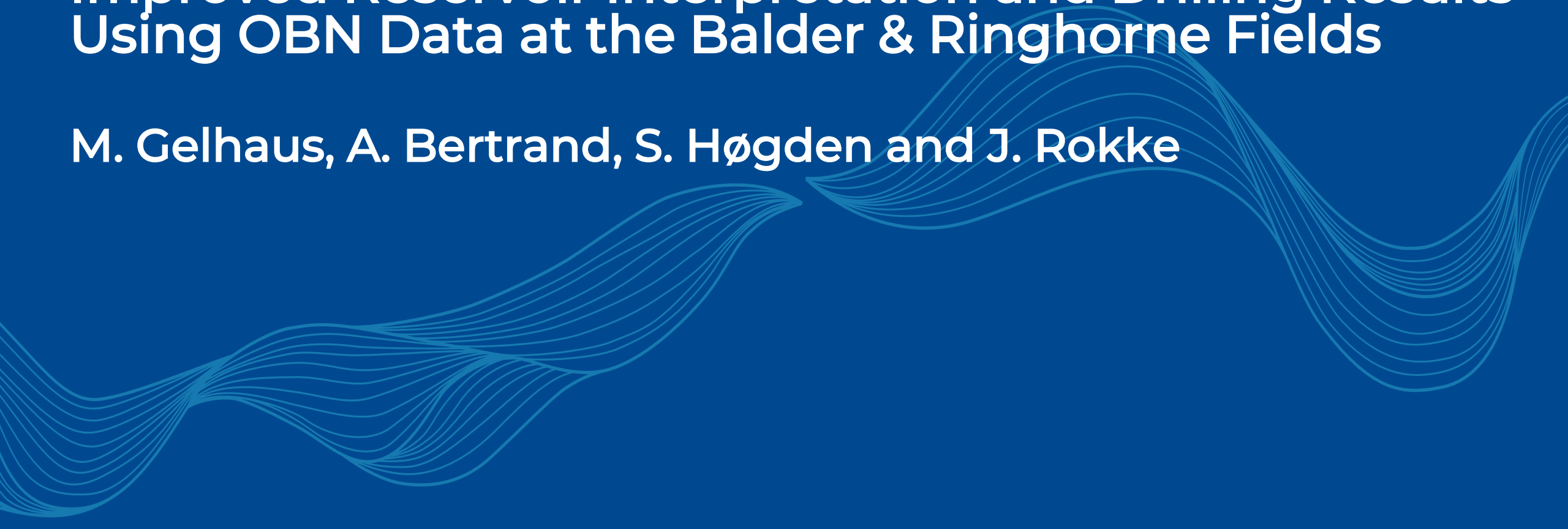


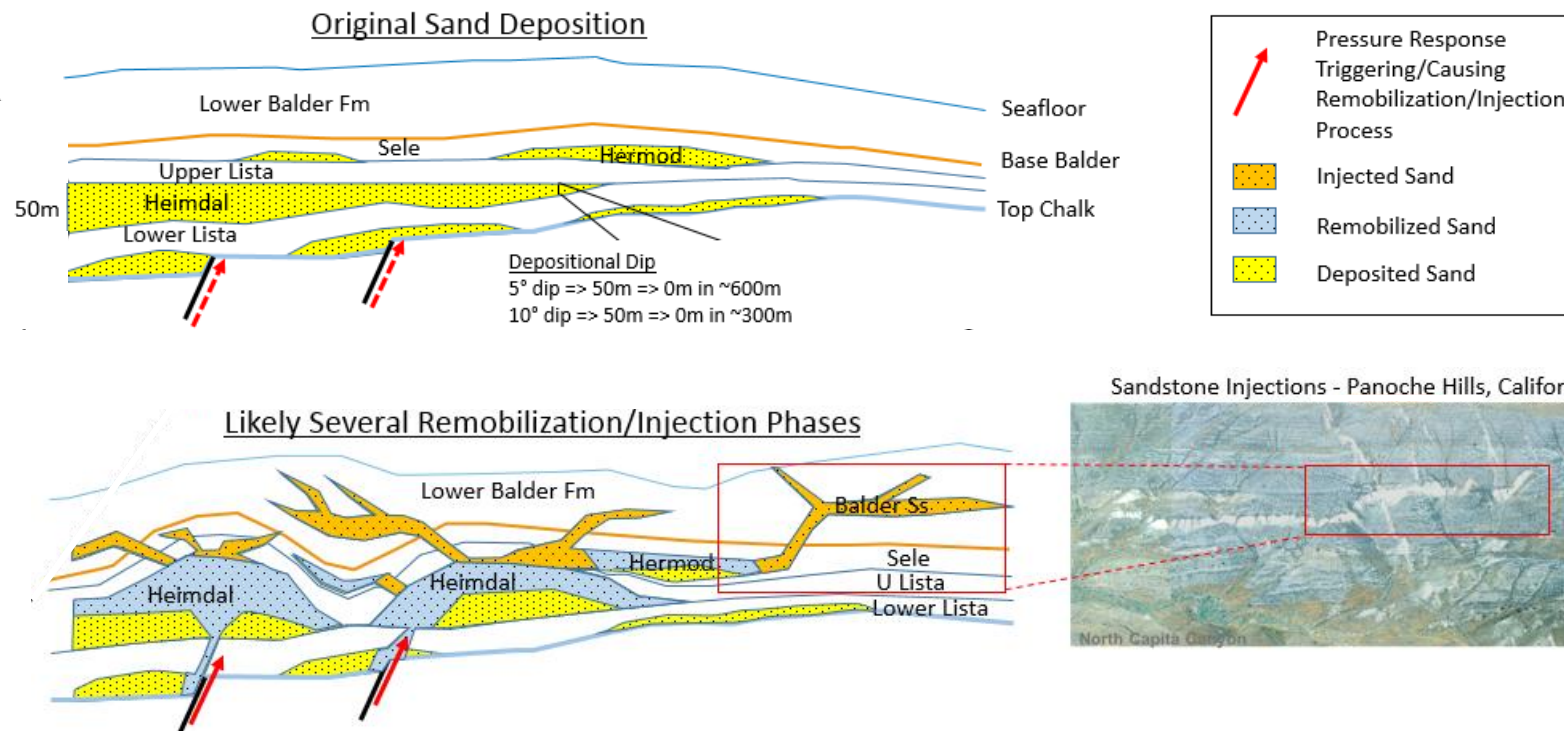
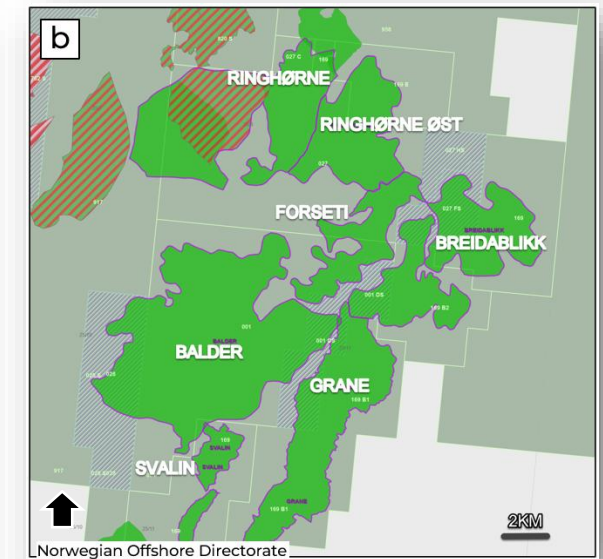
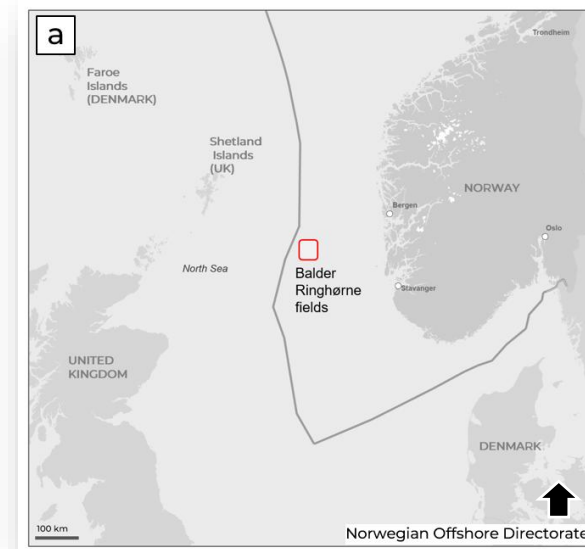
Improved Reservoir Interpretation and Drilling Results Using OBN Data at the Balder & Ringhorne Fields

M. Gelhaus, A. Bertrand, S. Høgden and J. Rokke

A series of light blue, wavy, horizontal lines that flow across the lower half of the slide, creating a sense of movement and depth.

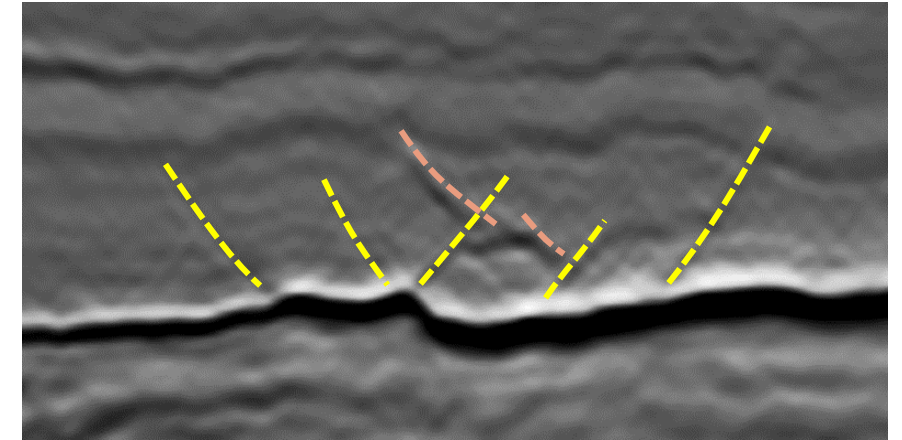
Balder Area

- First discovery on NCS (1967)
- Production started in 1999
- Remobilized and injected Paleogene deep water systems
- Subsea templates & FPSO – 26 new wells drilled in 2022-2025

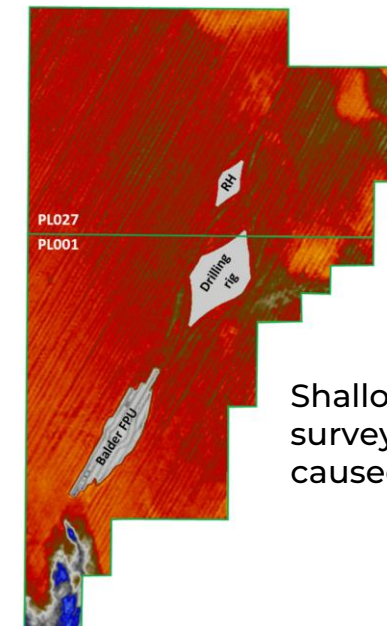


Motivation for OBN acquisition

- Existing challenges:
 - Sand mapping; steep, thin injectites
 - Wave-fronting from top chalk
 - Overburden heterogeneities disturbing image and depth conversion
- Need for improved velocity model, WAZ illumination, longer offsets
- Large infrastructures preventing longer and larger spread close passing
- VOI study based on future development drilling programs
- **Decision to acquire multi-azimuth, long offset OBN survey (summer 2023)**



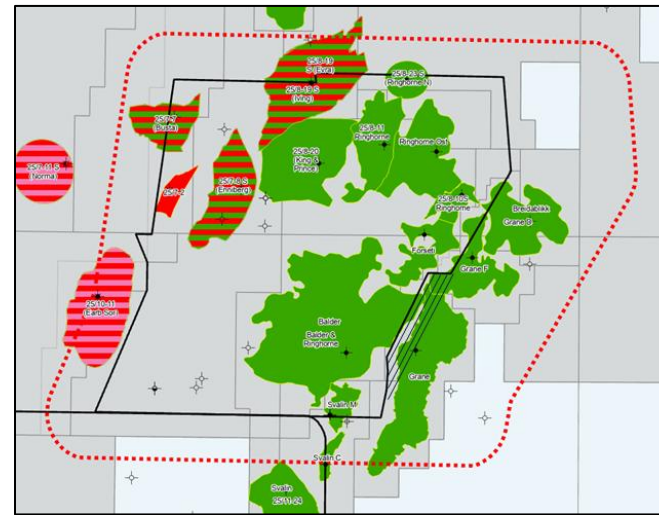
2001 NAZ, reprocessed in 2020. Example of wavefronting in XL



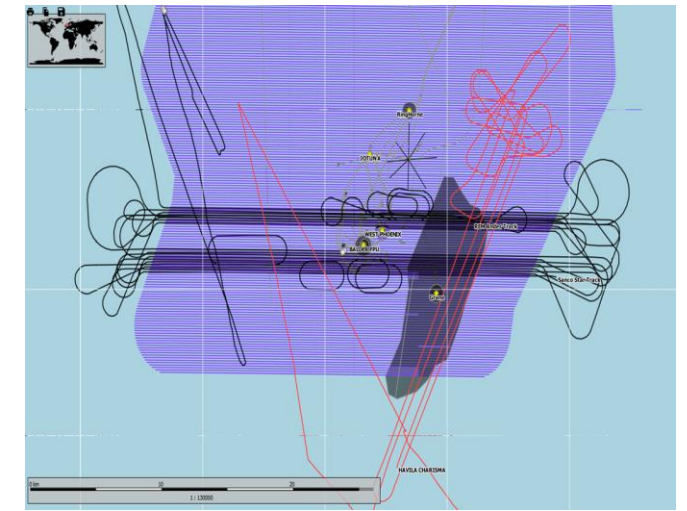
Shallow time slice from 2021 survey – showing data gaps caused by infrastructure

Complex Operation

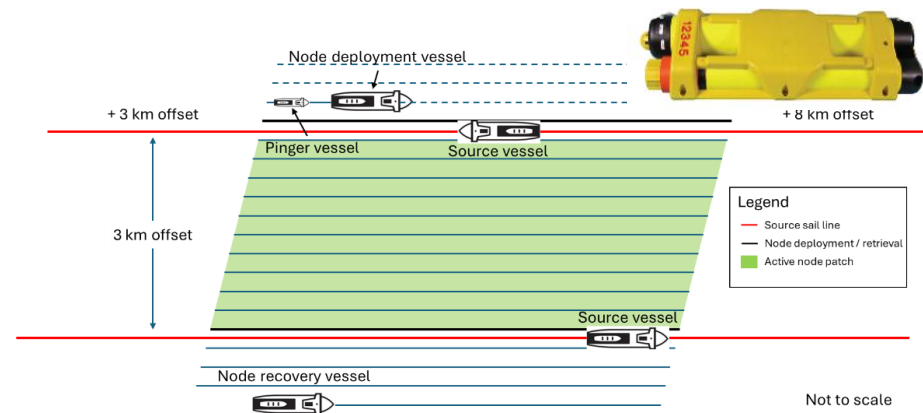
- Receivers (2-3 node vessels)
 - 426 sqkm, 300x50m node grid
 - Deployment with NOAR
 - Plus 400 nodes for undershooting (ROV)
- Sources
 - Dual vessels, triple source
- SIMOPS (rigs and time-sharing)
 - Diving on Balder
 - Timesharing with PRM over Grane
 - West Phoenix rig move



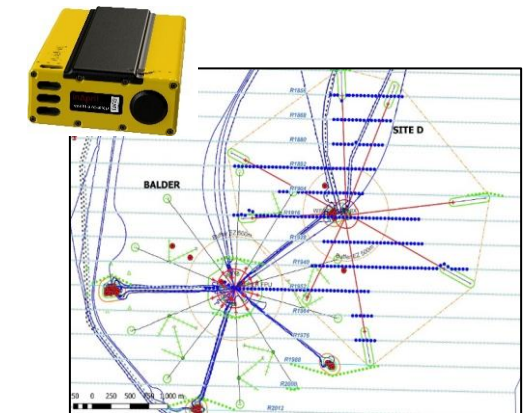
- Area under receivers
- Source area
- Utsira OBN area under receivers



Daily SimOps planning

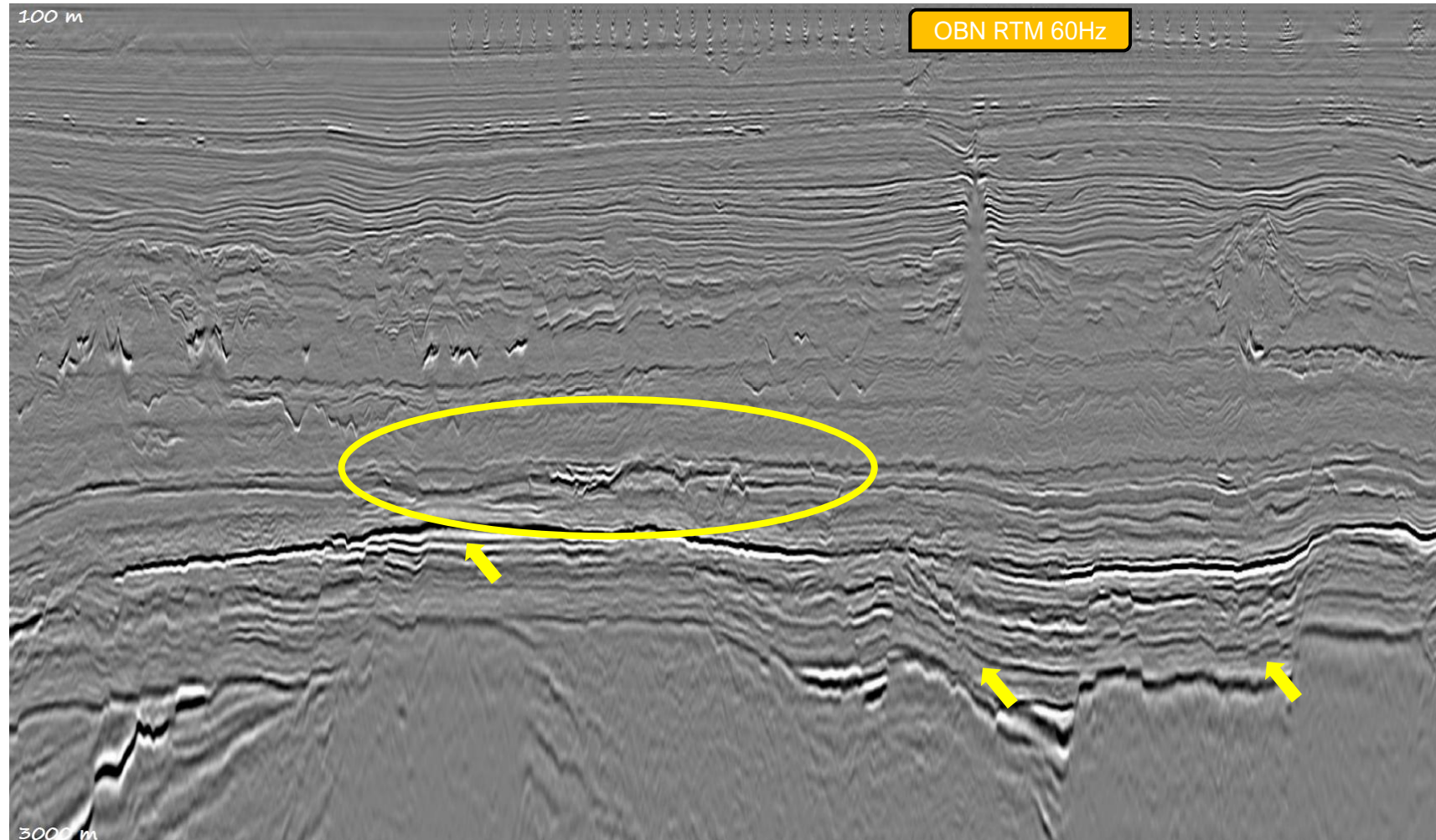


H-pattern - rolling

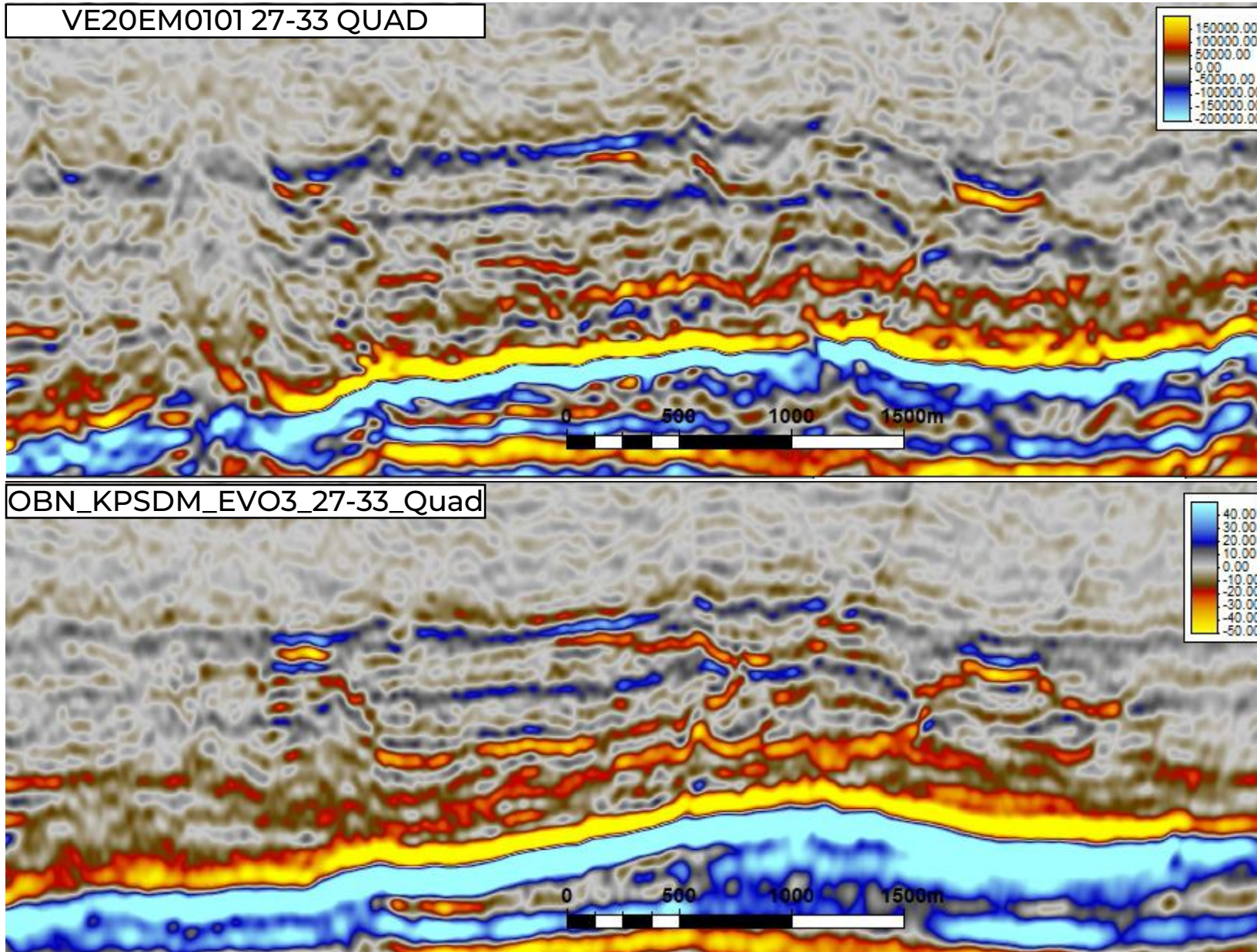


Undershooting

Processing example legacy streamer data vs OBN



Injectite complexity - Very well captured by OBN

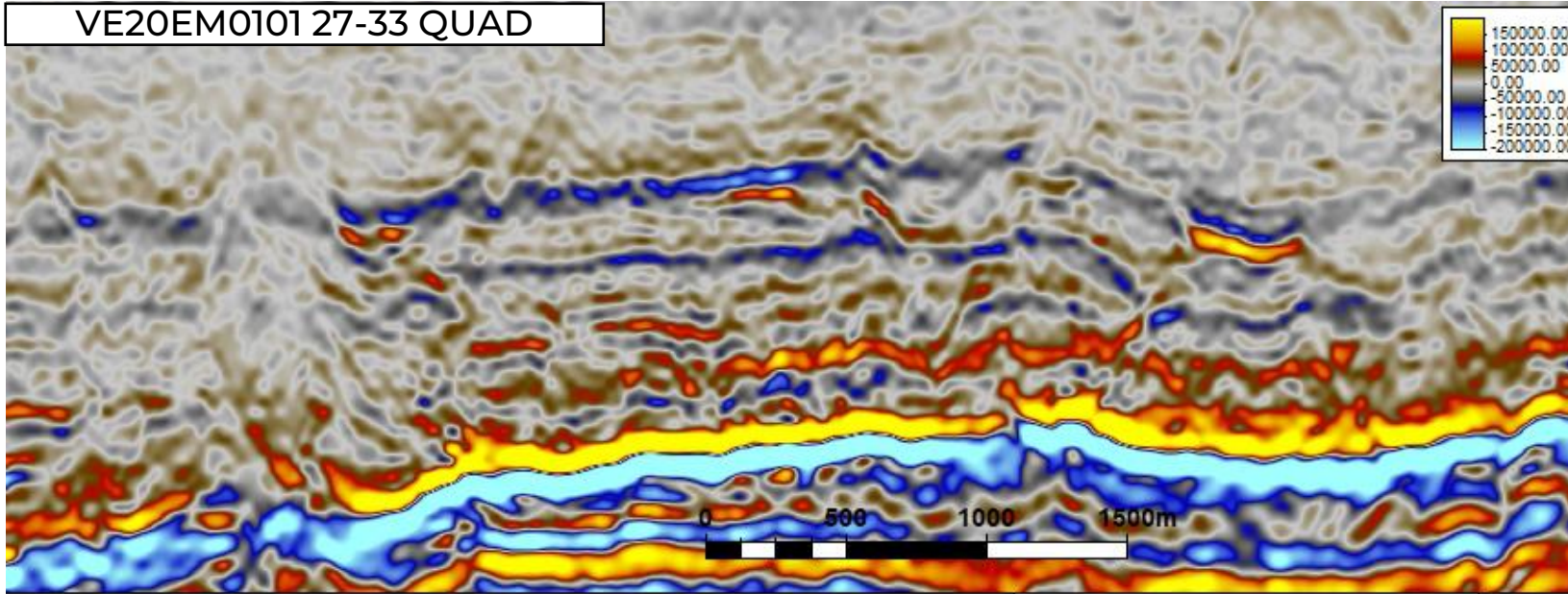


- Significantly more details in OBN

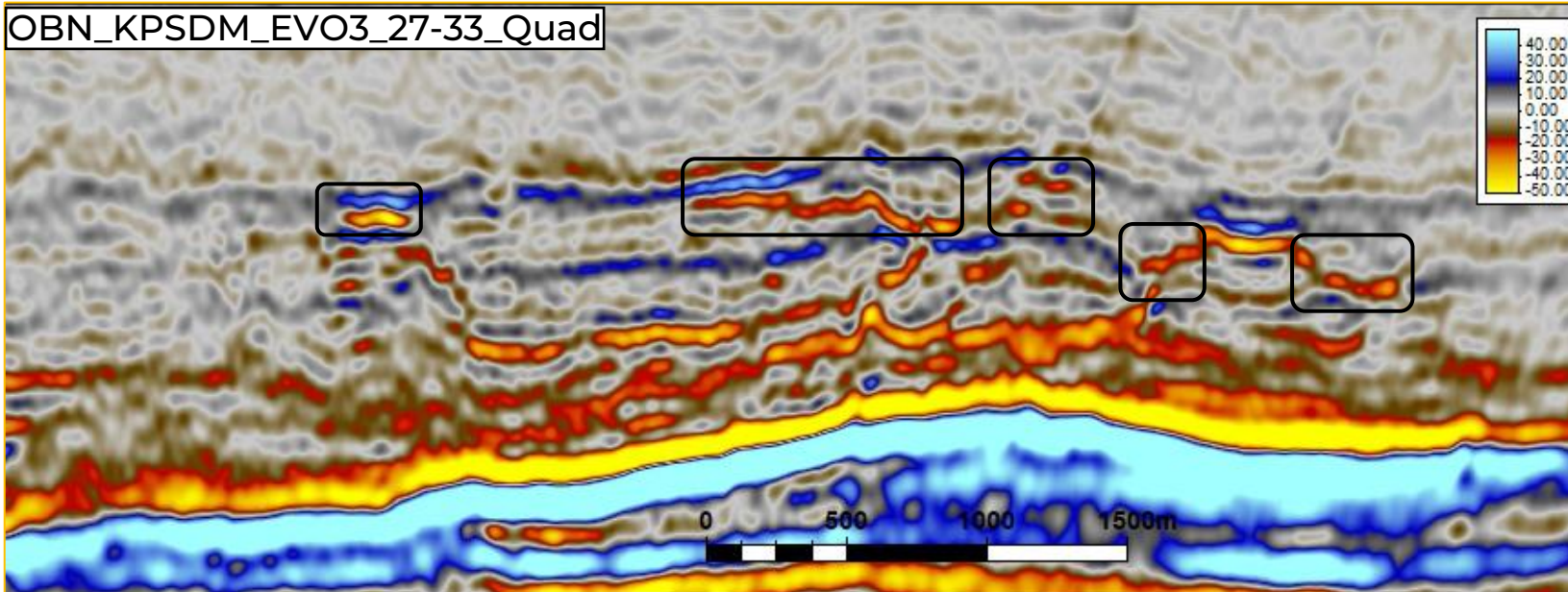
From Buriola et al, EAGE 2025

Injectite complexity - Very well captured by OBN

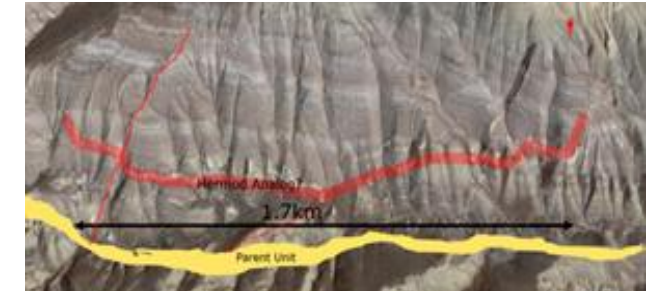
VE20EM0101 27-33 QUAD



OBN_KPSDM_EVO3_27-33_Quad



- Significantly more details in OBN (see highlighted boxes)



Right Angle Canyon, Panoche Hills, (California)

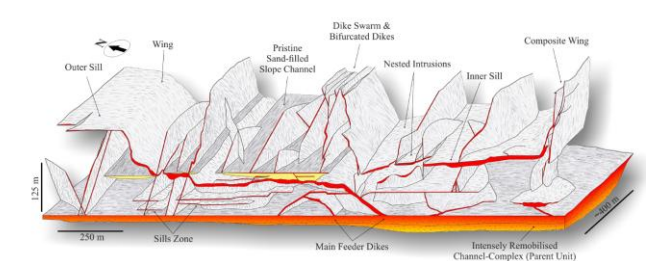
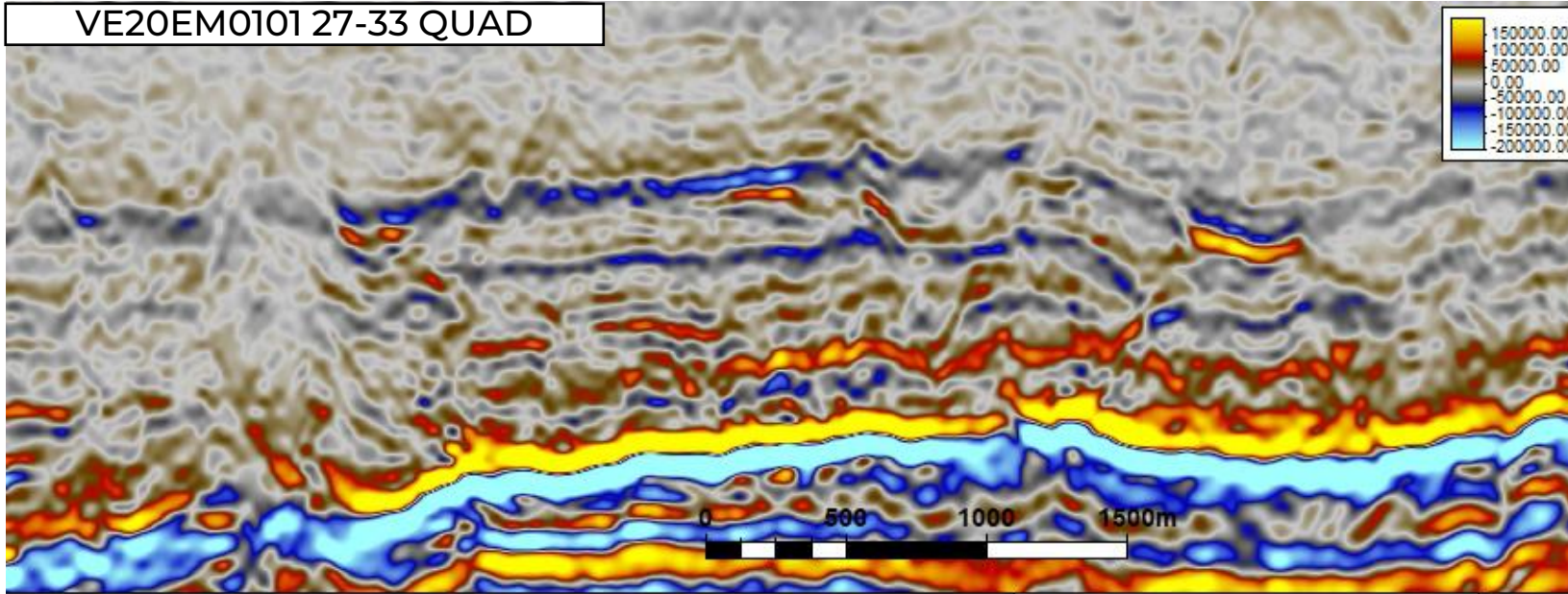


Figure 4.1.1: Synoptic representation of the Right Angle Canyon caudex-shaped intrusion. Location shown in Fig. 1.4.

Picture taken from:
Grippa et al. [2019] 'Seismic imaging of complex geometry: Forward modeling of sandstone intrusions', Earth and Planetary Science Letters, Volume 513

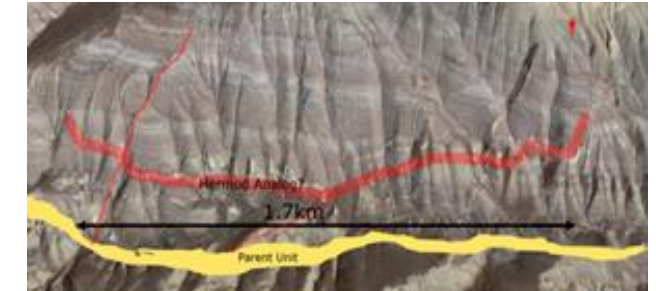
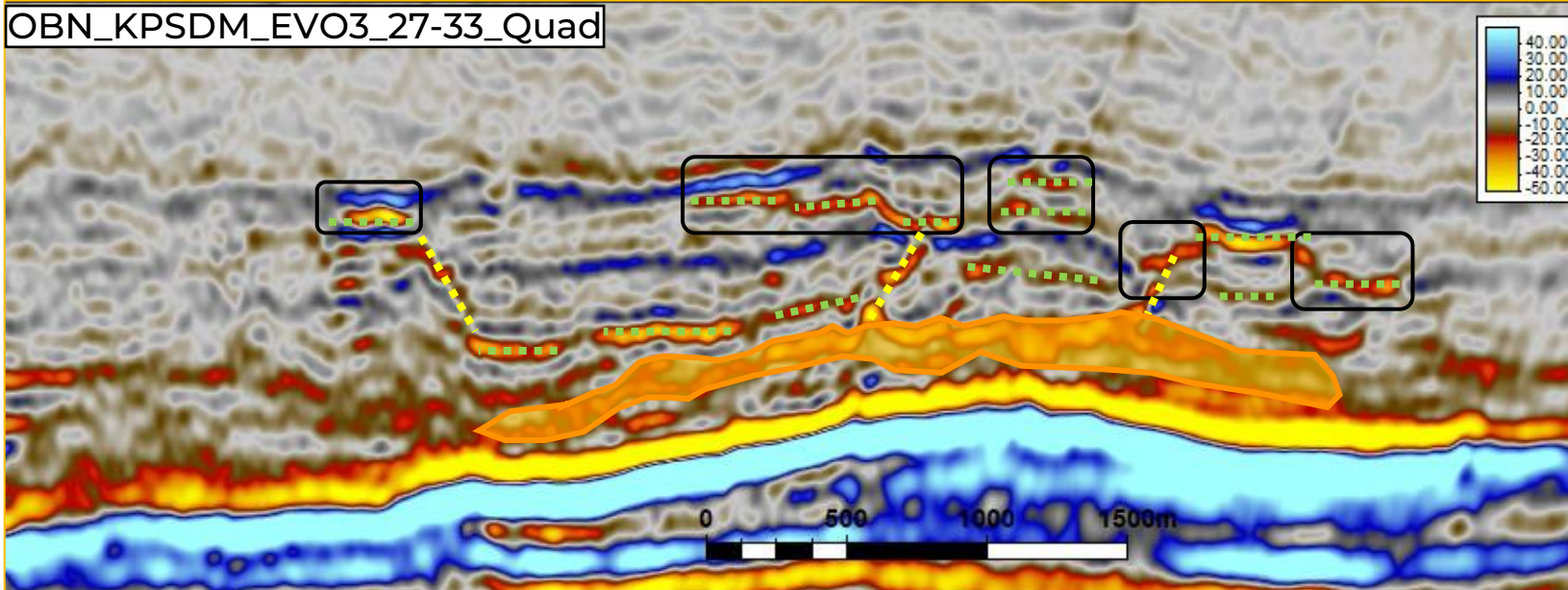
Injectite complexity - Very well captured by OBN

VE20EM0101 27-33 QUAD



- Significantly more details in OBN (see highlighted boxes)

OBN_KPSDM_EVO3_27-33_Quad



Right Angle Canyon, Panoche Hills, (California)

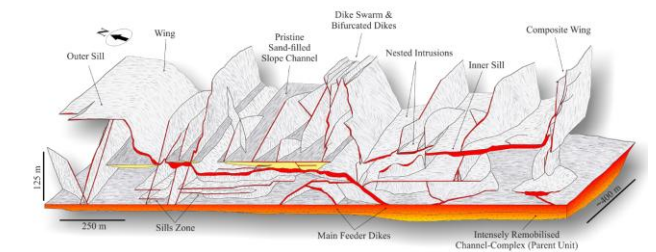
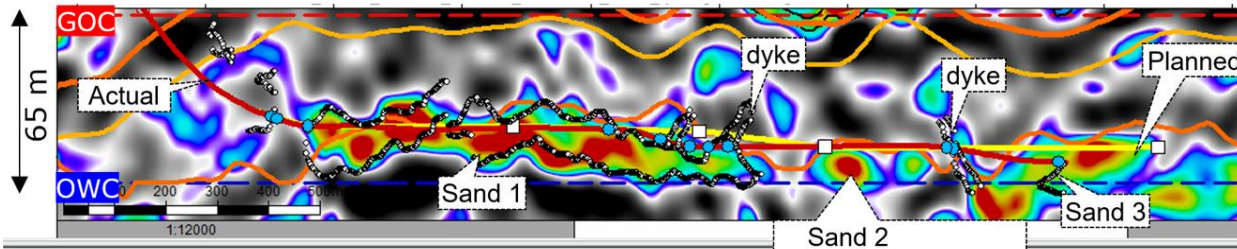


Figure 4.1.1: Synoptic representation of the Right Angle Canyon caudex-shaped intrusion. Location shown in Fig. 1.4.

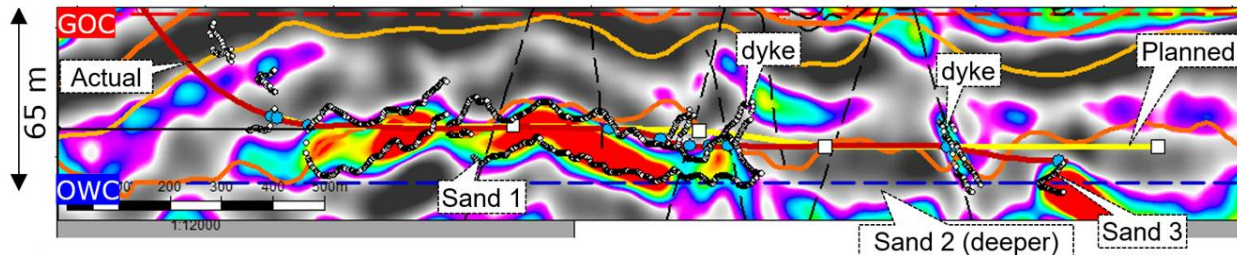
Picture taken from:
Grippa et al. [2019] 'Seismic imaging of complex geometry: Forward modeling of sandstone intrusions', Earth and Planetary Science Letters, Volume 513

Geosteering: first well to test OBN

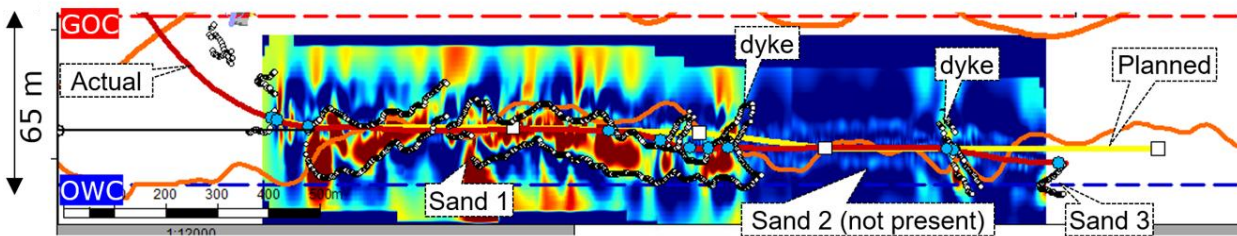
2001 Legacy Streamer Far Stack Quadrature - Depth



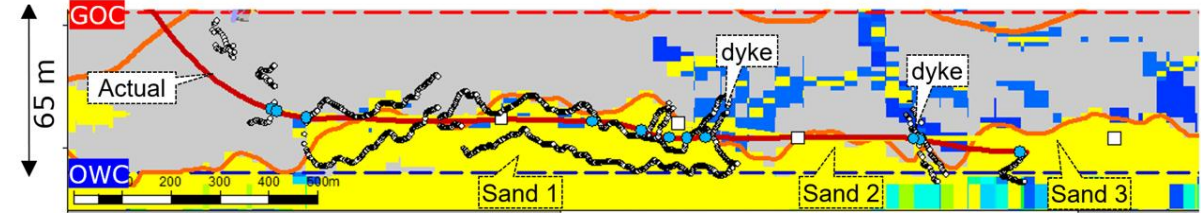
2023 OBN RTM Far Stack Quadrature - Depth



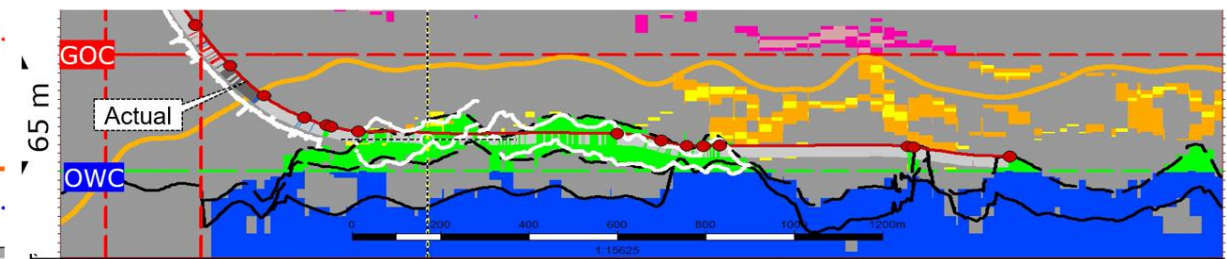
3D UDAR INVERSION



Static Model – Pre-Drill



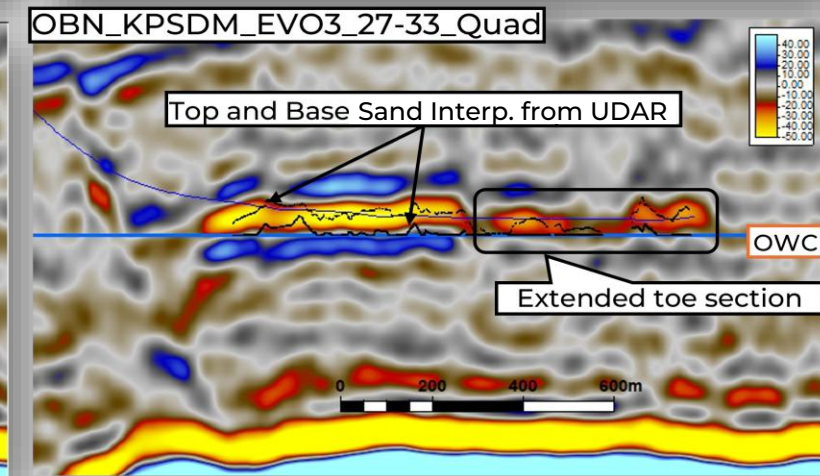
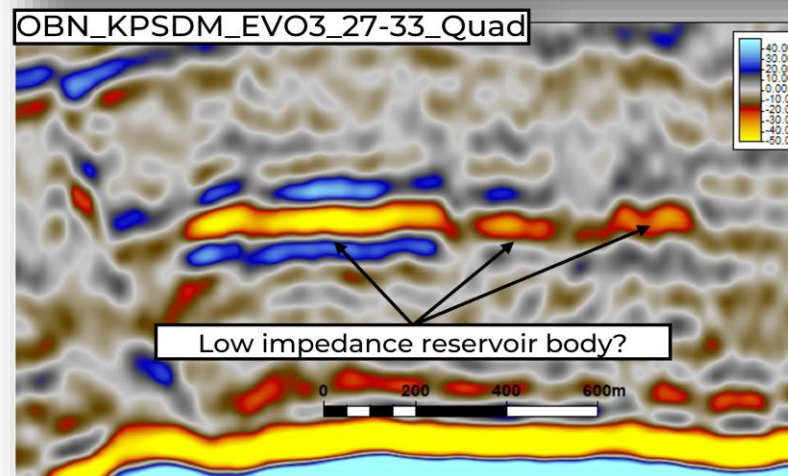
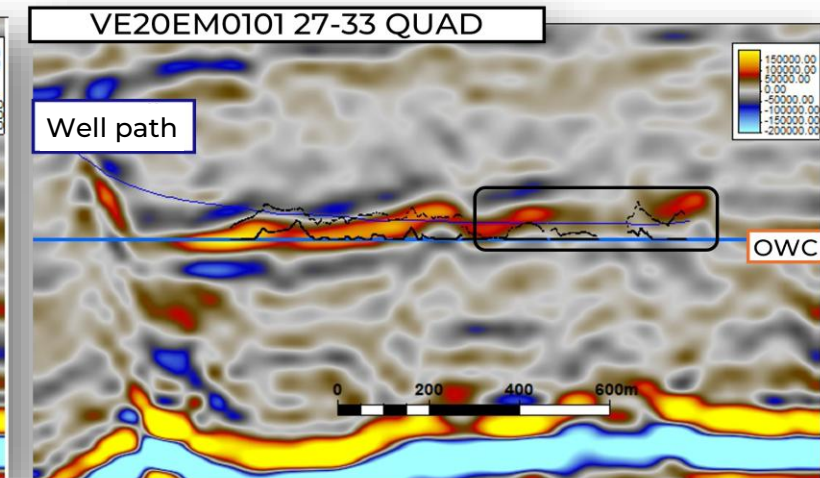
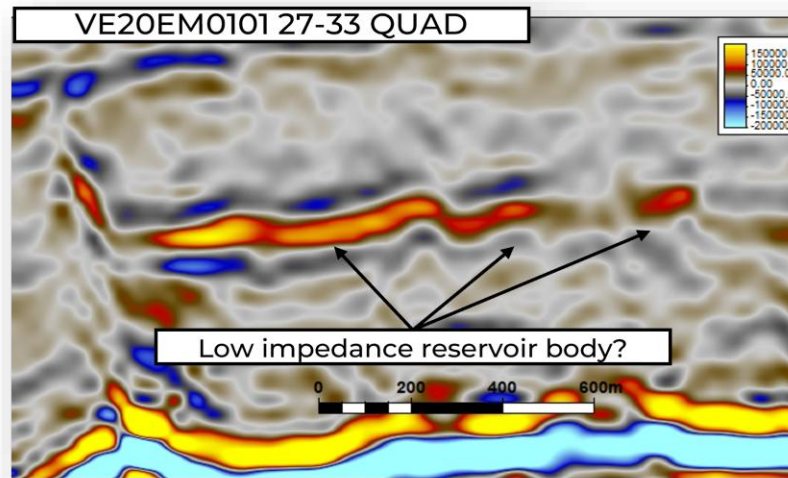
Static Model – Post-Drill



- Well planned using Legacy streamer data
- OBN indicates deeper sands, below OWC, in second half of well
- 3D Ultra Deep Azimuthal Resistivity (UDAR) validates OBN
- Well shortened and model updated accordingly

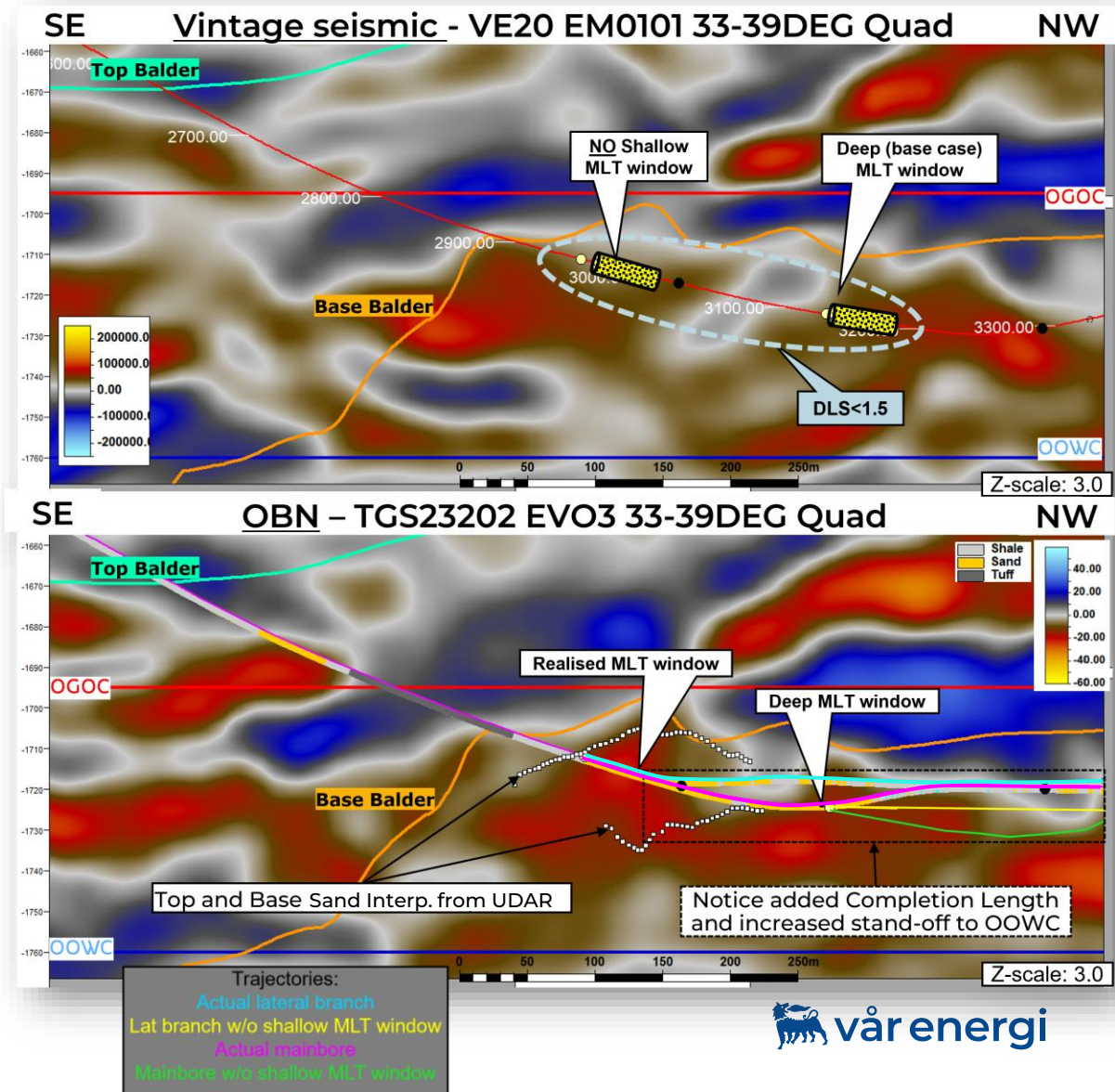
Well planning

- New infill candidate too uncertain from vintage seismic
- High confidence gained with OBN data allowed to lower uncertainties and accelerate planning
- **Avoided idle rig**
- OBN data showed additional potential by extending the well path by ~500 m (despite additional drilling risks – wellbore stability)
- **Approx 1/3 extra reserves**



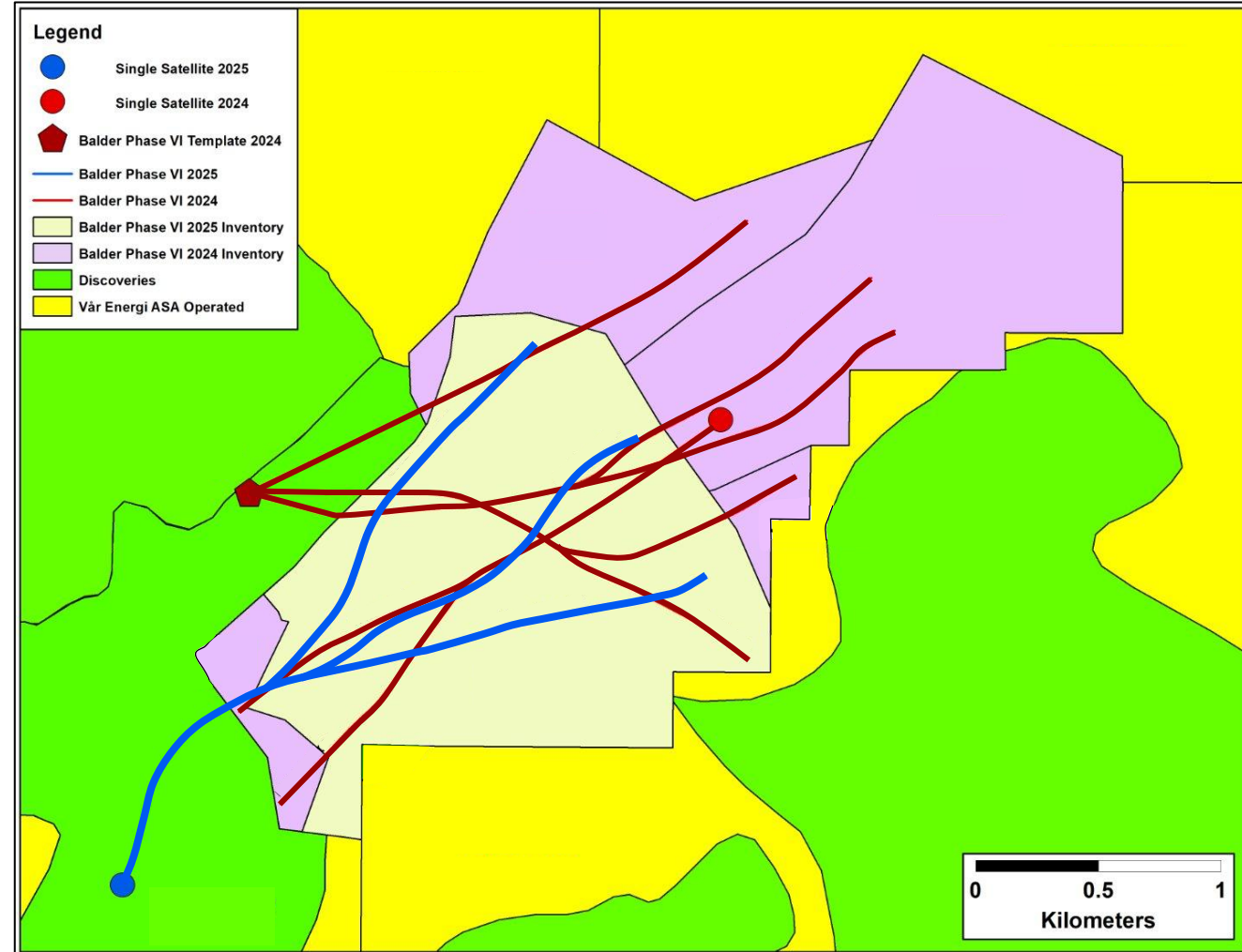
MLT junction planning and landing

- Requirements for Multi-Lateral (MLT) junction placement:
 - 40m continuous sand section
 - 3m sand thickness above the MLT window
 - Tangent section – DLS < 1.5
- Initial well planning (legacy seismic): deep MLT window
- With OBN: shallow window
- 15% extra completion in Main branch, 5% for the Lateral
- Maximize stand-off from the first completion segment in the Mainbore and Lateral, ca. 12m shallower



Project reframing

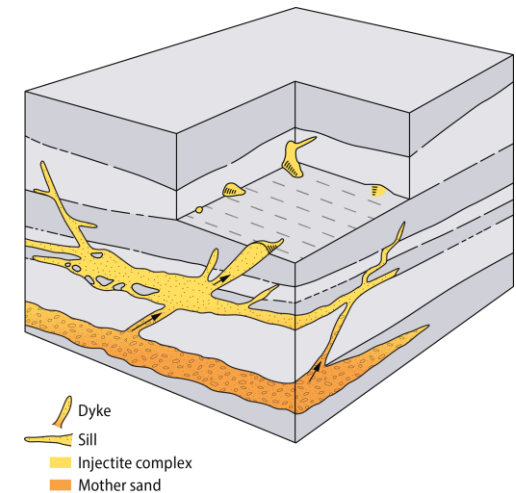
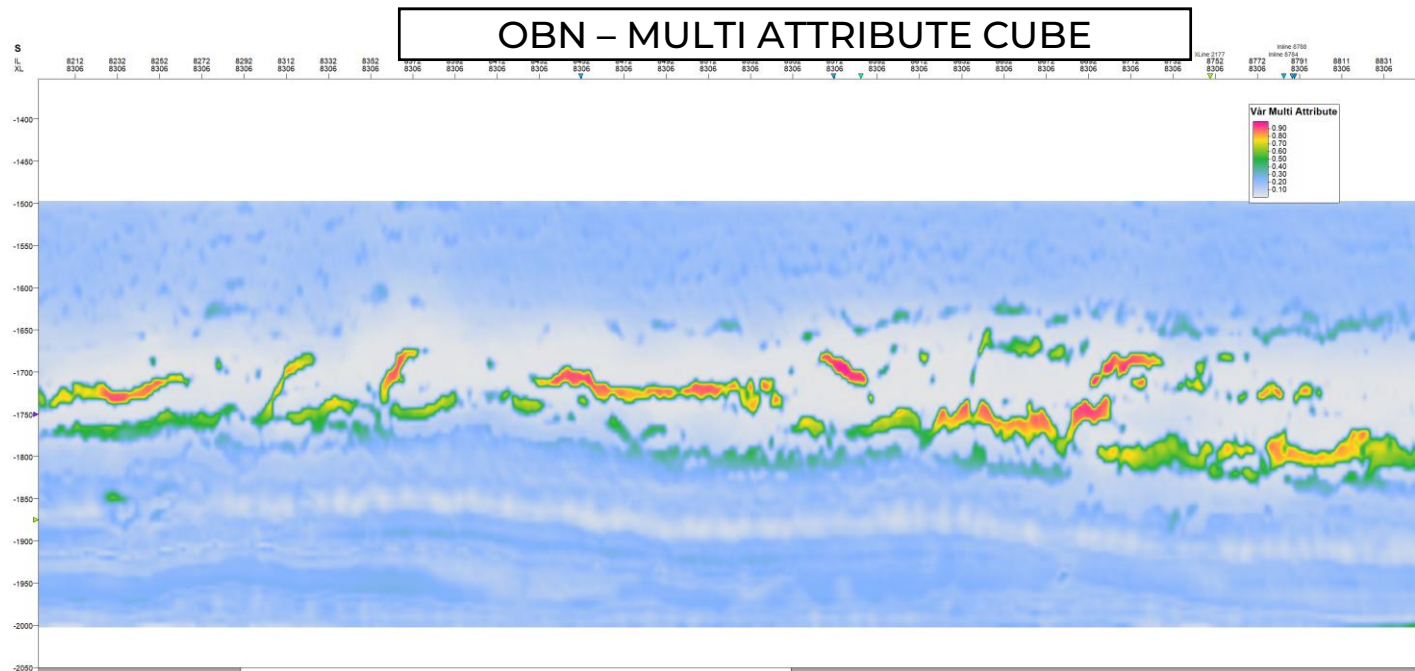
- Project to develop new area of the field
- Project scope 2024 (legacy seismic)
 - One template (1 mono, 2 dual)
 - One satellite (dual)
- OBN: overall slight reduction of volumes but more favourable resource distribution and density
- Project reframing 2025 (OBN)
 - One satellite (Tri-lateral)
 - >50% Capex reduction
 - Profitability (IRR) almost doubled



Indirect Value

Improved data quality from OBN helped developing new ML-based workflows

- Automated injectite geobody extraction is greatly improved by clearer injectite imaging and delineation
- Better amplitude definition enabled improving sand thickness prediction and standardise uncertainty estimation
- Faster and better results thanks to ML-ready data



Summary

- New OBN data at Balder has brought significant value, in different areas:
 - Target maturation
 - Detailed well planning and design
 - Project (re)framing
 - ML workflows
- Approval of major seismic investments can be challenging and estimating value might be complex or subjective but probably often underestimated
- Even after 25 years of production and multiple development phases, we can still improve our subsurface characterization and understanding, and create value from new data

Acknowledgements

- Many colleagues from Balder Subsurface for demonstrating the value of OBN data and providing examples
- Vår Energi and partner Kistos for permission to publish



- TGS and Viridien for permission to show data examples



Thanks for your attention

