

---

# PL498/498B Relinquishment Report

---



The inner Skagen quay of Stavanger, with MS Rogaland

## Content

<b>Chapter 1. Key license history</b>	p. 3
<b>1.1 License owners</b>	p. 3
<b>1.2 Award and work program</b>	p. 5
<b>1.3 Pre-well prospectivity</b>	p. 7
<b>Chapter 2. Database</b>	p. 9
<b>2.1 Seismic and well database</b>	p. 9
<b>Chapter 3. Review of geological framework</b>	p. 12
<b>3.1 Skagen, 7/8-6 S, pre-drill prospect evaluation</b>	p. 12
<b>3.2 Skagen, 7/8-6 S, well objectives</b>	p. 14
<b>3.3 Skagen, 7/8-6 S, well results</b>	p. 14
<b>Chapter 4. Prospect update, Post-well prospectivity</b>	p. 17
<b>Chapter 5. Technical evaluations</b>	p. 19
<b>Chapter 6. Conclusions</b>	p. 19

## List of figures

- Figure 1. PL 498/498 B location and outline
- Figure 2. Pre-well prospectivity in PL 498
- Figure 3. Seismic database
- Figure 4. Area extent of two reprocessed seismic surveys
- Figure 5. Overview of wells in common database
- Figure 6. Depth structure map and amplitude map, Skagen prospect
- Figure 7. Seismic randomline through the Skagen prospect.
- Figure 8. Crossline 15190 through the Skagen prospect.
- Figure 9. CPI plot, Ekofisk and Tor Fms
- Figure 10. Top Balder Fm time map showing post-well prospects and leads.
- Figure 11: Randomline from MC3D-CGMNOR94-R14

## List of tables

- Table 1. PL 498/PL 498B participants
- Table 2. PL 498/PL 498B work obligations
- Table 3. PL 498/498 B meeting overview
- Table 4. Pre-well assessment of the Skagen prospect
- Table 5. Petrophysical summary
- Table 6. Actual and prognosed well tops
- Table 7: Risk and volumetrics in prospects and leads

# 1 Key license history

## 1.1 License owners

PL498/498 B is located on the Jæren High, quadrant 7, in the North Sea. The licenses are illustrated in Figure 1.

PL 498 was awarded on 23. January 2009, as a result of an application in APA 2008, the application was delivered by an AMI consisting of Skagen 44, LOTOS (operator), Edison and 4Seas Energy

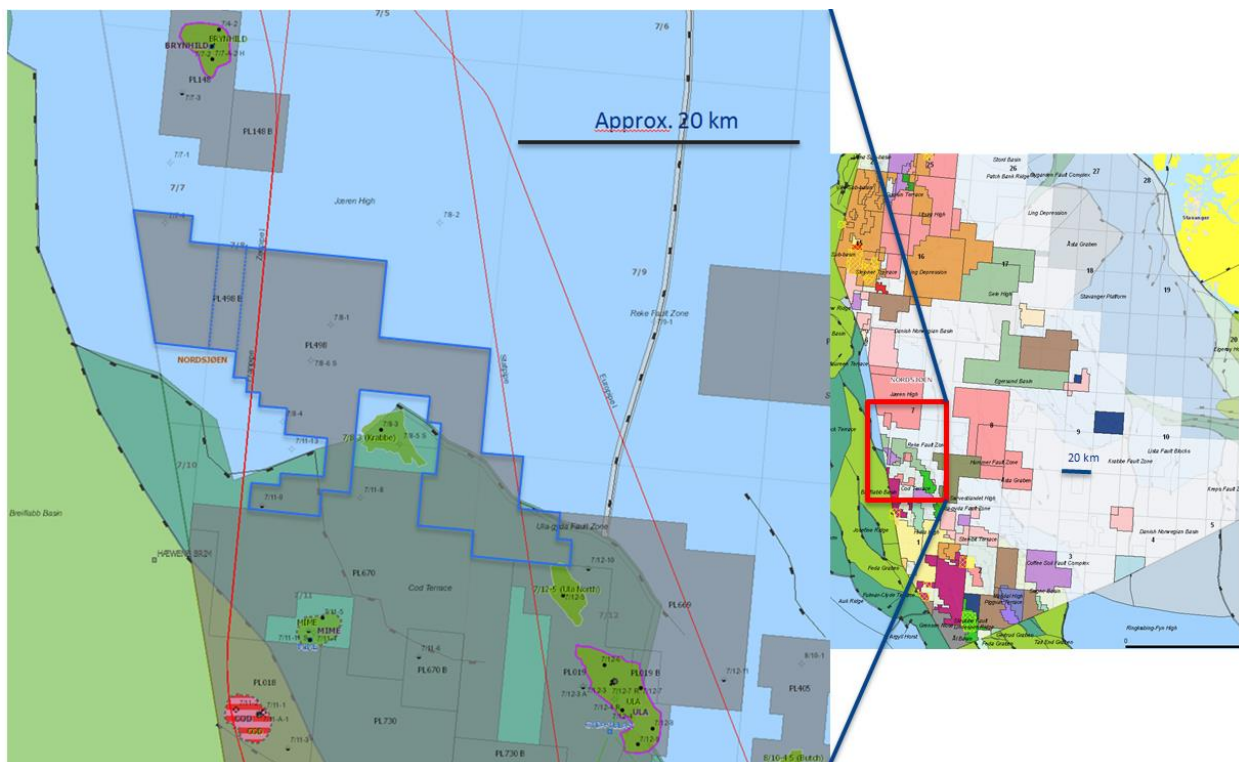


Figure 1: PL498/498 B location and outline, edited from npd.no.

The area of PL498 is 278.16 km<sup>2</sup>, covering parts of blocks 7/7, 7/8, 7/11 and 7/12. The area of PL 498 B is 14.91 km<sup>2</sup>, in block 7/8, see figure 1.

A summary of PL 498/PL 498B participants is presented in Table 1.

PL 498	Licensee valid from date	Licensee valid to date	Company longname	Interest [%]
01.01.2015	23.01.2015	<a href="#">Edison Norge AS</a>	25.000000	
		<a href="#">Lime Petroleum Norway AS</a>	25.000000	
		<a href="#">Lotos Exploration and Production Norge AS</a>	25.000000	
		<a href="#">Skagen44 AS</a>	25.000000	
31.03.2014	01.01.2015	<a href="#">Lime Petroleum Norway AS</a>	25.000000	
		<a href="#">Edison International Norway Branch</a>	25.000000	
		<a href="#">Lotos Exploration and Production Norge AS</a>	25.000000	
		<a href="#">Skagen44 AS</a>	25.000000	
30.09.2013	31.03.2014	<a href="#">Edison International Norway Branch</a>	25.000000	
		<a href="#">Lotos Exploration and Production Norge AS</a>	25.000000	
		<a href="#">Skagen44 AS</a>	25.000000	
		<a href="#">North Energy ASA</a>	20.000000	
		<a href="#">Lime Petroleum Norway AS</a>	5.000000	
31.12.2012	30.09.2013	<a href="#">North Energy ASA</a>	25.000000	
		<a href="#">Edison International Norway Branch</a>	25.000000	
		<a href="#">Lotos Exploration and Production Norge AS</a>	25.000000	
		<a href="#">Skagen44 AS</a>	25.000000	
28.10.2009	31.12.2012	<a href="#">Edison International Norway Branch</a>	25.000000	
		<a href="#">Lotos Exploration and Production Norge AS</a>	25.000000	
		<a href="#">Skagen44 AS</a>	25.000000	
		<a href="#">4Sea Energy AS</a>	25.000000	
23.01.2009	28.10.2009	<a href="#">Lotos Exploration and Production Norge AS</a>	25.000000	
		<a href="#">Skagen44 AS</a>	25.000000	
		<a href="#">4Sea Energy AS</a>	25.000000	
		<a href="#">Edison International Spa</a>	25.000000	

PL 498B	Licensee valid from date	Company longname	Interest [%]
	01.01.2015	<a href="#">Edison Norge AS</a>	25.000000
	-	<a href="#">Lotos Exploration and Production Norge AS</a>	25.000000
	-	<a href="#">Skagen44 AS</a>	25.000000
	-	<a href="#">Lime Petroleum Norway AS</a>	25.000000

Table 1: PL 498/PL 498B participants, from npd.no.

## 1.2 Award and work program

PL 498 was awarded on January 23<sup>rd</sup> 2009, as a result of an application in APA 2008, the area of license PL 498, and PL 498 B, is shown in figure 1. PL 498 B was awarded on February 7<sup>th</sup> 2014, from an application on add-on acreage in APA 2013.

The work programs/work obligations for PL 498 and PL 498B are displayed in table 2. The PL 498 received a one year extended BoV deadline associated with the add-on acreage application (PL 498B).

PL 498		Work obligations			
Work obligation	Decision	Task status	Expiry date	Wellbore if drilled	
Study of geology and geophysics		Approved			
	Decision to drill	Will be drilled	23.01.2011		
Drilling		Approved		7/8-6 S	
	Decision to continue (BoV)	In process	23.01.2015		
	Decision to enter extension period	Dropped	23.01.2015		
Relinquishment report		In process	23.04.2015		

PL 498B		Work obligations			
Work obligation	Decision	Task status	Expiry date	Wellbore if drilled	
Reprocessing of 3D seismic		In process			
Acquire new 3D seismic		In process			
	Decision to acquire new 3D seismic	In process	07.02.2016		
	Decision to drill	In process	07.02.2016		
Drill exploration well		In process			
	Decision to concretize (BoK)	In process	07.02.2018		
Conceptual studies		In process			
	Decision to continue (BoV)	In process	07.02.2019		
Prepare plan for development (PDO)		In process			
	Decision to enter extension period	In process	07.02.2020		
Relinquishment report		In process	07.05.2020		

Table 2: PL 498/PL 498B work obligations, from npd.no.

A summary of license meetings is shown in table 3. “MC” means Management Committee, “EC” means Exploration Committee and “WM” is Work Meeting, the latter is generally on EC level.

The reason for relinquishment is basically that the PL 498/PL 498 B licenses have drilled a dry Skagen prospect, and that the remaining prospects are too small or have too high risk to meet the economic cut-off criteria, and of course, too small to defend a new well.

Meeting	Date	Agenda (short)
EC/MC	13.02.2009	Establishing the license, approval of administrative procedures, explo. strategy and work
WM	20.02.2009	Seismic database
EC	03.03.2009	Database issues; wells and seismic, work program and 2009 budget
WM	08.05.2009	Seismic data from PGS, seismic interpretation, petrophysical database, seismic inversion tender
WM	10.09.2009	Seismic inversion data; status, comparison, porosity mapping. 2010 work program
EC/MC	25.11.2009	Status work performed in 2009, budget 2009 status, budget and work program 2010
EC	11.03.2010	Overpressure study (GPT), hydrocarbon migration study (Migris), study plan 2010
WM	26.05.2010	Results migration modelling (Migris), the Skagen prospect: Initial well plans
WM	09.09.2010	The Skagen prospect; parameterization, hydrocarbon migration, retention, risk, resources, well objectives & cost
WM	23.09.2010	The Skagen prospect; resources & economic evaluation, the Vågen prospect
WM	27.10.2010	The Skagen prospect; volumes & valuation
MC	30.11.2010	The Skagen prospect; DoD discussion, budget & work program 2011,
EC/MC	04.02.2011	The Skagen prospect, well locations, sidetrack scenarios, shallow hazards, budget 2010 summary, 2011 budget
EC	26.05.2011	The Skagen prospect; Site-survey and drilling preparations
EC	14.06.2011	The Skagen prospect; Establishing Drilling Work Group, negotiations for drilling rig (Jack-Up)
EC/MC	22.09.2011	The Skagen prospect; Drilling preparations. Work programs & Budgets; 2011 Status, 2012
EC	02.11.2011	The Skagen prospect; Drilling preparations
WM	18.01.2012	The Skagen prospect (7/8-6 S); Drilling plans, well status, data aquisition
EC/MC	22.05.2012	The Skagen prospect (7/8-6 S); Drilling plans, well status, data aquisition, additional G&G work, budgets
EC/MC	25.10.2012	The Skagen prospect (7/8-6 S); Well status, drilling planning, data aquisition, status G&G work, work program & budget 2013, Budget forecast 2014-2016
WM	16.11.2012	Drill Stem Test (DST) meeting/discussion
EC	06.06.2013	7/8-6 S Final Well Report, Status of ongoing interpretation (Paleocene, Cretaceous & Upper Jurassic Ula Fm), Low frequency seismic, budget status (APA 2013 add-on application)
EC/MC	26.11.2013	APA 2013 add-on application, Status of interpretation (Rogaland Gp, Cromer Knoll Gp, BCU, Ula Fm & Rotliegendes Gp), Interpretation focus, New seismic, 2014 Budget
WM	02.04.2014	Status seismic reprocessing and gravimetry, Status special studies (salt modelling: Tectonor & geochemistry/migration), Status seismic interpretation
EC/MC	24.06.2014	Status seismic reprocessing (Geokinetics), Status special studies (salt modelling: Tectonor & gravimetry: ARKeX), Status seismic interpretation, Budget forecast 2015
EC/MC	03.12.2014	Technical status; salt modelling, gravimetric modelling, seismic reprocessing, interpretational status on re-processed seismic, relinquishment proposal. 2014 budget status and 2015 budget proposal
EC/MC	25.06.2015	Technical status; Mapping & AVA, Pre-Stack Pro report (Sharp Reflections), interpretation status, the Skansen and Kongereke prospects and leads. Technical recommendation: Relinquishment PL 498/B. 2015 budget status, proposed 2016 budget.

Table 3: PL 498/498 B meeting overview.

### 1.3 Pre-well prospectivity

Figure 2 display the pre-well prospectivity of PL 498, and the basis for the APA 2008 application. The Skagen prospect is an intra Tor allocthonous unit, near the top Tor Fm, the other prospects are solely Upper Jurassic Ula Fm, generally in an intra-pod setting.

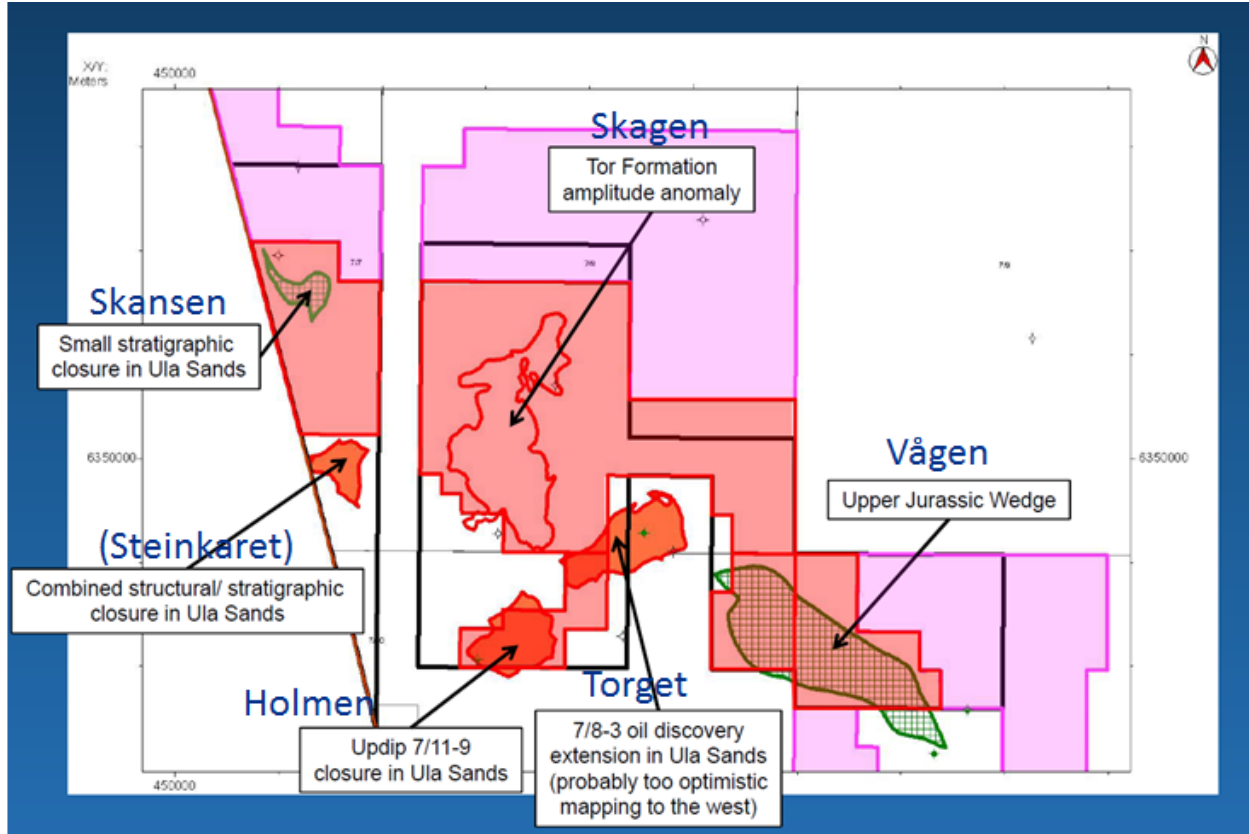


Figure 2: Pre-well prospectivity in PL 498.

The Skagen prospect was defined as a prominent “soft” and strong event on the original seismic. Post-depositionally, the entire Chalk Gp (Shetland Gp) has undergone halokinetic movement which explains the structural closure. The halokinesis may also induce fractures which again can lead to increased porosity and permeability in chalk rocks.

The top seal of the Skagen prospect is the dense rocks near Top Tor Fm plus the Ekofisk tight zone overlying the Top Tor Fm. The lateral seal of the Skagen prospect is faults which offsets the Top Tor seismic marker.

The main source rocks are the Mandal and Farsund Fms, of the Upper Jurassic. Seismic and geochemical data suggest these Fms are present and sufficiently mature beneath the Skagen prospect.

The pre-drill overview, geological risk and volumetrics, of the Skagen prospect are shown in table 4.

Prospect	Stratigraphic level	Pg	In-place volumes ( $10^6 \text{ Sm}^3$ )			Resources ( $10^6 \text{ Sm}^3$ )		
			P90	Mean	P10	P90	Mean	P10
<b>Skagen</b>	intra Tor Fm	0,22	14,50	41,90	65,50	2,47	8,04	14,70

**Table 4: Pre-well assessment of the Skagen prospect, geological risk and volumes.**

The TD criteria for the Skagen well 7/8-6 S was to drill 40 m below the base of the porous Tor zone, to accommodate logging of the reservoir section. In case of a Drill Stem test (DST), TD should be 95 m below the base of the porous Tor zone.



## 2. Database

### 2.1 Seismic & well database

Figure 3 shows the database used for seismic interpretation and mapping. The MC3D-CGMNOR94 raw data has been reprocessed twice, in 2007 and 2014, to get a clearer picture on the geology. The map extent of the two reprocessed surveys are displayed in figure 4, note how the 2007 reprocessing focus on the Skagen prospect and that the 2014 reprocessing cover a wider area. Both reprocessed datasets increased the seismic data quality, especially the R14 which was better regarding multiples, especially below the BCU.

In addition to the reprocessed seismic, regional seismic cubes (FUGRO) were also used within the PL 498/498 B to gain regional geologic understanding, especially regarding sand distribution in the Paleocene.

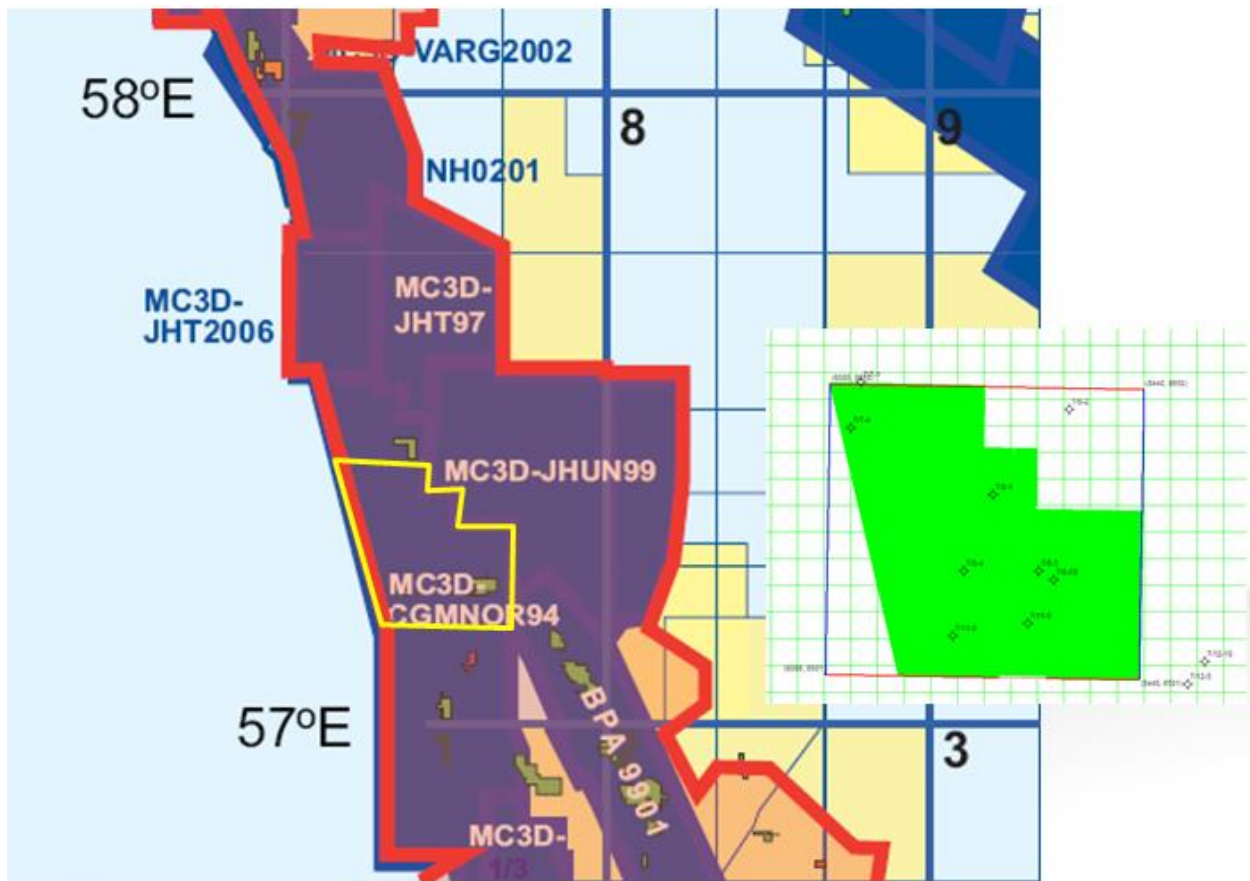


Figure 3: Seismic database; Only seismic 3-D surveys shown

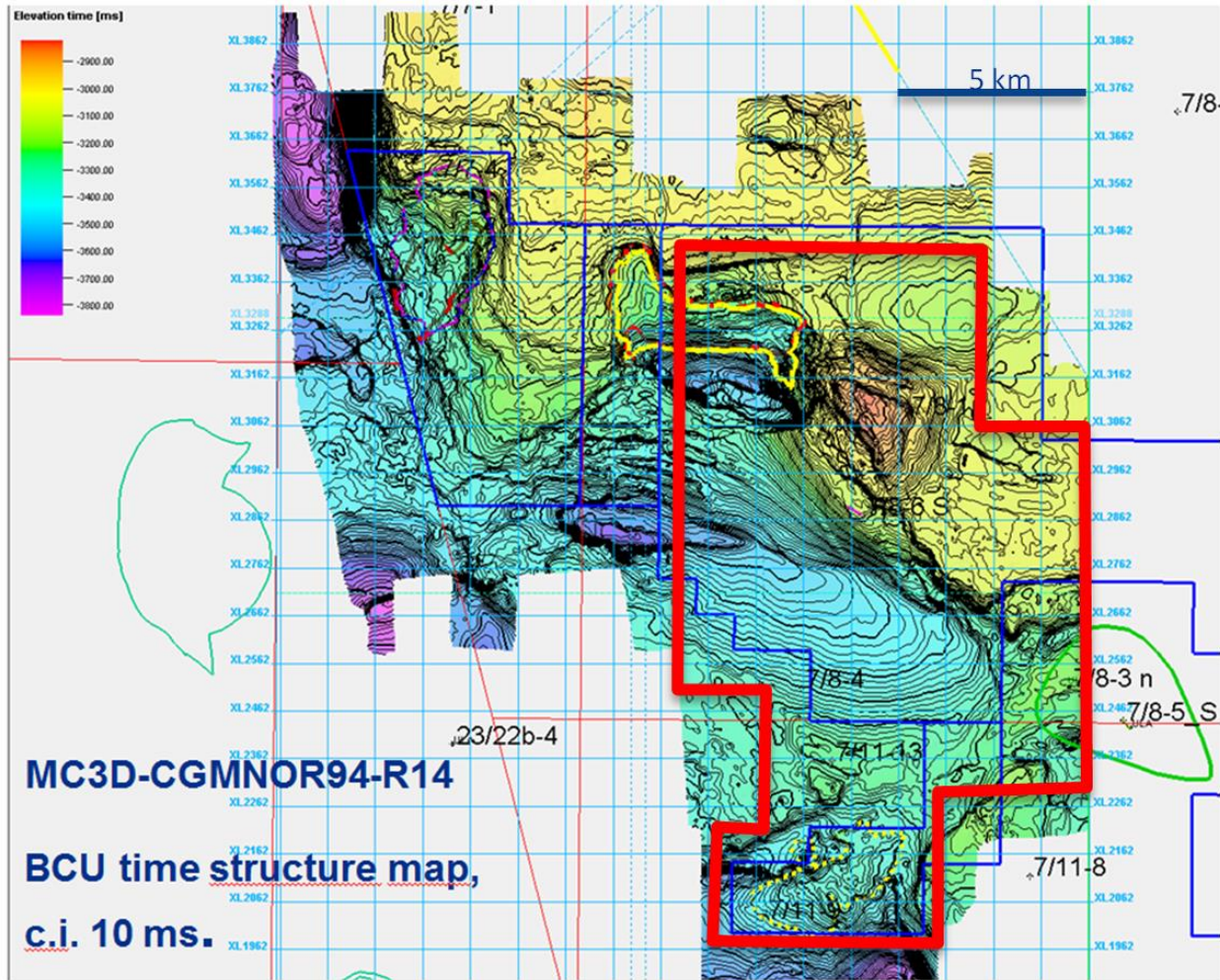


Figure 4: Area extent of two reprocessed seismic surveys, the MC3D-CGMNOR94-R14 covers the entire BCU map while the \*R07 is within the red polygon.

The wells of PL 498/PL 498B common well database is shown in figure 5. Note that the wells 7/7-4 and 7/8-5 S became available through DISKOS during 2008 and 2009.

The well 7/11-13, PL 497, was drilled with Maersk Guardian prior to the Skagen well, the well was dry. LOTOS had 10 % of PL 497 and had thus access to the well results, however, the negative results from the 7/11-13 well had impact on the prospectivity of the PL 498/ 498 B area, especially highlighting the high hydrocarbon migration risk in the area.

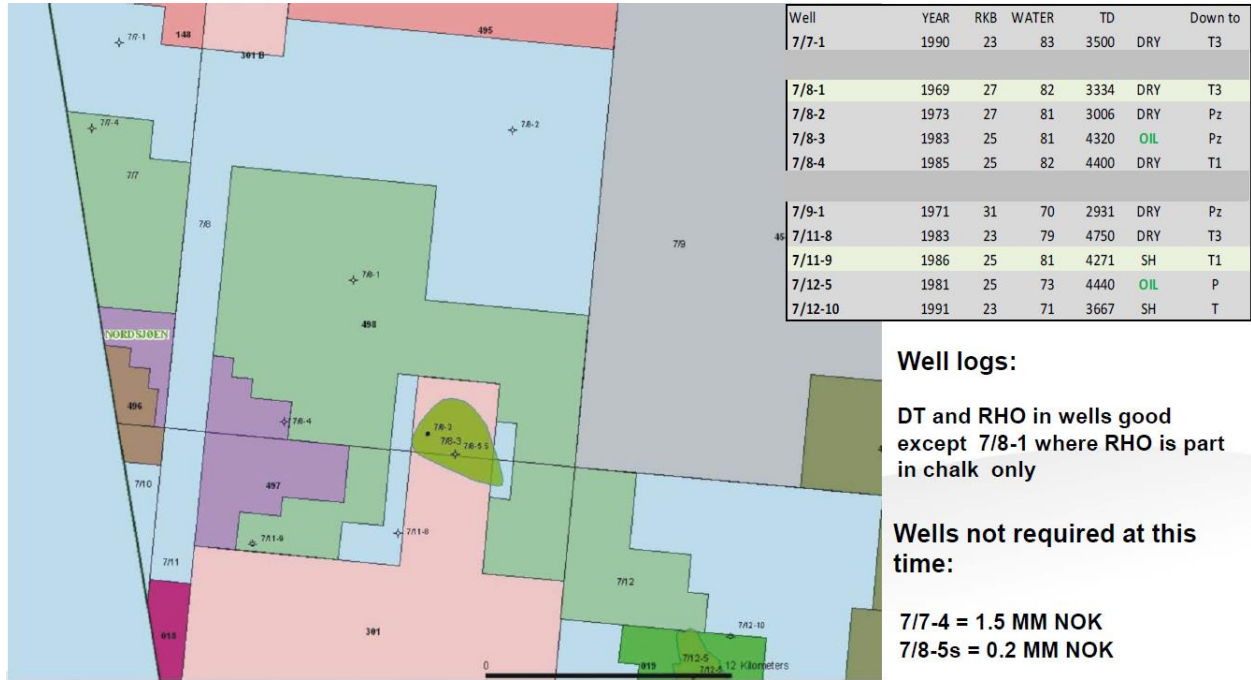


Figure 5: Overview of wells in common database

### 3. Review of geological framework

A number of special studies have been carried out in licenses PL 498/498 B in order to understand the geology and minimize and mitigate geological uncertainty. Special studies include includes seismic projects (reprocessing, inversion, AVA and low frequency seismic and pre-stack analysis) geological studies (overpressure, hydrocarbon migration modelling, gravimetry and salt modelling) and petrophysics. These studies were used to update interpretation and increase the geological understanding within the licenses.

#### 3.1 Skagen, 7/8-6 S, pre-drill prospect evaluation

Skagen is an intra Tor Fm prospect, basically a 3-way dip closure, based on seismic amplitude, against up-dip faults. Key wells are the 7/8-1 and 7/8-4. The source rock for Skagen is the Mandal and Farsund Fms, underlying the prospect and interpreted to be sufficiently mature.

Figure 6 shows a pre-drill depth structure map, top Tor Fm level, and figures 7 and 8 shows seismic lines through the prospect, figure 7 display the play concept; the relationship between the mature source rock (below BCU), the migration path (fault) and the prospect.

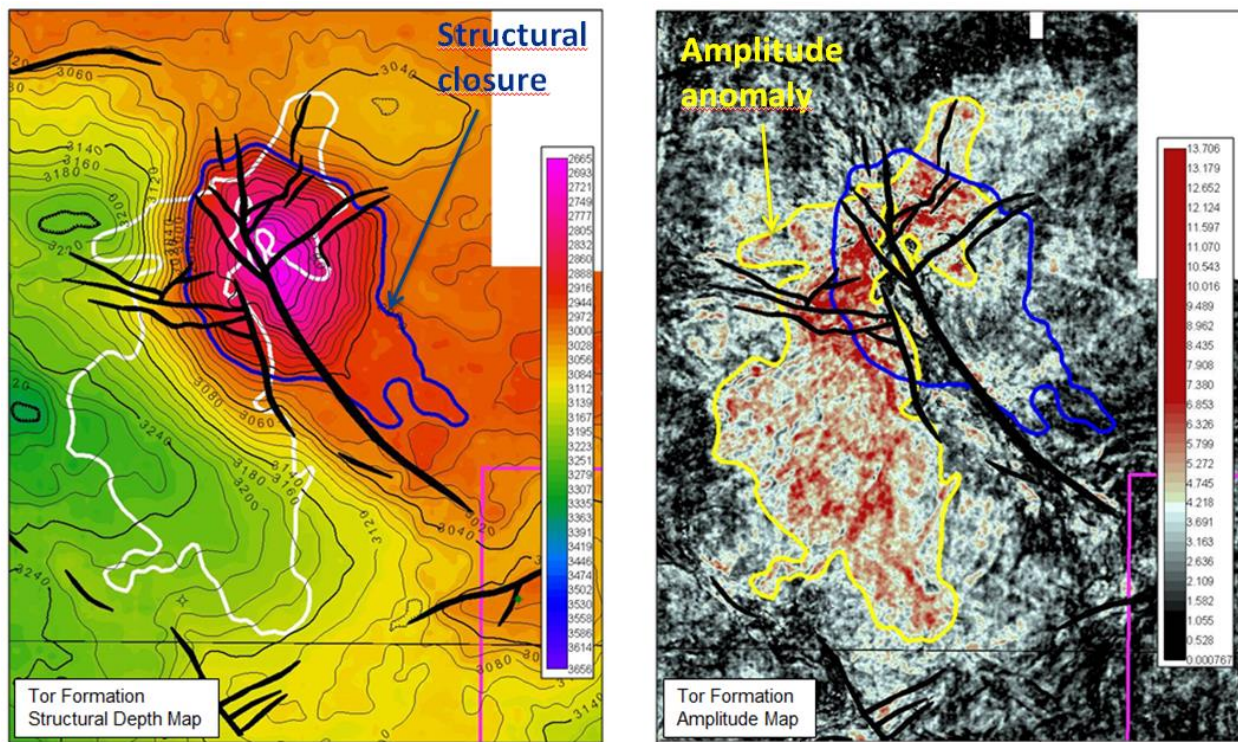


Figure 6: Depth structure map and amplitude map, the Skagen prospect.

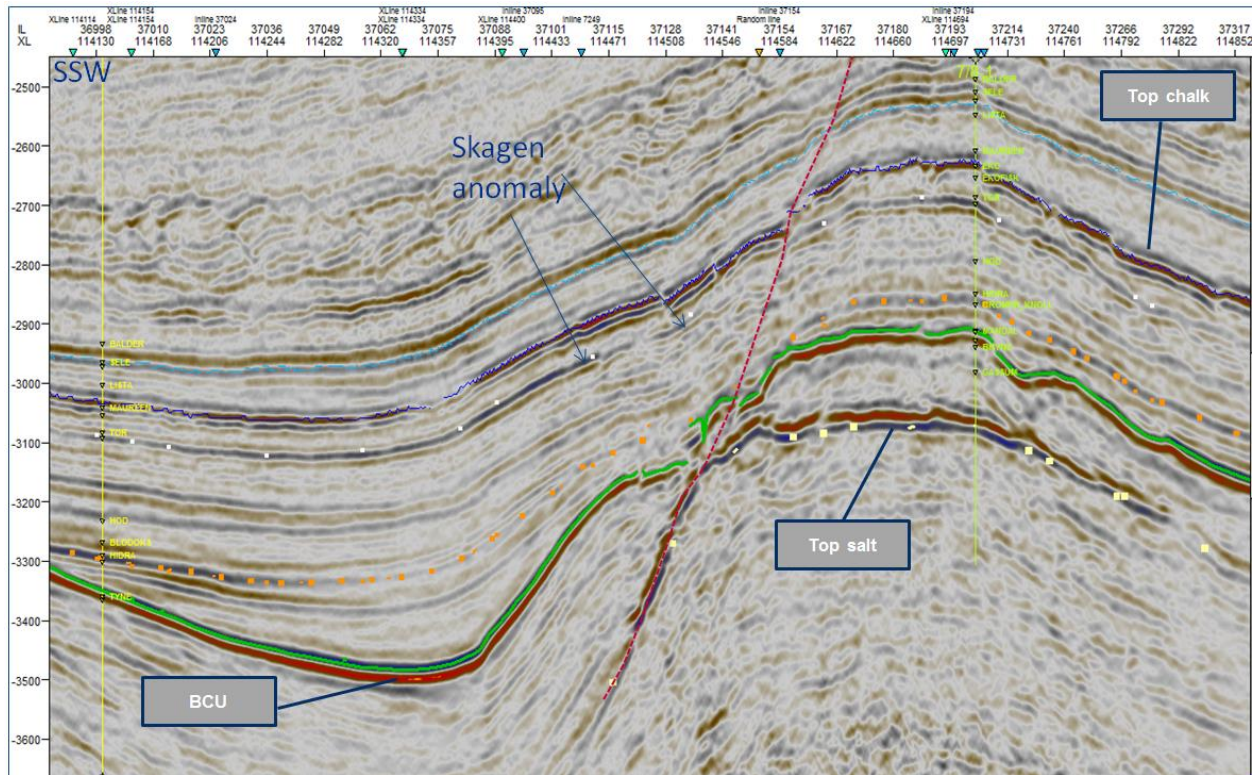


Figure 7: Seismic randomline through the Skagen prospect. From well 7/8-4 (left) through well 7/8-1 (right)

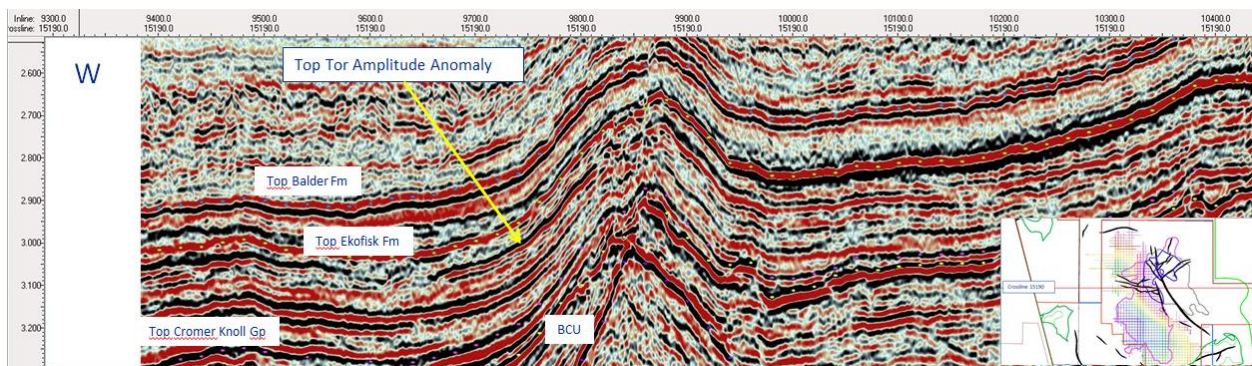


Figure 8: Crossline 15190 through the Skagen prospect.

### 3.2 Skagen, 7/8-6 S, well objectives

The well targeted the porous Tor zone, near top Tor Fm, a unit of Maastrichtian age (Uppermost Cretaceous), with a seismic soft response. The well targeted the P90 volume of the Skagen prospect.

In case of a discovery, the porous Tor zone would be cored and extensively logged by wireline logs in order to get an understanding on reservoir quality, i.e. porosity and saturation, in addition to fracture development, which is considered important with regard to Chalk reservoirs. A discovery would also lead to a DST.

### 3.3 Skagen, 7/8-6 S, well results

Prior to drilling 7/8-6 S, the operator had to do ground-work on the drilling location. Work involved moving away the top three meters of soft sea-bed mud to prepare for the legs of the Jack-up.

Maersk Guardian arrived on location November 4<sup>th</sup> 2012. The well reached TD intra-Tor Fm on the 14<sup>th</sup> of December, at 3220 m MD (3065.3 m TVDMSL), and the rig was off location January 5<sup>th</sup>, 2013. A deviated wellbore was chosen for the well, to avoid a fault close to the original landing area. The top section of the well, from the conductor to approx. 800 m (the setting depth of the 20 " casing) was drilled with a 9 7/8" pilot, to ensure that no shallow gas was present. Total Gas and Connection Gas remained low in this section, reaching maximum levels of 0,6% (700 m) and 1,3% (772 m), respectively.

Top Tor Porous zone was encountered at 3122 m MD (2971 m TVDMSL), it was water filled, no coring, wireline logging or DST was done. And the Skagen well 7/8-6 S was permanently plugged and abandoned as a dry well.

The well proved no free hydrocarbons or shows. The petrophysical summary is displayed in table 5, the values are derived by using the following cut-offs: PHIE $\geq$ 0.12 and VSH $\leq$ 0.5. Figure 9 shows the CPI of the Shetland or Chalk Gp. Maximum PHIE is 0.194, at the top of the Porous Tor zone. As a digression, the Porous Tor zone has an average PHIE of 0.155, and N/G of 0.711 with the cut-offs notified above. Note that PHIE and PHIT have been calculated from the sonic log, and the porosities are relatively similar to the porosity from the MRIL tool (MRIL\_T1PTOT\_1 in figure 9), but note that the MRIL porosity is slightly higher in general.

7/8-6 S	NET Reservoir						
Formations	Interval m MD	Gross m MD	Net m MD	N/G v/v	PHIE v/v	SWE v/v	VSH v/v
EKOFISK FM	3027.0-3095.0	67.955	12.649	0.186	0.136	0.907	0.070
TOR FM	3095.0-3202.7	107.700	32.704	0.304	0.148	0.998	0.025
<b>TOTAL</b>	<b>3027.0-3202.7</b>	<b>175.655</b>	<b>45.353</b>	<b>0.258</b>	<b>0.145</b>	<b>0.974</b>	<b>0.037</b>

Table 5: Petrophysical summary

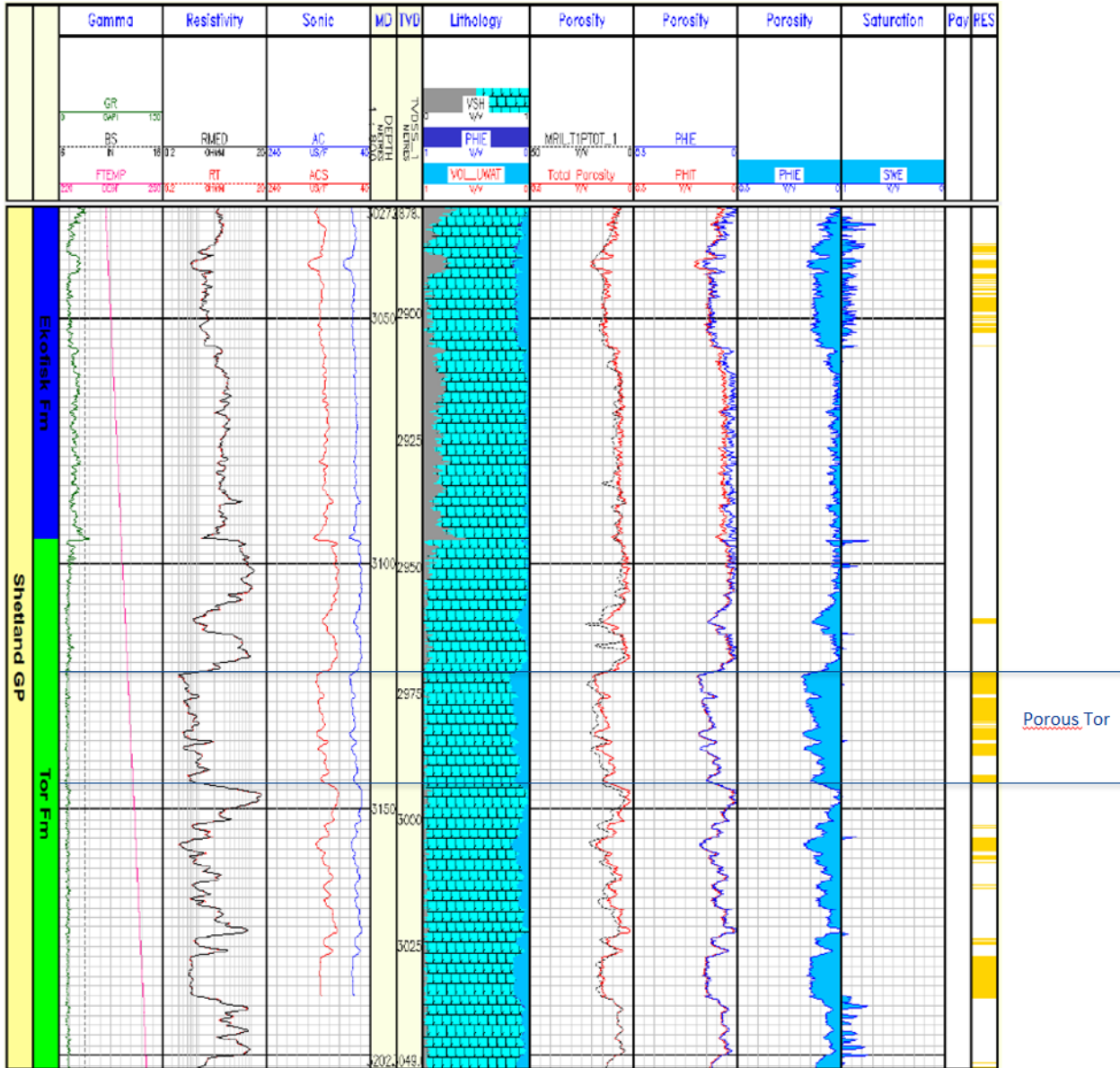


Figure 9: CPI plot, Ekofisk and Tor Fms

The depth prognosis in 7/8-6 S came in more or less as prognosed, especially in the Chalk Gp, see table 6 for comparison between prognosed and actual Fm tops.

Name	Actual Top (MD RKB)	Actual Top TVD RKB	Actual Top TVD MSL	Prognosed Top TVD MSL	TVD MSL High (+) / Low (-) (m)
Nordland Group	127	127	82	82	0
Hordaland Group	1351	1350.95	1306	1311	-5
Lark Formation	1351	1350.95	1306	n/a	n/a
Horda Formation	2584	2488.29	2443.3	n/a	n/a
Rogaland Group	2837	2739.82	2694.8	2663.5	31.3
Balder Formation	2837	2739.82	2694.8	2663.5	31.3
Sele Formation	2876.5	2778.25	2733.3	2701.5	31.8
Lista Formation	2898	2799.06	2754.1	2769	-14.9
Våle Formation	2969	2867.68	2822.7	2812	10.7
Shetland Group	3027	2923.7	2878.7	2877.5	1.2
Ekofisk Formation	3027	2923.7	2878.7	2877.5	1.2
Tor Formation	3095	2989.45	2944.5	2949	-4.5
Tor Formation (TD)	3220	3110.9	3065.3	3065.3	n/a

Table 6: Actual and prognosed well tops 7/8-6 S

The main risk on the Skagen prospect was considered to be Hydrocarbon migration. The fact that the well lacked free hydrocarbons, and had no shows, suggest that the reason for failure was lack of hydrocarbon migration. In addition, the reservoir was an important risk and the petrophysical results confirm the poor reservoir quality.

There were no HSEQ incidents while drilling the 7/8-6 S well, this was according to plan.



### 4. Prospect update, post-well prospectivity

After the unsuccessful Skagen well, the PL 498/PL 498 B hold two prospects and three leads (Figure 10). The two prospects are both in the Upper Jurassic Ula Fm, Kongereke and Skansen. The Holmen lead is also in the Ula Fm, the Tangloppe lead is intra-Cromer Knoll Gp and the Scampi lead is of Paleocene age.

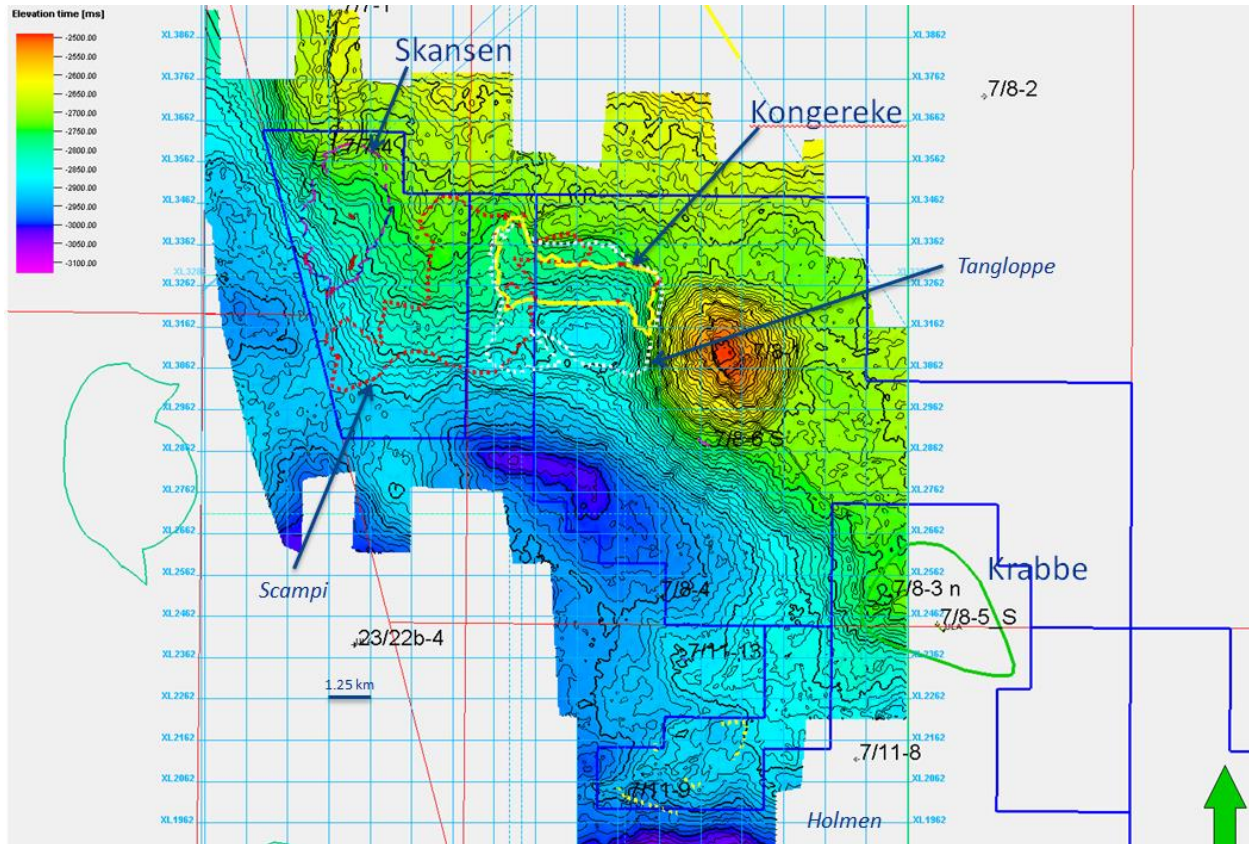


Figure 10: Top Balder Fm time map showing post-well prospects and leads.

The risk (and in-place volumes) and resources of the prospects and leads are shown in table 7, the risks are either too high and/or the resources too low to justify further drilling in the licenses PL 498 and PL 498 B.

Prospect (lead)	Stratigraphic level	PoS	In-place volumes (10 <sup>6</sup> Sm <sup>3</sup> o.e.)				Resources (10 <sup>6</sup> Sm <sup>3</sup> o.e.)			
			P90	Mean	P50	P10	P90	Mean	P50	P10
Kongereke	Ula Fm	0,24	1,95	7,19	5,74	14,41	0,68	2,58	2,05	5,20
Skansen	Ula Fm	0,24	2,28	7,12	6,04	13,40	0,81	2,56	2,15	4,84
Scampi	Andrew Fm	0,09	5,20		13,70	27,80	1,20		3,30	7,30
Tangloppe	intra Cromer Knoll Gp	0,05	4,60		11,60	22,60	1,20		3,20	6,60
Holmen	Ula Fm	0,39	0,50	1,38	1,24	2,45	0,13	0,42	0,37	0,78

Table 7: Risk and volumes in prospects and leads.

Another important geological conclusion, from wells and seismic, is that the Mandal and Farsund Fms (Upper Jurassic source rocks) are not deposited on top of the Triassic pods, hence the amount of available source rock may be less than first anticipated in this area.

To summarize PL 498/PL 498B petroleum geology we present figure 11, a seismic randomline from MC3D-CGMNOR94-R14. Note that the Rotliegende Gp approaches 5 km depth in the NW corner and that there are some internal structures in the Palaeogene, in addition to the prospects already described, however, the risk on most leads are quite high. Basically everything between the Rotliegende Gp and the Palaeogene Rogaland Gp has been analysed with regard to prospectivity and the Upper Jurassic Ula Fm seems to be the best option, with two prospects.

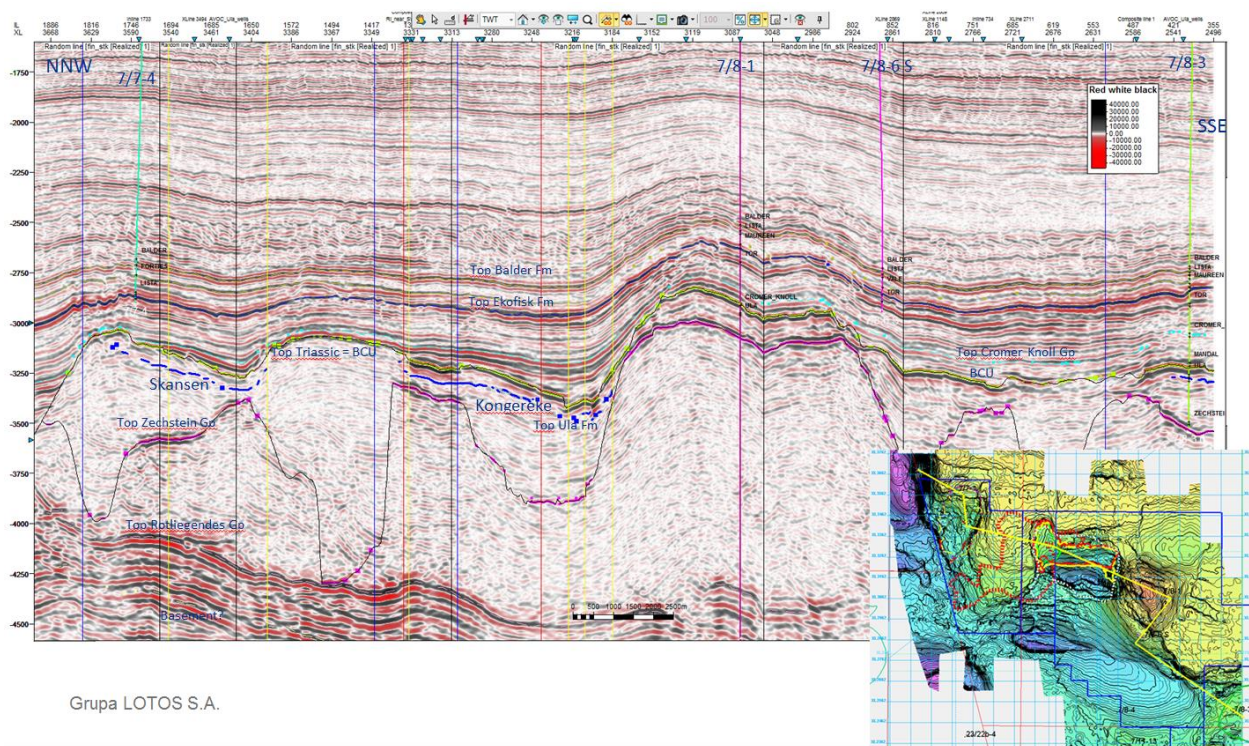


Figure 11: Randomline from MC3D-CGMNOR94-R14

## 5. Technical evaluations

A potential development of the Krabbe discovery (7/8-3), together with LOTOS having access to producing assets in the area, could have made the Kongereke and Skansen prospects look more attractive from LOTOS point of view.

As a digression, the distance from Kongereke and Skansen to the Ula facility (block 7/12) is about 38 and 43 km respectively, and the distance from Kongereke/Skansen to the Pierce field (Hæwene Brim, UK sector) is approximately 18 and 20 km respectively

A Krabbe (7/8-3) development could have made exploitation of the small PL 498/498B prospects more economic viable, especially if a subsea template on Krabbe could have pre-made connections of pipelines from “satellites”, as the Kongereke and/or Skansen. The distance from 7/8-3 to Kongereke and Skansen is about 15 and 19 km respectively.

## 6. Conclusions

As discussed in the previous chapters, and in particular in chapter 4, internal evaluations show that the remaining petroleum potential in PL498/PL 498 B is too small to meet the economic cut-off criteria.

Also, increased geological understanding of risks associated with presence of the prolific Upper Jurassic Mandal and Farsund Fms source rock, and hydrocarbon charge/timing challenges further substantiates the geological risks in the PL 498/PL 498 B area. The wells 7/11-13 (PL 497) and 7/8-6 S were both dry, the main risk on both of them was hydrocarbon migration/timing, and it is clear that the reason for failure on both wells was lack of hydrocarbon migration

The partnership concludes, based on a thorough assessment, that a BoV on PL 498, and/or a drill decision on PL 498 B cannot be justified, and is hence seeking relinquishment.