Edison Norge AS

Expiry Report
May 2017



Table of Contents

List of Figures

List of Tables

1 Key Licence History

PL770, which comprise parts of blocks 7123/6, 7124/4 and 7124/5, was awarded 07.02.2014 upon the APA2013 Licensing Round to Edison International Norway Branch (60%), North Energy ASA (20%) and Lime Petroleum Norway AS (20%). The current licensees are Edison Norge AS (60%), North E&P AS (20%) and Lime Petroleum Norway AS (20%). An area map with license boundary, prospect and leads outline together with discoveries made in the vicinity of the license is given in Fig. 1.1.

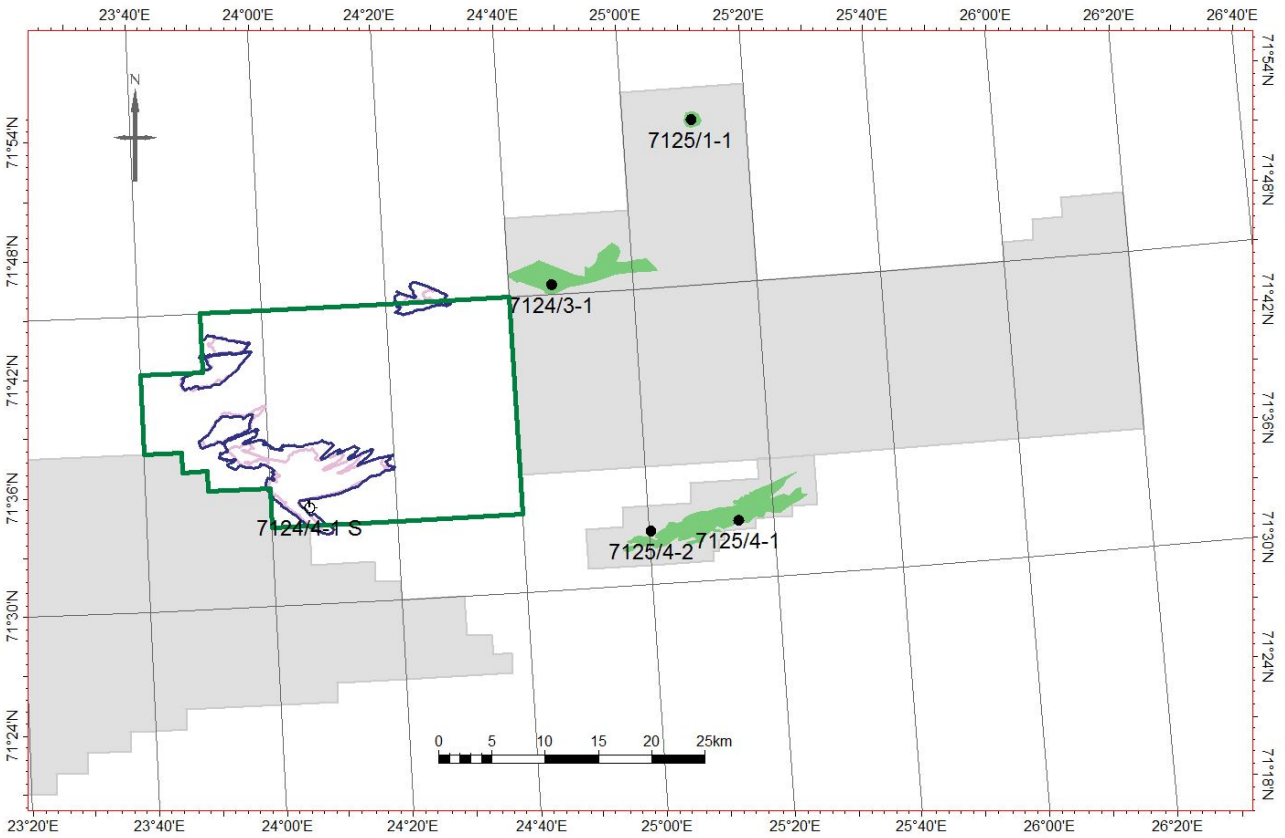

Fig. 1.1 PL770 area map. Realgrunnen Subgp. prospectivity (blue polygons) and Snadd Fm. prospectivity (purple polygons).

The work commitment for the first phase was to acquire 3D seismic data within 2 years from the date of award (07.02.2016). Within 2 years from the award the rights owner should decide whether to drill an exploration well (Drill or Drop decision gate). The obligation to perform drilling activities should be fully completed within 4 years from the date of award (07.02.2018).

One application for 1-year extension of the initial deadlines has been submitted by Edison Norge AS on behalf of the partnership. The background for the application was the delay in the arrival of the Fruholmen-Hammerfest East Merge seismic dataset, which resulted in a significant delay in the work program related to the final evaluation of the prospectivity in the license, and the de-risking of the defined prospect. The extension of deadlines was granted on 05.04.2016, with new deadline for the Drill or Drop decision 07.02.2017.

An overview of the license activity is given in Table 1.1. Additionally, internal Peer Reviews has been held in Edison Norge AS upfront decision gates.

Table 1.1 License activity.

Year	Date	Activity
2014	18.03.2014	Kick-off Meeting
	21.05.2014	EC/MC Meeting
	29.09.2014	EC Workshop Meeting
	29.10.2014	EC/MC Meeting
2015	17.06.2015	EC Workshop Meeting
	20.10.2015	EC Workshop Meeting
	09.11.2015	EC/MC Meeting
2016	07.11.2016	EC/MC Meeting

The technical evaluation of the prospectivity in the PL770 license concluded that the license was located within a highly prominent area in terms of hydrocarbon migration, but the evaluation did not lead to the identification of a prospect which met the technical requirements to commit to an exploration well, and therefore the Operator recommended to the partnership to relinquish PL770 at the Drill or Drop decision deadline of February 2017.

2 Database

2.1 Seismic Data

The seismic database used for the license evaluation and prospect assessment is defined by the common database, and is given in Table 2.1 and Fig. 2.1. Additionally, public available 2D seismic data has been used for the regional interpretation. At the time of award only the southern part of the PL770 license was covered by 3D seismic (MC 3D Fruholmen). To cover the northern part of the license with 3D seismic data Dolphin Geophysical AS acquired in 2014 the Hammerfest East survey. In order to have one consistent dataset for AVO Inversion Dolphin Geophysical AS re-processed the MC 3D Fruholmen and merged it with the newly acquired Hammerfest East survey. The resulting Fruholmen-Hammerfest East Merge is regarded as the main seismic survey for the evaluation of the PL770 license.

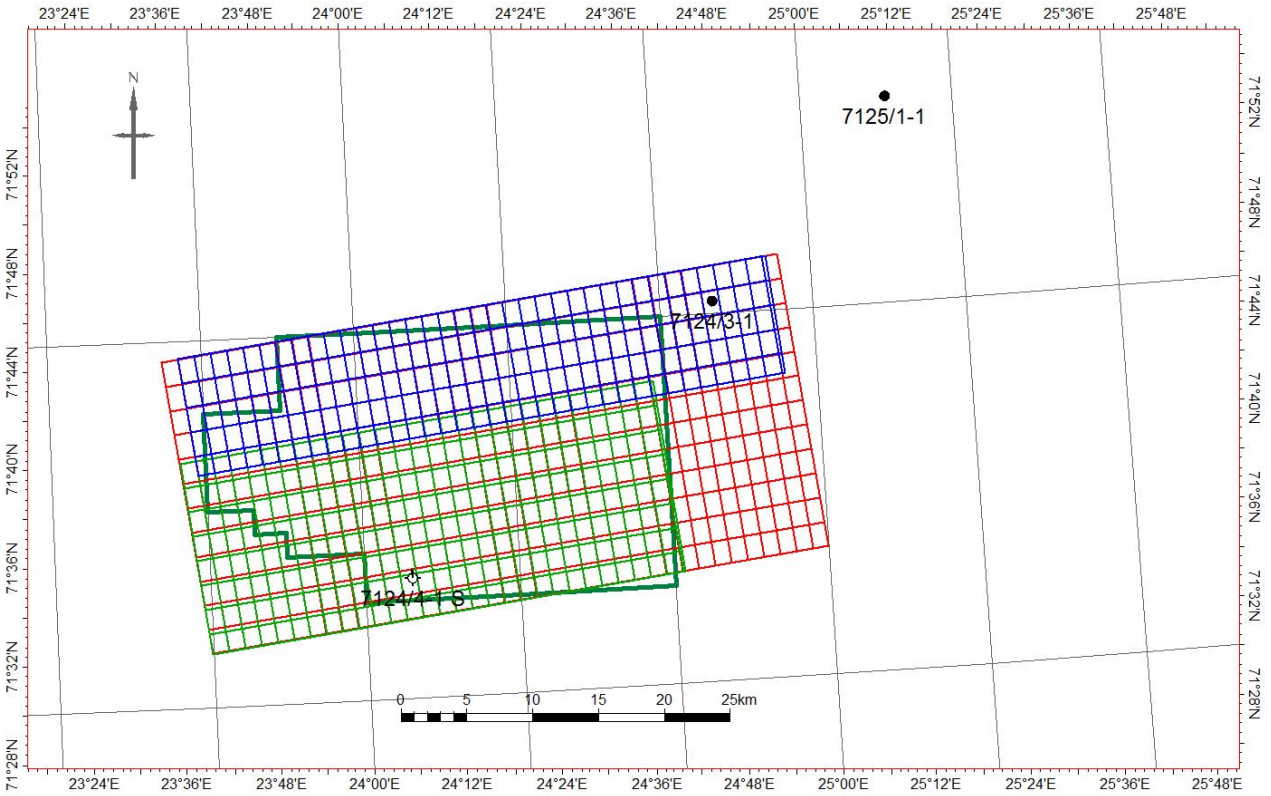

Fig. 2.1 PL770 seismic and well database. Fruholmen-Hammerfest East Merge (red), Fruholmen (green), and Hammerfest East (blue).

Table 2.1 Seismic database.

Survey	Type	Year	Company	Status	NPDID
Fruholmen 2007 3D	3D	2007	WesternGeco AS	Multi Client	4437
Fruholmen 2007 - re-processed	3D	2015	Dolphin Geophysical AS	Edison / PL770	NA
Hammerfest East (DOL14007)	3D	2014	Dolphin Geophysical AS	Multi Client	8153
Fruholmen-Hammerfest East Merge (ED15M02)	3D	2015	Dolphin Geophysical AS	Edison / PL770	NA

2.2 Well Data

The wells used for the evaluation of the PL770 license and prospect assessment are listed in Table 2.2 and shown in Fig. 2.1

Table 2.2 Well database.

Wellbores	NPDID	Petrophysics	FIT	Stratigraphy	Sedimentology
7124/4-1S	6678	X	X	X	X
7124/3-1	1066	X		X	X
7125/1-1	1350	X		X	X

2.3 Special Studies

Seismic acquisition (Dolphin Geophysical AS): 374 sqkm multi client 3D seismic (Hammerfest East) was acquired during 2014 in the northern part of PL770, filling the gap between the Fruholmen and the Bjarmeland 3D survey, enabling a detailed evaluation of the entire licensed acreage.

Seismic re-processing and merge (Dolphin Geophysical AS): The re-processing of the Fruholmen survey was carried by Dolphin Geophysical Ltd, UK. The primary aim for the reprocessing of the Fruholmen survey was to merge it with the Hammerfest East survey to produce one consistent dataset for subsequent AVO inversion analysis. Secondly the aims was to reduce the signal to noise ratio. The main processing challenge concerned multiple attenuation.

Mapping (Edison in-house): A total of 11 horizons (Seabed to Palaeozoic) has been interpreted both on regional scale and in greater detail on the Fruholmen-Hammerfest East Merge dataset. Depth conversion was done using the regional velocity cube from Estimages.

AVO (Edison in-house): In addition to the traditional AVO workflow, a FMD volume was produced by the processing contractor and used as an additional AVO attribute during the prospect assessment. The FMD attribute works extremely well for identification of Class II and Class III anomalies.

Rock Physics and Seismic Inversion (Edison in-house): The effect of reservoir property variations on elastic parameters was analysed by carrying out Rock Physics Modelling (RPM) in order to estimate AI, SI and VpVs, followed by seismic inversion. The study was concentrated at two intervals of interest; Realgrunnen Subgp. and Triassic (Snadd-Klappmyss Fms).

EM (EMGS and Edison in-house): A 1-D sensitivity study was carried out in-house for the Stø Fm. reservoir within the PL770. Following the positive results from the 1-D sensitivity study two multi-client CSEM datasets (AX7124 and BSMC08U) were purchased and used in the further evaluation of license PL770. Post-inversion sensitivity analysis was conducted, and a detailed evaluation of the identified prospects was performed in order to assess the impact of the CSEM results on both the PoS and the reserves in place using EMGS EMU software.

Geochemistry and Basin Modelling (IGI Ltd): An integrated Geochemistry and Basin Modelling study has been completed in a ca.17,000 sqkm study area in the Måsøy/Nysleppen Fault Complex. The study integrates a regional geochemistry database with a large grid-based 3D basin model constructed in Trinity T3 using eleven depth-converted grids and thermally-calibrated by integrating twelve 1D basin models using Genesis. A separate regional evaluation of source rock and oil geochemistry in the Barents Sea has been conducted in parallel with this study and has been used to evaluate the source rock potential and fluid composition in the PL770 area. To quantify the source rock potential further, the basin modelling incorporates a series of digitised palaeo-environmental reconstructions for the PL770 area taken from Ichron (2013) in order to determine the spatial and temporal extent of possible source rock depositional conditions.

Fluid Inclusion Stratigraphy (FIT): Fluid Inclusion Stratigraphy was carried on well 7124/4-1S (Heilo) in order to address the uncertainties related to migration and charge/palaeocharge.

Structural Reconstruction (Edison in-house): The aims of the study was to reconstruct the palaeogeography of the Jurassic Kapp Toscana Gp. in order to assess the likelihood of having sands eroded and re-deposited, and to attempt to predict the location of the re-deposited sands.

Fault Seal Analysis (Edison in-house): Most of the traps identified are fault-related and relies on the capacity of the structures to retain hydrocarbons and Fault Seal Diagrams have been created in an attempt to preliminary assess the sealing potential of the faults. Several scenarios have been modelled to take into account the uncertainties on both the stratigraphy nearby the faults and the hydraulic properties of the reservoirs.

3 Review of Geological and Geophysical Studies

Detailed seismic interpretation and mapping has been carried out in the PL770 license, with a total of eleven (11) horizons from the Seabed to the Palaeozoic being mapped (Fig. 3.1). The license evaluation has been focussed on the Triassic-Jurassic interval, and prospective intervals identified include the Snadd-Klappmyss Fms. of the Sassendalen Gp. and the Realgrunnen Subgp.

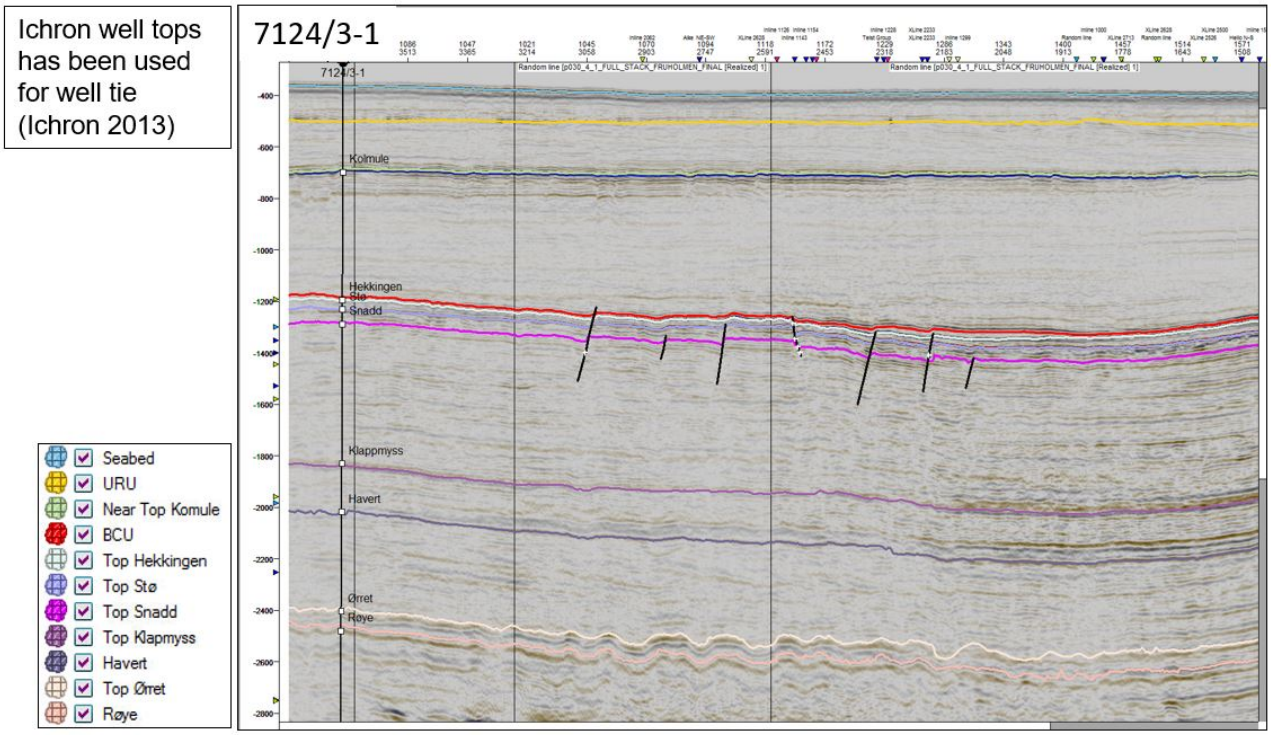

Fig. 3.1 PL770 interpreted horizons.

Several special studies has been carried out with the purpose of increasing the confidence in the geological and geophysical understanding of the area potential prior to the drill and drop decision. The block evaluation done for APA2013 application identified source effectiveness as being the main risk, which has been well addressed in the PL770 work program.

The PL770 license is located near several discoveries (e.g. Nucula, Bamse and Binne) and ca. 85km east of the Goliat Field. The carbon-isotope and biomarker composition of oils from 7124/3-1 and Nucula (Fruholmen reservoir) are consistent with a low to mid-mature Hekkingen Fm. However given the immaturity of the Hekkingen Fm. in the Nordkapp Basin, this implies that long-distance migration has occurred (up to 90km from the most proximal mid-oil mature Hekkingen Fm.) from the Hammerfest Basin. Oil samples from the Kobbe Fm. reservoir in the Nucula Discovery appear to be sourced from an alternative source rock from the Hekkingen Fm. The molecular and carbon-isotope composition suggests that a Triassic source rock is the most likely origin of oil in this deeper oil reservoir. The oil composition from the Binne Discovery (7125/1-1) is also consistent with a dominantly Triassic source, which may have originated from the Hammerfest and/or Nordkapp Basins.

As part of the Basin Modelling Study forty migration scenarios have been modelled to test the migration sensitivity to source expulsion volumes, charge timing, top seal capacity, fault seal capacity and migration loss. The greatest control on fluid migration from the Hammerfest Basin is the fault-segmentation of the Måsøy/Nysleppen Fault Complex. Both Triassic and Jurassic oil charge are likely to have migrated from the eastern Hammerfest Basin towards the Bamse and Nucula Discoveries, passing to the north of the PL770

license. PL770 is unlikely to contain hydrocarbon charge from the Nordkapp Basin and hydrocarbon spill from the Goliat Field. Overall, the prospectivity within PL770 is considered poor to moderate from a basin modelling perspective.

Amplitude anomalies was identified on the full-offset stack seismic at the Heilo North Prospect, and at the Alke, Lomvi, Vipe, Islom and Lunde leads. Sub-volumes of the Fruholmen-Hammerfest East Merge cube was loaded to Hampson-Russel and AVO attribute volumes were produced. An FMD volume was produced by the processing contractor and both attributes was analysed in parallel. The pre-stack gather analysis and both attributes (FMD and SPRC) all support each other. The results for the Realgrunnen Subgp. were not positive and the Heilo North Prospect appears to be the most positive at the Snadd Fm. level.

The CSEM dataset over PL770 (AX7124 and BSMC08U) has been re-processed and anisotropic 3D inversion was performed.

Rock Physics Modelling (RPM) was performed on wells 7124/4-1S, 7124/3-1 and 7125/1-1 with the objective to determine the effect of reservoir property variations (porosity, lithology and fluid type) on the acoustic and elastic parameters derived from the seismic inversion. The two most prospective intervals were analysed; Realgrunnen Subgp. and Triassic. Within the Realgrunnen Subgp. potential hydrocarbon saturation was found in the Lunde lead, while other areas with higher probability of HC saturation are located outside identified

structures. The Triassic was analysed in the interval top Snadd - base Klappmyss Fm. and the potential hydrocarbon accumulations identified was small and patchy. The most significant accumulations recognized are unconformable with identified structures and include the flanks of the Heilo North structure (top Snadd level), Eastern part of the Heilo North (base Upper Carnian) and partial Vipe/Islom leads (Upper Klappmyss Fm.).

The PL770 area is characterized by a complex fault pattern and its prospectivity is closely related to the hydraulic behaviour of the faults. Most of the traps identified are fault related and relies on the capacity of the structures to retain hydrocarbons. Faults in the area have generally limited displacement ranging from few tens to few hundreds of meters. For the assessment of the sealing behaviour of the faults, two reference wells have been used; 7124/4-1S (Heilo) and 7124/3-1 (Bamse). The results of the study shows a quite high sealing potential for all faults having a displacement higher than 50m. Higher leaking risk would exist for displacement less of 50m and where the stratigraphy is more similar to the one of the Heilo well than to the one of the Bamse well. In those areas, given the theoretical along-fault displacement variations, the risk of having smaller prospect areas and, in turn, smaller HC volumes are taking into account.

4 Prospect Update Report

PL770 is situated in Blocks 7123/6, 7124/4 and 7124/5 and was awarded in February 2014 following the APA2013 Licensing Round, based on the identification of the Heilo North Prospect interpreted on the Fruholmen 3D dataset. Exploration well 7124/4-1S (Heilo) is situated within the license area, just south of the Heilo North Prospect. The well was testing the Heilo prospect which was defined as a structural trap. The main objective was to test reservoir and hydrocarbon presence in the Jurassic -Triassic Stø to Fruholmen Fms. The Triassic Snadd, Kobbe, Klappmyss and Havert Fms. were secondary objectives. The well was dry but proved good reservoir properties in clean sands of the Middle Jurassic Stø and Upper Triassic Snadd Fms. The 7124/4-1S well was drilled in 2011 by GdF Suez, and is together with the 7124/3-1 (Bamse) and 7125/1-1 (Binne) wells considered as the key wells for the license evaluation.

During the initial license evaluation in 2014, a 'Northern Lead' was identified on 2D seismic located in the Northern most part of the license, in a promising position along the migration route to the Bamse structure (7124/3-1) (Fig. 4.1a). A detailed evaluation of this area was carried out in 2015 after the acquisition and processing of the Fruholmen-Hammerfest East Merge seismic, but the structure turned out to be heavily fault segmented, and only minor structures with insignificant volumes was identified. The Teist and Lomvi leads (Fig. 4.1b) was of only very limited size and consequently disregarded in the final evaluation. Time and depth maps for the Top Realgrunnen Subgp. is given in Fig. 4.2 and Fig. 4.3. The morphology of the Heilo North Prospect largely remained the same as was identified at the time of the application (Fig. 4.4).

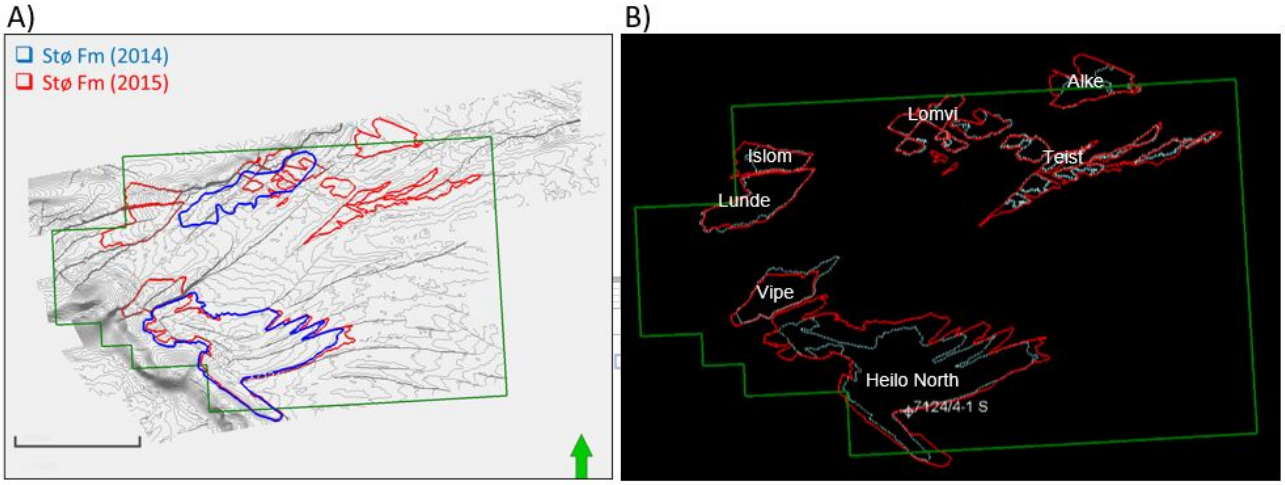

Fig. 4.1 PL770 2016 prospectivity map. A) Stø Fm. prospectivity 2014 (blue polygons) and Stø Fm. prospectivity 2015 (red polygons). B) Identified structural closures (2015) in Stø Fm. (red polygons) and Snadd Fm. (green polygons).

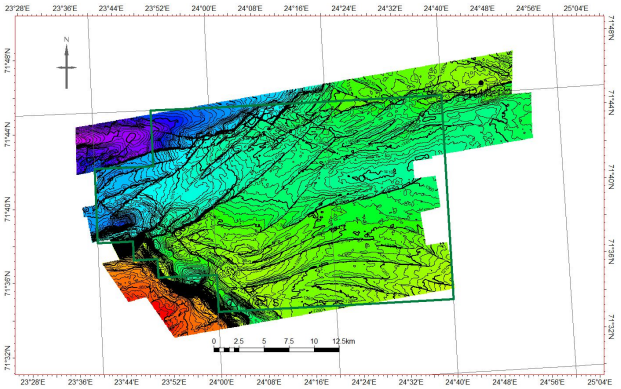

Fig. 4.2 Top Realgrunnen Subgp, time map.

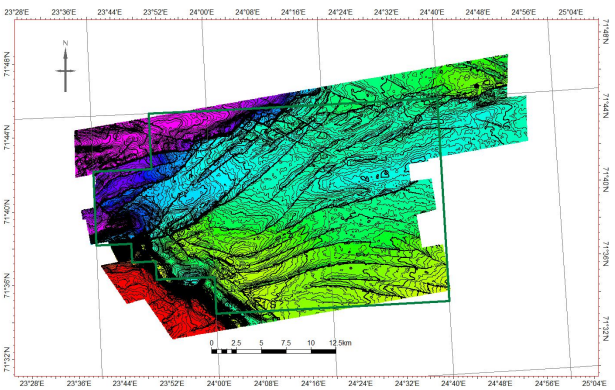

Fig. 4.3 Top Realgrunnen Subgp, depth map.

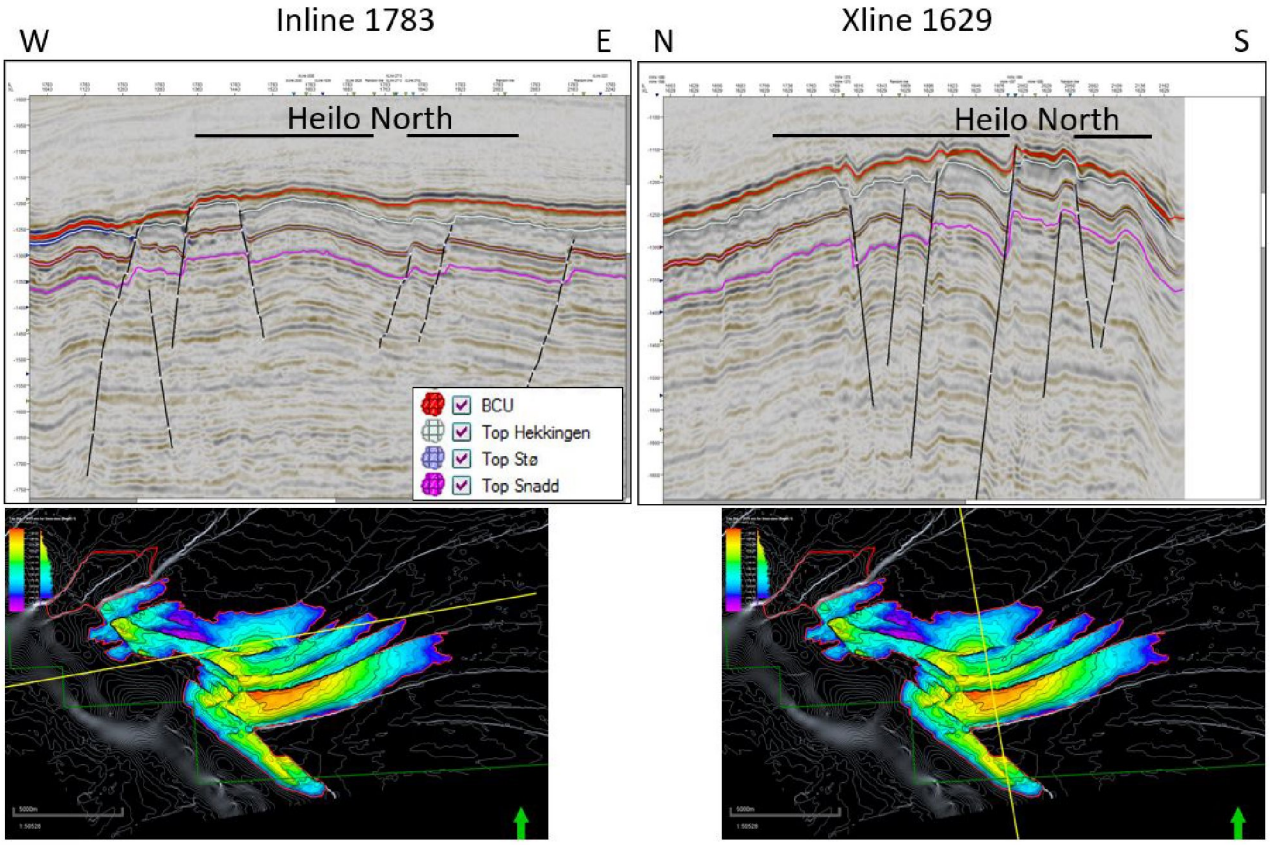

Fig. 4.4 Heilo North Prospect.

Results of the special studies has been summarized in Table 4.1. The Heilo North Prospect and the Lunde Lead was ranked as the most attractive, but the Heilo North Prospect has a very high risk and the Lunde Lead are of a too limited size to be considered a potential drilling candidate (see Table 4.3).

Table 4.1 Summary of prospect assessment

Prospect / Lead	EM	Inversion (min-max-mean)	Total oil eqv. resources (mean, 10^6 Sm^3)	Ranking
Heilo North	[redacted]	Fluid: 0.2-1.28-**0.54** Porosity: 11-27-**19**	Stø: 24,78 Snadd: 1,69	Most attractive
Vipe		Fluid: 0.05-0.5-**0.34** Porosity: 6-21-**14**	Stø: 3,95 Snadd: 1,03	
Alke		Fluid: 0.99-1.21-**0.92** Porosity: 23-36-**29**	Stø: 1,34 Snadd: 0,04	
Lunde		Fluid: 0.3-1.16-**0.59** Porosity: 13-34-**22**	Stø: 5,16 Snadd: 1,17	Most attractive
Islom		Fluid: 0.09-0.8-**0.29** Porosity: 6-26-**13**	Stø: 4,92 Snadd: 1,27	

For the initial evaluation done for the APA2013 license application, the probability of discovery in the Heilo North Prospect was calculated to 0.24 and 0.22 for Realgrunnen Subgp. and Snadd Fm. respectively. [redacted] the

probability was reduced to 0.14 and 0.12 for Realgrunnen Subgp. and Snadd Fm. (Table 4.3). The main risk were associated with source effectiveness due to the possibility of that the Heilo North Prospect could be in a migration shadow, like the Heilo Prospect, as indicated by the 7124/4-1S well.

Volumes calculated for APA 2013 together with the updated volumetric assessment are listed in Table 4.2 and Table 4.3 .

Table 4.2 Resource potential APA2013 evaluation.

Discovery/ Prospect/ Lead name [1]	D/ P/ L [2]	Case (Oil/ Gas/ Oil&Gas) [3]	Unrisked recoverable resources [4]						Probability of discovery [5] (0.00 - 1.00)	Resources in acreage applied for [%] [6] (0.0 - 100.0)	Reservoir		Nearest relevant infrastructure [8]	
			Oil [10^6Sm^3] (>0.00)			Gas [10^9Sm^3] (>0.00)					Litho-/ Chrono-stratigraphic level [7]	Reservoir depth [m MSL] (>0)	Name	Km (>0)
			Low (P90)	Base (Mean)	High (P10)	Low (P90)	Base (Mean)	High (P10)						
Heilo North (Stø Fm)	P	Oil	1.77	9.10	19.00	0.35	1.94	4.07	0.24	100.0	Stø Fm/Lower-Middle Jurassic	1260	Goliat FPSO	85
Heilo North (Snadd Fm)	P	Oil	0.37	2.03	4.21	0.07	0.43	0.91	0.22	100.0	Snadd Fm/Triassic	1330	Goliat FPSO	85

Table 4.3 Resource potential 2016 evaluation.

Prospect / Lead	Total Oil Equivalent Resources				Risk
	P10 Oil (10^6 Sm^3)	Mean Oil (10^6 Sm^3)	P50 Oil (10^6 Sm^3)	P90 Oil (10^6 Sm^3)	
Heilo, Realgrunnen	53,82	24,78	17,66	5,07	14
Heilo, Snadd	4,29	1,69	0,9	0,07	12
Vipe, Realgrunnen	8,73	3,95	2,7	0,78	27
Vipe, Snadd	2,33	1,03	0,66	0,17	29
Alke, Realgrunnen	2,79	1,34	0,99	0,04	43
Alke, Snadd	0,11	0,04	0,01	0	35
Lunde, Realgrunnen	12,82	5,16	2,99	0,43	32
Lunde, Snadd	2,98	1,17	0,64	0,09	30
Islom, Realgrunnen	9,6	4,92	4,04	1,13	34
Islom, Snadd	2,55	1,27	0,99	0,33	32

5 Technical Evaluations

The PL770 is located in an area with limited gas, oil and condensate processing and export infrastructure. The nearest existing processing infrastructure is the Goliat Floating Production, Storage and Offloading Vessel (FPSO) located 85km to the south-west. However it is not technical feasible for an oil tie-back solution at this distance. The main development scenario that has been considered is therefore a stand-alone FPSO vessel. The largest identified structure within the PL770 which hold the greatest estimated hydrocarbon volumes is the Heilo North Prospect. A potential future development has thus been based on the volumetric calculations of the Heilo North Prospect. The limited amount of hydrocarbons associated with the Heilo North Prospect cannot justify a standalone development, and considering the negative outcome of the prospect assessment and the high risk of this prospect is was decided not to go ahead with a full economical evaluation.

6 Conclusions

Since the award of PL770 in February 2014, Edison Norge has, on behalf of the Joint Venture, revised the geological and technical evaluation of PL770 through a comprehensive work program. The completed evaluation of the Realgrunnen Subgp. and the Triassic interval covering the Snadd-Klappmyss Fms, did not significantly change the prospectivity of the license since the time of award. The Heilo North Prospect still remain the largest structure within the license.

Based on the results of the geological and geophysical studies performed, it has not been possible to identify a prospect which met the technical requirements, in terms of risk and volume, to commit to an exploration well. The final assessment of the PL770 was presented to the MC committee on 17th October 2016. Considering the negative outcome of the prospect assessment, Edison Norge recommended the MC committee to drop the license. The recommendation was unanimously supported by the JV partners.