

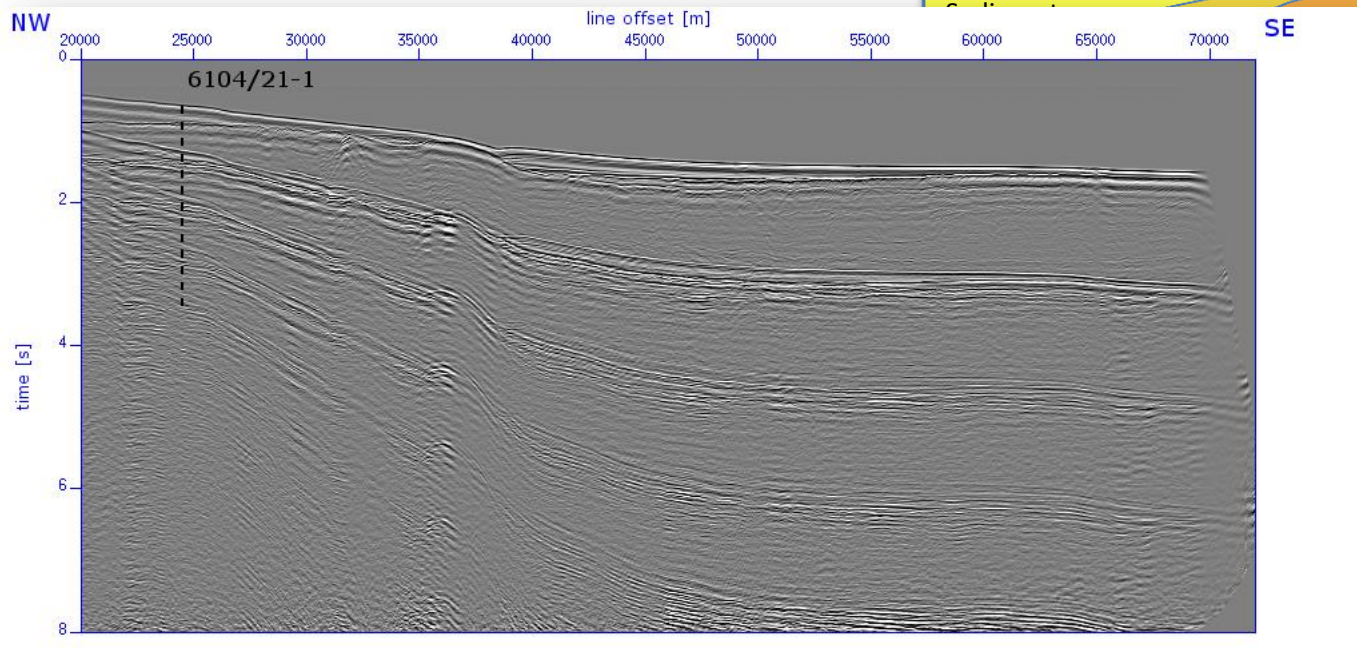
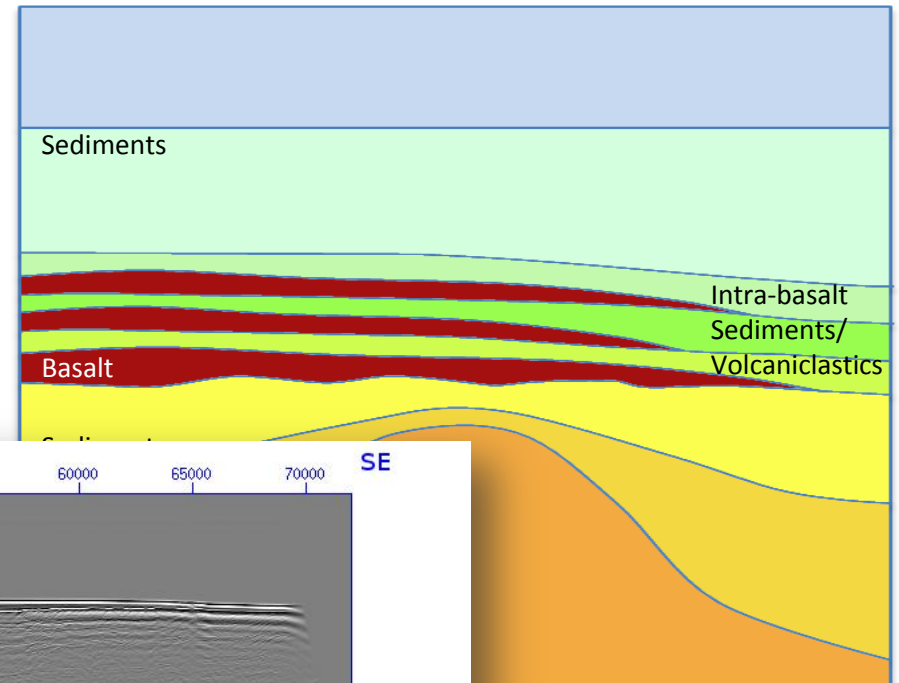
Sub-basalt imaging, using CSEM & MT to constrain the velocity model

May 2014, ROSE meeting

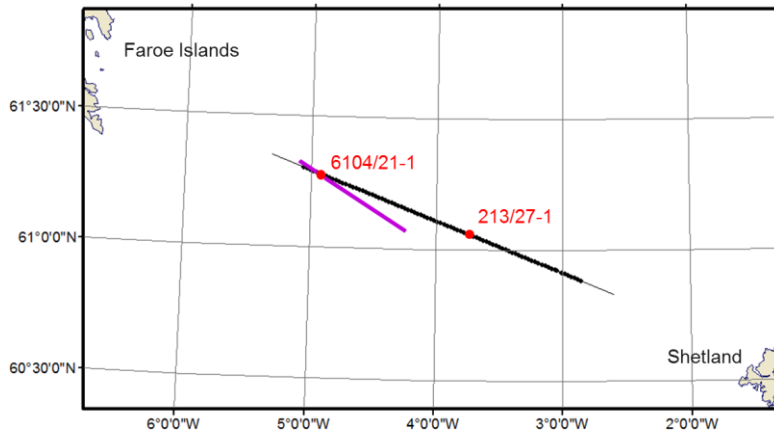
Martin Panzner, Wiktor W. Weibull, Jan Petter Morten

Seismic imaging challenges when basalt is present

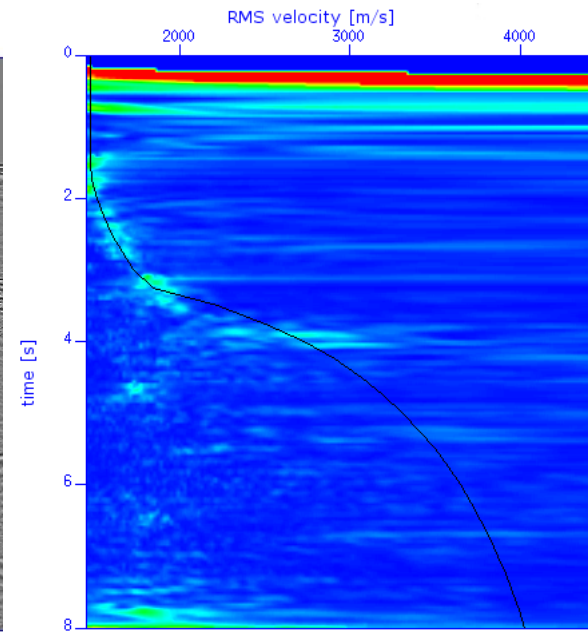
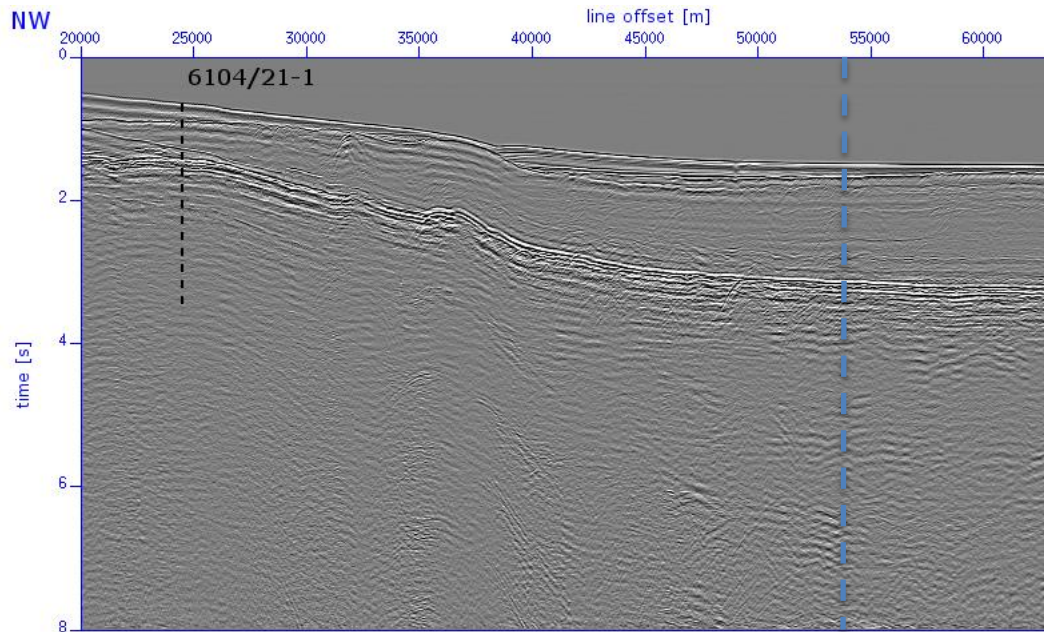
- Strong impedance contrast at top basalt interface
- Weak sub-basalt reflections
- Interbed multiples
- Rough top and base basalt interfaces can cause complicated



Seismic imaging – West of Shetland

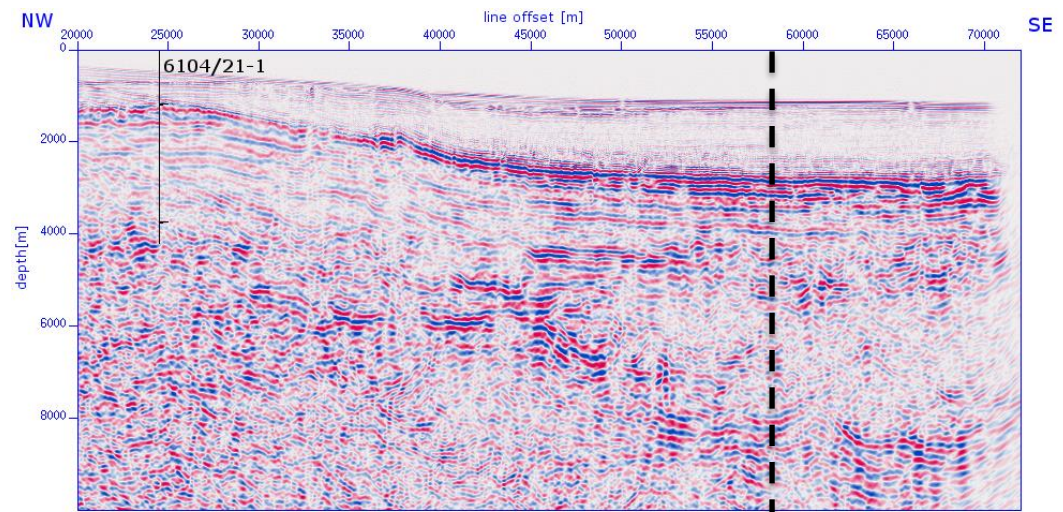
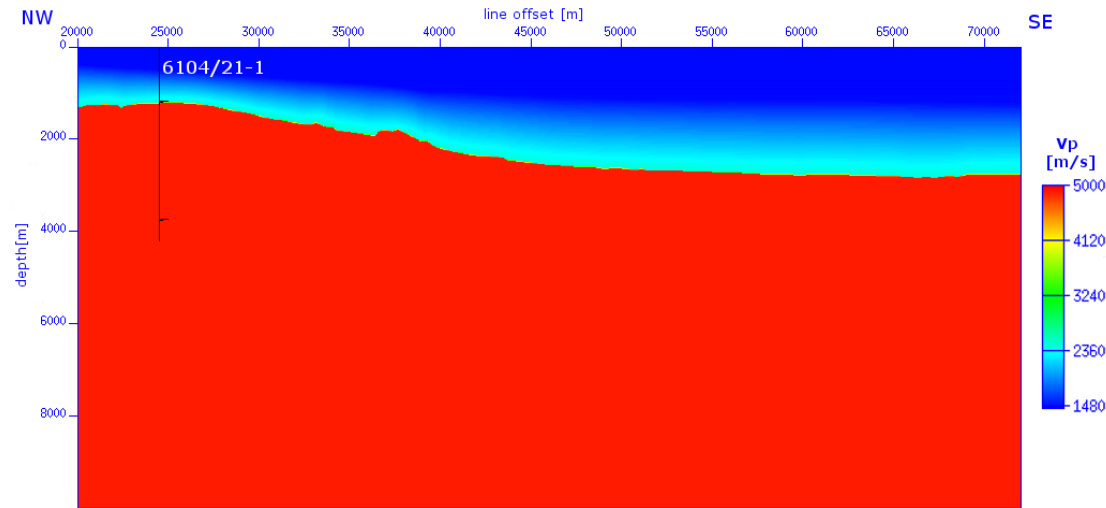


- Velocity analysis
 - Difficult to pick velocities from data below top basalt



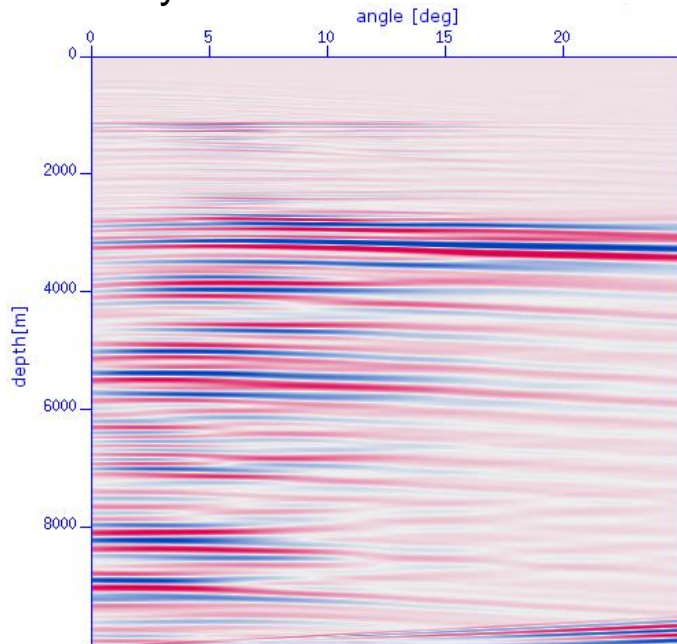
Seismic imaging – West of Shetland

- Supra-basalt sediments from semblance analysis
- Below top basalt flooded with average basalt velocity from refracted waves

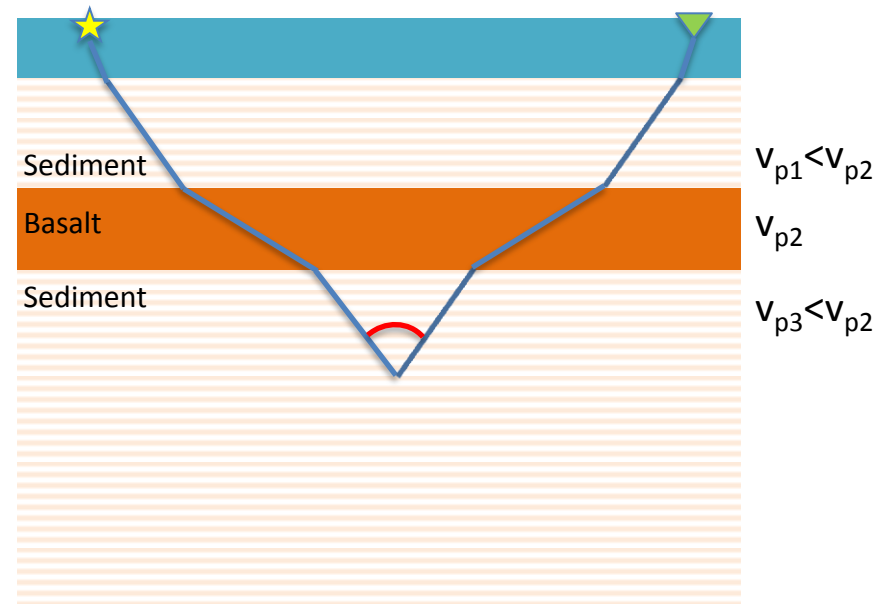


Seismic imaging – West of Shetland

- Sub-basalt reflections appear at small angles -> small moveout
- Difficult to use for velocity analysis

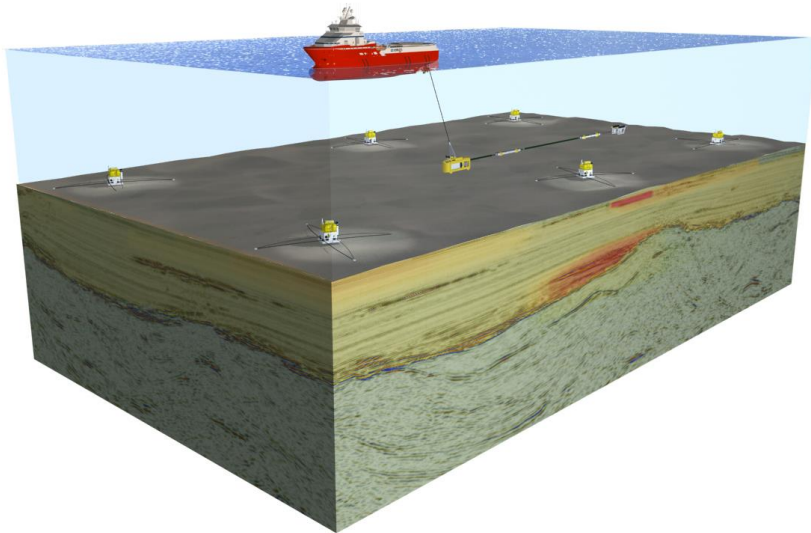


- Ray geometry:

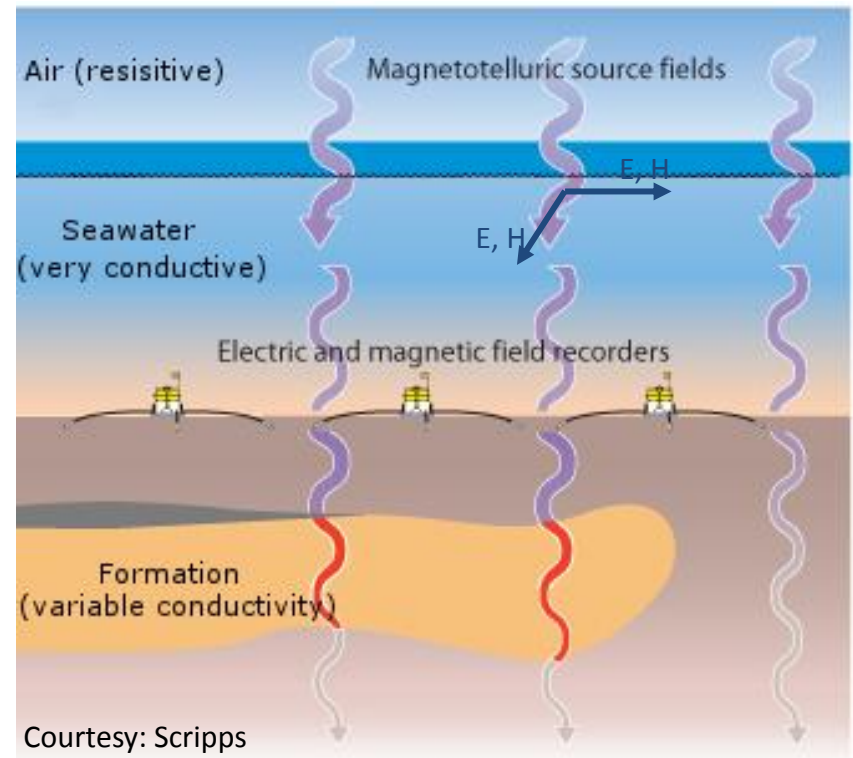


CSEM & MT basics

- Controlled Source Electromagnetic Method (CSEM)

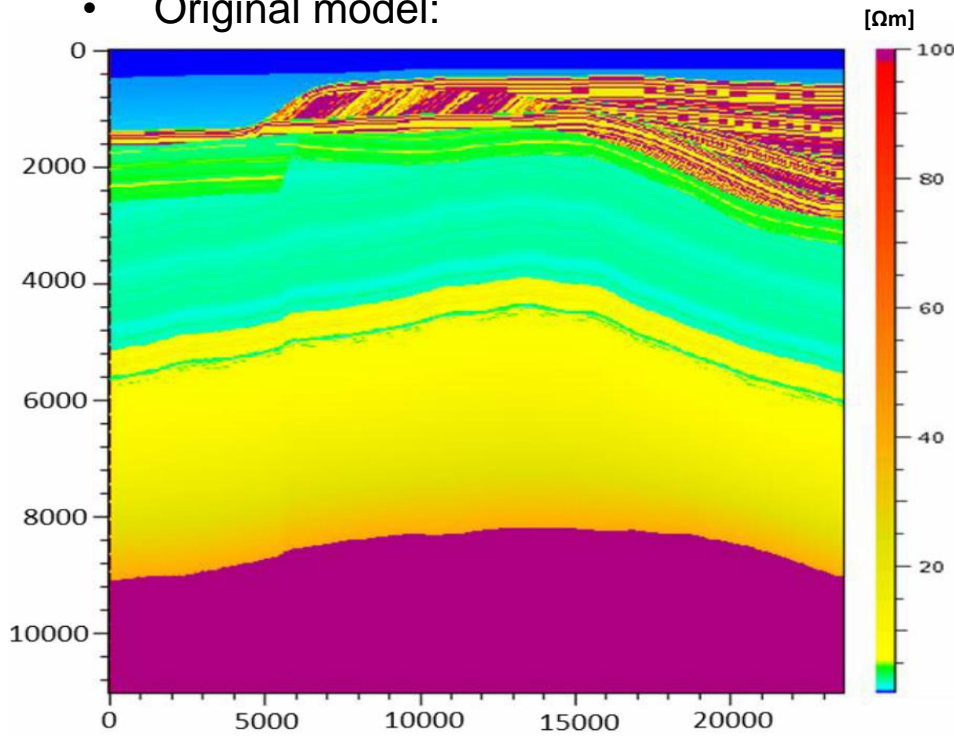


- Magnetotellurics (MT)

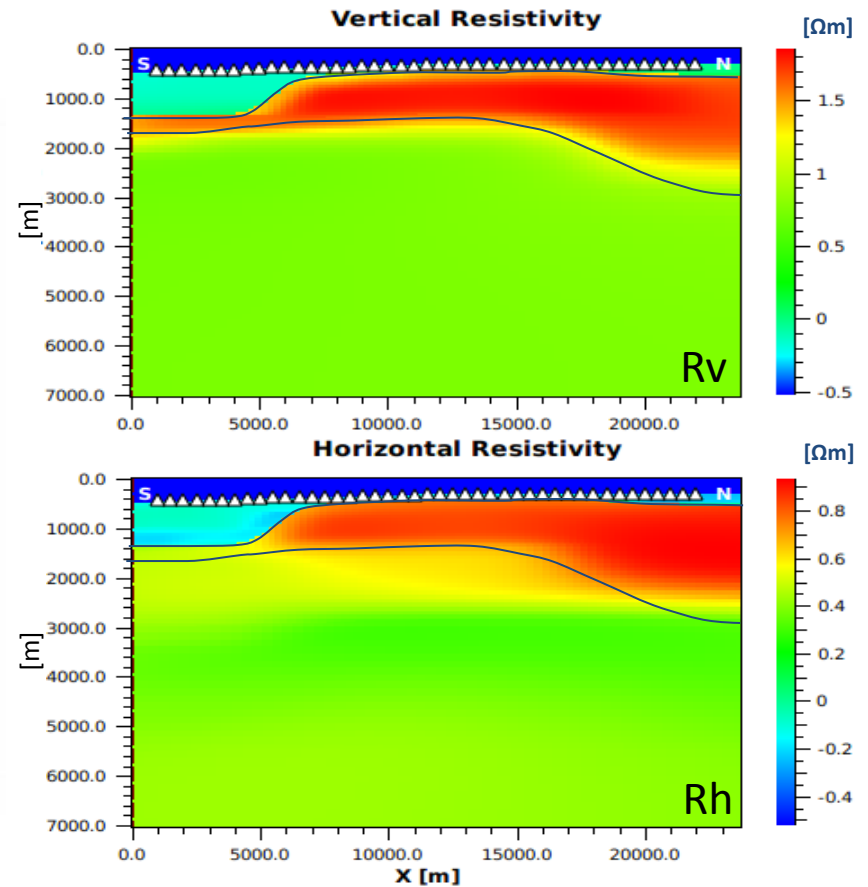


CSEM inversion– synthetic study

- Synthetic study by Herredsvela et al. (2012)
- Original model:

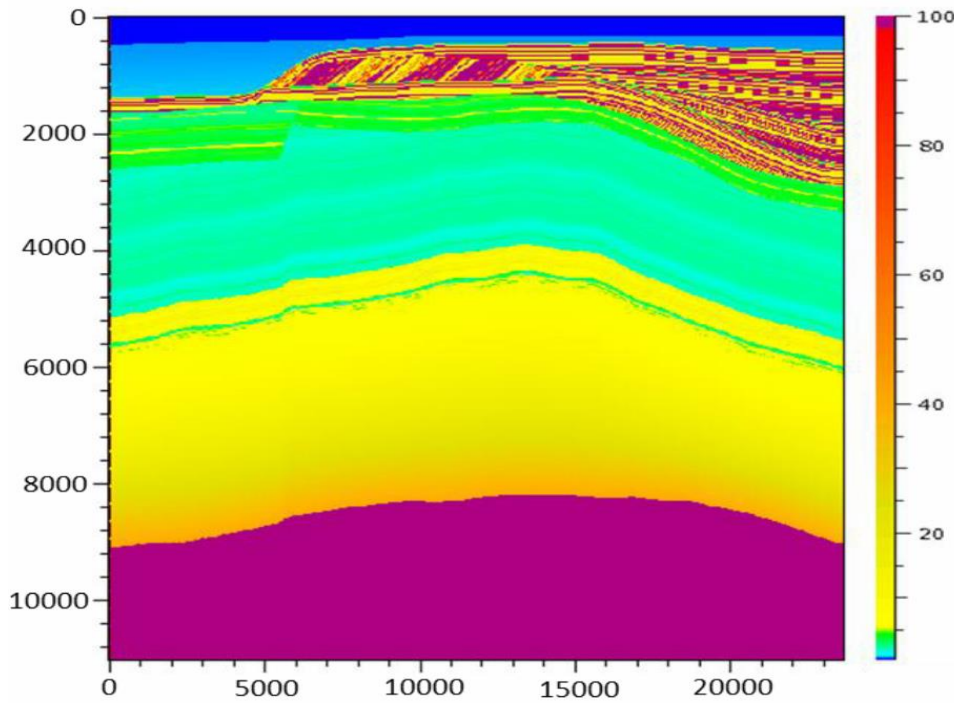


CSEM inversion result:

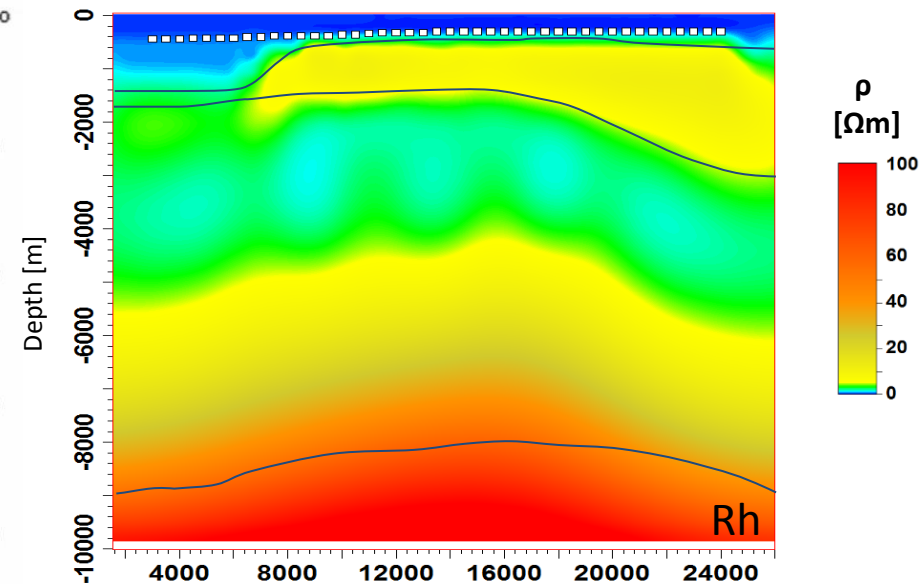


MT inversion– synthetic study

Original Model:

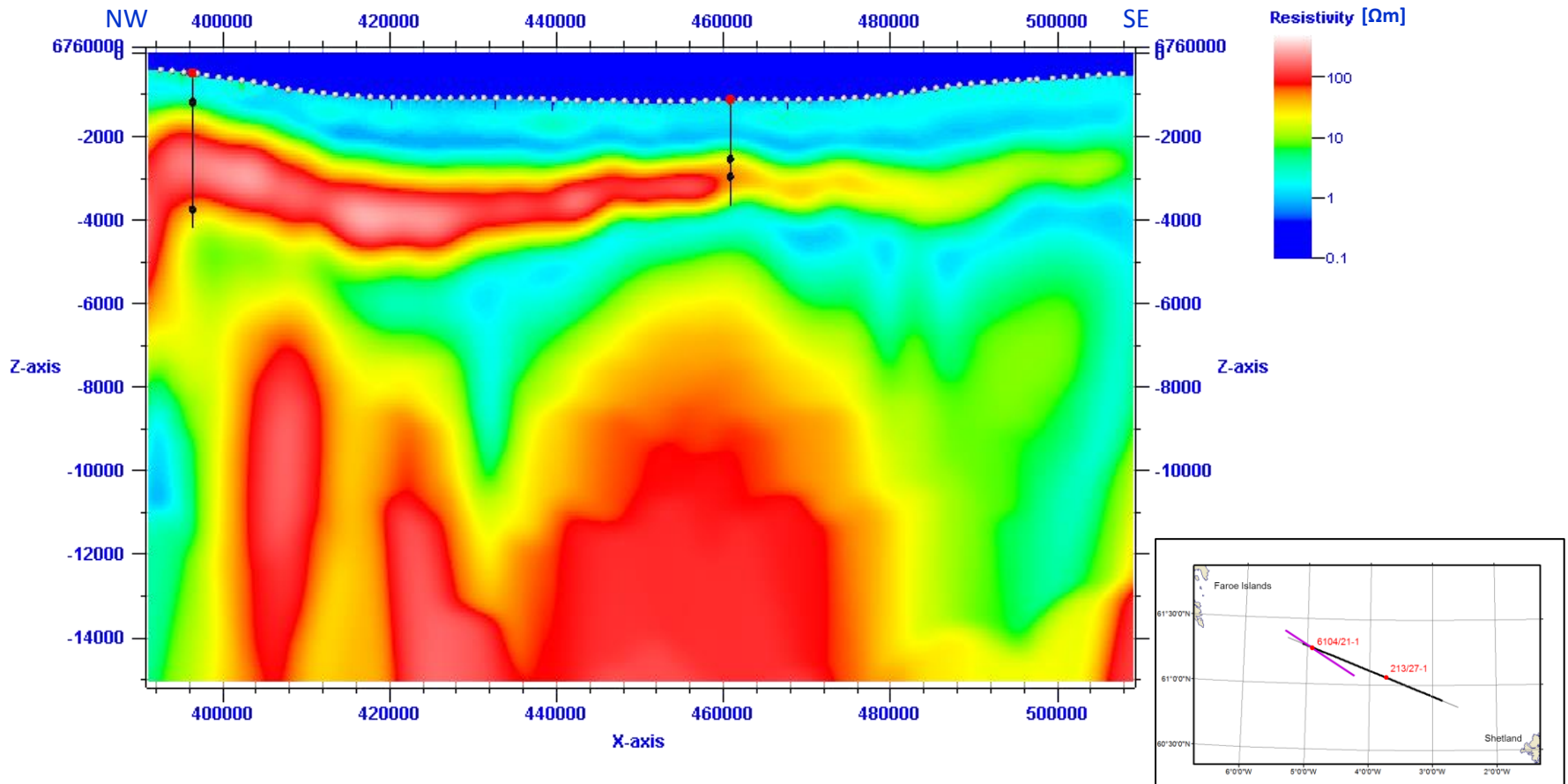


MT inversion result



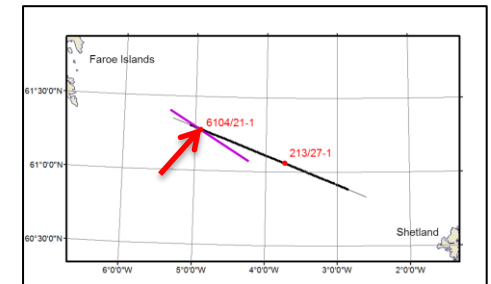
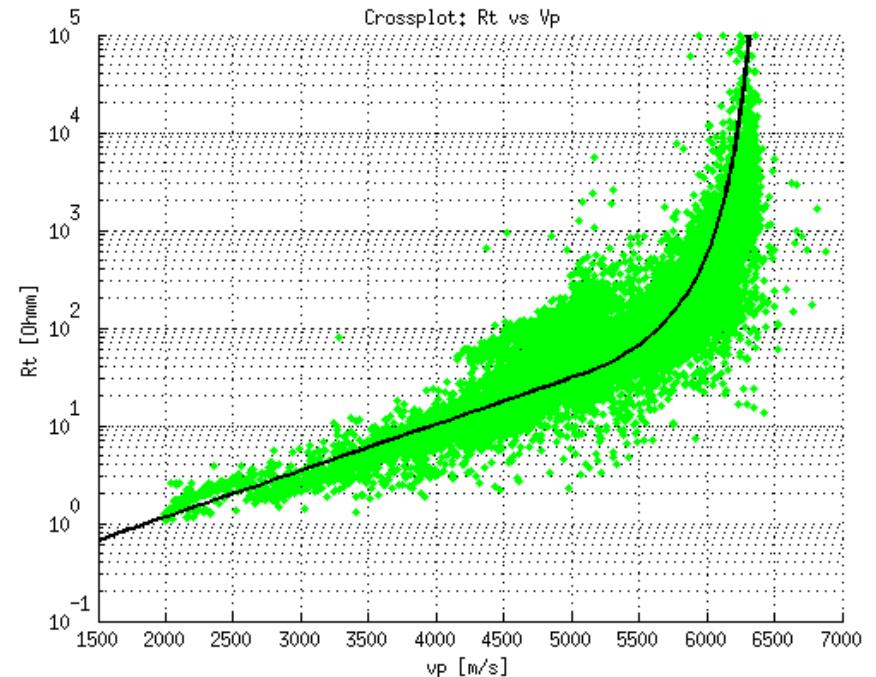
CSEM/MT imaging – West of Shetland

- Real data CSEM & MT joint inversion

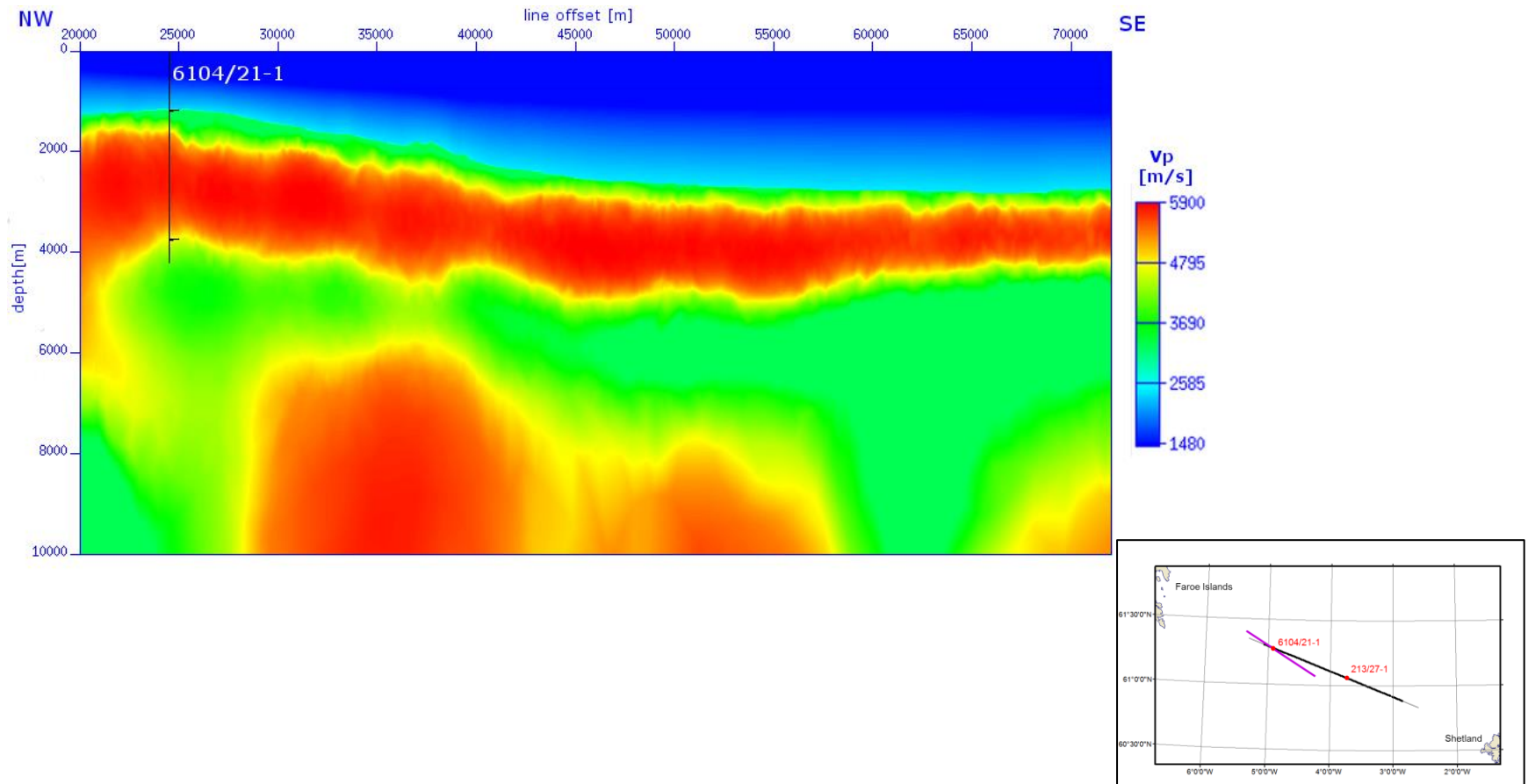


Well log analysis – correlation v_p and ρ

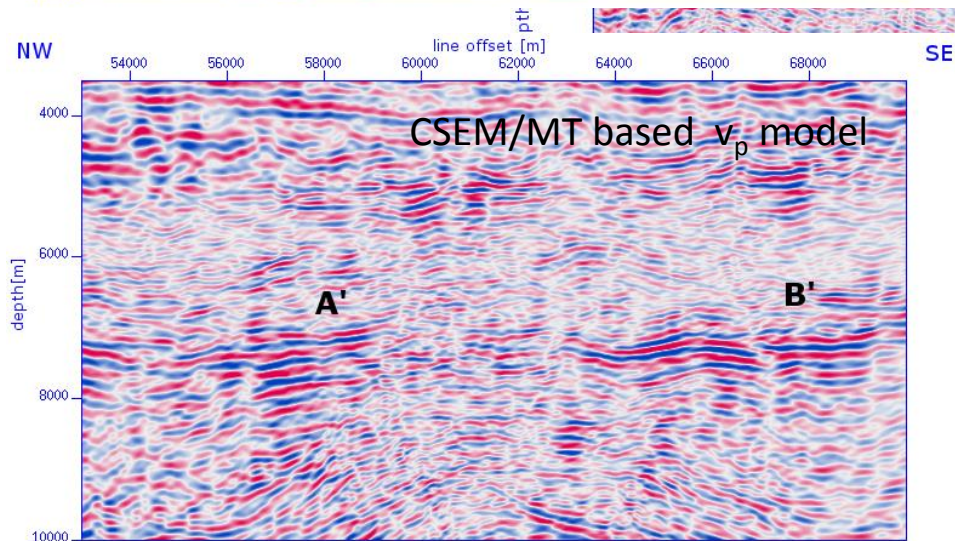
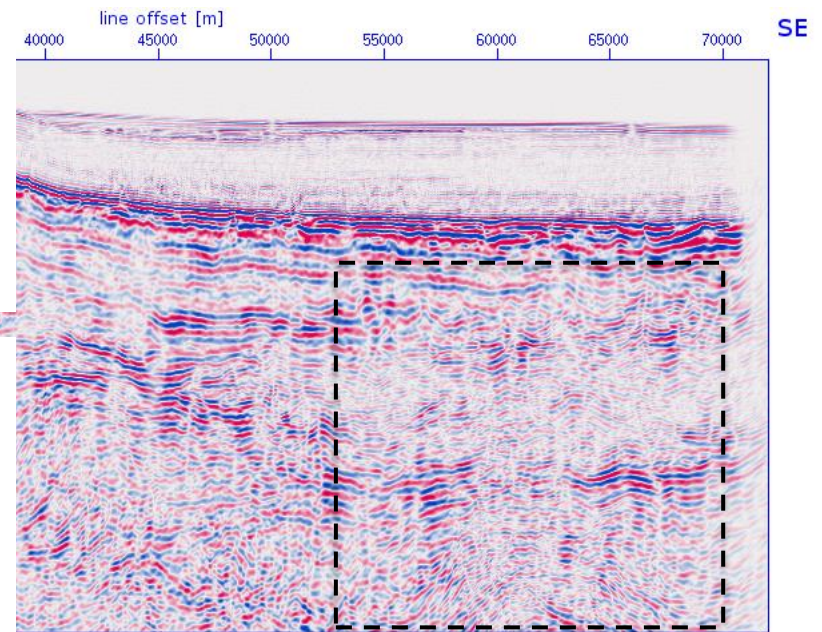
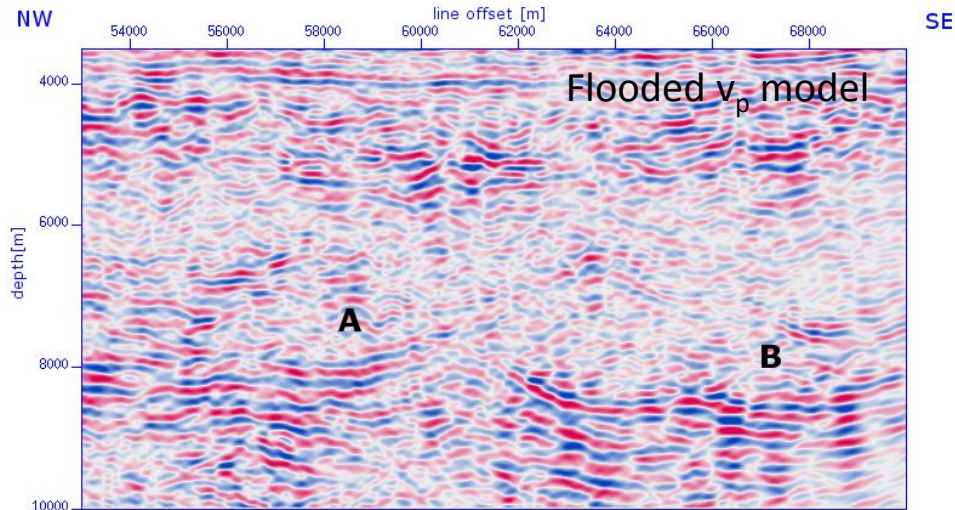
- Linear correlation for $v_p < 5000$, driven by the porosity and pore fluid properties
- Asymptotic behavior for $v_p > 5000$, driven by the matrix properties
- $\delta v_p(\rho)/v_p \ll \delta \rho(v_p)/\rho$



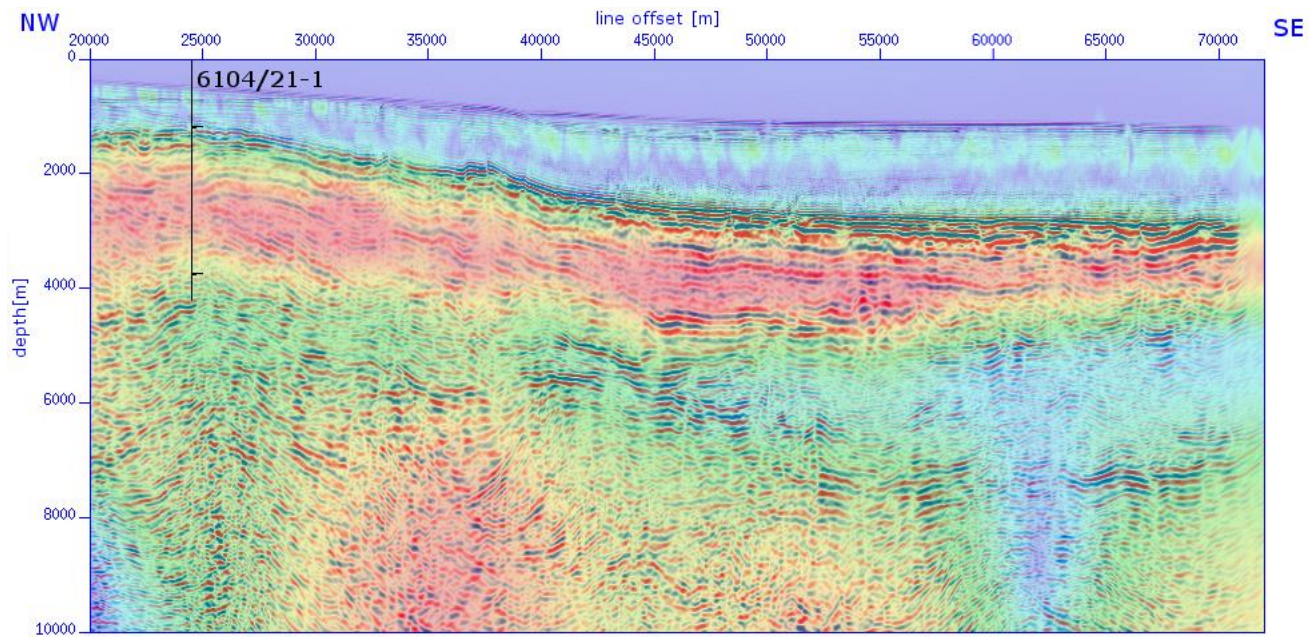
Updated velocity model



Improved seismic image - detail



Correlation CSEM/MT and Seismic



Discussion

- $v_p - \rho$ correlation from the well
 - Different lithology sub basalt, not necessarily the same correlation
 - Measured at well “log scale”
 - Also valid on “CSEM/Seismic scale” ?
- Geometry
 - CSEM line not at same location as Seismic line
- Seismic data quality
 - Available dataset very coarse sampled

Conclusions

- Resistivity models from CSEM & MT inversion can be used to map the thickness and extend of basalt layers
- The resistivity model can also be used to update the velocity model using v_p - ρ correlations from a nearby well
- Co-visualization can improve the seismic interpretation

Acknowledgements

- We wish to thank EMGS for the permission to publish these results.
- Børge Arntsen and the seismic depth imaging group at the IPT department at the Norwegian University of Science and Technology (NTNU)
- Rune Mittet at EMGS for interesting discussions.