An Integrated Approach to the Petroleum System of the Haltenbanken Area, Norwegian Sea

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ABSTRACT

The Haltenbanken region lies 150-200 km offshore Mid-Norway and consists of a highly faulted basin with SSW-NNE trending fault zones. The central part of Haltenbanken is the Halten Terrace and is separated from the Trøndelag Platform in the east by the Bremstein Fault Complex and from the Vøring-Møre Basin in the west by the Haltenbanken High. The major tectonic events in the Haltenbanken area can be summarized chronologically as: An initial crustal extension episode in the early Permian is recorded by N-NW trending basement that is onlapped by the Triassic succession.

Migration analysis in the Haltenbanken region shows that the Njord, Hyme and Pil fields cannot be filled if fault sealing is not considered. Faults that hold hydrocarbon charge throughout their entire lifetime, also, do not reproduce present-day hydrocarbon accumulations in Njord, Draugen and Tau. The best-fit scenario, where all the known fields are adequately filled, is obtained if fault sealing occurs at 3 Ma corresponding to the Pleistocene glacial events. Here, in the first migration phase prior to 3 Ma, the faults can hold a limited hydrocarbon column, but allow for communication between the pressure compartmentalized regions. This is essential for the charging of the Njord central dome. Draugen is charged by hydrocarbons expelled from the Spekk source rocks migrating over moderate to large distances from the west. In the second phase, from 3 Ma until present, the faults in the model are perfectly sealing. This results in the charging of the north-western flanks of Njord. The fault seals in recent times are necessary in order to explain a few features. The first is that Draugen shows biodegradation which suggests that this region has not been fed with fresh hydrocarbons in the last few million years (3-5 Ma). Secondly, the pressure data from the Njord and Pil & Bue fields show that the pressure compartments are currently not in communication with each other. Lastly, quartz cementation, which results in fault sealing above 70°C, occurs only after the faults at the BCU are buried to increased depths (~3 Ma for the shallowest region at Njord).

Our studies highlight the importance of using interdisciplinary multi-models in order to better understand hydrocarbon migration in the past and its correlation to present-day discoveries. Pressure and fault seal analyses must be performed both to explain present day reservoirs and the context of charging these traps in the past. Recent fault-sealing in the Haltenbanken region plays a crucial role in determining the accumulation sizes, especially in the Njord and Draugen discoveries, while the thermal evolution of the source rock horizons is important to reproduce the correct GOR ratios and constrain the contributions from different source rocks. In our presentation we will also elucidate recently drilled prospects in the region and show how our interdisciplinary multiscale approach improves both the regional and prospect level petroleum systems analysis.