PL476 relinquishment report

Document last updated 27-01-2011 10:32 CET

PL476 relinquishment report

List of figures

1 Introduction

The PL476 license is located on the eastern limit of the Halten Terrace, east of the Midgard Field (Fig. 1.1) and covering the Southern part of the Høgbrakken horst. One well, the Frusalen 6507/11-10, was drilled within the license in 2010. The well was dry and the results have been incorporated in the assessment of the remaining prospectivity.

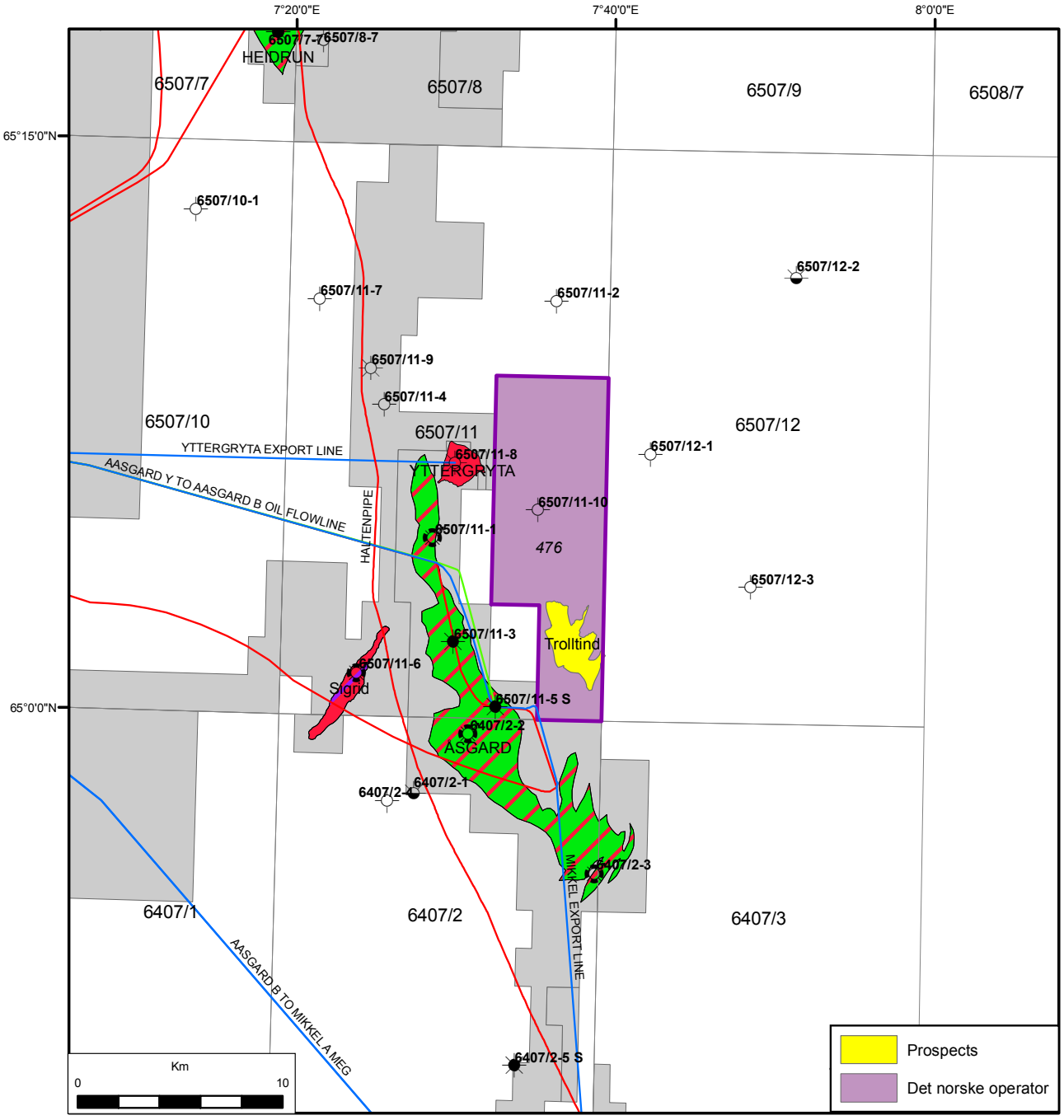


Fig. 1.1 Location of the PL476 license. *The PL 476 license is located on the Eastern limit of Halten Terrace , covering the Southern part of the Høgbrakken horst.*

2 Award and work program

The PL476 lisence was awarded 29.02.2008 as an APA 2007 license, valid to 29.02.2012 and applies to all stratigraphic levels. The license outline and nearby fields and discoveries are seen in (Fig. 1.1).
The PL476 licensees are:

- Det norske 40% operator
- Lundin 30%
- Noreco 30%

The work program:

- G&G studies within1 year
- Drill or drop within 1 year
- BOV within 3 years
- PDO within 4 years

The Frusalen Prospect was drilled in February 2010 and the work commitment has been fulfilled.

3 License database and Special studies

The well and seismic database for the PL476 license consist of all public wells and seismic 2D & 3D data over the license. The main seismic survey used for the evaluation of the license is the DN0701 3D seismic survey. This is a survey acquired by Det norske as an extension to the HT0701 3D seismic survey that covers PL432. The seismic and well database is shown in Fig. 3.1.

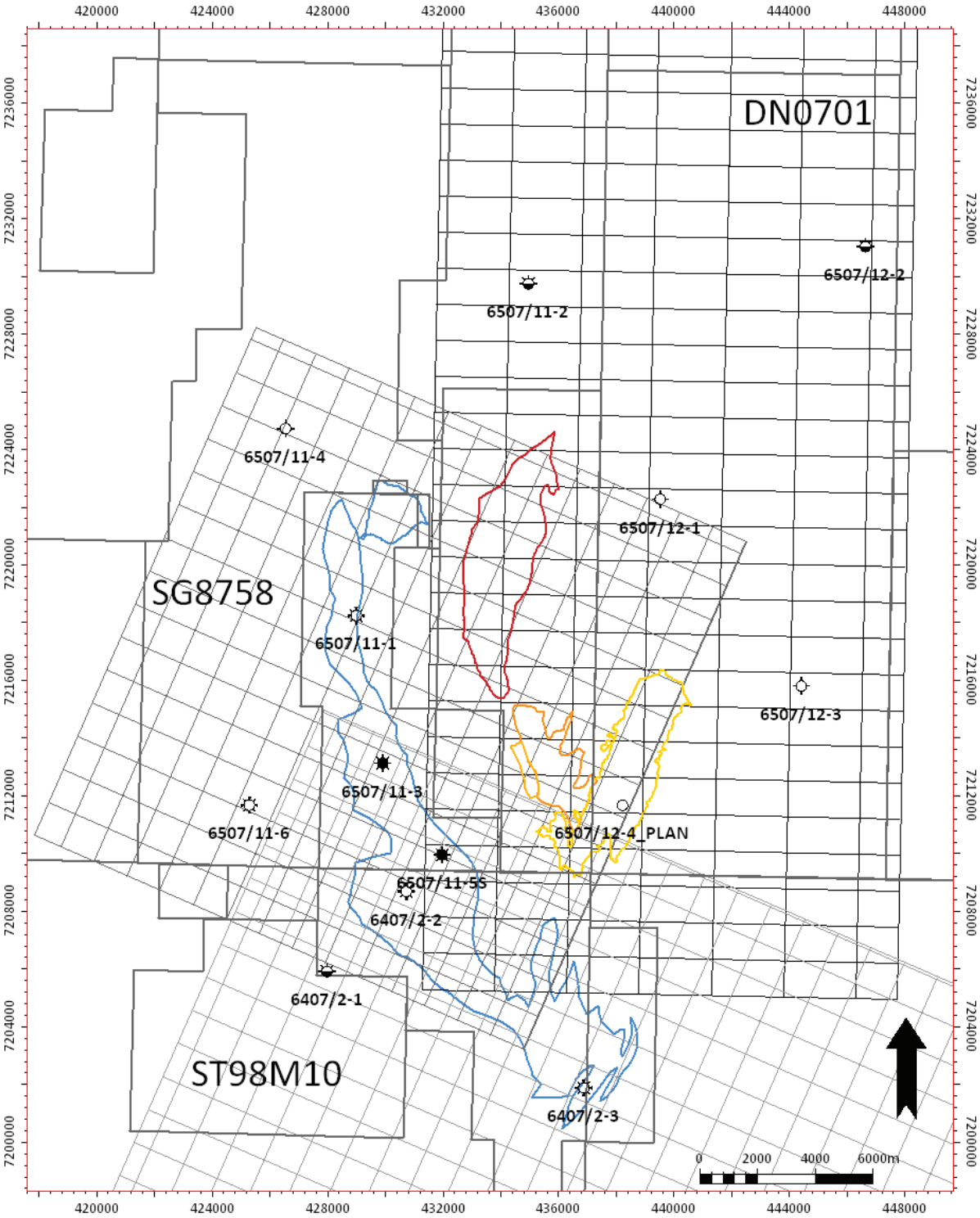


Fig. 3.1 Well and seismic database for PL476. *The well and seismic database for PL476 consist of public well data in the area. The seismic database consist of the survey DN0701 and all public 2D & 3D seismic over the license*

Well database

The common well database for the lisence was agreed to include the below listed wells:

Common well database:

Well	TD Formation	Location, field or structural element
6407/11-1	Triassic Grey Beds	Midgard field
6407/2-2	Triassic Grey Beds	Midgard field
6407/2-3	Jurassic Åre fm.	Midgard field
6507/11-1	Triassic Grey Beds	Midgard field
6407/2-1	Triassic Red Beds	Gimsan Basin
6507/11-2	Triassic Grey Beds	Høgbrakken Horst
6507/11-4	Jurassic Tilje fm.	Grinda Graben
6507/12-1	Triassic Red Beds	Ellingråsa graben
6507/12-2	Triassic Red Beds	Ellingråsa graben
6507/12-3	Jurassic Åre fm.	Trøndelag Platform

Seismic database

The common seismic database for the lisence include the following surveys:

The 2D seismic database included seismic lines from the following seismic surveys: SG8258, SG8158, SG8045, SG8558, SG8271, ST7701 as well as GMT84

The main 3D seismic cube for the evaluation of PL476 is the DN0701 3D survey. In addition the public 3D surveys ST98M10 and SG8758 that covers the Midgard field has been evaluated.

Special Studies

Several special studies has been carried out both in-house and by external parties to address the geological uncertainties of the PL476 prospectivity. These studies include:

- Elastic inversion of approximately 340km^2 of the DN0701 seismic 3D data by CGGV. The aim of the inversion was to aid interpretation of the reservoir units. This study included a pre-processing of the seismic data and inclusion of nearby well data.

- In-house pre-stack data conditioning of the DN0701 seismic 3D data utilizing the PsPro software. Based on this improved data both fluid and lithology inverted volumes were generated.

- Fluid inclusion study well 6507/11-10 Frusalen. This study addressed migration into the Frusalen prospect to assess if any hydrocarbons has previously moved through the prospect or not.

4 Frusalen 6507/11-10 exploration well

The pre-drill prospectivity for the PL476 license included the prospects Frusalen and Trolltind (Fig. 4.1). Both these prospects are rotated fault blocks with middle to early Jurassic reservoirs. During the winter 2009/2010 the Frusalen prospect was drilled and proven dry. Given the shared risk element on migration, this well result significantly reduces the chance of success for the Trolltind prospect.

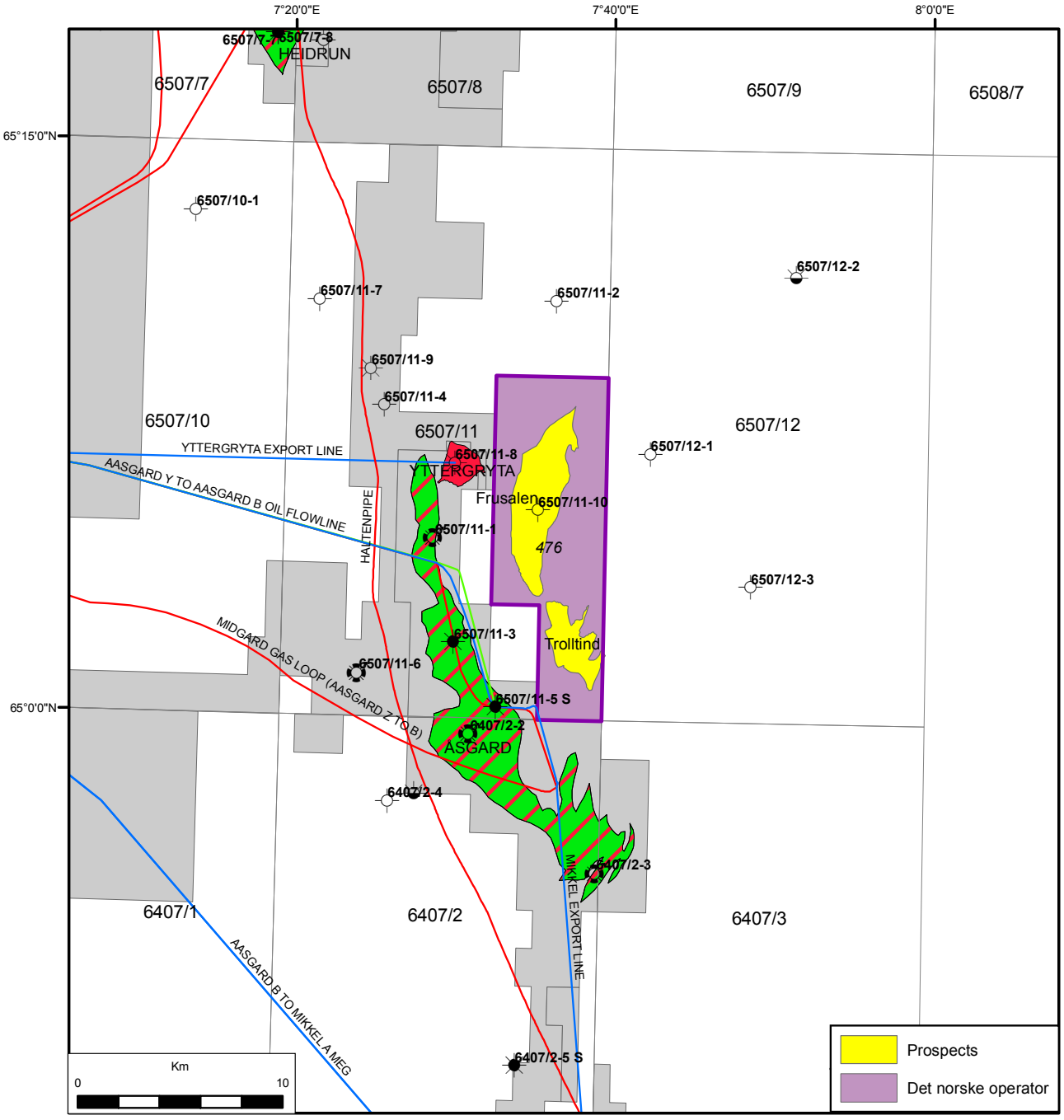


Fig. 4.1 Frusalen and Trolltind Prospects

4.1 Frusalen pre-drill prospect evaluation

The Frusalen prospect is located centrally in PL 476 on the southern part of the Høgbrakken horst. The prospect trap is a Jurassic to Early Cretaceous fault block located to the South of the dry 6507/11-2 well. The Frusalen structure is defined by a normal fault that separates the Høgbrakken horst into two parts and by normal faults to the East and West. Relative to the adjacent Høgbrakken Horst structure to the north, the Frusalen fault block is in a hanging wall position. A time structure map of the Base of Cretaceous with the prospect outline is seen in Fig. 4.2. A seismic line from the Frusalen structure to the Trolltind structure is seen in Fig. 4.3.

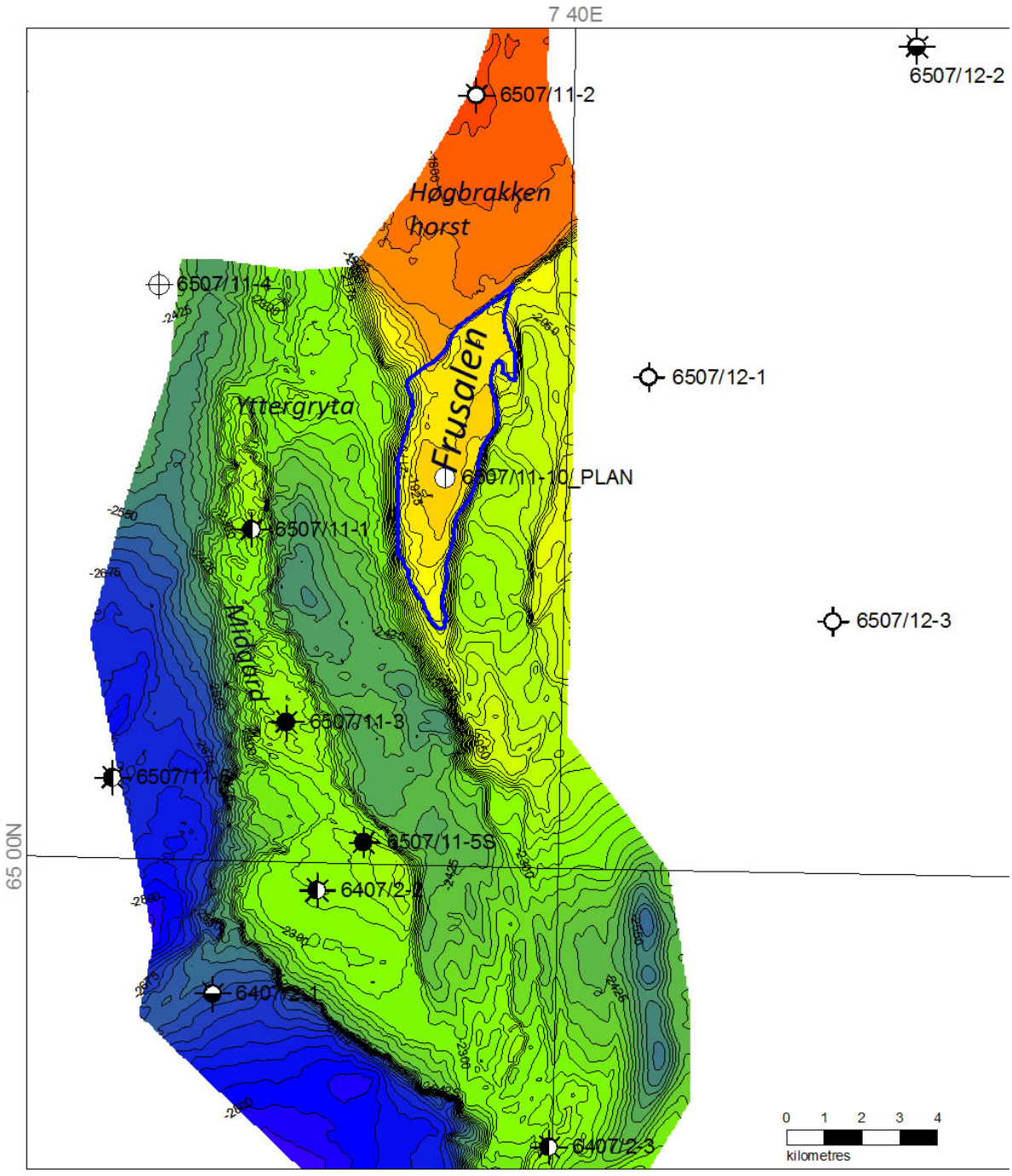


Fig. 4.2 Frusalen prospect - BCU time map. *The Frusalen fault block is located centrally in the PL476 license.*

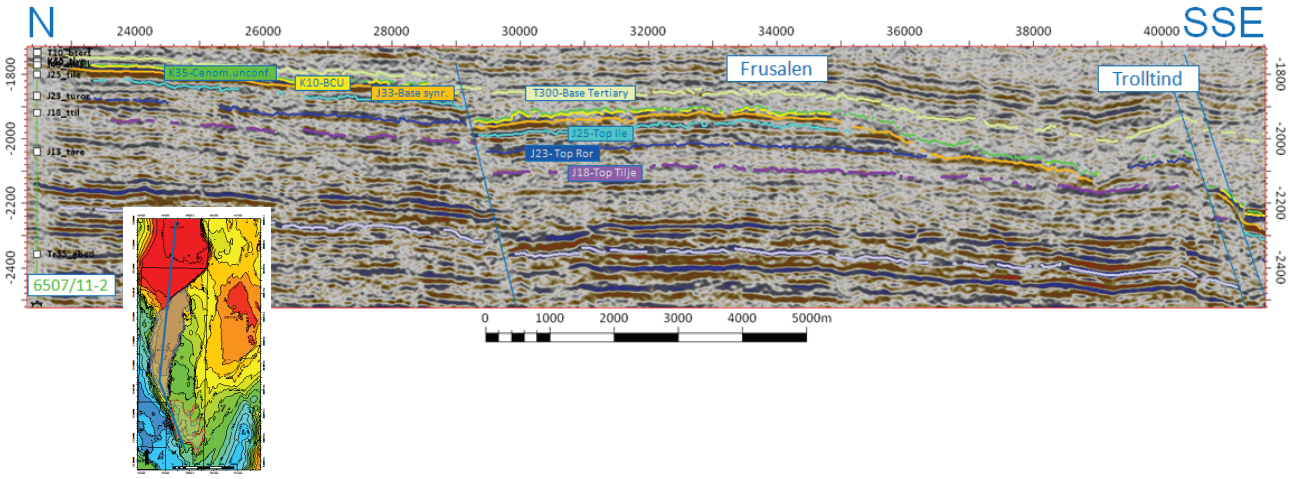


Fig. 4.3 Seismic tie-line , Frusalen and Trolltind prospect. *Seismic tie line from the 6507/11-2 well to the Frusalen and Trolltind prospects.*

Within the Fangst Group, the Ile Fm was considered to have the greatest volumetric potential and highest probability of discovery. The Garn Fm formed a secondary objective with a reduced chance of success due to its possible erosion and uncertain presence. Because of much poorer seismic quality and consequently higher uncertainties in structural definition, the reservoirs of the Båt Group (Tilje and Åre Fms) formed a third objective with lower chance of success.

Two scenarios for migration into the Frusalen prospect considered pre-drill. The most likely model included a fill-spill from the northern end of the Midgard field into the Yttergryta discovery and further into the Frusalen prospect. The second model for charge was a fill spill scenario from the southern part of the Midagard field across the graben into the Trolltind prospect and further into the Frusalen stucture.(Fig. 4.4) shows these migration routes on the BCU time map. The migration route via the Trolltind prospect demonstrates the shared risk on migration between the two prospects.

For the Ile Fm (main reservoir) a four-way closure was definable based on a gas-water contact at 2119mMD. The P50 (base case) volumes inside the closure were estimated to 7.6 x 109 Sm3 of recoverable gas. At the planned position, the well would leave < 1.0 x 109 Sm3 of recoverable gas upflanks. The well would penetrate the Top Ile structure ca. 28m downflank of the structural crest. The total probability of discovery was calculated to 0.36, with the main risk identified for the migration (P=0.5). The probability of reservoir presence was set to 1.0 and the probabilities for trap/seal and retention were 0.9 and 0.8, respectively.

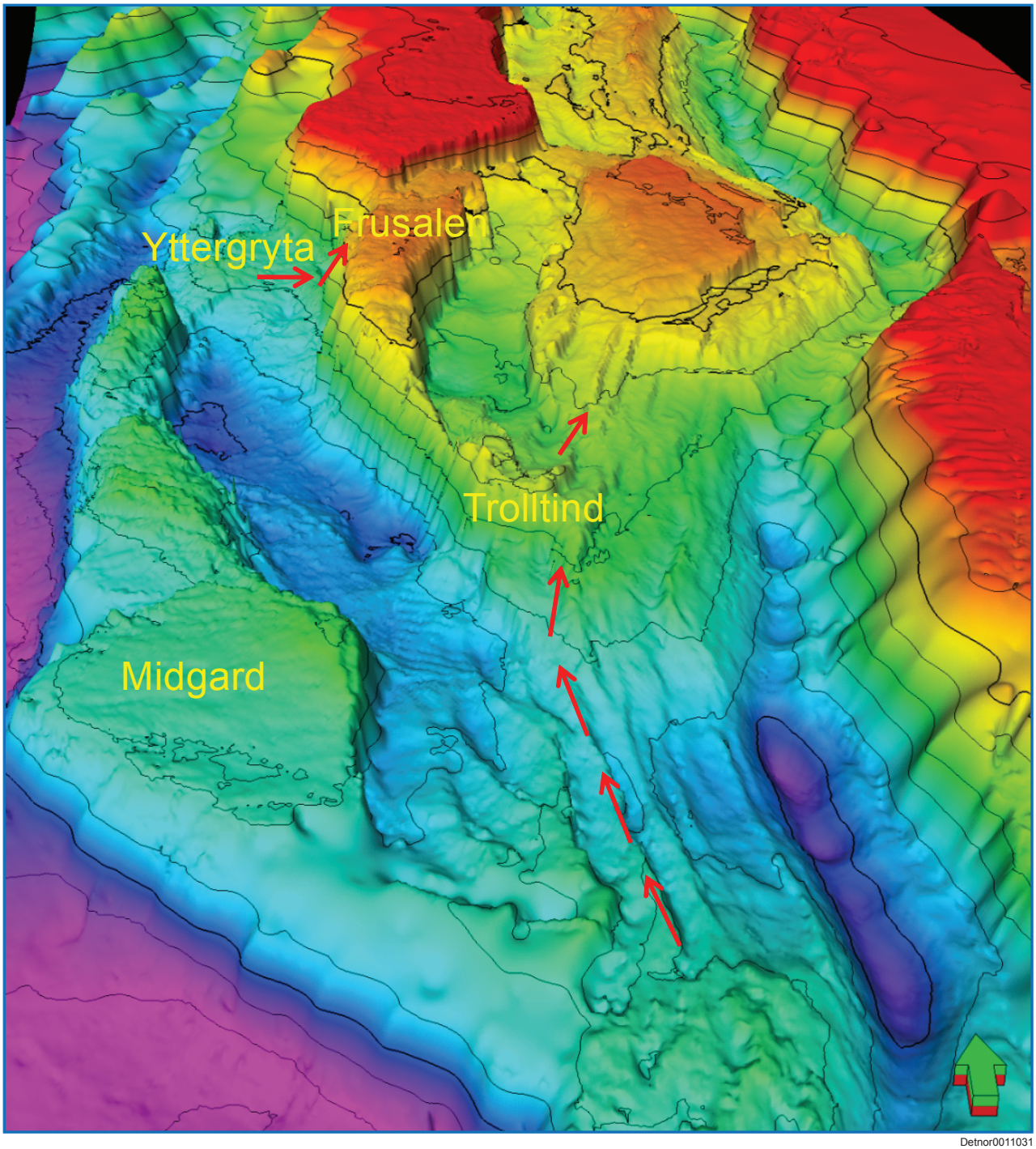


Fig. 4.4 Migration routes into the Frusalen prospect - BCU time map. *Two scenarios for migration into the Frusalen prospect considered pre-drill, shown on the BCU time map. The most likely model included a fill-spill from the northern end of the Midgard field into the Yttergryta discovery and further into the Frusalen prospect. The second model for charge was a fill spill scenario from the southern part of the Midagard field across the graben into the Trolltind prospect and further into the Frusalen stucture.*

4.2 Results Exploration well 6507/11-10

Objectives
The exploration well 6507/11-10 was the first well to be drilled in the PL476. The objectives of the well was to test the hydrocarbon potential of the Middle Jurassic Fangst Group and Lower Jurassic Båt Group in the Frusalen Prospect.
The Frusalen structure was assumed to be charged with hydrocarbons that were spilled from the northern parts of the Midgard Field via Yttergryta and migrated up-dip through the central parts of the western boundary fault. An alternative migration route was from the southern end of the Midgard Field and through the southern tip of the structure.

Well Results
The well reached a total depth of 2319mMD/2290mTVD-MSL, 34m into the Lower Jurassic Tilje Formation, on the 8th of February 2010.
The main target, the Ile Formation, was encountered 37m deeper than prognosed while the secondary objective, the Garn Formation came in 43m deeper than prognosed. Neither of the two potential reservoirs showed any signs of hydrocarbons. The shale formations of the Viking Gp. and also the Not and Ror Fm. were slightly thicker than prognosed. The Garn and Ile Fm. were slightly thinner and more shaly than anticipated.

The TD criteria for the well was to drill into the first water-bearing formation below Top Tilje Fm, or if hydrocarbons present in the Tilje and Åre Formations, drill through the intra Åre coal markers. Since no indications of hydrocarbons were recorded in the Tilje Fm, TD of the well was set 34m into the Tilje Fm, at 2319mMD, after drilling enough rat hole to ensure that all logging tools passed the formation boundary. Based on these results, the well was permanently plugged and temporarily abandoned on February the 17th 2010. The well has later been permanently abandoned.
The prognosed stratigraphy versus actual is seen in Fig. 4.5. CPI logs for the well is seen in Fig. 4.6 with a detailed look at Garn Fm and Ile Fm in Fig. 4.7 and Fig. 4.8 respectively.

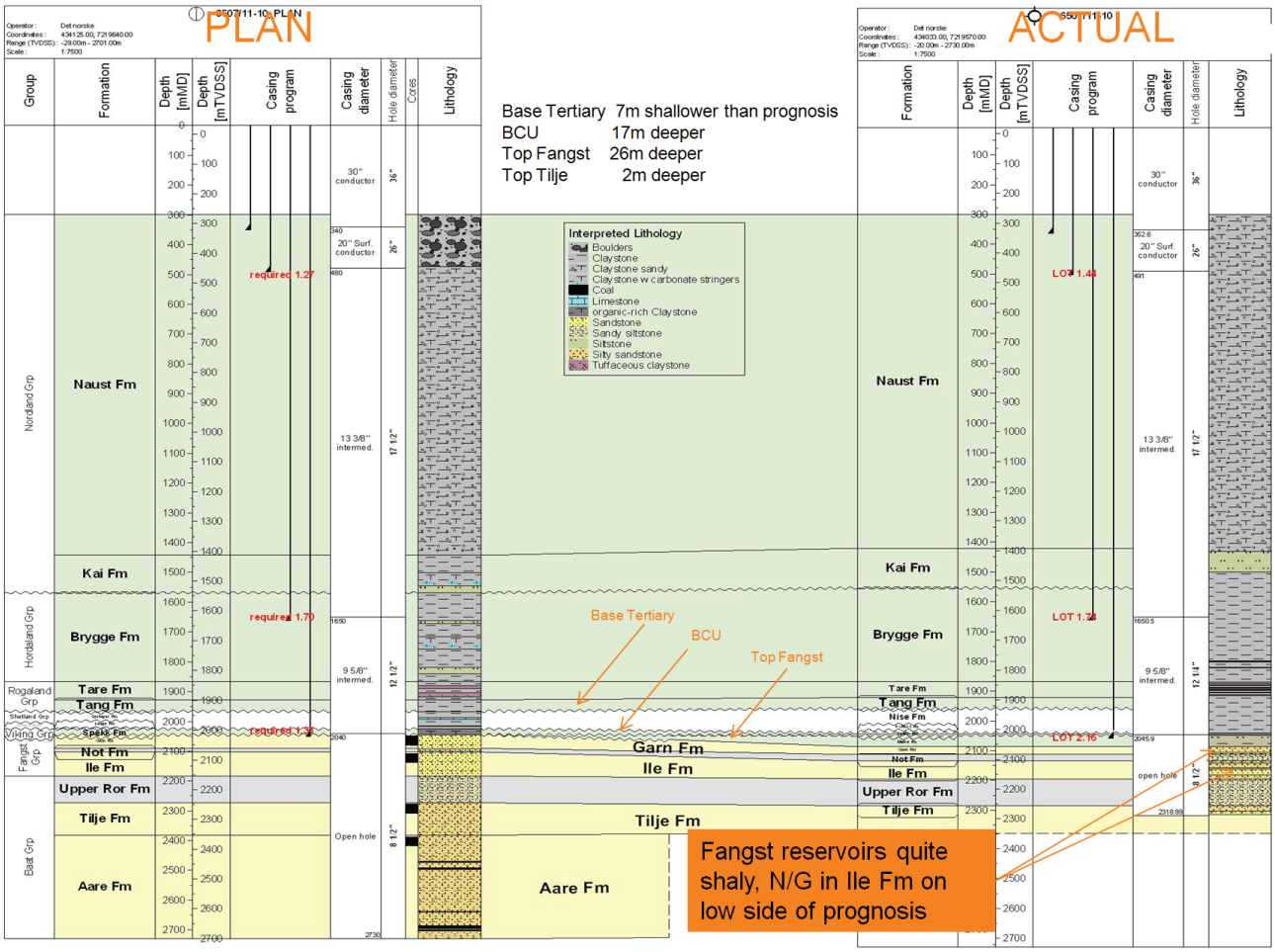
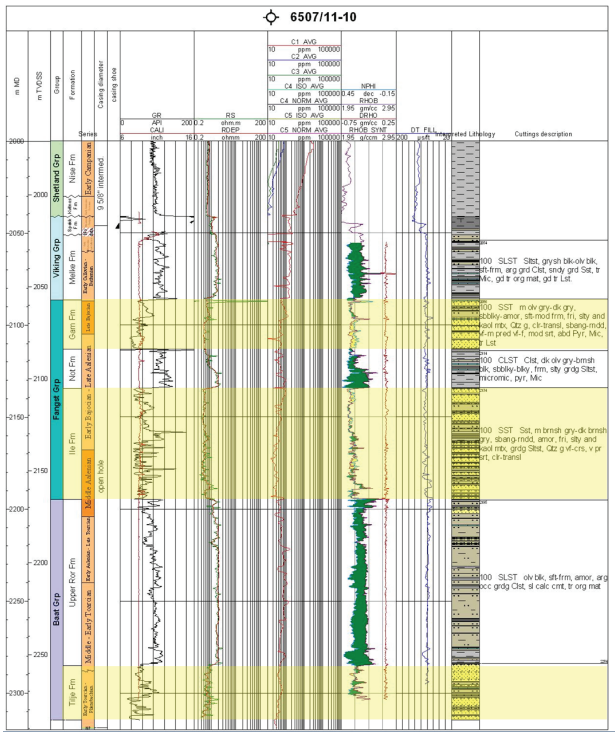


Fig. 4.5 Well 6507/11-10 prognosed versus actual stratigraphy. *The prognosed versus actual stratigraphy shows that only small changes to the pre-drill estimates were seen.*



Garn Fm:
Thickness: 28m (18m thinner than prognosis)
N/G: 0.85
avg PHI$_{net}$: 0.3

Ile Fm:
Thickness: 61m (23m thinner than prognosed)
N/G: 0.60
avg PHI$_{net}$: 0.29

Tilje Fm:
Thickness: only 35m drilled
N/G: 0.35
Avg PHI$_{net}$: 0.23

Fig. 4.6 Well 6507/11-10 CPI logs. *CPI logs for the overburden and reservoir section*

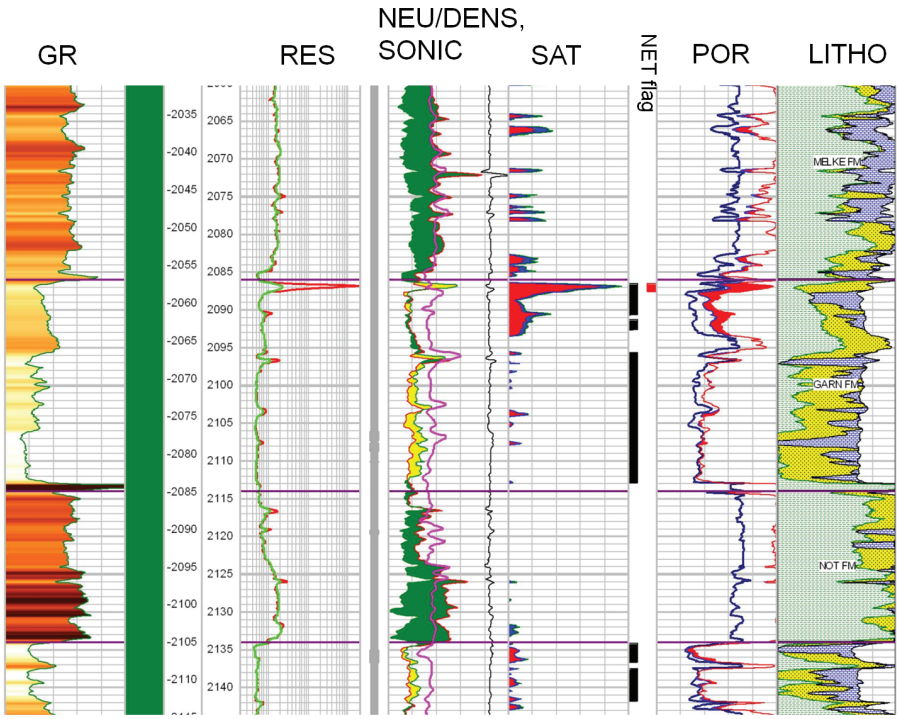


Fig. 4.7 Well 6507/11-10 Garn fm. CPI logs. *CPI logs for the Garn fm.*

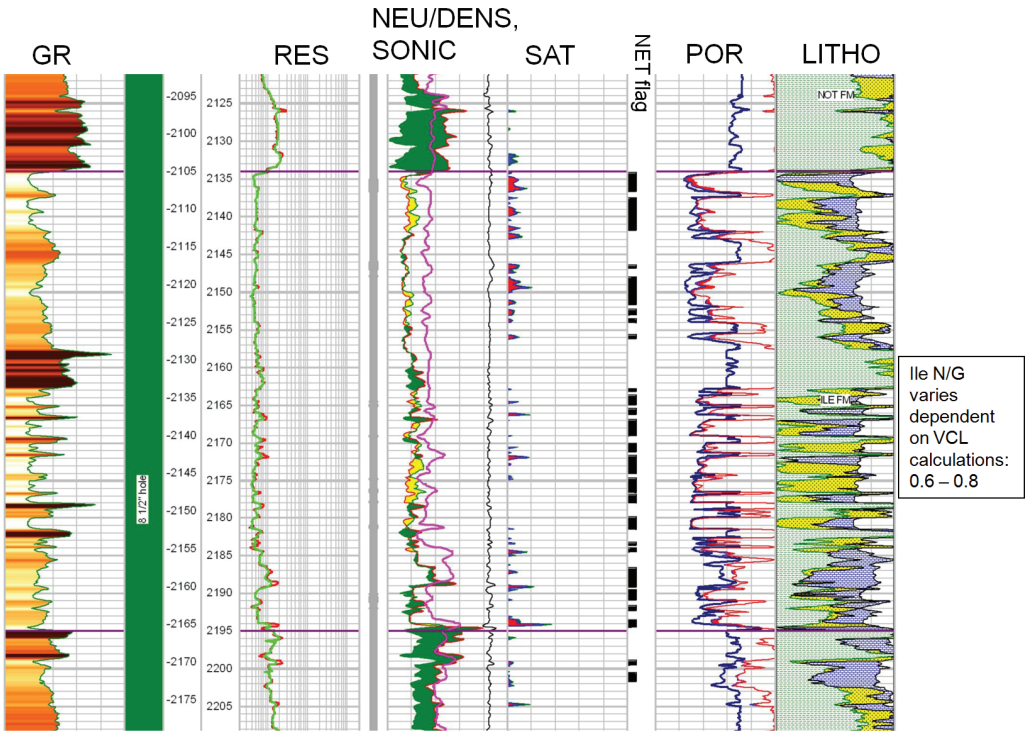


Fig. 4.8 Well 6507/11-10 Ile fm. CPI logs. *Ile fm. CPI logs*

5 Remaining prospectivity

Trolltind Prospect

The Trolltind prospect is the only remaining undrilled prospect within the PL476 license. The Trolltind Prospect is located in the southern part of the license on the footwall side of the graben structure separating the Midgard field from the PL476 area. Expected reservoirs in the Trolltind Prospect is sandstones of the Garn and Ile formations in the Fangst Group and sandstones in the Tilje Formation of the Båt Group. The trap is defined by several fault blocks within a 3-way closure against the fault (Fig. 5.1). The main risk elements of the Trolltind prospect is migration and lateral seal. The chance of success for the Trollind prospect has been reduced after drilling the dry Frusalen well.

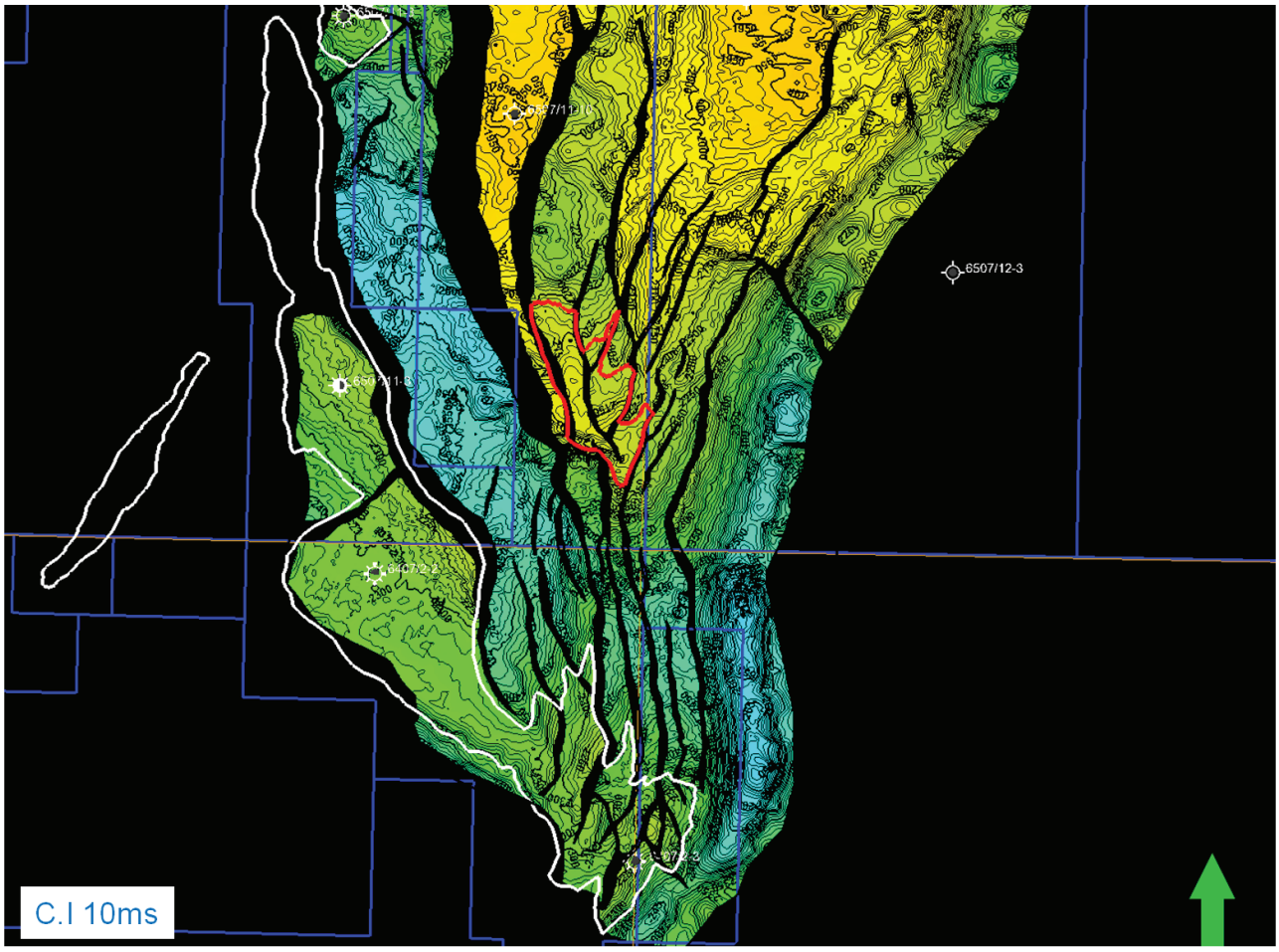


Fig. 5.1 Top Fangst Gp. structural time map. *The Trolltind area Top Fangst structural time map shows the difficult fill-spill route from Midgard to the Trolltind Prospect.*

The reservoirs are proven in the nearby Midgard field and also in exploration wells in the area , including the dry 6507/11-10 Frusalen well. The results from the Frusalen well shows a lower N/G for the Garn and Ile reservoirs than the pre-drill base-case. The reservoir properties of the Trolltind prospect has been reduced to reflect these results.

The most likely charge of prospect is by fill-spill from the Midgard field through a graben area and into the Trolltind Prospect (Fig. 5.1). The Top Fangst structural time map indicates that this graben area is highly faulted and structurally lower than the Midgard field (white outline) itself. Based on

this time-map it is recognized that the migration into the Trollind Prospect has a significant risk. To address this risk a sensitivity study on the depth conversion of this graben area was performed and six different velocity models have been generated, using combinations of 3D and 2D stacking velocities and well velocities. None of the generated velocity models give an output Top Fangst Group (top reservoir) depth map of the graben area shallower than the Midgard GWC contact. Fig. 5.2 shows the base-case depth map of the graben area.

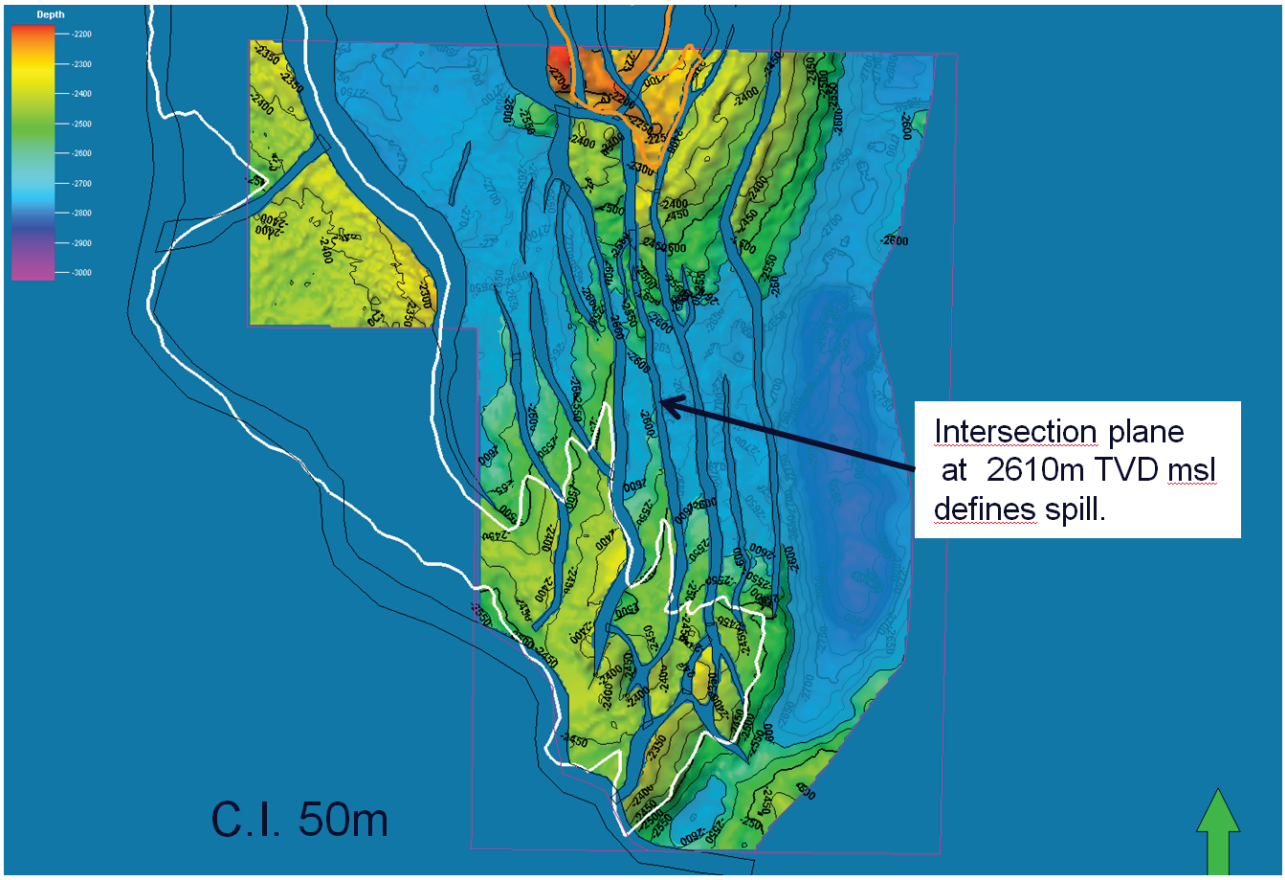


Fig. 5.2 Top Fangst depth map (base case) over graben area. *The base case depth map over the graben area shows a spill point of about 2610m. This is 115m deeper than the 2495m GWC in the Midgard field. The base-case velocity model is based on co-krieging of both 2D and 3D stacking velocities with well velocities from wells in the Midgard field.*

A seismic line through the Trolltind Prospect indicates the hanging wall position of the prospect relative to a horst block that represent the southernmost extension of the Frusalen structure (Fig. 5.3). The risk of lateral seal over this fault is critical , and only a small volume could be captured in the trolltind prospect if this fault is not sealing.

The below table summarizes the resources of the Trolltind prospect for both a sealing fault and a leaking fault towards the Frusalen horst block.

Prospect risk

The COS (Chance Of Success) of the Trolltind prospect is 11%. The chance of finding reservoir present and with sufficient reservoir quality is considered 100%. The COS of the seal of the trap 60%, while the Geometry of the trap is 90%. Source presence and migration are considered with risk of 100% and 30% respectively.

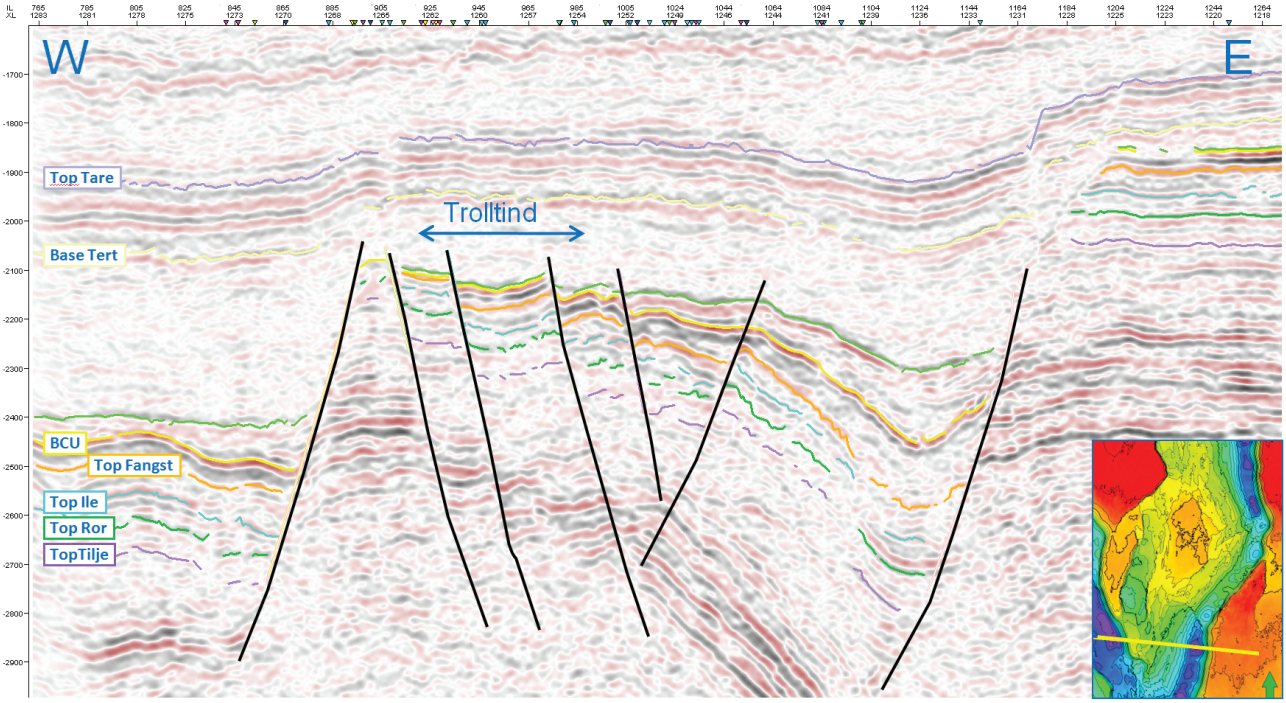


Fig. 5.3 Trolltind seismic crossline. *the seismic crossline over the Trolltind shows the faulted nature of the prospect and that lateral seal towards the horst to the west is critical to the prospect.*

Trolltind prospect summary table:

PL 476					Gross Recoverable recourses (Base)	
Prospect	Reservoir level	HC	RF %	COS %	Cond (MSm3)	Gas (GSm3)
Trolltind	Garn + Ile fm's	Gas	70	11	1,31	3,66

6 Recommendation

Based on the technical evaluation of the remaining resource potential in the PL476 it is decided to relinquish the license. The identified Trolltind prospect has a too high combined geological risk to represent an attractive exploration target for the license.