



PL093 F Status Report Surrender

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1 History of the production licence

PL093 F was applied for in APA 2019 as a licence extension to PL093 D. The license was awarded 14.02.2020 to OKEA ASA as operator (44.56%), Petoro (47.88%) and Neptune Energy AS (7.56%) as partners. The initial work obligations is shown in [Table 1.1](#).

Table 1.1 Work program

Work obligation	Decision	Expiry date
Study of geology and geophysics		
Acquire 3D seismic		
	Decision to drill	14.02.2022
Drill exploration well		
	(BoK) Decision to concretize	14.02.2024
Conceptual studies		
	(BoV) Decision to continue	14.02.2026
(PDO) Prepare plan for development		
	(PDO) Submit plan for development	14.02.2027
	Decision to enter extension period	14.02.2027

Overview of meetings held

PL093 F followed the Draugen meeting schedule, since the license was applied for as a licence extension to PL093 D. However, one separate meeting was scheduled to discuss the Løkka DoD recommendation was scheduled:

- 2022-01-28-EC PL093 F drop recommendation

Reason for lapse

Based on the subsurface evaluation briefly described in this document, the license lapses due to high geological risk and marginal volumes on the main prospect.

2 Database overviews

2.1 Seismic database

The seismic database is listed in [Table 2.1](#) and the outlines of the key seismic surveys are shown in [Fig. 2.1](#). PGS19M03 is used for the prospect mapping and SH13001 is used to tie the prospect to the wells in the area.

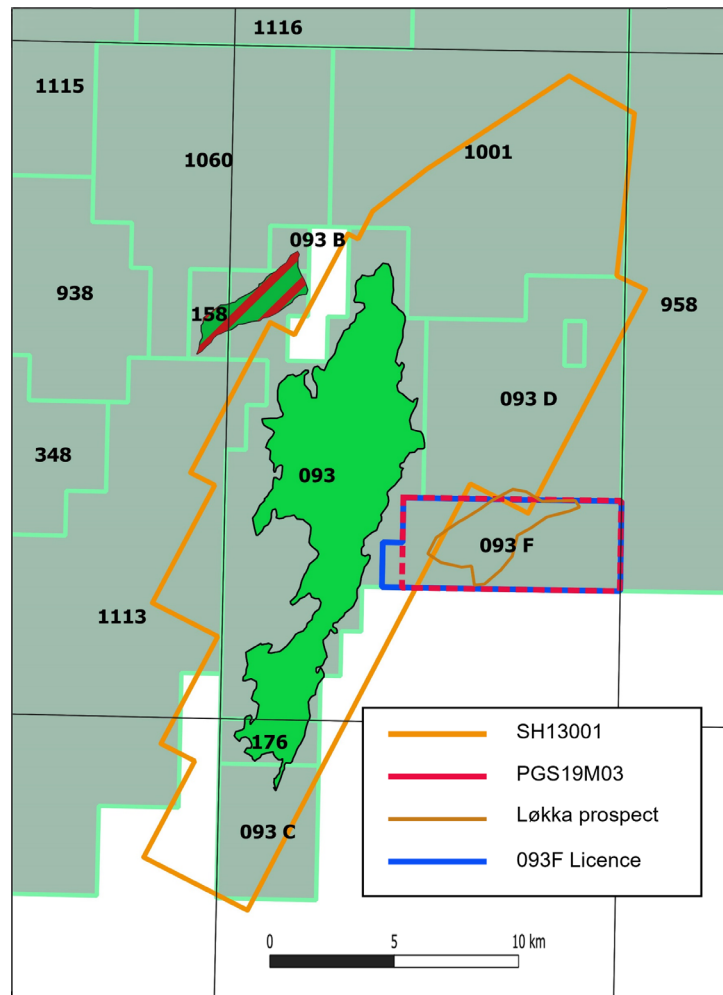


Fig. 2.1 Seismic database

PGS19M03 is shown in red and the SH13001 is shown in orange.

Table 2.1 Seismic database

Seismic database	Status	Stacks
PGS19M03	Not public	Full and partial stacks
SH13001	Public	Full and partial stacks

6407/9-A-4 AT3	
6407/9-A-4 AT4	
6407/9-A-5	
6407/9-A-6	
6407/9-A-6 T2	
6407/9-A-53 H	
6407/9-A-55 AH	
6407/9-A-58 H	
6407/9-B-1 H	
6407/9-B-2 H	
6407/9-B-5 H	
6407/9-C-1 H	
6407/9-C-1 HT2	
6407/9-C-2 H	
6407/9-D-1 H	
6407/9-D-2 H	
6407/9-D-3 H	
6407/9-E-1 H	
6407/9-E-2 H	
6407/9-E-3 H	
6407/9-E-4 H	
6407/9-E-4 HT2	
6407/9-F-1 H	
6407/9-G-1 H	
6407/9-G-2 H	
6407/9-G-3 H	
6407/9-G-5 H	

3 Results of geological and geophysical studies

Regional geostudy (Joint study between PL958 and PL093, PL158, PL176 and PL093B/C/D and F)

Main objective: Find support for Late Jurassic sand deposition and improve the understanding of HC migration into the Draugen area.

In order to achieve this, an integrated approach was chosen including the following special studies:

- Conditioning of pre-stack seismic data and relative AVO inversion
- Biostratigraphic evaluation of 30 wells and creation of a consistent set of lithostratigraphic well tops calibrated to 15 wells, with checkshots enabling seismic well tie
- Petrophysical evaluation of 42 wells
- Geopressure analysis of 56 wells forming basis for interpretation of overpressure cells
- Manual seismic interpretation combined with a PaleoScan model to enable efficient visualization and integration of seismic attributes
- New velocity model for depth conversion based on geostatistical approach to quantify uncertainties
- Sedimentology integrated with structural geology
- Fault seal analysis
- Petroleum system analysis
- Potential de-risking of sand presence and potential HC fill by geophysics

Table 3.1 lists the various special studies and highlight why and how they were integrated into the overall regional geostudy. For the work related to PL093 F, individual studies have been used in the evaluation of the Løkka prospect. The study did not support Draugen equivalent Rogn fm sand deposition at Løkka, nor a possible migration fairway into the structure.

Table 3.1 Special studies included in the regional geostudy

Special Study	Why?	How it was used
Biostratigraphy	To understand age of sands and a significantly better resolution on observed unconformities	Integrated with petrophysics, structural geology, sedimentology and calibrated with seismic data it formed basis for many new concepts
Petrophysical Well Evaluation	A consistent dataset of QC'ed and interpreted logs is an important part of a regional study	Sonic Logs for Depth Conversion, evaluated logs integrated with biostratigraphy and sedimentology and \emptyset and Sw logs improved understanding of migration in deeper strata
Geopressure Analysis	Understanding regional distribution of pressures to identify lateral and vertical barriers	Integrated with Fault Seal Analysis and sedimentology to understand migration
Fault Seal Analysis	To understand migration history and trap formation impacting prospectivity in the area	Integrated with Geopressure Analysis it was used to understand migration and how faults in the platform area can not hold significant columns
Seismic Interpretation & Attributes	Understanding mega-scale structural geology and distribution of different stratigraphies in region. Fault mapping, structural development and integration with all other disciplines. Spectral decom at nearly all horizons in the seismic volume showing geomorphologies to support thorough understanding of area and develop new concepts.	Interpretations guided by unconformities identified in biostratigraphic study calibrated with spectral decom attributes to form basis for structural geology, fault mapping, tectonostratigraphic evolution and detailed sedimentology. Seismic horizons were also depth converted and formed basis for Petroleum System Analysis. Seismic interpretation also formed basis for calibration with findings in biostratigraphic study.
Structural Geology	Structural architecture and development impact sand origin, presence and distribution, which involves areas where sands have been present but are later eroded.	Understanding of regional structural architecture was carefully integrated with biostratigraphic study and sedimentology. Fault and salt interpretations were supported by spectral decom attributes and formed basis for seismic interpretation, Fault Seal Analysis and Tectonostratigraphic Evolution
Sedimentology	Work closely with structural geologist to understand how the tectonic events impact sand origin, presence and distribution	The sedimentology study was based on both well observations integrated with Spectral Decom attribute maps, structural geology, fault mapping, biostratigraphic study and petrophysical evaluated logs
Sedimentology	Work closely with structural geologist to understand how the tectonic events impact sand origin, presence and distribution	The sedimentology study was based on both well observations integrated with Spectral Decom attribute maps, structural geology, fault mapping, biostratigraphic study and petrophysical evaluated logs
Depth Conversion	To get as accurate results as possible for the Petroleum System Analysis and prospectivity	Evaluated logs, updated well tops and new interpreted horizons were used with T/D curves to get the best velocity model with lowest uncertainty possible
Petroleum System Analysis	Understanding the migration history in the area	In addition to answering two of the four key questions the results and main findings of the Petroleum System Analysis supported the overall hypothesis of migration developed based on structural geology, sedimentology, fault seal analysis and geopressure. The findings of the geochemistry of the different oil and gas accumulations are significantly different than published literature, and supports the hypothesis that Johan Sverdrup can be used as an analogue, with HC contribution from a wide range of oils.
Pre-conditioning and inversion for AVO analysis	To prepare for AVO and improve resolution and confidence of horizon interpretations	Significant time was used to optimise the parameters to get the best quality seismic results. Acoustic Impedance volume with high confidence gave good insights, but more thorough work could be completed as only a short screening was done in this study.

4 Prospect update report

Prospect definition

The Løkka prospect was initially defined by a combination of a dip closure and a stratigraphic trap (Fig. 4.1). At the time of the application (APA2019), the identified prospect were partly covered by 2D and 3D (SH13001) seismic data. This meant a high uncertainty regarding the seismic interpretation and prospect definition. In 2020, the prospect was remapped on the newly acquired PGS19M03 3D seismic data (Fig. 2.1 and Fig. 4.2). Based on the new data, Løkka is now defined by a distinct fault towards north and dip closure towards south (Fig. 4.3). The top and base reservoir interpretation ties to the Draugen wells and, hence, the top and base Rogn Fm. interpretations at Draugen.

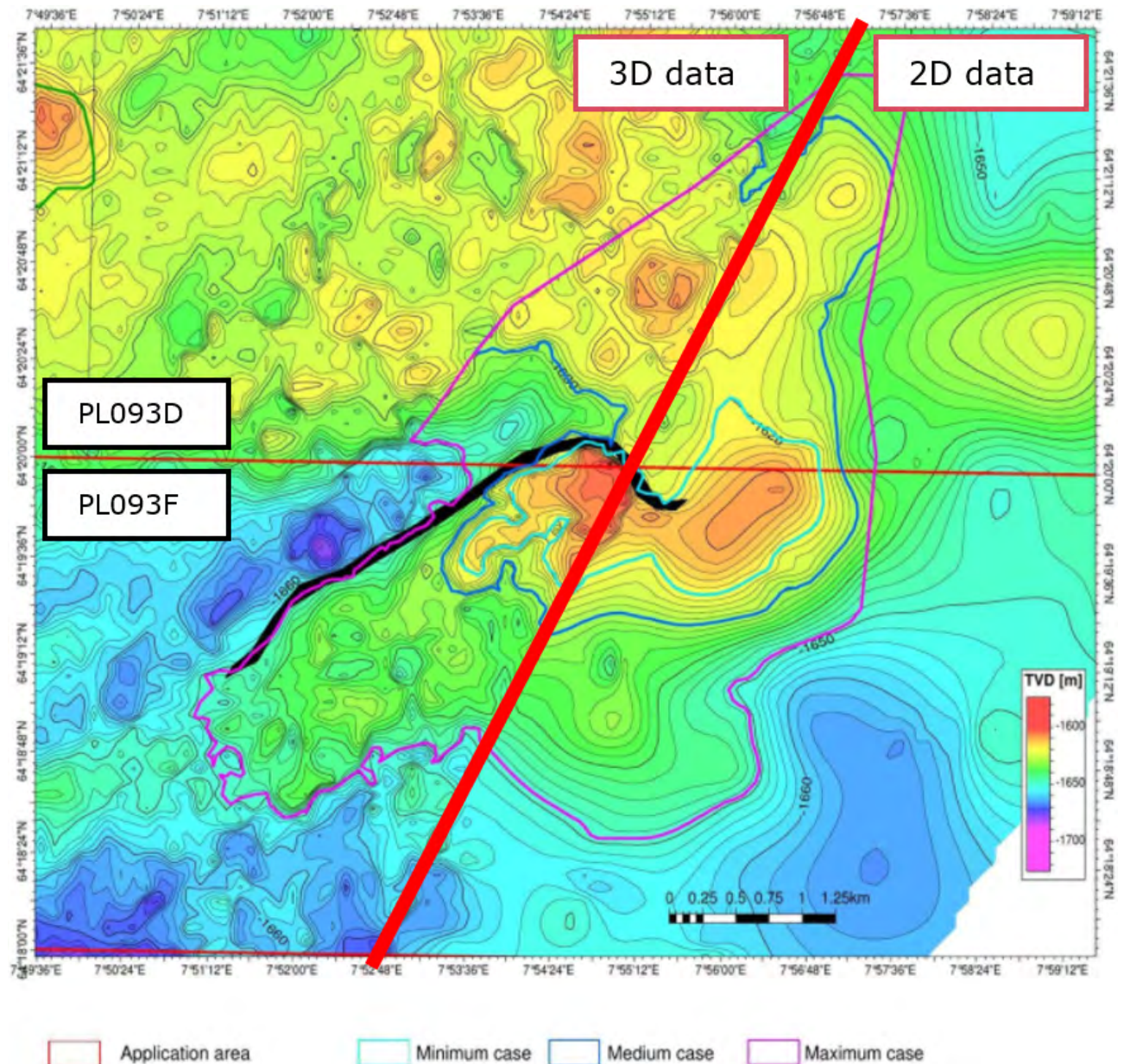
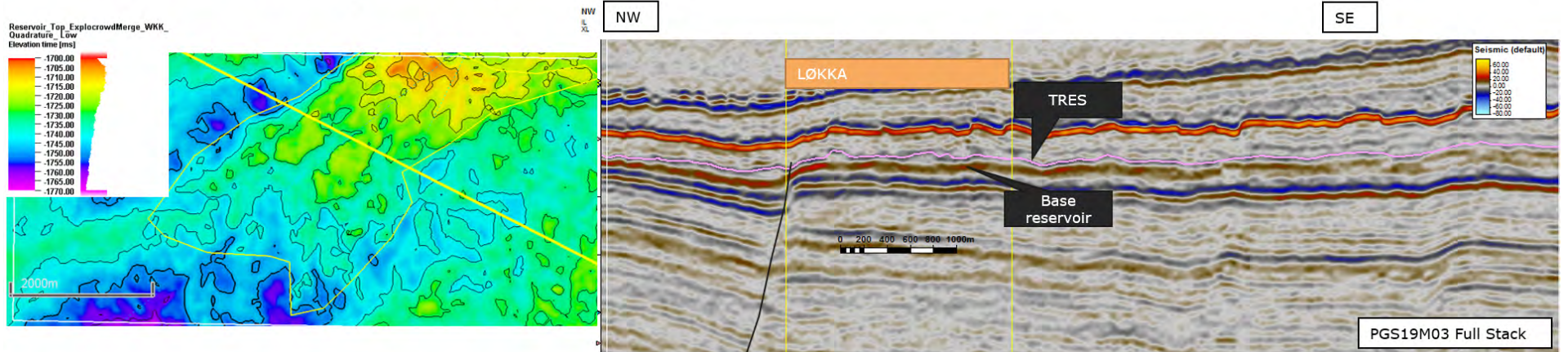


Fig. 4.1 APA2019 definition
Seismic by courtesy of PGS.

NW-SE trending seismic section



SW-NE trending seismic section

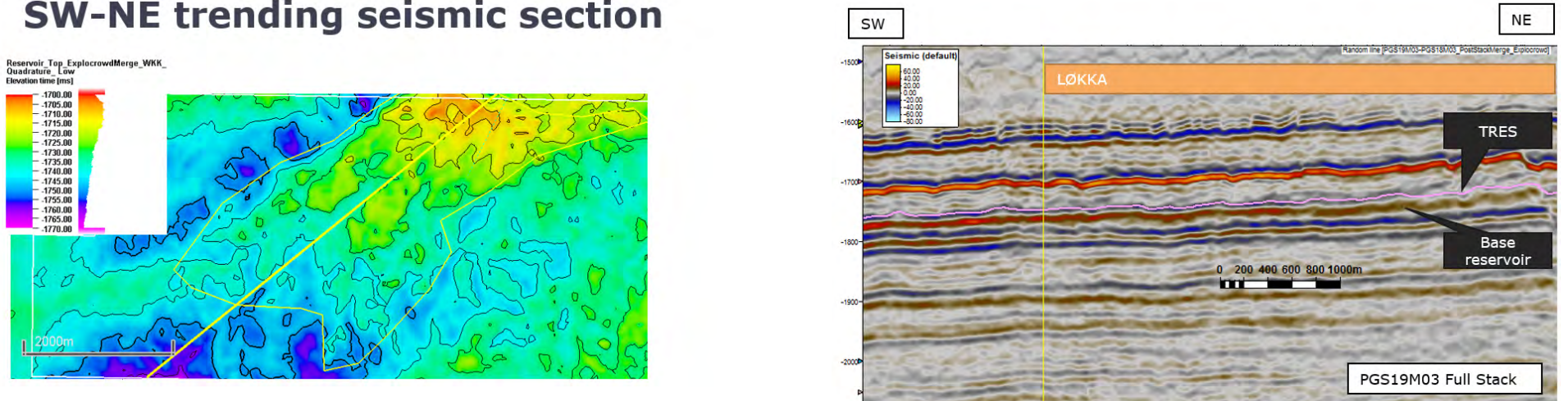


Fig. 4.2 NW-SE and SW-NE oriented seismic sections

Top reservoir time maps attached with the location line of the seismic section. SEG reverse polarity, soft is red. Seismic by courtesy of PGS.

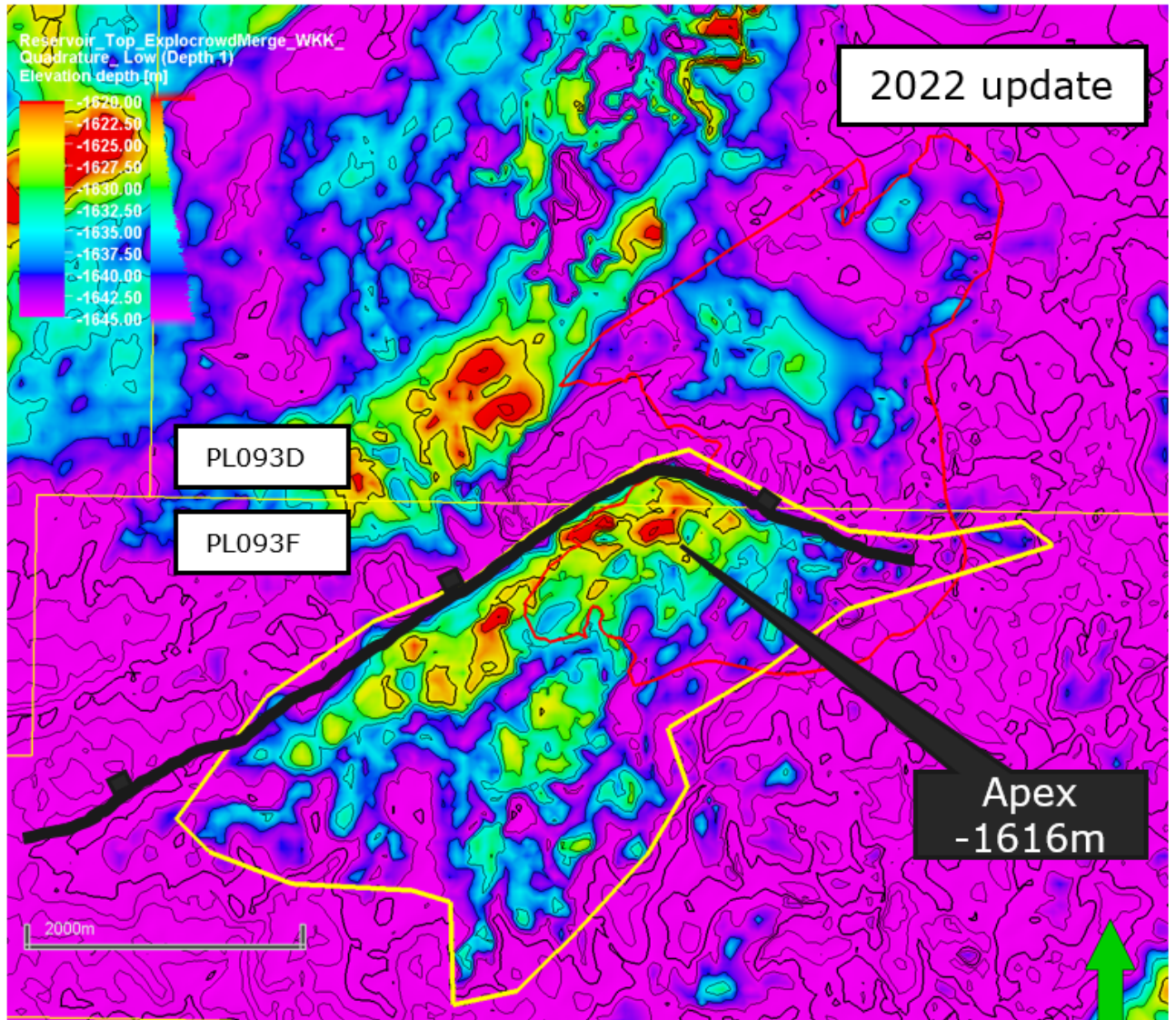


Fig. 4.3 Top reservoir depth map including the Løkka prospect outline

The updated Løkka outline is shown in yellow while the APA 2019 Løkka outline is shown in red. Seismic by courtesy of PGS.

Reservoir quality and presence

Løkka was initially interpreted as a possible basinward, small analogue of the Draugen field, which is interpreted as shoreface/sandbar deposits derived from a western sedimentary source. If sand is present, the distal location to the sediment source area could result in slightly poorer reservoir quality than in the Draugen field. This has been accounted for in the reservoir quality risk (Table 4.1).

As mentioned in 3 Results of geological and geophysical studies, the regional geostudy found no support of Rogn equivalent sand deposition East of Draugen. In addition, two exploration wells east of Draugen, 6407/9-12 and 6407/9-8, show no Rogn equivalent sand deposited east of Draugen (Fig. 4.4). Also, the top reservoir interpretation reflection at Løkka shows a similar seismic signal as 6407/9-12 and 6407/9-8 (Not included in CDB). Based on the above, the reservoir presence is seen as the highest risk element (Table 4.1).

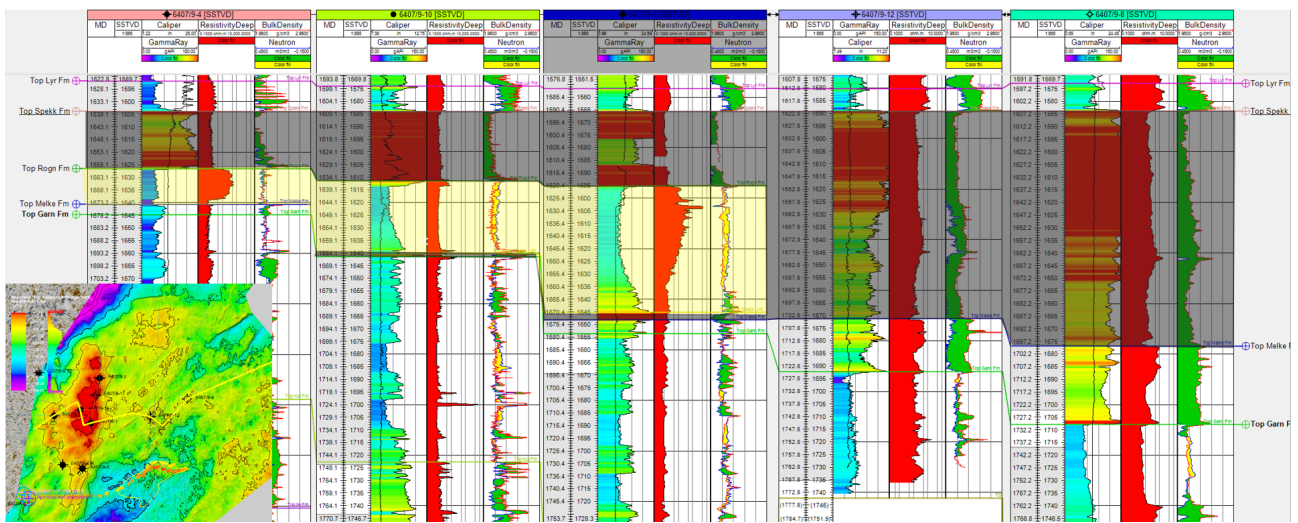


Fig. 4.4 Well correlation panel
Seismic by courtesy of PGS.

Trap

Løkka show a low-relief, but distinct structure in both time and depth (Fig. 4.2 and Fig. 4.3), therefore the trap is not seen as a major risk (Table 4.1).

Source and migration

The source is proven by multiple discoveries in the vicinity. However, there is little support for a possible migration fairway into the structure. In addition, a simplified petroleum system model (a most favorable model), which assume open faults, continuous sand presence and excessive HC generation indicates no charge into the structure. Due to this, migration is regarded as a major geological risk (Table 4.1).

Retention after accumulation

The 6407/9-12 (Skumnisse) and 6407/9-8 (Husmus) wells prove a similar Spekk top seal quality east of Draugen, therefore, Spekk Fm. shales are expected to provide adequate top seal for the Rogn Fm. sandstones of the Løkka prospect (Fig. 4.4). The possible hydrocarbons at Løkka is also retained by the juxtaposition against Spekk shales along the northern boundary fault (Fig. 4.2).

Table 4.1 Geological chance of success

Risk elements	APA 2019	2021 Update	Comment:
Reservoir	0.5	0.32	<ul style="list-style-type: none"> Reservoir presence: 0.4 (No sand confirmed east of Draugen) Reservoir quality: 0.8 (if present, more distal part of the depositional system)
Trap	0.9	0.9	<ul style="list-style-type: none"> High confidence in the presence of the container. Structural closure in both time and depth, although low relief.

Source and migration	0.4	0.4	<ul style="list-style-type: none"> Source presence and maturation proven in the area: 1 High risk on migration. Current seismic interpretation, depth conversion and petroleum system model do not indicate migration into Løkka.
Retention after accumulation	0.9	0.90	High confidence in top and lateral seals.
gCOS	0.16	0.10	

Volumetric assessment

Volumetric calculations for the Løkka Prospect were performed based on probabilistic Monte-Carlo simulations. The basis for the input parameters and uncertainty ranges used are described below. A summary of the input values is shown in [Fig. 4.5](#) and the APA2019 and the updated Løkka prospect STOOIP and Recoverable volumes is shown in table [Table 4.2](#).

GRV

GRV is defined by a depth converted top reservoir depth map and a constant OWC at 1640 (pre-production OWC at Draugen).

N/G and porosity

P50 and P10 is based on the spread in the Draugen wells. 6407/9-12 and 6407/9-8 is not included, as they do not fit the depositional concepts (this outcome is accounted for in gCOS). P90 take into account the more distal location of the prospect, compared to Draugen, resulting in slightly poorer reservoir quality.

Sw

Based on Draugen.

FVF (Bo)

Representative Bo from the Full field Draugen Reservoir Model.

Oil recovery factor

Based on conceptual a RF study for the area, assumes one water injector and one producer.

Name	Unit	Shape	Min	P90	P50	P10	Max	Mode	Mean
Thickness	m	Single	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Area uncertainty	%	Single	100	100	100	100	100	100	100
OWC	m	Single	1640	1640	1640	1640	1640	1640	1640
Net-to-gross	%	Beta	60.3	70.0	80.0	90.0	99.7	80.0	80.0
Porosity	%	Beta	15.1	20.0	25.0	30.0	34.9	25.0	25.0
Sw	%	Beta	3.12	15.0	23.4	30.0	34.1	25.0	22.9
FVF (Bo)	vol/vol	Beta	1.20	1.22	1.25	1.28	1.30	1.25	1.25
Oil rec fac	%	Single	30.0	30.0	30.0	30.0	30.0	30.0	30.0

Fig. 4.5 Reservoir and fluid properties

Table 4.2 STOOIP, Recovery factor and total recoverable volumes

Prospect in PL093 D and PL093 F	STOOIP P90/Mean/P10 (MSm ³)	Recovery factor	Recoverable volumes P90/Mean/P10 (MSm ³)
Løkka (2021 Update)	3.5/4.6/5.8	0.3	1.1/1.4/1.7
Løkka (APA 2019)	0.5 / 7.5 / 55.2	0.1 / 0.3 / 0.4	0.1 / 2.3 / 22.1

In summary, all data is included in the resource table for the Løkka Prospect, see [Fig. 4.6](#)

Table 4: Discovery and Prospect data (Enclose map)										
Block	6407/9	Prospect name	Lokka	Discovery/Prosp/Lead	Prospect	Prosp ID (or New!)	NPD will insert value	NPD approved (Y/N)	Yes	
Play name	NPD will insert value	New Play (Y/N)	No	Outside play (Y/N)	Yes					
Oil, Gas or O&G case:	Oil	Reported by company	OKEA ASA	Reference document					Assessment year	
This is case no.:	1 of 1	Structural element	Froan Basin	Type of trap	Struc/strat	Water depth [m MSL] (>0)	250	Seismic database (2D/3D)	3D	
Resources IN PLACE and RECOVERABLE Volumes, this case		Main phase			Associated phase					
		Low (P90)	Base, Mode	Base, Mean	High (P10)	Low (P90)	Base, Mode	Base, Mean	High (P10)	
In place resources	Oil [10 ⁶ Sm ³] (>0.00)	3,50	4,57	4,62	5,79					
	Gas [10 ⁹ Sm ³] (>0.00)									
Recoverable resources	Oil [10 ⁶ Sm ³] (>0.00)	1,05	1,37	1,39	1,74					
	Gas [10 ⁹ Sm ³] (>0.00)									
Reservoir Chrono (from)	Kimmeridgian	Reservoir litho (from)	Rogn Fm	Source Rock, chrono primary	Kimmeridgian	Source Rock, litho primary	Spekk Fm	Seal, Chrono	Kimmeridgian	
Reservoir Chrono (to)	Berriasian	Reservoir litho (to)	Rogn Fm	Source Rock, chrono secondary		Source Rock, litho secondary		Seal, Litho		
Probability [fraction]										
Total (oil + gas + oil & gas case) (0.00-1.00)	0,10	Oil case (0.00-1.00)	1,00	Gas case (0.00-1.00)	0,00	Oil & Gas case (0.00-1.00)	0,00			
Reservoir (P1) (0.00-1.00)	0,32	Trap (P2) (0.00-1.00)	0,90	Charge (P3) (0.00-1.00)	0,40	Retention (P4) (0.00-1.00)	0,90			
Parametres:		Low (P90)	Base	High (P10)	Comments					
Depth to top of prospect [m MSL] (> 0)		1616	1616	1616						
Area of closure [km ²] (> 0.0)		5,1	5,1	5,1						
Reservoir thickness [m] (> 0)		40	40	40						
HC column in prospect [m] (> 0)		24	24	24						
Gross rock vol. [10 ⁹ m ³] (> 0.000)		14,500	14,500	14,500						
Net / Gross [fraction] (0.00-1.00)		0,70	0,80	0,90						
Porosity [fraction] (0.00-1.00)		0,20	0,25	0,30						
Permeability [mD] (> 0.0)										
Water Saturation [fraction] (0.00-1.00)		0,15	0,23	0,30						
Bg [Rm3/Sm3] (< 1.0000)										
1/Bo [Sm3/Rm3] (< 1.00)		0,81	0,80	0,78						
GOR, free gas [Sm ³ /Sm ³] (> 0)										
GOR, oil [Sm ³ /Sm ³] (> 0)										
Recov. factor, oil main phase [fraction] (0.00-1.00)		0,30	0,30	0,30						
Recov. factor, gas ass. phase [fraction] (0.00-1.00)										
Recov. factor, gas main phase [fraction] (0.00-1.00)										
Recov. factor, liquid ass. phase [fraction] (0.00-1.00)										
For NPD use:										
Temperature, top res [°C] (>0)					Innrapp. av geolog-init:	NPD will insert value	Registrert - init:	NPD will insert value	Kart oppdatert	NPD will insert value
Pressure, top res [bar] (>0)					Dato:	NPD will insert value	Registrert Dato:	NPD will insert value	Kart dato	NPD will insert value
Cut off criteria for N/G calculation	1.	2.	3.					Kart nr		NPD will insert value

Fig. 4.6 NPD table 4: Updated prospect data

5 Technical assessment

Potential development solution has not been investigated since the detailed prospect evaluation of Løkka resulted in a small resource potential with very high risk.

6 Conclusion

At the time of the application, the upper Jurassic Løkka prospect was identified as additional resource potential east of Draugen. Due to the lack of 3D coverage, the prospect was considered as a high risk with regards to prospect definition. In addition, due to the lack of wells east of Draugen, reservoir and migration was also considered as a high risk. In Q3 2019, PGS19M03 was acquired east of Draugen. Consequently, Løkka was remapped by a distinct fault towards north and dip closure towards south. In November 2019, the 6407/9-12 Skumnisse well was drilled east of Draugen. The well was dry and no Rogn reservoir similar to the Draugen field was discovered. Based on this, the geological risk is assessed as high and unbalanced by the volume potential of the prospect. As a positive drill decision could not be made, the license lapses.