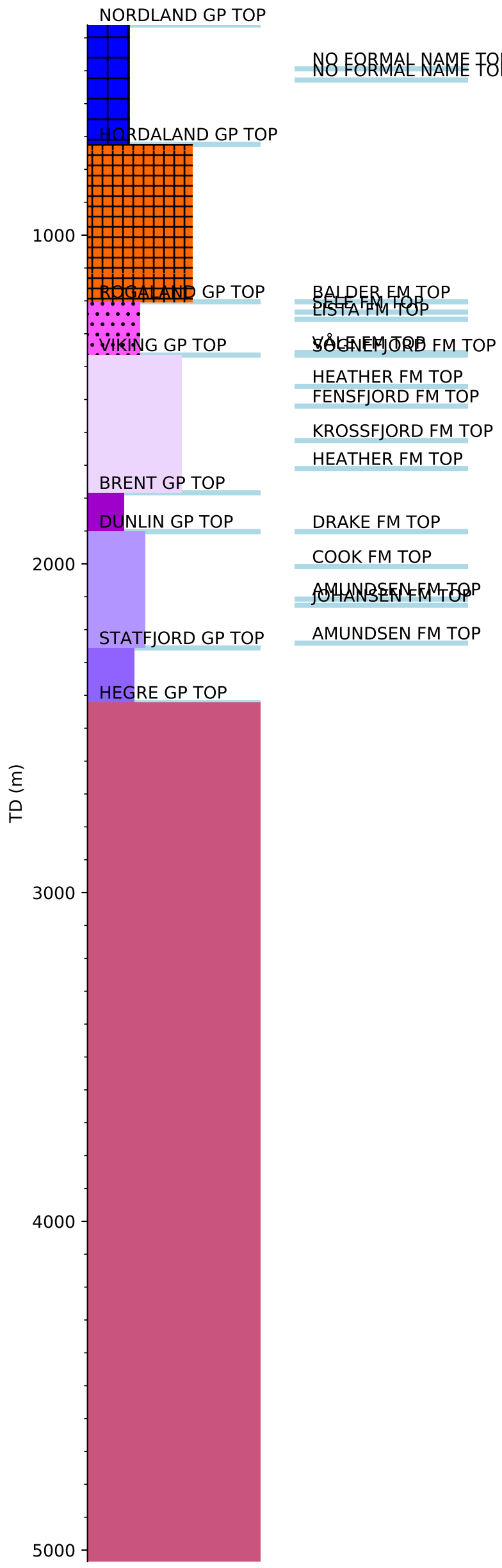
Groups

Formation Tops



Wellbore History

GENERAL

Well 31/2-4 is located some 10 km NNW of the discovery well 31/2-1 in a separate fault compartment near the crest of the Jurassic gas accumulation. This crestal area appeared also to coincide with the culminations of all deeper horizons that could be mapped. The well had two main objectives. The first was to appraise the Jurassic gas accumulation in the 31/2-1 Troll Discovery in a location with nearly maximum gross hydrocarbon column. The well should test lateral variations in this reservoir. The second major objective was to explore deeper Triassic/Palaeozoic Formations. The well would test possible hydrocarbon accumulations under the Late Jurassic Troll reservoir, explore possible pre-Jurassic source rocks, and provide geological ages for deep horizons and thus improve the regional geological setting.

TD of the well was proposed to be 5000 m below sea level or in Palaeozoic formations whatever came first.

Well 31/2-4 was originally drilled with Borgny Dolphin down to 815 m in 1980. The well was however suspended on 13 September 1980 due to a blow out on 34/10-10, where Borgny Dolphin's services were immediately required.

OPERATIONS AND RESULTS

Well 31/2-4 was re-entered (31/2-4 R) with the semi-submersible installation Borgny Dolphin on 9 October 1980 and drilled to TD at 5035 m in Early Triassic sediments of the Hegre Group. The well bore deviation did not exceed 4 deg and at 4693 m, the deepest survey point reported, there was only 2 m difference between drilled and true vertical depth. The top hole down to 815 m had previously been drilled with seawater and hi-vis pills. From 815 m to 1280 m the well was drilled with KC/polymer mud, from 1280 m to 1951 m it was drilled with KCl/polymer converting to gel/lignosulphonate, from 1951 m to 4029 m it was drilled with seawater/gel/dispersed lignosulphonate, and from 4029 m to TD it was drilled with a gypsum/lignosulphonate mud.

The top of the gas-bearing reservoir was found at 1364.5 m. The accurate pick of the GOC from logs was hampered severely by lithology effects placing the GOC somewhere between 1567 and 1573 m, with 1568 m as a likely place. A depth of 1572 m is however, more consistent with other wells in the field. OWC was found at 1580 m.

Lithologically, the reservoir sequence in 31/2-4 R is similar to that encountered in earlier wells in the block. A largely unconsolidated high porosity - high permeability sand occurred in the top part of the reservoir (Sognefjord Formation). This was underlain by a finer grained, better consolidated, but strongly micaceous sandstone (Heather Formation), in which porosity was somewhat reduced and permeability was low. Beneath this micaceous interval was a zone of more variable lithology, comprising interbeds of fine, micaceous sands and coarser cleaner sands (Fensfjord Formation). Thin (generally less than 1 m thick) carbonate cemented bands occurred throughout the reservoir and formed very low porosity - permeability horizons. Carbonate cementation did not appear to be restricted to any one particular litho-type, and the individual bands were not believed to be of significant lateral extent, (lateral contacts between cemented and non-cemented lithologies have been cored).

The seal in 31/2-4 is formed by a thick sequence of Palaeocene claystones. Reworked Late Cretaceous fauna occur in these claystones immediately above the reservoir.

No significant hydrocarbon indications were seen in the section below the main Jurassic accumulation. The well drilled Triassic sediments from 2422 m (Hegre Group) to TD. The upper section down to 3345 m was dominantly claystones/siltstones with interbedded sandstones. The lithology below 3345 was dominantly sandstone. One RFT run acquired pressure data points over the Jurassic reservoir section and two more runs acquired twelve good pressure points from the Early Jurassic to Triassic formations from 2142 m to 4969 m. The latter two runs showed two hydrostatic water gradients with a break somewhere between 2713 m and 3262 m. The break towards a higher gradient could represent a more saline water in the deeper section. An RFT gas sample was taken at 1566 m, just above the anticipated GOC. An extensive coring programme was carried out with a total of 29 recovered cores. Top coring point was in the Paleocene cap rock above the reservoir, and coring continued over the entire hydrocarbon bearing Late/Middle Jurassic reservoir section. A

LITHOSTRATIGRAPHY & HISTORY FOR WELL: 31/2-4 R