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Licence Relinquishment Report PL401

Reference is being made to the MPE letter of 12.03.2012 regarding relinquishment of production licence 401.

1 INTRODUCTION

The initial period for Production Licence 401 expired 16.12.2009. The partnership has unanimously decided to fully relinquish the acreage.
The Kasper prospect is a stratigraphic trap located at the Norwegian/Danish border, in the block 4/2, and lies along the well-known Paleocene Siri Fairway. The Kasper prospect relied on an amplitude anomaly identified within the TFO2006 application in between the two salt domes Emilie and Kasper (see figure 1). A new 3D seismic cube was required in order to define the anomaly more accurately. The AVO study indicates a very weak anomaly not conformed to the structure and no flat spot. An Electro-Magnetic study was attempted to determine if there is, or not, any evidence of HC accumulation. Unfortunately, the EM was not feasible for the Kasper prospect.
The Frigg sand of Eocene age constitutes the main reservoir level, thought to be filled by an upper Jurassic source-rock. A long migration route from the Tail-end Graben and the Søgne Basin is required to fill the prospect. This long migration path has been proven by the Nini and Nini east fields, lying south-west of the PL401 licence (see figure 1). In addition, the shallow depth above the two salt domes shows very clear gas/oil anomalies which constitutes a good evidence for a working HC migration in the area. The main risks of the prospect have been attributed to trap efficiency and reservoir quality.

Our date	Our reference	Administrative officer
2012-05-15		
Your date	Your reference	

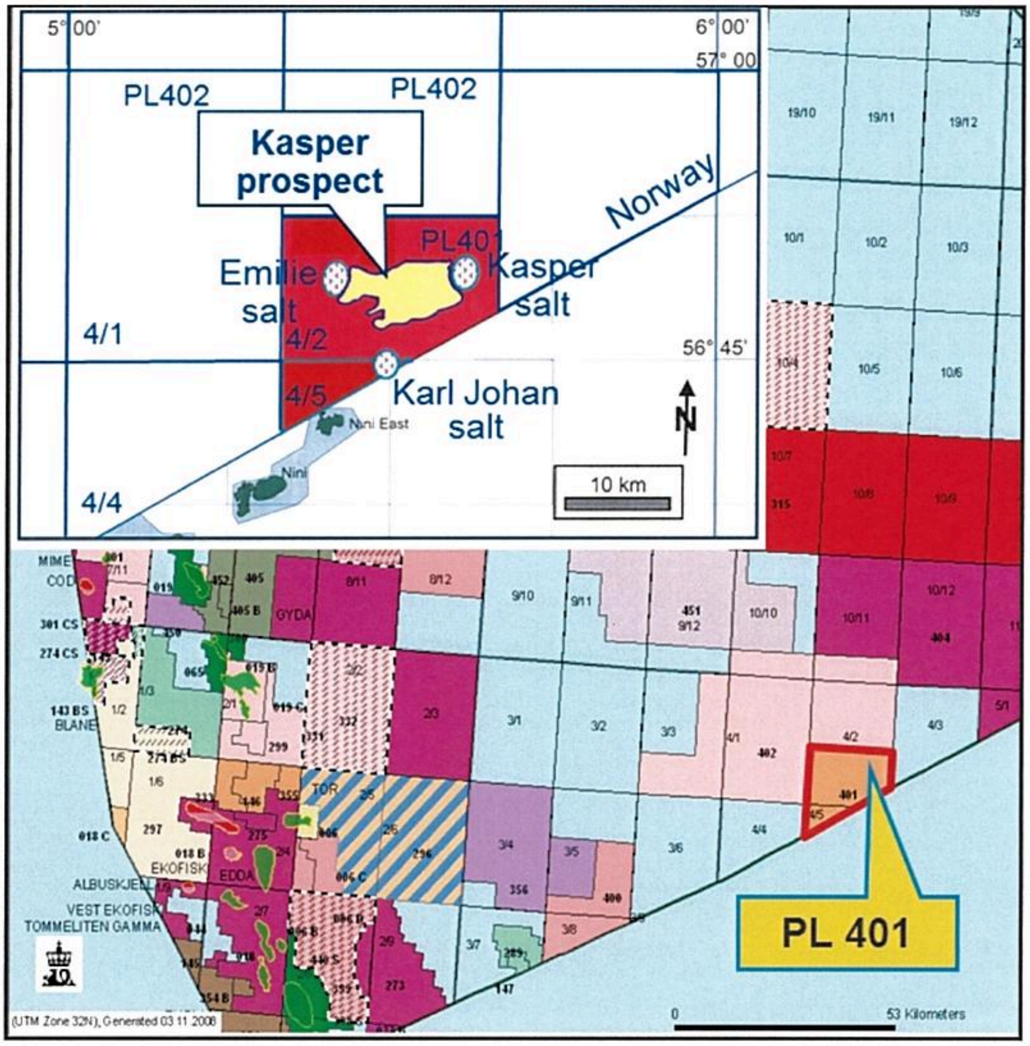


Figure 1: Kasper prospect location map

2 BACKGROUND AND LICENSE HISTORY

1. License award / expiry:
   - PL401 award: 16.02.2007 (TFO 2006). Expiry: 16.08.2012. Drill or Drop decision by 16.08.2009. D or D date extended by four months to 16.12.2009.
2. Partners and equity:
   - PL401: Statoil Petroleum AS (Operator) 70%,
     Dong E&P Norge AS 30%
3. Work obligations:
   - Minimum 250 km2 new seismic to be acquired over licence: fulfilled.
   - D or D decision within 2,5 years.

4 License history:

- 290 km^2 3D seismic over PL401 acquired in 2008, interpreted in 2009.

3 TECHNICAL WORK AND MEETINGS

Three Management Committee meetings have been held:

- MC NO. 1: April 20 2007
- MC NO. 2: November 11 2008
- MC NO. 3: October 28 2009

In addition, three Exploration Committee work meetings have been held:

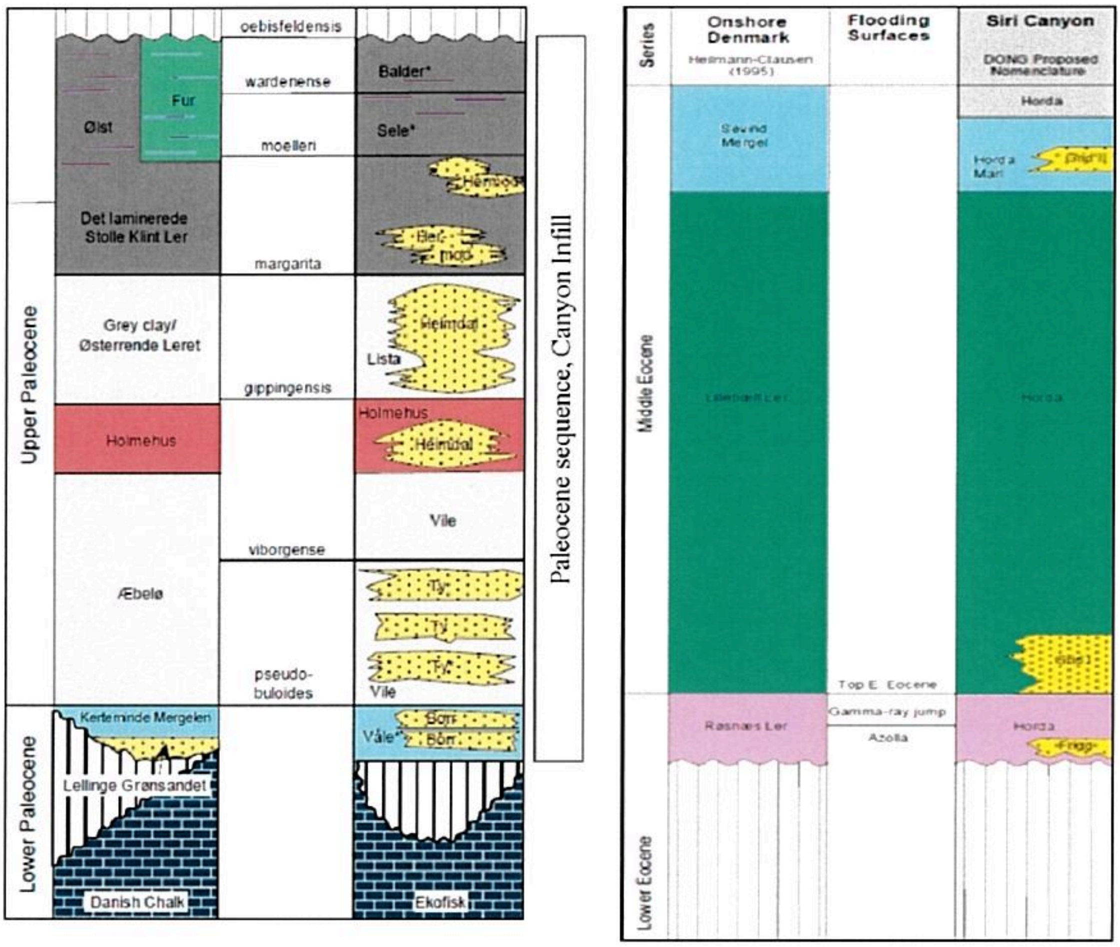
- EC NO.1: February 06 2008
- EC NO. 2: March 05 2008
- EC NO.3: May 11 2009

4 PROSPECT EVALUATION

The Siri canyon extends 150 km from the Stavanger plateform into the Danish Central Graben with a width ranging from 15 to 20km. It is 200 m deep and cut into the weakly consolidated underlying pelagic chalk section during Early Paleocene uplift of the Scandinavian hinterland by submarine sand flows. This major event was caused by the shelf-margin collapse of unstable glauconitic shelf sand on the Stavanger platform (Hamberg *et al.*, 2005; Rasmussen *et al.*, 2005).

A total of 5 fields were discovered along the Siri fairway in the Danish side.

The figure 2 illustrates the Eocene-Paleocene stratigraphy along the Siri Canyon. Several phases of canyon infill have been emphasis, indicating 4 reservoir levels, the Eocene Frigg sandstone being the last pulse of sediment supply from the Stavanger plateform. The Paleocene sand deposition history is recorded by the Ty, Heimdal and Hermod formations. The Vile, Holmehus, Lista, Sele and Balder formations represent hemipelagic and turbiditic mudstones and siltstones.

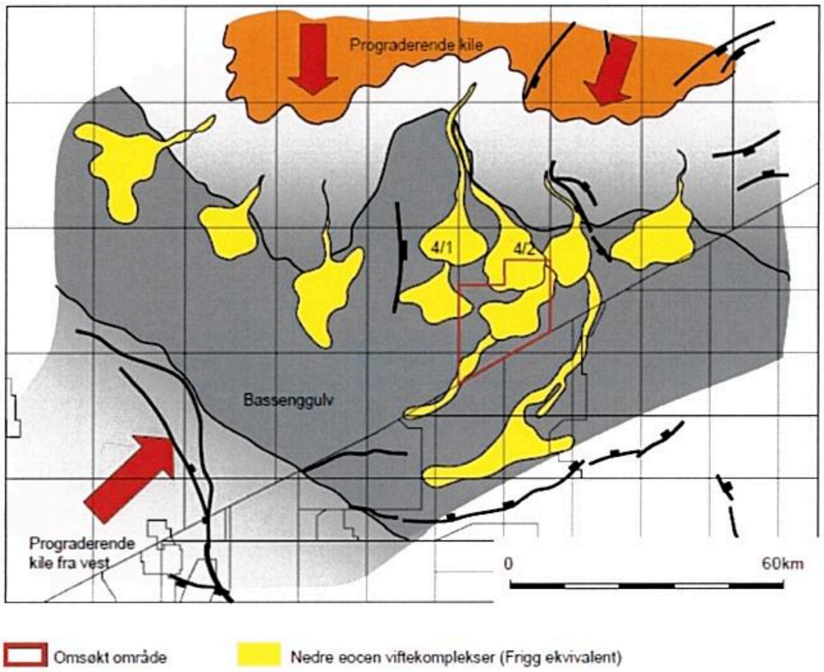


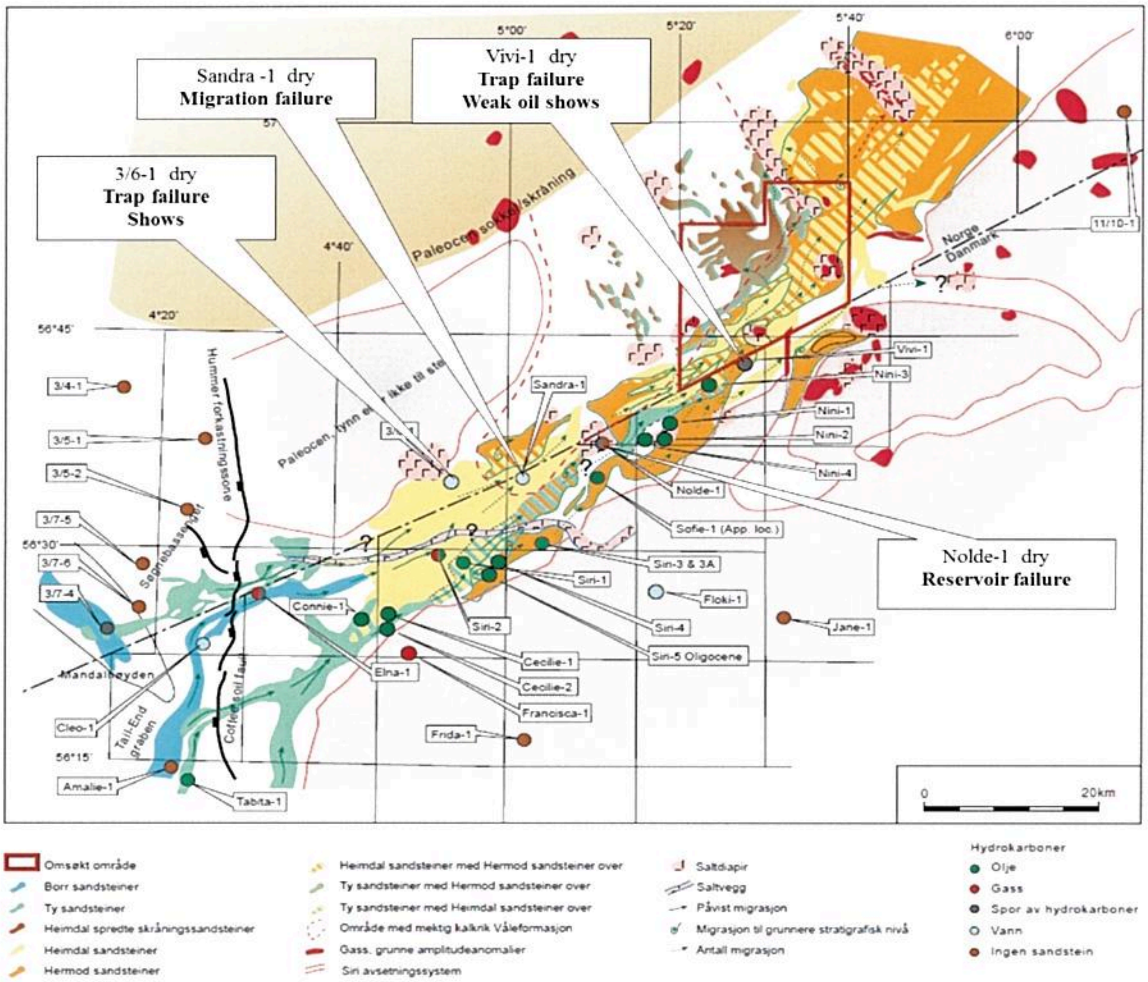
<u>Figure 2</u>: Paleocene- Eocene stratigraphic column

Eocene and Paleocene sandstones developed as lowstand basin-floor fans of thick glauconitic sandstones deposited from concentrated debris flow (see figure 3). The Siri Canyon sandstones are massives, remarkably clean with minor amount of detrical clays, structureless appearance showing sharp upper and lower boundaries. They are described as very fine to fine grained, well sorted and highly glauconitic with mudstone clasts. A post-depositional remobilization has been highlighted with the presence of numerous intrusive sandstones in the surrounding mudstones.

The depositional pattern is controlled by a strong interaction between gravity flow to turbiditic currents, salt-influenced seafloor topography and differential compaction.

Figure 3: Eocene sand distribution map: Frigg and Hermod sandstones (from TFO 2006)





<u>Figure 4</u>: Paleocene-Eocene sand distribution map in the Siri Fairway (from TFO 2006)

The sediments were supplied by an eroded shelf area located the E-NE of the Siri Fairway. The deposition of sandstone was episodic and related to shelf edge instability triggered by low-standing sea level or periods of tectonic activities. The figure 4 illustrates the reservoir distribution and spacial relationship of the 3 Paleocene sandstone members from TFO 2006. The results of 4 new wells from 2006 have been added to the figure.

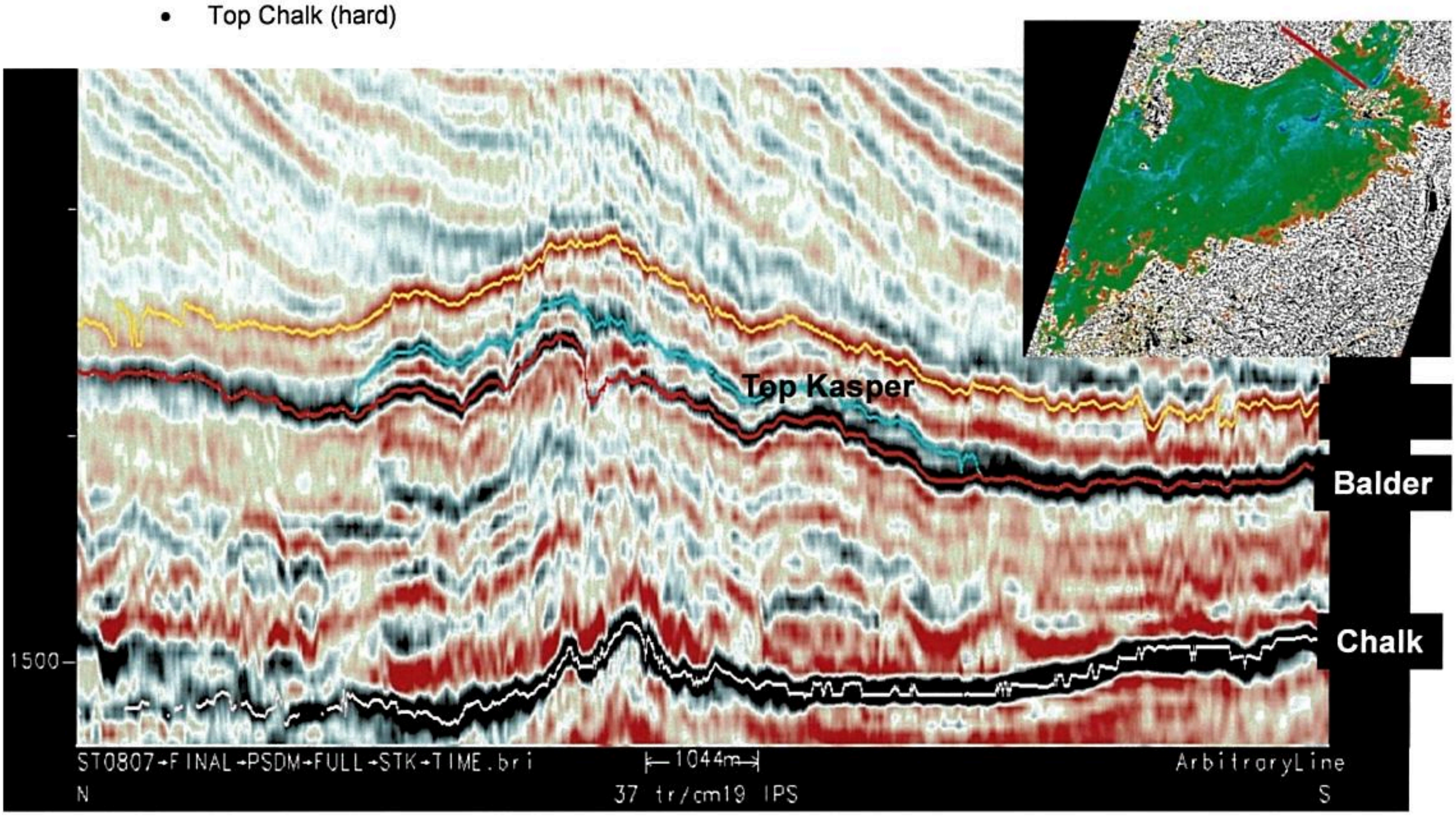
4.1 Seismic interpretation and analysis

The seismic interpretation was performed in 2009, using the new ST0807 PSDM seismic dataset acquired in 2008. This survey has a good data quality. The older MC3D-Q4 seismic dataset was used outside the area covered by ST0807. ST0807 was PSDM processed to handle velocity anomalies in the overburden due to shallow channels causing pull-up and reduction in data quality.

The seismic data was tied to the water-bearing Vivi-1 and oil-bearing Nini-3 wells in the Danish sector

The following horizons were interpreted (Figure 5):

- Top Horda Formation (soft)
- Top Kasper prospect (hard)
- Top Balder Formation (hard)
- Top Chalk (hard)



<u>Figure 5</u>: Interpreted seismic cross section over the Kasper prospect. Normal polarity, black positive.

The Kasper prospect is defined by a maximum negative amplitude anomaly above Top Balder and by a prominent isochrone anomaly for the Top Balder-Top Kasper interval (Figure 6). It pinches out to the North, South and East. The Western extension is more uncertain. It is interpreted as a Frigg equivalent basin floor fan in the Horda Formation of Early Eocene age

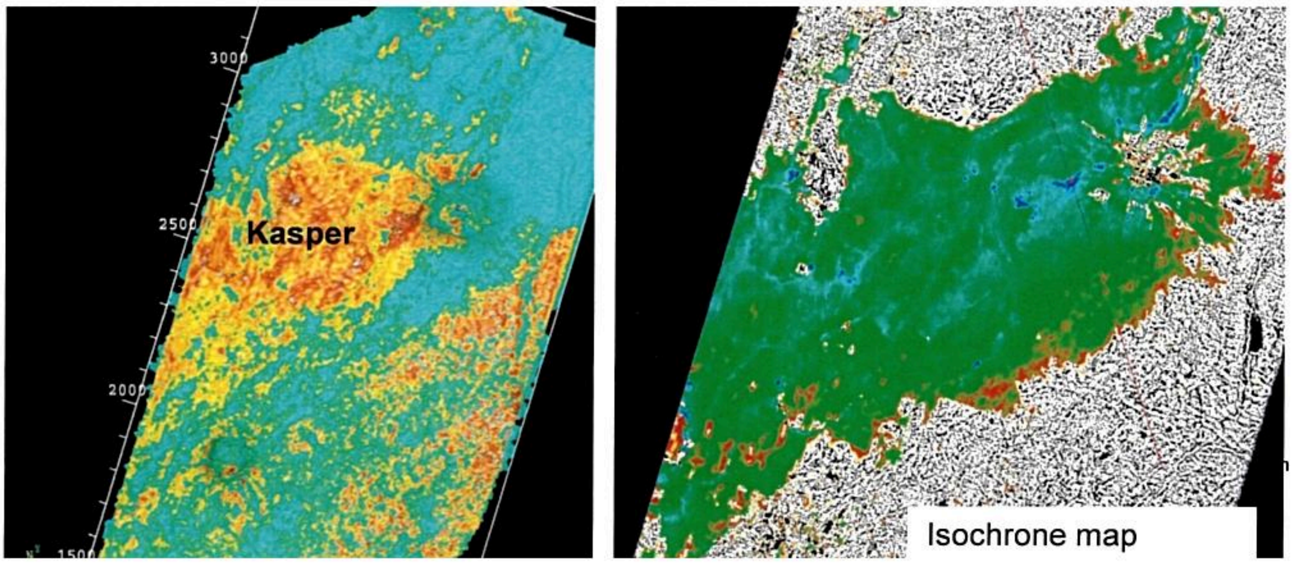


Figure 6: Maximum negative amplitude attribute map (left) and isochronal thickness map of Kasper prospect

Depth conversion was performed using the same velocities used in the PSDM processing. A top Kasper depth map and isochor thickness map are shown in Figure 7.

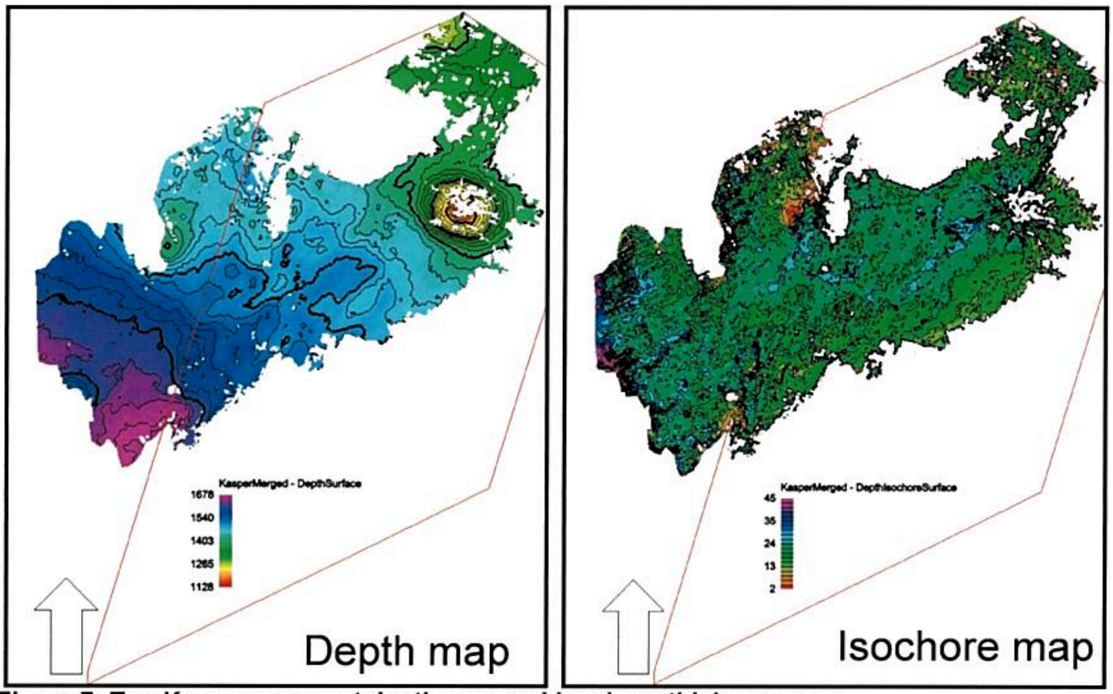


Figure 7: Top Kasper prospect depth map and isochore thickness map

Contrary to the old seismic data, the ST0807 survey has the data quality required to perform AVO analyses, which was performed by using pre- and post-stack data. The expected seismic response from water and oil filled sandstones was examined by comparing the synthetic response calculated from well logs and fluid substitution with the seismic data near the well containing the same type of sandstones as expected in the Kasper prospect. The Vivi-1, Nini-3 and Nini-4 wells were used for this analysis. AVO analysis over the Kasper was then compared to the expected fluid response.

All oil discoveries in the Siri Canyon show clear AVO anomalies, commonly associated with prominent flat spots. No comparable AVO anomalies which could indicate the presence of oil were observed in the Kasper prospect. The weak maximum negative amplitude anomaly in Kasper is most likely caused by sidelobes from Top Balder amplitude anomalies which are uncorrelated to the presence of hydrocarbons in Kasper. The hard seismic response at top Kasper level is neither compatible with the presence of an oil bearing sand.

4.2 Depositional model

The figure 8 represents a geological cross-section along the Siri Fairway axis from 1999, updated with the results of the Siri and Nini fields and the Nini-3 and Vivi-1 wells. The reservoirs are seen as non-connected sand bodies.

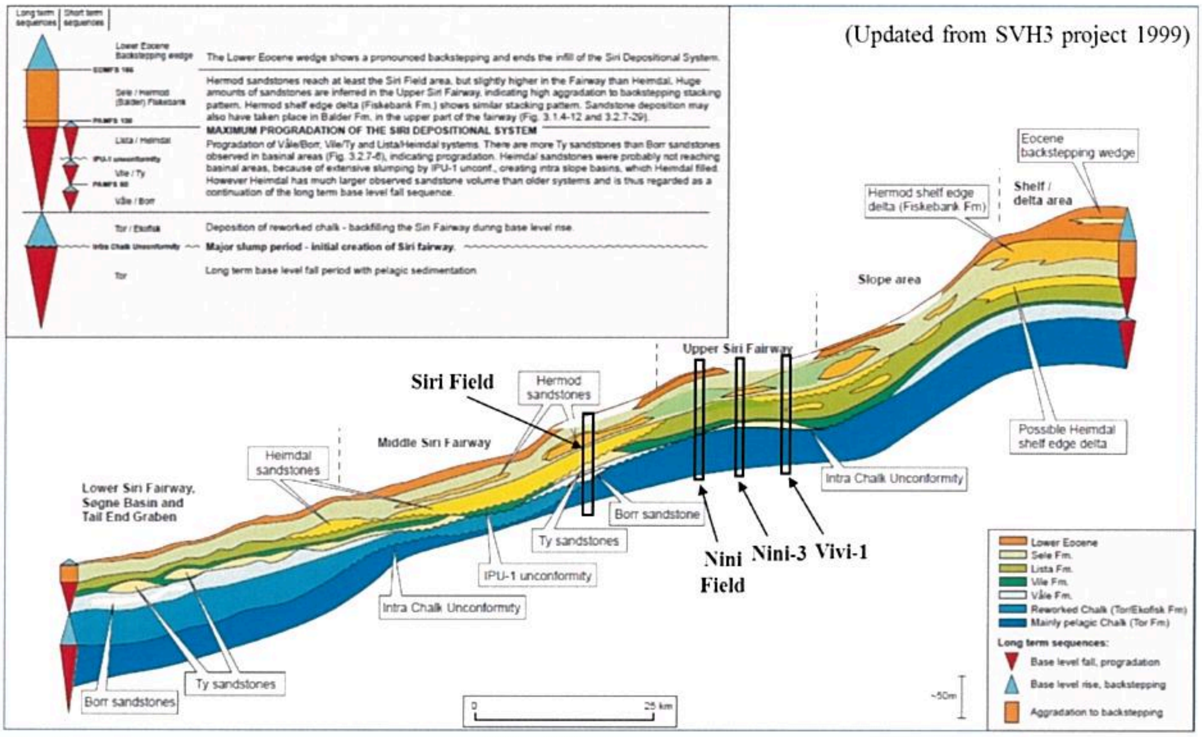


Figure 8: Geological cross-section along the Siri Fairway main axis.

The figure 9 shows a SW-NE seismic line along the kasper prospect and tied to the Nini-3 and Vivi-1 wells with geological interpretation of the Eocene-Paleocene sand bodies.

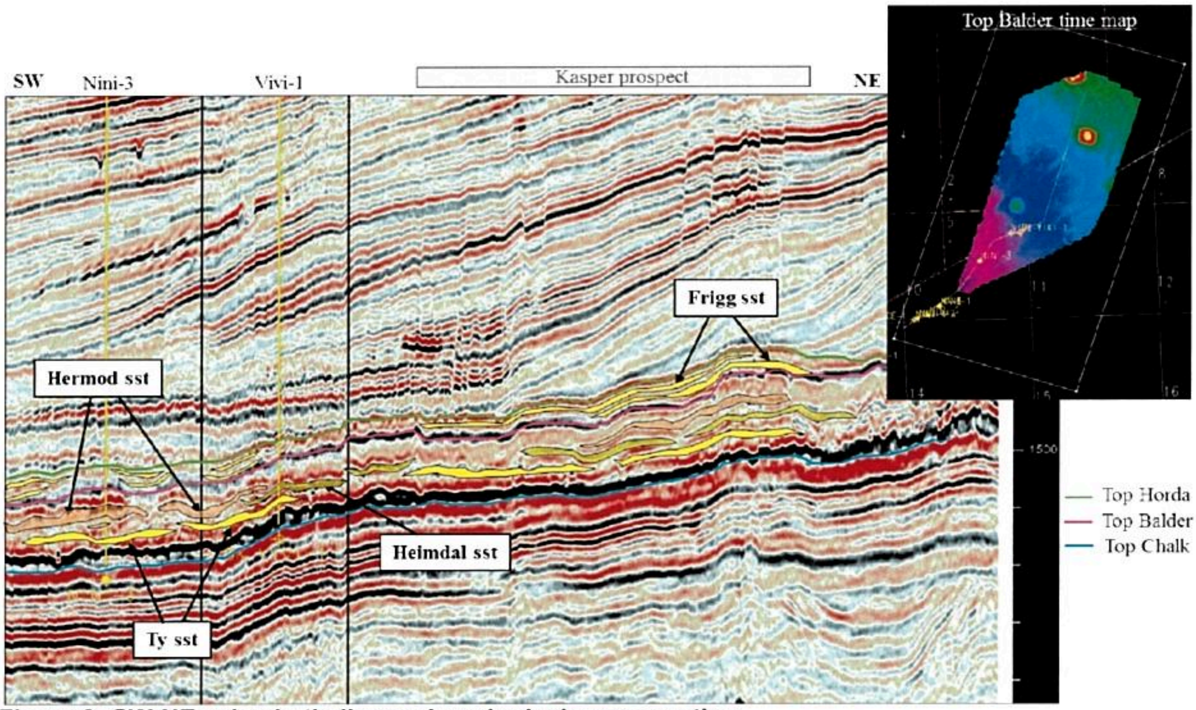


Figure 9: SW-NE seismic-tie line and geological cross-section.

The figure 10 is a well correlation panel along the Nini and Nini East fields. The 4 reservoir zones appear not to be all present in none of the displayed wells. The Frigg sand is well developed in Nini-4 and Nini-4 A whereas Ty, Heimdal and Hermod sands are absent. In Nini-3 and Vivi-1 wells the Frigg sandtone is absent, the Ty sandstone is well developed and Heimdal and Hermod sand package are limited.

The lowermost sst of Frigg, Hermod and Heimdal members represent post-depositional injected sand into surrounding formations. The Ty sand remobilisation and injection is related to post-depositional growth of the structure, controlled by NW-SE trending normal faults on the southeastern flank of the Nini structure.

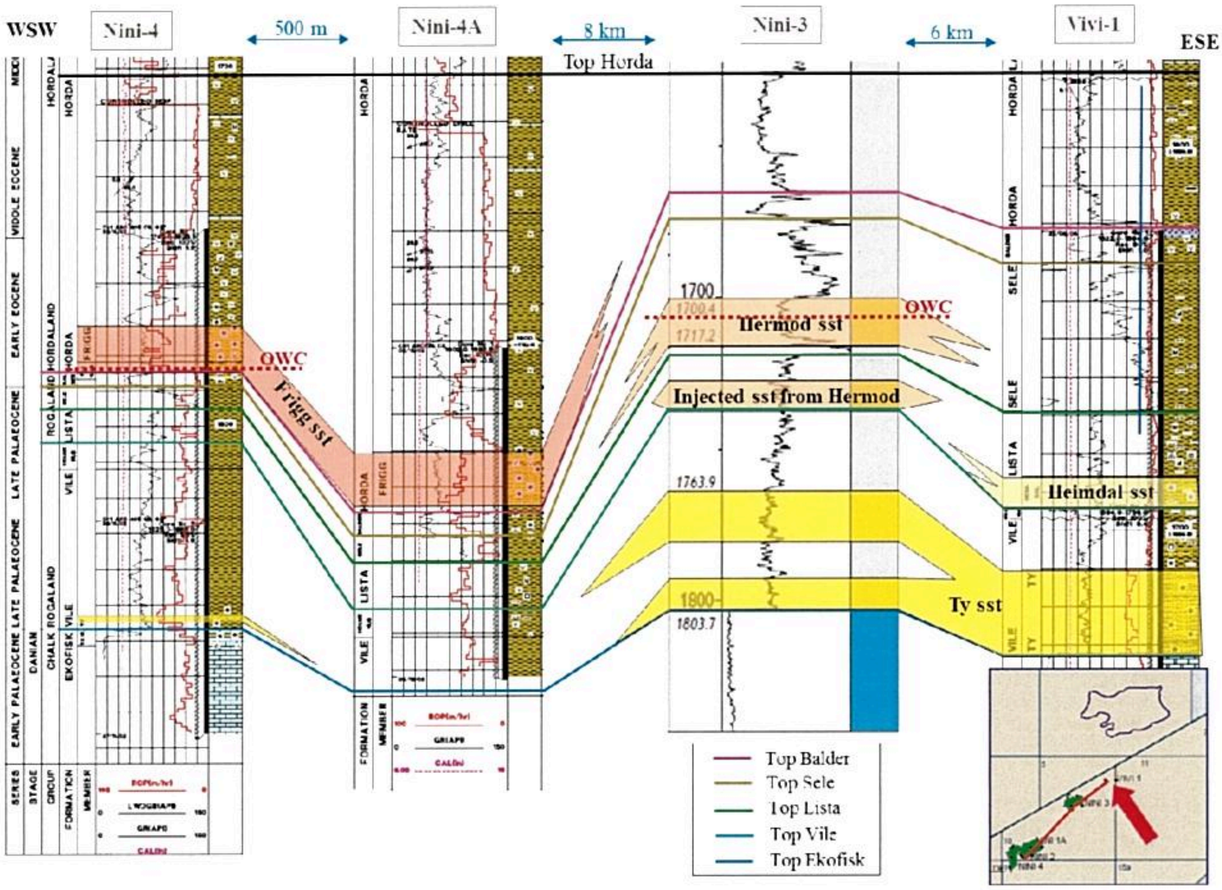


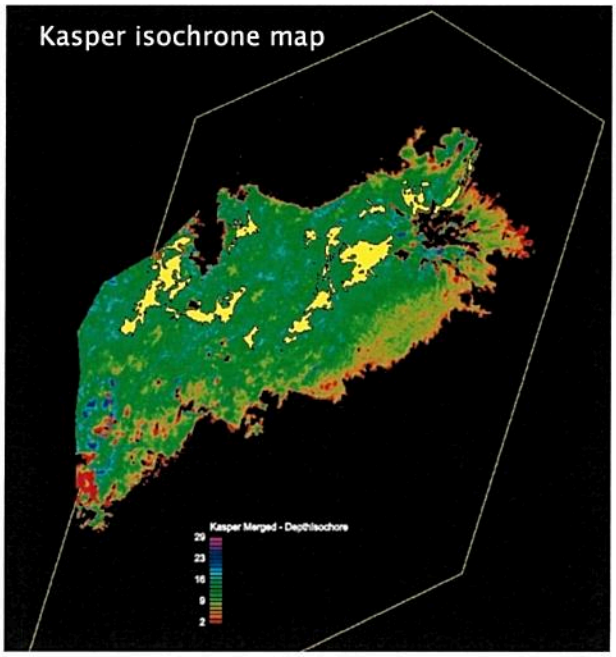
Figure 10: WSW-ESE well correlation panel

The Ty sand, Heimdal, Hermod and Frigg sands have been interpreted as present at the Kasper location (figure 9). The Kasper prospect lies closer to the sediments source, the Eocene-Paleoence unit look thicker than at Vivi-1 and Nini-3 location and the seismic response indicate several chaotic deposits which might well correspond to the 4 reservoir levels.

The reservoir presence and sand distribution in PL401 have been based on time maps and isochrones maps interpreted from the new seismic survey in addition to inputs from previous studies (SVH3). The figure 11 shows and isochrones map of the Frigg sandstone at Kasper location. The figures 12 and 13 show the Frigg, Hermod and Heimdal sandstone distribution maps using time maps at their corresponding reservoir levels.

Figure 11: Kasper isochrones map of Frigg sandstone.

The thickest areas (> 23 m) are shown in yellow. These areas also show the highest amplitudes.
Small and isolated areas were removed from the map.
The thick areas are assumed to represent channels and sand sheets with reservoir properties similar to Frigg in Nini-4.
GRV was calculated for the whole area after dividing the depth isochore by 2.



Part of the Kasper salt diapir is covered by the Frigg formation. No real channel feature is seen on the Kasper isochrone map. The Kasper prospect appears to contain poorer quality reservoir than Nini-4 with more sheet-like feature deposits.

Frigg sst parameters:
Av. N/G = 89%
Av. Ø = 29,5 %
Av. K = 1200 mD

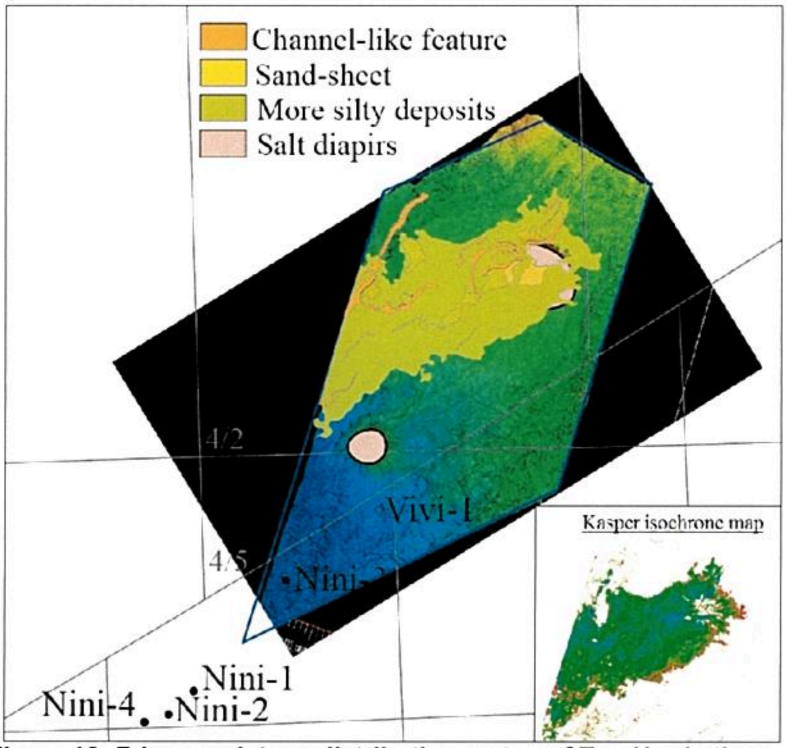


Figure 12: Frigg sandstone distribution on top of Top Horda time map

Herm Hermod and Heimdal members show more sandy deposits with channel/crevasse splays system at Kasper location than the Frigg sandstones (see figure 13). The same legend is applied on the three reservoir distribution maps.

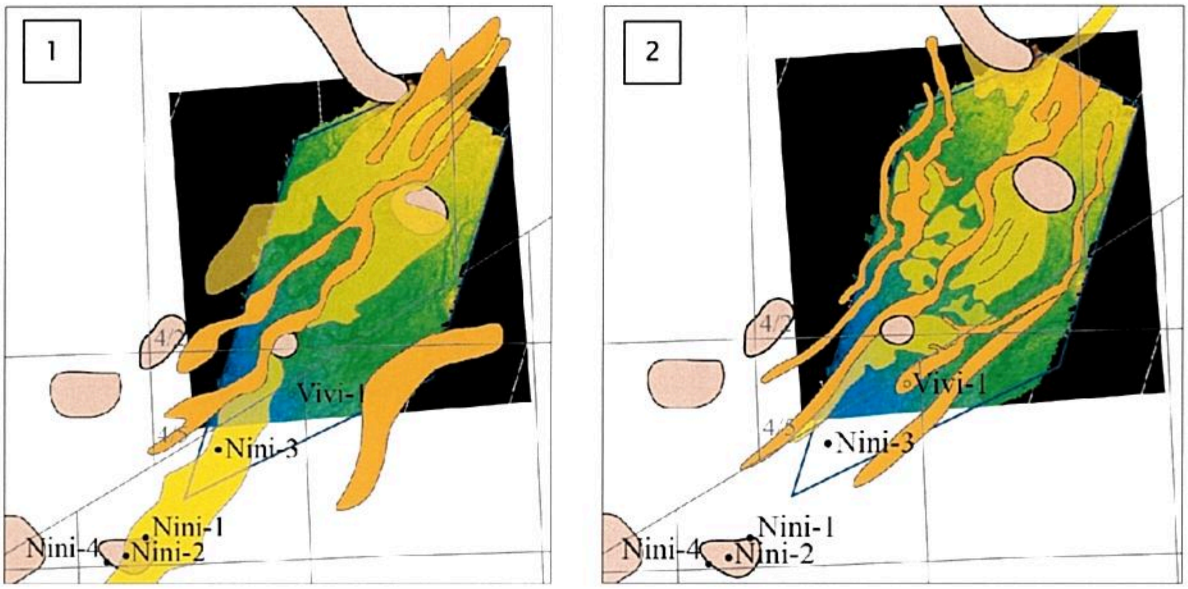


Figure 13: Hermod (1) and Heimdal (2) sandstone distribution on top of Top Balder time map

The reservoir parameters for the main representative wells is the AOI have been gathered and recorded in the table 1. A color code indicates which period of time the reservoirs belong to for each well. The table 2 gives the average parameters for each reservoir level and the table 3 gives the chosen parameters for the Frigg sand in the Kasper prospect.

Wells	Fromation name	Top Depth (m) TVDSS	Base Depth (m) TVDSS	Gross (m) TVD	Net Sand (m)	N/G (%)	Porosity (%)	Permeability (mD)	Sw (%)
Vivi-1	Heimdal Mbr	1647	1655	8	0.9	9	24	300	100
	Ty sand	1671	1694	23	14.5	63	26	345	100
Vivi-1A	Hermod mbr	1630.5	1648.8	18	12.5	67	26	335	64
Nini-4	Frigg sand	1734.3	1747.5	13.2	11.8	90	28	1300	21
	Ty sand	1815.2	1823.4	8.2	6.8	86	14	525	100
Nini-4A	Frigg sand	1770.8	1785.5	14.7	13.00	88	31	1100	100
Nini-3	Hermod mbr	1662	1678.7	16.7	14.90	89	29	No data	45
	Ty sand	1725.6	1741.9	16.3	12.90	79	29	No data	100
		1742.05	1753.15	11.1	11.10	1	26	No data	100
Siri Central	Heimdal/Hermod	2050	2150	100	50-90	0.5-0.9	31 (25-35)	15-250	<20

Early Eocene
Late Paleocene
Early Late Paleocene

Cut-off: Ø=15 %, Vsh = 50%

Table 1: Paleocene-Eocene reservoir parameters around the Kasper prospect.

Siri Fairway	Ty	Hermod/Heimdal	Frigg
Av. N/G	0.82	0.70	0.89
Av. porosity	0.24	0.27	0.29
Av. Permeability (mD)	435	295	1200

Table 2: Average parameters for each reservoir level

Kasper prospect	Mean	P90	P50	P10
N/G	0.79	0.69	0.79	0.89
Porosity	0.3	0.27	0.3	0.33
Oil saturation	0.7	0.64	0.7	0.75

Table 3: Frigg reservoir parameters for the Kasper prospect

4.3 Source and migration

The Kasper prospect requires a long migration route, more than 180 km, from the upper Jurassic source-rock in the Tail-end Graben and Søgne Basin. The figures 14 and 15 illustrate the play concept and the migration model from the Tail-end Graben and the Søgne Basin up into the Siri fairway.

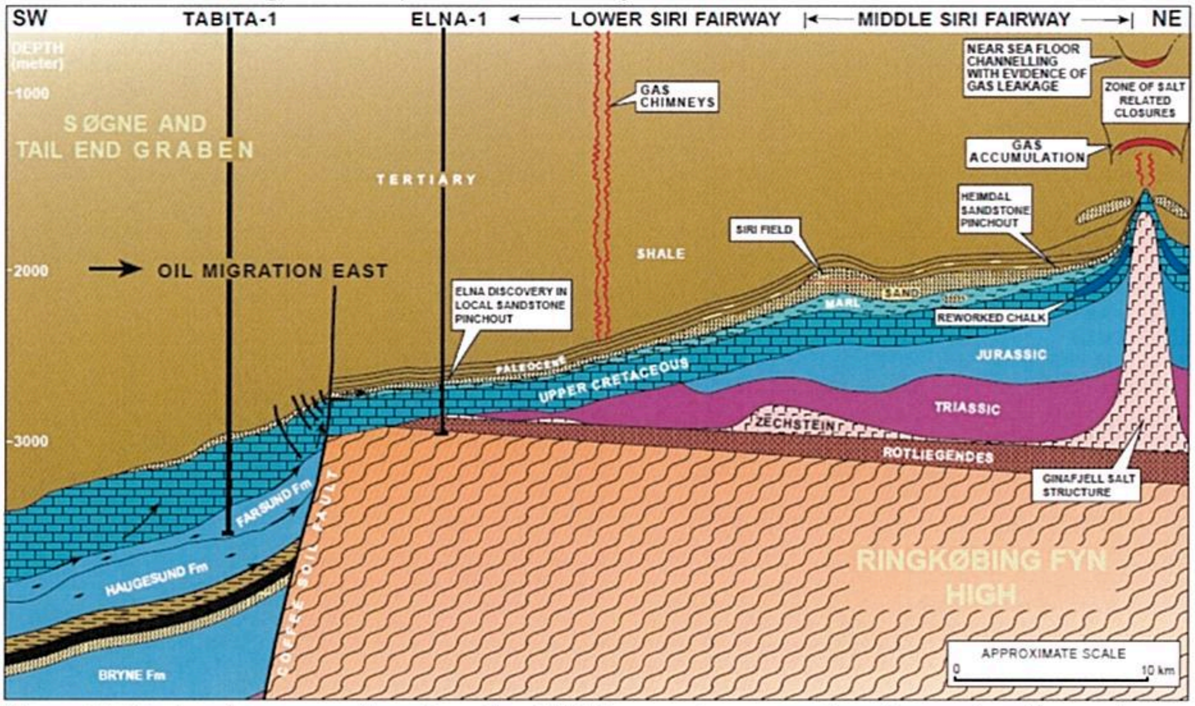
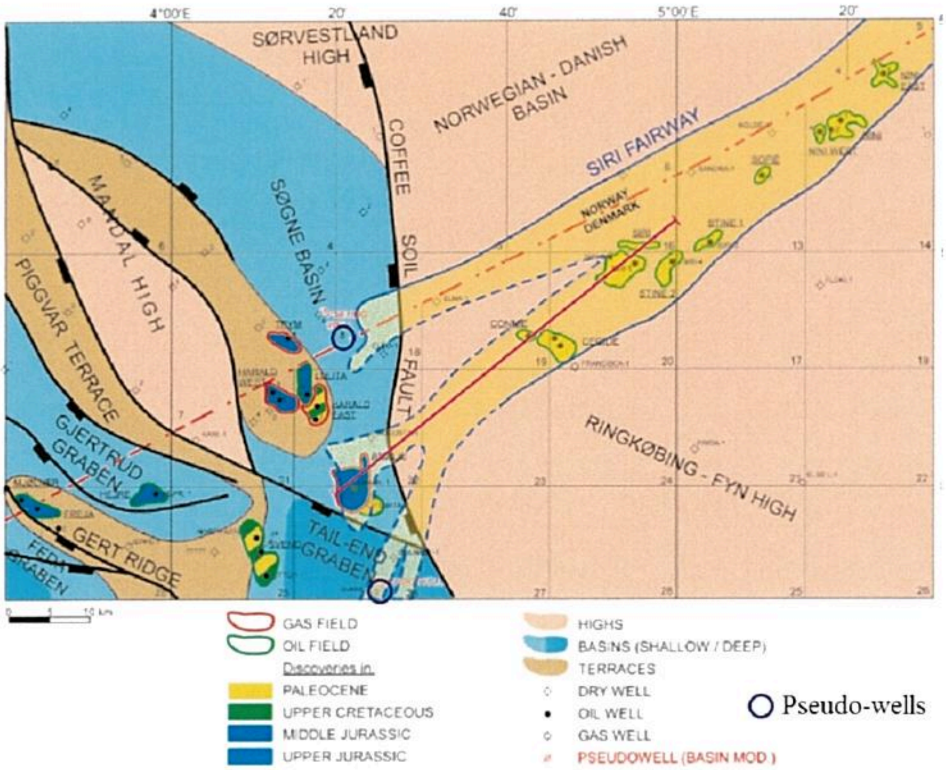
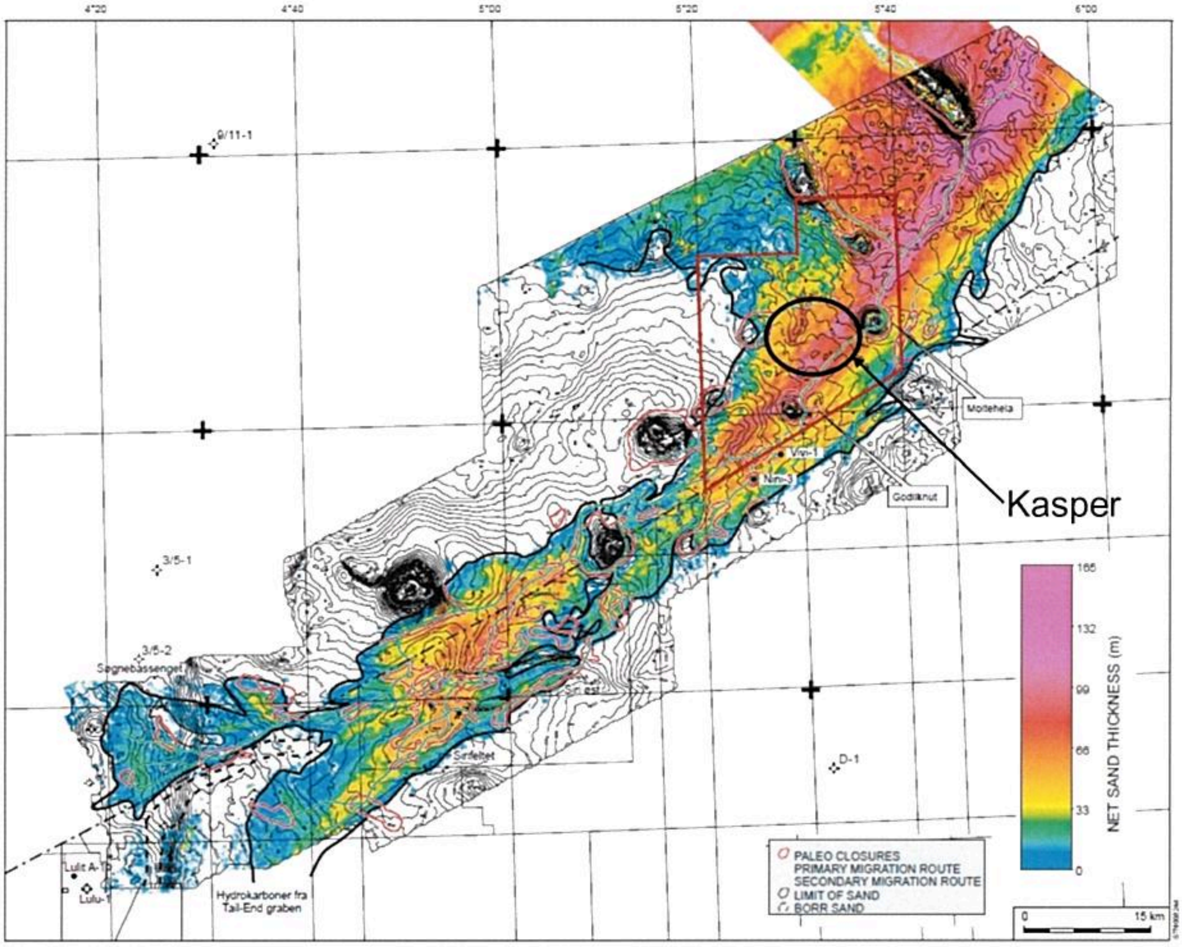


Figure 14: Regional cross-section along the Siri fairway, play concept and long migration route.



<u>Figure 15:</u> Conceptual migration model for the Siri Fairway

This long migration model has been proved by numerous fields lying along the Siri Fairway (see figure 15). Gas chimneys and shallow gas are also good indicator for Hydrocarbon accumulation in the area. The figure 16 is a paleo-migration map within the Siri canyon from TFO 2006. It shows paleo-closures, primary and secondary migration route. The Kasper prospect appears to lie clors to the primary migration route.



<u>Figure 16</u>: Paleo-migration pathway (from TFO 2006)

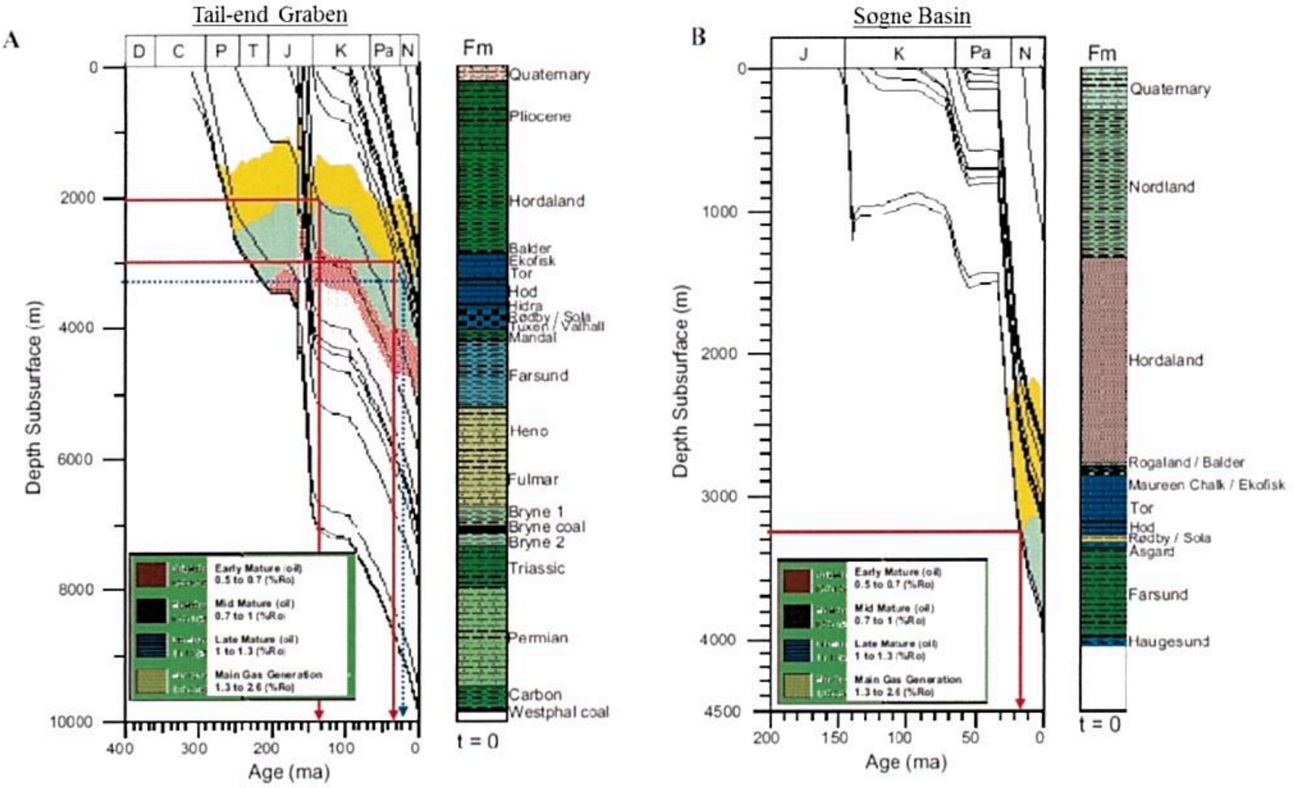
Basin modeling analysis have been carried over for both the Tail-end Graben and the Søgne Basin, using pseudo-wells (figure 17). The location of pseudo-wells can be seen in figure15.

<u>Tail-end Graben model</u>:

- Rapid subsidence (65m/Ma) toward the end of Jurassic.
- Decreased until Mid-Cretaceous after which it has subsided at 32m/Ma.
- The base of Farsund formation **entered oil window at ~130 Ma**.
- The top of Farsund formation **entered oil window at ~30 Ma**.
- The baseof Farsund formation entered the late Mature window at ~30 Ma.
- The temperature has been high for a long time period which has affected the generation and expulsion of hydrocarbon.

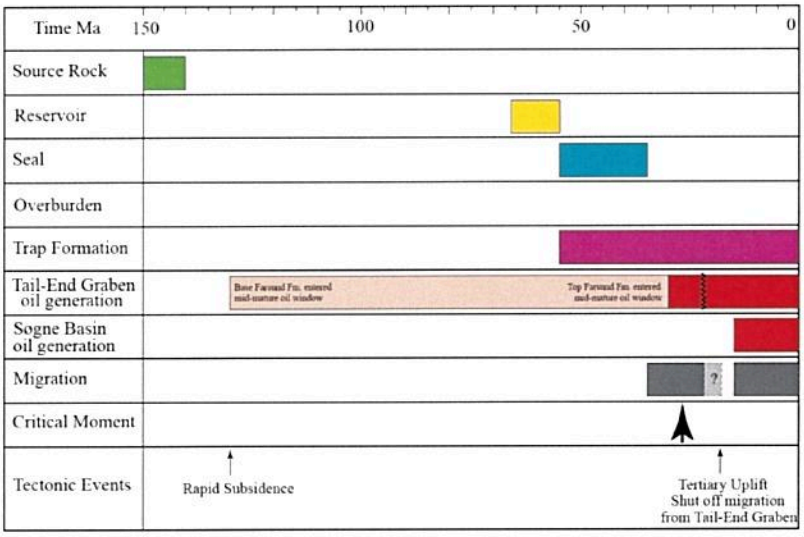
<u>Søgne Basin model:</u>

- Main phase of subsidence in Late Paleocene at 70m/Ma for the last 34 Ma.
- The base of Farsund formation **entered oil window at ~15 Ma**.
- The top of Farsund formation has only recently entered oil window.
- The Søgne Basin is a cool and shallow basin.



<u>Figure 17</u>: Subsidence curves from pseudo-wells, 1D Basin modelling (from Ohm *et al.* , 2006).

Oil generation and migration has to be compared with timing of trap formation. As described above the Farsund source-rock entered the mid-mature oil window at ~130 and ~30 Ma (0,7%Ro) in the Tail-End Graben and between 15 Ma and present time in the Søgne Basin. The Siri canyon sandstones were deposited during Paleocene time (66-55 Ma) and the seal was set up through Eocene time (55-35 Ma). A tilted OWC in the Siri Field indicates that hydrocarbon migrated into the structures before the Tertiary tilt (22-18 Ma), indicating that a low maturity hydrocarbon from the Tail-End Graben must have entered the Siri Fairway after Eocene time (35 Ma). The tertiary uplift has shut off the migration from the deep Tail-End Graben, which is no longer active nowadays. If the present undersaturated oil entered the Siri Fairway as saturated fluid, this may have occurred when the Fairway was buried 1 km less deeply than today, which means around 22 Ma.The figure 18 represents the event chart of the Siri Fairway petroleum system.



<u>Figure 18:</u> Event chart of the Siri Fairway petroleum system.

5 RESOURCES

5.1 Risk assessment

The table 4 gives a summary and comments on the Kasper prospect risk assessment.

The main risk relies on the trap efficiency of a stratigraphic trap with possible sand connectivity at the pinch-out line toward north-east and a risk of leakage into shallower sand bodies. Ptrap is estimated to 0,14. The risk at reservoir level is mainly due to uncertainties on the type of facies and though on reservoir quality. The reservoir producibility is proven by the Fields around and the uncertainty remains on the thickness, the reservoir needs to be thick enough to be producible. Preservoir is set to 0,56. The source rock is proven and the long migration model works in the Siri Fairway. Some risk is still attributed to long distance migration as no Fields are present north of the Kasper prospect. Psource is then 0,8.

Risk Factor	Probability	Comments
Trap Geometry	0,9	Thickening of the lower Eocene with well defined top. Uncertain Western extent.
Trap Seal	0,15	Stratigraphic trap with insignificant 4D closure. Long pinch-out line in the sediment source direction. The prospect is penetrated by faults near diapirs (apex) and overlying clinoforms may cause leakage through sand layers.
Ptrap	**0,14**	
Reservoir Presence	0,7	Uncertainties on type of facies: good sand or poorer reservoir?
Producibility	0,8	Uncertainties due to a small reservoir thickness (15-20 m).
Preservoir	**0,56**	
Source Presence	1	Proven by Siri fairway fields
Source Migration	0,8	Long distance migration proven by nearby discoveries and fields. The closest well was dry due to leakage.
Psource	**0,8**	

Table 4: Kasper prospect risk assessment

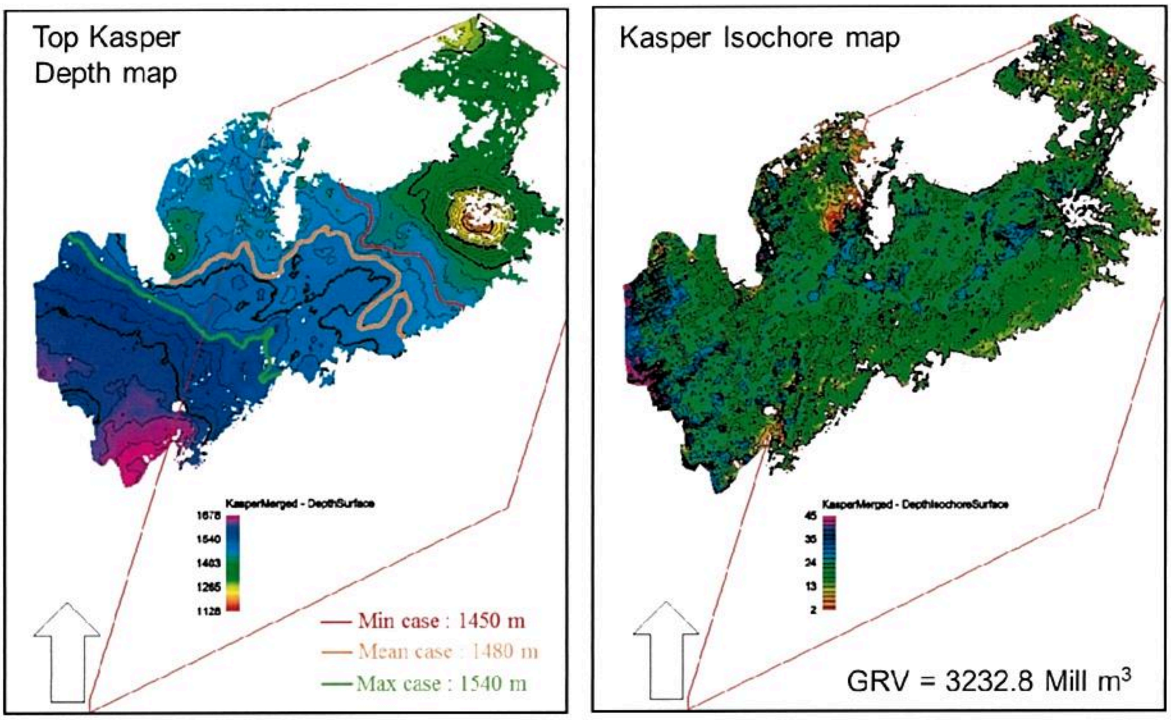
The associated Chance of Success (Pg) is calculated to be **0,06** without using DFI and **0,04** after DFI derisking.

5.2 Volume estimation

Experience from Paleocene and Eocene sands has shown that there is commonly a clear positive correlation between sand content and isochore thicknesses.

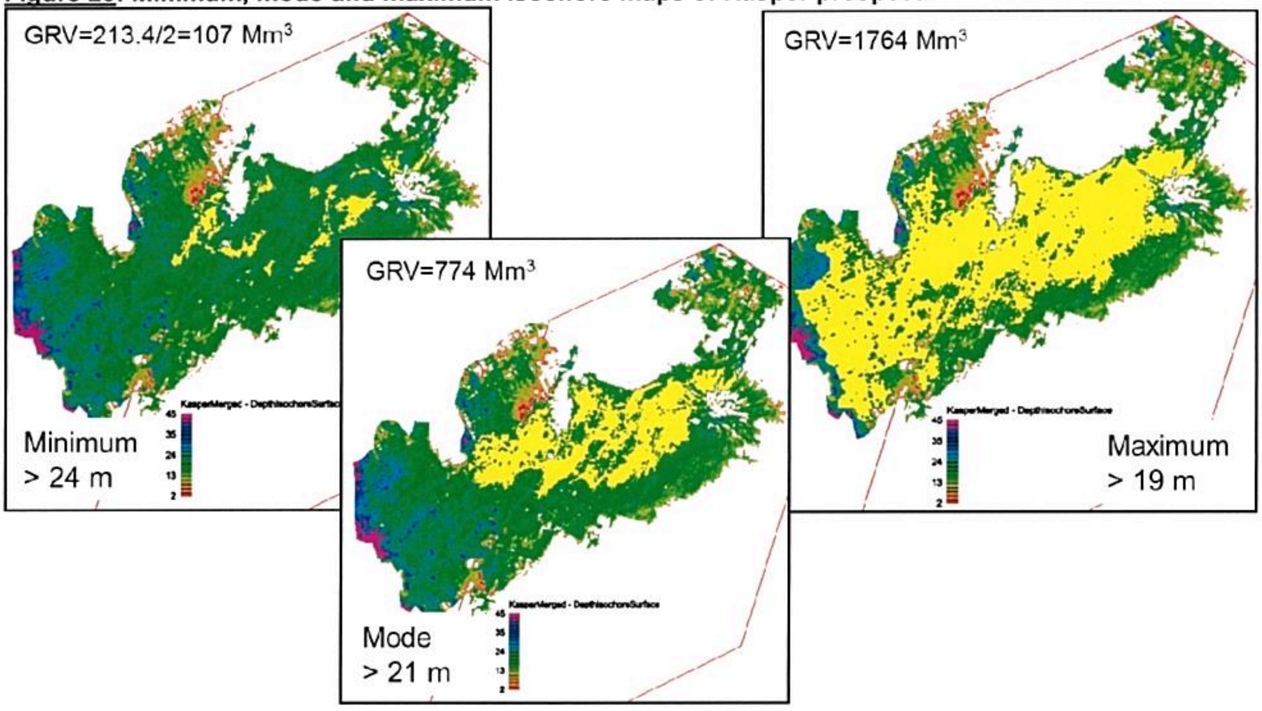
Even though Kasper shows small variations in isochore thicknesses, we apply the same method for Kasper to restrict the areal extent of the prospect. The GRV estimation method is then based on the depth isochore map and was calculated for the whole area after dividing the map by 2 (see figure 19). The depth map in the figure 19 illustrates the min case at 1450 m, the mean case at 1480m and the max case at 1540 m. The isochore map highlights in blue the thickest area in the prospect.

The figure 20 shows the minimum, mode and maximum isochore maps, the yellow areas being the location of minimum thickness for each case, respectively 24m, 21m and 19m.

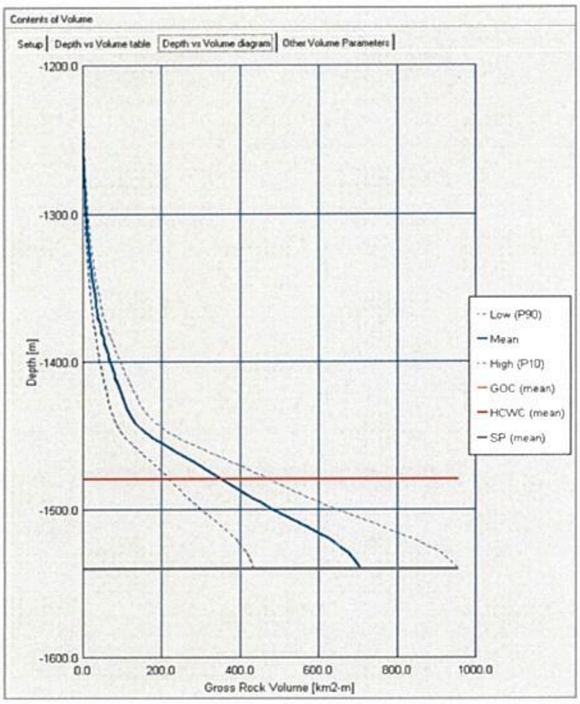


<u>Figure 19</u>: Kasper depth map and isochore map.

<u>Figure 20</u>: Minimum, mode and maximum isochore maps of Kasper prospect.

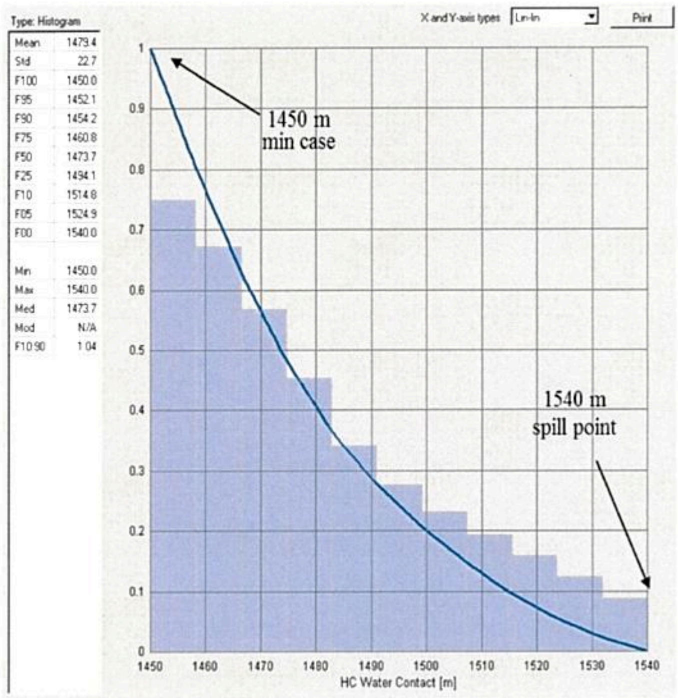


The Gross Rock Volume and the HC water contact distribution curves used in GeoX for volume calculation are illustrated in figure 21. The figure 22 shows the results of volume calculation using GeoX, total recoverable resources and uncertainties associated with the calculation. The main uncertainties rely on OWC distribution and GRV calucation.



GRV distribution

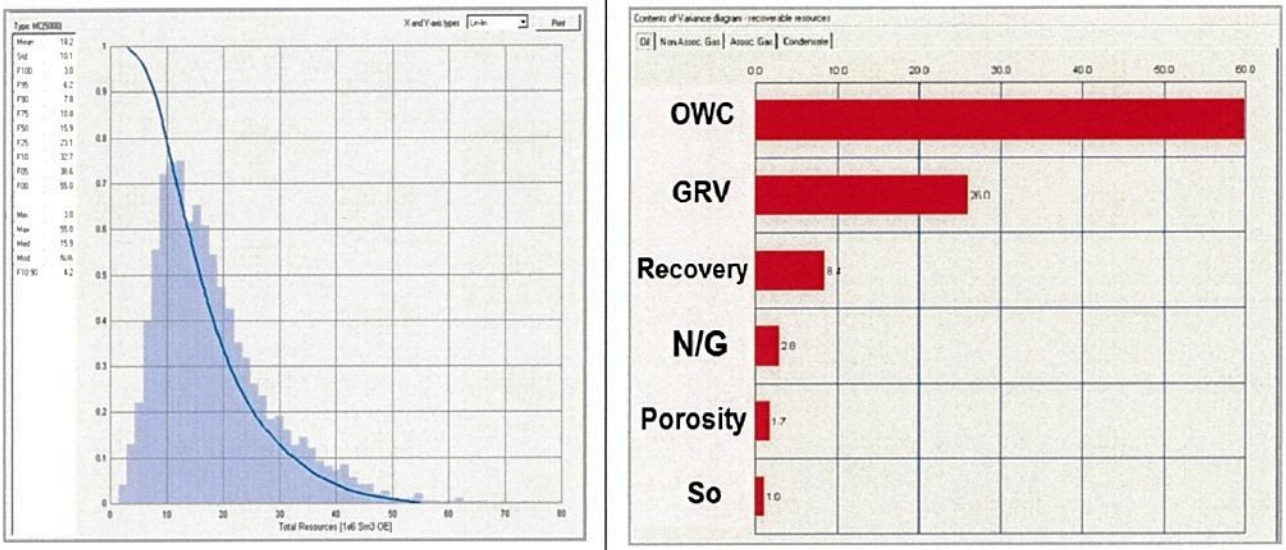
- Thickness : Min = 23m, Max = 27m
- HCWC = 1540m (fill the whole prospect)
- Spill point = 1540 m



HC water contact distribution

- Stratigraphic trap HCWC distribution
- Risk the chance that the prospect can handle 100m of HC column

<u>Figure 21</u>: GRV and HCWC distribution curves (from GeoX)



Total recoverable resources

Uncertainty parameters

<u>Figure 22</u> : Total recoverable resources diagram and variance diagram (from GeoX)

The table 5 sums up the final volume calculation for the Kasper prospect. The mean volume has been decreased from 34,6 10^6 Sm^3 OE defined during TFO 2006 to 18,3 10^6 Sm^3 OE after the new evaluation. The table 6 gives the In place volume of the Kasper prospect.

	Recoverable Resources	Mean	P90	P50	P10
New evaluation 2009	Oil	17.4	7.4	15.3	30.9
	Assoc. gas	0.76	0.29	0.64	1.41
	Total 10^6 Sm^3 OE	**18.3**	**7.8**	**15.9**	**32.7**
TFO 2006	Oil	33.1	21.3	31.8	46.3
	Assoc. gas	1.46	0.81	1.38	2.24
	Total 10^6 Sm^3 OE	**34.6**	**22.4**	**33.2**	**48.3**

Table 5: Recoverable resources of the Kasper prospect

In Place Resources 10^6 Sm^3 OE	**Mean**	**P90**	**P50**	**P10**
Oil	49.8	22.2	43.7	87.7
Assoc. gas	2.18	0.89	1.86	3.97
Total	52	23	45.5	91.7

Table 6: In place resources of the Kasper prospect

As a conclusion, the Kasper prospect remains a high risk prospect (Pg = 0,04) after re-evaluation using the new seismic data. The main risk is the trap seal.

The prospect has been downgraded due to a lack of DFI anomalies which should have been seen on this seismic data quality and with the reservoir quality seen in nearby discoveries and fields.

6 REMAINING PROSPECTIVITY

Four prospects are still present in the PL401 licence, all of them being located on top of the salt domes: Sinneskulo, Husafjelles, Moltehei and Godliknut (see figure 23). The reservoir is thought to be Heimdal and Hermod sand of Paleocene age and the oil migration is seen to be the main risk. No DFI anomalies are observed. In addition, 2 leads lied at the western border of PL401 Litlekulå and Klumpen. No new evaluations have been performed for the reamaining prospects using the new seismic cube. The table 7 gives a summary of recoverable resources for these prospects from the old evaluation in 1999.

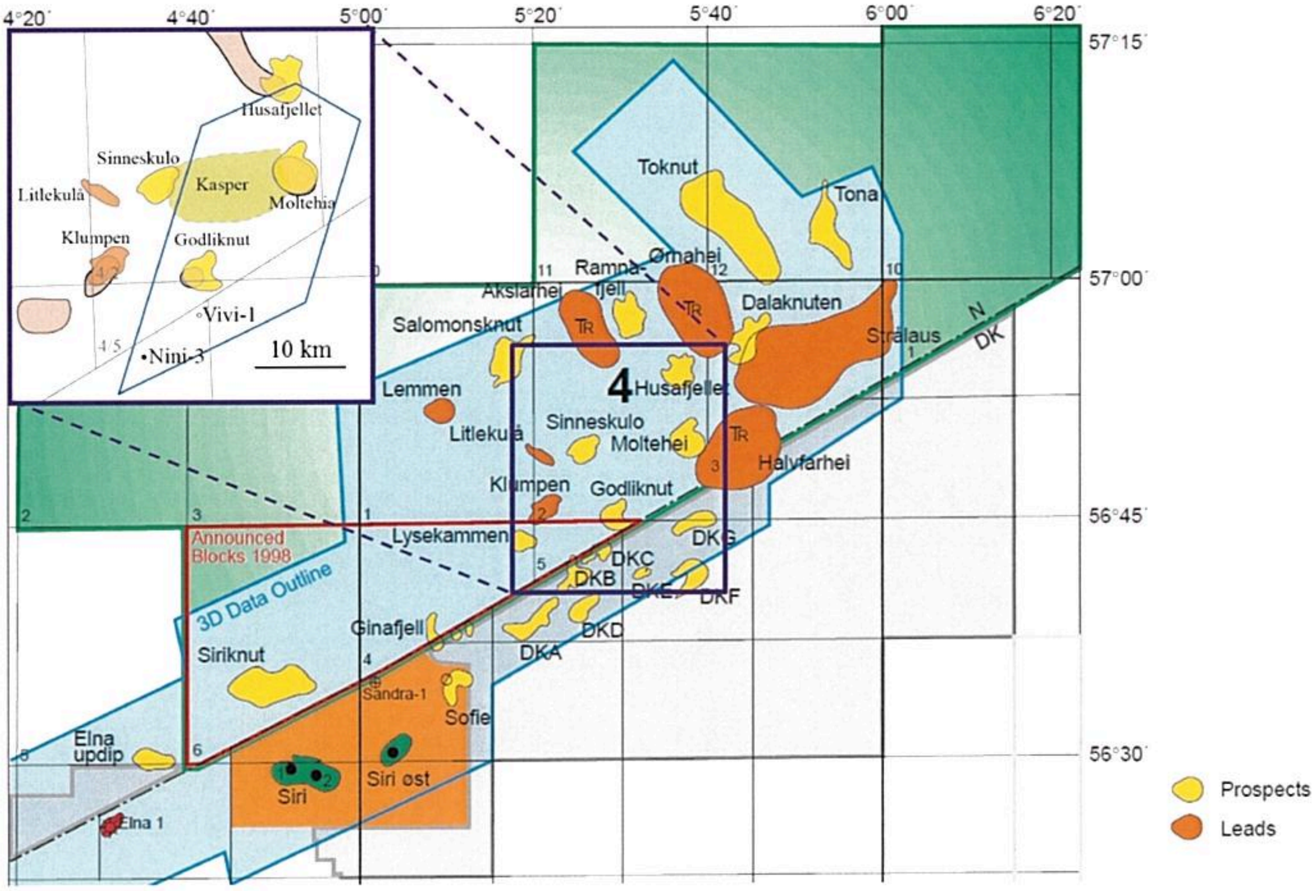


Figure 23: Remaining Prospects and Leads in the AOI.

	P90	Mean	P10	Pres	Ptrap	Psource	Pg	HC column (m)
Molteheia	8.6	11,3	14,4	0,8	0,75	0,4	0,24	168
Goldliknut	4,3	6,2	8,2	0,8	0,75	0,45	0,27	143
Sinneskulo	0,5	0,8	1	0,6	0,75	0,15	0,07	60
Husafjellet	8,5	12,5	16,9	0,7	0,75	0,3	0,16	142

Table 7: Risk and Recoverable Resources main phase oil (10^6 Sm3) for the remaining prospects in PL401 (from SVH3, 1999).

7 TECHNICAL / ECONOMICAL EVALUATIONS

The remaining prospectivity of PL401 is regarded as high risk, and not large enough to support a well commitment in the licence. This view was presented to the partners 28th October 2009 after a reassessment of the play models within the license.

The licence application in TFO 2006 was based on a seismic anomaly between two salt diapirs, with a reservoir potential in Lower Eocene Frigg sandstones and estimated reserves of 21- 47 MSm^3 oil in a prospect called Kasper. The main risk was supposed to be trap seal, which was based on a stratigraphic pinchout towards North and South.

Thorough investigations into surrounding dry and discovery wells, analysing AVO responses in detail, have significantly reduced the probability of making a discovery in PL 401. The typical signatures found in the discovery wells in corresponding stratigraphic levels in the same area, are found to be absent over Kasper. The possibility to increase our geological understanding by acquiring Electromagnetic data over the licence was discarded, as the combination of shallow water depth, thin reservoir and salt influence would be unfavourable for a good result.

The PL401 is located almost 300 km Southeast of the nearest StatoilHydro operated infrastructure (Sleipner). Therefore PL 401 is well outside any SH core area. The recent TechEc evaluation for the PL 146 in the Central Graben concluded that utilising the nearby Ekofisk facilities for processing and export was highly unlikely, unless a separate processing plant was built at a very high cost. After interpretation of the new seismic, the recommended volumes were reduced to 15.9 MSm^3 o.e. (P50), and the P(g) to 0,04 after DFI derisking.

	Mean	P90	P50	P10
Oil	17.4	7.4	15.3	30.9
Assoc. gas	0.76	0.29	0.64	1.41
Total OE	18.3	7.8	15.9	32.7

8 SUMMARY AND CONCLUSIONS

The work programme for the initial period of PL 401 has been fulfilled.
The new technical evaluation has been based on interpretation of the ST0807 PSDM seismic survey acquired in 2008. The interpretation reduced the hydrocarbon potential upon which the licence application in TFO2006 was based.
Consequently, the hydrocarbon potential of the acreage does not justify an exploration well and PL 401 is fully relinquished.
All communication in the partnership is found on License web, the seismic dataset ST0807 PSDM is loaded in PetroBank.

[redacted]

References

Statoil, SVH3 project, 1999.

Statoil, TFO 2006 application.

S.E. Ohm, D.A. Karlsen, A. Roberts, E. Johannessen and O. Høiland, 2006. *The Paleocene Sandy Siri Fairway:an efficient "pipeline" draining the Prolific Central Graben?* Journal of Petroleum Geology, Vol.29.