EVALUATION OF THE OIL ACCUMULATION POTENTIAL IN THE RINGVASSØY-LOPPA FAULT COMPLEX (SW BARENTS SEA)

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Introduction

Most discoveries in the SW Barents Sea are found in the Jurassic Stø sandstones of the Hammerfest Basin, although deeper intervals (Triassic Fruholmen and Tubåen Fms) also show accumulations at several locations. These deeper reservoirs host oil discoveries, whereas the Stø reservoirs are generally gas/condensate bearing. Oil and gas accumulations in the SW Barents Sea show evidence of being complex mixtures of hydrocarbons generated from different source rocks (Killops et al., 2014). The upper Jurassic Kimmeridge Clay equivalent Hekkingen shales are the richest, most oil-prone source rock, in the region. Nevertheless, other organic-rich stratigraphic intervals from the Carboniferous to the Cretaceous show potential for oil and gas in the SW Barents Sea (Ohm et al., 2008).

Fault complexes located at the rim of the basin have been proposed to be more conducive to oil accumulations in the SW Barents Sea (e.g., Goliat field). Indeed, highly faulted areas with a thinner top seal on the flanks of the basin may be partially leaking gas while retaining oil (Ohm et al., 2008, and references therein). The Ringvassøy-Loppa Fault Complex (RLFC) separates the Hammerfest Basin and the Loppa High to the east, from the Tromsø Basin to the west. In the RLFC, most wells are dry, except well 7119/12-3, which shows gas and condensate in the Stø Fm. However, the area has not been intensively explored, and the potential for oil accumulation in the RFLC is not well constrained. A basin and petroleum systems model (BPSM) was elaborated to investigate the exploration potential for oil in the RFLC and adjacent areas. The resulting model integrates new fluid inclusion data and previously published geochemical data to gain additional insight on potential sources, migration pathways, and accumulations in the RLFC, and their correlation with current oil and gas fields in the Hammerfest Basin.

Results

Fluid inclusion and geochemical data from four wells located in the RLFC (7119/12-1, 7119/12-3 and 7119/12-4) and the Hammerfest Basin (7119/12-2) are presented along with the results of the BPSM built for the RLFC and adjacent areas.

Wells 7119/12-1 and 7119/12-4, in the southern RLFC, were classified as dry wells. However, high abundance of light oil or condensate fluid inclusions was observed in the Stø interval in both wells, suggesting the presence of a paleocolumn (Parnell et al., 2001). In addition, strong water-soluble petroleum species anomalies were recorded, pointing at undiscovered nearby oil or condensate accumulation (Hall et al., 2002). Indicators of proximity to liquid accumulation were also measured in fluid inclusions from the Cretaceous Kolmule Fm in well 7119/12-3, located farther north in the RLFC.

In the three RLFC investigated wells, the lower Hekkingen Fm shows a rich oil-prone interval with total organic carbon (TOC) averaging 7.1 wt% (3.3 to 11.5 wt%). Thermal maturity

evaluation was based on measured vitrinite reflectance (VRo), VRo equivalent from a basin constructed relationship with Rock-Eval Tmax, methylphenanthrene index, and fluid inclusion fluorescence. Maturity estimates consistently suggest that the lower Hekkingen Fm has reached early oil window during Late Cretaceous (0.6-0.7 %VRo) in the southernmost well 7119/12-4. Within the studied area, the organic-rich lower Hekkingen interval is progressively deeper and more mature to the north, reaching 0.9 %VRo in well 7119/12-3. No significant change in maturity was observed at well 7119/12-2 (Hammerfest Basin), although the Hekkingen interval is substantially shallower at this location (~900 m). The Cenozoic uplift and erosional events that affected the Barents Sea (Vorren et al., 1991) likely impacted the RLFC area to a much lesser extent. This agrees with the uplift estimates showing a decreasing trend westward in the SW Barents Sea (Ohm et al., 2008). Additional potential source rock intervals are observed in the overlying upper Hekkingen, Kolje and Knurr Fms, with TOC values up to 4.4 wt%, but immature within the study area and, generally, of lower quality. Triassic shales show some oil and gas potential with TOC >2 wt% and have reached the peak oil window maturity in the RLFC. Hence, they could be responsible for potential accumulated hydrocarbons in this area. The contribution of fluids from deeper intervals is supported by the detection of highly mature species in fluid inclusions.

Preliminary results from BPSM confirm potential upstructure oil accumulation nearby well 7119/12-4. The BPSM further suggests that the RLFC area was less severely impacted by the uplift and erosion than the Hammerfest Basin. This implies potentially longer local hydrocarbon generation which may have favored the presence of oil accumulations in the RLFC. However, uplift and erosion events have been proposed to favor oil selective preservation in the SW Barents Sea (Ohm et al., 2008). Their beneficial or prejudicial effect on potential oil accumulation in the RLFC remains to be established.

Conclusions

Fluid inclusion analysis results indicate the presence of an oil or condensate accumulation nearby well 7119/12-4 in the RLFC, which is supported by a BPSM of the area. The Jurassic Hekkingen Fm is the most oil-prone and has reached peak oil window maturity level in the north of the RLFC. On the other hand, Triassic intervals show oil and gas source rock potential that could also have contributed to the potentially accumulated hydrocarbons in the area. Upcoming BPSM results, including maximum burial/subsidence history reconstruction and gas-oil ratio of initial oil, will be used to discuss hydrocarbon generation, migration and preservation in the RLFC and adjacent areas.

References

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