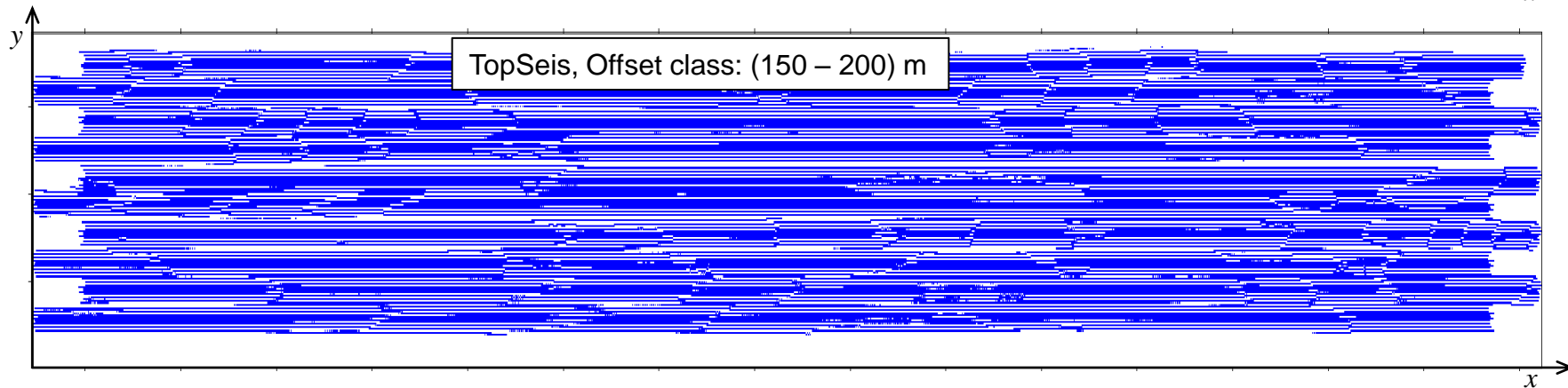
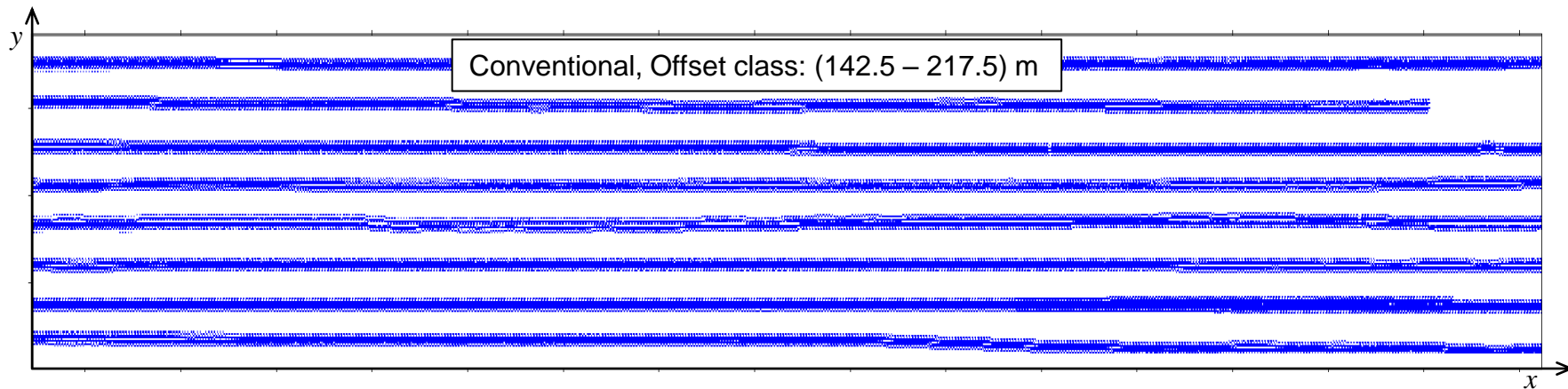
- High fold
- High resolution
- Dense crossline sampling
- Zero offsets
- Split-spread offsets
- Full-azimuth near-offsets

The highlighted circles show near-offset data surrounding the airgun source arrays





Real Field Test; near offset CMP coverage



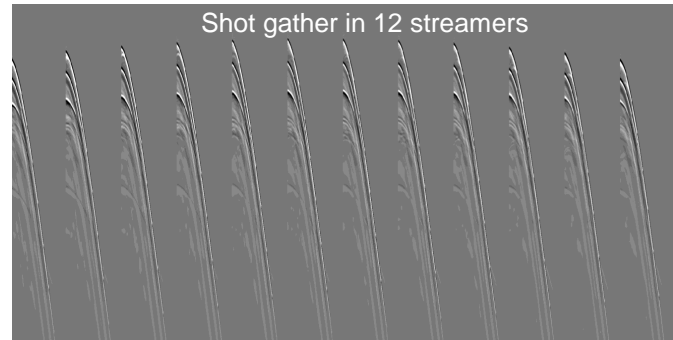
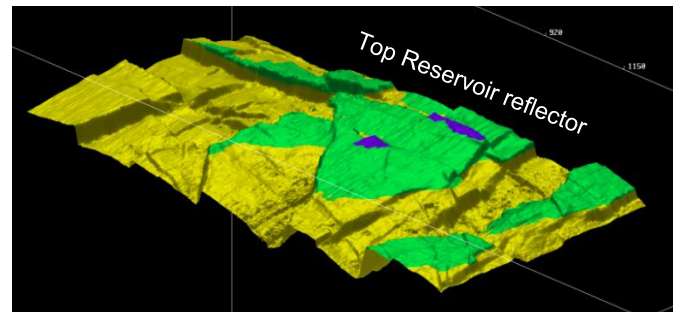



2014 - 2015

- Comprehensive modelling program
- Geowave Voyager shooting over the spread of Endeavour
- Geowave Voyager with wide-towed source to assess the wide-tow limits

2016

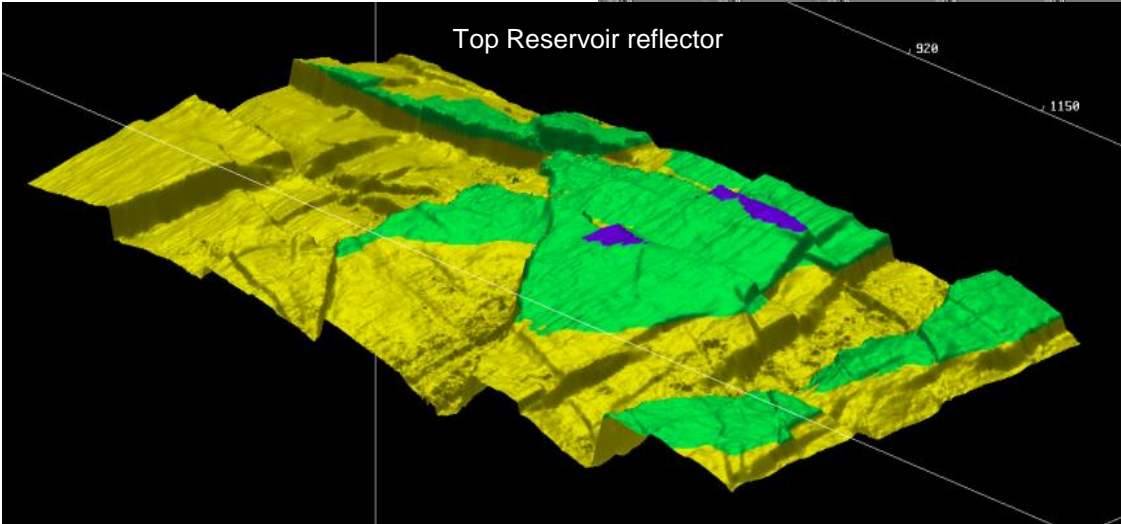
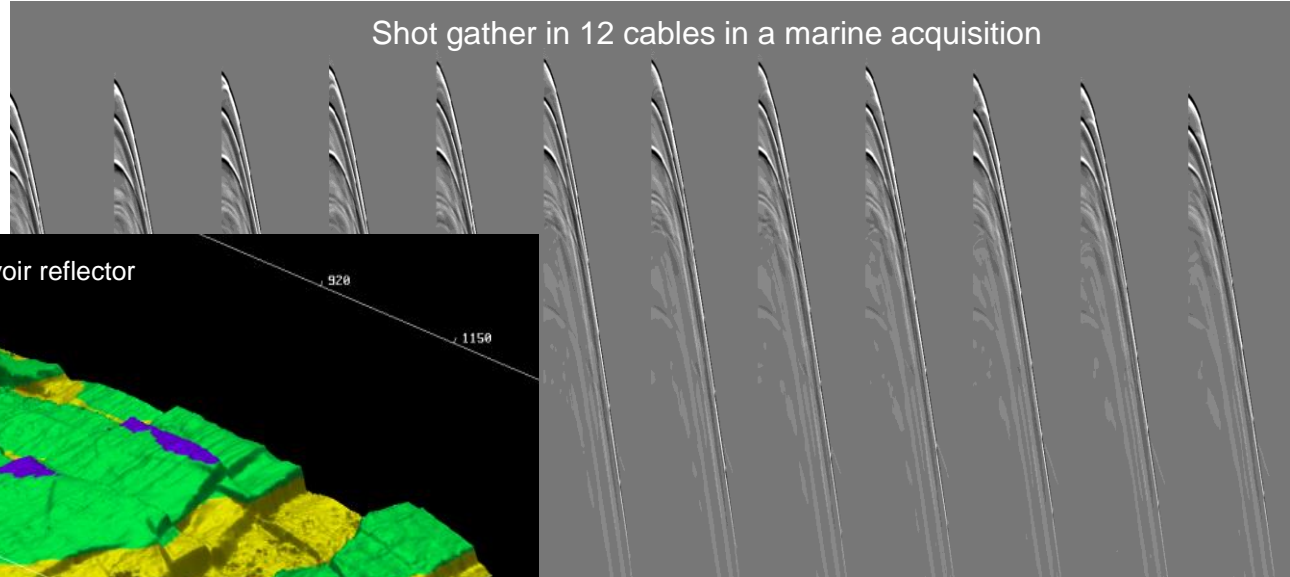
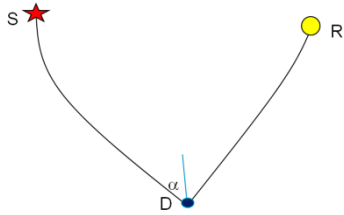
- 2D line (30 km) of TopSeis vs BroadSeis offshore Gabon
- 3D TopSeis on Frigg-Gamma in the North Sea (15 x 3) km



Thanks to  for the synthetic Barents Sea model

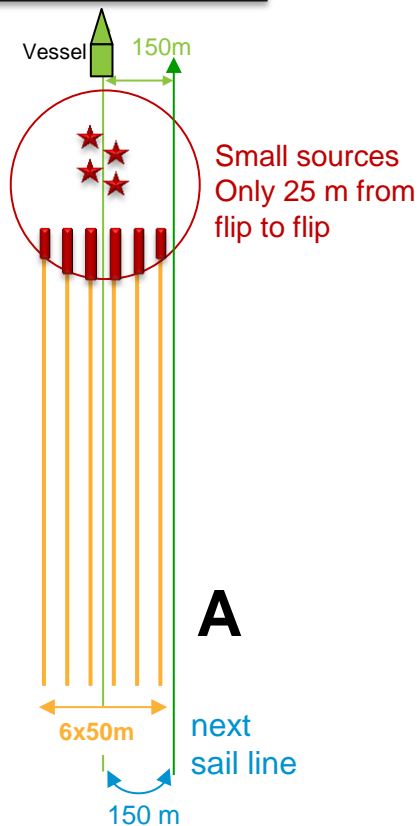


Computing the contributions from all reflectors and diffractors in the model

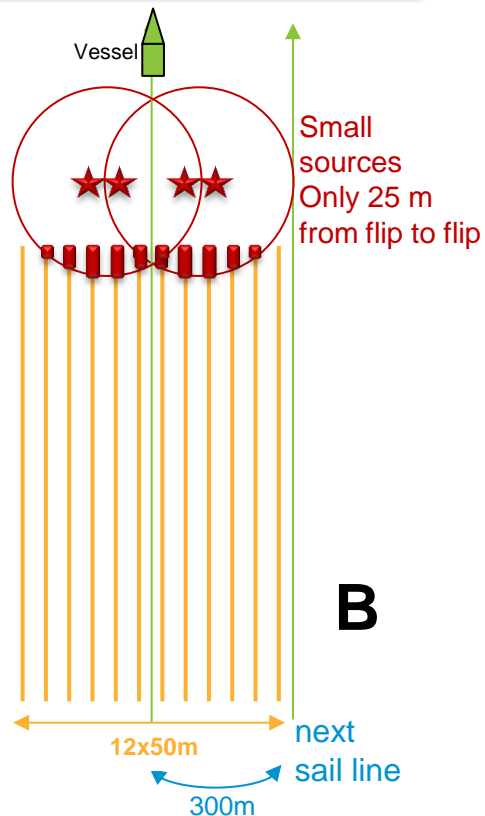


*developed in Oslo R&D by Peng Zhao and Vette Vinje

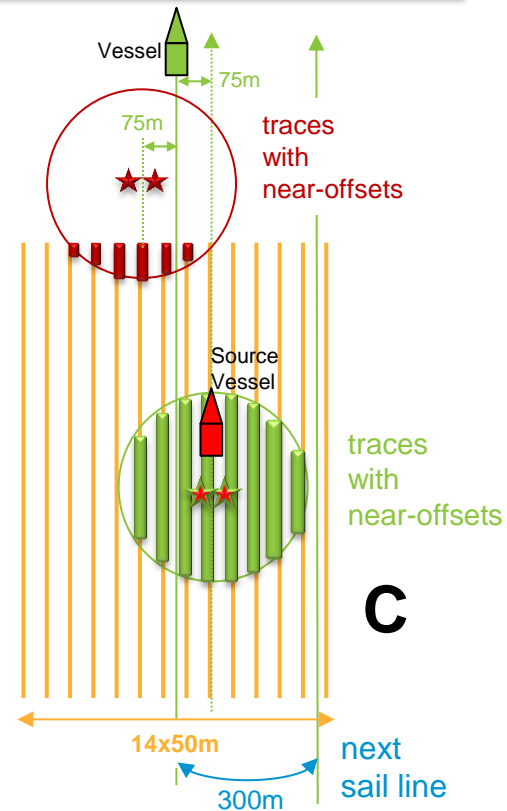
Dense Narrow Spread



Large double source separation

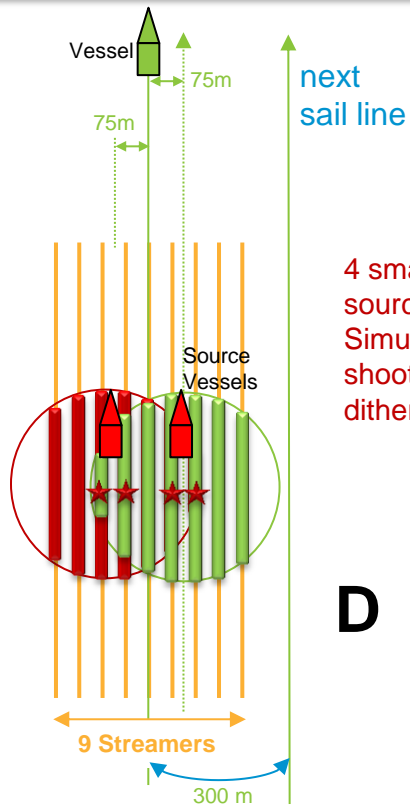


Extra Source Vessel over the spread



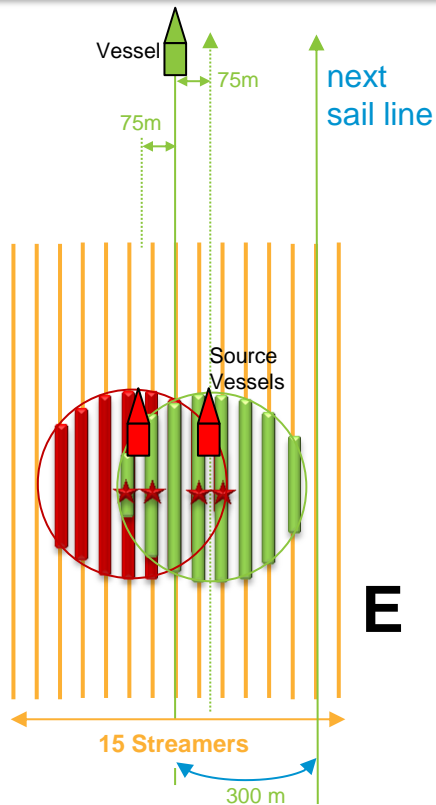
How did we get there: Different surveys

Source Vessel over the spread,
SimSource, narrow tow



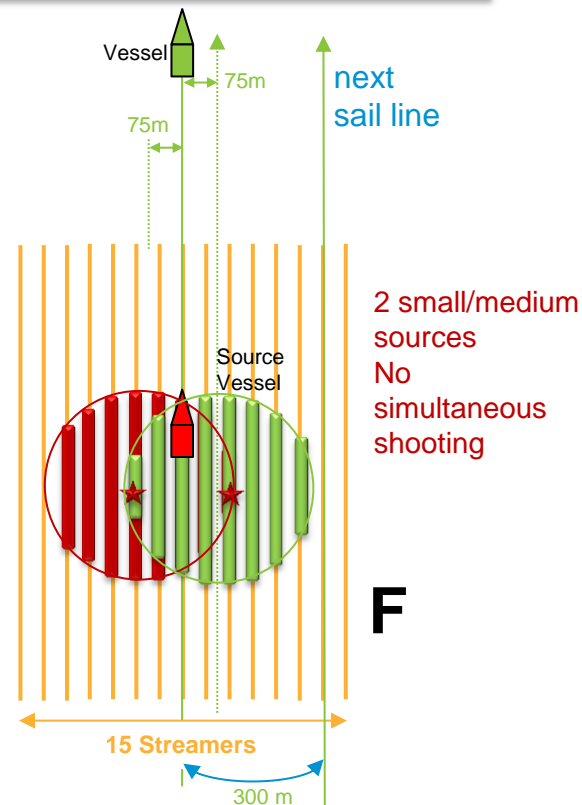
D

Source Vessel over the spread,
SimSource, wide tow



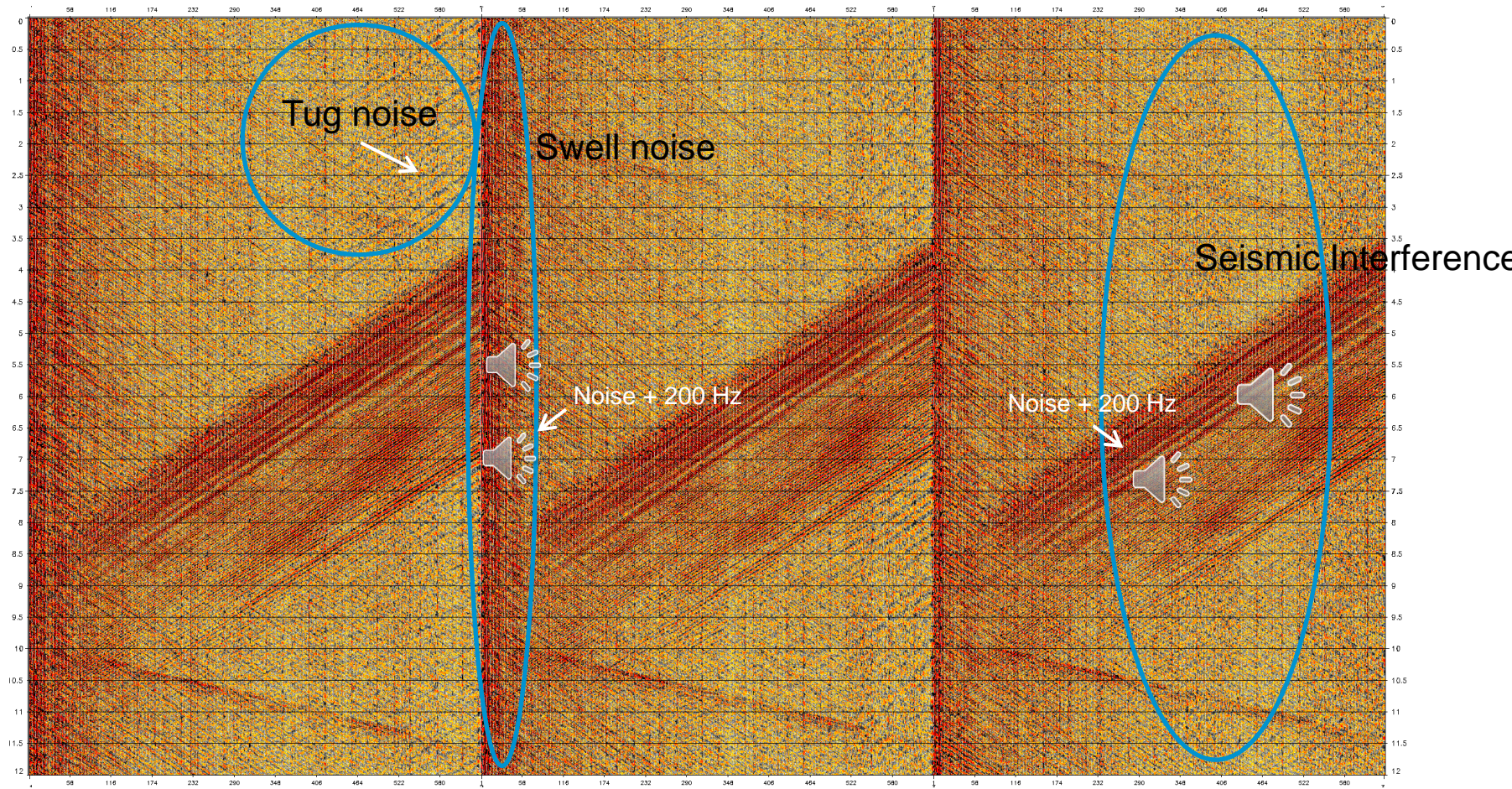
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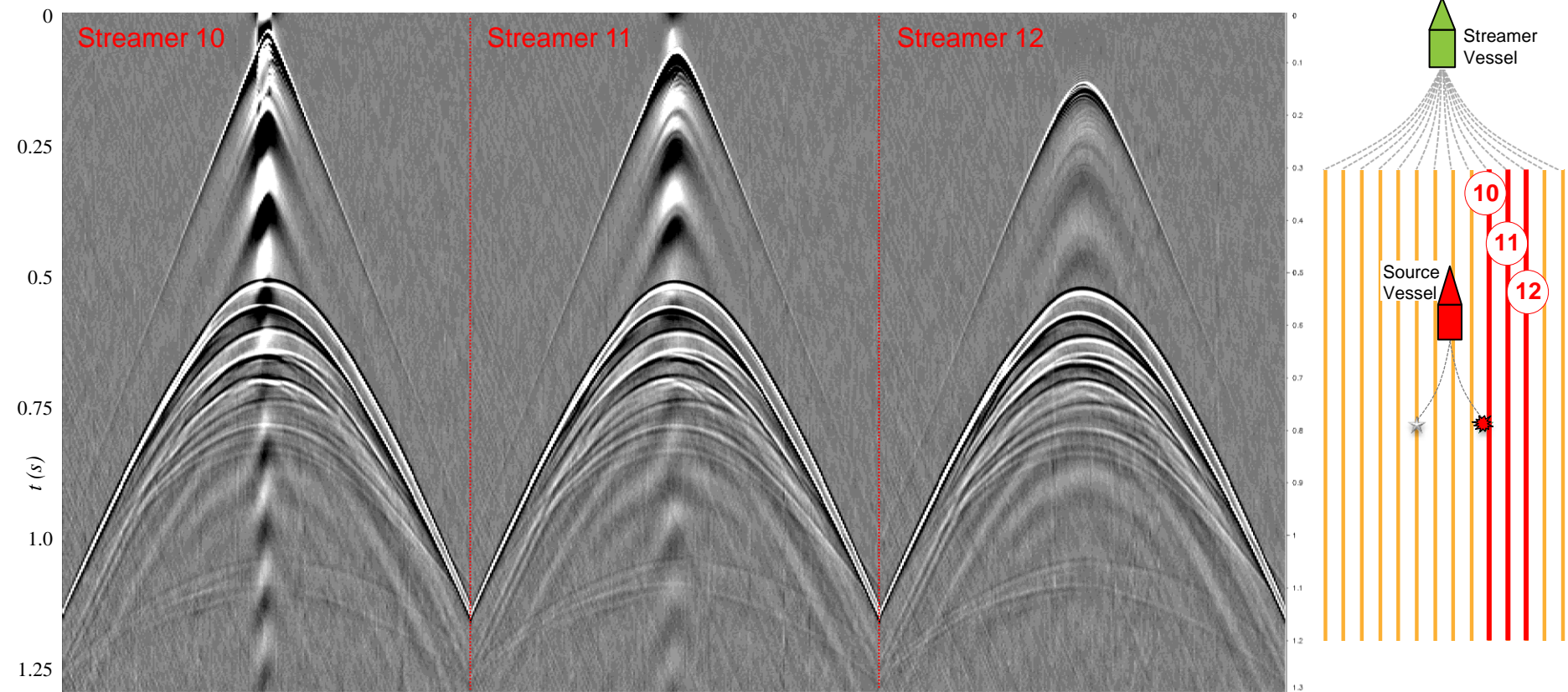
Source Vessel over the spread,
wide tow

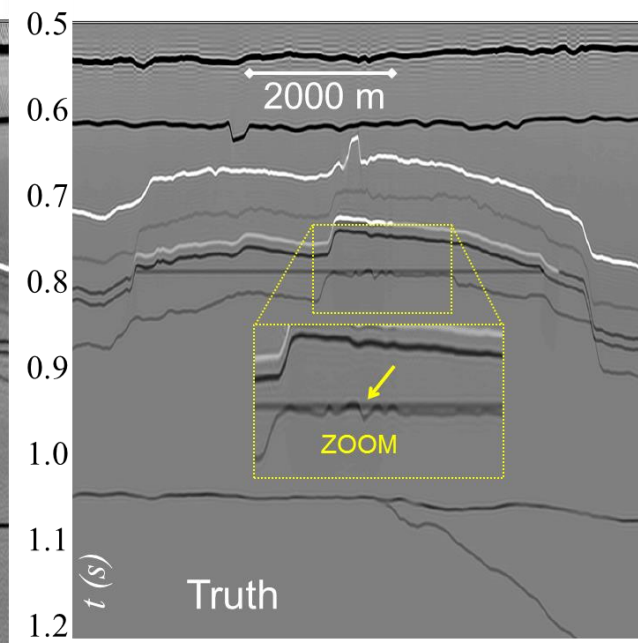
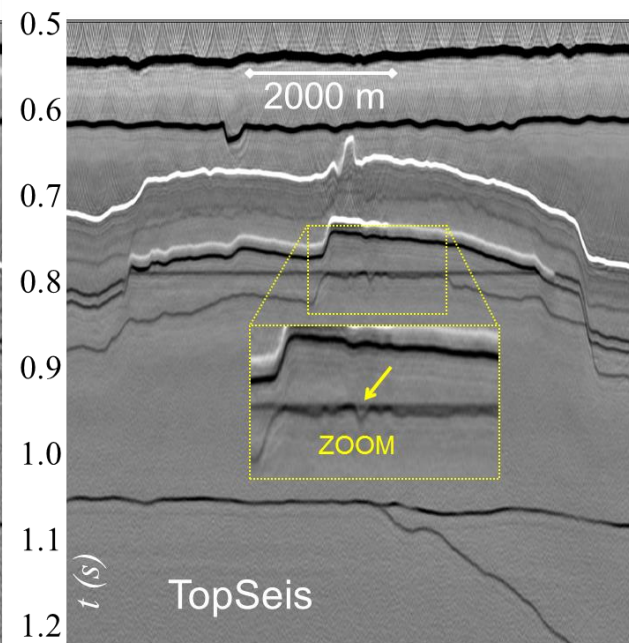
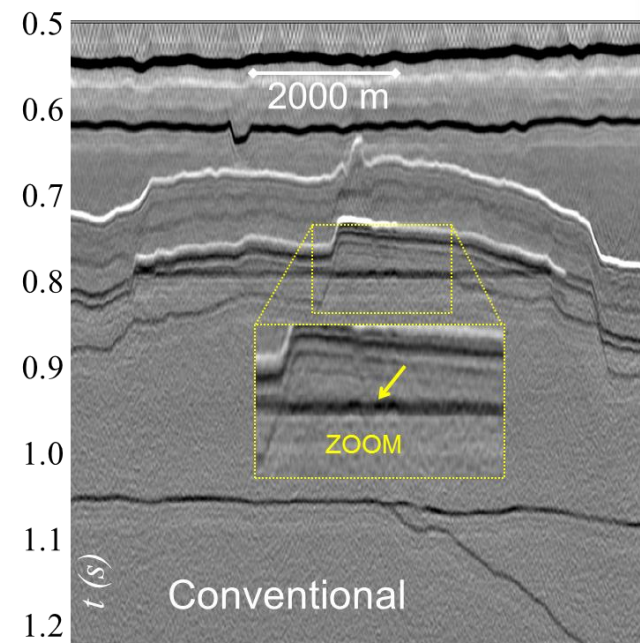


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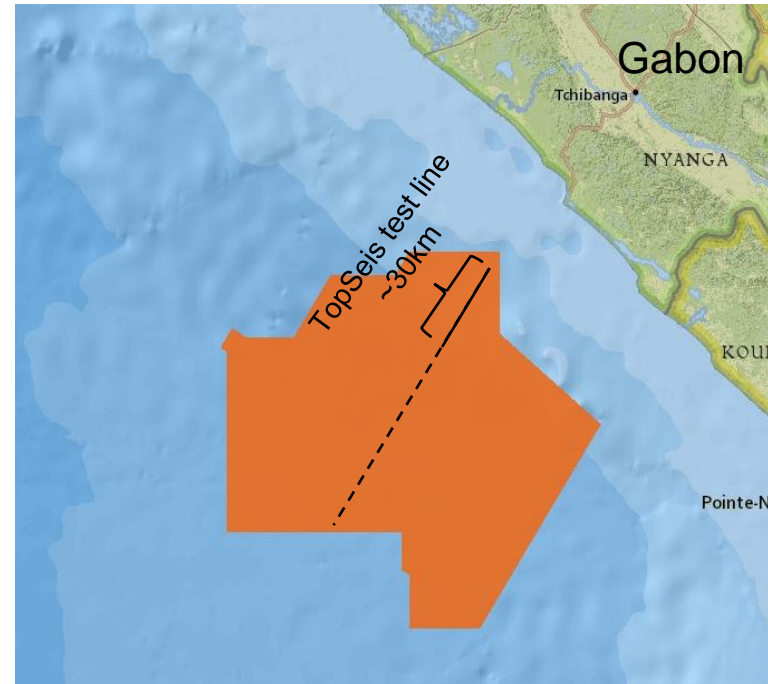
Noise to be added – from real noise records

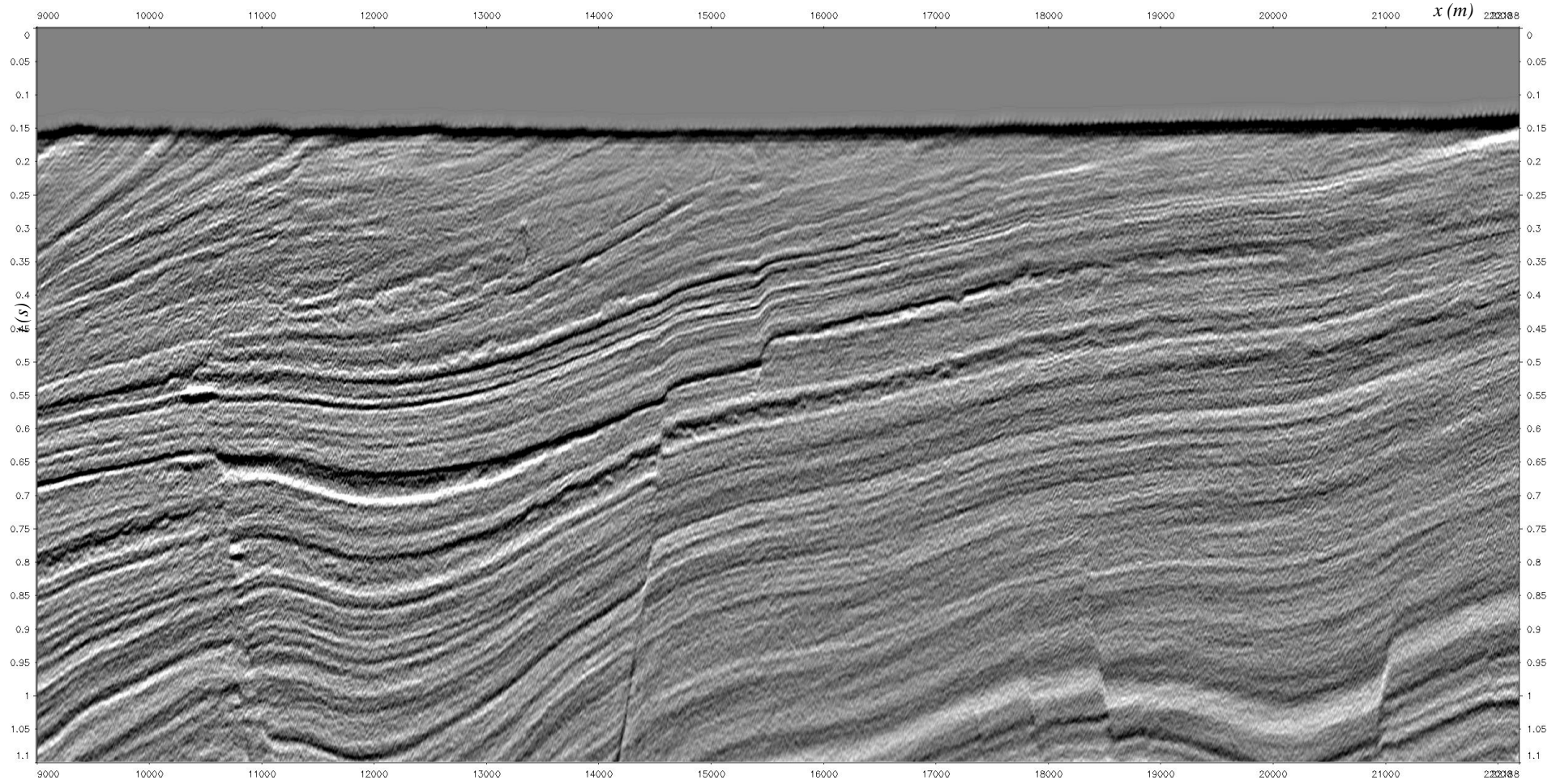


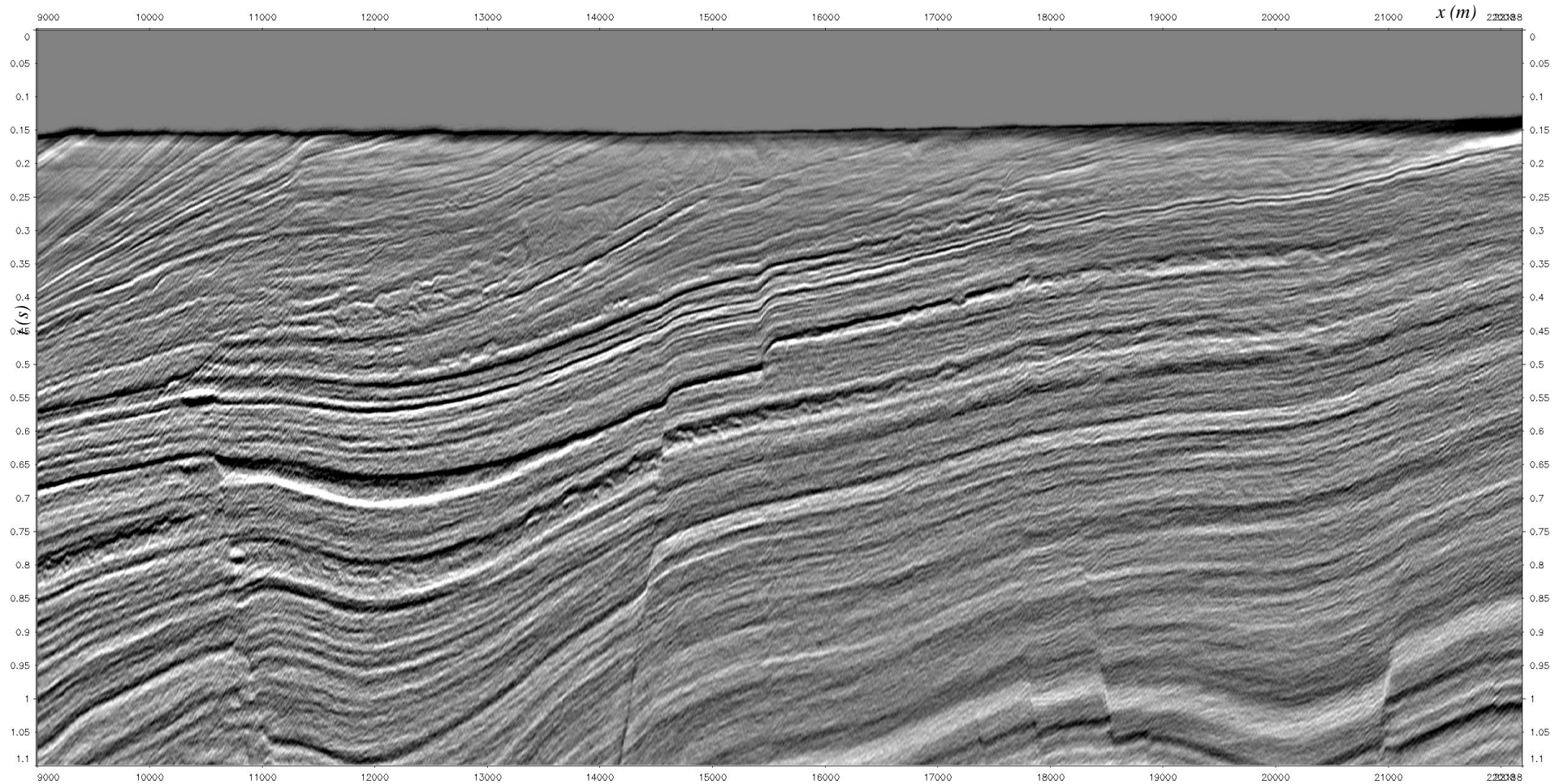


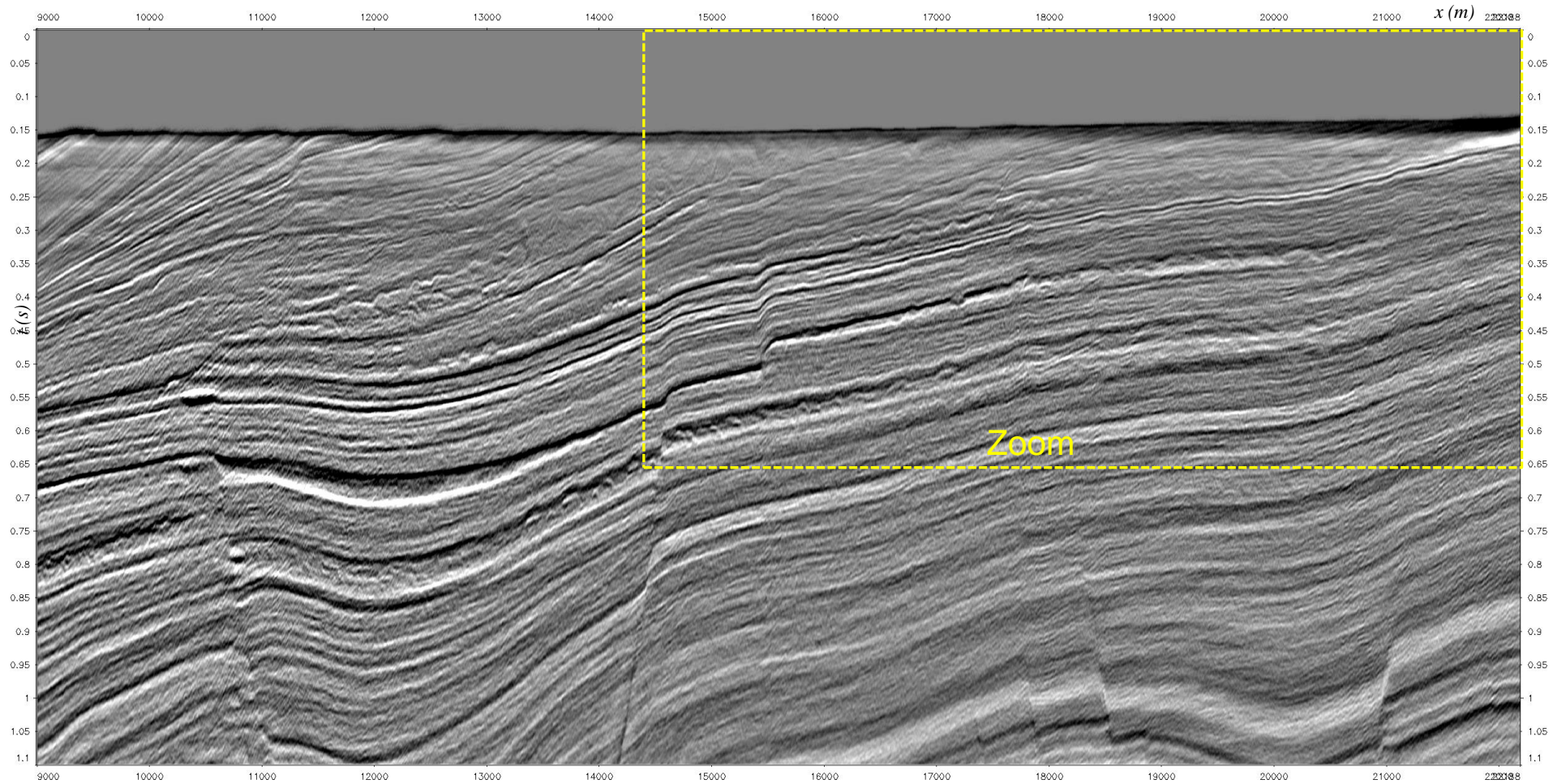


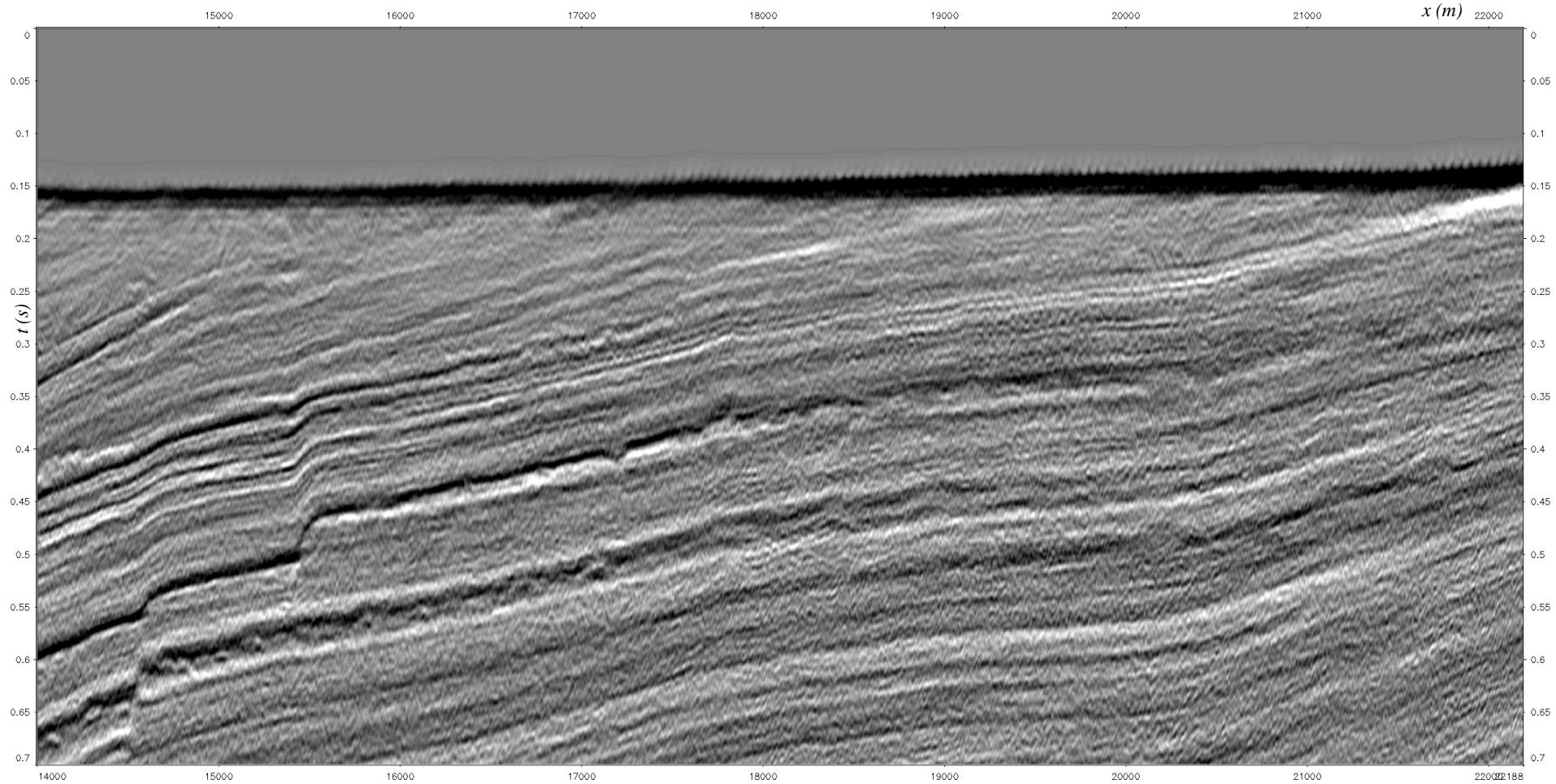
- Field test performed 20th March 2016.
- ~30 km of data acquired offshore Gabon.
- MultiClient BroadSeis data acquired in 2015 is reference.
- Water depths from 1000 m to 100 m
- Line chosen to test TopSeis at varying water depths from 100m at shallow end

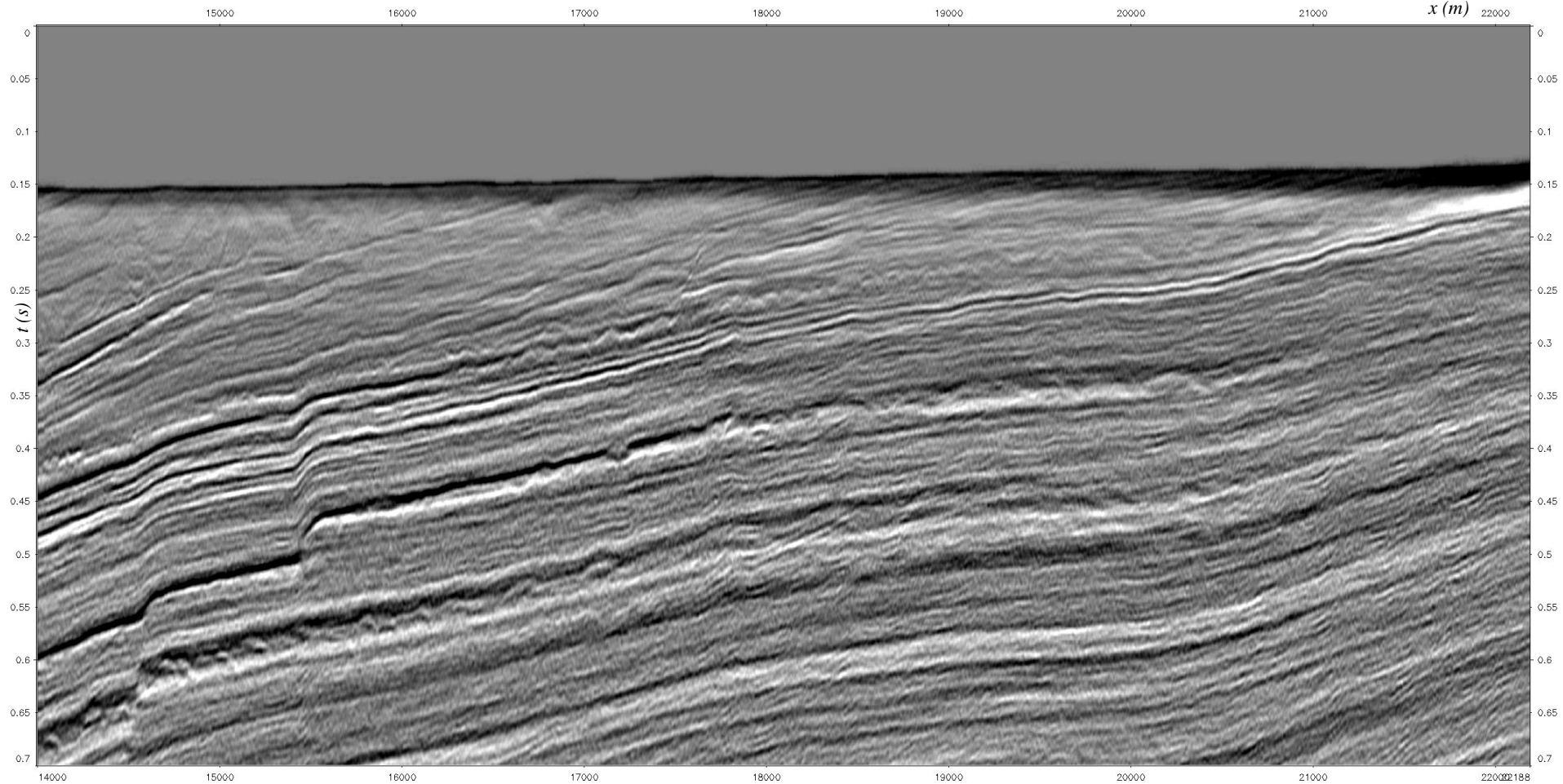






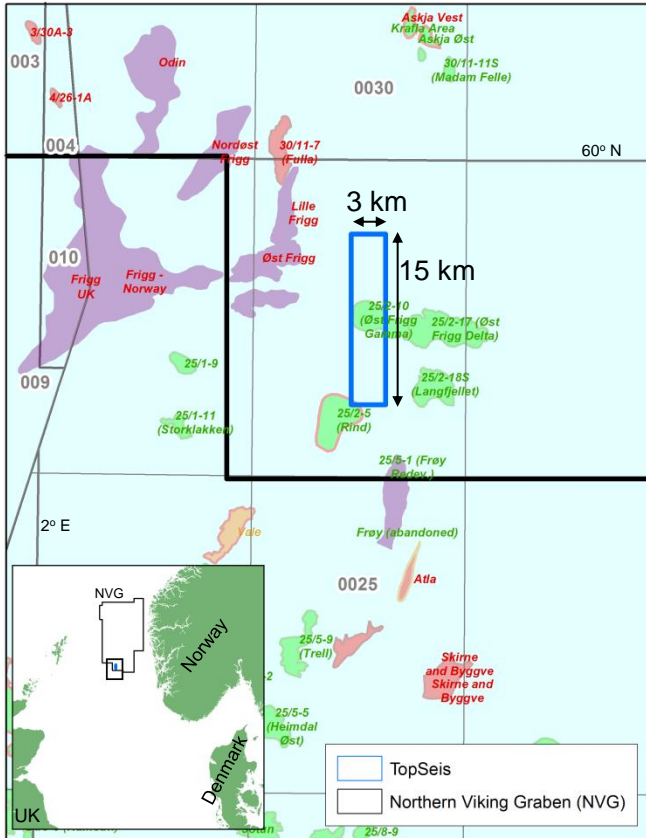






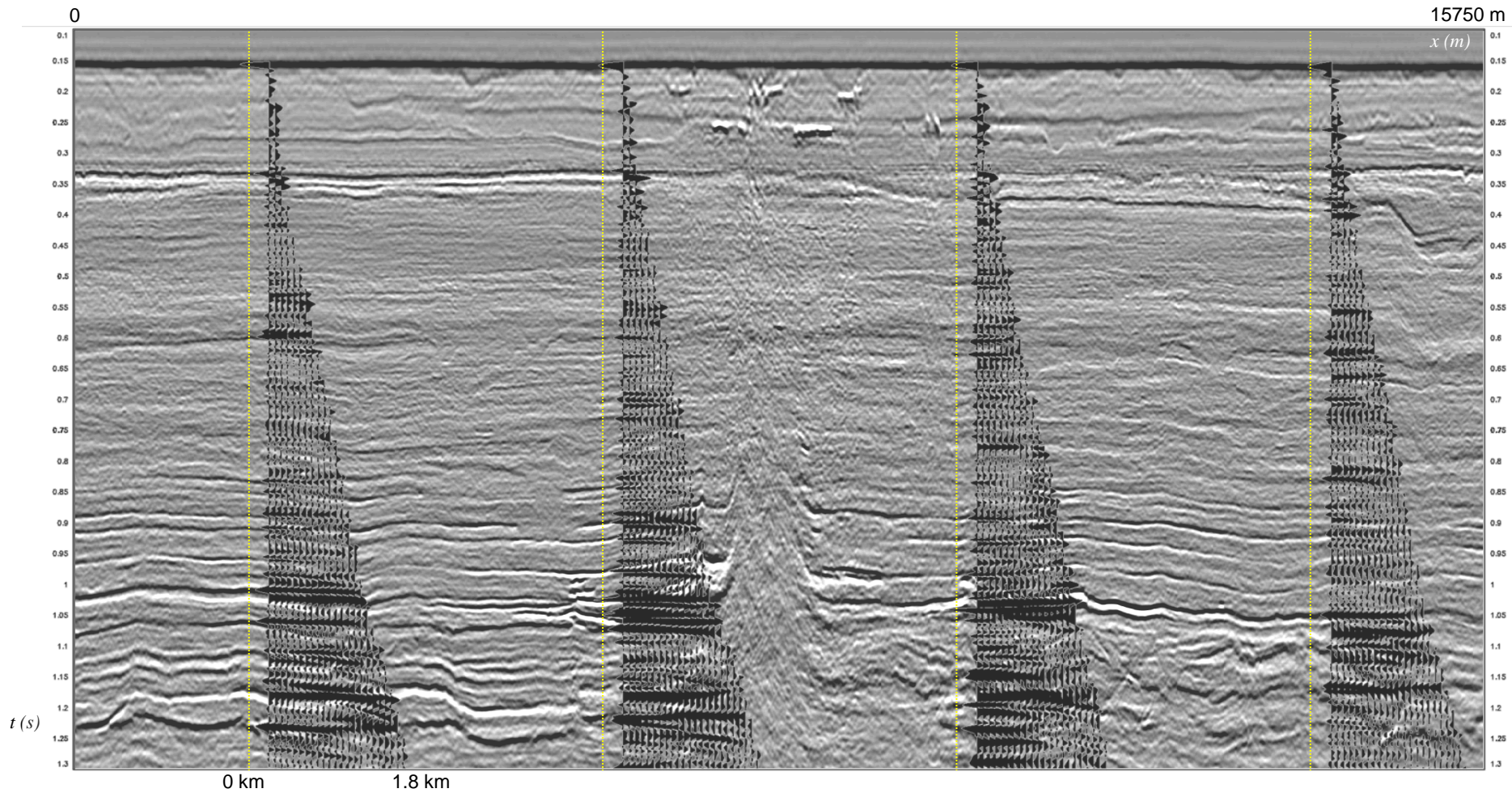


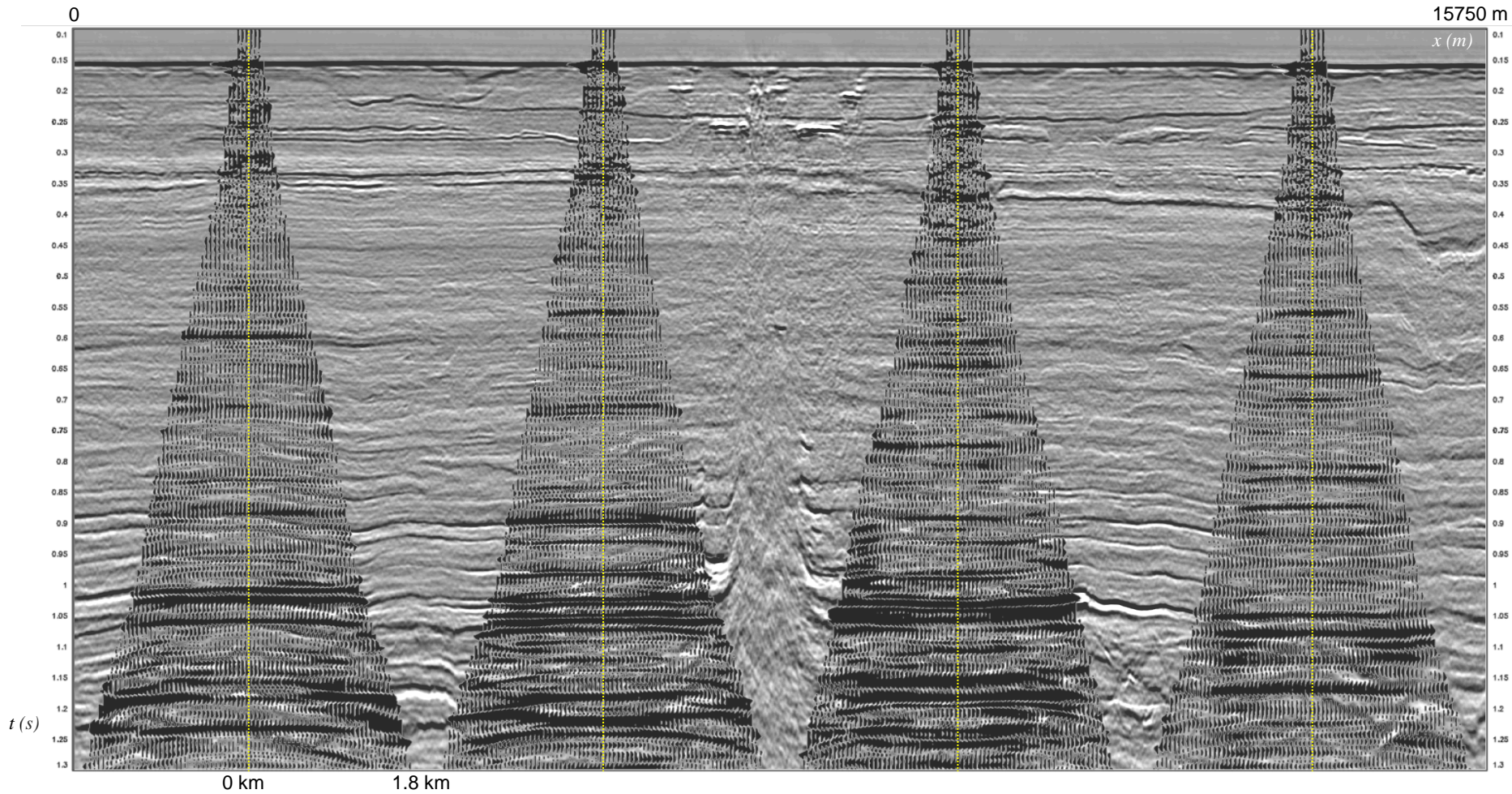
TopSeis North Sea field test – Frigg Gamma

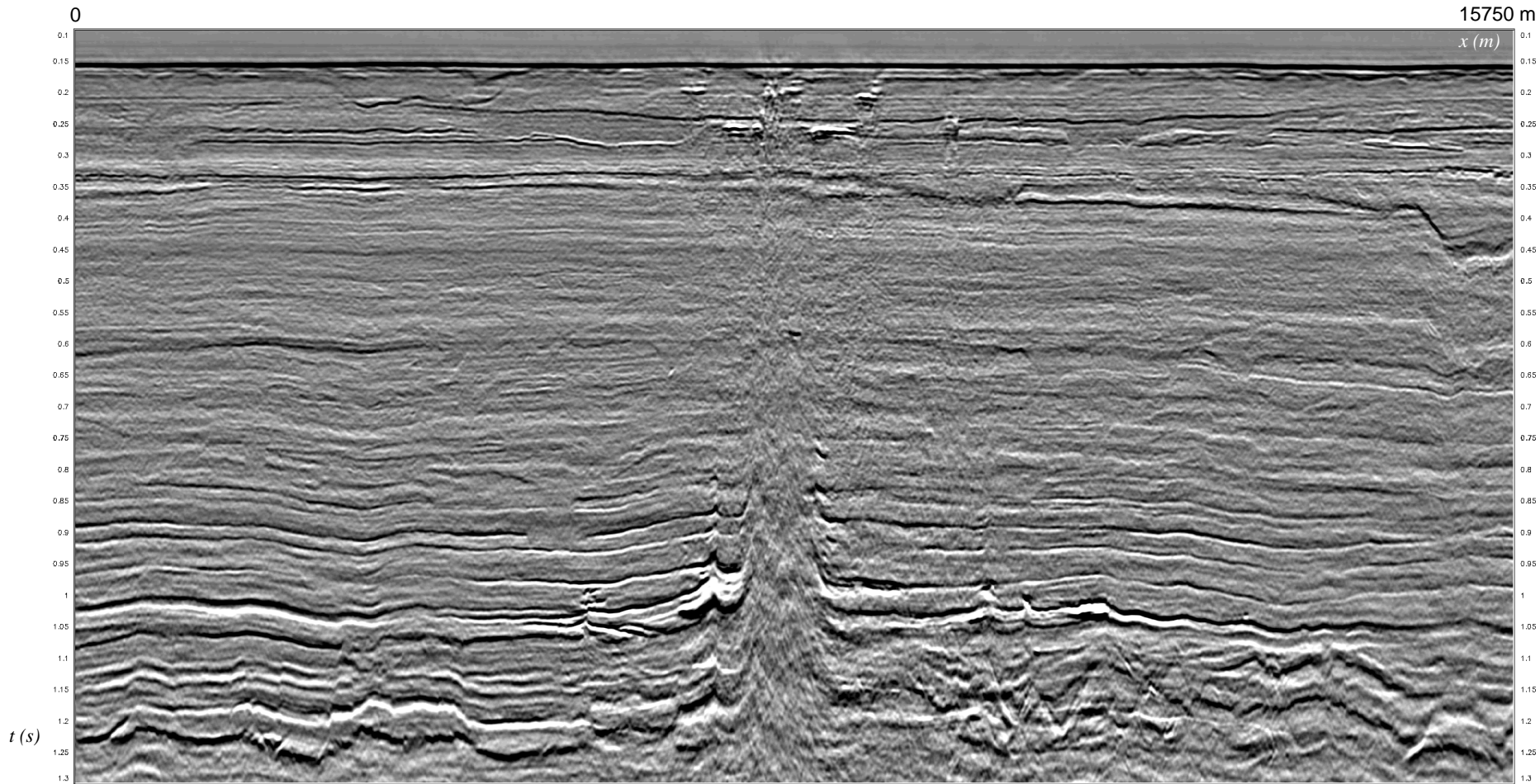


- Field test performed June 2016
- 15x3 km full fold over Frigg-Gamma
- MultiClient BroadSeis data acquired in July 2016 is reference.
- Water depth ~100 m
- Processing is **work-in-progress**

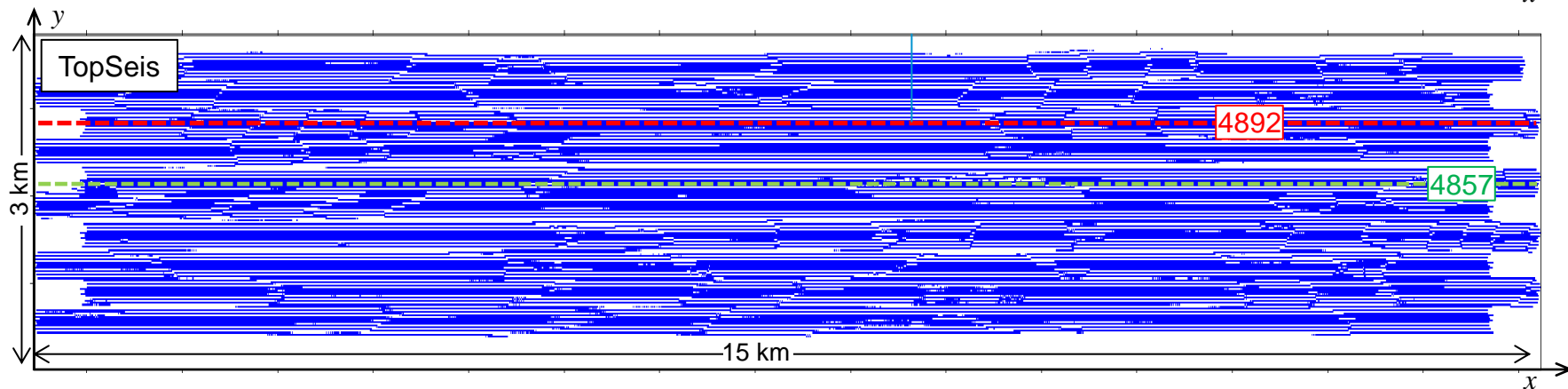
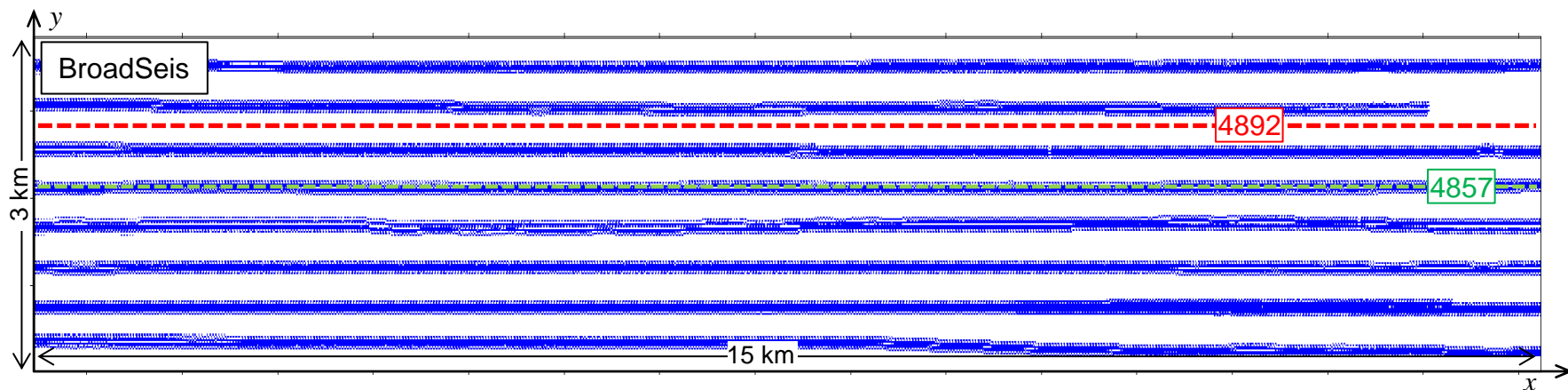




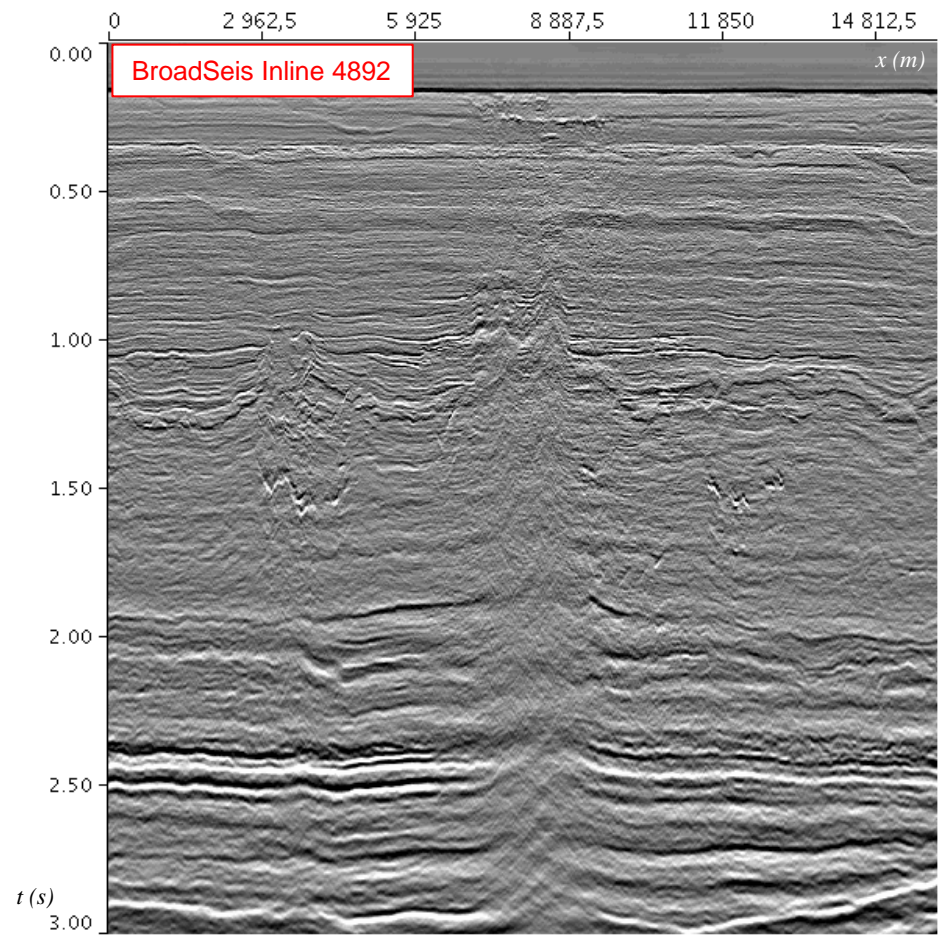
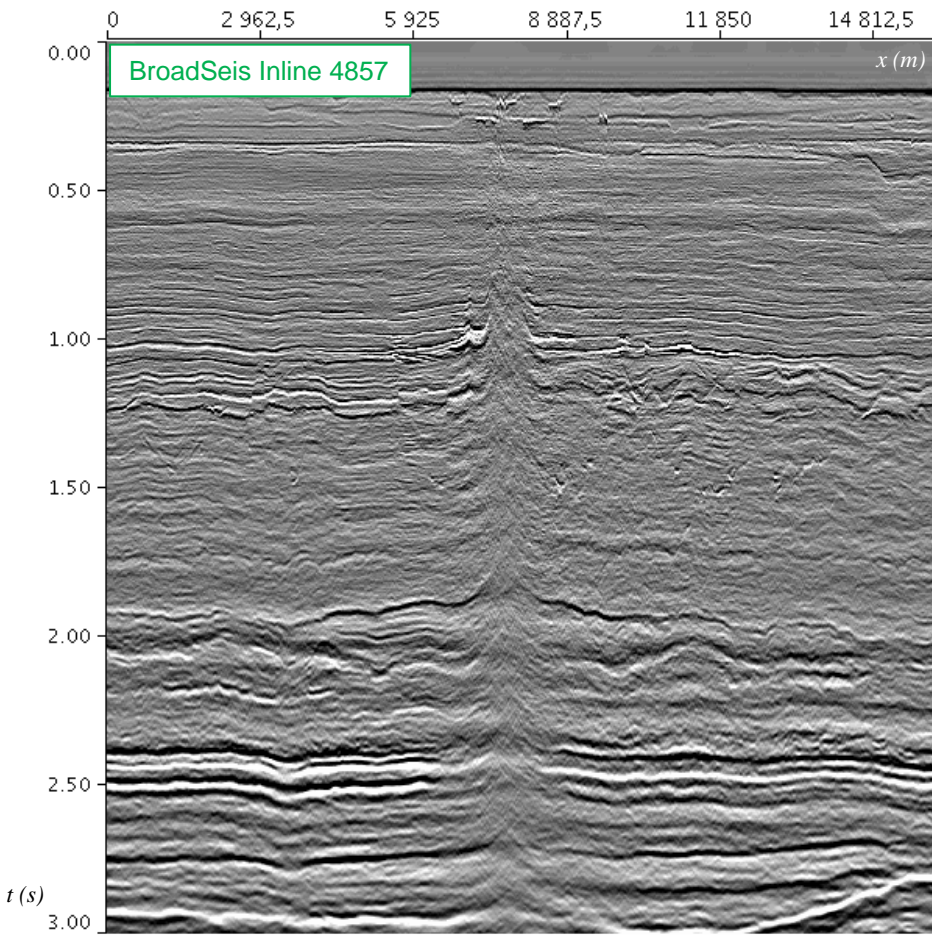


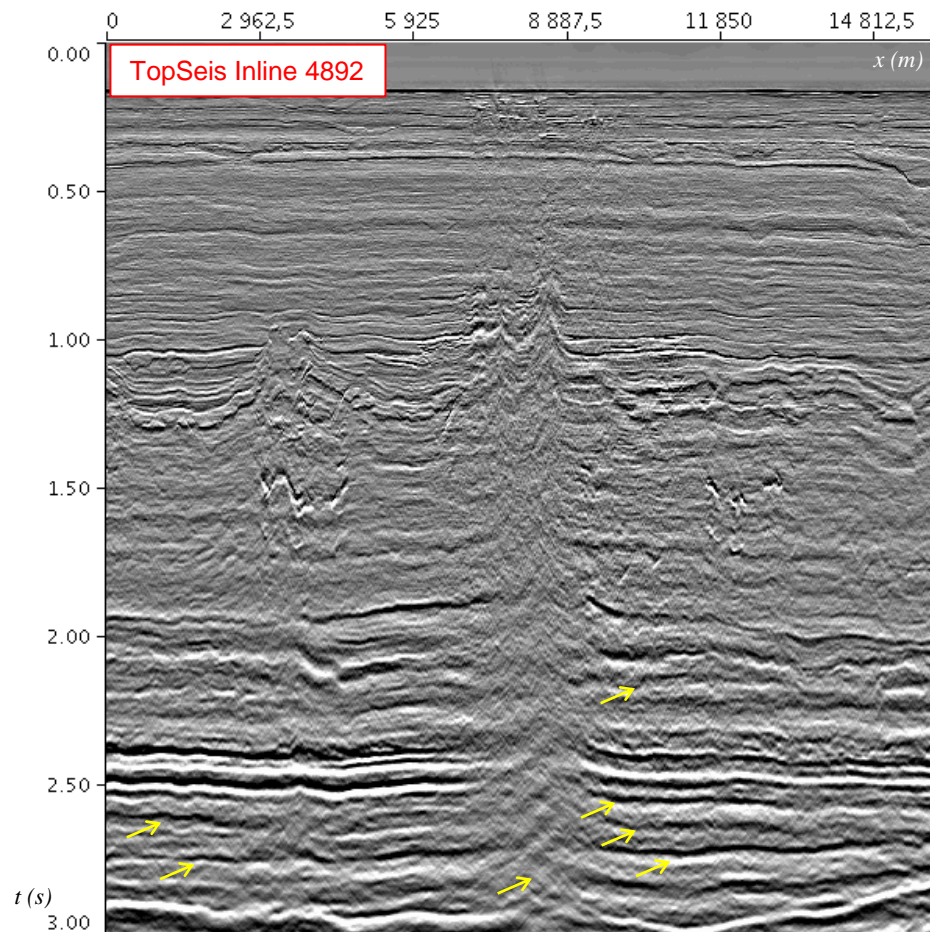
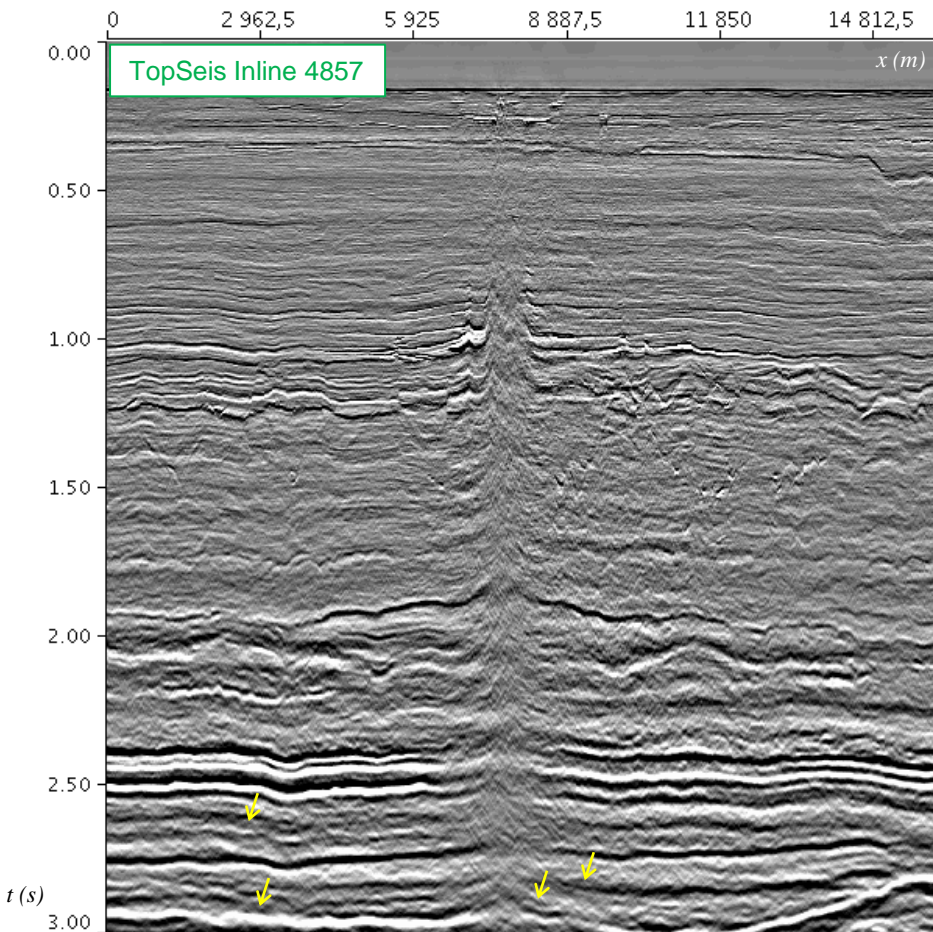


Frigg Field Test; Location of the Inlines

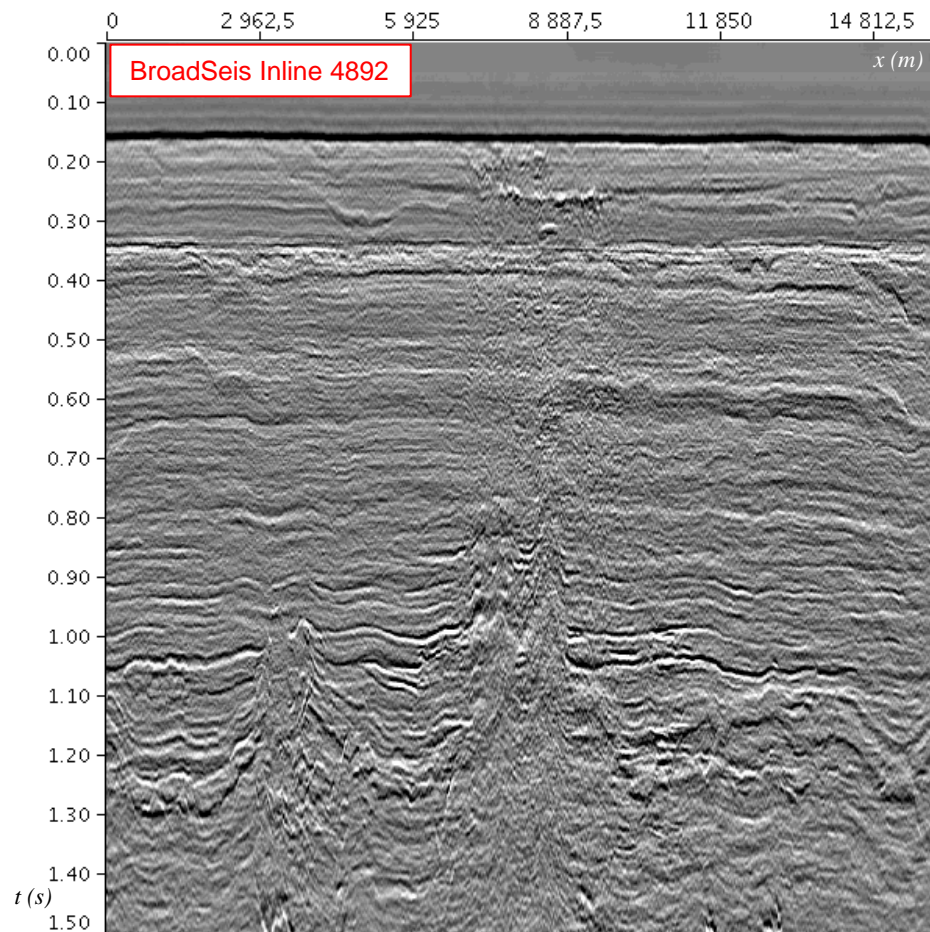
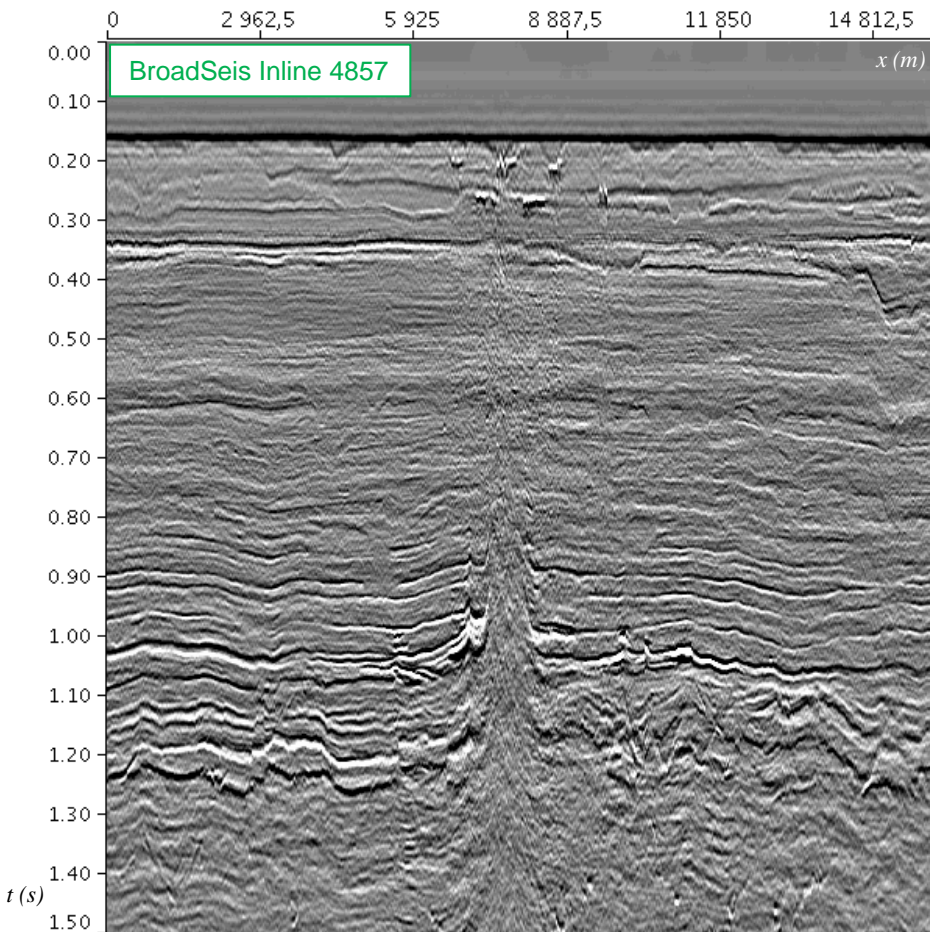


BroadSeis Inlines – down to 3 s



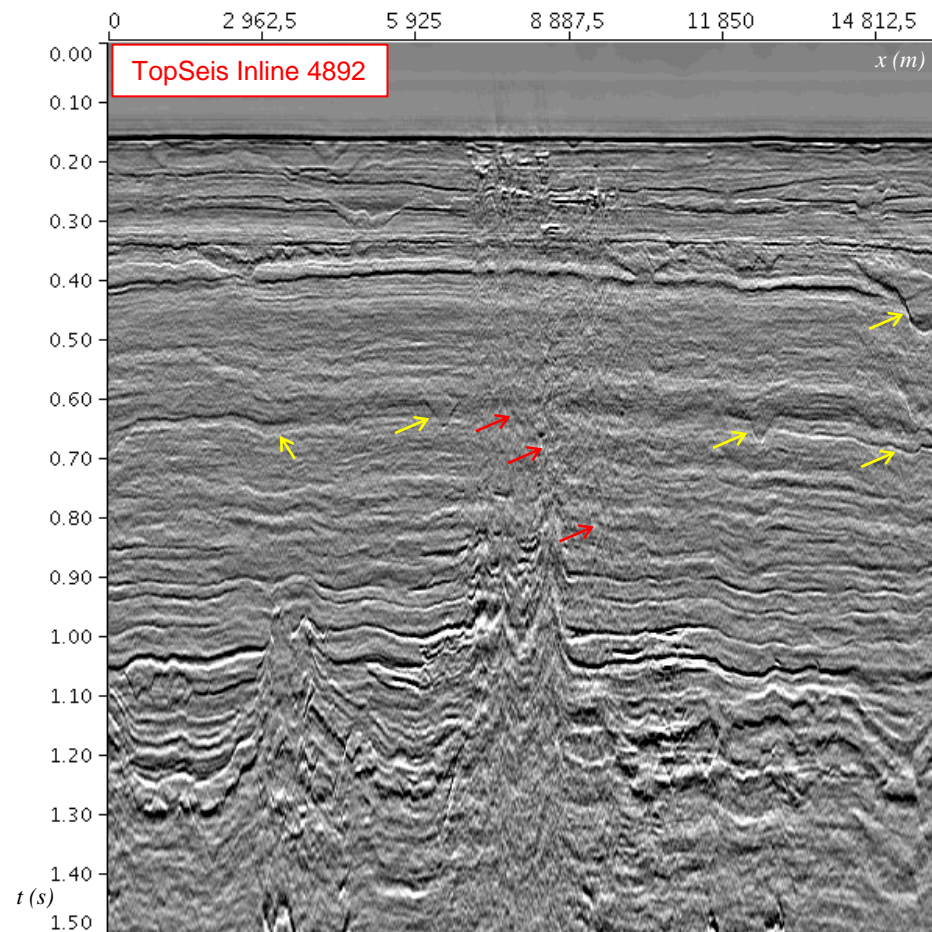
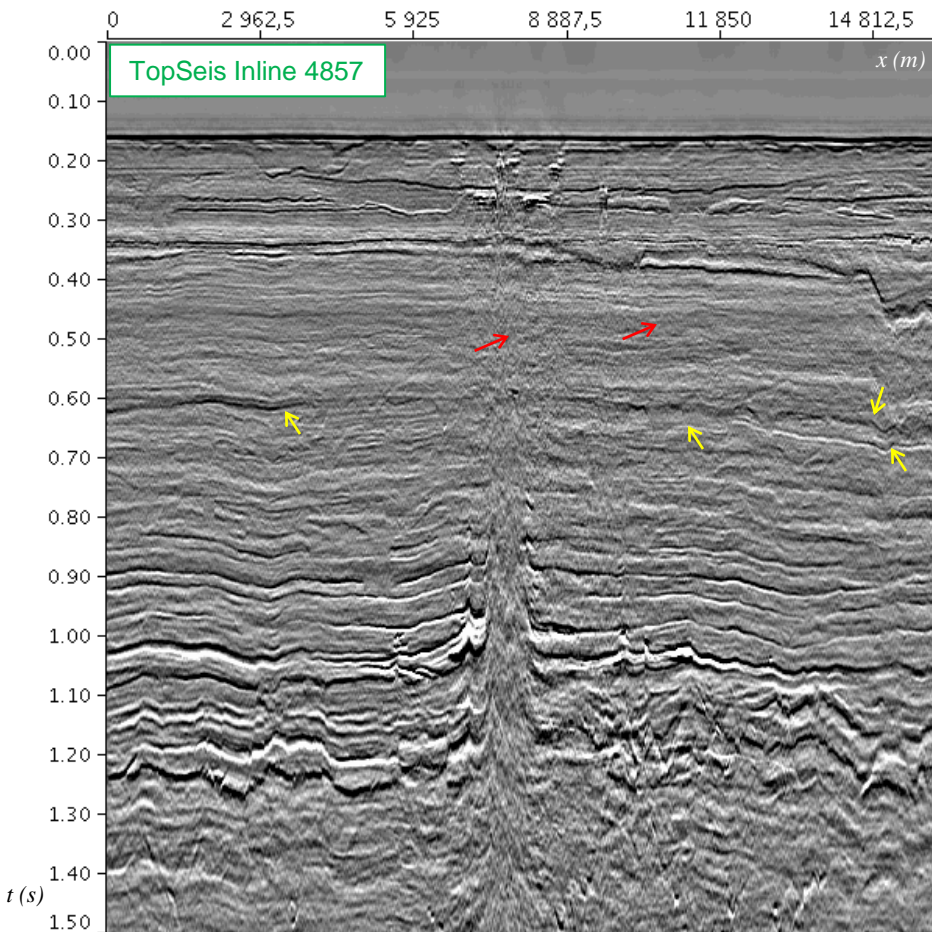


BroadSeis Inlines – down to 1.5 s



TopSeis Inlines – down to 1.5 s

↘ : Structural Improvements
↘ : Reduced noise



Calcite columns, as in Frigg



Hydrocarbon-related fluid migration and processes
of carbonate diagenesis
Pobiti Kamani area (Eocene, Varna, NE Bulgaria)



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journal homepage: www.elsevier.com/locate/palaeo



The formation of giant tubular concretions triggered by anaerobic oxidation of methane as revealed by archaeal molecular fossils (Lower Eocene, Varna, Bulgaria)

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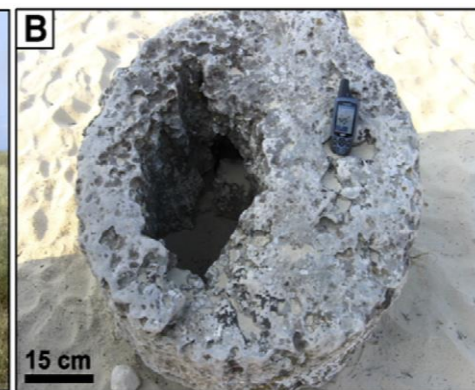
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ABSTRACT

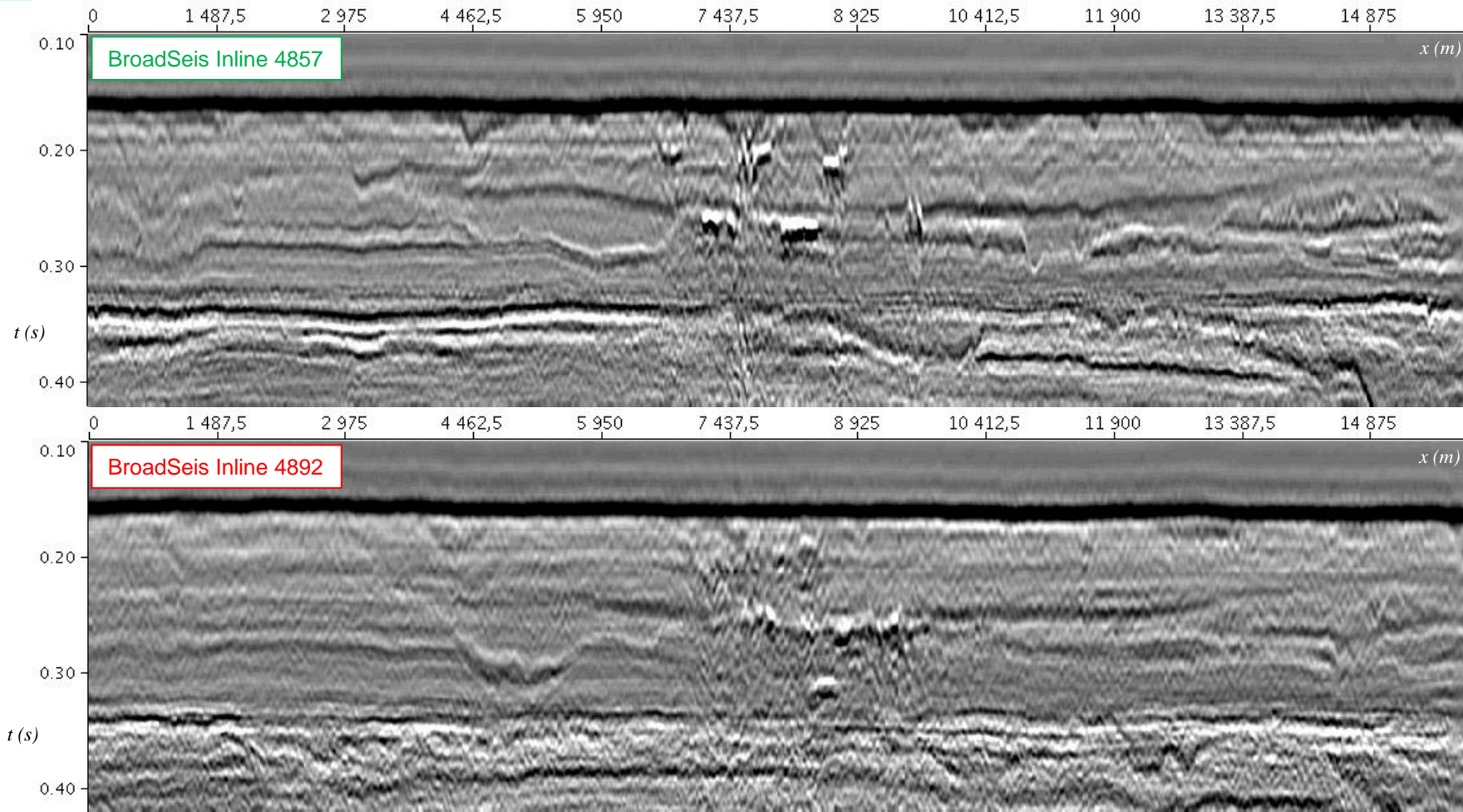
Impressive, several meters high tubular concretions in shallow marine calcareous sands and sandstones represent part of the well-exposed, subsurface plumbing network of an Early Eocene methane seep system in the Balkanides foreland (Pobiti Kamani area, Varna, NE Bulgaria). An integrated approach, including petrography, inorganic geochemistry and lipid biomarker analyses was used to reconstruct the evolution of pore fluids and cementation conditions during tube formation and particularly, the role of methane-related



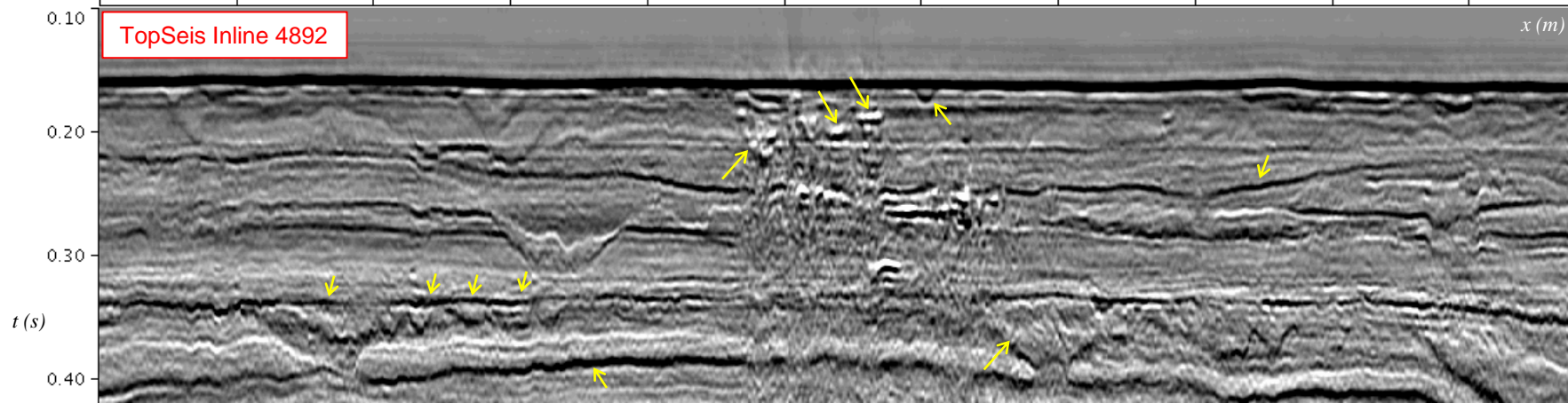
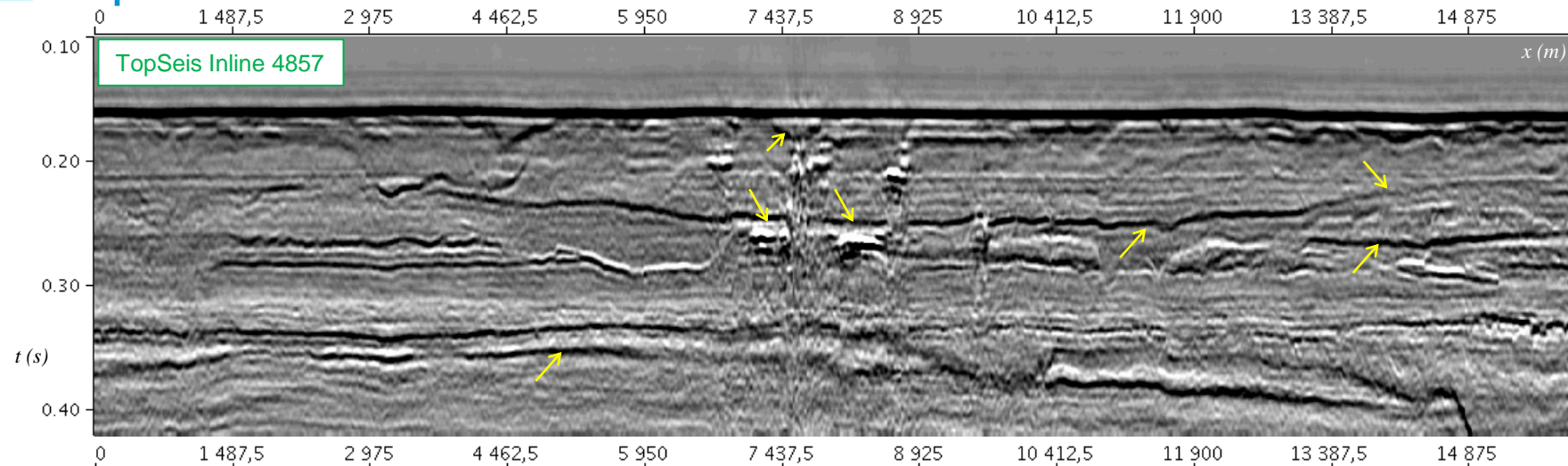


Thanks to Erling Rykkelid (AkerBP) for the photos

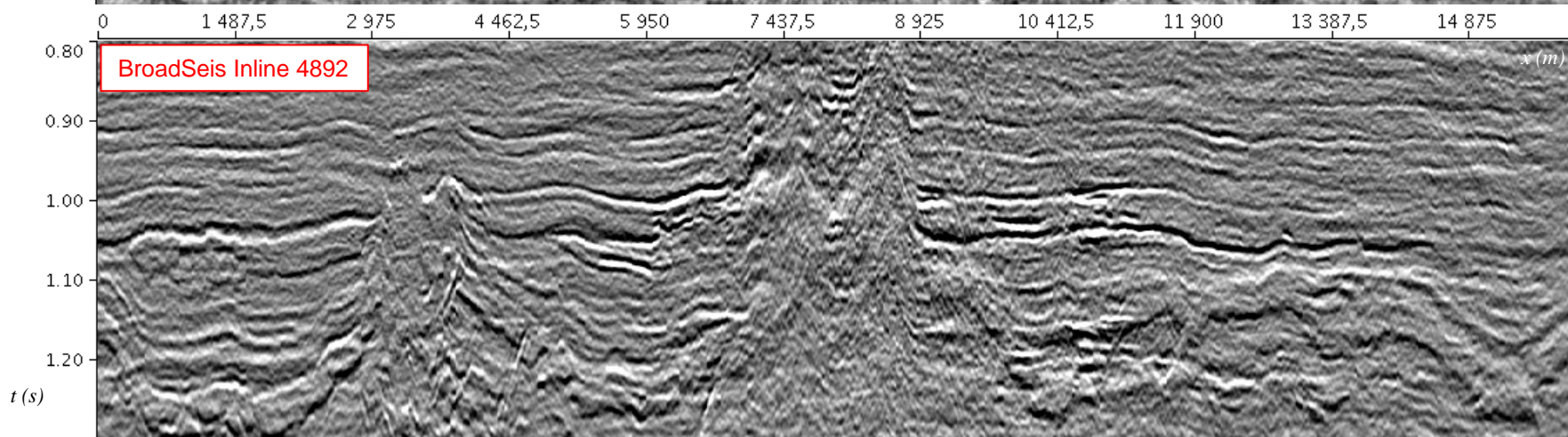
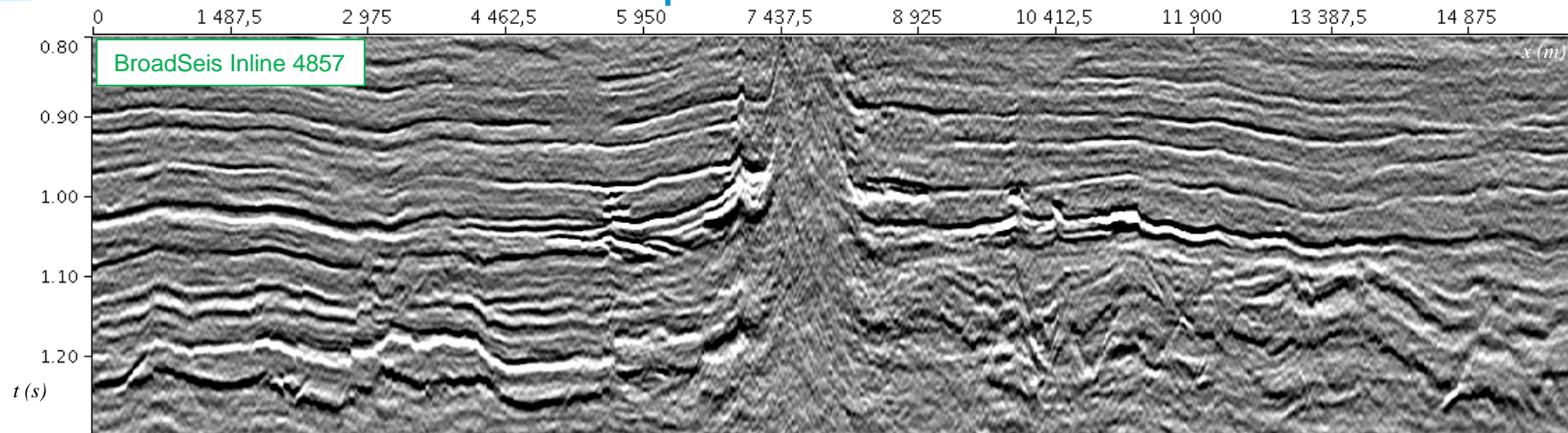
BroadSeis Inlines – Shallow zoom



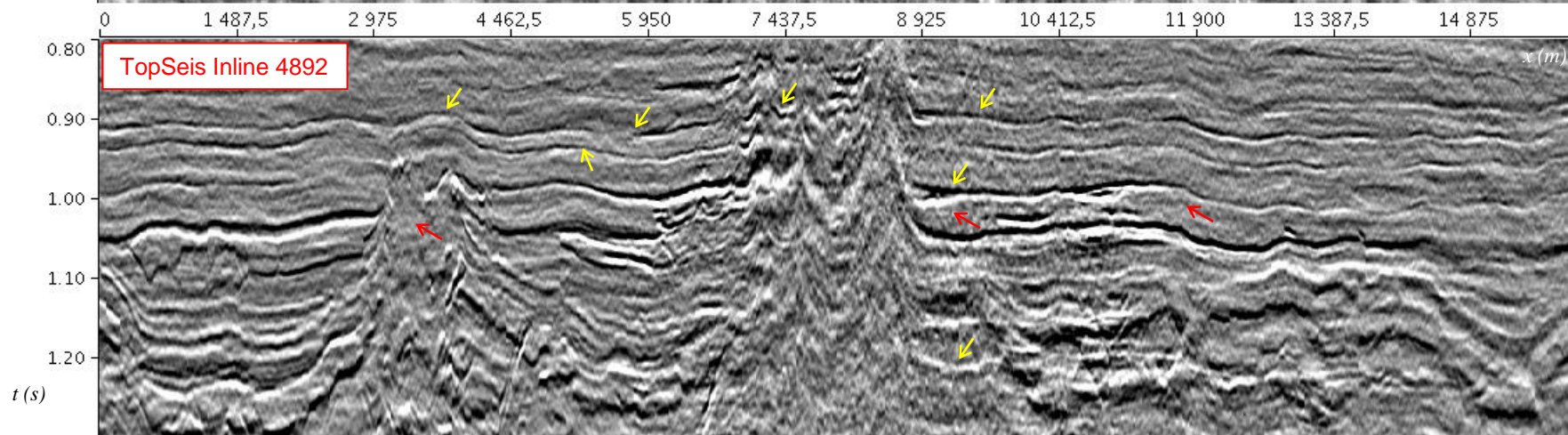
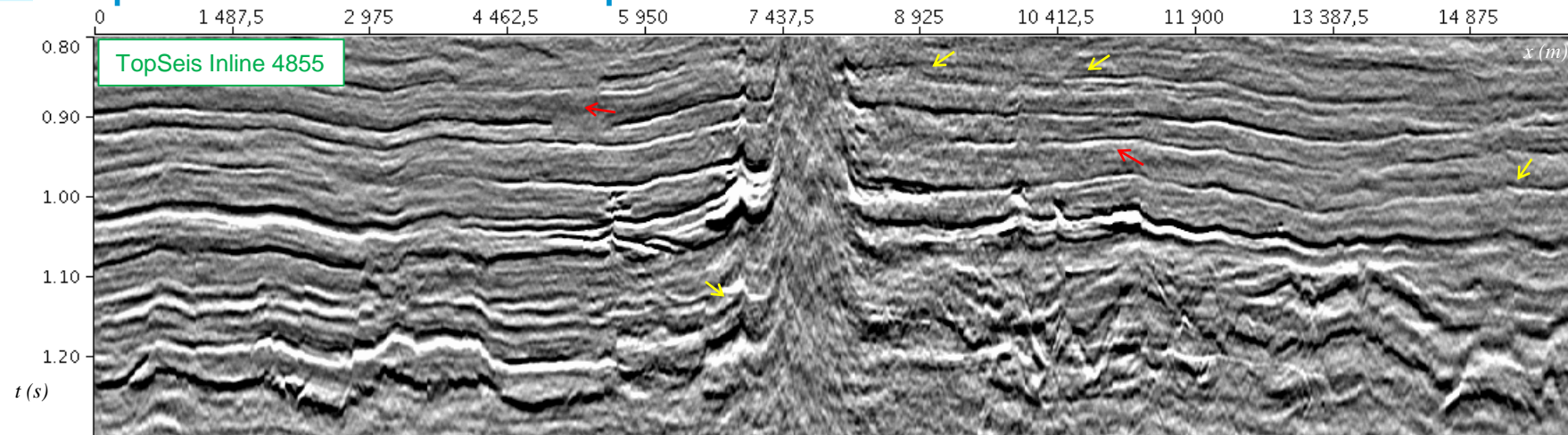
TopSeis Inlines – Shallow zoom



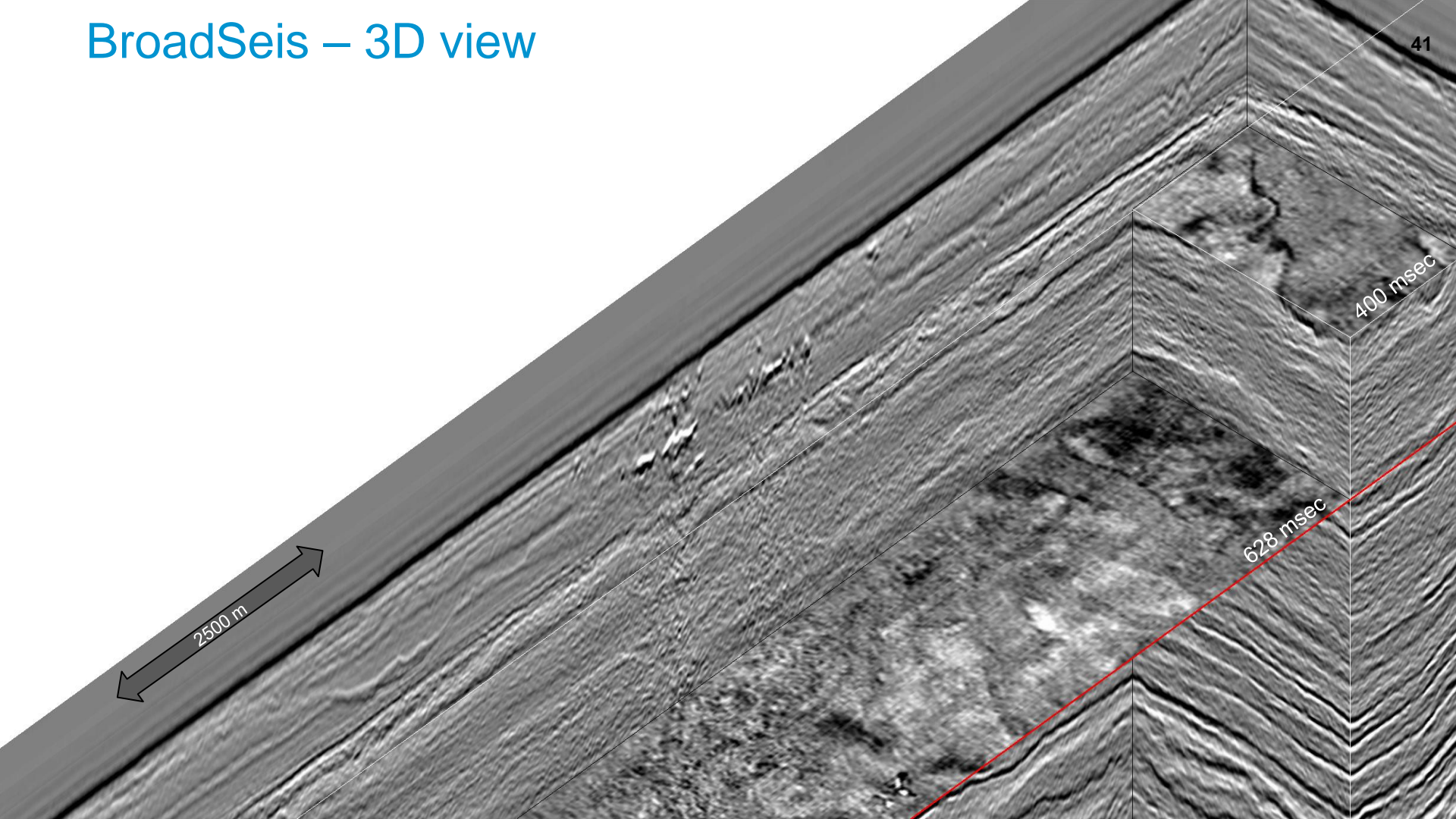
BroadSeis Inlines – Deeper zoom



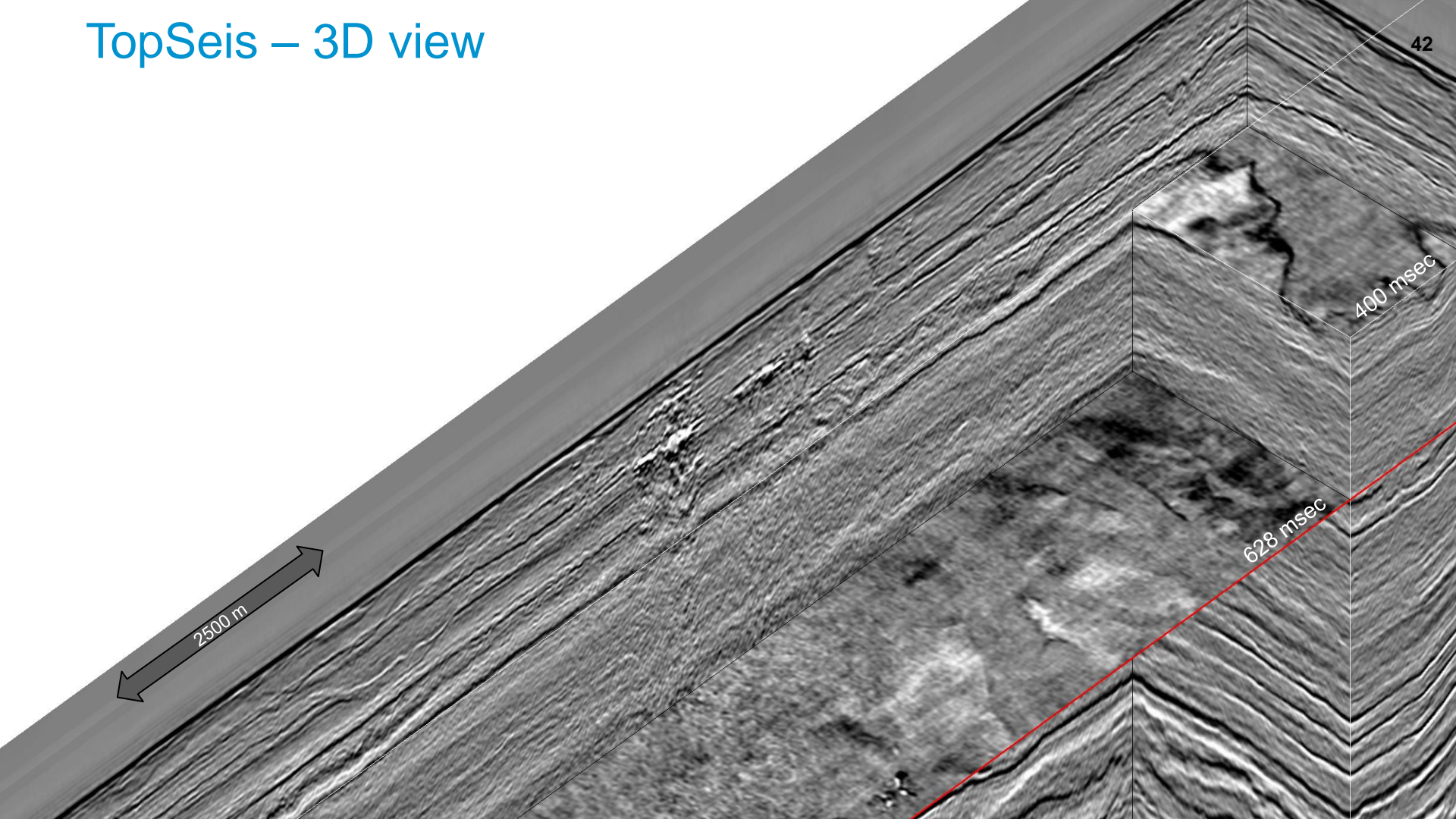
TopSeis Inlines – Deeper zoom



BroadSeis – 3D view



TopSeis – 3D view



Conclusions – TopSeis

- ✓ Provides unique illumination and fold for improved imaging and reservoir characterization
- ✓ Complete top-to-bottom solution
- ✓ Has been verified in a comprehensive modelling and field test program
- ✓ First commercial survey in 2017



The project is a result of close cooperation between Lundin and a cross-disciplinary team of experts from CGG



Acknowledgements

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CGG Subsurface Imaging:
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Oceanic Endeavour, Geowave Voyager, Oceanic Champion, Geo Caspian