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Investigation of the petroleum systems of the South Viking Graben, Norway by pseudo-3D basin modeling and geochemical characterization of hydrocarbons and source rocks

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Although considered to be in a mature phase of exploration, discoveries are still being made in the Norwegian South Viking Graben. Recoverable reserves in this well explored hydrocarbon province include 329.8 x 10^6 Sm^3 oil and 456.8 x 10^9 Sm^3 gas, most of which are reservoired in sandstones of Paleogene age (83% and 48% respectively). The remaining reserves are stored in Upper and Middle Jurassic as well as Triassic reservoirs. Although numerous studies covering different aspects of the petroleum systems and various sub-areas have been undertaken previously, a comprehensive study of the area using the large amount of available data remains unpublished. This study aims at investigating the active petroleum systems of the South Viking Graben in order to facilitate exploration efforts in the area. It comprises a detailed study of source rocks and hydrocarbons in the area, as well as pseudo-3D basin modeling.

Major source rocks in the area are the shales of the Upper Jurassic Heather and Draupne Formations, and the Middle Jurassic Vestland Group. Based on Rock-Eval analysis, the oil- and gas potential is determined for the Upper Jurassic source rocks using the method described by Dahl et al. [1]. Mapping reveals significant facies and potential variations, which are shown to be related to dilution effects and varying degrees of anoxia using results from Rock-Eval pyrolysis, gas chromatography, biomarker and stable carbon isotope analysis. Based on the mapping results, the up to 1500 m thick Lower Draupne Formation is classified as mostly gas-prone source, while the up to 360 m thick upper, post-rift section of the Draupne Formation is a rich oil-prone source. The Heather Formation is a lean gas-prone source.

Interpretation of molecular and isotopic characteristics and multivariate analysis of biomarker data allows identification of seven hydrocarbon families, which can be related to the three active source horizons based on carbon isotopic and biomarker data. Three families are sourced from the Draupne Formation, the Heather Formation and the Middle Jurassic strata each source one family, while the remaining families represent mixtures of Upper and Middle Jurassic sources. The available data in this study allows characterization of 87% of the recoverable oil reserves and indicates that the main source rock in the area is the Upper Jurassic Draupne Formation with 278.1 x 10^6 Sm^3 of recoverable oil, equaling over 96% of the total characterized oil reserves (Figure 1).

Pseudo-3D basin modeling, based on the source rock potential maps generated, allows the investigation of timing of oil and gas generation in the area, calculation of generated and expelled hydrocarbon mass and timing for in-reservoir alteration. Based on the identification of hydrocarbon families and calculated mass generated, the efficiency of the hydrocarbon systems is evaluated.

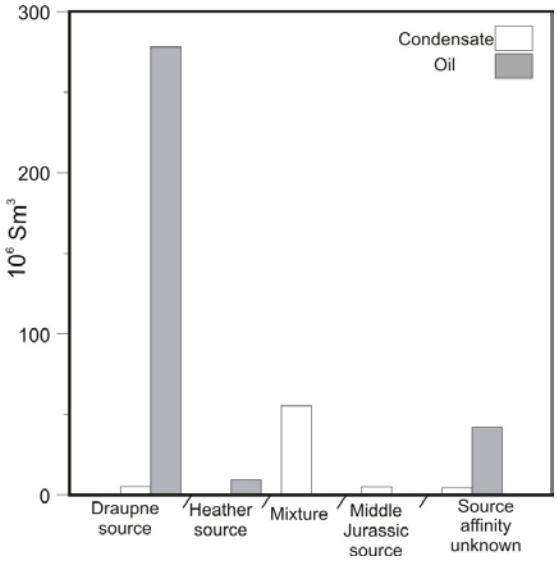

Figure 1. Contribution of the identified source horizons to the total recoverable oil and condensate reserves based on oil-source rock correlations.

References

[1] Dahl, B., Bojesen-Koefoed, J., Holm, A., Justwan, H., Rasmussen, E., Thomsen, E., 2004. A new approach to interpreting Rock-Eval S2 and TOC data for kerogen quality assessment. Organic Geochemistry 35 (11-12), 1461-1477.