PL721 Relinquishment Report

Contents

List of Tables

List of Figures

1 License History

1.1 Introduction

PL721 license is situated in the northern part of the Barents Sea in Block 7321/4 and has an area of 292.809 km² (Figure 1). DEA Norge (40%), as operator, and the partners Aker BP (40%) and Wintershall Norge (20%) have decided to relinquish the license after the disappointing results of exploration well 7321/4-1 T2 on drilled the Gråspett prospect. 7321/4-1 T2, was drilled during September 2018 and completed as a dry hole after reaching a total depth of 1600 meters below sea surface. The well encountered poorly developed reservoir sections in Jurassic and Triassic formations, and no movable hydrocarbons were discovered. Extensive post well studies, lessons learned and remaining prospectivity evaluation have been completed, with the conclusion that no commercial exploration potential remain in the license that can justify additional drilling activities. The work commitment of PL721 has been fulfilled and the license was relinquished on 13th August 2019.

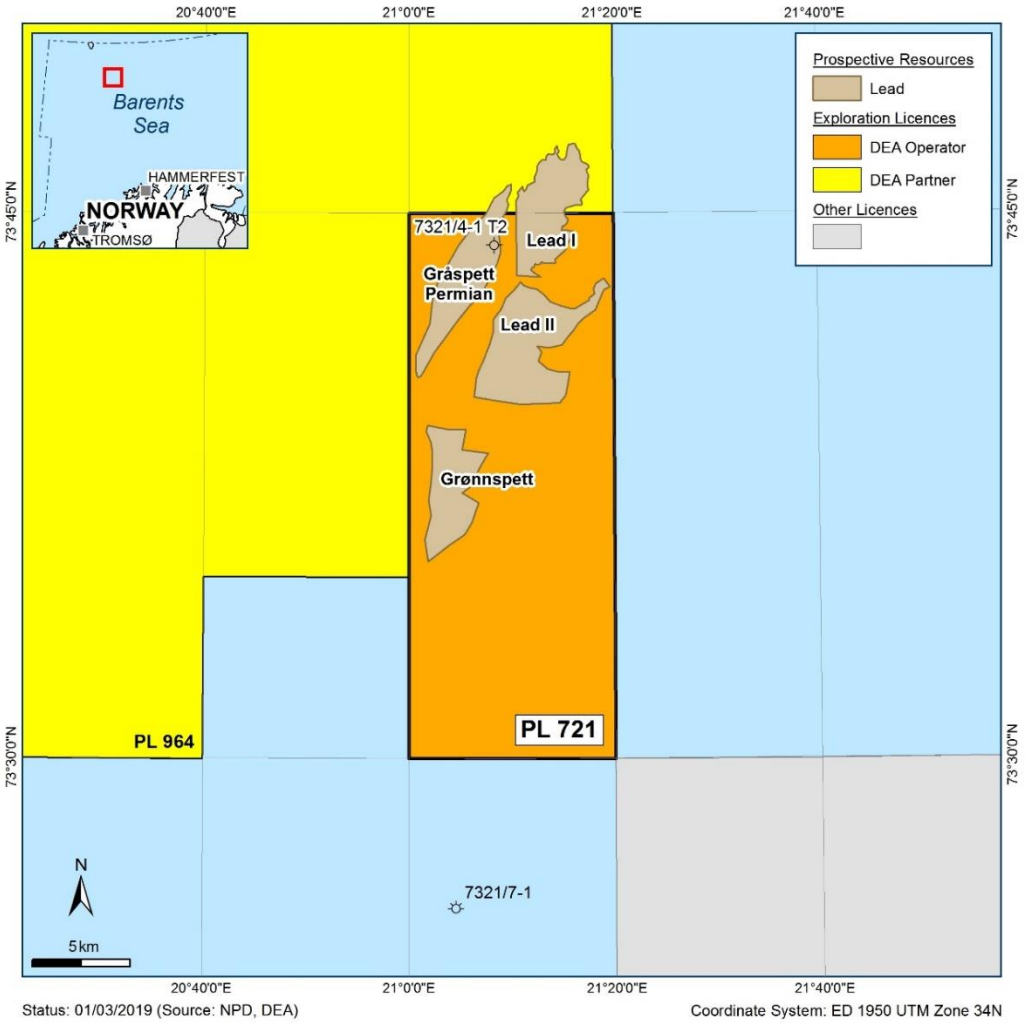

Figure 1: PL721 license map with remaining prospectivity

1.2 Key license history

1.2.1 Summary of award and participants

PL 721 is located in the northern part of the Barents Sea and was awarded on the 21st June 2013 in the 22nd License Round. On 21st June 2016, a 1-year extension was granted to the license with a drill or drop decision on June 21st, 2017. The initial license term was extended to 21st June 2020, on the 21st June 2019 the license entered the extension to the initial period. On the 13th May 2019 the partnership applied for relinquishment, which was effective as from 13th August 2019.

The license was originally awarded to RWE DEA Norge as operator (40%; now DEA Norge), Repsol Exploration Norge (20%), OMV Norge (20%) and Wintershall Norge (20%). 30th November 2016, OMV transferred it 20% equity to Aker BP and on 28th February 2017, Aker BP took over the additional 20% Repsol Norge equity.

1.2.2 Initial work obligations and work periods

Within 3 years of the award (by 21st June 2016):

- Acquire 3D seismic (commitment completed in 2013 by the purchase of HF13 from TGS)
- G&G studies (completed)
- Drill or drop decision (drill decision approved in June 2017)

Following the completion of the initial 3 years work program, DEA Norge (formerly RWE Dea Norge) recommended to drill an exploration well on the Gråspett prospect, which was not approved by the partnership. It was agreed to extend the license by one year to evaluate new 3D seismic broad band processing (Clarify) data. The extension period allowed for the re-establishment of the license with new license partner Aker BP and a drilling recommendation was approved in the partnership.

Within 6 years from the award (by the 21st June 2019):

- Drill an exploration well (completed in September 2018 with the 7321/4-1 T2)

Within 7 years from the award (by the 21st June 2020):

- Decision to enter license extension period (license relinquished on 13th August 2019)

1.2.3 Overview of meetings held

The table below contains the list of EC/MC meetings held during the license period 2013-2019:

Table 1: Overview of held EC/MC meetings and meeting content

#	Date	Participants	Meeting content
1	29.08.2013	RDN, OMV, Repsol, Wintershall	License establishment, common database, work program, budget
2	21.11.2013	RDN, OMV, Repsol, Wintershall	Status technical work, status 3D purchase, proposal for P-cable test acquisition, special studies, work program, budget
3	13.05.2014	RDN, OMV, Repsol, Wintershall	Status prospectivity, status 3D processing, preparation for future operations, site survey, work program, budget
4	18.11.2014	RDN, OMV, Repsol, Wintershall	Site survey operations, status prospectivity, status of HF13 reprocessing, special studies, work program, budget
5	21.04.2015	RDN, OMV, Repsol, Wintershall	Geophysics and inversion study, special studies: 2D/3D structural reconstruction, basin modelling, geochemistry, reservoir quality study
6	10.12.2015	RDN, OMV, Repsol, Wintershall	Area and Permian prospectivity, work program and budget
7	Feb 2016	RDN, OMV, Repsol, Wintershall	Realgrunnen upside, Permian prospectivity, technical-economical evaluation
8	08.12.2016	Dea Norge, Aker BP, Wintershall	Re-establishing license, common database, status G&G work, HF13 3D seismic reprocessing update, way forward, tentative well planning, budget
9	09.05.2017	Dea Norge, Aker BP, Wintershall	Status G&G work, way forward, preliminary well planning, work program, budget. Drill recommendation
10	16.11.2017	Dea Norge, Aker BP, Wintershall	Gråspett well planning status, HSE, risk and stakeholder management, way forward, work program, budget
11	14.06.2018	Dea Norge, Aker BP, Wintershall	Status drilling preparations, risk and stakeholder management, budget
12	15.11.2018	Dea Norge, Aker BP, Wintershall	Exploration well Gråspett – summary of operations and HSE performance, subsurface summary of well results, lessons learnt, work program, budget
13	07.03.2019	Dea Norge, Aker BP, Wintershall	Summary of Gråspett well results and operations, post-well studies, PL721 remaining prospectivity, budget, recommendation to relinquish

2 Database

2.1 Well database

The PL721 license was situated in an underexplored area in the northwestern Barents Sea with the closest offset well some 38km away (7321/7-1). Table 2 provides an overview of the wells used the prospectivity evaluation. The exploration wells are displayed in Figure 2.

The PL721 partnership drilled the 7321/4-1 T2 well in 2018 that became part of the common database. In the vicinity (~43km) one recent dry exploration well (7322/7-1) has been drilled targeting upper Cretaceous in the Fingerdjupet Sub-basin, located south-east of the license. The well was pre-traded and the results of this well was used in the Gråspett well planning and remaining prospectivity analysis.

Table 2: PL721 most relevant wells database

Well	Operator	Year	TD [mMD] & Stratigraphy	Results
7320/3-U-1	IKU	1985	33.5m in Jurassic Hekkingen Fm	Un-biodegraded migrated oil proven
7321/7-1	Mobil Exploration Norway INC	1988	3,550m in Triassic Snadd Fm	Dry with shows. Weak shows in Cretaceous Kolje Fm, Jurassic Stø- and Triassic Snadd formations
7321/8-1	Norsk Hydro Produksjon AS	1987	3,482m in Permian Røye Fm	Dry with shows. 1) Realgrunnen Gp -water wet with residual HC; 2) Triassic - water wet; 3) Permian sandstone of poor quality
7321/9-1	Norsk Hydro Produksjon AS	1988	1,800m in Triassic Snadd Fm	Dry with shows. 1) Realgrunnen Gp. to Late Triassic sandstone - weak HC shows; 2) Low Cretaceous and Triassic Snadd Fm -no reservoir in Cretaceous and water wet Triassic
7321/4-1T2	DEA Norge	2018	1,600m in Triassic Snadd Fm	Dry with shows. Weak oil shows in Realgrunnen Gp, gas shows in Cretaceous and Realgrunnen Gp
7322/7-1	Spirit Energy Norge AS	2018	797m in Low Cretaceous	Dry. No sandstone in Cretaceous Knurr Fm

2.2 Seismic database

The 3D seismic survey HF13 (Hoop Fingerdjupet 2013) was acquired by TGS in 2013 and bought by each PL721 partner as part of the work commitment. 569 km² of the HF13 survey were selected as part of the license common database.

The HF13 3D seismic Clarify reprocessing was purchased and included in the common database.

Table 3: PL721 common seismic database

Type	Survey Name	Company	Year
3D	HF13	TGS	2013
3D	HF13 Clarify broad band re-processing	TGS	2016
2D	All public lines available over PL721		
2D	NBR06 – NBR11	Fugro Multi Client Service AS	2006 - 2011

The most recent interpretations have been performed on the NBR (2D) and HF13_Upgrade_PRCMIG (3D) surveys within and in the close vicinity of PL721. Figure 2 shows the location 3D seismic survey and Figure 3 the position of the 2D seismic lines part of the license common database.

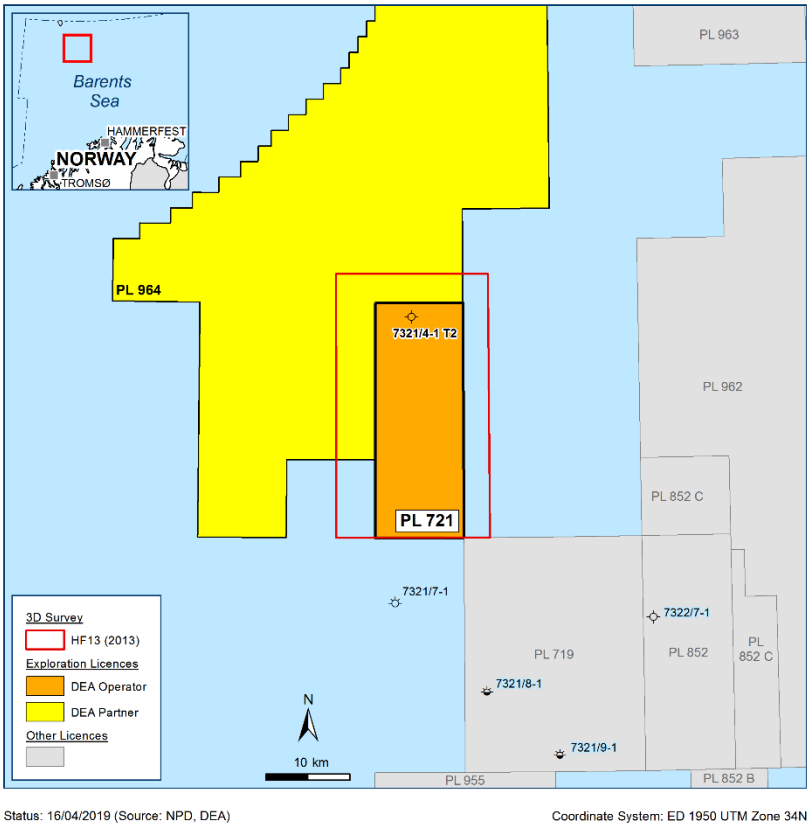

Figure 2: 3D seismic coverage in PL721

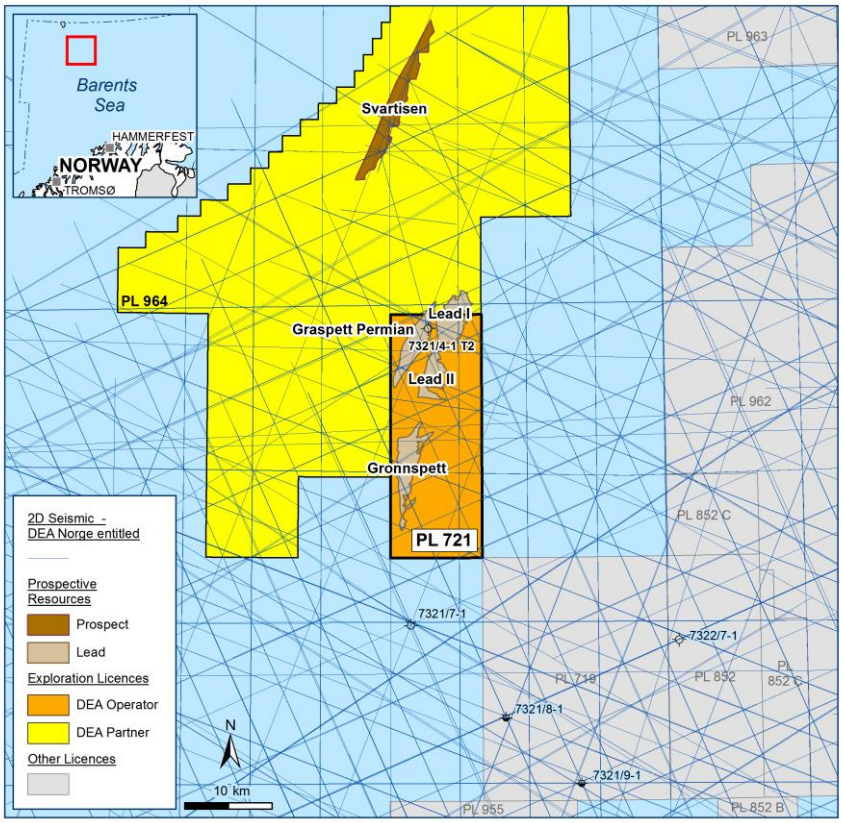

Figure 3: 2D seismic lines entitled to PL721

2.3 Special studies

In connection with the license evaluation and the preparation of the drill or drop decision, the following geological and geophysical studies were undertaken in-house DEA and third party companies (Table 4). The studies conducted after license establishment are part of the common database.

Table 4: Special studies performed for PL721 prospectivity evaluation

#	Year (start)	Study	Author/Company
1	2013	Purchase of THG 3D HF13 pre-stack time migration multi-client 3D	TGS
2	2014	Site survey + DUG hi-res reprocessing	Calecore & DUG
3	2014	Geochemistry study, Cretaceous and Jurassic source rocks identification and maturity modelling	Exploro AS
4	2015	Reservoir Quality study – Petrography and Diagenesis of Triassic and Jurassic sandstones of the Barents Sea area	DEA Wietze Laboratory
5	2015	Structural restoration PL721, 2D and 3D	Midland Valey
6	2015	Top seal risk analyses	Seals International
7	2017	7321/8-1 Permian cuttings analysis	FIT

3 Review of Geological and Geophysical Framework

3.1 Results of block evaluation and major changes compared to original license application

The prime focus for the initial license phase was the Jurassic Gråspett prospect, initially defined on 2D seismic data. The prospect was matured for the drilling decision, based on HF13 3D seismic data and offset wells calibration, and the prospect evaluation was further supported by special studies (Table 4).

Additionally, three Jurassic leads (Grønspett, Lead 1 and Lead 2) and one Permian lead (Gråspett Permian) have been identified and evaluated in full. A summary of the additional lead evaluation is provided below.

The results of 7321/4-1T2 well introduced four major learnings to the geological understanding of the block compared to the license application:

- Jurassic reservoir interpretation: Prior to the drilling of Gråspett 7321/4-1 T2 well, Top Stø Formation was not resolved as proper and mappable seismic event. Mapping of the Realgrunnen Group was performed and correlation from the offset wells showed thickening of the Jurassic Realgrunnen Group succession into the Gråspett prospect. It was interpreted that this thickness variation was valid for the Stø Formation reservoir succession. The thickness prognosis for the Realgrunnen Group was in line with the actual thickness encountered in the 7321/4-1 T2 well, however, the Stø Formation gross and net-to-gross reservoir was below prognosis.
- Jurassic reservoir facies model: Tidal mouth bars were the primary facies types prognosed in the 7321/4-1 T2 well. Post well evaluation showed prime reservoir facies to be distal shoreface with no indications of tidal influenced setting.
- Burial history of the Gråspett structure: The area uplifted was initial estimated to ~1500m. From 7321/4-1 T2 sonic velocities and thin section analyses the burial history is now estimated 2000m uplift over the area.
- New Cretaceous and Upper Jurassic plays: The 7321/4-1 T2 well encountered sandstone stringers in the Cretaceous Knurr Formation and a 20m thick siltstone package at the Top of the Jurassic Fuglen Formation which can be considered for further prospectivity evaluations in the wider block area.

3.2 Prospect update

3.2.1 Prospects originally presented in license application

Prospects Gråspett and Grønnspett

Summary from R22 application:

Prominent horst and rotated fault blocks form the main structural elements in PL721, positioned between Leirdjupet Fault Complex and several NNE-SSW striking faults. Two main prospects, Gråspett and Grønspett, were identified on 2D seismic data during the R22 evaluation. The Gråspett prospect was defined by a structural 4-way dip horst block. The Grønnspett prospect a rotated 3-way dip fault block.

The main reservoir is the Jurassic Stø Formation interpreted to be deposited as shallow marine sandstone. The Jurassic Nordmela and Tubåen formations have been regarded as secondary targets. In the application area, the Stø Fm was prognosed in a present depth of 1300-1500m, with a high net to gross reservoir population (0.8-1) and relatively good porosity of 18% in Gråspett and 15% in the deeper Grønnspett prospect. The risk of porosity reduction has been considered for the Grønnspett prospect as erosion of about 2000m sediment was modelled and paleo-temperatures might have exceeded 100°C in the Stø Formation. The permeability was assumed to be good, around 200mD.

Extracts from the IKU well 7321/3-U-1 on a structure north of PL721, show migration of fresh oil. It was concluded that the Hekkingen Formation provides an active oil prone source rock in the area. Trap formation and timing appear to be favorable for the prospects east of Stappen High. The primary filling of the prospects occurred in the Late Cretaceous east of Stappen High.

Due to the general uplift in the area, a high degree of micro-fracturing and faults as conduits for leakage through the top seal is likely. A seal type II/III trap were prognosed. The seals are usually breached due to excess pressure build ups, they leak off their charge quickly and are dependent on late re-charge to be able to hold a column today. The main geological risk for the Gråspett and Grønnspett prospects was concluded to be associated with retention.

Table 5 and Figure 4 summarizes the pre-drill prospectivity applied for Round 22 by licensees.

Table 5: Main prospectivity applied for Round 22 by licensees with post Gråspett comments

Company	Name in R22	Type	POFH	Age of reservoir	Post drill comments
RWE Dea Norge / E.ON	Gråspett / Ibsen	Prospect	24 %	Lower Jurassic	Drilled as 7321/4-1 T2 in 2018, dry well with shows
RWE Dea Norge	Grønnspett	Prospect	25%	Lower Jurassic	Post-drill 7321/4-1 T2: decrease of POFH and resources below economic threshold
E.ON	Ibsen South	Lead	20%	Lower Jurassic	Post-drill 7321/4-1 T2: decrease of POFH and recources below economic threshold

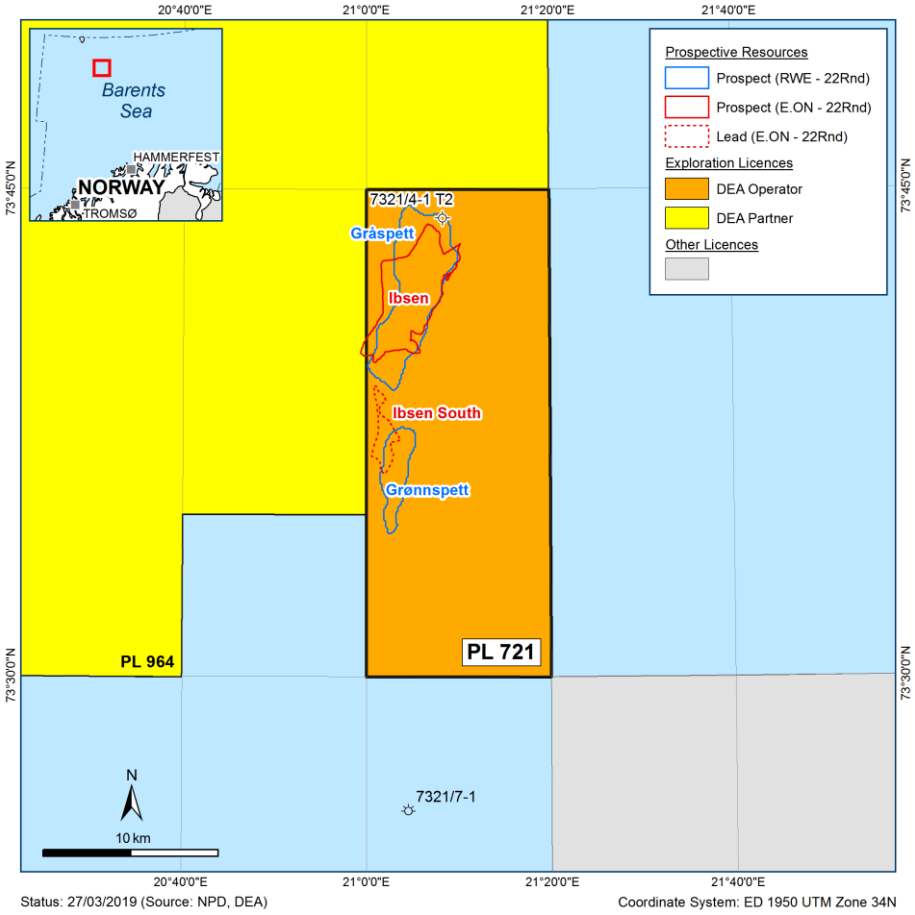

Figure 4: Prospect and lead outlines of prospectivity prior PL721 evaluation, status R22 application

3.2.2 Remaining prospectivity in PL721

The remaining prospectivity of PL721 following the post well analysis of the Gråspett well 7321/4-1 T2 and updated prospectivity evaluation is summarized in the

Table 5 and illustrated in Figure 5.

Table 6: Prospect and leads after PL721 evaluation, post-drill 7321/4-1 T2

Prospect name	Status	Age of reservoir	Depth of crest [mSS]	POFH (main risk)	Exp. Fluid	P90-P50- P10 rec. volumes [mmboe]
Grønnspett	Lead	Lower Jurassic	1420	14.6 % (Retention)	Oil / Gas	1.6-5.9-10.8
Lead 1	Lead	Lower Jurassic	1660	14.6 % (Retention)	Oil / Gas	1.5-11.0-27.0
Lead 2	Lead	Lower Jurassic	1650	14.6 % (Retention)	Oil / Gas	5.0-15.5-29.8
Gråspett Permian	Lead	Permian	2700	10.0 % (reservoir presence and quality)	Gas	17.6-76.7-212.7

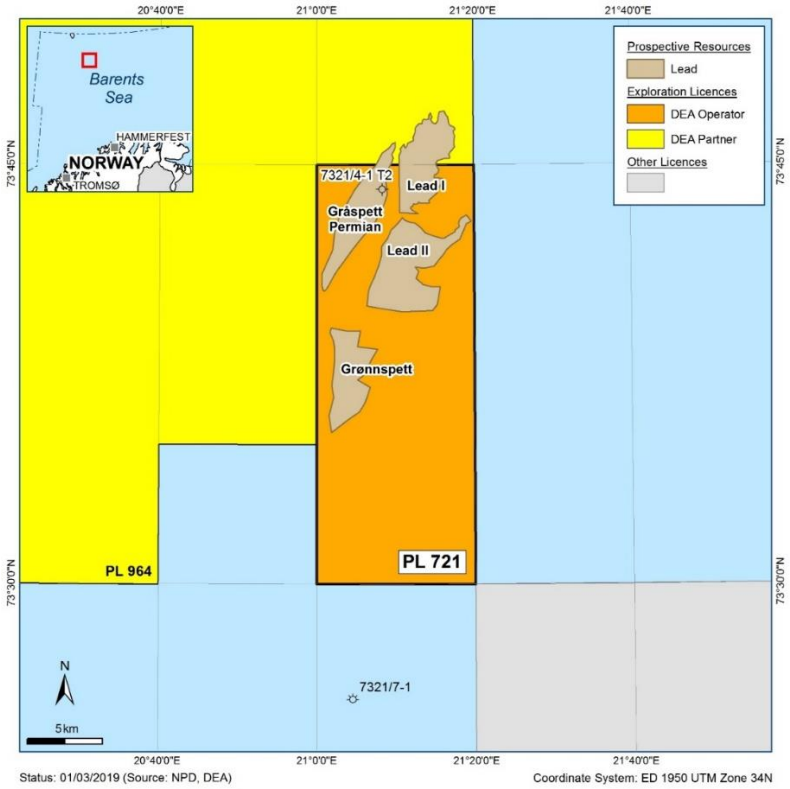

Figure 5: Lead map of the remaining prospectivity post Gråspett 7321/4-1 T2 well result

Permian

Lead Permian Gråspett

Permian Gråspett is a structural lead with an area of 27km^2. Despite seismic reprocessing efforts, the Permian structure is poorly imaged but remains as a mappable horst structure in the deeper level of the Gråspett structure.

The closest offset well penetrating the Permian Gipsdalen Group is situated 150km to the south (Neiden). Reservoir quality of the Gipsdalen Group is closely linked to depositional facies and secondary porosity through karstification. Exposure and/or karstification is not interpretable from the seismic data. For volumetrics evaluation the following reservoir parameter have been applied: Net to gross range from 40% to a maximum of 100%, porosity range from minimum of 7% and a maximum of 17%. Top reservoir is interpreted to be at around 2690mSS with uncertain thickness distribution from 100m to 500m having a most likely thickness of 350m.

At the time being two source rocks of Upper Jurassic and Lower Triassic age are interpreted to be in the gas window in the drainage area. The latter can contribute to Gråspett Permian from the Bjørnøya Basin through direct fault juxtaposition. Whereas for the Upper Jurassic source rock no communication pathway has been identified during the evaluation process.

The main risk is given by the reservoir presence and reservoir quality. The probability of finding movable hydrocarbons in the Permian Gråspett prospect is estimated to be 10%.

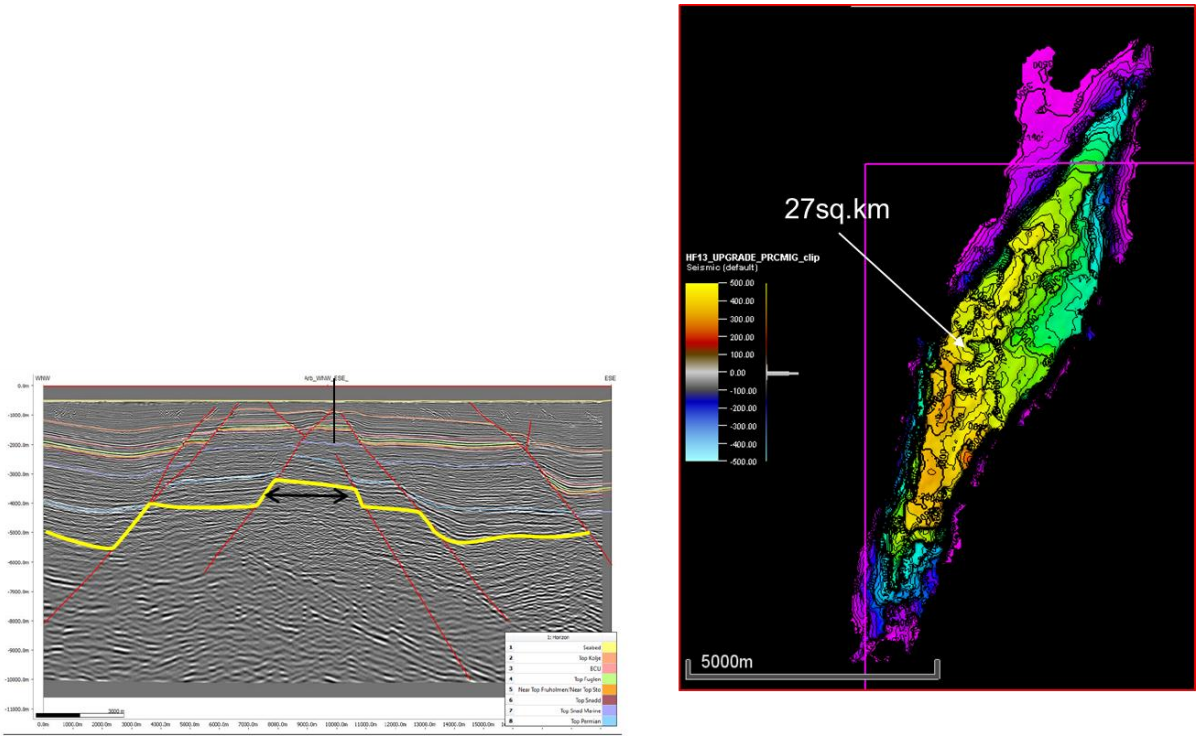

Figure 6: Seismic line through lead Permian Gråspett and top reservoir depth map

Jurassic Realgrunnen Group

For all three Jurassic leads (Lead 1, Lead 2 and Grønnspett) the same assumptions have been used for the depositional model, the burial history, the charging history and the volumetrics.

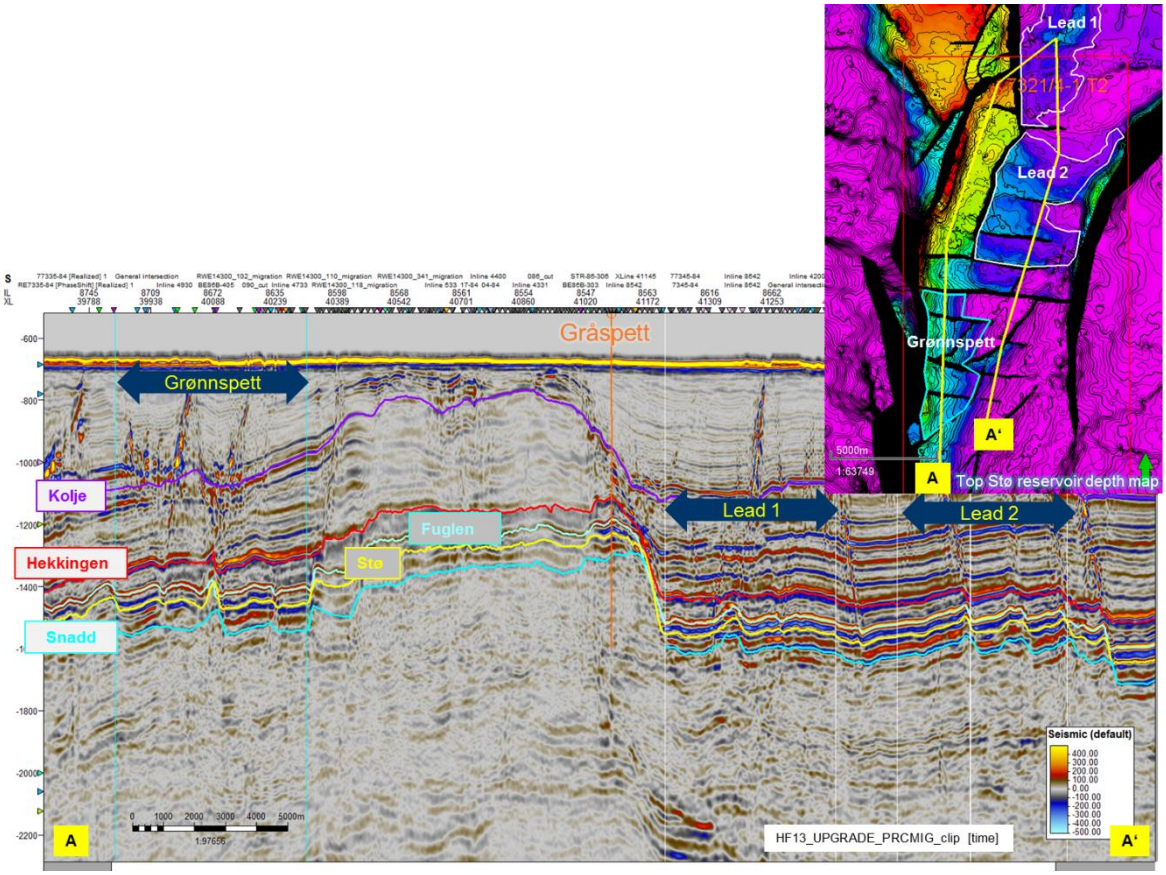

Figure 7: Seismic line across the leads Grønnspett, Lead 1 and Lead 2 and top reservoir depth map

Lead 1

Lead 1 is a two-way dip, two-way fault closure situated on the eastern downthrown side of the Jurassic Gråspett structure. The western bounded fault has a variable throw of 180m to 260m across the prospect and juxtaposed the Jurassic sediments of Lead 1 against the Triassic Snadd Formation. Nevertheless, fault seal is not assumed to be critical as thick shale sequences in between thin sands are likely to generate good fault membrane (SGR <70%). Top reservoir is at 1660mSS and the last closing contour is interpreted to be at 1800mSS.

The reservoir of the lead is restricted to the Jurassic Stø Formation. Fine- to medium grained sandstones with fair to poor reservoir qualities have been encountered in the 7321/4-1 T2 well (Gråspett). The latter is ~1km west of the lead. Currently, the depositional model for PL721 is interpreted as distal shoreface linking to the south where the Fingerdjupet wells (7321/7-1, 7321/8-1 and 7321/9-1) have met lower to upper shoreface of decent quality. Not only the depositional setting contributes to poorer reservoir quality it is also attributed to the deeper burial of the area of the PL721. Intense cementation with syntaxial quartz overgrowth have

been observed in thin sections of the Stø Formation (7321/4-1 T2). The burial is currently estimated to be higher than 2000m.

The following reservoir parameter have been applied: net to gross range from 10% to a maximum of 60% with a most likely at 49%. The porosity range from 10% (correspond to the cut-off), a most likely at 12% and a maximum of 14%. The net rock volume has been assessed by using top and a near-base of the reservoir including an uncertainty range of ± 30%.

Further learnings are implemented from 7321/4-1 T2 well as the low fracture gradient in the overburden and an open fracture network. The large uplift points to a very weak top seal, incapable to preserve any hydrocarbon column height over time. Therefore, the retention of charge is evaluated with 0.3 which reflects the highest risk in the area.

The presence of source rock is confirmed in the wider area. The Gråspett well has drilled an excellent Upper Jurassic source rock in the late oil / early gas window. Further, gas readings have been measured during all drilling. No liquids have been detected along the trajectory, but liquids are present in micropores of cuttings (rarely) and side wall cores. For Lead 1 the risk access to charge is evaluated with 0.9.

The main risk is given by trap validity / retention of charge with 0.3. The reservoir quality has been assessed with 0.6. The probability of finding movable hydrocarbons in Lead 1 is estimated to be 15%.

Lead 2

Lead 2 is a two-way dip, two-way fault closure situated on the eastern downthrown side of the Jurassic Gråspett structure. At least two E-W striking faults are within the reservoir section having a negligible throw juxtaposing sand vs. sand. The western bounded fault has a variable throw of 200 to 80m across the prospect and juxtaposed the Jurassic sediments of Lead 1 against the Triassic Snadd Formation. Nevertheless, fault seal is not assumed to be critical for the large western fault as thick shale sequences in between thin sands are likely to generate good fault membrane (SGR <70%).

Top reservoir is at 1650mSS and the last closing contour is interpreted to be at 1800mSS.

The reservoir of the lead is restricted to the Jurassic Stø Formation. Fine- to medium grained sandstones with fair to poor reservoir qualities have been encountered in the 7321/4-1 T2 well (Gråspett). The latter is ~2-3km north-west of the lead. Currently, the depositional model for PL721 is interpreted as distal shoreface linking to the south where the Fingerdjupet wells (7321/7-1, 7321/8-1 and 7321/9-1) have met lower to upper shoreface of decent quality. Not only the depositional setting contributes to poorer reservoir quality it is also attributed to the deeper burial of the area of the PL721. Intense cementation with syntaxial quartz overgrowth have been observed in thin sections of the Stø Formation (7321/4-1 T2). The burial is currently estimated to be higher than 2000m.

The following reservoir parameter have been applied: net to gross has a minimum from 10% to a maximum of 60% with a most likely at 49%. The porosity is evaluated with a minimum of 10% (correspond to the cut-off), a most likely at 12% and a maximum of 14%. The net rock volume has been assessed by using top and a near-base of the reservoir including an uncertainty range of ± 30%.

Further learnings are implemented from 7321/4-1 T2 well as the low fracture gradient in the overburden and an open fracture network. The large uplift points to a very weak top seal, incapable to preserve any hydrocarbon column height over time. Therefore, the retention of charge is evaluated with 0.3 which reflects the highest risk in the area.

The presence of source rock is confirmed in the wider area. The Gråspett well has drilled an excellent Upper Jurassic source rock in the late oil / early gas window. Further, gas readings have been measured during all drilling. No liquids have been detected along the trajectory, but liquids are present in micropores of cuttings (rarely) and side wall cores. For Lead 2 the risk access to charge is evaluated with 0.9.

The main risk is given by trap validity / retention of charge with 0.3. The reservoir quality has been assessed with 0.6. The probability of finding movable hydrocarbons in Lead 2 is estimated to be 15%.

Lead Grønnspett

Lead Grønnspett is a two-way dip, two-way fault closure situated on the southern prolongation of the Jurassic Gråspett structure in a structurally deeper position. At least three E-W striking faults and one NE-SW striking fault are within the reservoir section having a negligible throw juxtaposing sand vs. sand.

Top reservoir is at 1420mSS and the last closing contour is interpreted to be at 1800mSS.

The reservoir of the lead is restricted to the Jurassic Stø Formation. Fine- to medium grained sandstones with fair to poor reservoir qualities have been encountered in the 7321/4-1 T2 well (Gråspett). The latter is nearest ~10km north of the lead. Currently, the depositional model for PL721 is interpreted as distal shoreface linking to the south where the Fingerdjupet wells (7321/7-1, 7321/8-1 and 7321/9-1) have met lower to upper shoreface of decent quality. Not only the depositional setting contributes to poorer reservoir quality it is also attributed to the deeper burial of the area of the PL721. Intense cementation with syntaxial quartz overgrowth have been observed in thin sections of the Stø Formation (7321/4-1 T2). The burial is currently estimated to be higher than 2000m.

The following reservoir parameter have been applied: net to gross has a minimum from 10% to a maximum of 60% with a most likely at 49%. The porosity is evaluated with a minimum of 10% (correspond to the cut-off), a most likely at 12% and a maximum of 14%. The net rock volume has been assessed by using top and a near-base of the reservoir including an uncertainty range of ± 30%.

Further learnings are implemented from 7321/4-1 T2 well as the low fracture gradient in the overburden and an open fracture network. The large uplift points to a very weak top seal, incapable to preserve any hydrocarbon column height over time. Therefore, the retention of charge is evaluated with 0.3 which reflects the highest risk in the area.

The presence of source rock is confirmed in the wider area. The Gråspett well has drilled an excellent Upper Jurassic source rock in the late oil / early gas window. Further, gas readings have been measured during all drilling. No liquids have been detected along the trajectory, but liquids are present in micropores of cuttings (rarely) and side wall cores. For Lead Grønnspett the risk access to charge is evaluated with 0.9.

The main risk is given by trap validity / retention of charge with 0.3. The reservoir quality has been assessed with 0.6. The probability of finding hydrocarbons in Lead Grønnspett is estimated to be 15%.

4 Reason for relinquishment

The Gråspett exploration well, 7321/4-1 T2, was drilled in PL 721 in September 2018 and completed as a dry hole after reaching a total depth of 1600 meters below sea surface. The prime objective of the well was prognosed oil-filled reservoir of the Jurassic Stø Formation and with a secondary objective in the Triassic Snadd Formation. The Gråspett well encountered poorly developed reservoir sections in both the Jurassic and Triassic formations, and only weak oil shows were encountered in the reservoirs. No movable hydrocarbons were discovered. Extensive post well studies and lessons learned have been completed, with the conclusion that the prime reason for failure is related to leaking top seal. This was identified as the prime risk element during the pre-drill risk assessment.

A license remaining prospectivity evaluation has been completed, with the conclusion that no commercial exploration potential remains in the license. Three small Jurassic leads are mapped in the license, however, the Gråspett well has decreased the probability of finding movable hydrocarbon to 14.5%. The leads have resource potential below the economic threshold and is not of commercial interest.

An additional lead has been mapped in Permian formations, which was not penetrated by the Gråspett well. Following the analysis of the well results where weak dry gas shows were encountered in the lower parts of the well, this lead is gas prone and with a low probability of finding movable hydrocarbon of 10%. The lead has resource below the economic threshold and is not of commercial interest.

The work commitment in PL721 has been fulfilled and license relinquishment was effective from 13th August 2019.