



Wellbore History

GENERAL

The well 6406/11-IS was drilled on a truncational/fault seal trap structure on the western slope of the Frøya High near the southern end of the Halten Terrace. The main objective of the well was to test the hydrocarbon potential in the Early to Middle Jurassic Fangst Group. Secondary objectives were to test the reservoir properties the underlying Tilje Formation, as well as possible sand development in the Tertiary. The well should also evaluate the source rock properties in the Early Jurassic Åre Formation. Planned total depth was 4526 m RKB TVD beneath a seismic marker interpreted as Triassic Evaporite. The well was the first well on a new block and the pressure prognosis was uncertain. Formation pressures were to be watched closely while drilling.

OPERATIONS AND RESULTS

Wildcat well 6406/11-1 S was spudded with the semi-submersible installation Treasure Saga on 19 October 1990 and drilled to TD at 4185 m in the Late Triassic Red Beds. To avoid shallow gas the well was spudded and drilled deviated from a location 260 m NNW of the planned target location. During drilling the Nordland Group, two shallow gas intervals were penetrated at 893 - 897.5 m and 1148 - 1150 m. To get back to vertical drilling the well was deviated from 1235 m to 2165 m MD. Only minor problems occurred while drilling down to the 12 1/4" section. After drilling the 12 1/4" hole down to 3395 m, the VSP tool become stuck at 3383 m. A total of 5 days were spent recovering the wire line and miring the fish down. Only minor problems with tight spots occurred while drilling to TD.

Formation pressure was hydrostatic down to ca 1520 m, from where a gradual pressure build up was indicated in the Hordaland Group down through the Rogaland Group, estimated to a maximum of 1.60 g/cc EMW at 2400 m in the upper part of the Shetland Group. From here a slight pressure depletion down to approximately 3000 m was indicated. From 3000 m down to the Jurassic sandstones of the Fangst Group, increasing gas levels and decreasing sonic velocity indicated a new pressure build up. The pressure build up continues down to 3630.8 m in the Ile Formation where a maximum pressure gradient of 1.71 g/cc EMW was estimated on the basis of FMT recordings. High gas levels in the Åre Formation of the Båt Group indicate a possible new pressure build up towards the bottom of the well.

No significant sand development was seen in the Tertiary. The Fangst Group comprised shales of the Not Formation before penetrating the reservoir sands of the Ile Formation at 3599 m. The well drilled further through the Early Jurassic Båt Group comprising the Ror, Tilje and Åre Formations before penetrating the Triassic Grey Beds at 4134 m and Red Beds at 4149 m.

FMT pressure measurements showed a possible gas/condensate gradient over the Ile Formation. The first appearance of C2+ components in the mud gas readings came at 3599 m in the Ile Formation. Sands of the Ile Formation contained moderate to good oil shows. Sands of the Tilje Formations also had weak oil shows, and weak, intermittent oil shows were recorded from 4025 m to 4100 m in the Åre Formation. Organic geochemical analyses showed that mainly gas-prone source rocks were penetrated in the well. These are the Upper Jurassic Melke Formation shales, which have a fair gas potential (and some condensate), and coals and shales within the Ile, Ror, and Åre Formation. Coal in the Ile Formation may have some minor potential for waxy oil. The well is immature (Ro < 0.5 %) down to about 2500 m, moderately mature (Ro 0.5 - 0.6 %) down to 3600 m and peak oil mature (~ 0.8 %) at about 4100 m, remaining within the oil window to TD at 4188 m. The analyses further confirmed oil stain from migrant hydrocarbons in the interval 3600 m to 4100 m. Extracts, FMT oil, and DST3A oil from the Ile Formation all showed a very waxy composition. PVT analyses of the FMT oil showed a pour point of 34 °C, bubble point pressure of 275 bar at 80 °C, and stock tank oil density of 0.8754 g/cm3. The GOR from single stage flash was 126.5 Sm3/Sm3.

LITHOSTRATIGRAPHY & HISTORY FOR WELL: 6406/11-1 S

Three segregated FMT fluid samples were taken in the Ile Formation, and the sample from 3694.3 m contained 1.5 litres of oil and 7 litres of water. In the Tilje and Åre Formations no reliable pressure measurements were obtained due to tight formation and hole conditions. As the planned DST of the Tilje Formation was cancelled a cased hole RFT-tool was run here, with the objective to obtain fluid samples. This sampling was not conclusive as the chambers contained mainly filtrate water. A total of 11 conventional cores were cut in the Ile and Ror Formations, recovering