Edison Norge AS

Expiry Report
March 2017



EDISON
Edison Norge

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1 Key Licence History

PL707, consisting of blocks 7127/5, 7127/6 and 7128/4, was awarded 21.06.2013 upon the 22nd Licensing Round to Edison International Norway Branch (50%), North Energy ASA (20%) and PGNiG Upstream International AS (30%). The current licensees are Edison Norge AS (50%), PGNiG Upstream International AS (30%) and Lime Petroleum Norway AS (20%). Full license history are listed in Table 1.1.

Table 1.1 License history

Licensee valid from date	Licensee valid to date	Company name	Interest
31.03.2016		Edison Norge AS	50%
		PGNiG Upstream International AS	30%
		Lime Petroleum Norway AS	20%
01.01.2015	31.03.2016	Edison Norge AS	50%
		PGNiG Upstream International AS	30%
		North Energy ASA	10%
		Lime Petroleum Norway AS	10%
29.11.2013	01.01.2015	Edison International Norway Branch	50%
		PGNiG Upstream International AS	30%
		North Energy ASA	10%
		Lime Petroleum Norway AS	10%
21.06.2013	29.11.2013	Edison International Norway Branch	50%
		PGNiG Upstream International AS	30%
		North Energy ASA	20%

The work commitment for the first phase was to acquire 3D seismic data within 2 years from the date of award (21.06.2015) in all awarded areas already covered by seismic surveys. Within 2 years from the date of award (21.06.2015) the rights owners should decide whether to drill an exploration well (Drill or Drop). The obligation to perform drilling activities should be fully completed within 4 years from the date of award (21.06.2017).

Two applications for extension of the initial deadlines, of a total of 18 months, has been submitted by Edison Norge AS on behalf of the partnership.

Application for 1-year extension of the Drill or Drop decision was submitted on 23.04.2015. The background for the application was to await the results of the 7130/4-1 well (Ørnen) drilled in PL708, targeting the same under-explored Permian Spiculitic play as identified in PL707. The extension of deadline was granted on 21.08.2015, with new deadline for the Drill or Drop decision 21.06.2016.

The 7130/4-1 well (Ørnen) was completed in January 2016 and extensive data acquisition and sampling was carried out. An application for additional 6-months extension of the Drill or Drop decision was submitted on 22.04.2016 to allow an in-depth evaluation of the well results of the Ørnen well, and its implications on the prospectivity in PL707. The extension of deadline was granted on 30.06.2016, with new Drill or Drop deadline 21.12.2016.

An overview of license activity is given in Table 1.2. Additionally, internal Peer and Functional Reviews has been held in Edison Norge AS upfront decision gates, and Edison Norge AS requested a meeting with the NPD to inform on the status on the license before submitting the application for 6-months extension of the initial deadline.

Table 1.2 License activity

Year	Date	Activity
2013	30.09.2013	Kick-off Meeting and License Establishment
	06.12.2013	EC/MC #1
2014	04.03.2014	EC Workshop #1
	05.11.2014	EC/MC #2
	15.12.2014	EC Workshop #2
2015	25.03.2015	EC/MC #3
	10.11.2015	EC/MC #4
2016	17.03.2016	EC/MC #5
	28.10.2016	EC/MC #6

The technical and economical evaluation of the main segment of the Greater Lyng Prospect in PL707 resulted in a critical size of the P50 and P90 recoverable resources, below the threshold for a stand-alone development. The project did not prove to be economic for the Barents Sea, and the partnership did not see any other option than to drop the license. A notification letter of the DoD decision was sent to the Authorities on 24.11.2016.

2 Database

2.1 Seismic Data

The seismic database used for the license evaluation and prospect assessment is defined by the common database and listed in Table 2.1. Location of the seismic database is showen in Fig. 2.1. Additionally, public available seismic data has been used for the regional interpretation, and for defining the up-dip closure of the Greater Lyng Prospect.

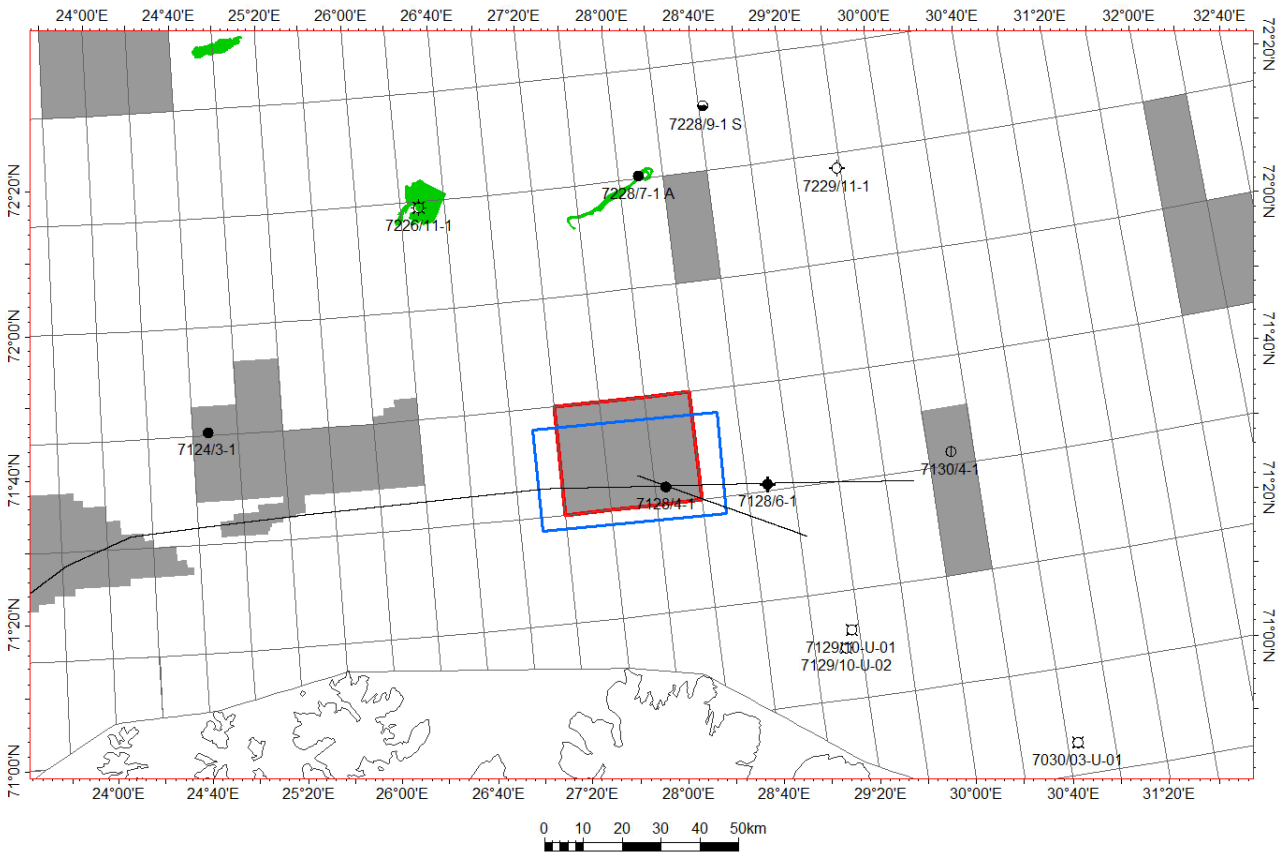

Fig. 2.1 Seismic and Well Database

Table 2.1 Seismic database

Survey	Type	Year	Company	Status	NPDID
FIN12	3D	2012	Fugro Multi Client Services AS	Multi-client	7661
SSHS11-119, -312	2D	2011	Searcher Seismic	Multi-client	7431

2.2 Well Data

Per today only three wells has tested the Spiculitic Play on the Finnmark Platform; 7128/4-1, 7128/6-1 and 7130/4-1. These wells are considered as the key wells for the PL707 prospect assessment.

Wells 7128/4-1 and 7128/6-1 were drilled in 1994 and 1991, respectively, and are public available. It has not been possible to trade/purchase the 7130/4-1 well (Ørnen, 2016) for the PL707 license, and the well has consequently not been included in the common database. Only Edison Norge AS and Lime Petroleum Norway AS had access to this well due to their partnership in PL708.

Additionally, offset exploration and shallow stratigraphic wells have been included in the evaluation to constrain the stratigraphy. The well database is shown in Fig. 2.1

Table 2.2 Well database

Wellbore	NPDID	Petrophysics	FIT	Stratigraphy	Sedimentology	Core
7128/4-1	2049	X	X	X	X	X
7128/6-1	1836	X	X	X	X	X
7130/4-1	7788	X		X	X	X
7124/3-1	1066	X		X		
7226/11-1	1177	X		X		
7228/7-1A	4257	X		X		
7228/9-1S	1486		X	X		
7229/11-1	1643		X	X		
7129/10-U-01	1145			X		
7129/10-U-02	1142			X		
7030/03-U-01	1141			X		

2.3 Special Studies

An extensive work program has been carried out in order to assess the prospectivity within the licensed acrage, and to mature the main prospect in the PL707 license (Greater Lyng prospect).

- **Mapping** (Edison in-house): A total of 13 horizons has been mapped on the 3D FIN12 survey, from the seabed to the Basement, for the purpose of assessing the license prospectivity, while 9 horizons has been mapped on a regional scale for input to the Basin Modelling study.
- **Regional Reconstruction / Structural Validation** (Edison in-house): The study was designed to improve the understanding of the timing of deformation and its implications on the effectiveness of the petroleum systems (i.e. traps, burial history, sediment dispersal pathways) by means of structural restoration.
- **Fracture Study** (Edison in-house): Main objectives of the study was to 1) assess the variations of the secondary porosity within the reservoir units by means of creation and analysis of Discrete Fracture Networks, 2) analyse the connectivity of the fracture systems and 3) recognition of sweet spots and preferable drilling direction.
- **Petrophysical Evaluation** (Edison in-house): Petrophysical analysis was carried out on 6 wells in the area in order to investigate reservoir properties and parameters, and fluid contacts.
- **Fluid Mobility Study** (Apex Spectral Technology): Applying the ADF® DHI technology to a subcube of the FIN12 3D seismic to identify zones with high fluid mobility likely associated with hydrocarbons.
- **Rock Physics & Seismic Inversion** (Edison in-house): The effect of reservoir property variations on elastic parameters was analysed by carring out Rock Physics Modeling (RPM) in order to estimate AI, SI and VpVs, followed by Seismic Inversion. Inverted porosity cube highlighted variations in reservoir properties within the uppermost part of the spiculitic sequence in the prospect area. The results were combinded with the results of the Fluid Mobility Study, and QC'ed after drilling the 7130/4-1 (Ørnen Well).
- **Sedimentological Model / Seismic Attributes** (Potsdam University): Multiphase project adressing the conditions controlling the deposition of the spiculitic sequences as well as their later modification to

develop predictive concepts for their occurrence. The study comprise a critical litterature review, sedimentation patterns in the Barents Sea, assessment of controls over spiculites, analysis of seismic data, assessment of existing subsurface data, and final integration of results in a depositional model.

- **Geochemistry & Basin Modelling** (IGI): The study was focussed on predicting the likelihood and location of any hydrocarbons. Key questions relate to the age, quality, presence and maturity of Jurassic and Permian source rocks.
- **Depth Conversion** (Edison in-house): Velocity modelling and depth conversion was carried out using the Velit software. Final model contained 10 layers. Well 7128/4-1 has been used to calibrate the stacking velocities. Pseudo-well generation was used due to lack of well control and to provide a more robust depth conversion.

3 Review of Geological and Geophysical Studies

PL707 is situated in Blocks 7127/5, 7127/6 and 7128/4 on the Finnmark Platform (Fig. 3.1), a tectonic stable large northerly dipping monoclinal ramp bounded to the south by the outcrop of the Caledonides. All formations from Cretaceous to Basement sub-crop successively below the Quaternary Nordland Gp when approaching the shore of Finnmark, Fig. 4.2. For hydrocarbons to accumulate on this monocline either local 4-way closures, 3-way closures with a sealing East-West up-dip fault, or a stratigraphic trap have to be in place.

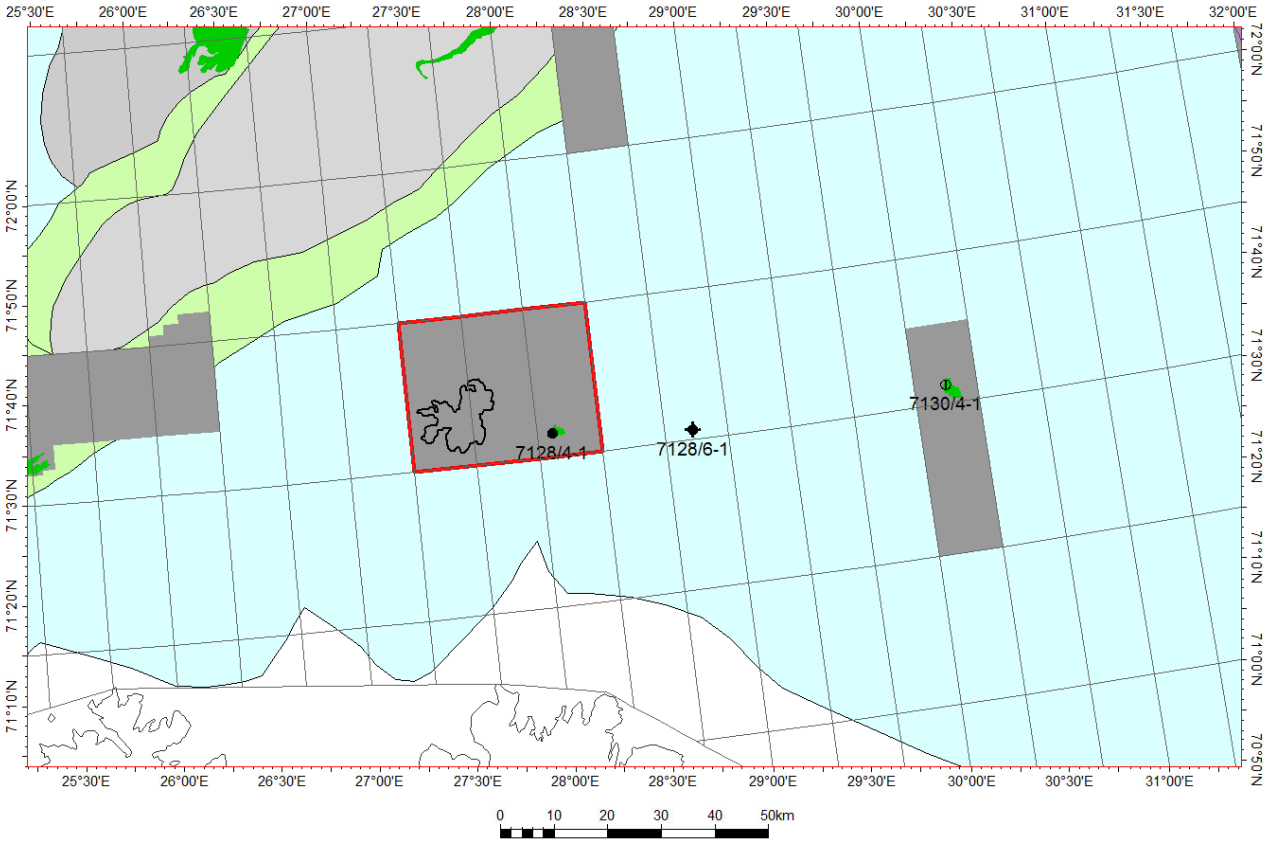

Fig. 3.1 PL707 location

Exploration well 7128/4-1 (Omd West Discovery well) is situated within the license area, c. 13 km east of the main prospect. The primary target was the Soldogg sandstones with secondary objective to test the reservoir potential of the carbonates of the Ørn Fm and the Upper Permian succesion. The well proved a gascap over moveable oil in the light spiculite facies of the Røye Fm, while the sandstones of the Soldogg was tight. Further 27 km to the east the 7128/6-1 well was drilled to the Basement. The well was heavily cored and penetrated the black spiculitic facies. The two wells has been extensively analysed and descriped in the litterature, and form the basis for the license evaluation.

Detailed seismic interpretation and mapping has been carried out in the PL707 license, with a total of thirteen (13) horizons from the Seabed to the Basement being mapped (Fig. 4.2). The license evaluation has been focused on the Palaeozoic sequence, and prospective intervals identified include the Upper Permian Røye Fm and the Carboniferous Soldogg Fm. The Greater Lyng Prospect has been defined within the spiculitic sequence of the Røye Fm, containing two segments; Lyng East and Lyng West. The mapping and subsequent evaluation of the Carboniferous sequence showed that the largest structure within the Soldogg Fm was tested by the 7128/4-1 well. The remaining prospectivity within the Carboniferous was regarded as neigliable, and the further license evaluation was focused on the Røye Fm.

Understanding the controlling factors for the deposition of the spiculites, as well as their later modifications through diagenesis was critical, and Edison Norge has worked closely with Potsdam University, in order to define a depositional model for the spiculites of the Røye Fm. The integration of regional data from the Barents Sea with an in-depth review of relevant analogues from the present day Arctic region allowed a suggestion of a depositional scenario for the spiculite-rich sequence of the Røye Fm. The best reservoirs occur in the light coarse spiculites, as seen in 7128/4-1, when the spicules are dissolved and leave behind moldic porosity. Secondary porosity caused by karstification, fractures and diagenetic processes can increase the reservoir properties of the spiculite reservoir. The spiculites are deposited on the inner to outer shelf where they are concentrated by physical processes (waves, storms etc) and create horizontal and continuos beds that drape across existing topographic highs. Based on the analogy to the 7128/4-1 and 7128/6-1 wells the spiculite reservoir reservoir surrounding the Greater Lyng Prospect creates a gradual facies barrier, and thereby a pinch-out of the porous spiculites. The final depositional model indicated that there was a higher risk for the non-winnowed facies of the black spiculites to occur in the PL708 area due to the more distal location, which was later confirmed by the 7130/4-1 well.

In order to better understand the burial history of the spiculitic mounds on the Finnmark Platform, a study on the Lower Havert Delta was carried out. The topsets of the clinoforms and the associated MFS was mapped across the Platform, providing a suitable surface for flattening the seismic. By correlating the PL707 and PL708 areas, it is clear that the PL707 area was buried earlier than the PL708 area. Sands belonging to the Havert Delta was penetrated by all three key wells (7128/4-1, 7128/6-1 and 7130/4-1) and can be identified on the well logs. A correlation of the three wells shows that the 7128/4-1, situated close to the Greater Lyng Prospect, was situated approx 40m shallower than the Ørnen Prospect at the time of deposition of the Havert Delta. A such difference in depositional depth can potentially have a large impact on the spiculitic facies.

The spiculitic reservoir of the Røye Fm is characterized by an amplitude anomaly in the seismic data due to an increase in acustic impedance related to the transition from the soft shales of the Havert Fm to the underlying denser Røye Fm. The distribution of spiculitic mounds across the Finnmark Platform is easily recognizable in the available seismic datasets, both by traditional mapping and by means of seismic attributes. Edison Norge has carried out a number of special studies (inversion study, fluid mobility study and frature study), in order to identify porous areas with good reservoir properties within the spiculitic mounds.

A seismic inversion study (Rock Physics Modeling) was carried out on the 3D FIN12 survey and calibrated to the 7128/4-1 and 7128/6-1 wells. Analysis of Relative Acoustic Impedance and Porosity cubes highlighted the distribution of the best expected porosities is often related to the mounded feature, but zones of porous reworked-type spiculites were also identified outside the mounds. Porosity barriers was identified in the Total Porosity cube in both the Lyng East and Lyng West segment, which defines the southernmost extension of the Greater Lyng Prospect (Fig. 4.3). A revision of the study was carried out after the completion of the 7130/4-1 (Ørnen Well), which showed that the elastic and reservoir properties of the Ørnen Well are consistent with the other wells in the area, and the original model was not significantly modified.

In combination with the seismic inversion study, a Fluid Mobility Study was performed by APEX Solutions on a subcube of the 3D FIN12 survey. Changes in the frequency spectrum are used to predict zones with mobile hydrocarbons. The study identified several anomalies within the Palaeozoic interval, but not all were consistent with the geology in the area. Edison Norge re-evaluated the final deliverables from Apex Solutions, and found that the Alpha High component showed inconsistent results. The two remaining components of the study, Dominant Frequency and Alpha Low showed good consistancy with the other studies performed on the spiculitic interval, and highlighted the area of the Greater Lyng Prospect. A general NE-SW oriented maximum permeability direction was inferred from the fluid mobility study.

Variations of secondary porosity within the spiculite reservoir unit has been assessed by means of Discrete Fracture Networks. Several sweet spots with relative high secondary porosity and permeability was identified. The largest of these is related to the identified Greater Lyng Prospect, and is located in the same area as where the largest connected fracture component is found. This indicates that there is a large volume of rock in which intense fracturing could both contribute to the total porosity and enhance the permeability, particularly in the NE-SW direction, as also inferred by the fluid mobility study.

A comprehensive Geochemistry/Basin modeling study has been conducted by IGI in order to identify (and quantify) the key source rocks and their maturity in the PL707 area as well as predicting the likelihood and location of any hydrocarbons. The study concluded that the oils from the 7128/4-1 well are unusual in their composition in comparison to most oils in the Southern Barents Sea, and originate from mixed sources. Two phases of charge is indicated by the geochemistry of the oils found in 7128/4-1, with the former subjected to biodegradation before fresh charge. An early charge from a Lower Triassic or Upper Paleozoic source rock, indicated by age-diagnostic bio-markers, is contributing with significant amounts of hydrocarbons. A second charge is indicated by the oil geochemistry, but the source rock is not yet well documented. The Greater Lyng prospect has a large fetch area down dip to the north, but can also be fully charged by vertical migration from the underlying Permo-Carboniferous source rocks below the prospect itself.

Edison Norge has used a regional velocity model for the Barents Sea (product from Estimages) to conduct the depth conversion. The model was additionally used for the evaluation of the PL708 area, where it proved to be robust and predictive for the Ørnen Prospect. Additionally, an in-house Velocity Modeling and Depth Conversion study has been carried out at prospect level in PL707 to support the regional velocity model.

4 Prospect Update Report

Greater Lyng Prospect

The Greater Lyng Prospect is one of a series of similar mounded features seen on the seismic across the Finnmark Platform at Top Permian level. The prospect is the largest of the mounds identified within the PL707 license acrage, situated c. 13 km west of the Omd West discovery well (7128/4-1). Two segments, Lyng East and Lyng West, have been identified within the Greater Lyng Prospect (Fig. 4.1). The main reservoir of the spiculitic mounds, of the Permian aged Røye Formation, are draping over underlying carbonate development. Top Røye Fm Time and Depth maps are given in Fig. 4.2. The overall trap architecture of the Greater Lyng Prospect is descriped as a stratigraphic/diagenetic trap, with a lateral shale out as the retaining trap element. The top seal is expected to be the thick basal shales of the Havert Fm as seen in wells 7128/4-1, 7128/6-1, 7130/4-1 and 7229/11-1. The dense or tight non-reservoir unit of the Permian carbonates are providing the base seal.

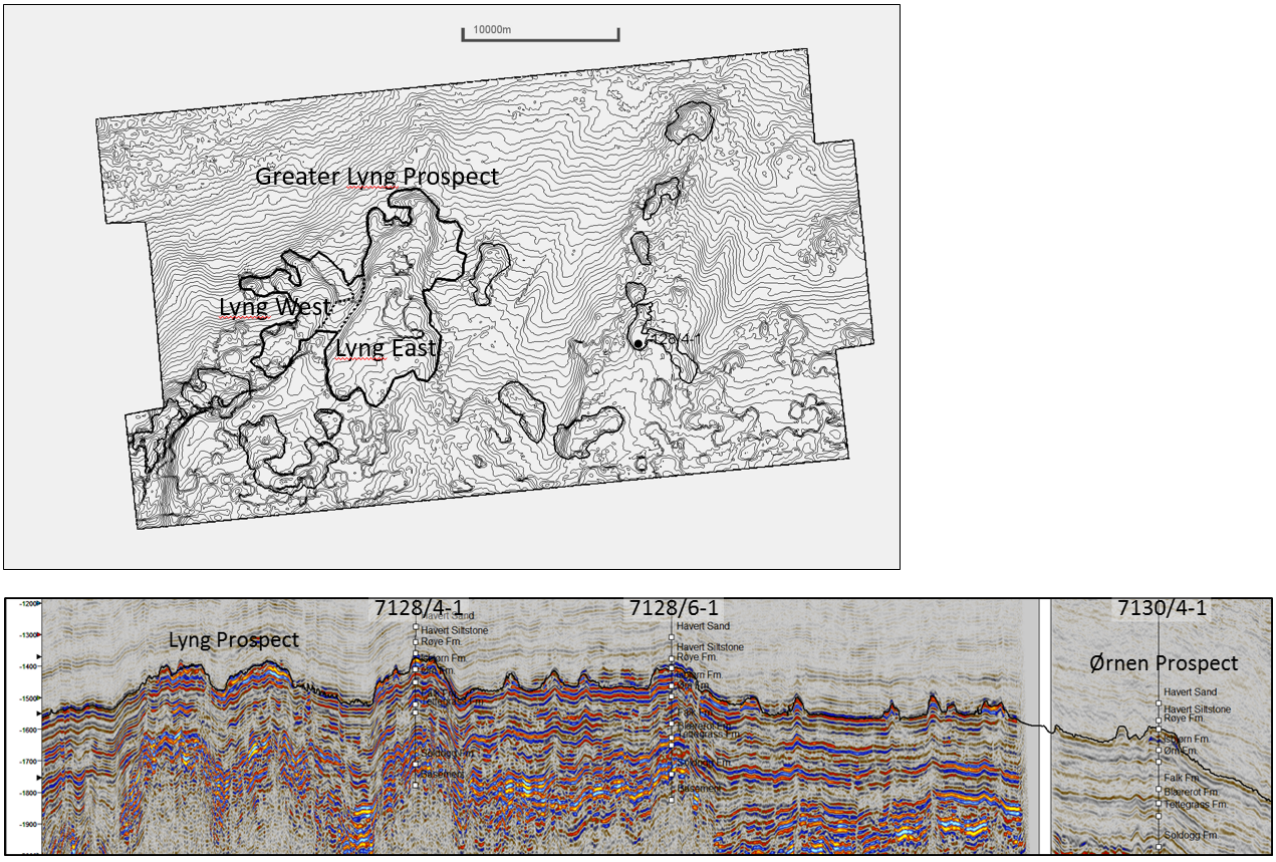

Fig. 4.1 Identified spiculitic mounds

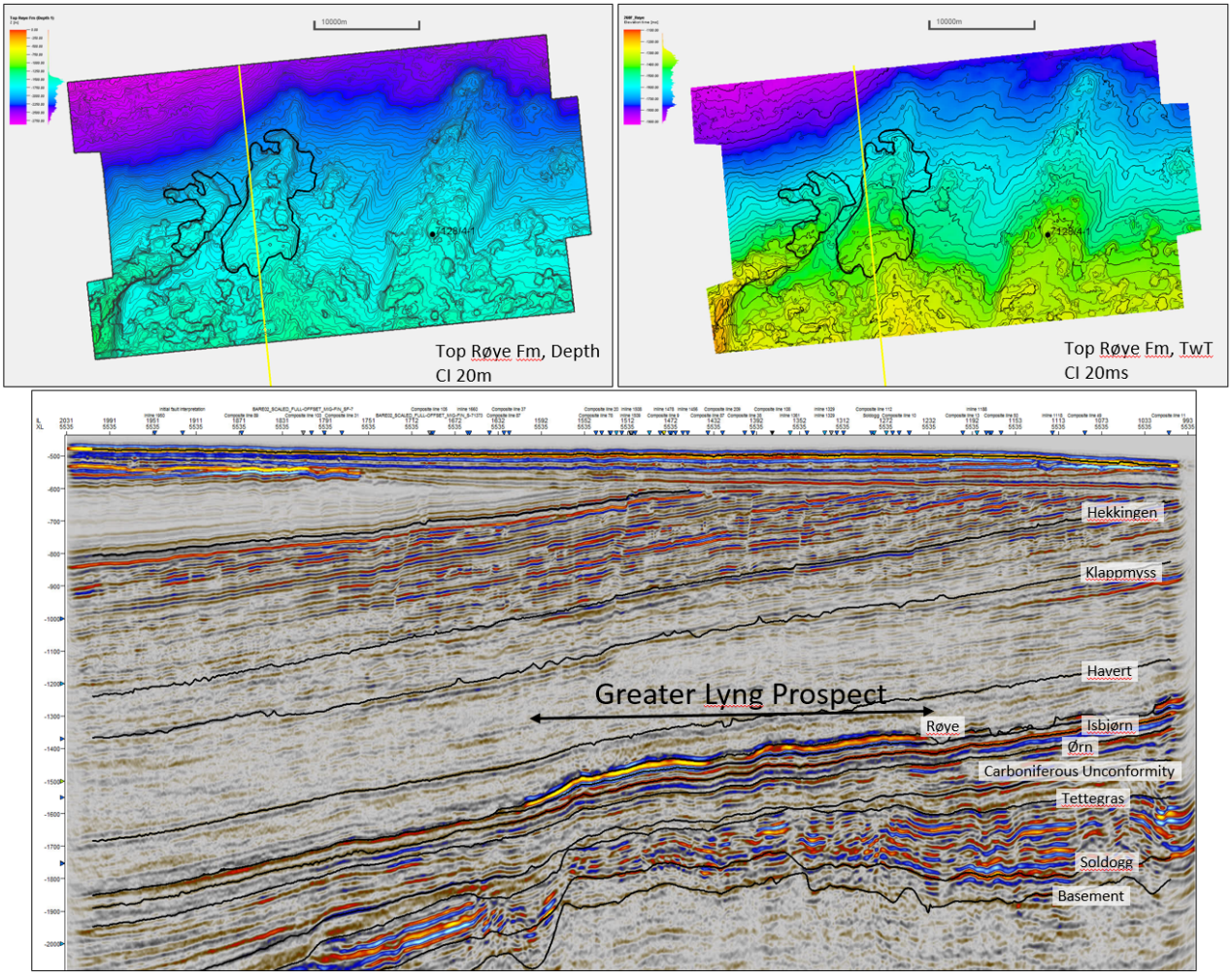

Fig. 4.2 Top Røye Fm, time and depth maps

Big efforts has been put into defining the southern extension of the Greater Lyng Prospect. The spiculitic mounds within the PL707 licensed acrage is extending outside the 3D FIN12 survey towards the south, and it has not been possible to identify an up-dip closure based on the 3D seismic data alone. All public available 2D seismic lines in the area has been analysed, but the line density is to sparse to allow for a confident mapping. Due to the location of PL707 within the restricted petroleum zone, and boardering the area where no petroleum activity should be initiated, it was not possible to acquire new seismic further to the south. Instead, the work program has included a number of special studies (eg. fluid mobility study, seismic inversion and fracture study) with the objective of identifing areas with internal porosity variations that could hold the potential of creating porosity barriers, and act as the up-dip closure of the Greater Lyng Prospect.

The products of the seismic inversion study include a Relative Acustic Impedance (AI) cube, Total Porosity cube, Vp/Vs cube and SLD cube. Relative AI and Total Porosity are considered the most robust parameters to predict porous intervals of the Spiculitic sequence. The Relative AI cube was used to identify the distribution of hard-core spiculites and potentially porous layers above, while Total Porosity most likely highlights the best quality spiculites. A porosity barrier is inferred from the Total Porosity cube which is defining the up-dip extension of the Greater Lyng Prospect (Fig. 4.3). All inverted properties used in the analysis indicate the same area as the most prospective, defined as the Greater Lyng Prospect.

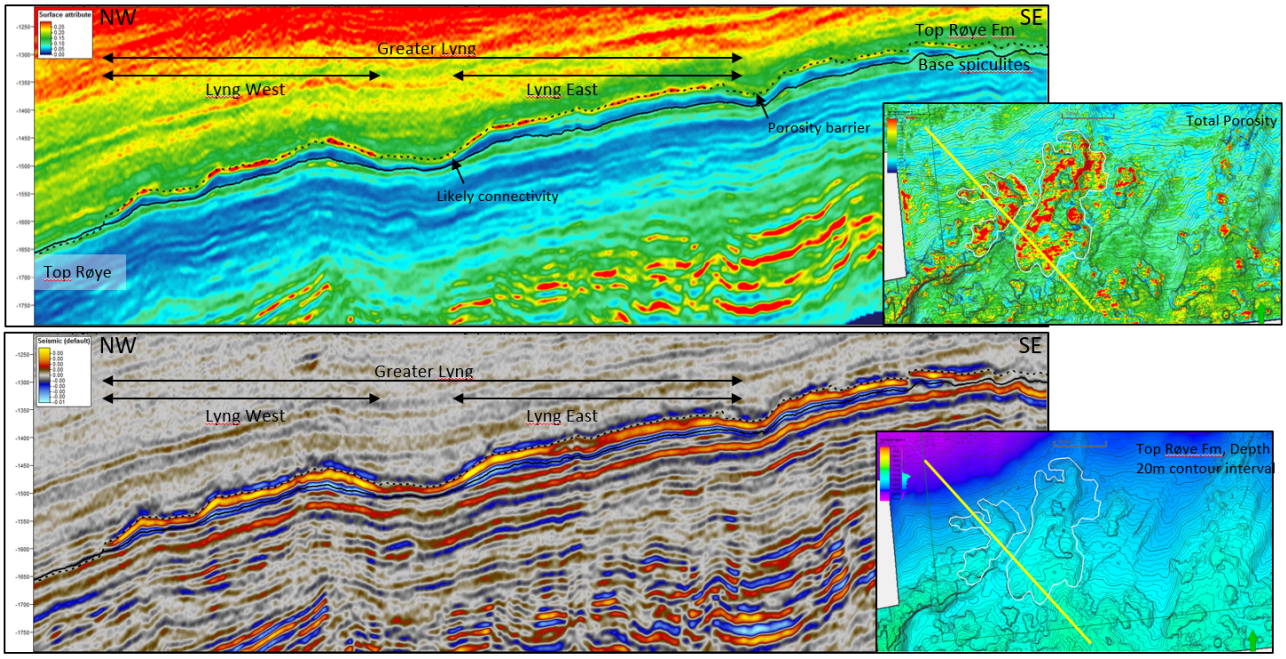

Fig. 4.3 Greater Lyng Prospect

The main risk elements associated with the Greater Lyng Prospect is the Reservoir Effectiveness, Source Effectiveness and the Trap Effectiveness. Reservoir Effectiveness is considered a risk due to the lack of production data from an offshore analogue, and the risk of encountering spiculites with low permeability either due to facies or to diagenetic modification of the reservoir. As no commercial discoveries has yet been made on the Finnmark Platform, the Source Effectiveness is being risked. Trap Effectiveness is also considered a risk, as the Greater Lyng Prospect is purely depending on a stratigraphic trap to retain any hydrocarbons.

Well 7130/4-1 was drilled in PL708 and completed in January 2016. Great expectations were put on the outcome of this well, as it was targeting the same spiculitic reservoir as identified in the Greater Lyng Prospect, and adding another important calibration point. The Risk Assessment was re-evaluated after the completion of the 7130/4-1 well.

Unfortunately, the 7130/4-1 well encountered a highly diagenetic modified spiculitic reservoir with aboundant chert development and very low reservoir potential. The spiculitic reservoir was not production tested and did thereby not further de-risk the Reservoir Effectiveness. A non-commercial gas discovery was reported from the 7130/4-1 in the Soldogg Fm, in addition to residual hydrocarbons in the Spiculitic reservoir. These results points towards the presence of a working hydrocarbon system in the area, and the risk on the Source Effectiveness was consequently downgraded. The geological COS was changed from 0.255 to 0.21 after the drilling of the 7130/4-1 Well.

A revision of the volumetric calculation of the Greater Lyng Prospect has been undertaken after the drilling of the Ørnen Well (7130/4-1) in PL708. Lyng East is the main prospect segment while Lyng West is considered as an upside potential that will only be developed in case of succes in the Lyng East segment. An economical evaluation has been carried out for the Lyng East segment only. The pre-Ørnen well volumes for the Lyng East segment was estimated to 237.4 Mbbls oil eqivalents for the P50 case. The updated evaluation are taking into account the thickness of the spiculitic reservoir encountered in the 7130/4-1 well, increasing the expected reservoir thickness from 10-20-70 (min-mode-max) to 20-40-70. The post-Ørnen well volumes for the Lyng East segment was consequently increased to 371.7 Mbbls oil eqivalents for the P50 case.

5 Technical Evaluations

The Finnmark Platform is generally underexplored, only a few exploration wells have been drilled and there are no infrastructure in place to facilitate a relative fast development of any discovery in this region.

A technical evaluation has been carried out for the oil case for the Lyng East segment, as well as for the Greater Lyng Prospect. The Lyng West segment is considered as an upside potential for a future development in case of succes in the Lyng East segment.

Given a discovery in the Lyng East segment, the evaluated development scenario involves a floating production ship (FPSO) with 6 oil producers, 3 water injectors and 1 gas injectors with 3 4-slots templates for the P50 case. For the Greater Lyng Prospect additional 2 oil producers and 1 water injector is required.

The economical evaluation has been performed only for the oil case of the Lyng East segment using the technological assumptions as input for the evaluation. Recoverable reserves for the Lyng East segment (P50 case) are equal to 105 Mbbls, which gives only marginal positive economics for the P50 case. Taking into account the uncertainties on the well productivity and cost assumptions, a sensitivity study was carried out with increased FPSO costs and higher number of wells so simulate more conservative production performance.

The outcome of the sensitivity study shows that P50 is extremely sensitive to the cost assumption and reservoir performance, increasing the risk of having a robust project, and only the P10 volumes can support a commercial development.

6 Conclusions

Since the award of the PL707 license in June 2013, Edison Norge has, on behalf of the PL707 JV, performed a comprehensive work program. The main geological plays that have been proven in the area are the Upper Permian Spiculites (Røye Fm) and the Lower Carboniferous sandstones (Soldogg Fm). The evaluation of the PL707 showed that the Upper Permian Spiculities are the main reservoir within the licensed acrage, and additional potential in the Lower Carboniferous Soldogg Fm is considered to be negligable. The spiculitic play has been deeply studied and matured from 2013 to 2015, when the JV decided to apply for an extention of the initial period, in order to await the well results of the 7130/4-1 (Ørnen) well, and include these in the final prospect assessment of the Lyng Prospect.

Edison Norge believes that the Greater Lyng Prospect is a highly interesting prospect, located in a favorable setting for hydrocarbon generation and migration. Source effectiveness, reservoir effectiveness and trap effectiveness are the main risk elements, and the geological chance of succces is 21%. Updated volumetrics point out a medium size potential for the Greater Lyng Prospect. There are no infrastructure in the area, and the results of the economical evaluation showed that the Greater Lyng Prospect is only economical for the P80 case or greater.

The final assessment of the PL707 was presented to the MC committee on 28th October 2016. Considering the outcome of the economical evaluation, Edison Norge recommended the MC committee to drop the PL707 license. All partners in the JV voted in favour of a relinquishment.