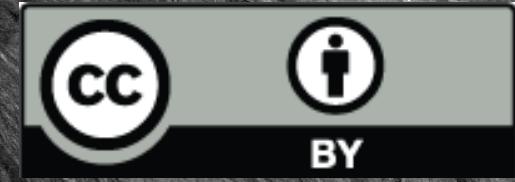
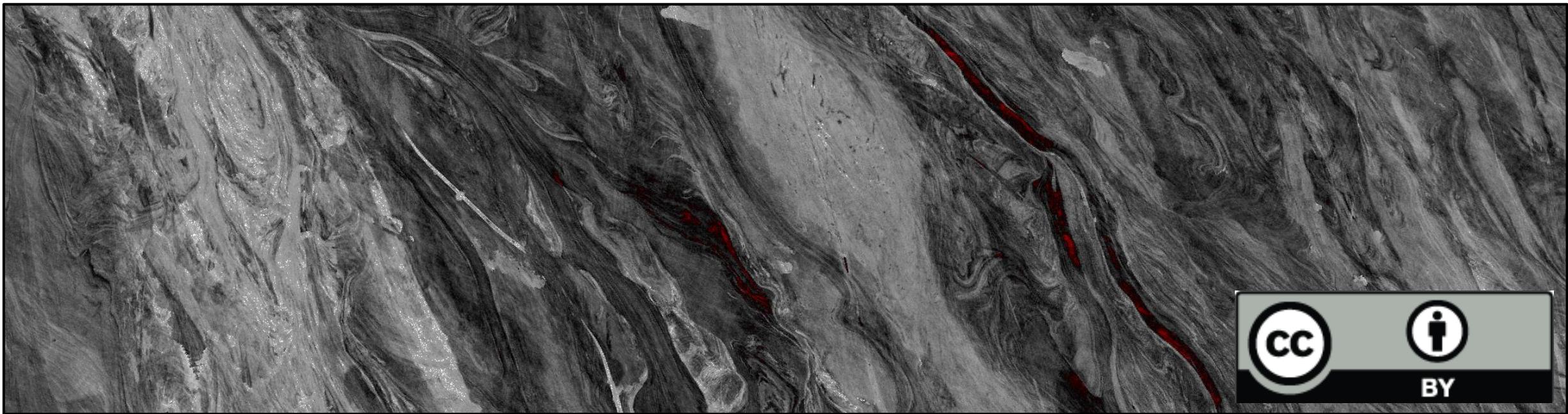


Extensive, Gas-Charged Quaternary Sand Accumulations of the Northern North Sea and North Sea Fan



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Abstract

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Sediments deposited by marine-based ice sheets are dominantly fine-grained glacial muds, which are commonly known for their sealing properties for migrating fluids. However, the Peon and Aviat hydrocarbon discoveries in the North Sea show that coarse-grained glacial sands can occur over large areas in formerly glaciated continental shelves. In this study, we use conventional and high-resolution 2D and 3D seismic data combined with well information to present new models for large-scale fluid accumulations within the shallow subsurface of the Norwegian Continental Shelf. The data include 48,000 km² of high-quality 3D seismic data and 150 km² of high-resolution P-Cable 3D seismic data, with a vertical resolution of 2 m and a horizontal resolution of 6 to 10 m in these data sets. We conducted horizon picking, gridding and attribute extractions as well as seismic geomorphological interpretation, and integrated the results obtained from the seismic interpretation with existing well data.

The thicknesses of the Quaternary deposits vary from hundreds of meters of subglacial till in the Northern North Sea to several kilometers of glaciogenic sediments in the North Sea Fan. Gas-charged, sandy accumulations are characterized by phase-reserved reflections with anomalously high amplitudes in the seismic data as well as density and velocity decreases in the well data. Extensive (>10 km²) Quaternary sand accumulations within this package include (i) glacial sands in an ice-marginal outwash fan, sealed by stiff glacial tills deposited by repeated glaciations (the Peon discovery in the Northern North Sea), (ii) sandy channel-levee systems sealed by fine-grained mud within sequences of glaciogenic debris flows, formed during shelf-edge glaciations, (iii) fine-grained glacimarine sands of contouritic origin sealed by gas hydrates, and (iv) remobilized oozes above large evacuation craters and sealed by megaslides and glacial muds. The development of the Fennoscandian Ice Sheet resulted in a rich variety of depositional environments with frequently changing types and patterns of glacial sedimentation. Extensive new 3D seismic data sets are crucial to correctly interpret glacial processes and to analyze the grain sizes of the related deposits. Furthermore, these data sets allow the identification of localized extensive fluid accumulations within the Quaternary succession and distinguish stratigraphic levels favorable for fluid accumulations from layers acting as fluid barriers.

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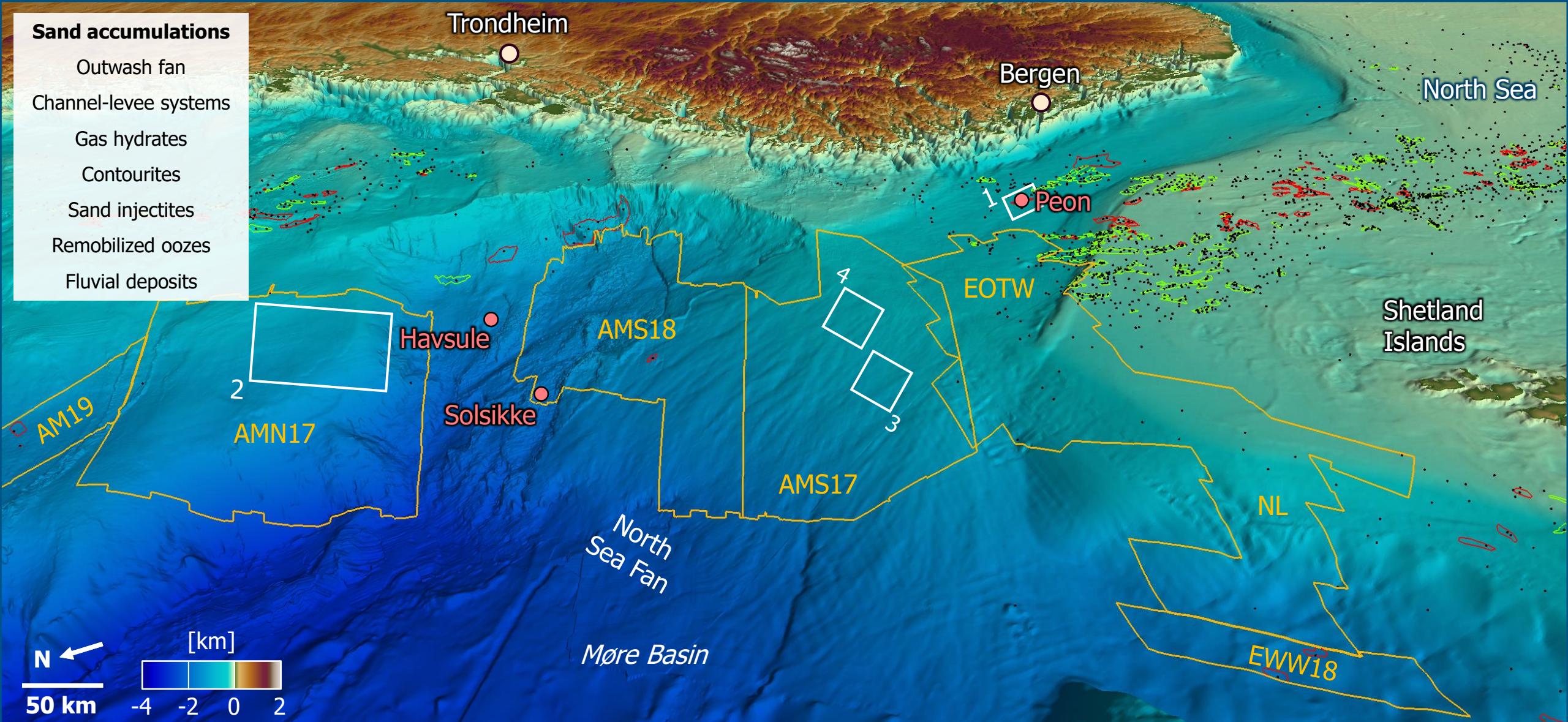
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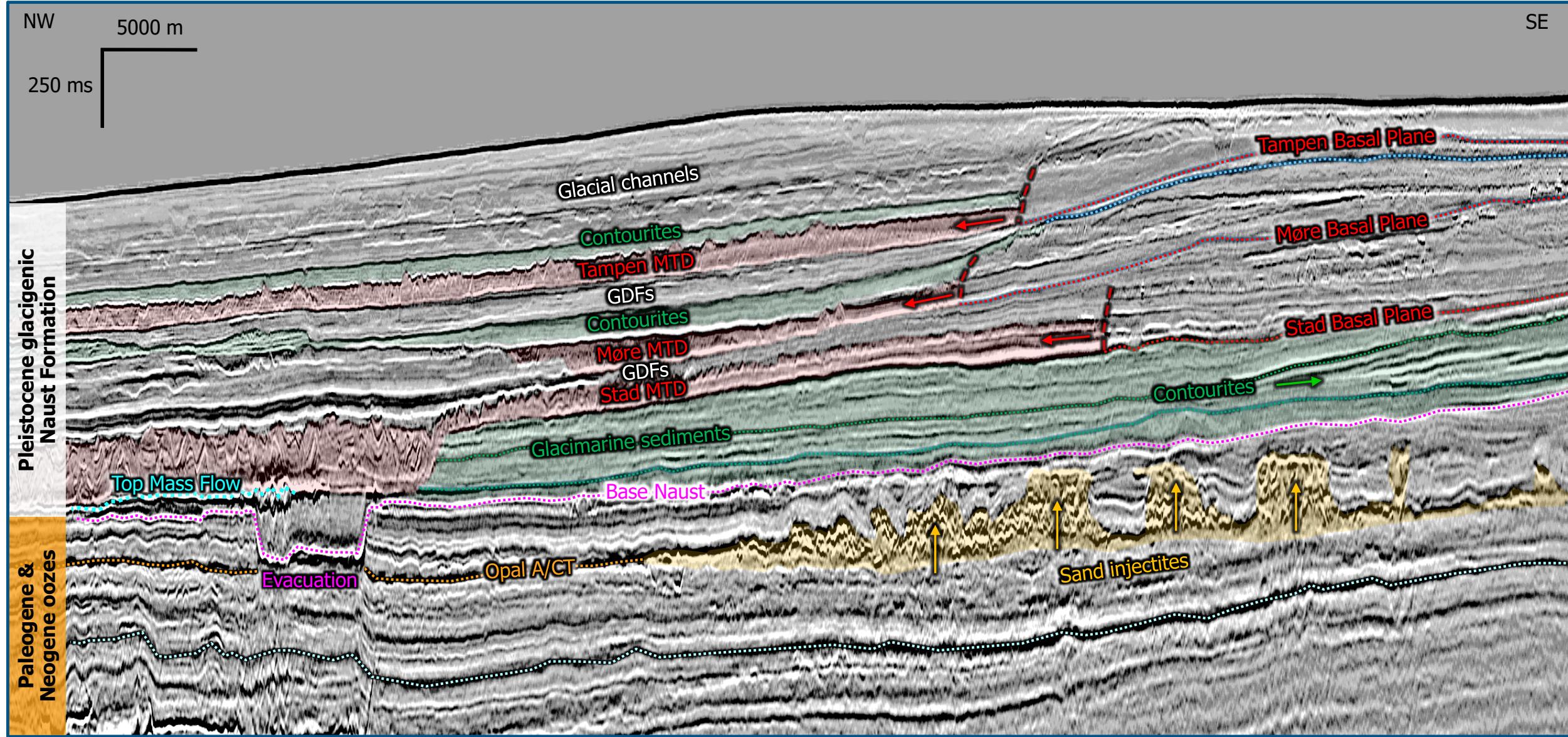
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Study Area

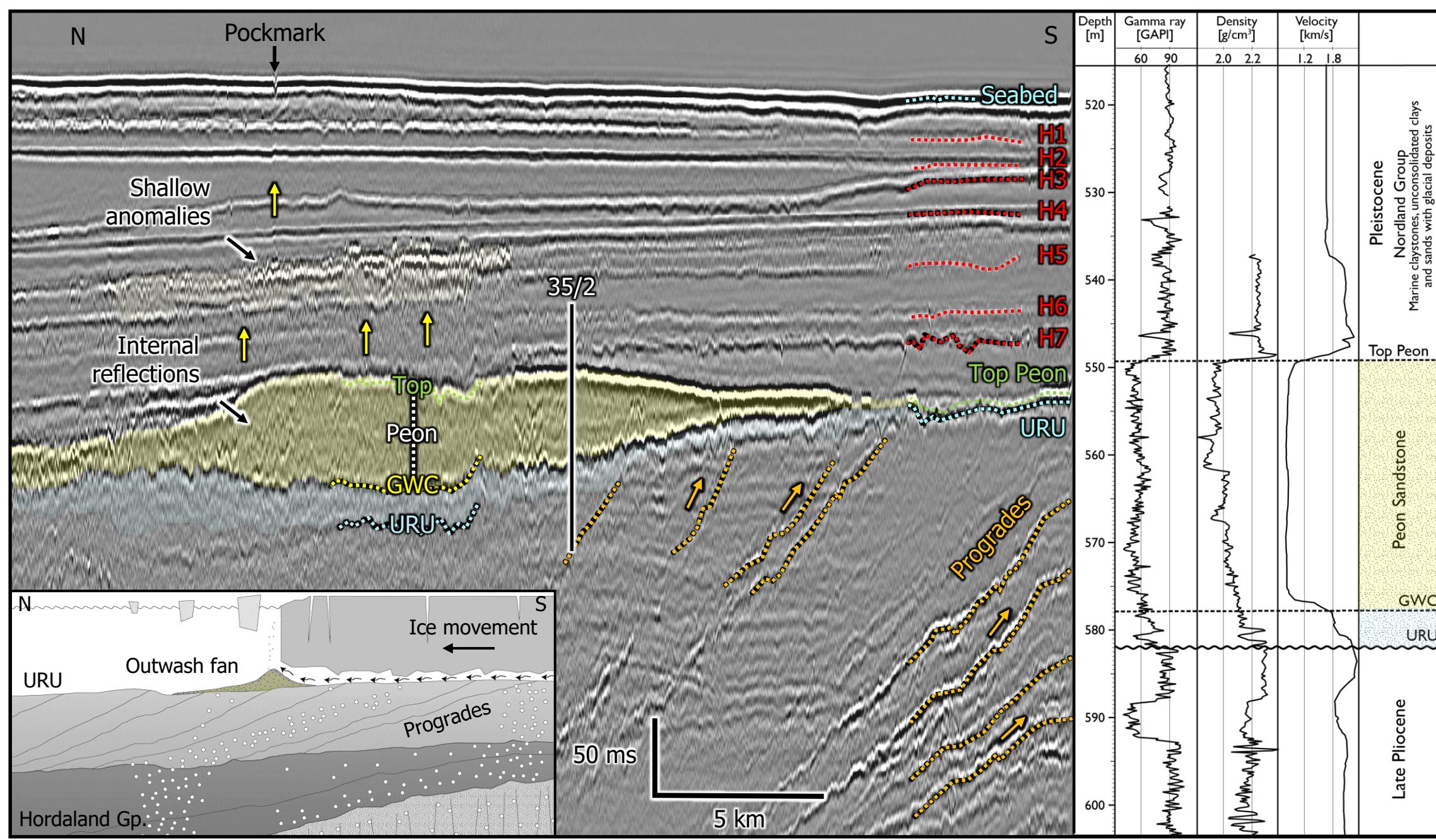


North Sea Fan: Glacial Stratigraphy



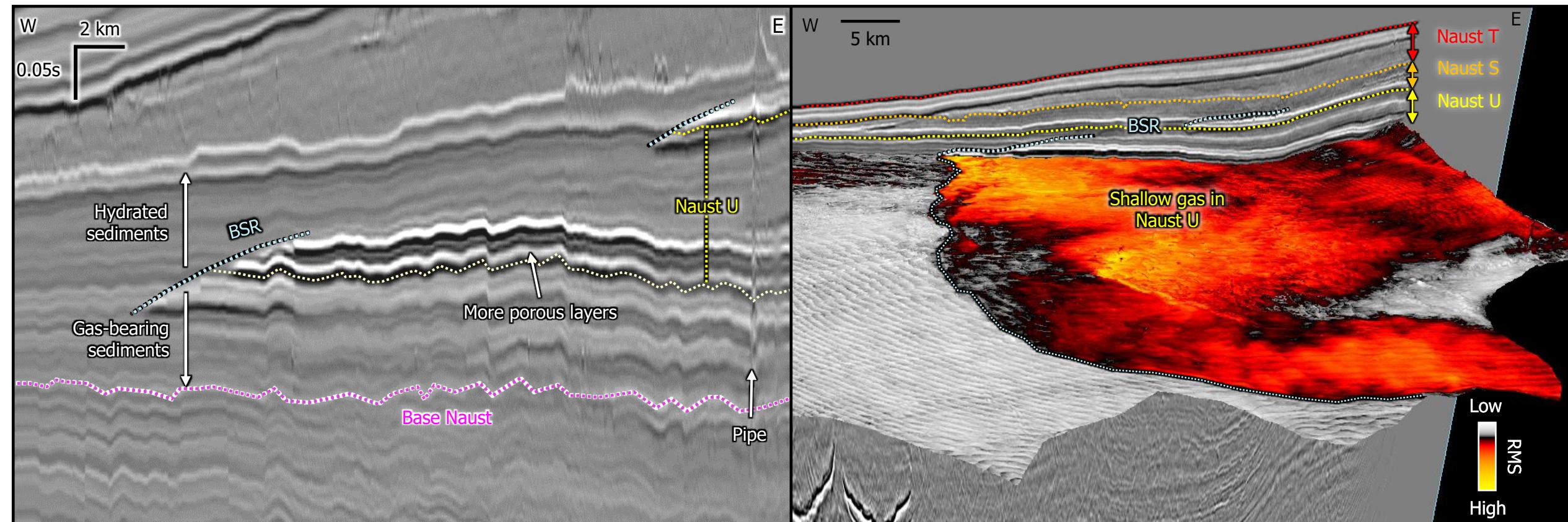
Well-tie Peon

Bellwald et al. (2020)



Shallow Gas below BSR

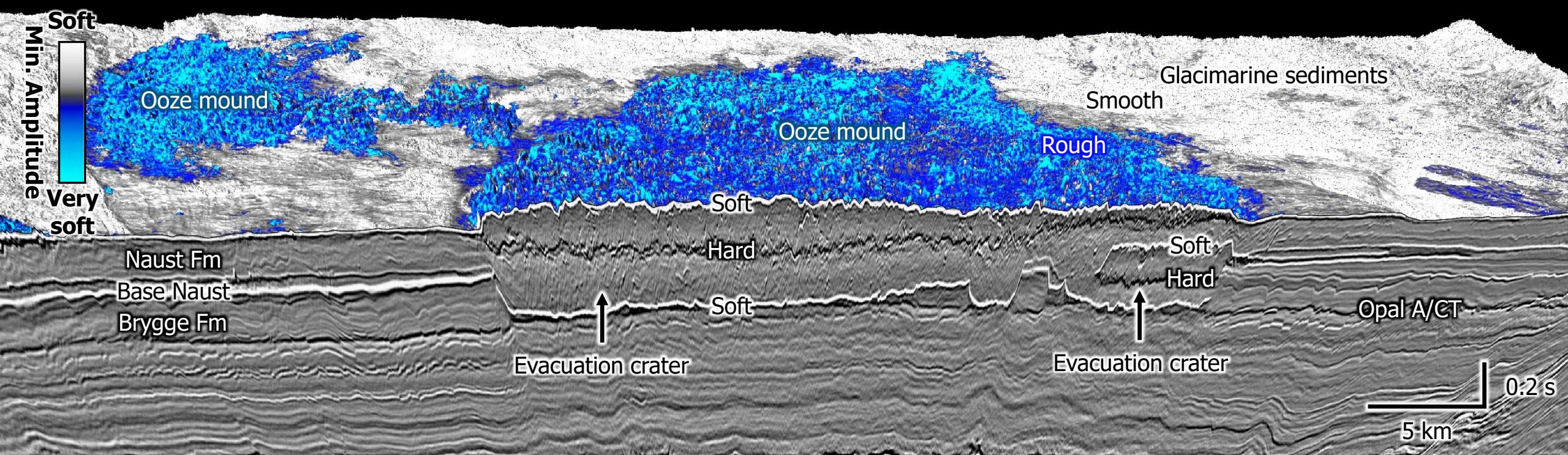
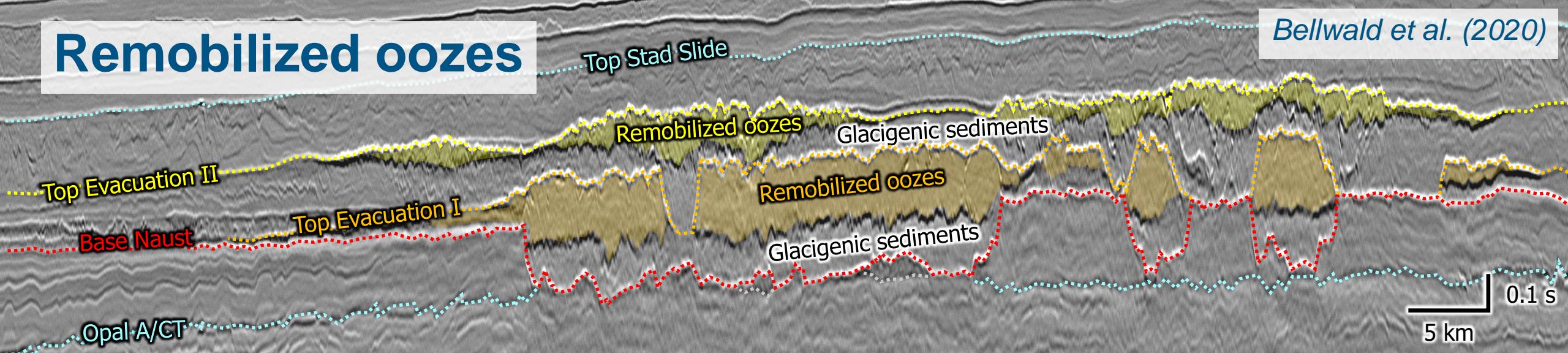
Bellwald et al. (2020)



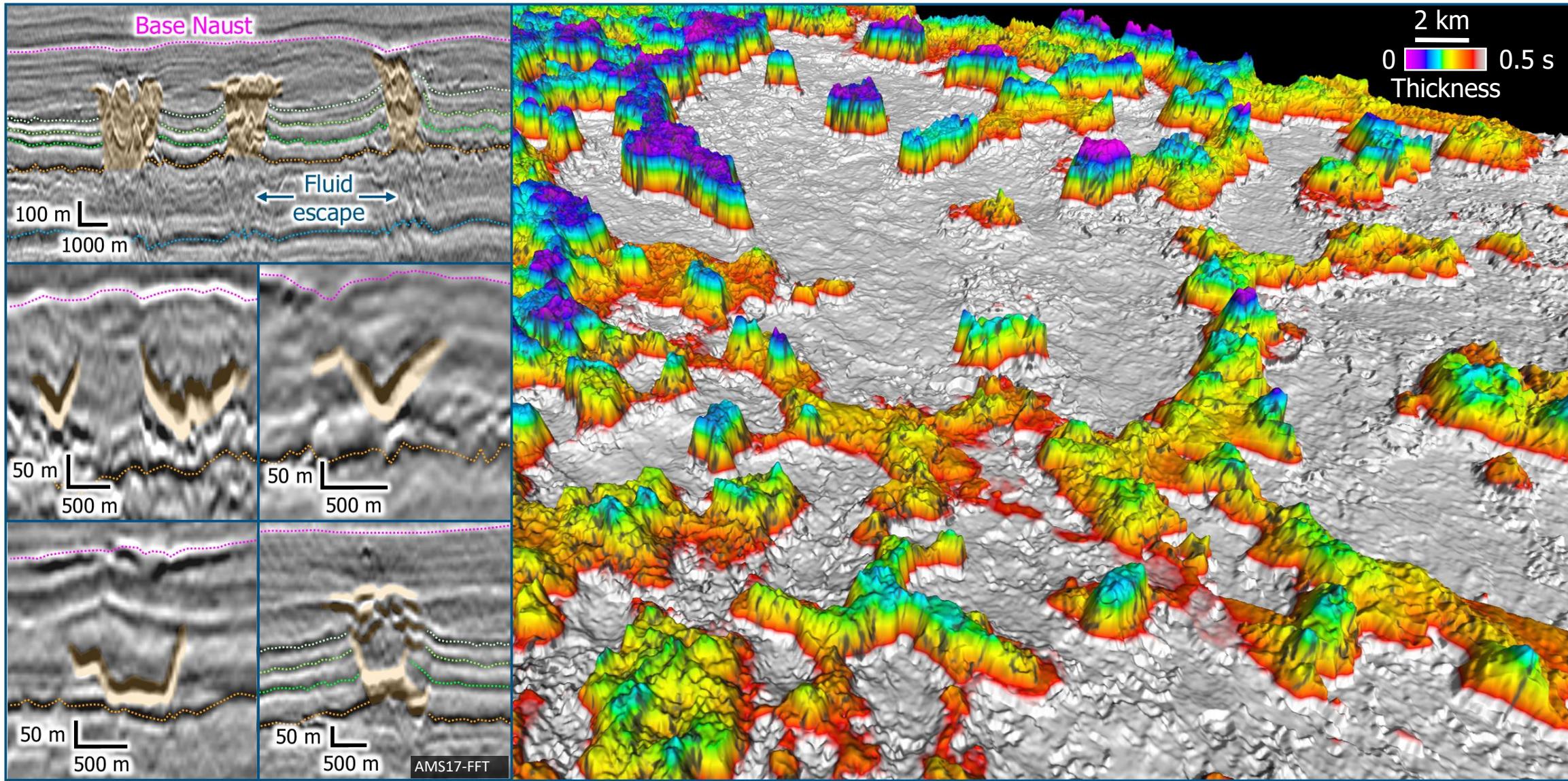
Fine-grained glacimarine sands of contouritic origin sealed by gas hydrates

Remobilized oozes

Bellwald et al. (2020)



Sand Injectites



Bellwald et al. (2020); Millett et al. (2020)

References

- Batchelor, C.L., Ottesen, D., Dowdeswell, J.A., 2017. Quaternary evolution of the northern North Sea margin through glacigenic debris-flow and contourite deposition. *Journal of Quaternary Science* 32(3), 416-426.
- Bellwald, B., Planke, S., Vadakkepuliyambatta, S., Buenz, S., Batchelor, C., Manton, B., Zastrozhnov, D., Myklebust, R., Kjølhamar, B., 2020. Quaternary and Neogene Reservoirs of the Norwegian Continental Shelf: Evidence from New 3D Seismic Data. *82nd EAGE Annual Conference and Exhibition 2020, Extended Abstracts 2020*.
- Buenz, S., Mienert, J., 2004. Acoustic imaging of gas hydrate and free gas at the Storegga Slide. *Journal of Geophysical Research, Solid Earth* 109(B4).
- Lawrence, G.W.M., Cartwright, J.A., 2010. The stratigraphic and geographic distribution of giant craters and remobilised sediment mounds on the mid Norway margin, and their relation to long term fluid flow. *Marine and Petroleum Geology* 27(4), 733-747.
- Millett, J.M., Manton, B.M., Zastrozhnov, D., Planke, S., Maharjan, D., Bellwald, B., Gernigon, L., Faleide, J.I., Jolley, D., Walker, F., Abdelmalak, M.M., Jerram, D.A., Myklebust, R., Kjølhamar, B.E., Halliday, J., Birch-Hawkins, A., 2020. Basin Structure and Prospectivity of the NE Atlantic Volcanic Rifted Margin: Cross-border examples from the Faroe-Shetland, Møre and Southern Vørings Basins. *Geological Society of London, Special Publications*, 495.
- Riis, F., Berg, K., Cartwright, J., Eidvin, T., Hansch, K., 2005. Formation of large, crater-like structures in ooze sediments in the Norwegian Sea. Possible implications for the development of the Storegga Slide. *Marine and Petroleum Geology* 22, 257-273.