

Relinquishment Report for PL468 & 468B



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1 INTRODUCTION

1.1 License owners

- Det norske oljeselskap ASA (95 %), operator
- GDF SUEZ E&P Norge AS (5 %)

1.2 Award and work program

The PL468 license was awarded 29.02.2008 as an APA 2007 license, valid to 01.03.2013. The license extension PL468B was awarded 04.03.2011 as an APA 2010 license. The license outline and nearby fields and discoveries are seen in Fig. 1.1.

The work program for this award included:

- G&G studies within 2 years
- Acquire 3D seismic over all the license area within 2 years
- Drill or drop decision within 2 years
- BOV within 4 years
- PDO within 5 years

The Dovregubben prospect, seen in Fig. 1.1 and Fig. 1.2, was drilled early in 2011 by the Aker Barents drilling rig. The well was plugged and abandoned as a dry well 24.02.2011.

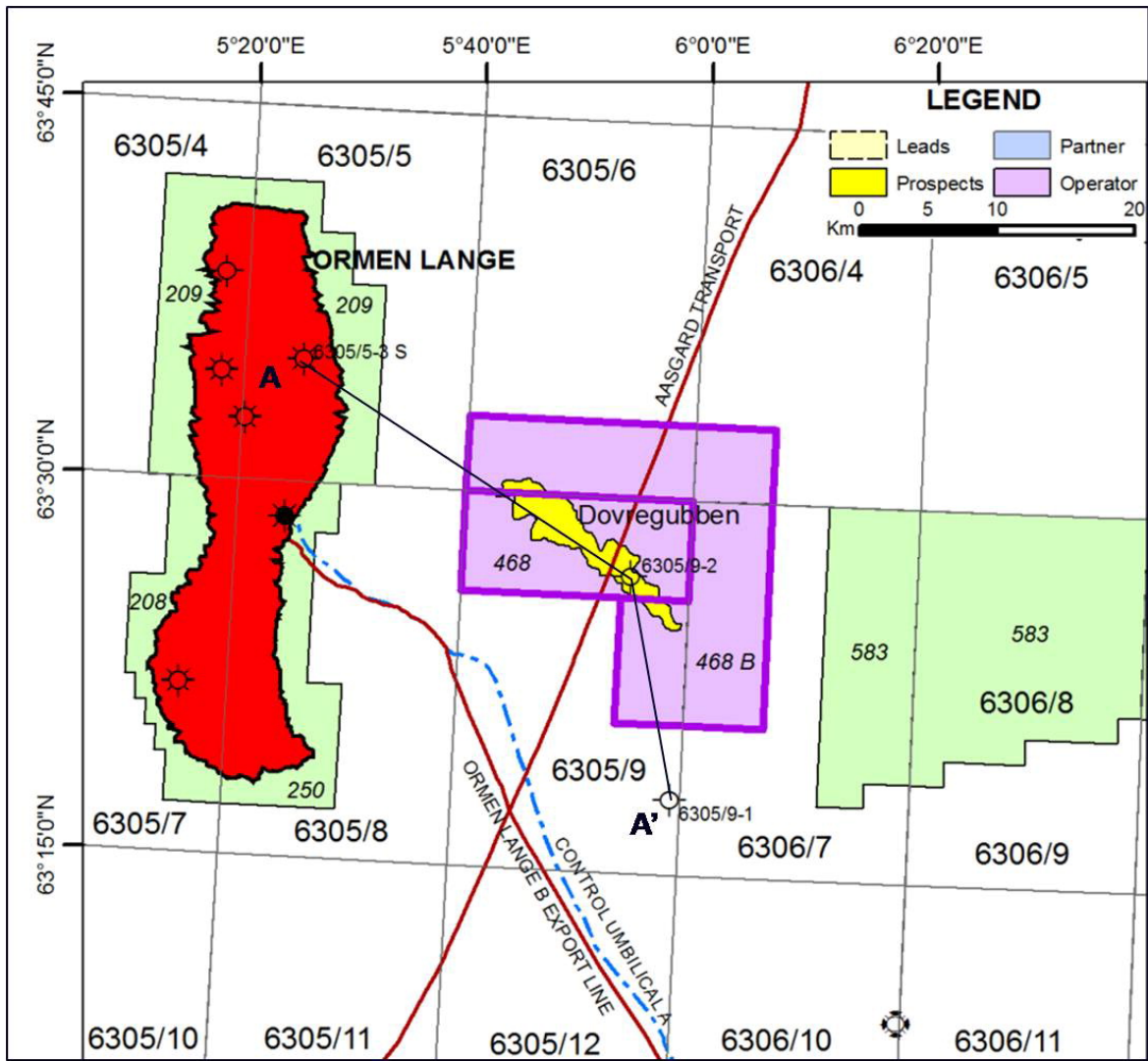


Fig. 1.1 Location of the PL468 and PL468B licenses with position of geoseismic section indicated

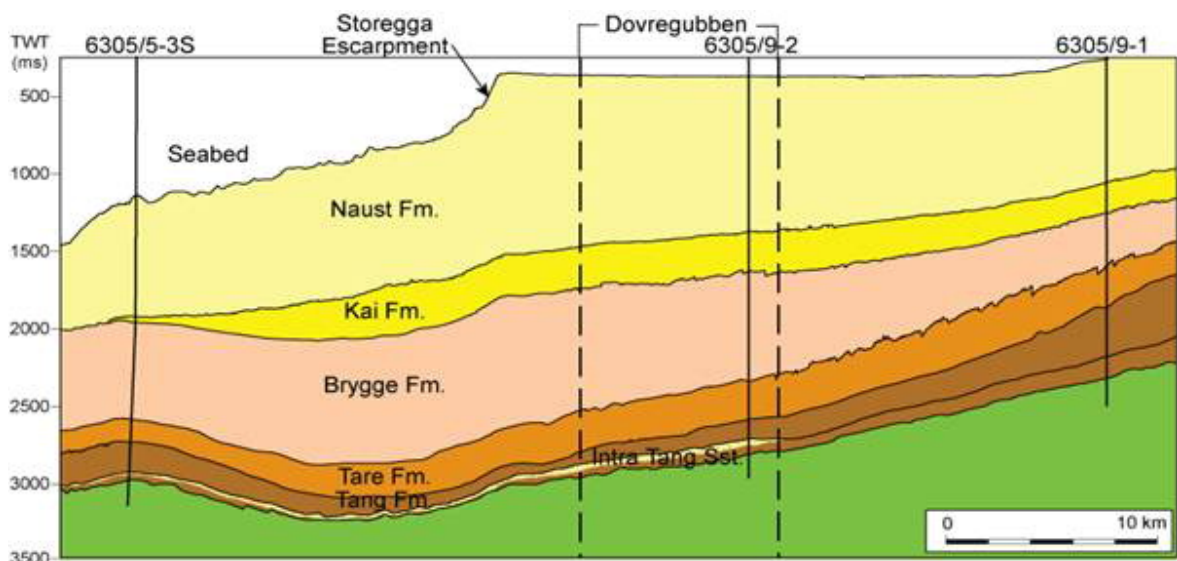


Fig. 1.2 Geoseismic section across the Ormen Lange Dome and the Dovregubben prospect

1.3 PL468 & 468B pre-drill prospectivity

The exploration well 6305/9-2 is located in the northern part of block 6305/9 in PL468, 25 km east of the Ormen Lange field. The westernmost part of the license is cut by the Storegga Escarpment, see Fig. 1.3, comprising the landward boundary of the giant Storegga landslide. The water depth in the license area varies from approximately 275 meters on the shelf in the east to more than 800 west of the escarpment.

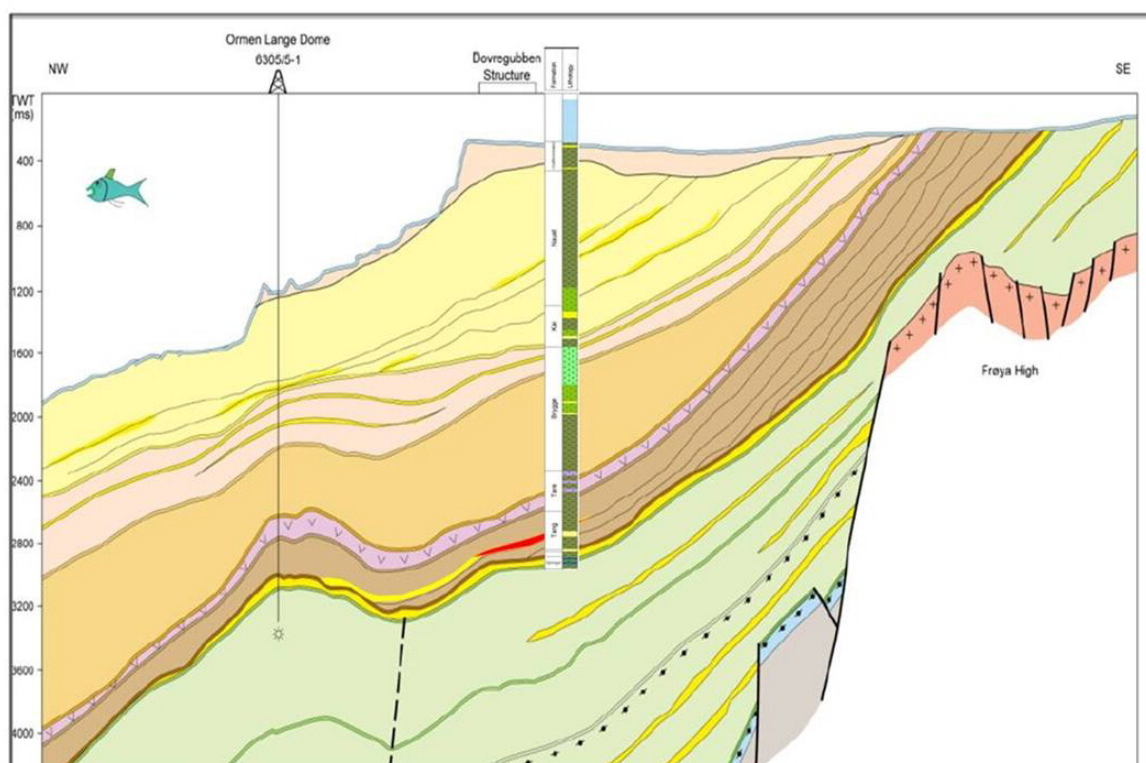


Fig. 1.3 The Dovregubben playmodel with the Storegga Escarpment indicated

The main objective was to test the presence of hydrocarbons in the Dovregubben prospect, in Tang Formation channel sandstones (Paleocene, Rogaland Gp). The Dovregubben prospect was defined as an intra Tang Formation channel sandstone, combined with an up-dip stratigraphic pinch out or fault seal to ensure up-dip seal towards the east (Fig. 1.3). A present day oil-mature Cretaceous source rock is expected to be present in the NW of Dovregubben. Migration into the Dovregubben prospect was assumed to be spill from the Ormen Lange field or vertical oil migration along faults from the basin in the NW as seen in Fig. 1.4.

Secondary prospectivity was identified in the Egga Formation (Paleocene, Rogaland Group) and the Springar Formation (Maastrichtian, Shetland Group).

A table showing the expected recoverable reserves for the Dovregubben prospect prior to drilling the 6305/9-2 well, is presented below, in Table 1.1.

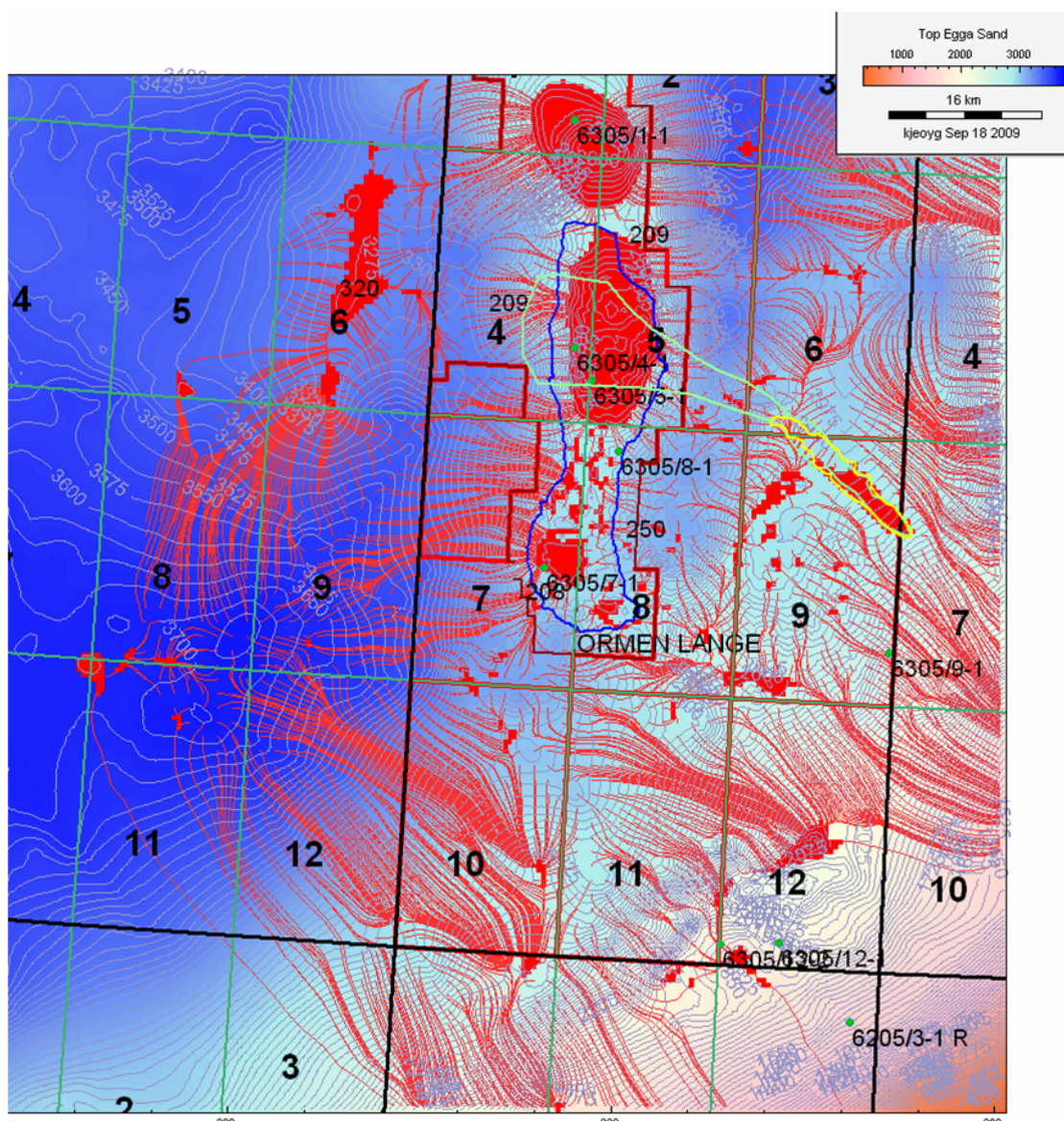


Fig. 1.4 Migration into the Dovregubben Prospect. Turonian/Cenomanian Source Rock. Parameters: 500 m Thickness, 2 % TOC, HI = 130 mgHC/g TOC

Table 1.1: Expected recoverable reserves for the Dovregubben prospect prior to drilling

PL468 & 468B					GROSS RECOVERABLE RESERVES/RESOURCES					
					Low		Base		High	
Category	Reservoir level	HC	RF (%)	POS (%)	Oil (MSm ³)	Gas (GSm ³)	Oil (MSm ³)	Gas (GSm ³)	Oil (MSm ³)	Gas (GSm ³)
PROSPECTS										
Dovregubben	L. Tertiary/Tang Fm	Gas	60	20	0.5	12.5	0.8	19.9	1.0	25.9

2 DATABASE

2.1 Seismic database

The seismic database is shown in Fig. 2.1 and in the underlying Table 2.1. With reference to the committed work program for PL468, 375 square kilometres of 3D seismic data (AX0801) was acquired in 2008 by Aker Exploration as operator of PL468. A post-stack merge of AX0801 and PGS Mega merge was performed in order to tie the Ormen Lange and 6305/9-2 wells to the AX0801 data set. The seismic surveys AX0801, MC3D-OLSE98, NH9602 and BPN9602 was reprocessed from field tapes and merged before migration. The merged dataset, in total 850 square kilometers, was then pre stack time migrated. The work was done in order to increase the confidence in AVO-analysis and improve the definition of the Dovregubben prospect. Due to delays in accessing the necessary field data from traded 3D seismic surveys, this data set was finished autumn 2011.

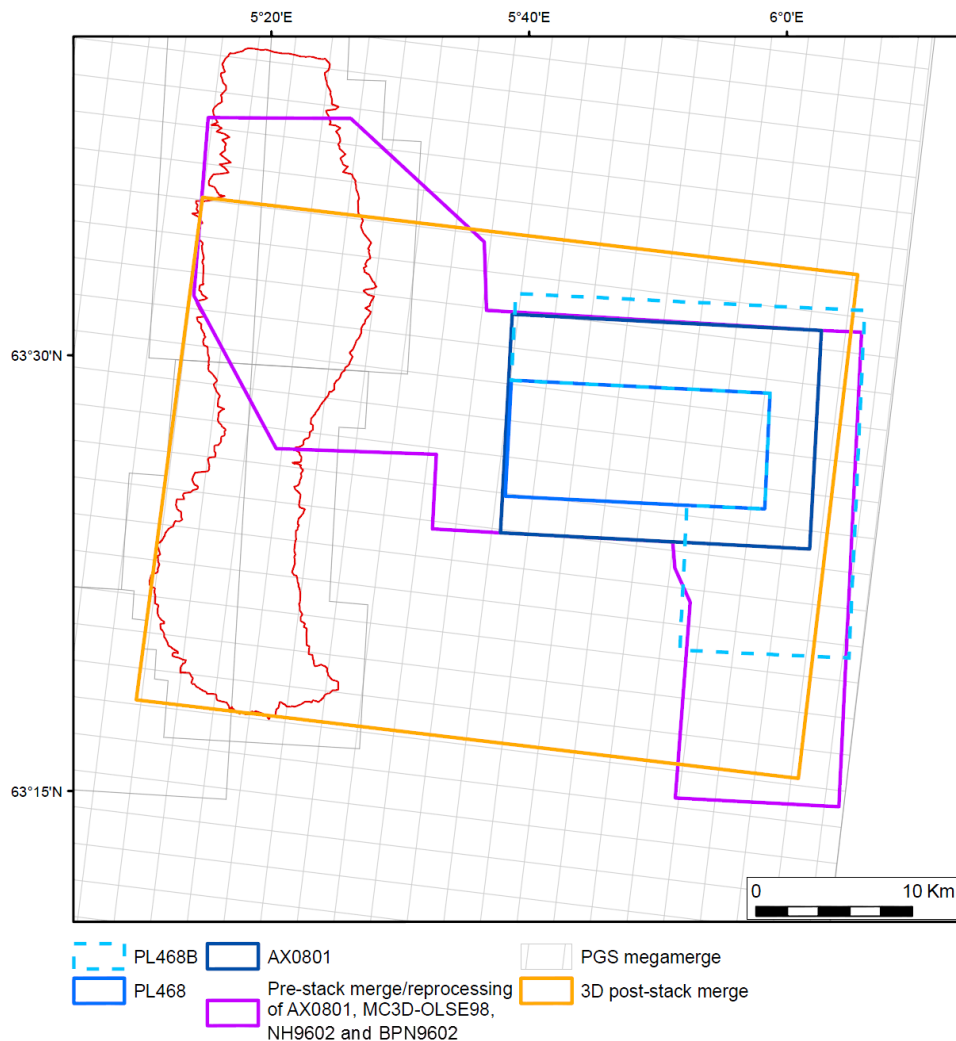


Fig. 2.1 Seismic database

Table 2.1: Seismic database

Seismic surveys	3D/2D	Angle stacks	Comments
AX0801	3D	Yes	Acquired by Aker Exploration 2008 as part of the PL468 work program
3D post-stack merge PL468	3D/2D	No	Post-stack merge of AX0801 and PGS Mega merge
Various regional surveys	2D	No	Used for regional ties
Pre-stack merge/reprocessing of AX0801, MC3D-OLSE98, NH9602 and BPN9602	3D	Yes	Finished Q3/Q4 2011

2.2 Well data

Fig. 2.2 shows the wells in the common database, the wells are also presented in Table 2.2, which includes well name, TD Formation and location, field or structural element. The wells 6305/5-3S and 6305/9-1 have been traded because they were considered to be particularly important for the evaluation of the Dovregubben prospect.

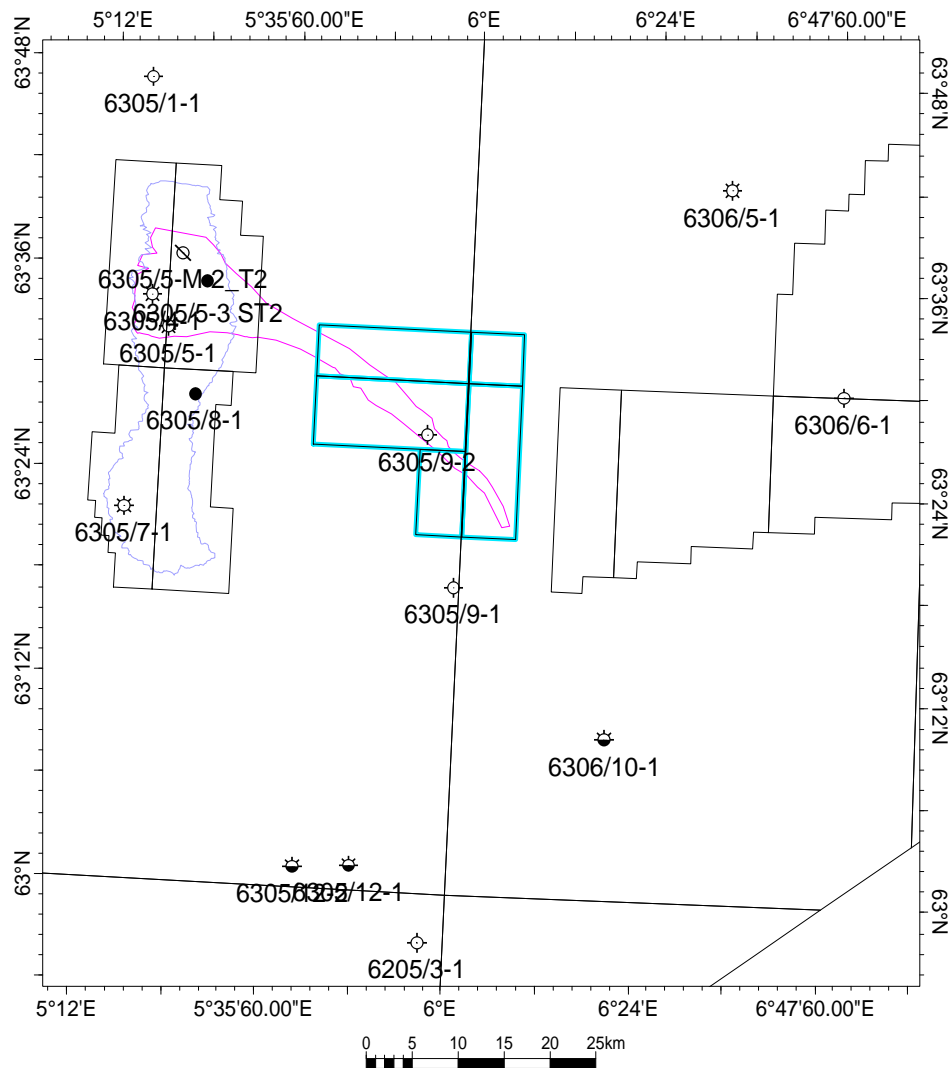


Fig. 2.2 Map of common well database. PL468 and PL468B in blue, the Dovregubben fan in pink, and the Ormen Lange Field in lilac.

Table 2.2: Common well database

Well	TD Formation	Location, field or structural element
6205/3-1 (R)	Spekk Fm, Late Jurassic	Gossa High
6305/1-1	Lysing Fm, Late Cretaceous	Ormen Lange
6305/4-1	Springar Fm, Late Cretaceous	Ormen Lange
6305/5-1	Nise Fm, Late Cretaceous	Ormen Lange
6305/5-M-2-T2	Springar Fm, Late Cretaceous	Ormen Lange
6305/5-3S	Springar Fm, Late Cretaceous	Ormen Lange
6305/7-1	Springar Fm, Late Cretaceous	Ormen Lange
6305/8-1	Nise Fm, Late Cretaceous	Ormen Lange
6305/9-1	Springar Fm, Late Cretaceous	Rås Basin
6305/12-1	Red Beds, Late Triassic	Slørebotn Sub-basin
6305/12-2	Basement, Pre-Devonian	Slørebotn Sub-basin
6306/5-1	Kvitnos Fm, Late Cretaceous	Klakk Fault Complex
6306/6-1	Basement, Pre-Devonian	Frøya High
6306/10-1	Basement, Pre-Devonian	Gossa High

2.3 Special studies

Several special studies have been carried out both in-house and by external parties to address the geological uncertainties of the PL468 prospectivity. These studies include:

- An AVO feasibility study made by Odin Petroleum on 4 wells: 6305/4-1, 6305/7-1, 6305/8-1 and 6305/9-1.
- AVO modeling study made by Norsar
- In-house Rock Physics modelling

The aims of these studies were comparison between modelled seismic response against real seismic response, and a description of AVO behavior. The conclusion of the modelling of the Dovregubben prospect was that it indicated presence of gas (or oil) in Dovregubben.

3 DOVREGUBBEN EXPLORATION WELL 6305/9-2

3.1 Dovregubben pre-drill prospect evaluation

The Dovregubben prospect was defined as an Intra Tang Fm channel sandstone, combined with an updip stratigraphic pinch out or fault seal to ensure up-dip seal towards the east. The prospect was defined by an elongated seismic AVO- and frequency anomaly in the Tang Formation (Fig. 3.1 and Fig. 3.2). The entire Dovregubben Prospect outline was defined to be approximately 50 km long, 2-3 km wide in the channelized section and up to 12 km wide across the distal fan in the northern part of the Ormen Lange Field.

Structural depth map at top reservoir (Lower Tang Formation) is shown in Fig. 3.3. Seismic dip and strike sections through the prospect are shown in Fig. 3.4 and Fig. 3.5.

The potential recoverable resources was 20×10^9 Sm³ of gas, with a probability of discovery of 20 %. The highest risk was associated with the trap. The prospect was considered as a high risk prospect since it was dependent on either up-dip stratigraphic pinch-out or up-dip fault seal or a combination of these. In addition, Lower Tang Formation sandstones are rare and considering the unproven play, a fair risk was associated with the presence and quality of the reservoir.

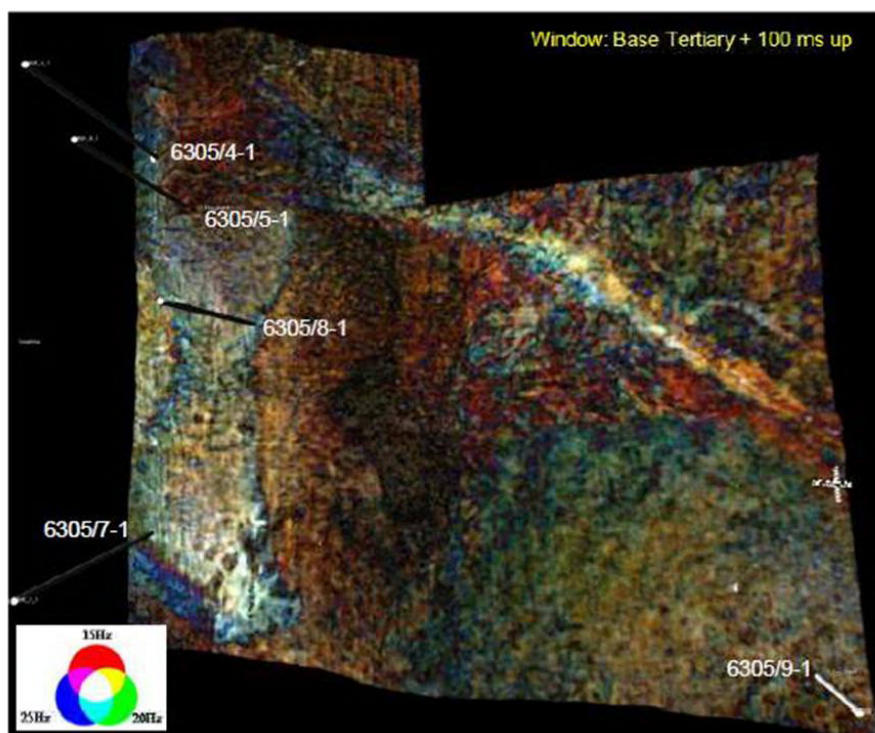
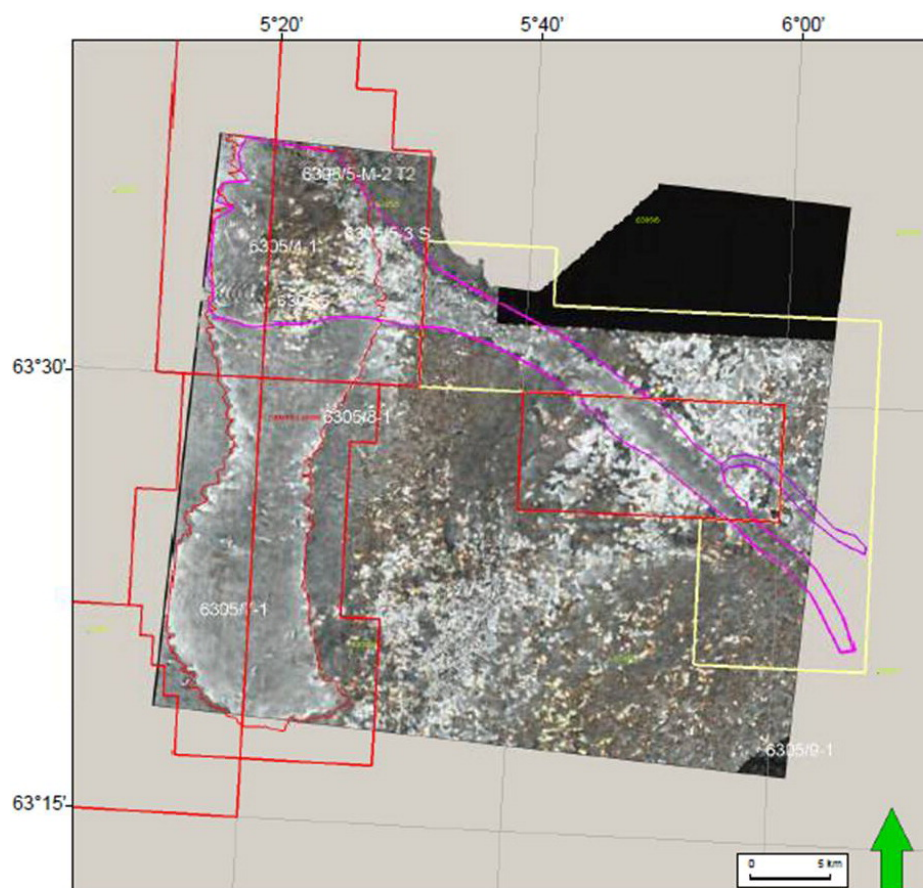


Fig. 3.1 Frequency blend maps (RGB-blending). The Dovregubben Prospect channel is a distinct feature on the frequency blending maps. The channel transects PL468 and overlaps the northern part of the Ormen Lange gas field.

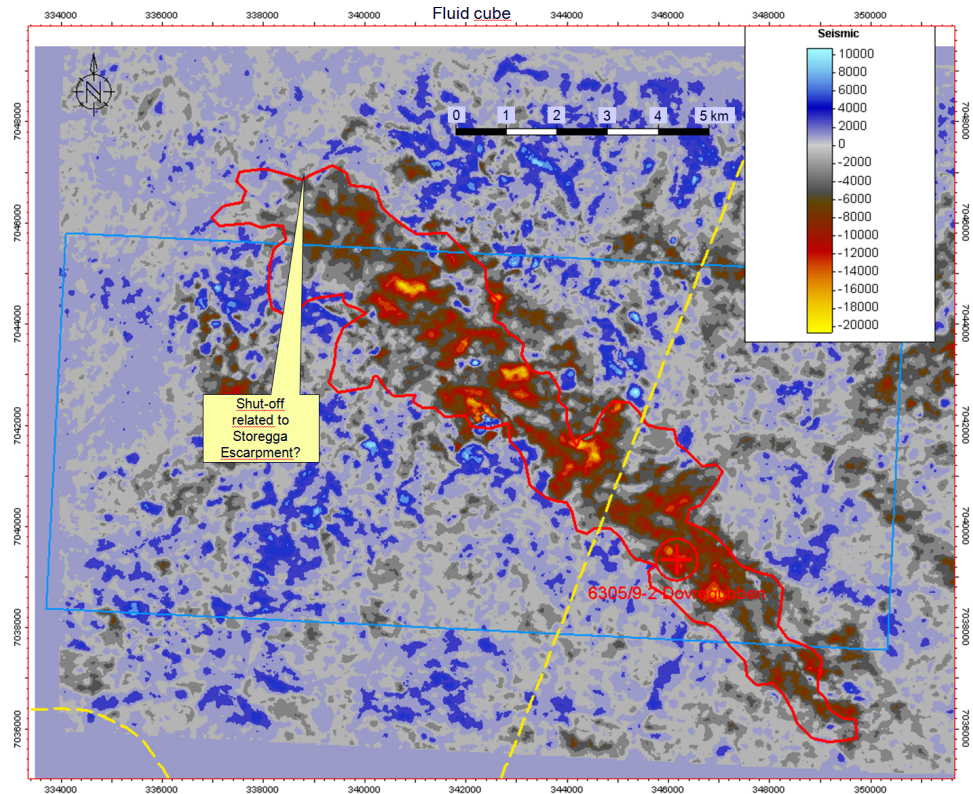


Fig. 3.2 AVO attribute map, fluid response. This attribute, fluid response (Acoustic Impedance/Gradient Impedance (AIGI)) indicates with warm colours areas of potential petroleum accumulation. The abrupt change in values in the NW corner of the Dovregubben channel is believed to be an artifact due to effects from the overlying Storegga Escarpment on the seismic data quality.

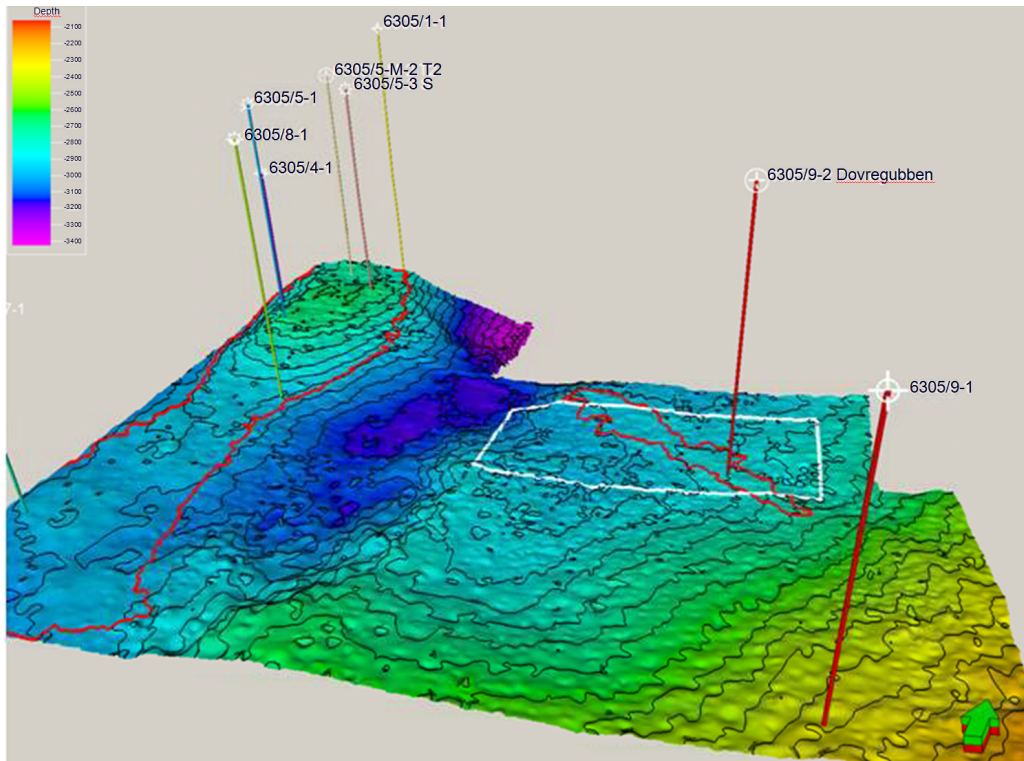


Fig. 3.3 Structural Depth map, Top Reservoir (Lower Tang Formation). The Dovregubben prospect and the Ormen Lange field outline in red.

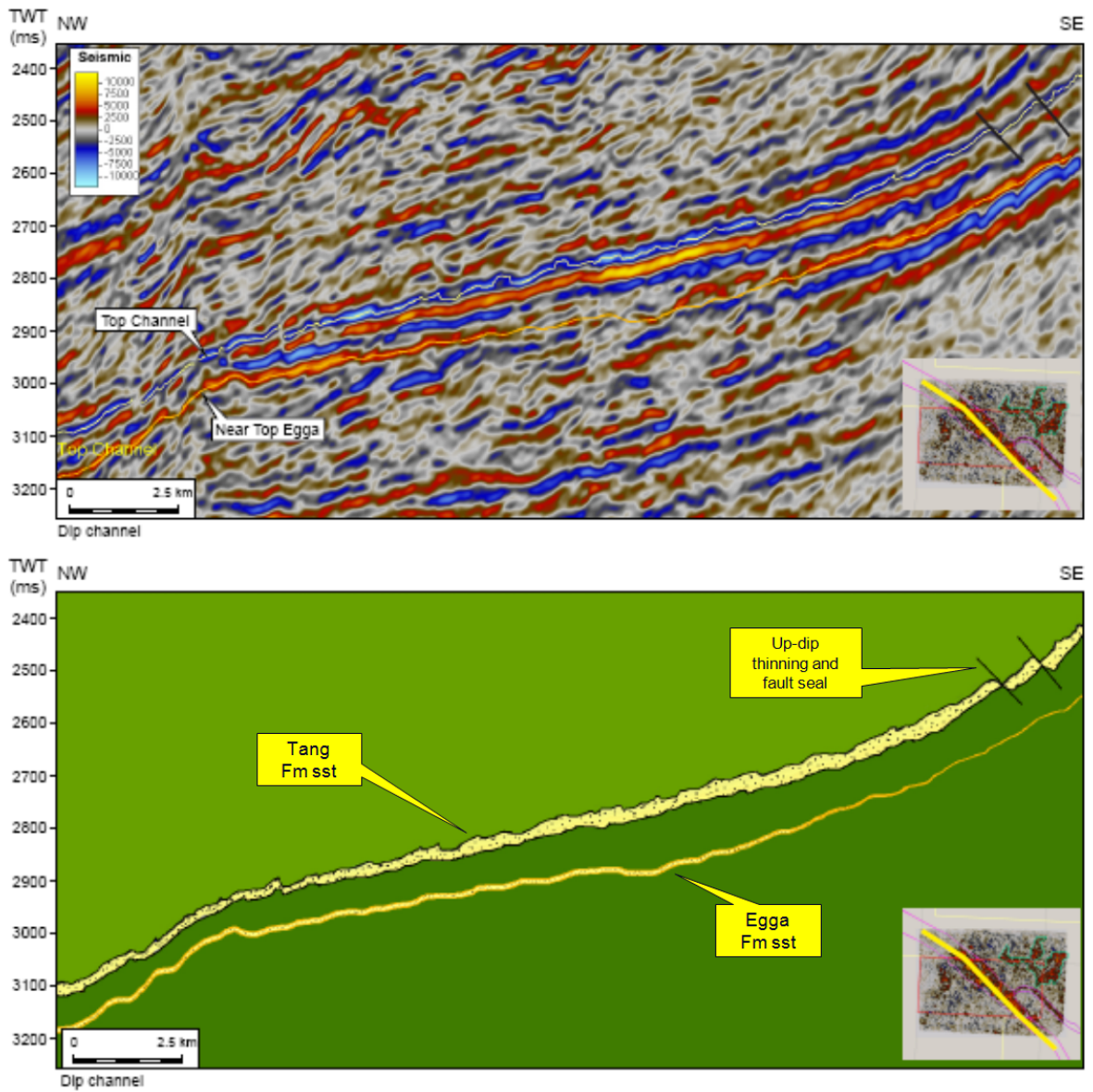


Fig. 3.4 Seismic dip section through the Dovregubben Prospect. *This section is mainly showing the central segment of the prospect. The up-dip part of the channel extends further to SE, and the down-dip part of the prospect extends further to the NW. Note the smaller faults in the up-dip part, which was believed to be the sealing faults updip.*

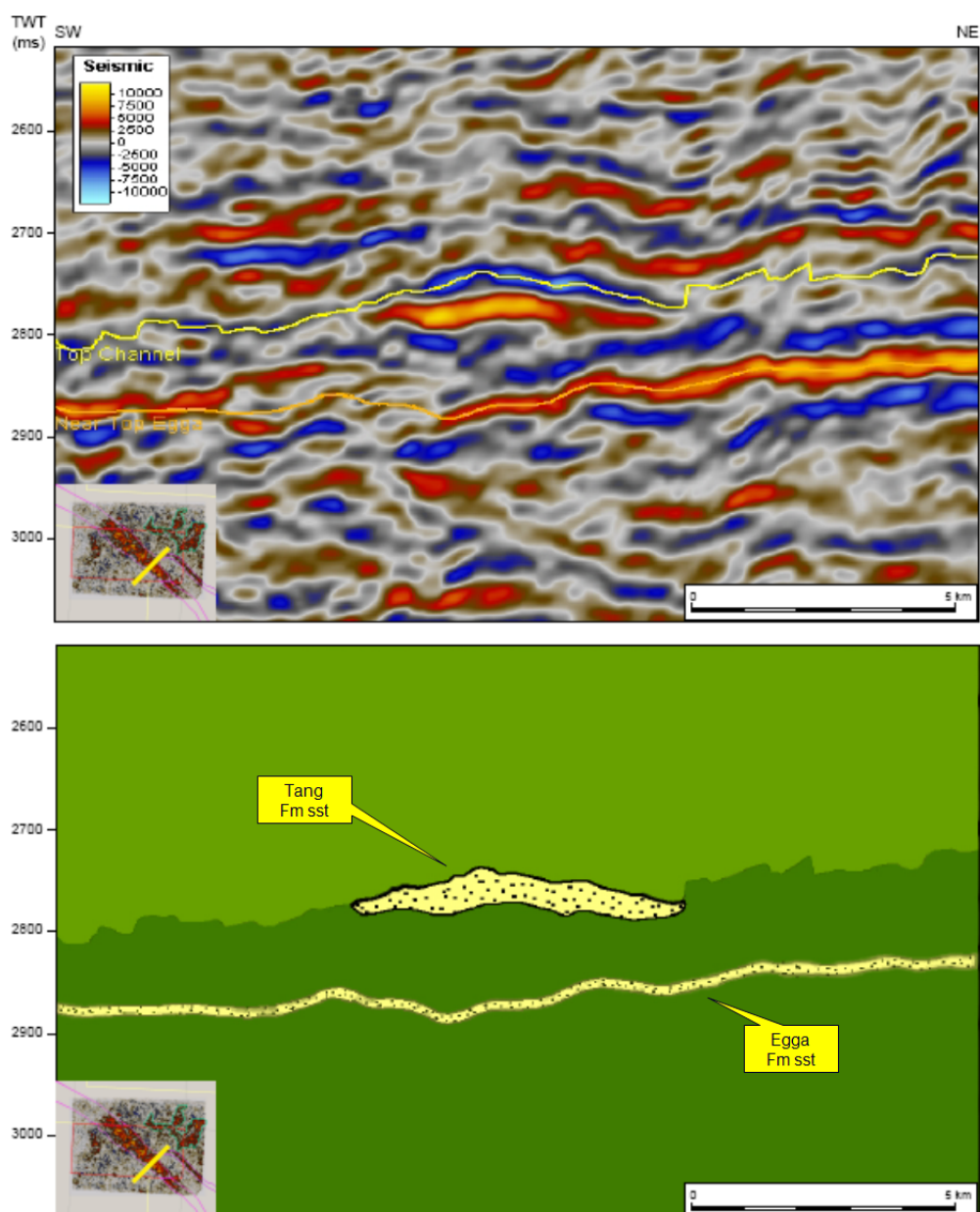


Fig. 3.5 Seismic strike section through the Dovregubben Prospect. *Differential compaction at top reservoir level was interpreted to indicate presence of sandstones in the reservoir.*

3.2 Well 6305/9-2

3.2.1 Objectives

The main objective of the well was to test the presence of hydrocarbons in the Dovregubben prospect, in Tang Fm channel sandstones (Paleocene, Rogaland Gp). Secondary prospectivity was postulated in the Egga Fm (Paleocene, Rogaland Gp) and Springar Fm (Maastrichtian, Shetland Gp).

3.2.2 Well results

Well 6305/9-2 was spudded 26th Dec 2010, and reached TD at 3075m MD in the Springar Fm 14th Feb 2011. The well was drilled with Aker Barents, and it was permanently plugged and abandoned as a dry well 24.02.2011. The rig left the well location 13th March 2011.

No hydrocarbons were identified in the well. Only a few thin sands with porosity were identified, with porosity up to 25.1 % and a total net reservoir thickness of 10.36 meters. In the Paleocene the well encountered thinner Tang Fm sandstones with poorer reservoir quality than expected. The secondary targets contained Egga Fm reservoir and Springar Fm units with reservoir properties as expected.

No coring was performed. Wireline logs prove generally poor reservoir quality, though porosities as high as 25% were seen in thinner intervals through the gross sandstone interval of 5 m in the Tang Fm sandstones. The reservoir properties in the Egga and Springar Formation intervals were also of poor quality. The statistics derived from the petrophysical evaluation for the well are found in Table 3.1.

Table 3.1: Reservoir Zonal averages

Unit Name	Depth Parameters			Net Reservoir Parameters				
	Top (MDRKB)	Base (MDRKB)	Gross (MD)	Net (MDRKB)	N/G (V/V)	Phi (V/V)	Sw (V/V)	Vsh (V/V)
Tare Fm	2420.0	2554.5	134.5	0	0	-	-	-
Tang Fm.	2554.5	2956.0	401.5	3.35	0.008	0.134	0.999	0.330
Våle Fm.	2956.0	2989.0	33.0	0.30	0.009	0.111	1.000	0.263
Egga Fm.	2989.0	3016.0	27.0	2.90	0.107	0.133	0.995	0.342
Springar Fm.	3016.0	3073.5	57.5	3.81	0.066	0.172	0.987	0.277
Rogaland Gp.	2420.0	3073.5	593.0	10.36	0.016	0.147	0.993	0.312
Criteria;	Net Reservoir: PHIE>10 %, VCL<40 %							

Shallow gas was encountered unexpectedly in Quaternary sandstones.

The geology and the depth prognosis of the well came in very much as prognosed, though with reduced quality in the reservoir interval. See Table 3.2 for lithostratigraphic information.

Table 3.2: Actual well tops

Tops	Prognosis			Actual			Thick-ness (m)	Low/High (+/-) (m)
	MD RKB (m)	TVD RKB (m)	TVD MSL (m)	MD RKB (m)	TVD RKB (m)	TVD MSL (m)		
Seabed	314	314	274	314	314	274	-	-
Nordland Group	314	314	274	314	314	274	1340	-
Undifferentiated	-	-	-	314	314	274	191	-
Naust Fm	510	510	470	505	505	465	897	-5
Kai Fm	1400	1400	1360	1402	1402	1362	252	+2
Hordaland Group	1675	1675	1635	1654	1654	1614	766	-21
Brygge Fm.	1675	1675	1635	1654	1654	1614	766	-21
Brygge Ooze	-	-	-	1654	1654	1614	160	-
Base Ooze	1930	1930	1890	1814	1814	1774	-	-
Brygge Fm. Lower part	-	-	-	1814	1814	1774	606	-
Rogaland Group	2490	2490	2450	2420	2420	2380	596	-70
Tare Fm.	2490	2490	2450	2420	2420	2380	134.5	-70
Tang Fm. Upper part	2760	2760	2720	2554.5	2554.5	2514.5	345	-205.5
Intra Tang Sst	2890	2890	2850	2895.5	2895.5	2855.5	11	+9.5
Base Intra Tang Sst	2920	2920	2880	2910.5	2910.5	2870.5	-	-9.5
Tang Fm. Lower part	2920	2920	2880	2910.5	2910.5	2870.5	45.5	-9.5
Våle Fm.	-	-	-	2956	2956	2916	33	-
Egga Sst Mb.	3010	3010	2970	2989	2989	2949	27	-31
Base Egga Sst	3024	3024	2984	3016	3016	2976	-	-8
Shetland Group	3058	3058	3018	3016	3016	2976	-	-42
Springar Fm	3058	3058	3018	3016	3016	2976	-	-42
TD	3140	3140	3100	3075	3075	3035	-	-65

The prognosed stratigraphy versus actual is presented below (Fig. 3.6 and Fig. 3.7). CPI logs for the well are shown in Fig. 3.8.

Pre well it was believed to be high probability of presence (0.8) and quality (0.9) of the reservoir. This was mainly because of well defined seismic anomaly indicating channel/fan system. If this channel/fan was present, it was expected to be a high quality reservoir. Another pro was gas filled sand stringers down dip in Ormen Lange. But there were also a con: this sandstone is poorly developed in the distal part over Ormen Lange ("Lista Lead").

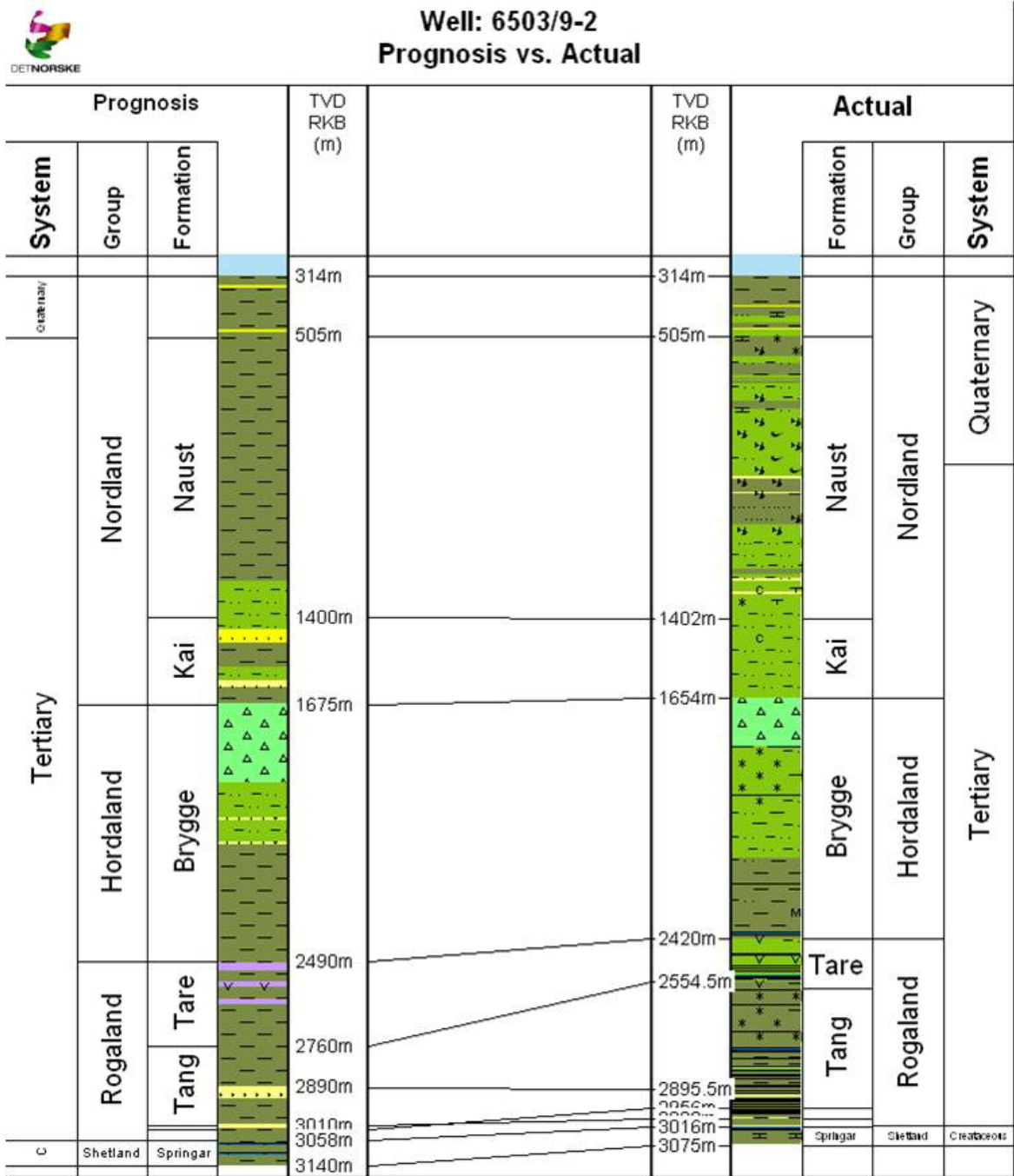


Fig. 3.6 Prognosis vs. actual stratigraphy, well 6305/9-2



Well: 6503/9-2
Prognosis vs. Actual

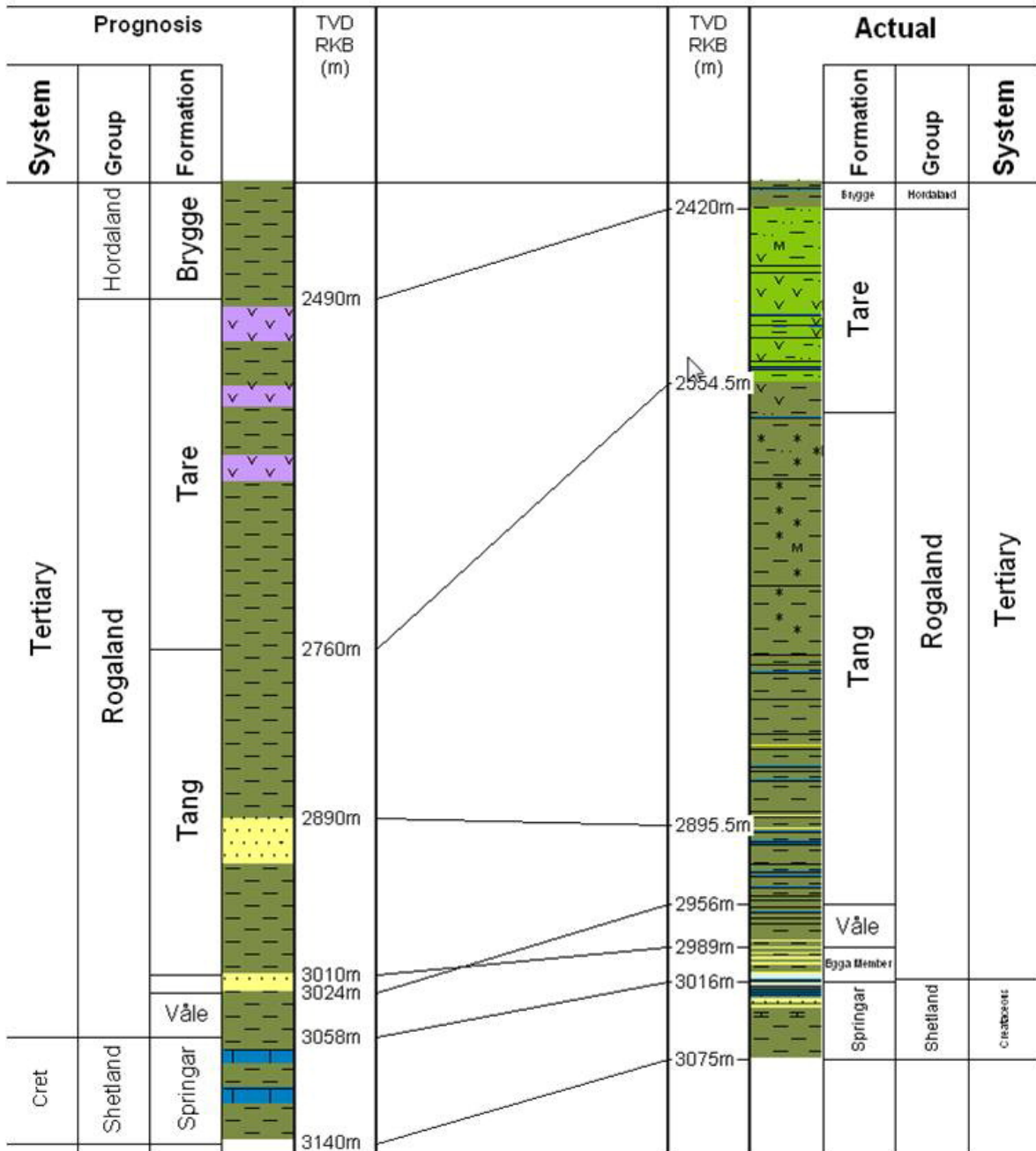


Fig. 3.7 Prognosis vs. actual stratigraphy, Reservoir section well 6305/9-2

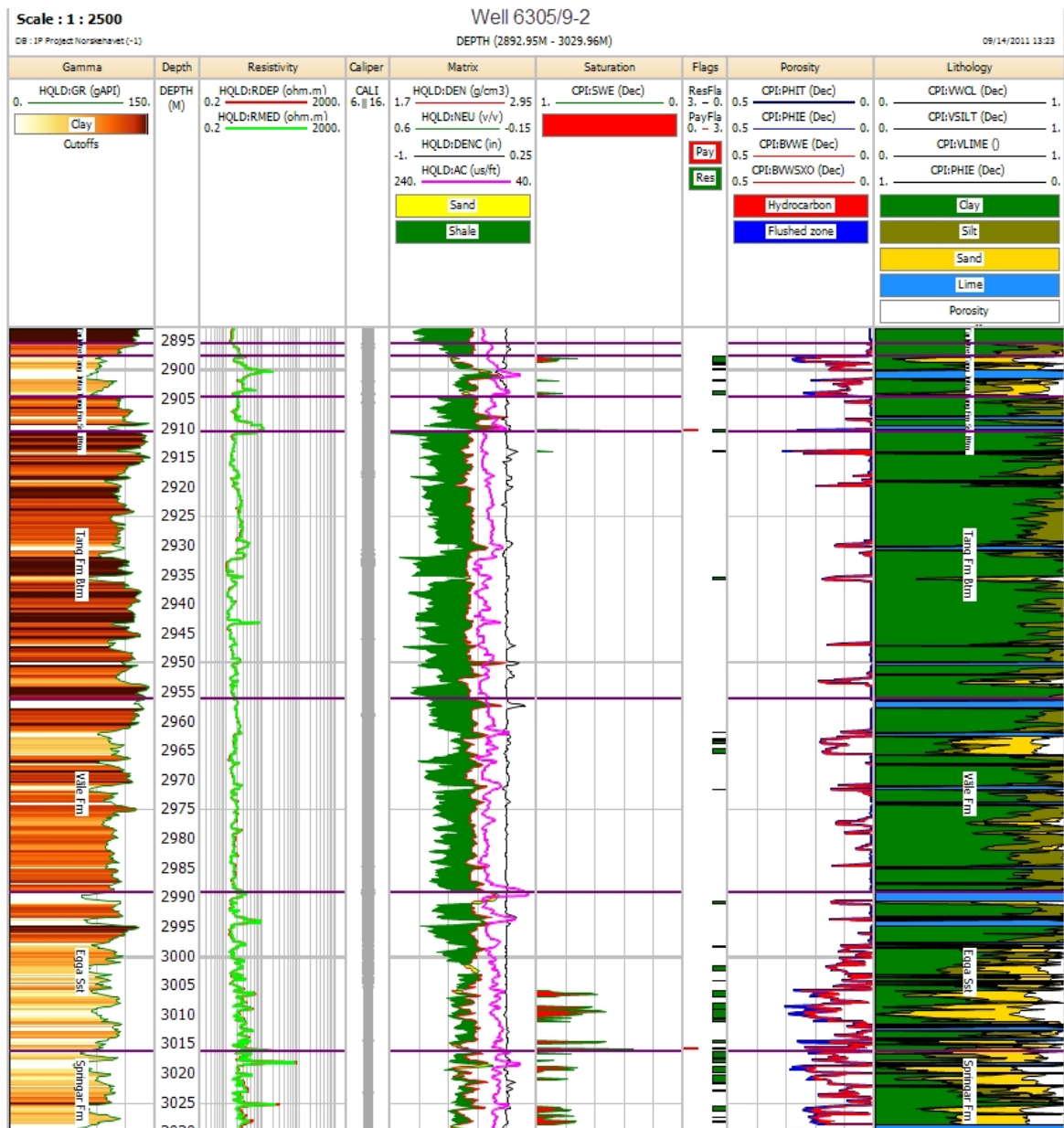


Fig. 3.8 CPI log for the well 6305/9-2

In addition, Lower Tang Formation sandstones are rare. The risk of presence and quality of the reservoir turned out to be too optimistic (failure) as seen in the figures Fig. 3.6, Fig. 3.7 and Fig. 3.8

Pre well it was concluded to be a high risk on the seal (0.3) of the prospect, and a moderate risk on migration & timing (0.7). It is difficult to say if it is failure of charge or trap. If gas has migrated through and the trap doesn't work, we would not have seen traces of the gas (gas shows). But it could also be that migration of HC into the prospect was a failure.

4 REMAINING PROSPECTIVITY

The fluid cube in Fig. 4.1 showed similar anomalies as in the Dovregubben towards NE, the Kalvaknuten lead. Before the 6305/9-2 well was drilled, the Kalvaknuten lead was believed to represent potential petroleum accumulations at the same stratigraphic level as the Dovregubben prospect. But since Dovregubben was dry with very thin reservoir, this Kalvaknuten lead seems to be a very high risk lead.

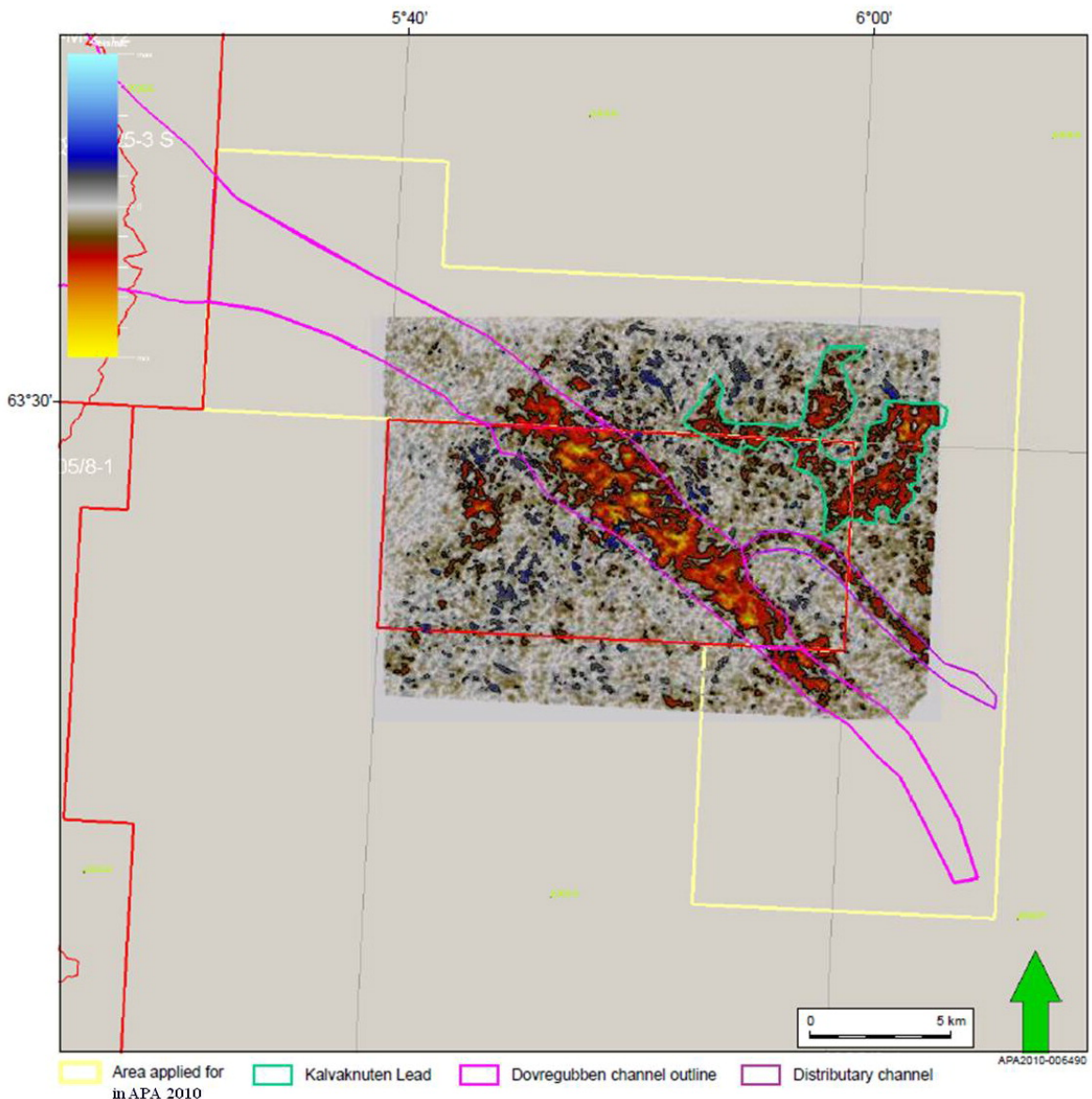


Fig. 4.1 AVO attribute map, fluid response in the Kalvaknuten lead. *This is at the same stratigraphic level as Dovregubben, Intra Tang Formation, and was believed to be a potential HC accumulation before the Dovregubben well proved to be dry.*

After the 6305/9-2 well was drilled the partnership has received the new seismic data which is mentioned in 2.1 Seismic database. This is a merged dataset, in total 850 square kilometers, which was pre stack time migrated. This dataset has been interpreted, and from this evaluation there seems to be small gas pockets updip of the 6305/9-2 Dovregubben well. Fig. 4.2 shows small areas that bright up on the far offset data. This may be interpreted as small gas pockets trapped against small faults. No new prospectivity was discovered in the new dataset.

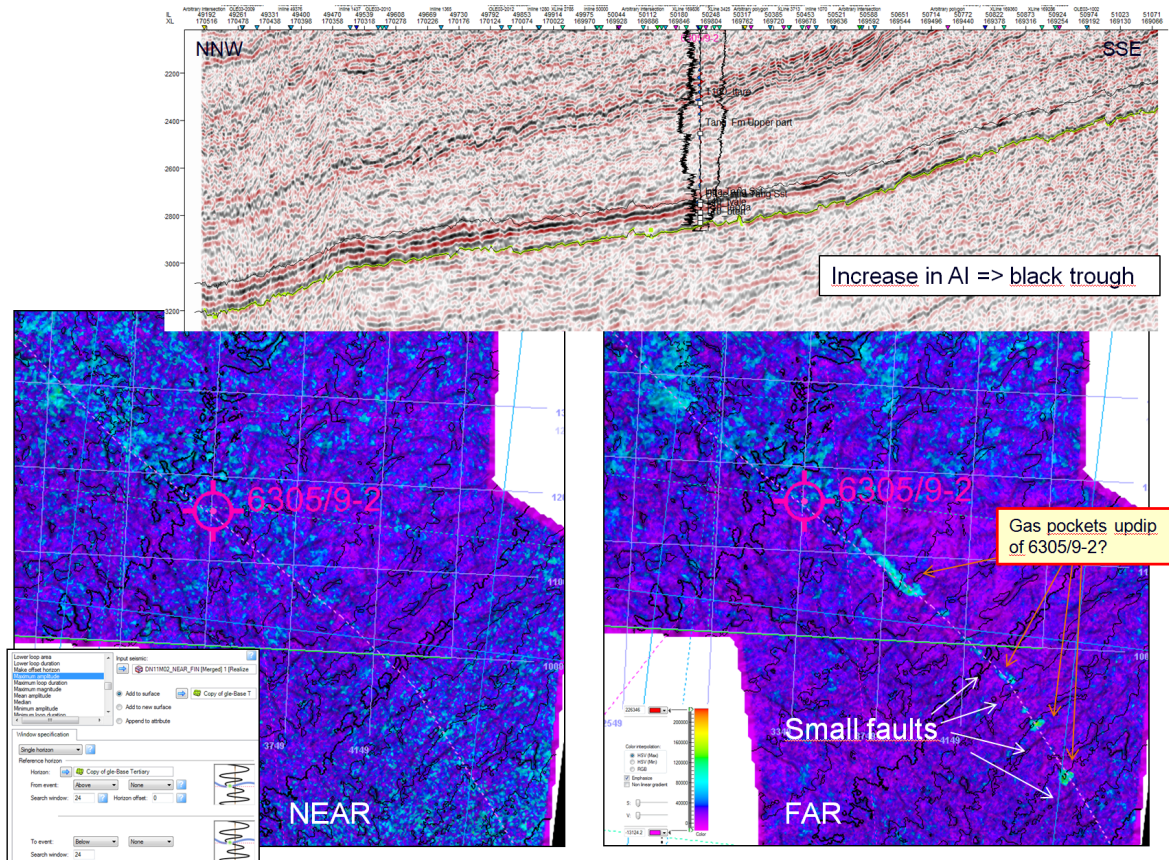


Fig. 4.2 Gas pockets updip of the 6305/9-2 well ?. A seismic line with well tie is shown on top. The two attribute maps below show maximum amplitudes around the top channel (24 ms above and below). Near offset data to the left and far offset data to the right.