

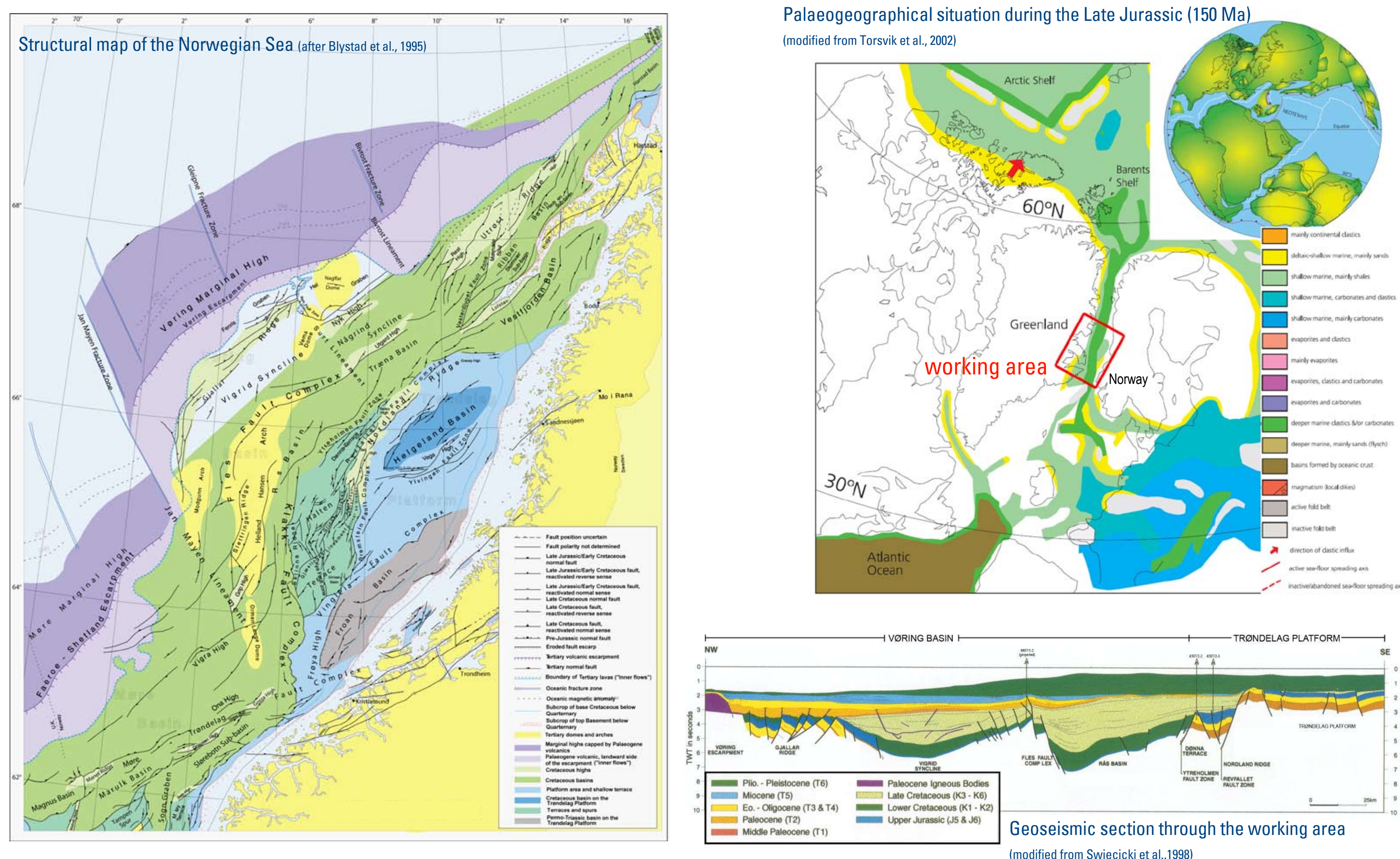
3D Source Rock Modelling of the Late Jurassic Vøring Basin off Mid-Norway

Maik Inthorn¹, Janine Zweigel², Ute Mann¹

¹SINTEF Petroleum Research, Trondheim, Norway; ² now at Statoil ASA, Stjørdal, Norway

An underexplored petroleum province

The greater Vøring Basin off mid-Norway, close to the well established petroleum plays of the Dønna and Halten Terraces, has **high potential for petroleum prospectivity**. It remains under-explored, although several discoveries of mainly gas but also oil were made in the last few years. One **important risk-factor** for the area is the presence or absence of an **effective source rock**.



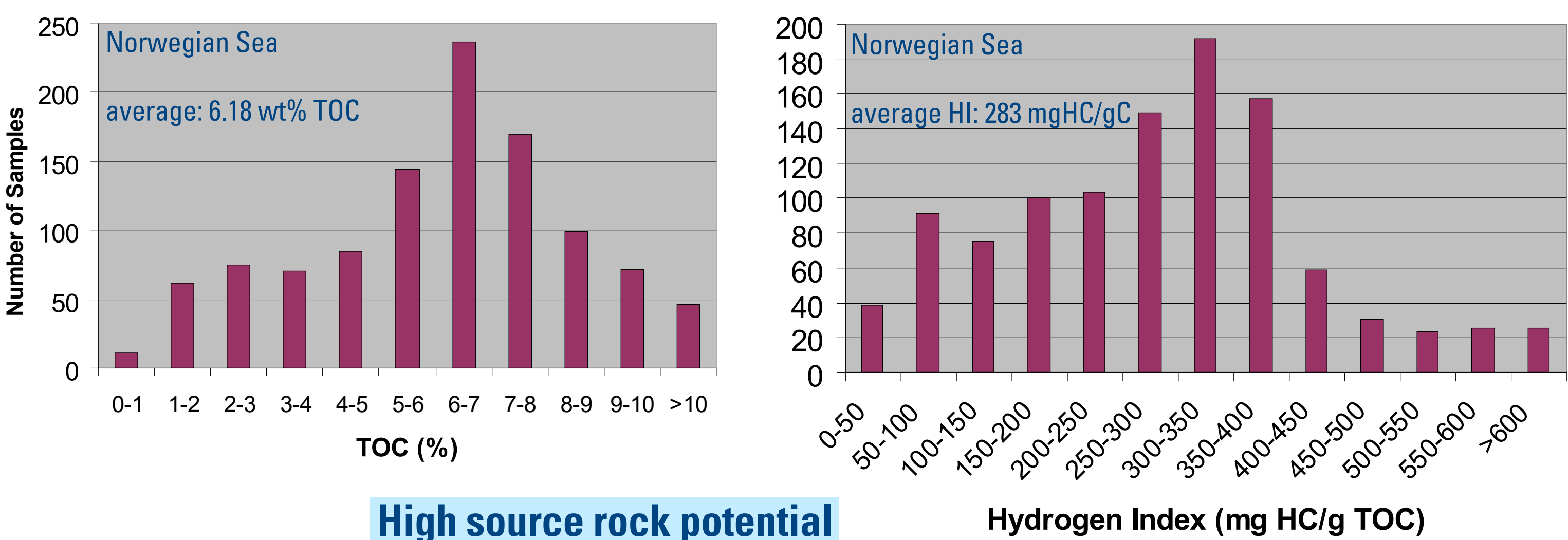
Spekk Formation source rock

- * **Equivalent to the Kimmeridge Clay** and Draupne formations of the North Sea
- * Only source rock off mid-Norway proven capable of generating significant quantities of oil
- * Covered by 9000 to 13000 m of Cretaceous and Tertiary sediments in the central parts of the Vøring Basin (Brekke, 2000) -> **overmature**
- * **Higher chances** for prospectivity suggested **at local highs** and **at the western flank** of the basin where the overburden is less - but there covered by Tertiary lava drapes and invisible to seismic

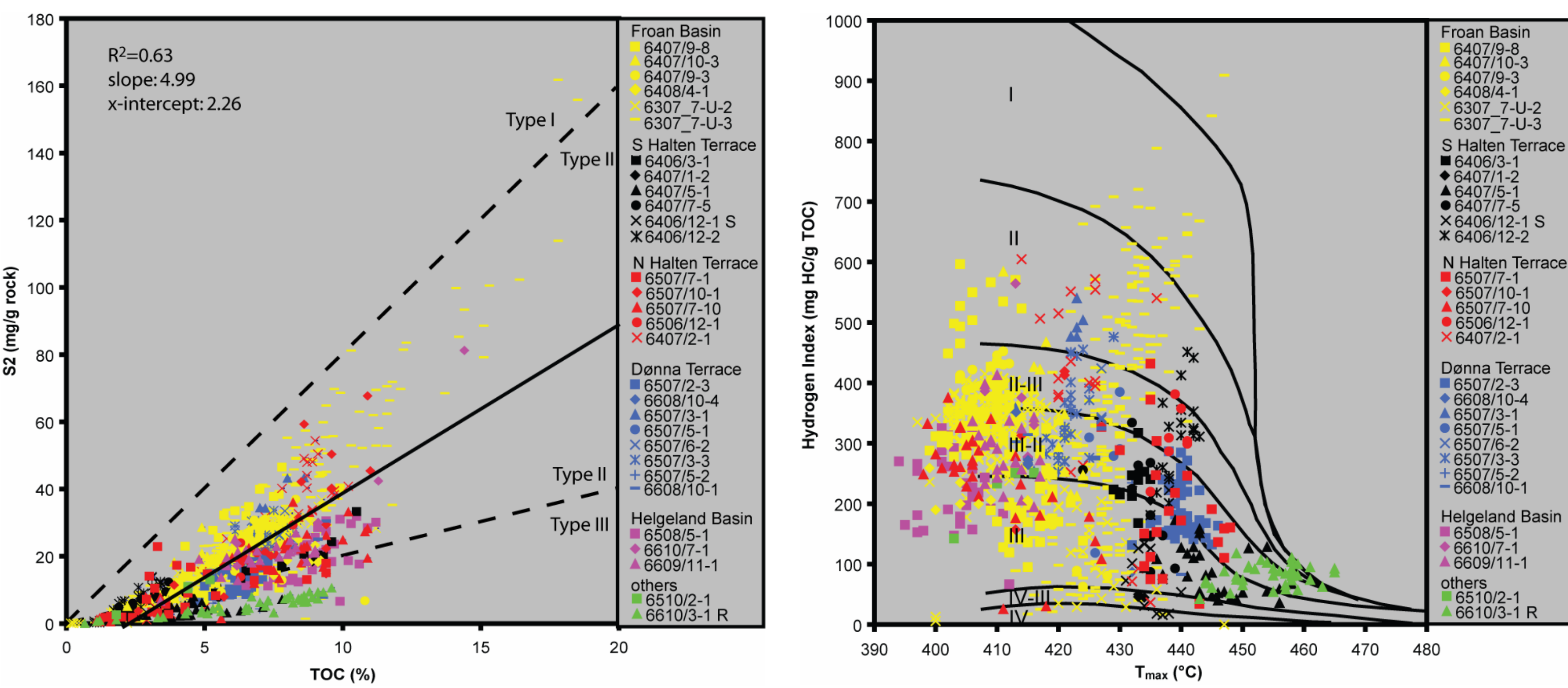
There is no direct information on quality and distribution of the Spekk Fm in the deeper Vøring Basin available

Well data collection and interpretation

- * No well ever reached Late Jurassic rocks in the deeper Vøring Basin
- * Therefore, well data from the eastern and western margin of the Jurassic rift zone (Halten Terrace, Dønna Terrace, Trøndelag Platform, East Greenland) were analysed
- * Data from 28 wells in the Norwegian Sea comprising 1077 Spekk Fm samples were compiled



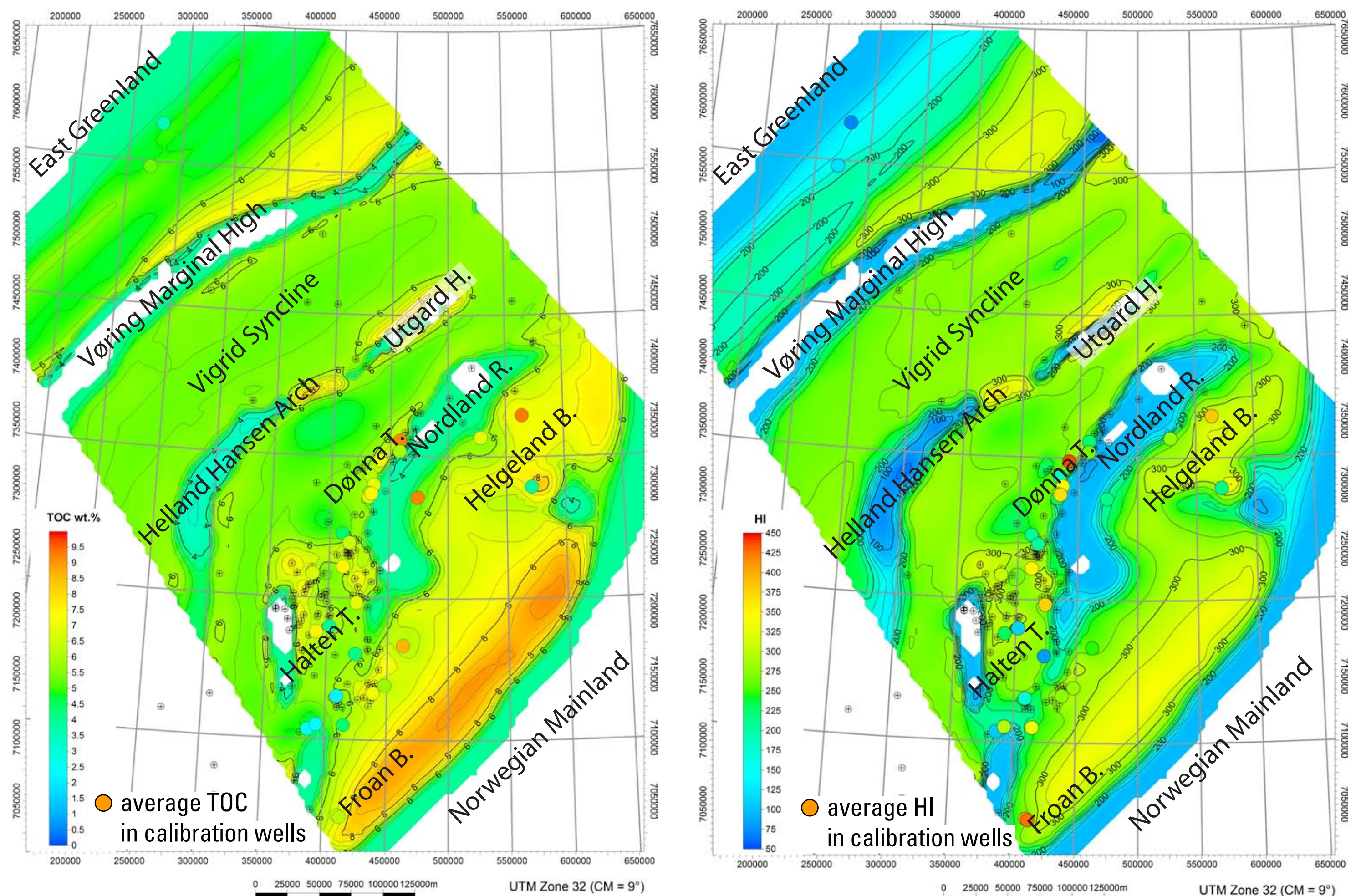
High source rock potential



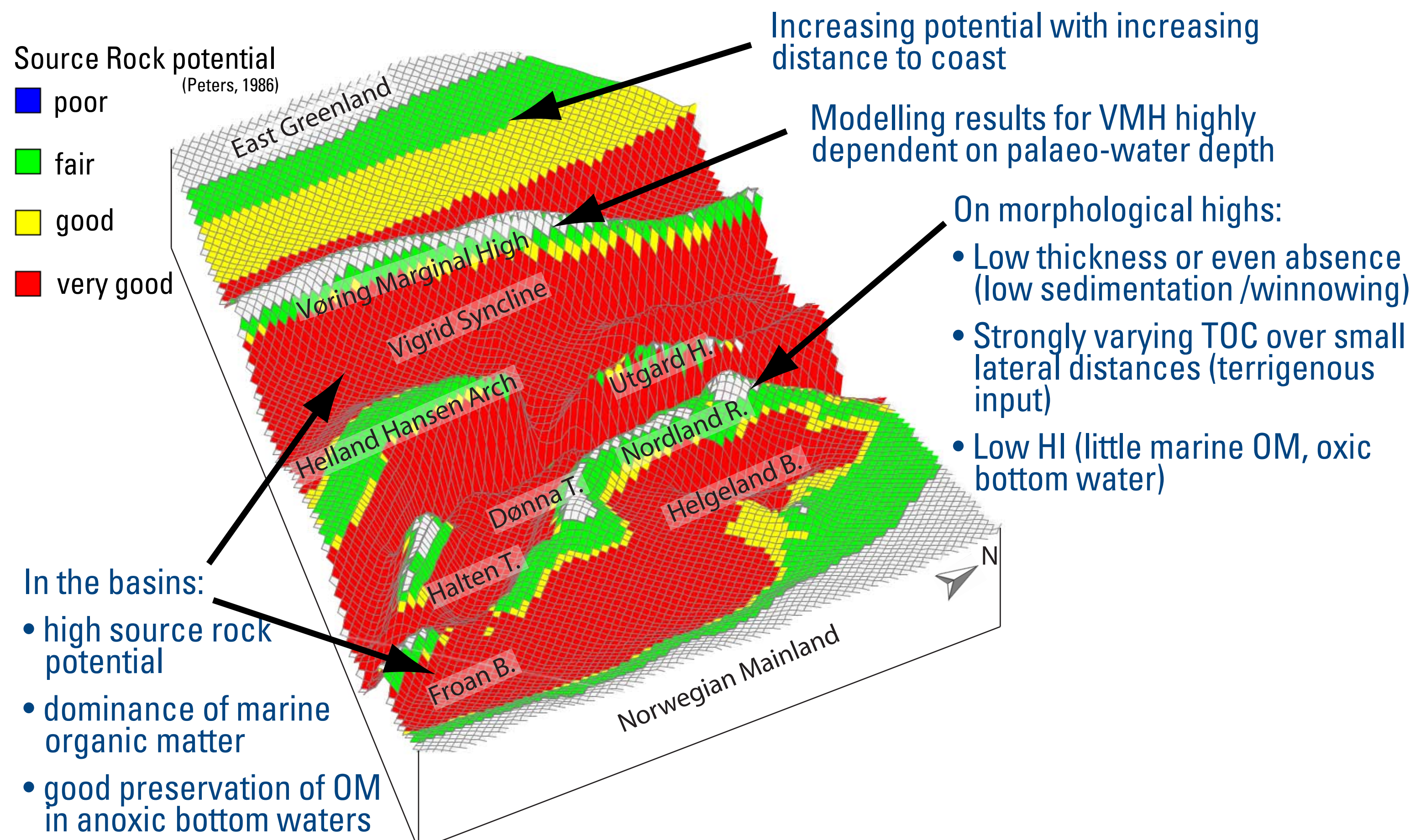
- * The Late Jurassic rift zone between Norway and Greenland represented a **marine basin with anoxic** deep waters and deposition of organic matter rich clays
- * Input of **terrigenous organic matter is significant** as indicated by bulk organic, maceral and biomarker data
- * Kerogen composition and petroleum potential of the Spekk Fm **vary significantly over short lateral distances**
- * Most samples from the Spekk Fm. represent a **mixture of type II and type III kerogens**
- * High content of pyrolytically **“dead” organic carbon** (inertinite)
- * The results indicate that the eastern part of the Norwegian Sea represented a shallow shelf environment

Organic facies modelling

We applied SINTEF’s process-based **source rock modelling tool OF-Mod 3D** to form a spatial picture of TOC and HI distribution during the Late Jurassic in the entire rift area between mid-Norway and East Greenland. Based on the data interpretation, a detailed palaeo-water depth reconstruction, structural and seismic information and general process-understanding a 3D model was developed, on which several conceptual settings were tested.



- * Generally good fit of modelled TOC and HI with the calibration data
- * Some strong deviations close to morphological highs because of local patterns of organic matter input and distribution with currents



Conclusions

- * Our modelling results indicate **very good source rock potential of the Spekk Fm over large parts of the Vøring Basin area** (5-7 wt% TOC, HI of 250-300 mgHC/gC)
- * Distribution and quality of the source rock are **highly dependent on paleo-water depth**
- * In the **basins**, organic matter of **marine origin dominates**, but the overall volume of high quality source rock is limited as primary production and sedimentation rates are low
- * At **morphological highs** already existing in the Jurassic, **potential is reduced** (2-4 wt% TOC, HI of 100-200 mgHC/gC) because of high content of terrigenous organic matter. Current and wave action provide **good oxygenation** reducing preservation of organic matter
- * **Special local patterns** of sediment input (rivers) and transport close to the coast of the Norwegian mainland and the local highs resulted in rather strong variation in source rock quality over small lateral distances and can not be matched by the model
- * In **anoxic bottom water** conditions comparatively low marine primary production (50 to 100 gCm⁻²yr⁻²) is sufficient to support high organic matter content and hydrocarbon potential of the sediments as preservation is rather good.

Acknowledgements

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