Relinquishment Report PL1141 ans PL1141B

Styggehøe (2214 moh)

Table of Contents

List of Figures

List of Tables

1 License history

PL1141 was awarded in the APA2021 license round on the 11.03.2022 [1]. The license is situated on the Gudrun Terrace in block 16/1 west of the Ivar Aasen, Edvard Grieg fields and the Apollo discovery (Fig. 1.1). The license group consists of Aker BP (Operator, 70%) and Equinor Energy (30%). The PL1141B license was awarded at 17.02.2023 as an extension to cover the outline of the main Upper Jurassic Styggehøe Prospect [2]. The work program in the initial phase was set to drill a firm well within 2 years (11.03.2024). By drilling the Styggehøe Well 16/1-35 S, with completion date 28.02.2023, the license obligations became fulfilled [3].

Two prospects were identified inside the license (Fig. 1.1). The main prospect Styggehøe, was defined as a complex Upper Jurassic syn-rift fansystem in the hanging wall. The critical element was the trap which is fault-seal depending or relied on a facies change in the Draupne Formation. The underlying Middle Jurassic Vestland Group Nautgardstinden Prospect is defined as a fault depending trap in the hanging wall. Both stacked prospects have been tested by 16/1-35 S and is classified as dry on both stratigraphic target levels [3].

No further remaining prospectivity have been identified in the license after drilling 16/1-35 S. The partnership has therefore decided to relinquish PL1141 and PL1141B.

MC meetings were held at least once and EC meetings twice a year, in accordance with JOA article 2.1. These meetings were combined ECMC meetings, and in addition several EC work sessions have been organised. Below is a list of the meetings held during the licence term: Table 1.1.

Table 1.1 MC, EC and Work meeting activity in the PL141 /PL1141B

Date	Activity	Comment
2022		
27.01.2022	Post APA Work meeting with application partner	Informal Well planning discussion
22.02.2022	Post APA Work meeting with application partner	Informal Well planning discussion
09.03.2022	MC and EC meeting #1	Formal and administrative issues, Common database, Well planning, Budgets
17.06.2022	Work meeting	Well planning discussion
09.09.2022	Work meeting	Well planning discussion
15.11.2022	MC and EC meeting #2	Formal and administrative issues, Styggehøe well planning update, Work Program and Budget
2023		
31.03.2023	EC Work meeting	Styggehøe Post well status
06.12.2023	MC and EC meeting #3	Formal and administrative issues, 16/1-35 S well result update and post well studies, Budget and Way Forward

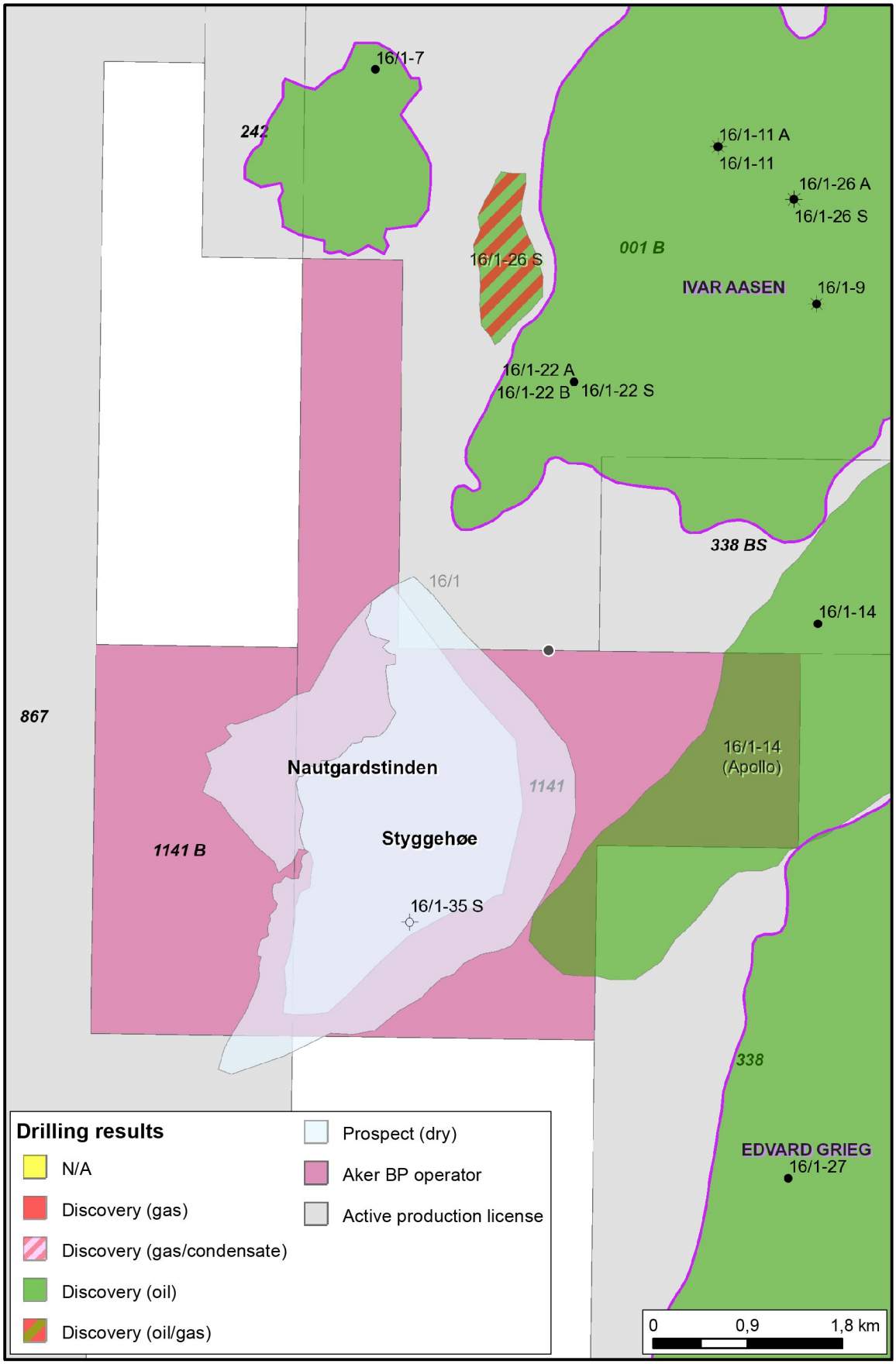

Fig. 1.1 License and prospects outline

2 Database

2.1 Seismic data

The license area is covered by 3D seismic of varying vintage and acquisition layout (Fig. 2.1). The Ocean Bottom Nodes (OBN) seismic data, AX18200 is the main survey used for the license prospect evaluation and well planning. The OBN data was acquired in 2018-2019 and delivered in 2020 as a regional processed cube. Several internal derived cubes have been generated with as main aim to image and assess the risk profile of the prospects. PGS16M04-PGS16910VIK datasets have been used to assess the regional geological setting and well correlation in the larger context.

Table 2.1 Pl1141 Common seismic database

Survey Name	Type	Vintage	Operator/Owner	Diskos survey ID/ NPDID	Public
PGS16910VIK/PGSM04	3D	2017	PGS	10085394302	No
AX18200	3D	2019	Aker BP	10085401360	No

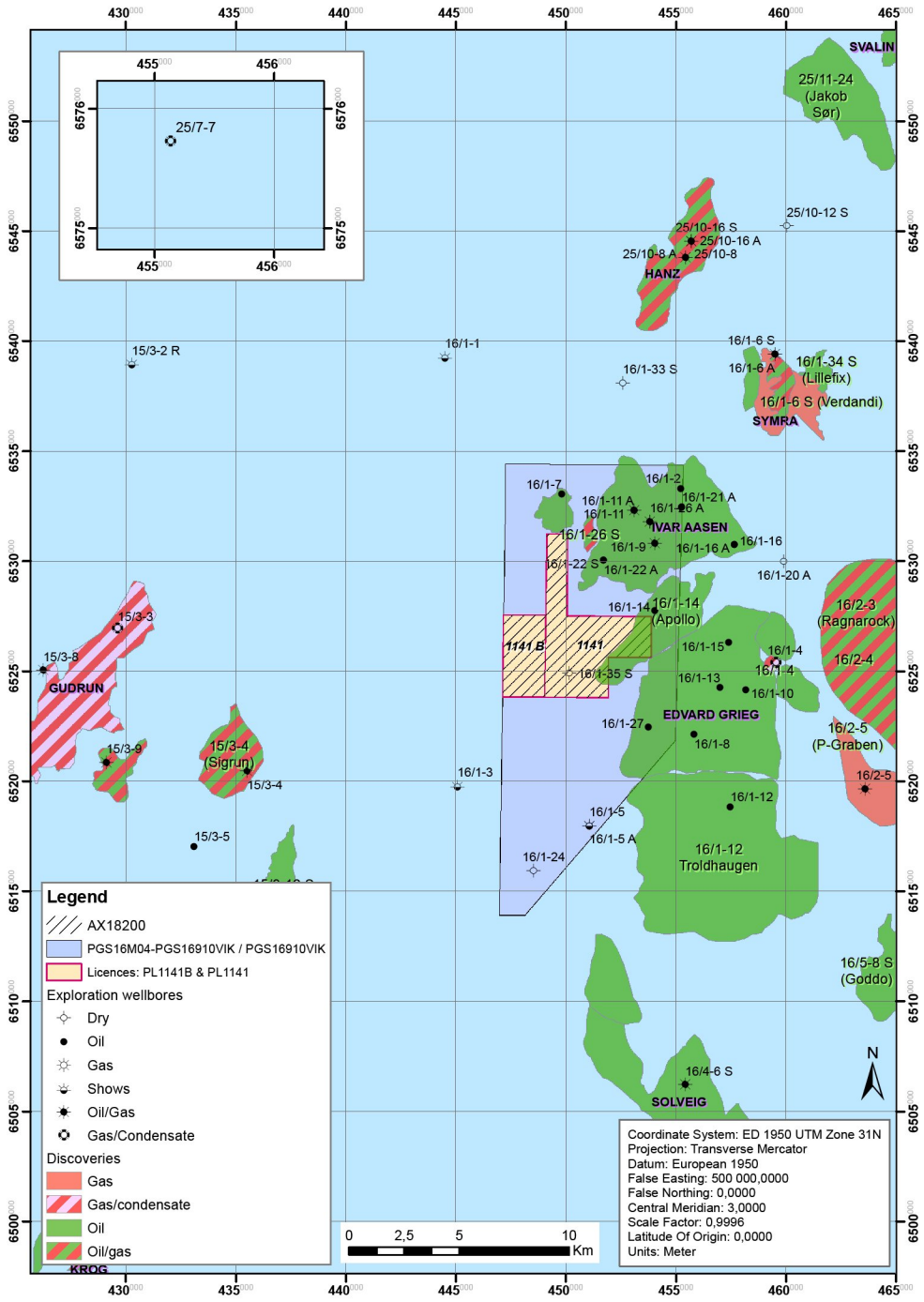

Fig. 2.1 Seismic and well database PL1141 / 1141B. *Map showing outlines of the seismic surveys and common well database used in evaluation of the prospectivity in PL1141 / PL1141B and well planning (16/1-35 S).*

2.2 Well Data

The main reference wells used in the geological and geophysical evaluation of the prospects and well planning are listed in Table 2.2 and shown on the map in Fig. 2.1.

Table 2.2 PL1141 and PL1141B common well database

Well	NPDID	Year	Stratigraphy at TD	Status	2 year released
15/3-2 R	311	1977	Middle Jurassic	Shows	x
15/3-3	313	1979	Triassic	Gas/Condensate	x
15/3-4	314	1982	Triassic	Oil/Gas	x
15/3-5	52	1984	Middle Jurassic	Oil	x
15/3-8	5175	2006	Late Jurassic	Oil/Gas	x
15/3-9 /T2	6354	2010	Middle Jurassic	Oil/Gas	x
16/1-1	147	1967	Late Cretaceous	Oil shows	x
16/1-2	332	1976	Pre-Devonian	Shows	x
16/1-3	84	1982	Pre-Devonian	Oil shows	x
16/1-4	2072	1993	Pre-Devonian	Gas/Condensate	x
16/1-5	3279	1998	Pre-Devonian	Shows	x
16/1-5A	3626	1998	Late Jurassic	Shows	x
16/1-6A	4767	2003	Late Cretaceous	Dry	x
16/1-6S	4711	2003	Paleocene	Oil/Gas	x
16/1-7	4928	2004	Late Triassic	Oil	x
16/1-8	5612	2007	Late Triassic	Oil	x
16/1-9	5773	2008	Late Triassic	Oil/Gas	x
16/1-10	5879	2009	Early Jurassic	Oil	x
16/1-11	6157	2010	Late Triassic	Oil/Gas	x
16/1-11A	6364	2010	Late Triassic	Oil/Gas	x
16/1-12	6166	2009	Pre-Devonian	Oil	x
16/1-13	6232	2010	Late Triassic	Oil	x
16/1-14 /T2	6399	2010	Late Triassic	Oil	x
16/1-15	6517	2011	Pre-Devonian	Oil	x
16/1-16	6823	2012	Permian	Oil	x
16/1-16A	7095	2013	Late Triassic	Oil	x
16/1-20 AT3	7256	2013	Late Triassic	Dry	x
16/1-21A	7530	2015	Late Triassic	Oil	x
16/1-21S	7529	2015	Late Triassic	Oil	x
16/1-22A	7716	2015	Late Triassic	Oil	x
16/1-22S	7531	2015	Late Triassic	Oil	x
16/1-24	7616	2015	Late Jurassic	Dry	x
16/1-26A	7940	2016	Middle Jurassic	Dry	x
16/1-26S	7915	2016	Late Triassic	Oil/Gas	x
16/1-27	8124	2017	Basement	Oil	x
16/1-33S	9062	2020	Late Triassic	Dry	x
16/2-5	6042	2009	Basement	Oil/Gas	x
16/4-6S	7098	2013	Late Triassic	Oil	x
25/10-8	2955	1997	Early Permian	Oil/Gas	x
25/10-8A	3098	1997	Late Jurassic	Dry	x
25/10-12ST2	7293	2015	Triassic	Dry	x
25/10-16A	8491	2018	Late Triassic	gas	x
25/10-16S	8490	2018	Late Triassic	Oil/Gas	x
25/7-7	8846	2019	Middle Jurassic	Gas/Condensate	x

3 Geological and geophysical studies

Studies relevant for the evaluation of prospectivity in the PL1141 / PL1141B

Seismic Data AX18200

The aim of the OBN acquisition and technology was to reduce the uncertainty in the velocity model by FWI, and obtain a full azimuth recording with high fold for the deeper section.

The OBN was used in the well planning and in the post-well analysis. The OBN was chosen above the PGS16M04 streamer data as it aimed to address the seismic imaging and processing challenges observed in the vintage dataset:

- Velocity estimates
  - Lateral thickness variation in high velocity Cretaceous intervals
  - Improving a better imaging of Upper Jurassic fan systems
  - Improving depth conversion and geometries in the deeper section
- Increasing fold using multi-azimuth approach for structural imaging
  - Improving fault geometry imaging

Seismic data analysis AX18200

Using the final angle stacks from the contractor (7-16, 14-23, 21-30, 20-40, 40-50 degrees) as a starting point, the following in-house conditioning workflow has been applied:

- Sorting the angle stacks into pseudo gathers
- Residual denoise, using 3D edge-preserving smoothing
- Spectral balancing between the traces in the pseudo gathers
- Bandwidth extension to increase the vertical resolution
- Trim statics (alignment between the traces) on the pseudo gathers

Post stack Blueing of AX18200

To enhance the data below the BCU, the high frequencies were boosted through an in-house blueing approach. A blueing operator is calibrated to the reflectivity logs to mimic the positive slope of the frequency spectrum. The corner frequencies of the operator are then adjusted to give the desired trade-off between increased resolution and low noise levels. The blueing process gave the desired uplift in terms of enhancing the vertical resolution and improving the reflector continuity. Several spectral enhancement techniques have been evaluated, and AI-based signal-to-noise and spectral enhanced combined cubes have been produced to improve the understanding of prospect specific interpretations in the well planning.

Seismic Data analysis

Extensive in-house geophysical work has been carried out on the entire AX18200 dataset. This included post stack attribute analysis such as spectral decomposition and combined thin bedform-amplitude attributed to image fan systems and facies changes. This was aiming to

understand better the well location and the connectivity of the stacked fan systems [1]. The attribute analysis revealed a diversity of lobe-geometries comprising the fan complex of the Styggehøe Prospect, and the main source points and feeder channels along the crest of the Utsira High. The post-well studies confirmed the pre-drill depositional concept inside the seismic resolution and no additional interpretation could improve the interpretation.

Structural

- Structural analysis was performed on a large area, by mapping fault trends and types, and creating structural framework models near the prospect for drilling hazard assessment.

Post well studies

Post well studies aimed to improve the regional understanding of the Upper and Middle Jurassic deposition, migration and reservoir diagenesis and petrography. More details on the post-well studies are reported in various reports (Table 3.1).

Table 3.1 16/1-35 S - Post Well Studies

Study	Study	Materiel used for analysis	Reporting
Migration / Charge	Geochem	Cuttings & SWC	Geochemistry Data Report – Well 16/1-35 S, Styggehøe [4] APT. 2023
	Fluid Inclusion	Cuttings	A Stratigraphic Reconstruction of Bulk Volatile Chemistry from Fluid Inclusions in: 16/1-35 S [5]
Stratigraphy	Biostratigraphy routine report	Cuttings & SWC	Integrated Biostratigraphy of the AkerBP Exploration Well 16/1-35 S Styggehøe [6]
Petrography / Stratigraphy	Rockscreen (Photo and XRF)	Cuttings	
Petrography	CCA	SWC	Petrographic analysis and reservoir quality of sidewall core samples from well 16/1-35 S (Styggehøe) [7]
	HR Images	Cuttings	
	Thin sections (AFE)	SWC	
	Qemscan (AFE)	SWC	
	XRD/XRF	SWC	XRD & XRF Data [8]

Summary of the main results of the post-well studies

- Well tie of the Styggehøe Well to the Full Stack AX18200 (Fig. 3.1) are in good alignment with pre-drill interpretation.
- Post well seismic analysis confirm pre-drill analysis.
- Post well geochemical studies show absence of migration of fluids through the prospects, but show a clear signal of nearby hydrocarbons. This should be expected due to the vicinity to Edvard Grieg Field and the Apollo Discovery. The analysis indicated that initial show occurrences should be taken with caution due to Drill Bit Metamorphism and cracking of the oil based mud. No strong indication of hydrocarbons are observed.
- Lithostratigraphic subdivision has been revised based on biostratigraphic analysis. This includes:
  - Adjustment of the formation tops within the Rogaland Group and identification of the Ty Formation
  - Presence of shallow marine Hugin Formation instead of Sleipner Formation observed further north in the West Cable Well 16/1-7
  - Identification of Eiriksson Formation, Statfjord Group

- Confirmation of the pre-drill depositional model and reservoir potential in Upper Jurassic and Middle Jurassic [1] . Although the Upper Jurassic succession comprise more out of larger amount of fine sand than expected.

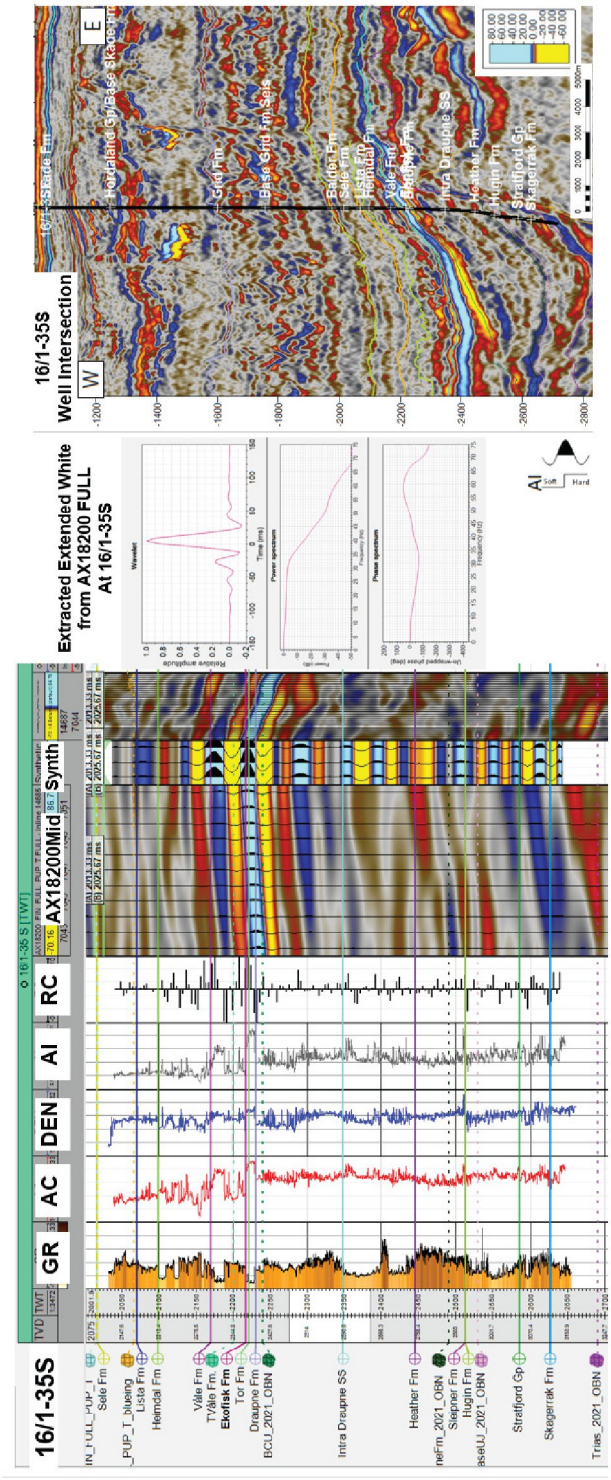

Fig. 3.1 16/1-35 S well tie *Well tie to AX18200 FULL stack using an Extended White wavelet that was extracted around the 16/1-35S wellbore from the AX18200 FULL stack data. Logs are tied using synthetic seismic data from just below Top Sele Fm to TD. Above Top Sele Fm the well is tied by matching well tops to interpreted seismic horizons.*

4 Prospect update

In PL1141 and 1141B two stacked prospects were identified as described in the APA 2021 [1] application and have been tested by well 16/1-35S [9]. No further leads or prospects were identified in the post well analysis.

Styggehøe

The Styggehøe Prospect was defined as Upper Jurassic syn-rift fan in a hanging-wall setting. The trap (lateral seal) was considered to be the highest risk element, as it was postulated as depending on fault -seal processes at the crest or facies change. Reservoir sandstones was believed to consist of sediments sourced from the Utsira High into a stacked fan system formed by various mass-wasting processes. Well 16/1-35 S confirmed the high sand content of the Upper Jurassic interval, comprising 267 metre net sand. The sediments are heterolithic as expected but no internal or top seal lithology is present. Inside the Upper Jurassic succession, the pressure was sampled and depleted with 7 bar that is in accordance with the depletion models of the nearby producing fields. Based on the well it is concluded that the fault-seal and top seal is not effective at the well location. Intensive geochemical analysis can not give confident migration indications through the drilled succession. The main failure for the well is Trap and Charge.

Due to the observed pressure depletion, and the high amount of sand and no good indication for compartmentalization, no further leads have been identified in the Pl1441 in the Upper Jurassic.

Post well no new seismic interpretation has been conducted as the well-tie fit very well the pre-drill interpretation Fig. 3.1 and mapping of the prospect in the APA application is still relevant [2] [1].

Nautgardstinden

The secondary objective of well 16/1-35 S was to test the HC potential in the Vestland Group, sharing the same hanging wall configuration as the Upper Jurassic.

The reservoir came in with good reservoir properties, but was water wet. Pressure sampling revealed close to hydrostatic pressure in the reservoir and indicate a top seal separating the Vestland Group from the depleted Upper Jurassic succession. The main pre-drlil risk for the Nautgardstinden Prospect was related to seal and charge. Lack of charge is considered to be the main failure mechanism in the post well analysis.

Post well no new seismic interpretation has been conducted as the well-tie fit very well the pre-drill interpretationFig. 3.1 and mapping of the prospect in the APA application is still relevant [2][1].

Overview of the considered plays in PL1141

- Upper Jurassic play - tested with the Styggehøe well. No remaining prospectivity
- Middle Jurassic continental to shallow marine play - tested with the Styggehøe well. No remaining prospectivity
- Triassic to Lower Jurassic Play - tested with the Styggehøe well. No remaining prospectivity
- Paleocene sandstones - tested with the Styggehøe well. No remaining prospectivity
- Injected and remobilized sandstones within the Hordaland Group - No prospectivity identified

5 Technical evaluation

No technical evaluations have been carried out since there is no discovery or remaining prospectivity in the license.

6 Conclusion

Drilling of 16/1-35 S Styggehøe tested two prospects in a hanging wall configuration in the Draupne Formation and the Vestland Group. The well is classified as dry with as main failure charge and seal in the Upper Jurassic, and charge in the Middle Jurassic. No remaining prospects are identified in the license (Fig. 1.1):

Due to the statements above, the partnership in PL1141/1141B has unanimously decided to relinquish the license.

References

1 AkerBP. 2021: APA 2021 - Application for block 16/1 (Styggehøe)

2 AkerBP. 2022: APA 2022 - Application for additional acreage (PL 1141) block 16/1

3 AkerBp 2023 : Final well report 16/1-35S

4 APT, 2023. Geochemistry Data Report - Well 16/1-35 S, Styggehøe

5 FIT, 2023. A Stratigraphic Reconstruction of Bulk Volatile Chemistry from Fluid Incusions in: 16/1-35 S

6 Paleo7, 2023. Integrated Biostratigraphy of the AkerBP Exploration Well 16/1-35 S Styggehøe, Offshore Norway

7 Stratum Reservoir, 2023. Petrographic analysis and reservoir quality of sidewall core samples from well 16/1-35 S (Styggehøe)

8 Core Laboratories, 2023. XRD and XRF data

9 AkerBP, 2023 (Martin Carlsen et. al.), Final Well Report Exploration, PL1141 Section A Geology, Well 16/1-35 S (Styggehøe)