Alternative Source Rocks on the Norwegian Continental Shelf: Potential Cretaceous Sourcing in Deepwater Basins

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ABSTRACT

Jurassic sequences have long been considered the key source rocks in the Norwegian Sea. However, in the Møre and Vøring Basins, these intervals are likely to be exhausted of any hydrocarbon generation potential due to deep burial and corresponding high maturity. An integrated geochemical and basin modelling investigation was therefore carried out to explore the potential for younger deepwater plays on this part of the Norwegian Continental Shelf. Evaluation of key source rock characteristics including richness, kerogen type and maturity, provided an initial appraisal of Cretaceous sources, which indicated the potential for both oil and gas generation, whilst optical maturity data indicated immature-early oil window maturity throughout most of the drilled locations. Many hydrocarbon samples from the deepwater wells exhibit very different geochemical compositions compared to hydrocarbons associated with Jurassic sources. For example, stable carbon isotope compositions of fluids and stains from the Ellida discovery and Ormen Lange field are heavy (-28.5‰ to -26.5‰) when compared to the Tyrihans field (which has a strong correlation to the Spekk Formation) at -29.5‰. This significant isotopic variation is attributed to alternative sourcing rather than facies heterogeneity or maturity differences within the Spekk Formation. Further evidence for Cretaceous sourcing comes from the biomarker compounds. Greater C29 hopane contents in the hydrocarbons of the deeper basins correlate strongly with the more terrestrial signature of potential Cretaceous source intervals. Close proximity of these drilled locations to the palaeo-coastline is likely to have increased terrestrial contribution in comparison with the typical open-marine signature of Jurassic sources. In addition, the high 24-nordiacholestanes, a class of age-diagnostic biomarkers, demonstrates the likelihood of a Cretaceous interval having sourced these hydrocarbons. 1-D basin modelling was conducted for selected drilled wells in the study area, calibrated to measured vitrinite reflectance and temperature data. The models predicted main oil window maturity (0.7-1.0% Ro) for the Jurassic sources in the deepwater wells. However, it is likely that the more deeply buried kitchen areas will hold highly mature and postmature Jurassic source rocks, with Cretaceous intervals potentially lying in the oil window.