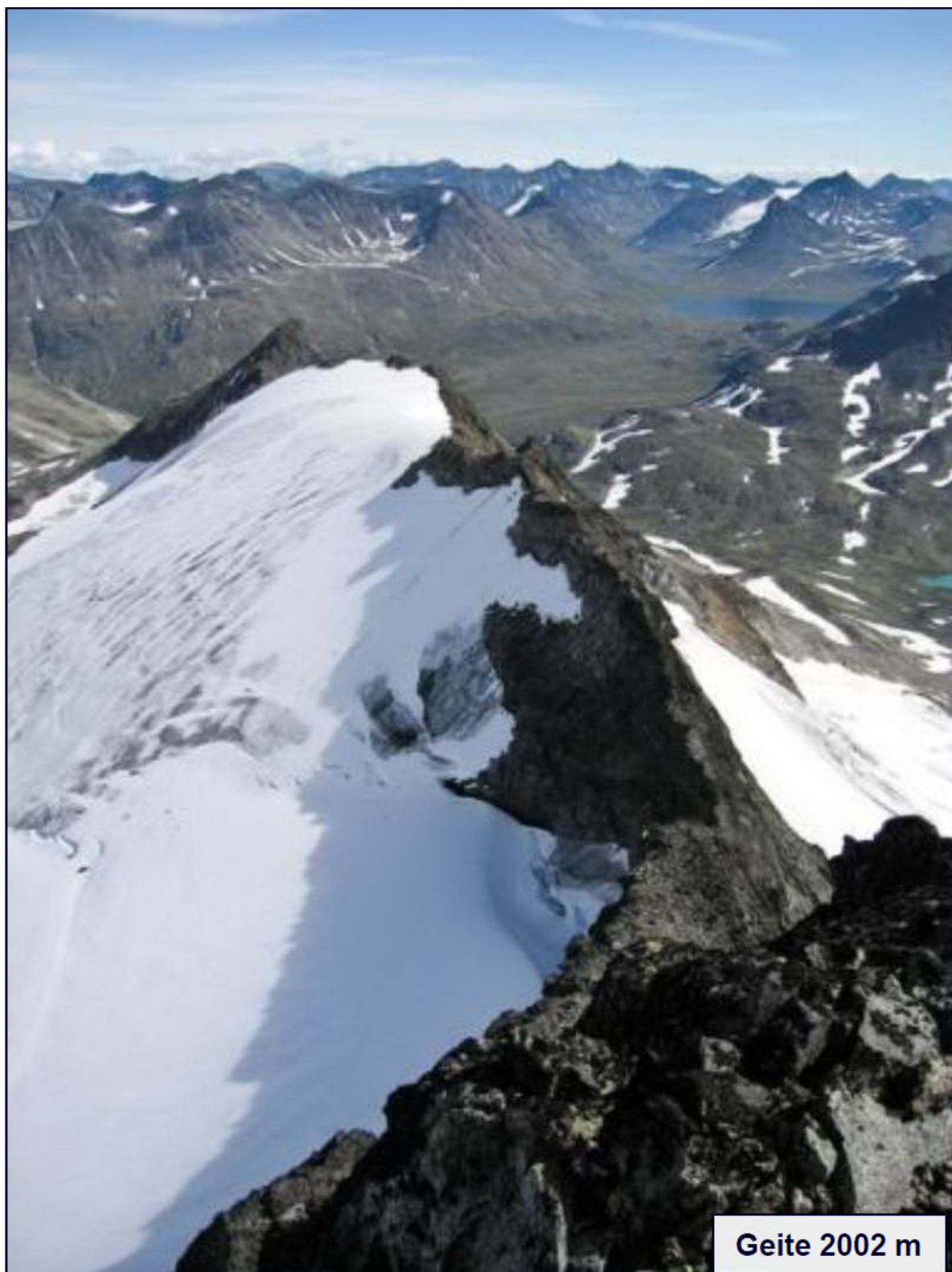


# Relinquishment report PL497/PL497B



# Relinquishment report PL497/PL497B

<b>1 INTRODUCTION</b>	<b>1</b>
1.1 Licence owners	1
1.2 Award and work program	1
1.3 PL497/PL497B pre-drill prospectivity	3
<b>2 DATABASE</b>	<b>4</b>
2.1 Seismic database	4
2.2 Well data	6
2.3 Special studies	7
<b>3 GEITE EXPLORATION WELL 7/11-13</b>	<b>9</b>
3.1 Geite pre-drill prospect evaluation	9
3.2 Well 7/11-13	11
3.2.1 Objectives	11
3.2.2 Well results	11
<b>4 REMAINING PROSPECTIVITY</b>	<b>15</b>

## List of figures

1.1	Licence outline and the Geite Prospect .....	2
2.1	Seismic database .....	4
2.2	Map of common well database .....	6
3.1	Geite Prospect on Top S1-P3 depth level with faults.....	9
3.2	Crossline 7040 through the Geite Prospect. ....	10
3.3	Inline 7180 through the Geite Prospect. ....	10
3.4	Pre-well play concept .....	11
3.5	Prognosis vs. actual stratigraphy, well 7/11-13 .....	13
4.1	Depth structure map, base Farsund Fm.....	15
4.2	Random line through the Kniven Prospect .....	16
4.3	Depth map, top reservoir Paleocene .....	17
4.4	Random line through the Pal 1 Prospect .....	17

## List of tables

1.1	Expected recoverable reserves for the Geite Prospect prior to drilling	3
2.1	Seismic database	5
2.2	Common well database	7
3.1	Reservoir Zonal averages	12
3.2	Actual well tops	12
4.1	Expected recoverable reserves for the Kniven and Pal 1 prospects	18



# 1 INTRODUCTION

## 1.1 Licence owners

- Det norske oljeselskap ASA (35 %) , operator
- Dana Petroleum Norway AS (25 %)
- Bridge Energy Norge AS (15 %)
- Capricorn Norge AS (15 %)
- Lotos Exploration and Production Norge AS (10 %)

## 1.2 Award and work program

The PL497 license was awarded 23.01.2009 as an APA 2008 license, valid to 23.01.2016. The license extension PL497B was awarded 19.02.2010 as an APA 2009 license. The license outline and nearby fields and discoveries are seen in Fig. 1.1.

The work program for this award included:

- Reprocess 3D seismic within 4 years
- Drill one firm well within 4 years
- BOV within 4 years
- PDO within 4 years

The Geite Prospect, seen in Fig. 1.1, was drilled as 7/11-13 in 2012 by the Maersk Guardian jackup. The well was plugged and abandoned as a dry well 03.11.2012.

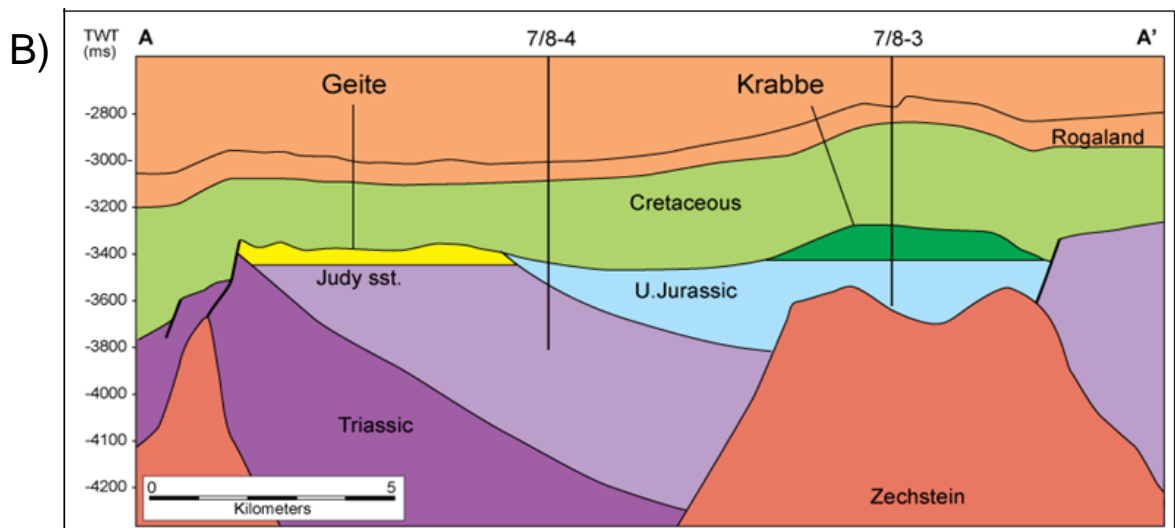
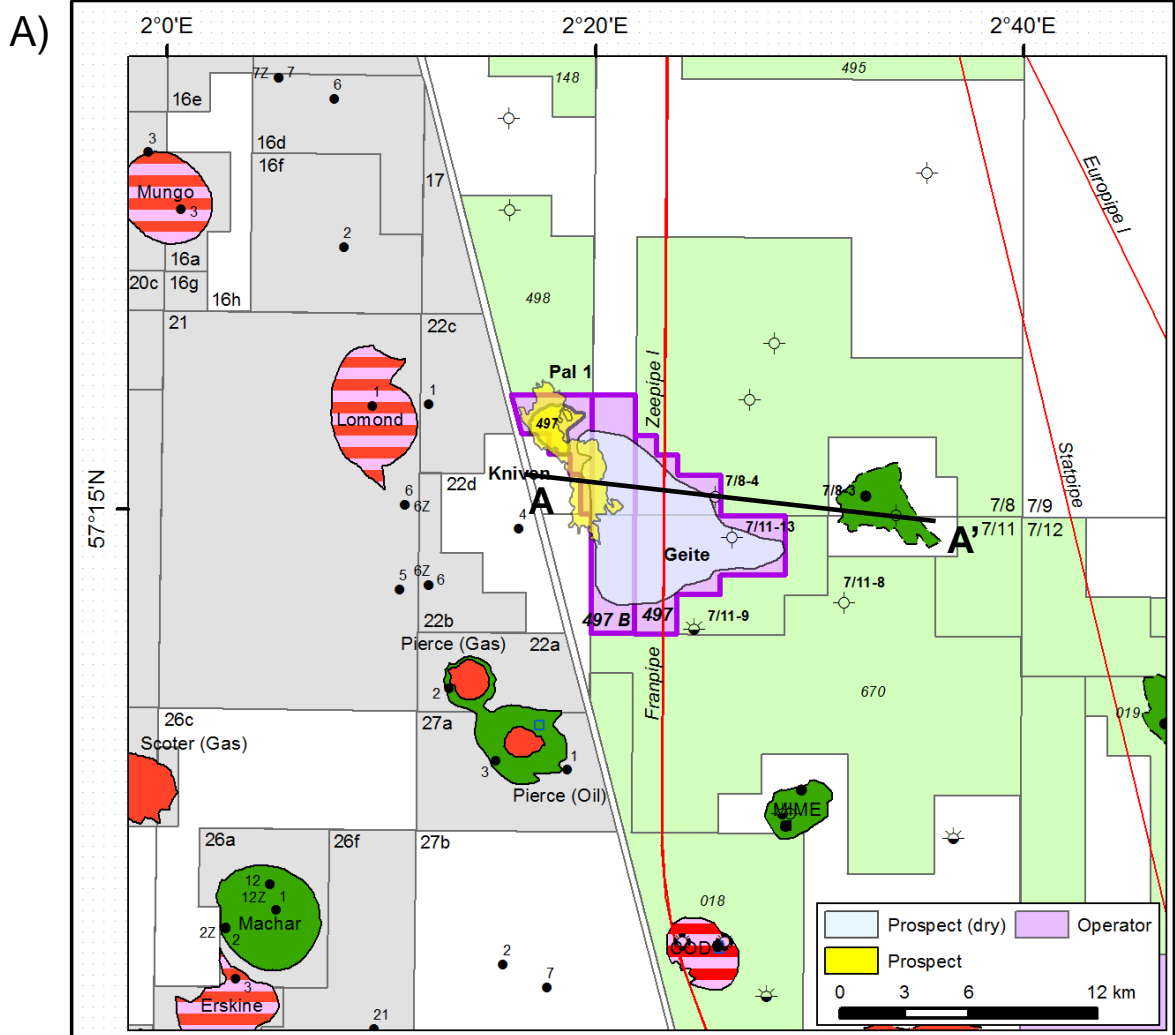


Fig. 1.1 Licence outline and the Geite Prospect. Fig 1A shows the location of the PL497 and PL497B licenses with position of geoseismic section indicated. Fig 1B is a geoseismic section across the Geite prospect and the Krabbe Field.



## 1.3 PL497/PL497B pre-drill prospectivity

The Geite Prospect in PL497/PL497B, positioned in the corner between the Blocks 7/11, 7/8 and 7/7, is located on the Cod Terrace (see Fig. 1.1). The Geite Prospect belongs to the confirmed Triassic intra-pod play, with the prognosed reservoir in the Skagerrak Formation Judy Sandstone Member. The Skagerrak Formation represents the most sand-rich part of the Triassic in this area. The Geite Prospect is located approximately 33 km northwest of the Ula Field.

The prospect is a rotated fault block with Triassic sandstones truncated towards the Base Cretaceous Unconformity (BCU) (Fig. 1.1). The 7/8-4 well had already tested the fault block, but downdip of the Geite Prospect. The Skagerrak Formation is generally very heterogeneous in the area. The reservoir quality was defined by the 7/8-4 and 7/11-8 wells. These two wells are key wells for the prospect as together, they display a fairly complete Skagerrak Formation.

The main source rock for both oil and gas are the Mandal and Farsund formations. These formations are mature for oil on the Cod Terrace adjacent, south and west, of the structure.

Well objectives:

- To carry out all operations in a safe and cost efficient manner without:
  - Causing any injury or ill health to any personnel involved;
  - Creating any damage to the environment.
- To investigate the hydrocarbon potential in the primary and secondary targets.
- Fulfil NPD's regulations for data acquisition.
- In case of discovery:
  - Core the reservoir section(s).
  - Perform logging with an extensive wireline logging suite.

The planned TD criteria for the dry case scenario of the well was 50m into the Judy Sandstone Member (S1-P3) in the Triassic Skagerrak Formation (prognosed depth 3785mMD). In the discovery case the TD criteria was set to a depth of 4035mMD.

A table showing the expected recoverable reserves for the Geite Prospect prior to drilling the 7/11-13 well, is presented below, in Table 1.1

Table 1.1 Expected recoverable reserves for the Geite Prospect prior to drilling

PL 497 and PL497B					GROSS RECOVERABLE RESERVES/RESOURCES					
					Low		Base		High	
CATEGORY	RESERVOIR LEVEL	HC	RF (%)	POS (%)	Oil (MSm <sup>3</sup> )	Gas (GSm <sup>3</sup> )	Oil (MSm <sup>3</sup> )	Gas (GSm <sup>3</sup> )	Oil (MSm <sup>3</sup> )	Gas (GSm <sup>3</sup> )
<b>PROSPECTS</b>										
Geite	Skagerrak Fm. Triassic	Oil	30	20	8	2	17	3	31	6



# 2 DATABASE

## 2.1 Seismic database

The seismic database is shown in Fig. 2.1 and in the underlying Table 2.1

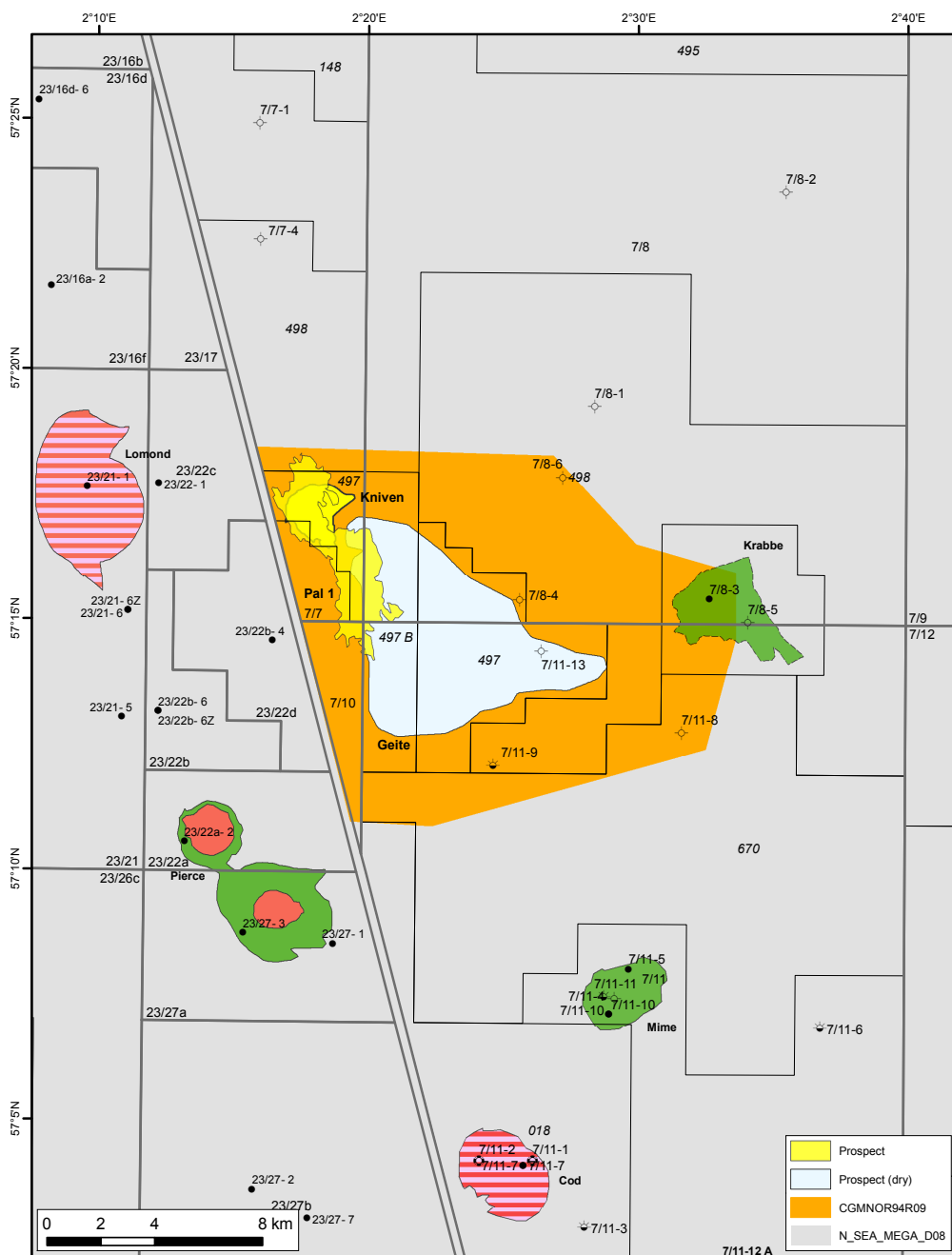


Fig. 2.1 Seismic database



Table 2.1 Seismic database

Seismic surveys	3D/2D	Angle stacks	Comments
CGMNOR94R09	3D	Yes	Re-processed for the licence group by Schlumberger Western-Geco in 2010 as a part of the PL497 program
N_SEA_MEGA_MERGE	3D	No	Used for regional ties and understanding

With reference to the committed work program for PL497, the survey CGM NOR94 in PL497 was reprocessed by Schlumberger Western-Geco in 2010. The area covered 500 sq.km. of reprocessing area, where output from the migration is approximately 250 sq.km. All data acquired was run through regularisation (3D binning). Then, the continuous 3D area was processed through 3D Pre-stack time migration and stacked. The geophysical aspect and objective is to perform a good multiple attenuation in the area. The main problem was internal multiples below the BCU.

The final deliveries for the CGMNOR94R09 were:

- full stack 0-36
- near-angle 0-13
- mid-angle 13-26
- far-angle 26-39
- Inversion-Abs\_AI
- Inversion-Abs\_VpVs
- Inversion-Rel\_AI
- Inversion-Rel\_VpVs
- Inversion-lambdarho
- Inversion-lambdamu
- Inversion-SI
- Inversion-PR
- Inversion-murho

In addition a regional survey, N\_SEA\_MEGA\_D08, was used for regional ties and regional understanding.



## 2.2 Well data

Fig. 2.2 shows the wells in the common database for PL497/PL497B. Key wells are marked in red. The wells are also presented in Table 2.2, which includes well name, status, Operator, TD, Formation/Group, Year P&A, Biostrat, Chemostrat, CPI and Core study.

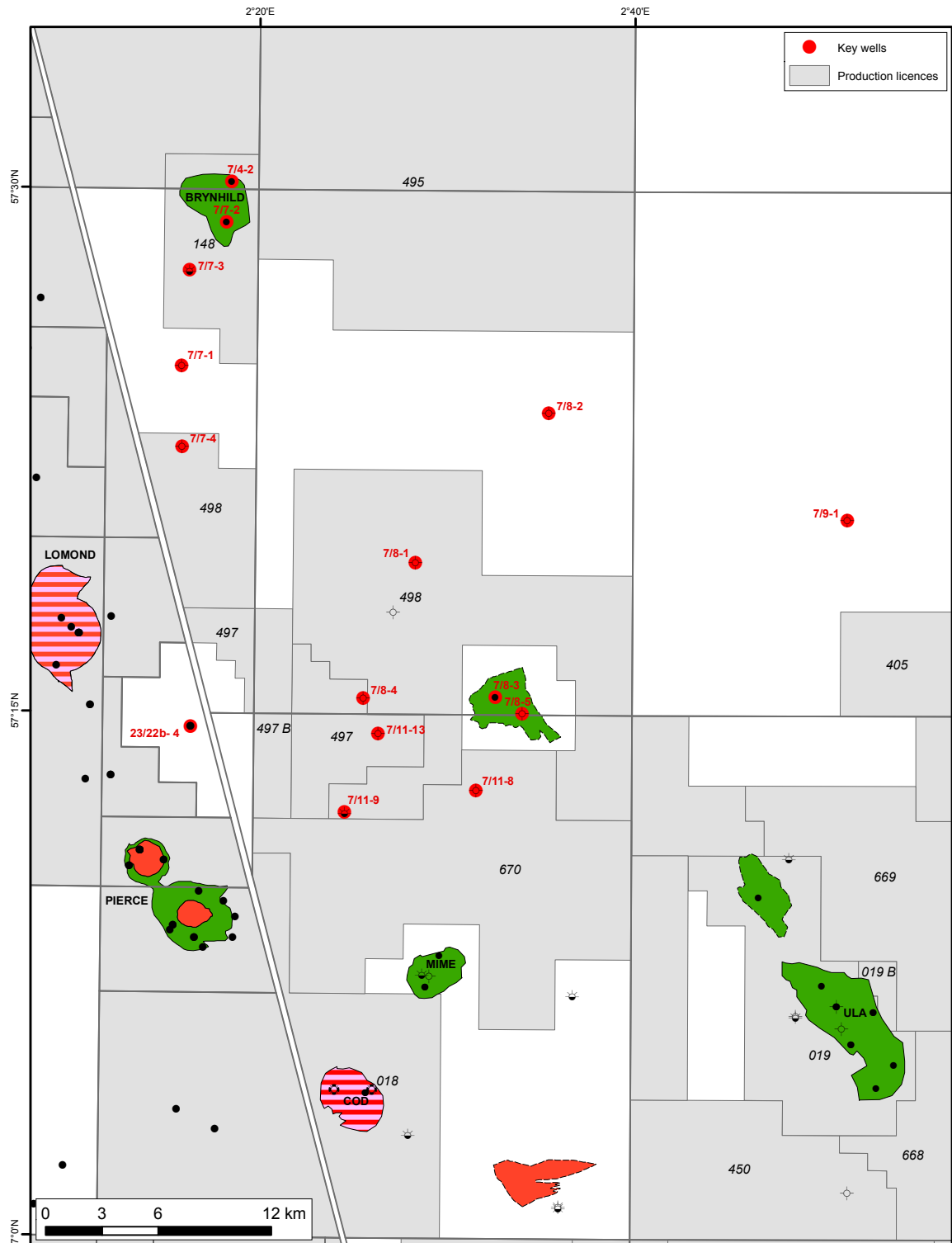


Fig. 2.2 Map of common well database



Table 2.2 Common well database

Well	Status	Operator	TD (MD) m RKB	Formation/Group	Year P&A	Biostrat	Chemostrat	CPI	Core study
7/4-2	Oil	Lundin	3459	Zechstein Gp	2008	APT		X	
7/7-1	Dry	Statoil	3500	Smith Bank Fm	1990	APT	X		X
7/7-2	Oil	Statoil	3430	Zechstein Gp	1992	APT		X	
7/7-3	Shows	Statoil	3584	Zechstein Gp	1993	APT	X	X	X
7/7-4	Dry	BG	3054	Ekofisk Fm	2007	APT		X	
7/8-1	Dry	Phillips	3334	Gassum Fm	1969	APT		X	
7/8-2	Dry	Phillips	3006	Zechstein Gp	1973	APT		X	
7/8-3	Oil	Conoco	4320	Zechstein Gp	1983	APT	X	X	X
7/8-4	Dry	Conoco	4400	Smith Bank Fm	1985	APT	X	X	X
7/8-5 S	Dry	Talisman	4168	Skagerak Fm	2006				
7/9-1	Dry	Conoco	2931	Zechstein Gp	1971	APT		X	
7/11-1	Gas/Cond	Phillips	3974	Zechstein Gp	1968	APT			
7/11-2	Gas/Cond	Phillips	3427	Tor Fm	1968	APT			
7/11-3	Oil shows	Phillips	3350	Ekofisk Fm	1969	APT			
7/11-4	Dry	Phillips	3322	Tor Fm	1969	APT			
7/11-5	Oil	Hydro	4478	Smith Bank Fm	1982	APT		X	
7/11-6	Shows	Hydro	4500	Smith Bank Fm	1982	APT	X	X	X
7/11-7	Oil	Phillips	4927	Zechstein Gp	1983	APT	X	X	X
7/11-8	Dry	Hydro	4750	Smith Bank Fm	1983	APT	X	X	X
7/11-9	Shows	Hydro	4271	Smith Bank Fm	1986	APT	X	X	X
7/11-10S	Oil	Hydro	4566	Smith Bank Fm	1990	APT	X	X	X
7/11-11S	Oil shows	Talisman	4679	Smith Bank Fm	2007	FMB		X	
7/11-13	Dry	Det norske	3800	Skagerak Fm	2012	APT		X	
7/12-2	Oil	BP	3676	(Triassic)	1976	APT			
7/12-5	Oil	BP	4440	(Triassic)	1981	APT		X	
7/12-6	Oil	BP	3700	(Triassic)	1981	APT	X	X	X
7/12-10	Oil shows	BP	3667	(Triassic)	1991	APT		X	
7/12-11	Shows	BP	3868	Skagerak Fm	1991	APT		X	X
8/10-1	Dry	Phillips	3089	Zechstein Gp	1969	APT		X	
23/22b-4	Oil	Agip	4322	Skagerak Fm	1992			X	

## 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 PL497/PL497B prospectivity. These studies include:

1. Chemostrat study
2. Diagenesis study
3. Fluid Inclusion Study
4. Inversion study, Paleocene

Regarding no. 1, a chemostratigraphic study was undertaken on the mostly barren Triassic fluvial and lacustrine successions encountered in several wells located in the Norwegian Central Graben. The wells in question are Well 2/1-7 (southernmost study well - located in the southern part of the Gyda Field), Well 7/11-7 (located in the Cod Field), Well 7/12-6 (located in the Ula Field) and the wells 7/11-9, 7/11-8, 7/8-4 and 7/8-3 (all located north of the Mime Field). The study was done with a view to erecting chemostratigraphic zonations



and a chemostratigraphic correlation for the Triassic successions in the above wells, based on stratigraphic changes in the inorganic geochemistry of the sedimentary rocks.

Regarding no. 2, a diagenesis project was carried out to understand the controlling factors for the reservoir quality in the Geite Prospect, and to predict/model porosity/permeability in different facies in the Triassic succession.

Regarding no. 3, a stratigraphic reconstruction of bulk volatile chemistry from fluid inclusion (FIS study) was done on the Geite Well, 7/11-13, by the Fluid Inclusion Technologies, Inc. The result was in summary: there is no evidence of significant oil or gas migration through the penetrated section. However, the interpreted shallow microseep/macroseep implies deeper prospectivity in the area.

Regarding no. 4, an in-house inversion study with focus on detecting sand in the Paleocene was done during autumn 2013.



# 3 GEITE EXPLORATION WELL 7/11-13

## 3.1 Geite pre-drill prospect evaluation

The Geite Prospect is a rotated fault block with Triassic sandstones truncated towards the BCU. The 7/8-4 well has already tested the fault block, but downdip of the Geite Prospect. The Skagerrak Formation is generally very heterogeneous in the area. The reservoir quality was defined by the 7/8-4 and 7/11-8 wells. These two wells are key wells for the prospect as together, they display a fairly complete Skagerrak Formation. The main source rock for both oil and gas are the Mandal and Farsund formations. These formations are mature for oil on the Cod Terrace adjacent, south and west, of the structure.

The Geite Prospect is shown on Top S1-P3 depth level faults in Fig. 3.1. A seismic crossline and inline through the prospect is shown in Fig. 3.2 and Fig. 3.3. The play concept pre well is shown in Fig. 3.4.

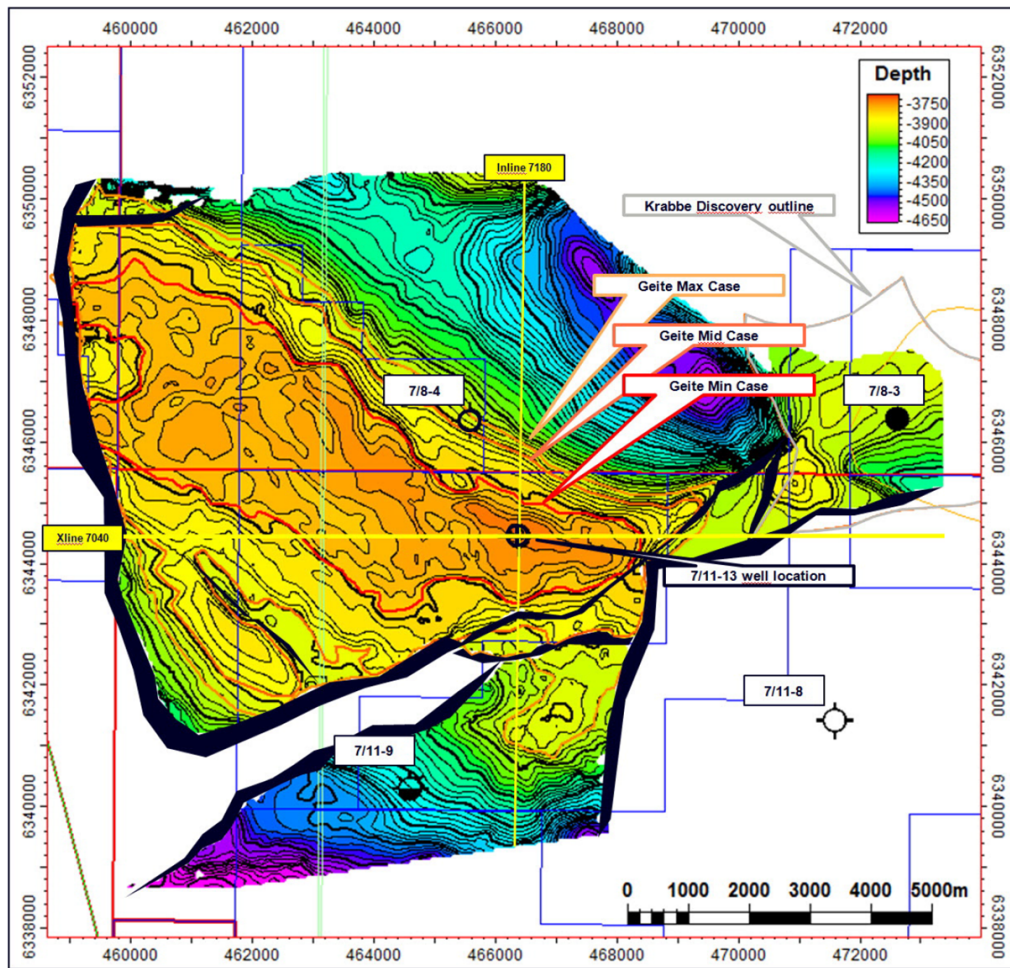


Fig. 3.1 Geite Prospect on Top S1-P3 depth level with faults.. 20 m contour interval. Min., base and max. prospect outline shown, and location on seismic lines.

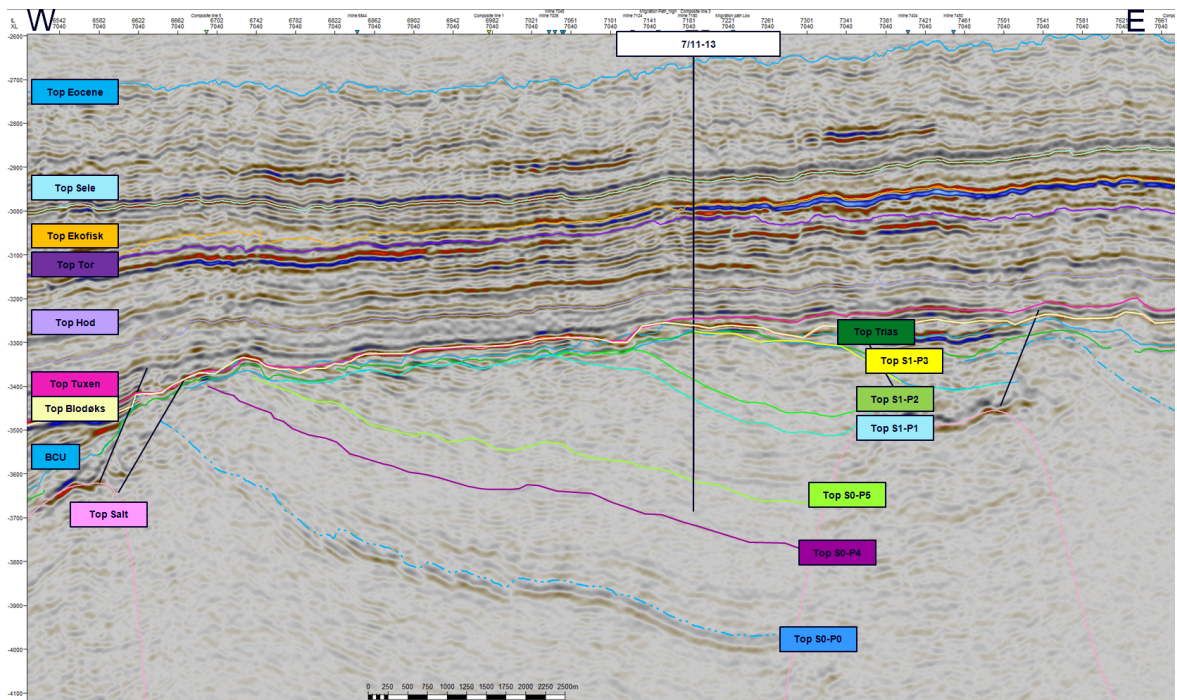


Fig. 3.2 Crossline 7040 through the Geite Prospect.

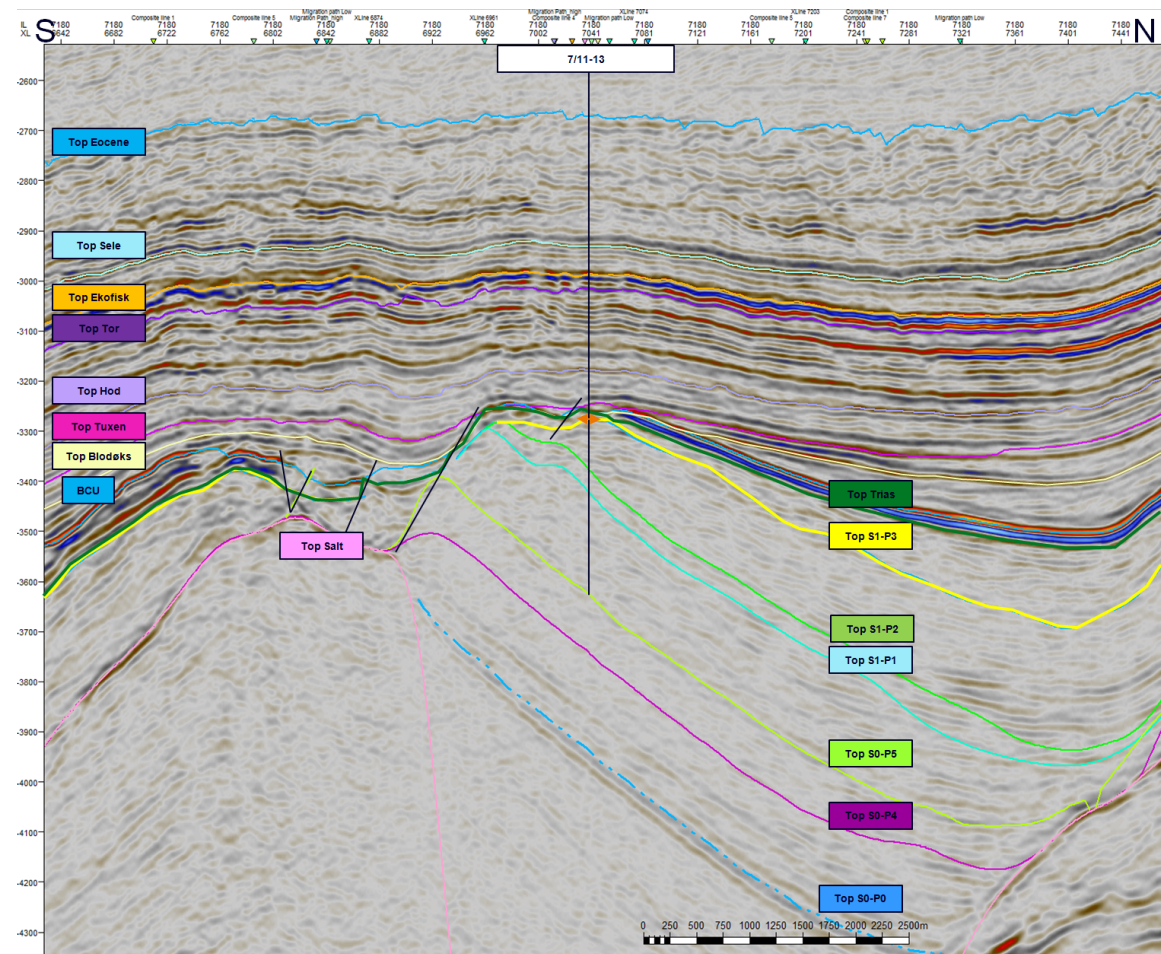


Fig. 3.3 Inline 7180 through the Geite Prospect.



# Play Concept (pre-well)

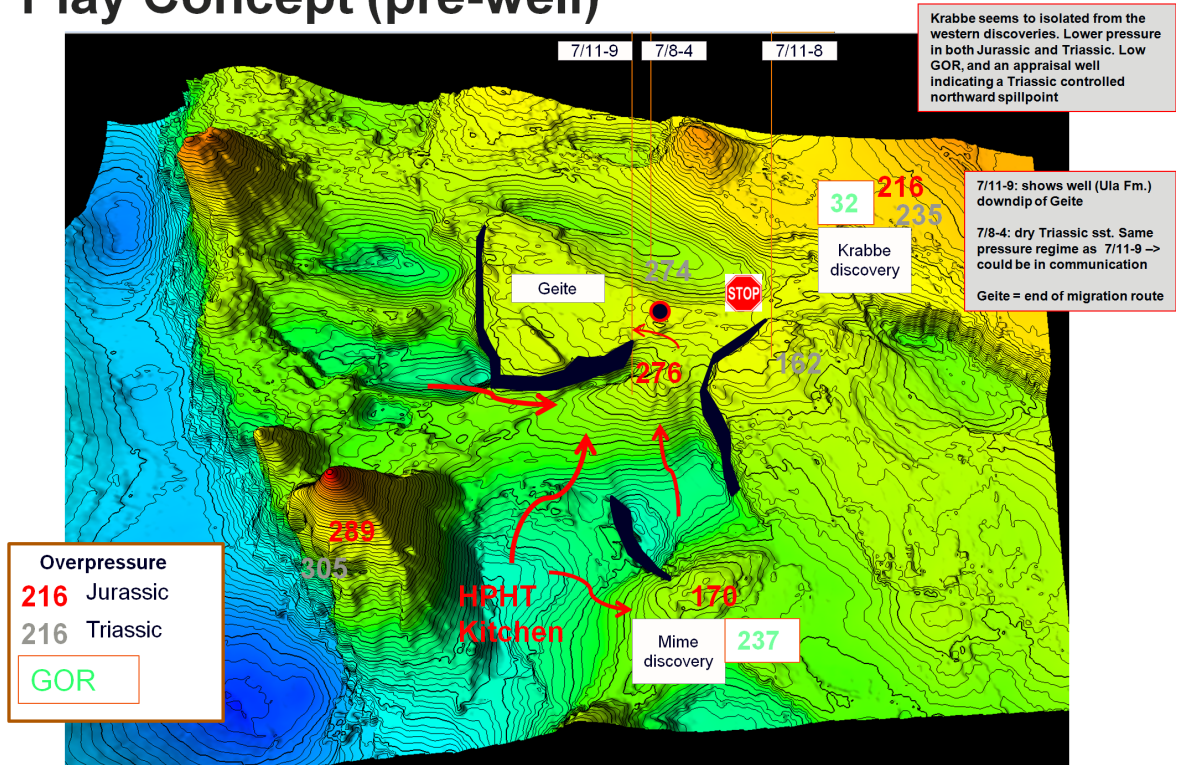


Fig. 3.4 Pre-well play concept

## 3.2 Well 7/11-13

### 3.2.1 Objectives

The reservoir target in well 7/11-13 was the late to middle Judy Sandstone Member in the Triassic Skagerrak Formation, with an overlying shale referred to as the Julius Mudstone Member. The objective for the petrophysical evaluation of 7/11-13 were to evaluate the reservoir interval with respect to reservoir quality, fluid saturation and fluid contacts.

### 3.2.2 Well results

The PL 497 license received the jack-up rig Maersk Guardian on the 1st of September 2012. The well was spudded on the 8th of September 2012. The well was drilled to the final TD on the 13th of October 2012, and the rig went off license on the 3rd of November 2012. The well was drilled as a vertical well. A slight shallow gas warning had been indicated at 335mMSL, but no shallow gas was observed. Total depth of the well was 3800mMD / 3758.06mTVD MSL.

The reservoir target, the Skagerrak Formation (Judy Sandstone Member), was penetrated at 3746mMD (3704.0mTVD MSL). Unfortunately the target was found to be water bearing. No wireline logging was performed. Based on these results, 7/11-13 Geite was permanently plugged and abandoned as a dry well.



The well proved no hydrocarbons in the prognosed reservoir sections, neither moveable nor residuals. CPI zonal averages are presented in Table 3.1 . Average porosity, water saturation and clay volume are calculated for the net intervals. The best reservoir potential sections are found in the Judy Sandstone Member, where effective porosities up to 21% are estimated. The average effective porosity in the calculated net interval in this sandstone is 17.8%. A net/gross ratio of 32% is calculated for the total Skagerrak Formation interval, when a cutoff of 15% is used for the porosity and 50% is used for the shale volume. However, the results are dependent on the cutoffs. When decreasing the porosity cutoff from 15% to 12%, the net/gross ratio increase to 58%.

Table 3.1 Reservoir Zonal averages

7/11-13 Reservoir Summary

Zone Name	Units	Top	Bottom	Top	Bottom	Gross	Net	N/G	Av Phie in net interval	Av Swe in net interval	Av Vcl in net interval
Skagerrak Formation:		MD	MD	TVDSS	TVDSS	TVDSS	TVDSS	TVDSS			
Julius Mudstone Member	m	3697.00	3746.00	3655.43	3704.33	48.98	10.36	0.21	0.165	0.927	0.304
Judy Sandstone Member	m	3746.00	3785.77	3704.33	3744.09	39.75	18.43	0.46	0.178	0.908	0.260
All zones	m	3697.00	3785.77	3655.43	3744.09	88.73	28.79	0.32	0.173	0.915	0.276

Cutoffs Used:

Zone Name Phie Vcl  
 Julius Mudstone Member >= 0.1' <= 0.50  
 Julius Sandstone Member >= 0.1' <= 0.50

The geology and the depth prognosis of the well came in as prognosed. See Table 3.2 and Fig. 3.5 for lithostratigraphic information.

Table 3.2 Actual well tops

Tops	Prognosis		Actual			
	MD BRT (m)	TVD MSL (m)	MD BRT (m)	TVD BRT (m)	TVD MSL (m)	High (+) /Low (-) (m)
Nordland Group (sea bed)	121.5	80.5	121.60	121.60	80.50	
Base Nordland Group	799	757.9	800.00	800.00	758.90	+1.0m
Hordaland Group	1430.1	1389	1434.50	1433.46	1392.36	+3.4m
Eocene	2653.1	2612	2656.00	2655.16	2614.06	+2.1m
Rogaland Group						
Balder Formation	2920.1	2879	2922.50	2921.66	2880.56	+1.6m
Sele Formation	2941.1	2900	2943.00	2942.16	2901.06	+1.1m
Lista Formation	2983.1	2942	2990.00	2989.16	2948.06	+6.1m
Våle Formation	3035.1	2994	3030.00	3029.16	2988.06	-5.9m
Shetland Group						
Ekofisk Formation	3060.1	3019	3076.50	3075.66	3034.56	+15.6m
Tor Formation	3120.1	3079	3136.50	3135.66	3094.56	+15.6m
Hod Formation	3484	3442.9	3469.00	3468.16	3427.06	-15.8m
Blødøks Formation	3625	3583.9	3625.00	3624.16	3583.06	
Hidra Formation	3630	3588.9	3631.50	3630.66	3589.56	
Cromer Knoll Group						
Rødby Formation	3655	3613.9	3641.00	3640.16	3599.06	-14.8m
Tyne Group						
Mandal Formation	3674	3632.9	3680.00	3679.16	3638.06	+5.2m
Skagerrak Formation	3708	3666.9	3697.00	3696.16	3655.06	-11.8m
TD (dry case)	3785	3740	3800.00	3799.16	3758.06	

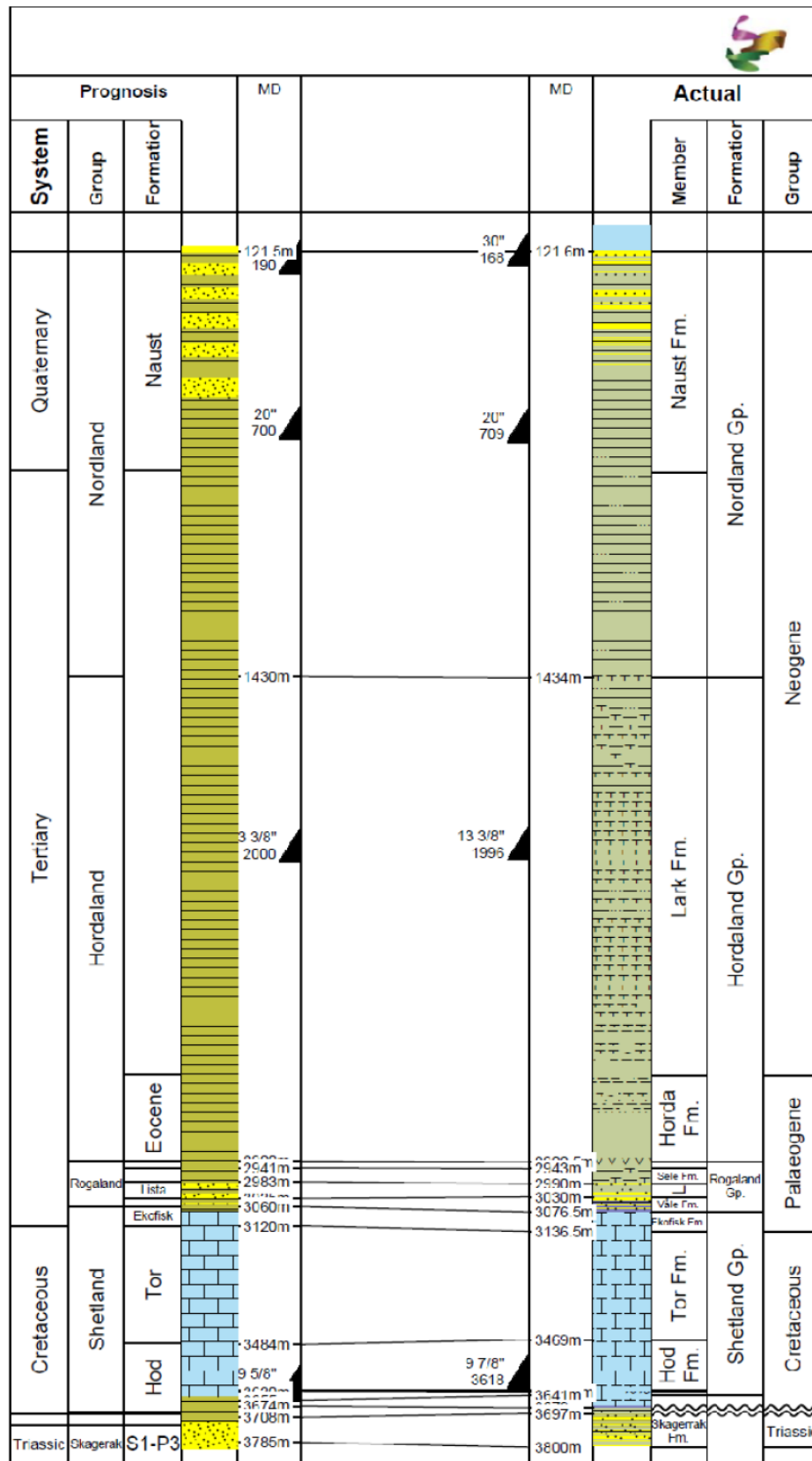


Fig. 3.5 Prognosis vs. actual stratigraphy, well 7/11-13



Pre-drilling, there was estimated to be a high probability (1.0) of reservoir presence and a moderate risk (0.6) for the probability of reservoir quality. The well results confirmed good quality reservoir.

The trap geometry and trap seal were not seen as high risks for the Geite Prospect (1.0 and 0.9, respectively). This model seems to fit after drilling, the Lower Cretaceous and Upper Jurassic shales were even thicker than prognosed.

The presence and maturation of the source rock was not seen as a high risk, and the probability was set to 0.9. The highest risk prior to drilling was estimated to be the migration and timing of the source rock, this probability was set to 0.5. The well results confirmed that the migration and/or timing were probably the main failure.

## 4 REMAINING PROSPECTIVITY

The PL497/PL497B joint venture has carried out an evaluation of the remaining prospectivity in the licence and has matured two prospects (Kniven and Pal 1). The matured prospects are medium to high risk and have too marginal volumes to be of economical interest. The Kniven Prospect is also evaluated to be positioned in an area close to high pressure and temperatures. Testing Kniven would therefore require the planning of an HPHT well.

The Kniven (main) Prospect is a 3-way structural closure with juxtaposition against Triassic shales. The reservoir in the Kniven Prospect is the shallow marine Ula Formation of Late Jurassic age. The play is a classic inter-pod play with shoreface sands deposited in salt-collapse structures, sourced from local, emerged Triassic pods or the Sørvestlandet High emerged lands to the east. There is also possibilities of preserving thin, transgressive, basal sands on the Triassic pods (e.g. the Ula Formation in UK well 23/22b-4). The reservoir quality of the Jurassic sands is likely to be very variable.

The seal of the Kniven Prospect is the Upper Jurassic and Lower Cretaceous marine shales, and the source rocks are expected to be the Upper Jurassic Mandal and Farsund formations. The Kniven prospect could have been charged from the local kitchen area to the west.

The top reservoir depth map is shown in Fig. 4.1, and a NW-SE orientating random line through the Kniven Prospect is shown in Fig. 4.2.

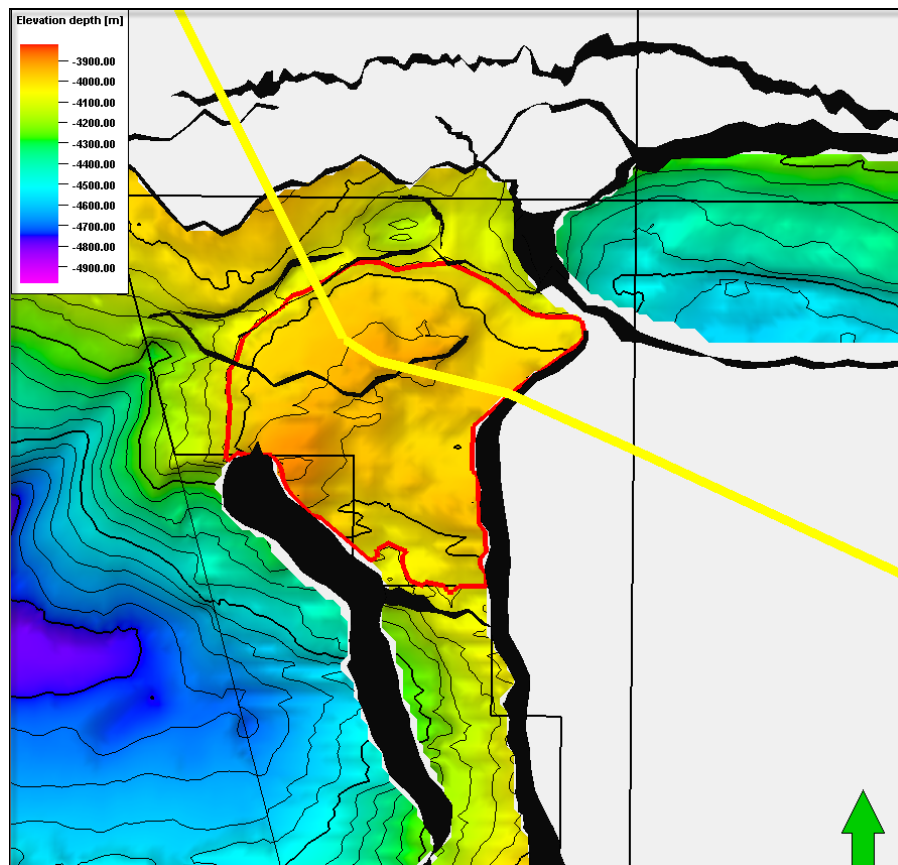


Fig. 4.1 Depth structure map, base Farsund Fm. *The Kniven Main Prospect is marked with a red bold line*

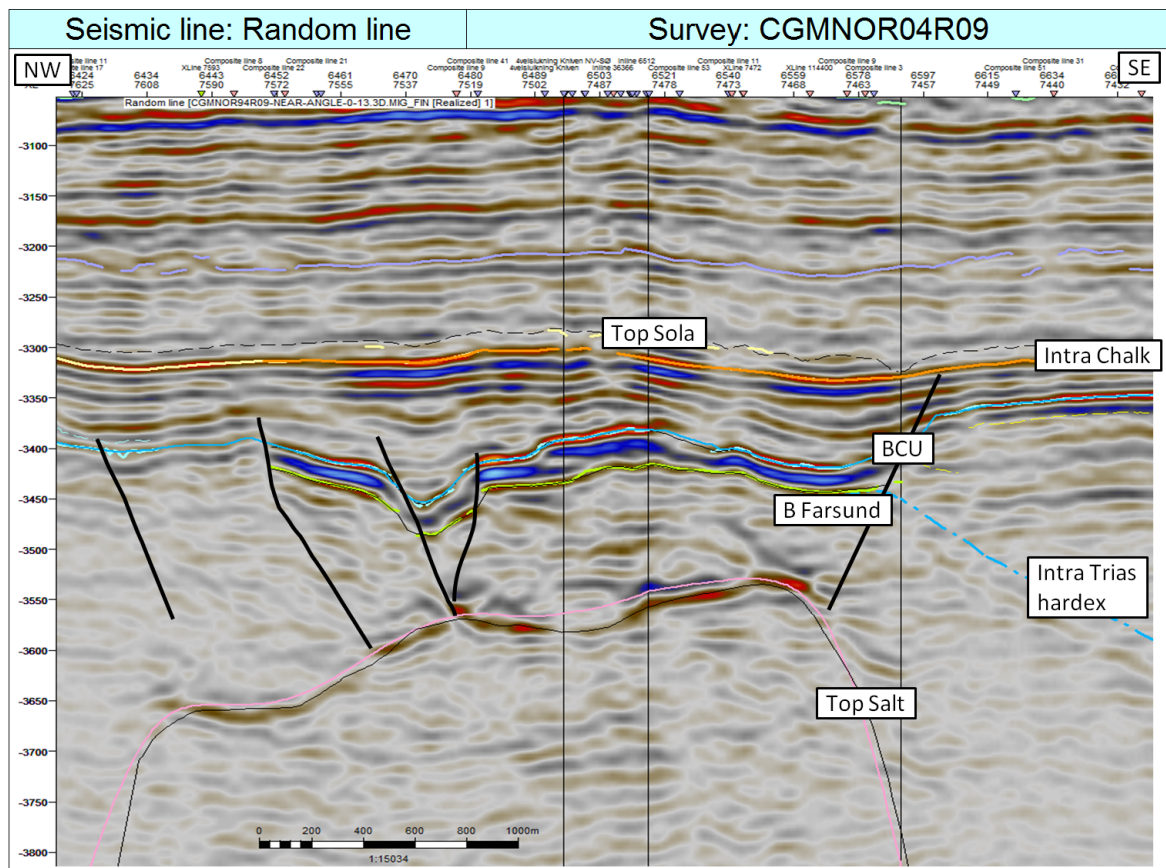


Fig. 4.2 Random line through the Kniven Prospect

The Pal 1 Prospect is a 4-way structural closure with late to middle Paleocene (Forties/Listra formations) reservoir. The reservoir represent a submarine fan system, with stacked, unconfined low to high-density turbidite sands, filling a system of NNW-SSE trending channels sourced from the East Shetland Platform to the northwest. These are interbedded with rythmites and hemipelagic shales of the Lista and Sele formations. The main depocentre for this fan system was in the Forties Basin on the UK sector, and the Pal 1 Prospect is probably located on the very margin of this, close to the pinch-out.

The seal for the Pal 1 Prospect is thought to be the Sele Fm shales (upper Rogaland Group) and the overlying Hordaland Group. The source is expected to be the same as for the Kniven Prospect (the Upper Jurassic Mandal and Farsund formations), and the filling of the prospect could be caused by vertical migration and/or spill from the Pierce Field. The top reservoir depth map is shown in Fig. 4.3, and a N-S orientating random line through the Pal 1 Prosepect is shown in Fig. 4.4.

A table showing the expected recoverable reserves for the Kniven and Pal 1 prospects is presented below, in Table 4.1. A technical- economical evaluation of two different scenarios have been done, regarding tie-back to the Ula Field or a tie-back to the UK Pierce Field. Due to small volumes and the probability of a HPHT well, the economics turn out negative (tie-back to the Ula Field) or marginal (tie-back to the Pierce Field). There is also a risk of asphaltene problems in the Ula reservoir, as shown in the Mime and Krabbe Fields. The production on the Mime Field had a rapid decline, probably due to asphaltene precipitates. This, together with the high salinity and Calcium content at the Krabbe Field, would have been difficult/expensive to handle in an eventually co-ordinated development.

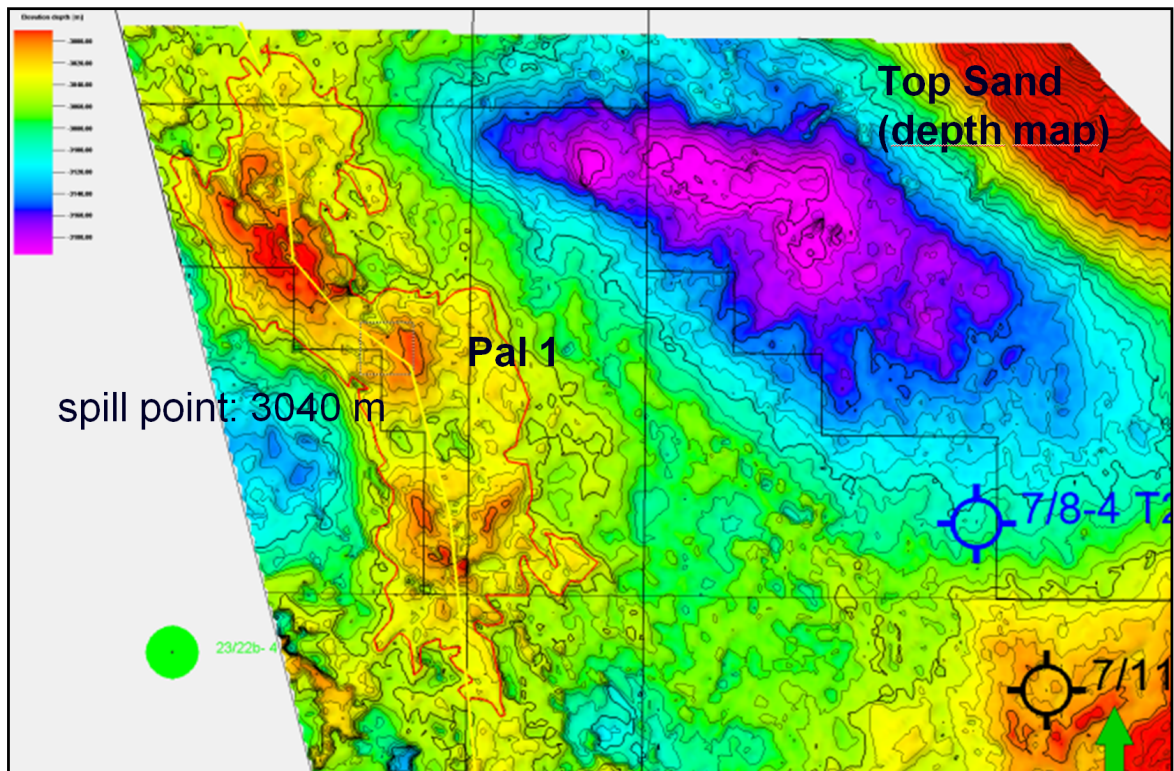


Fig. 4.3 Depth map, top reservoir Paleocene. The Pal 1 Prospect is marked with a red bold line.

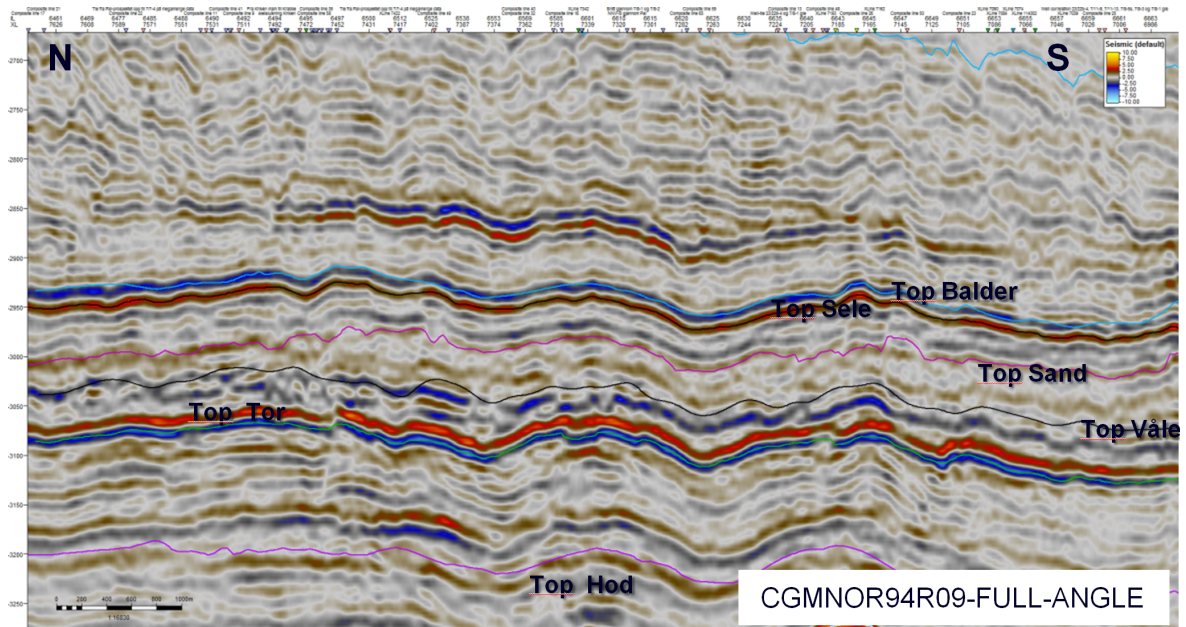


Fig. 4.4 Random line through the Pal 1 Prospect



Table 4.1 Expected recoverable reserves for the Kniven and Pal 1 prospects

PL 497 and PL497B					GROSS RECOVERABLE RESERVES/RESOURCES					
					Low		Base		High	
CATEGORY	RESERVOIR LEVEL	HC	RF (%)	POS (%)	Oil (MSm <sup>3</sup> )	Gas (GSm <sup>3</sup> )	Oil (MSm <sup>3</sup> )	Gas (GSm <sup>3</sup> )	Oil (MSm <sup>3</sup> )	Gas (GSm <sup>3</sup> )
<b>PROSPECTS</b>										
<b>Kniven, main</b>	Ula Fm. Upper Jurassic	Oil	35	45	1.1	0.2	2.3	0.3	3.6	0.5
<b>Pal 1</b>	Sele/Lista Fms, Late Paleocene	Oil	37.5	22	1.2	0.2	1.8	0.3	2.5	0.4