Relinquishment Report for PL494

Document last updated 29-03-2016 14:57 CEST

Relinquishment Report for PL494

List of figures

List of tables

1 Key license history

PL494 was awarded to Dana Petroleum Norway AS (Operator - 40%), Det norske oljeselskap ASA (30%) and Bridge Energy ASA (30%) on January 23rd 2009, as part of the APA2008.
The license commitment was to acquire 200km² 3D seismic data and make a drill-or-drop (DoD) decision by January 23rd 2012.
Additional acreage in PL494B an PL494 C were awarded 04.02.2011 and 03.02.2012, respectively.

Fortis Petroleum Norway AS entered the partnership 01.06.2013 by taking over a 16% share from Dana Petroleum. Tullow Oil Norge AS obtained a 15% share from Bridge Energy on 29.08.2014.
Det norske oljeselskap ASA took position as the operator on 19.03.2013.

The DoD deadline and the subsequent phases have been extended three times; from 23.01.2016 to 23.07.2016, then (BOV and PDO) to 23.07.2017 and finally (BOV and PDO) to 23.01.2018.

During the license period, 15 MC-meetings have been held, in addition to several EC- or MC-work meetings.

The work obligation has been fulfilled.

Well 2/9-5S was drilled on the Jurassic Heimdalshø Prospect in 2014. The remaining prospectivity in the license is considered high risk and a modest volume potential.
An unanimous decision not to continue with the license (decide a BoV) was taken by the partnership in January 2016.

2 Database

2.1 Seismic database

After license award, the PL494 partnership purchased 680 km2 of 3D seismic data MC3D-CGR2010 acquired by PGS in 2010. Prior to drilling of the Heimdalshø Prospect, the data was in 2013 reprocessed by PGS for the license group. The dataset was named MC3D-CGR-2013RM. Both near, mid, far, ultra far and full offset cubes were produced. The reprocessing resulted in a considerable uplift of the data quality.

The coverage of the seismic cube can be seen in Fig. 2.1

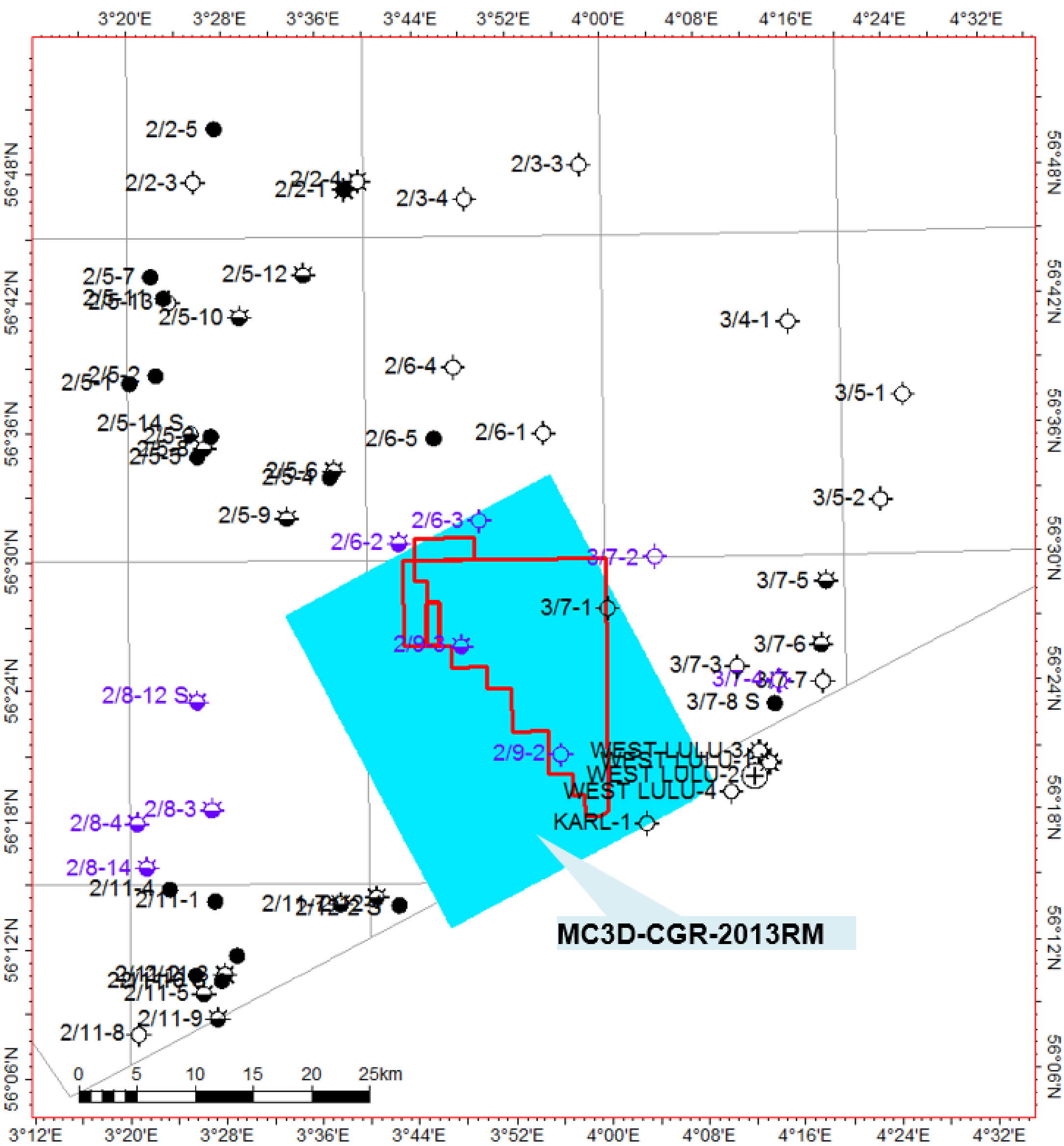


Fig. 2.1 Seismic and well database

2.2 Well data

Fig. 2.1 shows a map with wells in the common database. Table 2.1 shows an overview of the wells.

Table 2.1 Wells in common database

Well	Result	Year P&A	TD (MD) (m)	TD stratigraphy (age)	Status
2/2-1	oil/gas	1982	4003	Late Permian	Relinquished
2/2-3	dry	1983	4100	Triassic	Relinquished
2/2-4	gas	1988	4020	Triassic	Relinquished
2/2-5	oil	1992	4082	Late Jurassic	Relinquished
2/3-3	dry	1971	2973	Late Permian	Relinquished
2/3-4	dry	1984	3386	Late Permian	Relinquished
2/5-1	oil	1970	3972	Late Jurassic	Relinquished
2/5-2	oil	1971	3597	Late Cretaceous	Relinquished
2/5-3	oil	1972	3731	Late Permian	Relinquished
2/5-4	oil	1973	3490	Late Cretaceous	Relinquished
2/5-5	oil	1974	3456	Late Cretaceous	Relinquished
2/5-6	oil/gas shows	1978	4132	Triassic	Relinquished
2/5-7	oil	1984	4531	Triassic	Relinquished
2/5-8	oil shows	1988	3367	Late Cretaceous	Relinquished
2/5-9	oil shows	1992	5460	Late Jurassic	Relinquished
2/5-10	oil shows	1993	4701	Triassic	Relinquished
2/5-10A	oil shows	1993	4715	Triassic	Relinquished
2/5-12	oil shows	2002	4153	Late Jurassic	Relinquished
2/5-13	dry	2009	4675	Triassic	Relinquished
2/5-14S	shows	2009	3845	Late Cretaceous	Relinquished
2/6-1	dry	1969	3336	Late Permian	Relinquished
2/6-2	oil shows	1980	4760	Late Permian	Relinquished
2/6-3	dry	1983	4060	Pre-Devonian	Relinquished
2/6-4S	dry	1990	3617	Late Permian	Relinquished
2/6-5	oil	1997	3260	Pre-Devonian	Relinquished
2/7-29	oil	1994	4900	Early Permian	Relinquished
2/8-3	oil/gas shows	1972	4115	Late Jurassic	Relinquished
2/8-4	oil	1973	2852	Late Cretaceous	Relinquished
2/8-12S	shows	1989	5300	Triassic	Relinquished
2/8-14	oil shows	1991	4392	Late Jurassic	Relinquished
2/9-2	dry	1979	4367	Early Permian	Relinquished
2/9-3	oil shows	1989	4859	Early Permian	Relinquished
2/11-1	oil	1969	4691	Late Jurassic	Relinquished
2/11-2	oil	1974	2806	Late Cretaceous	Relinquished
2/11-3	oil shows	1977	3052	Early Cretaceous	Relinquished
2/11-5	oil shows	1979	2945	Early Cretaceous	Relinquished
2/11-6S	oil	1982	4076	Late Cretaceous	Relinquished
2/11-7	shows	1986	5042	Late Jurassic	Relinquished
2/11-9	shows	1993	4406	Early Carboniferous	Relinquished
2/11-10S	oil	1994	4090	Late Cretaceous	Relinquished
2/12-1	oil	1987	4795	Early Permian	Relinquished
2/12-2S	shows	1990	5757	Triassic	Relinquished
3/4-1	dry	1994	3107	Late Permian	Relinquished
3/5-1	dry	1978	3426	Early Permian	Relinquished
3/5-2	dry	1978	3825	Triassic	Relinquished
3/7-3	dry	1981	3540	Late Permian	Relinquished
3/7-5	shows	1992	3666	Late Permian	Relinquished
3/7-6	oil shows	1996	4120	M. Jurassic	Relinquished
3/7-7	oil shows	2010	3930	Late Jurassic	Relinquished
3/7-8S	oil/gas	2013	4188	Permian	Relinquished
West Lulu-1	gas/condensate	1984	13870	Triassic	Relinquished
West Lulu-2	res. oil shows	1985	13300	Triassic	Relinquished
West Lulu-3	gas/condensate	1985	12653	Triassic	Relinquished
West Lulu-4	shows	1986	12630	Triassic	Relinquished
Karl-1	oil shows	1983	15811	Permian	Relinquished

2.3 Special studies

No special studies has been incorporated in the database.

3 Review of geological framework

At the time of application, Upper Jurassic was the main stratigraphic interval of interest. The play concept for the main prospect Gemini (later named Heimdalshø) comprised reservoir sandstones of the Upper Jurassic Ula Formation, interpreted as shoreface sands of Oxfordian to Volgian in age. The sands were suggested trapped along the western flank of the Mandal High, on a faulted terrace east of and updip of wells 2/9-2 and -3. Fig. 3.1 shows the structural elements and key wells on the west flank of the Mandal High. The depositional model suggested that the Upper Jurassic sandstones observed in these wells represented distal parts of the expected reservoir sandstones of Gemini. The reservoir was mapped to be restricted to the east by the western bounding fault of the Mandal High. Further to the west, the reservoir was mapped to be juxtaposed against the overlying chalk of the Hod Formation and shales of the Farsund and Mandal formations, which also represented the cap rocks of the prospect.

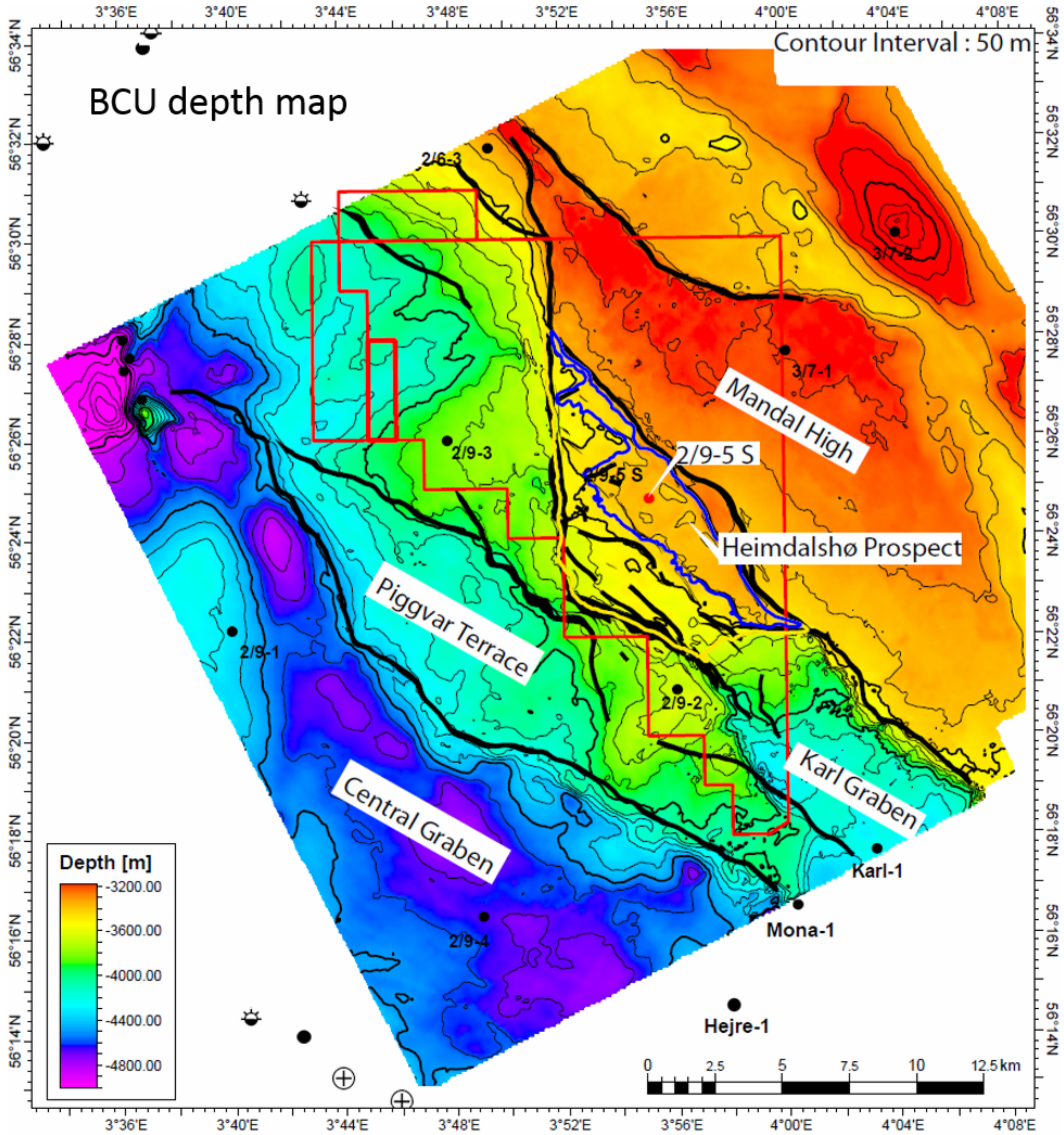


Fig. 3.1 Structural elements in the Mandal High area

The proximity to source rocks and the prospect location (along the crest of the Mandal High) was considered to favour sourcing of hydrocarbons to Gemini. A possible migration fairway was defined by 2/9-3, which has reported shows in Upper Jurassic sandstones.
The Gemini prospect belongs to the proven NJU-3 play model of NPD. Main prospect risk was the presence of reservoir.

Secondary levels with mapped leads was in the Lower Cretaceous and Upper Cretaceous/Lower Paleocene.

Prior to drilling of the Gemini/Heimdalshø Prospect, a refined mapping and evaluation of the reservoir concept led to an understanding of a reservoir divided into a lower and and an upper part. The lower reservoir sandstone was expected to have a shallow-marine shoreface origin with a possible Kimmeridgian or late Oxfordian age (basal sandstone unit). Separated by a shaly interval, an overlying intra-Farsund Formation reservoir sandstone of Volgian age with an expected gravity flow origin was anticipated.
A deeper secondary reservoir target was predicted in the pre-rift sandstones of pre-Upper Jurassic age. There is no good well control for the age and lithology of these sandstones. However, seismic mapping suggested a Permian age of these sandstones, possibly eolian sandstones belonging to the Rotliegend Group, with potentially good reservoir properties. This reservoir has a high risk on presence.

As prospect evaluation proceeded, several studies within biostratigraphy, geochemistry, fluid inclusion analysis, sedimentology, structural reconstruction, basin/petroleum systems modeling and seismic inversion was performed.

Main risks before drilling were reservoir presence and seal. Mandal High was assumed to act as a sand source and the model was that the Mandal High was and elevated high at time of the deposition providing a local sand source for the Gemini/Heimdalshø Prospect. The sealing capacity of the chalk overlying the prospect provided an additional risk.

Drilling of well 2/9-5S, Heimdalshø, increased the understanding of the structural and stratigraphic development of the area. The Mandal High was probably not a major sediment source for reservoir sands to the terraces on the western flank of the high as earlier postulated. Any sandy sediment drainage may have been in a more easterly direction. The high or parts of the high may have been drowned during Late Jurassic and /or the terrace areas may have been bypass or non-deposition areas, leaving only very minor amounts of sand in the 2/9-5S position.
As a result of the well, reservoir potential in a close proximity, and possibly also to more distal western areas to the Mandal High, is now considered more high risk compared to the pre-drill view.

Also the pre-Jurassic section, although penetrated only barely within a mapped wedge structure, proved to be developed as Zechstein carbonates and Rotliegend Group volcanics and siltstone/mudstone with virtually no reservoir potential.

A positive result of the Heimdalshø well would have opened up for additional prospectivity in the area: (i) proving the Mandal High as a valid sediment source and (ii) providing possible migration routes towards the Mandal High and decreasing migration risks to intra Mandal High prospects. Unfortunately, with the negative well results, the possibility of the high being a sand source for prospects and leads west of the high remain high. Similarly, the lack of sand in the well did not open up for the mapping of new carrier beds for hydrocarbon migration towards the Mandal High. The remaining prospectivity in PL 494 is thus regarded to have high risk.

Migration fairway potential into the western flank of the Mandal High has also been downgraded, as no potential carrier beds was penetrated in the Heimdalshø location. A combined evaluation utilizing wells and seismic data (geophysical analysis (eg.inversion data), making geological models, does not reveal any prospectivity of interest within the PL494 area.

Other areas south-west and north-west of the high can not, however, be ruled out as more favorable regarding reservoir and charge potential.

4 Prospect update

All the prospectivity still remaining in PL494 (see Fig. 4.1, Fig. 4.2 and Table 4.1), except Torshammer and Nirvana, was identified in the APA2008 application for block 2/9. The main prospect was Heimdalshø, drilled in 2014. In the initial phase of the prospect evaluation, only a Kimmeridgian reservoir was considered likely. Seismic inversion data supported such an interpretation. Both the upper and lower terraces were included in the prospect model. Later, prior to drilling, an upper and a lower terrace was postulated. The upper terrace was drilled, as migration and charge risk was lower.

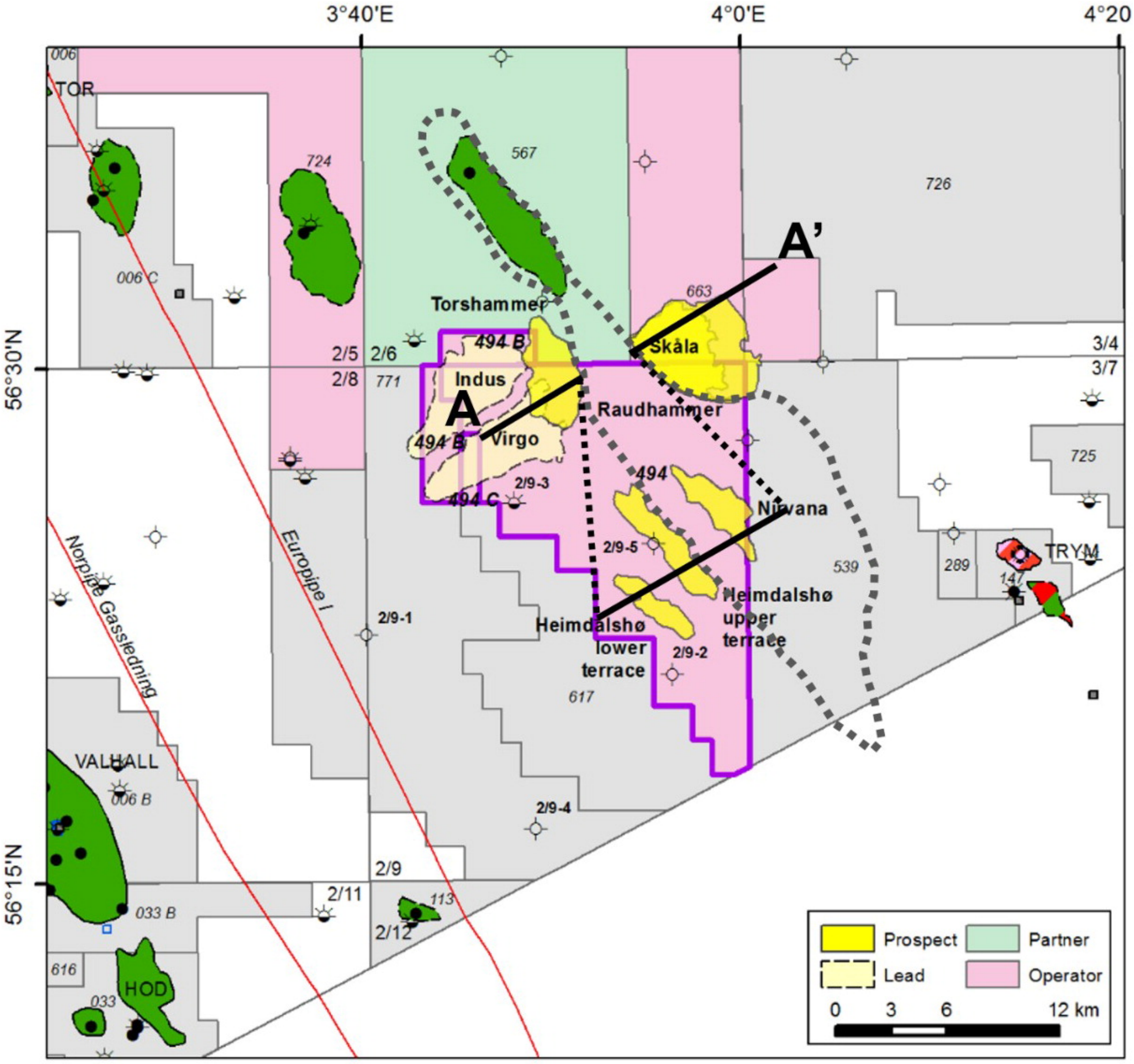


Fig. 4.1 Overview of remaining prospectivity in the PL494 licenses. *A-A` shows location of geoseismic section in Fig. 4.2*

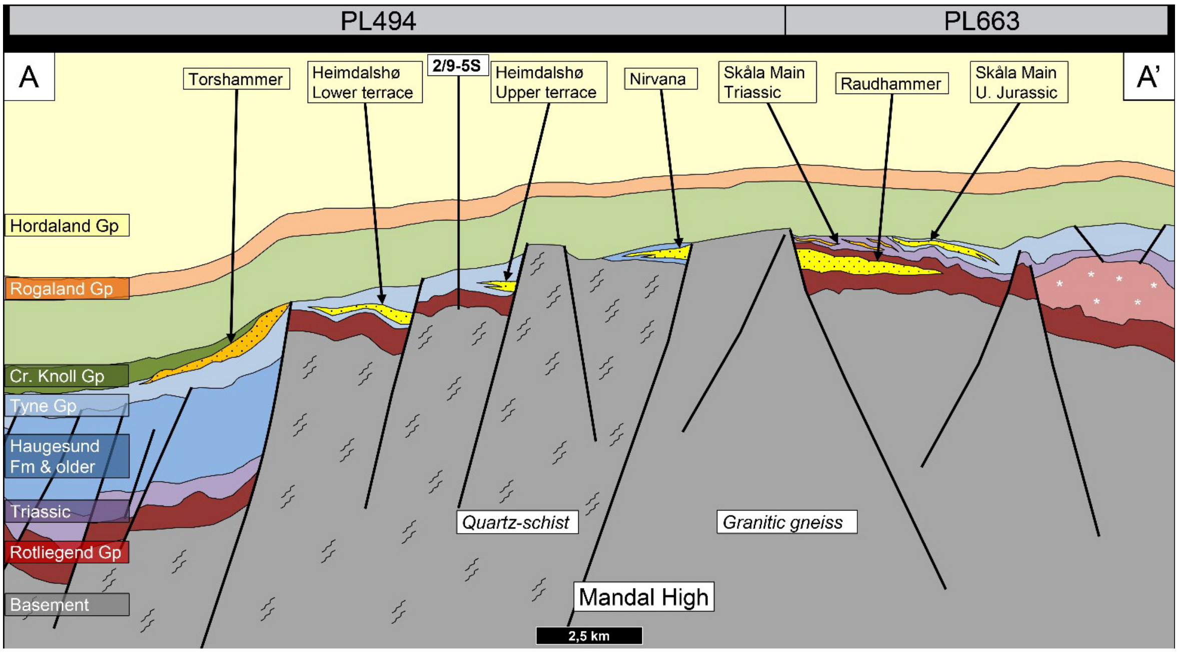


Fig. 4.2 Geoseismic section of remaining prospectivity in the PL494 licenses. *See Fig. 4.1 for index map*

Table 4.1 Summary table of volume and risk assessment of remaining prospectivity

PL 494, 494B and 494C					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)**	**% of total mean volumes in PL494**
PROSPECTS											
Heimdalshø, lower terrace	Upper Jurassic	oil	40	14,5	2,41	0,37	**4,95**	**0,73**	7,82	1,14	100
Heimdalshø, upper terrace	Upper Jurassic	oil	40	6,9	1,87	0,29	**4,63**	**0,68**	7,74	1,10	100
Torshammer	Upper Jurassic	oil	40	10,4	0,80	0,12	**4,31**	**0,65**	9,18	1,37	100
Nirvana	Upper Jurassic	oil	40	3,1	3,85	0,61	**9,44**	**1,37**	16,30	2,29	100
Skåla	U.Jurassic/Triassic	oil	40	13,5	2,10	0,12	**6,86**	**0,35**	14,50	0,72	27*
Raudhammer	Rotliegend	oil	48	4,0	3,20	0,16	**14,10**	**0,69**	28,00	1,34	27
LEADS											
Virgo Upper Unit	Lower Cretaceous	oil		< 5			4,7	1			
Virgo Lower Unit	Lower Cretaceous	oil		< 5			3	0,7			
Indus Upper Unit	Lower Cretaceous	oil		< 5			2,8	0,6			
Indus Lower Unit	Lower Cretaceous	oil		< 5			3	0,7			

* 18 % for P50 (9% for P90 og 36% for P10)

The 2/9-5S well proved water-wet and a reservoir sandstone was not penetrated. Reasons for lack of reservoir is discussed in 3 Review of geological framework.
Pre- and post-drill results can be seen in Table 4.2 and Table 4.3. A Heimdalshø pre-well depth map is shown in Fig. 4.3. An associated seismic section is in Fig. 4.4.
The interpretation of seismic horizons on the Heimdalshø terrace was not altered post-drill, as the well picks seemed to be correct.
For more information regarding well 2/9-5S, reference is made to the Final Well Report; *FWR 2_9-5 S Heimdalshø Section A Geology*.

Table 4.2 Pre-drill vs. post-drill reservoir and fluid parameters in Heimdalshø - Volgian

Volgian parameters				
	PRE-DRILL			WELL RESULT
	Min	P(50)	Max	Result
Reservoir age	Volgian			Only Volgian shale encountered
Reservoir facies	Deep marine sandstones			Predominantly shale, only 3.4m sand encountered
Hydrocarbon type	Oil			Dry
Top reservoir, m		3325		
Hydrocarbon column	150	200	400	Dry
Area closure, km^2	15	25	46	
Reservoir thickness		40		3.4
N/G (fractional)	0.2	0.33	0.6	1
Porosity (fractional)	0.14	0.18	0.23	0.25
GRV, 10^9 Sm^3		1970		
Share in License, % GRV		100%		
Sh %	0.55	0.77	0.85	Dry
1/Bo	0.59	0.67	0.77	Dry
1/Bg				Dry
Recovery Factor	0.25	0.4	0.5	

Table 4.3 Pre-drill vs. post-drill reservoir and fluid parameters in Heimdalshø - Kimmeridgian

Kimmeridgian parameters				
	PRE-DRILL			WELL RESULT
	Min	P(50)	Max	Result
Reservoir age	Kimmeridge			Only shale encountered
Reservoir facies	Shallow marine sandstones			Not present
Hydrocarbon type	Oil			Dry
Top reservoir, m		3390		
Hydrocarbon column	85	135	335	Dry
Area closure, km^2	6	17	35	
Reservoir thickness		40		No reservoir
N/G (fractional)	0.1	0.3	0.5	No reservoir
Porosity (fractional)	0.14	0.18	0.23	No reservoir
GRV, 10^9 Sm^3		1641		
Share in License, % GRV		100%		
Sh %	0.5	0.77	0.85	Dry
1/Bo	0.59	0.67	0.77	Dry
1/Bg				Dry
Recovery Factor	0.25	0.4	0.5	

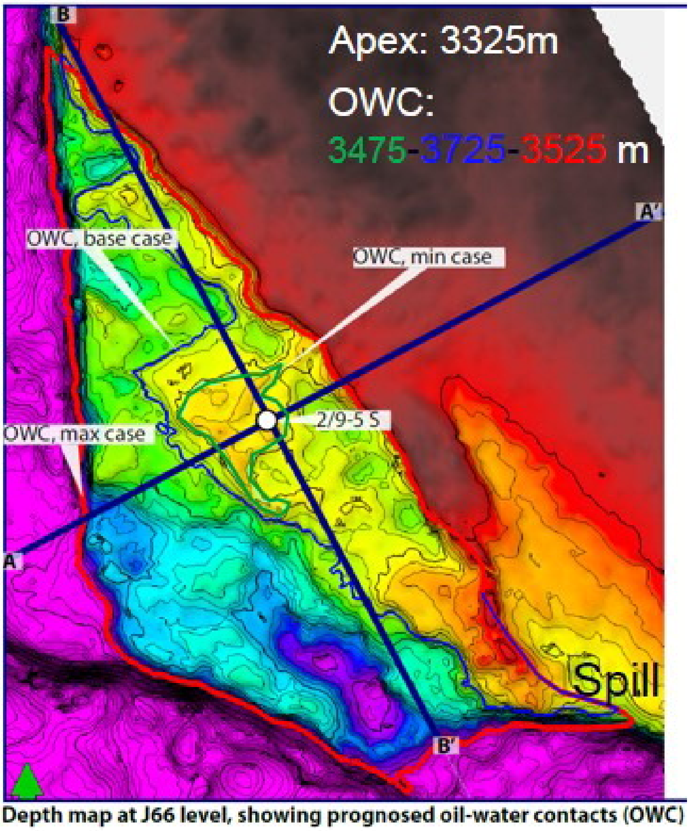


Fig. 4.3 Heimdalshø Prospect. *Pre-drill OWC-contacts*

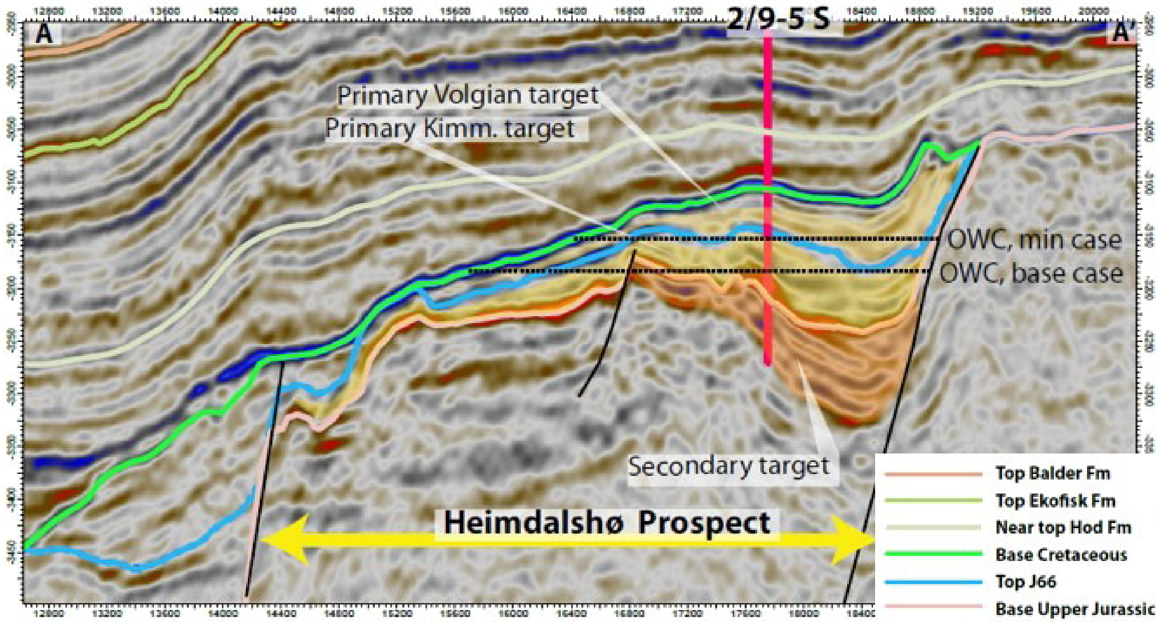
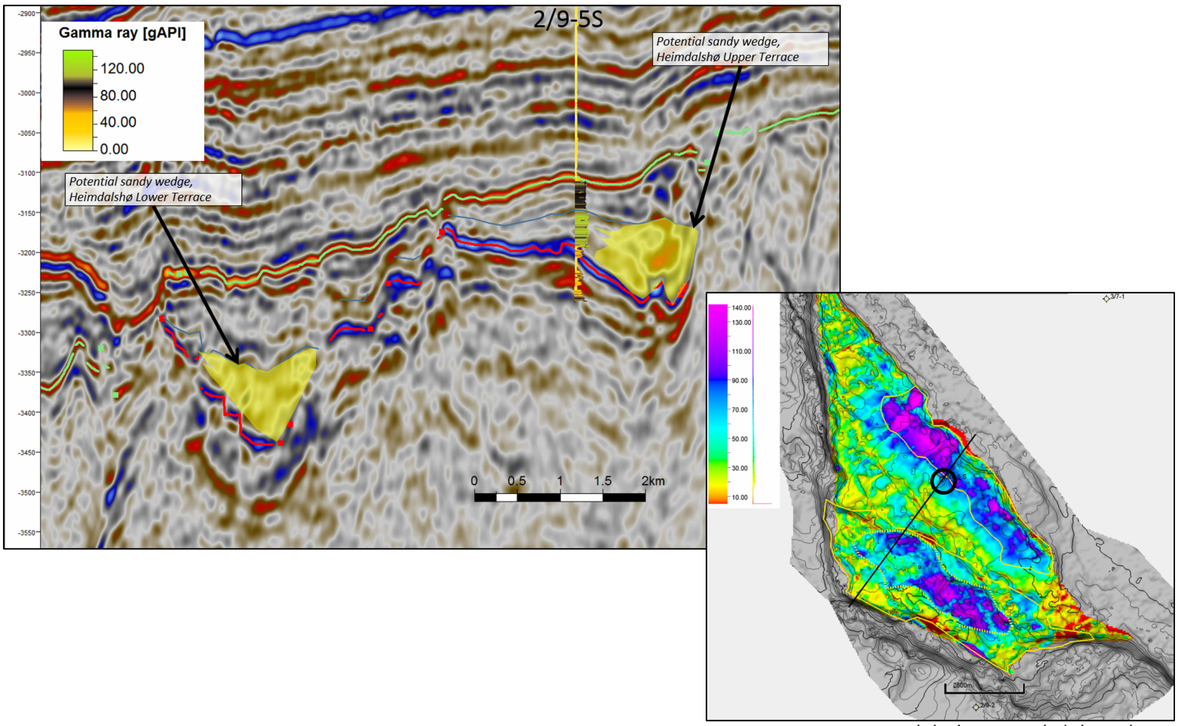


Fig. 4.4 Heimdalshø Prospect interpreted on the 3D seismic dataset MC3D-CGR2010. *Heimdalshø Prospect with a primary targets in Volgian and Kimmeridgian and a secondary pre-Jurassic target. HC-contacts indicated. Index map for seismic line is shown in Fig. 4.1*

The remaining prospects within the license area are shown in Fig. 4.5, Fig. 4.6, Fig. 4.8 and Fig. 4.7. High risk and a modest resource potential is, unfortunately, associated with this prospectivity.

<u>Heimdalshø upper and lower terraces</u>, Fig. 4.5, are two prospects remaining in the Heimdalshø terrace area after drilling of the 2/9-5S. These are structural fault-bounded, 3-way dip traps. Reservoir is expected to be of Volgian age, as sandstones deposited by gravity flows from the high to the east. Inversion data support presence of sand and amplitude anomalies correspond with thickness anomalies on the terraces.



Lower Farsund thickness TST (m) draped on intra Farsund depth map (m)

Fig. 4.5 Remaining prospectivity on Heimdalshø lower and upper terrace. *MC3D-CGR2010*

Main risk, in addition to a considerable risk on reservoir presence and quality, is on a likely migration route from the basin to the west.

<u>The Nirvana Prospect</u> sitting on the Mandal High, Fig. 4.6, is defined by a half-graben development. Graben infill is uncertain, but is tentatively assigned to the Upper Jurassic Ula Formation. Reservoir model is based on a geological model, as no nearby wells have proven this reservoir. Older reservoir possibilities such as Bryne sandstone, Triassic heterolithics, remnants of intra Mandal High Zechstein basin, Permian volcanics or fractured basement are not likely to provide good reservoirs.
Main risk for the prospect is assigned to the complicated migration route, dependent on fractured basement.

Fig. 4.7, the <u>Torshammer Prospect</u>, forms a stratigraphic trap with reservoir of anticipated Volgian age. Seismic inversion data indicates a reservoir of mixed lithology, which can be explained by the fact that parts of the basement high is phyllitic with restricted sand potential. The variable reservoir facies seems to extend beyond the prospect, adding to the seal risk.

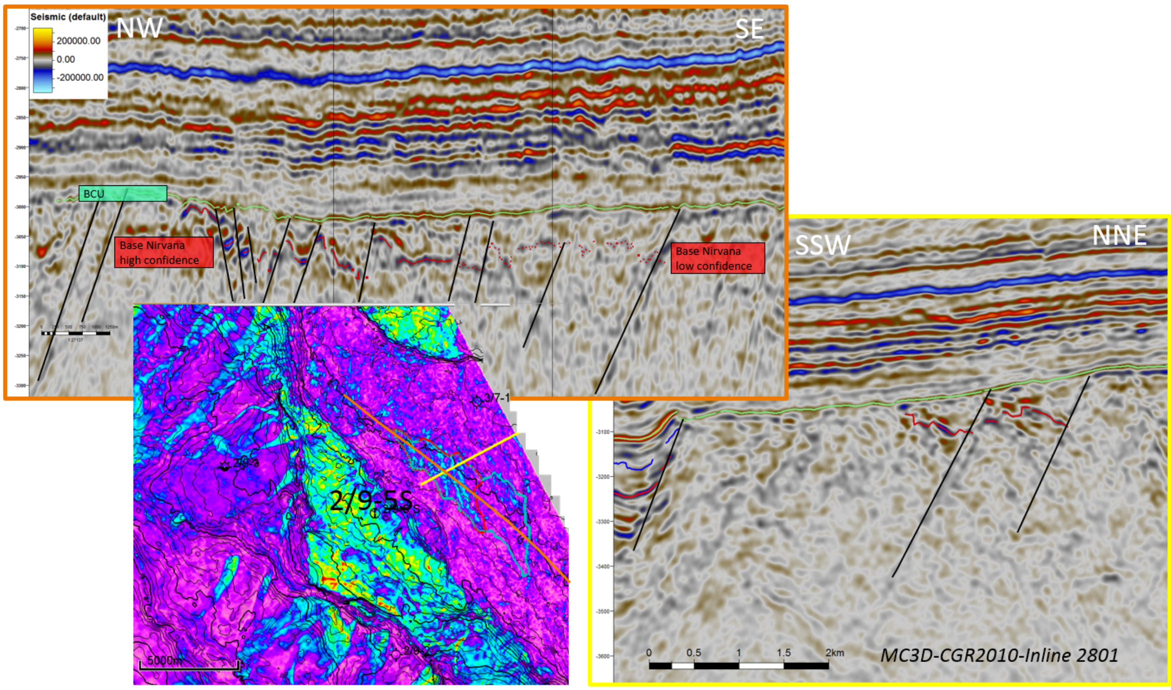


Fig. 4.6 Nirvana Prospect, Mandal High

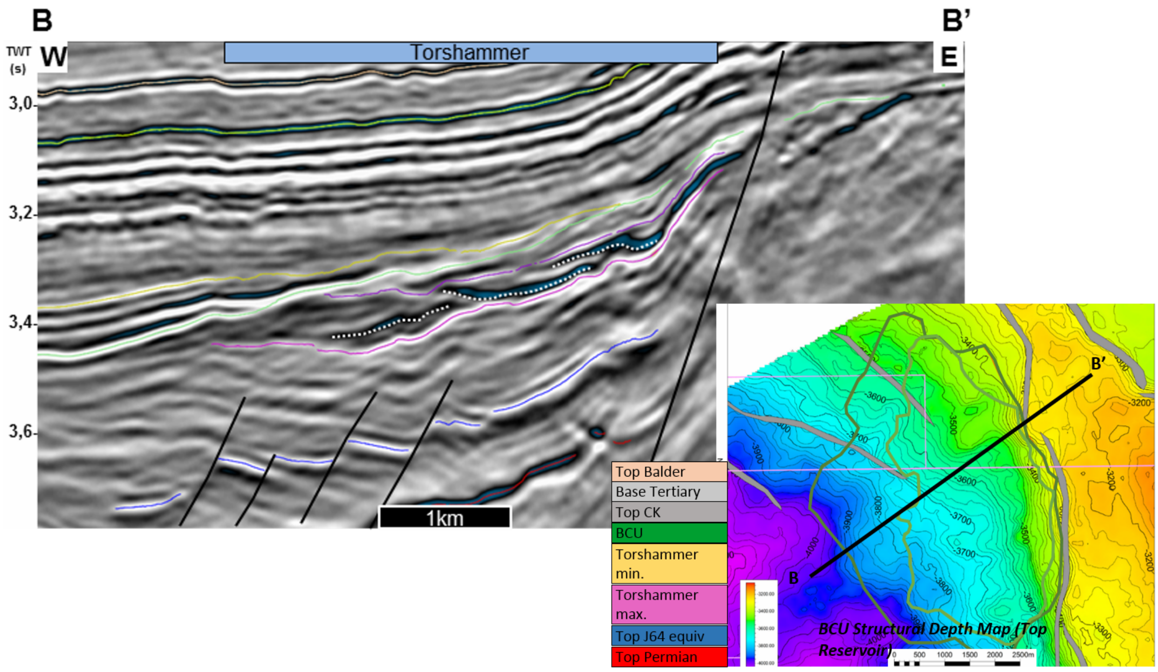


Fig. 4.7 Torshammer Prospect

Main risk related to Torshammer is seal (base and lateral) and reservoir quality. Top seal is also variably Upper and Lower Cretaceous, and thief sands are possible.

Fig. 4.8 is showing the Indus and Virgo leads. These are stratigraphic traps, with reservoir in Lower Cretaceous, possibly Ran equivalent sandstones.
Both reservoir and trap constitute main risks.

Skåla and Raudhammer prospects are mainly situated outside of the PL 494 license areas, in block 2/6 (former (PL663), and are not shown in more detail.

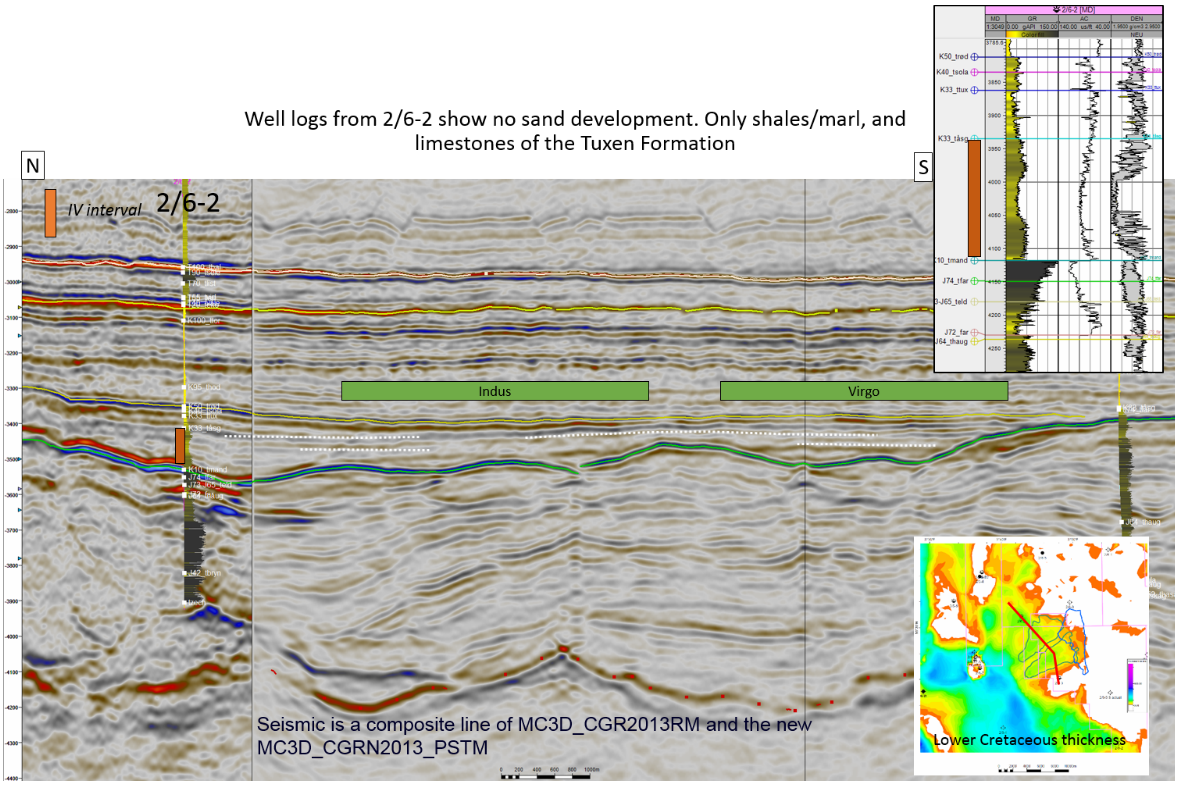


Fig. 4.8 Comparison between well 2/6-1 and the Indus and Virgo leads

5 Technical evaluations

Technical-economical evaluations have been run for prospects in a neighboring license (PL663) in November 2015, as a development with tie-back to the Ekofisk Field. Economic conditions have since changed, but the order of magnitude is comparable. Minimum economical volume (recoverable) estimated is in the range 20-25 mmboe. This means that calculated mean volumes in the remaining prospects presented in 4 Prospect update could be above this lower limit. The commercial risks associated are, however, very high, and the decision not to continue with the licenses was unanimous.
Fig. 5.1 shows the distance between the PL494 area and Ekofisk.

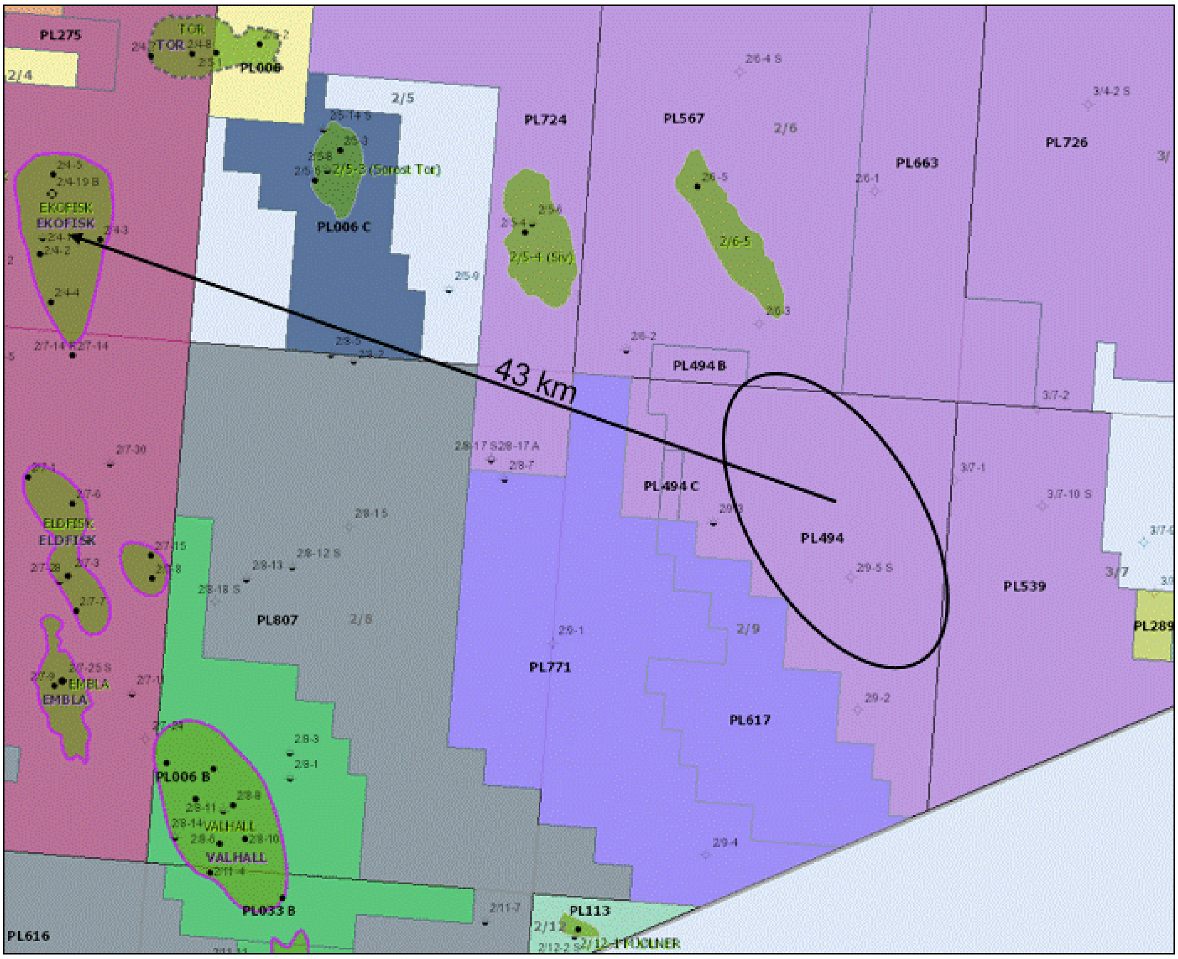


Fig. 5.1 Tie-in distance from PL494 to Ekofisk

6 Conclusions

The partnership in PL494/494B/494C has completed the license studies and evaluations. Prospects remain in the area investigated, however, the associated risk is considered to be high. Also, non of the evaluated possibilities within the licensed area are high-impact.