PL 921 – License Status Report

Relinquishment of PL921, parts of block 32/4 and 32/7

Summary

Gladsheim was a firm well commitment from APA 2017. The exploration strategy was to test the oil migration from Troll in the Upper Jurassic and de-risk neighbouring prospectivity. Furthermore, the well was to test evidence of lean gas from the northern Stord basin within three deeper closures in the Lower Jurassic. Also, part of the Gladsheim well strategy, was to acquire additional data to support carbon capture storage potential.

The primary target was the Gladsheim Sognefjord Fm prospect; a low relief, 4-way, structural closure with a prognosed apex at 1213 m MSL and spill at 1256 m MSL. The Sognefjord Fm is sealed by Upper Jurassic Draupne Fm shales, where a new migration model predicted hydrocarbons spilled from south east Troll into Gladsheim. Below are three Jurassic closures at Brent Group, Johansen Formation and Statfjord Group levels, where the chance of finding gas were around 0.5, due to the high source and migration risk.

West Hercules moved to Gladsheim location and spudded the well 32/4-2 on the 9th September 2019. Observed shallow gas, which caused a re-spud of 32/4-3 S, 24.09.2019, at new location with a new well design. No hydrocarbons were found in any of the targets.

The dry-well results currently have helped de-risk prospectivity in the area for the Upper Jurassic targets and the license is to be relinquished.

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1 Licence history

Licence: PL921

Awarded: 02.03.2018

License period: Expires 03.03.2020
Initial period: 5 years

License group:

Equinor Energy AS	50% (Operator)
Petoro AS	20%
DNO Norge AS	15%
Lundin Norway AS	15%

License area: 258.4 km2

Work programme: The work programme is based the drilling of the Gladsheim prospect together with post well analysis:

- G&G screening for additional prospectivity for the Gladsheim well
- Well planning and data acquisition
- Partner alignment
- Exploration drilling and testing of the Gladsheim prospect
- Post well analysis of the exploration well results
- Reporting related to the decision to concretize (BoK) in PL921

Meetings held:

27.04.2018	EC/MC startup meeting
05.10.2018	EC work meeting
23.11.2018	EC/MC meeting
11.01.2019	EC work meeting
13.05.2019	EC work meeting
25.06.2019	EC Gladsheim CO2 storage data acquisition proposal
17-18-20-23.09. 2019	Status meetings
14.11.2019	EC/MC meeting
13.12.2019	EC meeting
06.02.2020	EC/MC meeting

Work performed:

2018:	Licence start-up & screening for additional prospectivity for the Gladsheim well
2018-2019:	Geological well planning and data acquisition program
2019:	Site survey over Gladsheim prospects and drilling of Gladsheim 32/4-2 and 32/4-3 S
2019-2020:	Post-well analysis
2020:	Decision to concretize (BoK) & reporting

Reason for surrender:

The Gladsheim prospect in PL921 was dry in all the stratigraphic targets. The hydrocarbon migration was the main risk and the likely primary reason for failure. No further Upper Jurassic prospectivity is of interest in the area.

2 Database overviews

2.1 Seismic data

The seismic surveys within the common database for PL921 included the 3D CGG17M0 and CGG18M01 (initially the fast track and then the final) together with the NSR06 2D survey. The seismic surveys can be viewed in Figure 2.1 and are summarised in Tables 2.1 and 2.2.

Table 2.1 List of seismic surveys in the PL921 common database.

Seismic survey	Survey type	Contractor	Year	NPDID
CGG17M01	3D	CGG	2017	7984, 8194, 8195, 8196, 8252
CGG18M01	3D	CGG	2018	7984, 8128, 8179, 8194, 8195, 8196, 8252, 8332
NSR06	2D	TGS	2006	4373

Table 2.2 Coordinates for CGG17M01 and CGG18M01.

Coordinates	x	y
1	577474.99	6748807.72
2	577474.98	6690477.53
3	528433.93	6689862.82
4	528365.62	6748124.69

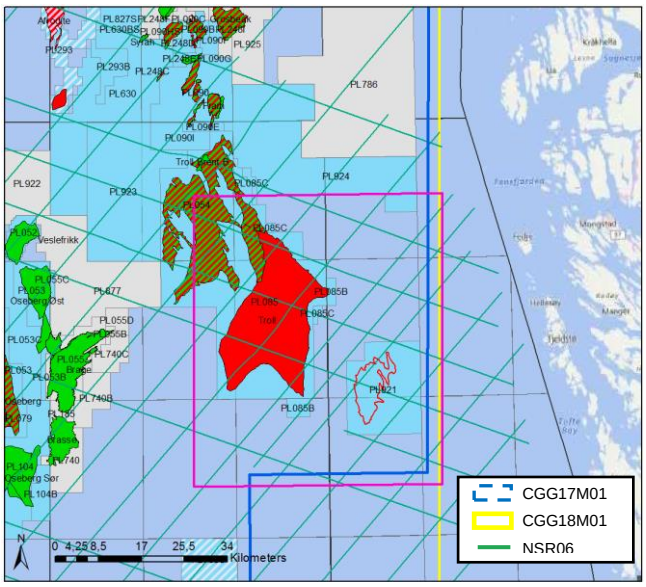

Figure 2.1 Common database of seismic surveys in PL921.

2.2 Well data

Table 2.3 Well database for PL921.

Well	Year	Age at TD	Drilling operator	Status	Present license	NPDID
31/2-4 R2	1982	Early Triassic	A/S Norske Shell	Oil/Gas	PL054	503
31/2-6	1981	Middle Jurassic	A/S Norske Shell	Oil/Gas	PL054	399
31/2-18A	1992	Middle Jurassic	Norsk Hydro Produksjon AS	Oil/Gas	PL054	1898
31/3-1	1983	Triassic	Den norske stats oljeselskap AS	Gas	PL085	20
31/3-2	1984	Early Jurassic	Norsk Hydro Produksjon AS	Oil/Gas	PL085	100
31/3-3	1984	Early Jurassic	Saga Petroleum ASA	Dry	PL085	447
31/3-4	2014	Middle Jurassic	Tullow Oil Norge AS	Dry	PL551	7292
31/5-2R	1983	Triassic	Saga Petroleum ASA	Oil/Gas	PL085	499
31/5-5R	2002	Middle Jurassic	Norsk Hydro Produksjon AS	Oil/Gas	PL085	4593
31/6-1	1983	Pre-Devonian	Norsk Hydro Produksjon AS	Oil/Gas	PL085	22
31/6-2	1983	Early Jurassic	Den norske stats oljeselskap AS	Gas	PL085	34
31/6-3	1983	Triassic	Norsk Hydro Produksjon AS	Dry	PL085	35
31/6-5	1984	Early Jurassic	Den norske stats oljeselskap AS	Oil/Gas	PL085	105
31/6-6	1984	Late Triassic	Den norske stats oljeselskap AS	Gas	PL085	127
31/6-8	1985	Early Jurassic	Norsk Hydro Produksjon AS	Oil/Gas	PL085	466
31/8-1	2011	Middle Jurassic	Eon Ruhrgas Norge AS	Dry	PL416	6604
32/2-1	2008	Triassic	Talisman Energy Norge AS	Dry	PL369	5839
32/4-1 T2	1996	Basement	Phillips Petroleum	Dry	PL205	2918
35/10-1	1992	Early Jurassic	Den norske stats oljeselskap AS	Oil	PL173	1822
35/11-7	1992	Early Jurassic	Mobil Exploration Norway INC	Oil/Gas	PL090	1979
35/11-17	2014	Early Jurassic	Statoil ASA	Oil/Gas	PL090	7408
35/11-B-22H	2016	Middle Jurassic	Statoil ASA	Oil	PL090	7945
35/12-1	1992	Early Jurassic	Saga Petroleum ASA	Dry	PL174	1881
35/12-3S	2011	Middle Jurassic	Wintershall Norge ASA	Dry	PL378	6516

3 Results of geological and geophysical studies

The 2017 APA application focused on the primary Gladsheim prospect - mapped as a low-relief four-way structural closure at Sognefjord Fm level with the top seal identified as Upper Jurassic Draupne Fm shales. The prospect was to prove potential eastward migration via fill-to-spill from Troll. The following Table 3.1 shows the performed G&G studies since the award of PL921.

Table 3.1 Summary of work done for the PL921 license.

Pre-well	Post-well
Mapping	Mapping of target reservoir
Seismic attributes and interpretations	Biostratigraphy
DFI analysis	DFI analysis
Risk and volume predictions	Failure risk and GRV re-analysis
Depth conversion	VSP well-tie and re-analysis Depth conversion
Migration concept	Geochemistry (ongoing) & Flair data interpretation
Well prognosis	Actual Formation Tops prognosis

The PL921 award, compromised of the southern PL921 the main Sognefjord Fm Gladsheim prospect, with a potential deeper Triassic lead, Rambutan, as seen in Figure 3.1.

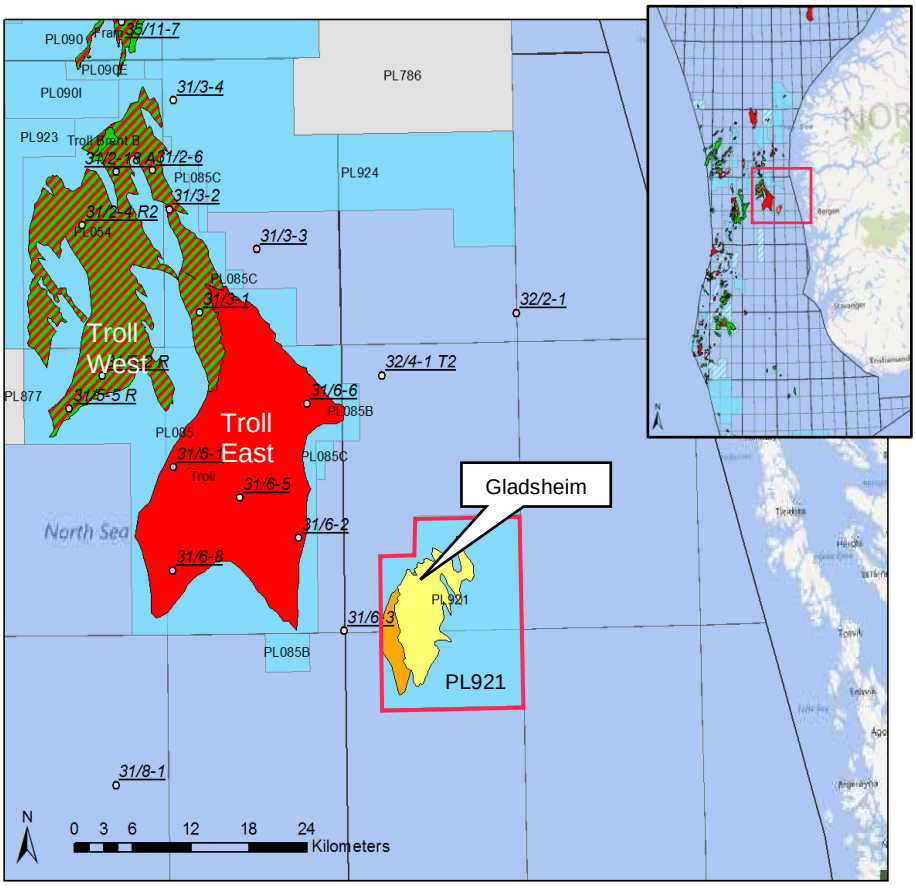

Figure 3.1 Licene PL921 East of Troll Field, with main Gladsheim target highlighted in yellow.

Geophysical forward modeling using the nearby 31/6-3 well has been performed to assess expected amplitude response from brine, oil and gas. A clear difference in amplitude response for gas versus brine/oil is shown, whereas only a small decrease is expected in an oil compared to brine-case. At Gladsheim, no amplitude shut-off or flat events are observed and suggested it could be explained by the small expected difference between oil and brine. A weak DHI downgrade was given to Gladsheim.

In terms of risk, there was no risk is attached to reservoir and trap. The relatively high prospect risk is due to migration challenges. A new model of fill-spill mechanisms in Troll was encouraging for a potential oil filling of Gladsheim. In the new model, oil migrates from the Viking graben in Eocene times and fills the Troll West structure. Later, during Neogene times, gas enters the Troll structures and displaces the oil. At the same time significant uplift and tilting causes spilling of oil from the southeastern corner of Troll East and into Gladsheim. The overall results of the performed studies prior to drilling the Gladsheim prospect gave an overall success risk of 0.16 after a DFI downgrade was applied.

Below the main Gladsheim prospect, three Jurassic closures have been mapped at Brent Group, Johansen Formation and Statfjord Group levels. Hydrocarbon accumulations in the deeper structures are dependent on an unproven deep source. The probability of finding hydrocarbons at deeper Jurassic levels were considered low (less than 5%) due to the high source and migration risk. The Rambutan lead was not matured further after having too high risk in the screening phase.

The Gladsheim well targets can be summarised in Figure 3.2, showing the primary Sognefjord Fm target and the deeper three secondary targets on a seismic section.

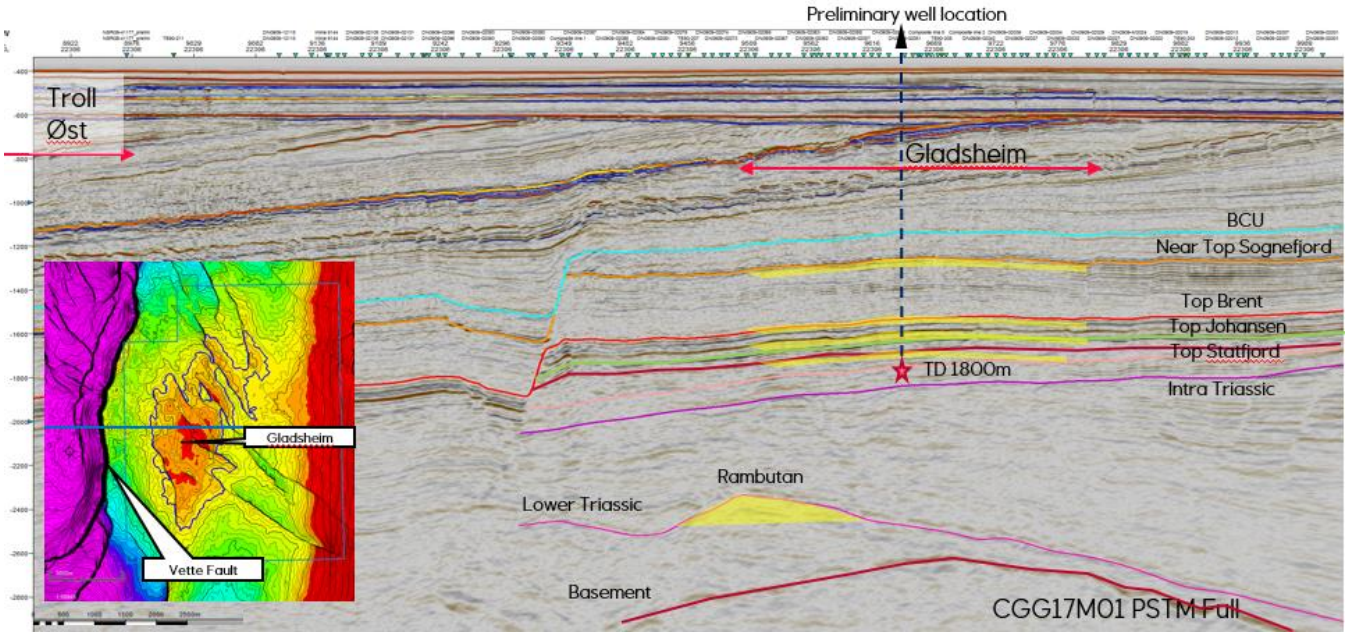

Figure 3.2 W-E seismic section of CGG17M01-PSTM-Time crossline 22304, highlighting the main reservoir targets for Gladsheim and the deeper, unmatured Rambutan lead, prior to spud. A map highlights the outline of the Gladsheim prospect.

4 Prospect update report

Assessment of the Gladsheim prospect has been evaluated post-drill well 32/4-3 S. All targets drilled into brine-filled reservoir. The primary target in the Sognefjord Fm, had better than prognosed properties, with a net reservoir of 166 m and porosity at 31%. The secondary targets were generally not as good as expected. After the reservoir parameters were re-analysed with the help with biostratigraphy results, the net reservoir thickness was much lower than expected in the Brent Gp and the Statfjord Gp. See Table 4.1 summary of reservoir properties at well location.

Table 4.1 Prognosed and actual target Formation depths and reservoir properties at well 32/4-3 S location.

	Sognefjord Fm		Brent Gp		Johansen Fm		Statfjord Gp	
	Progn(mean)	Actual	Progn(mean)	Actual	Progn(mean)	Actual	Progn(mean)	Actual
Fm Top (m TVD RKB)	1246	1231	1586	1628	1678	1729	1750	1805
Gross Thickness (m)	100	166.6	44	24.1	50	51.1	50	24.1
Net reservoir Sand (m)	94	120.2	30	18.4	41	48.9	24	8.4
NTG	0.94	0.72	0.68	0.77	0.82	0.96	0.48	0.35
PHIT (v/v)	0.28	0.31	0.25	0.23	0.20	0.22	0.18	0.18

The following seismic section in Figure 4.1 shows the interpreted, updated formation picks of 32/4-3 S on the CGG18M01-Time seismic together with the key interpreted horizons. The key horizons did not change in terms of time interpretation, but the CGG18M01-PSDM velocities were better at prognosing depths. The following primary target surface, Top Sognefjord Fm, in depth can be seen to right in Figure 4.1.

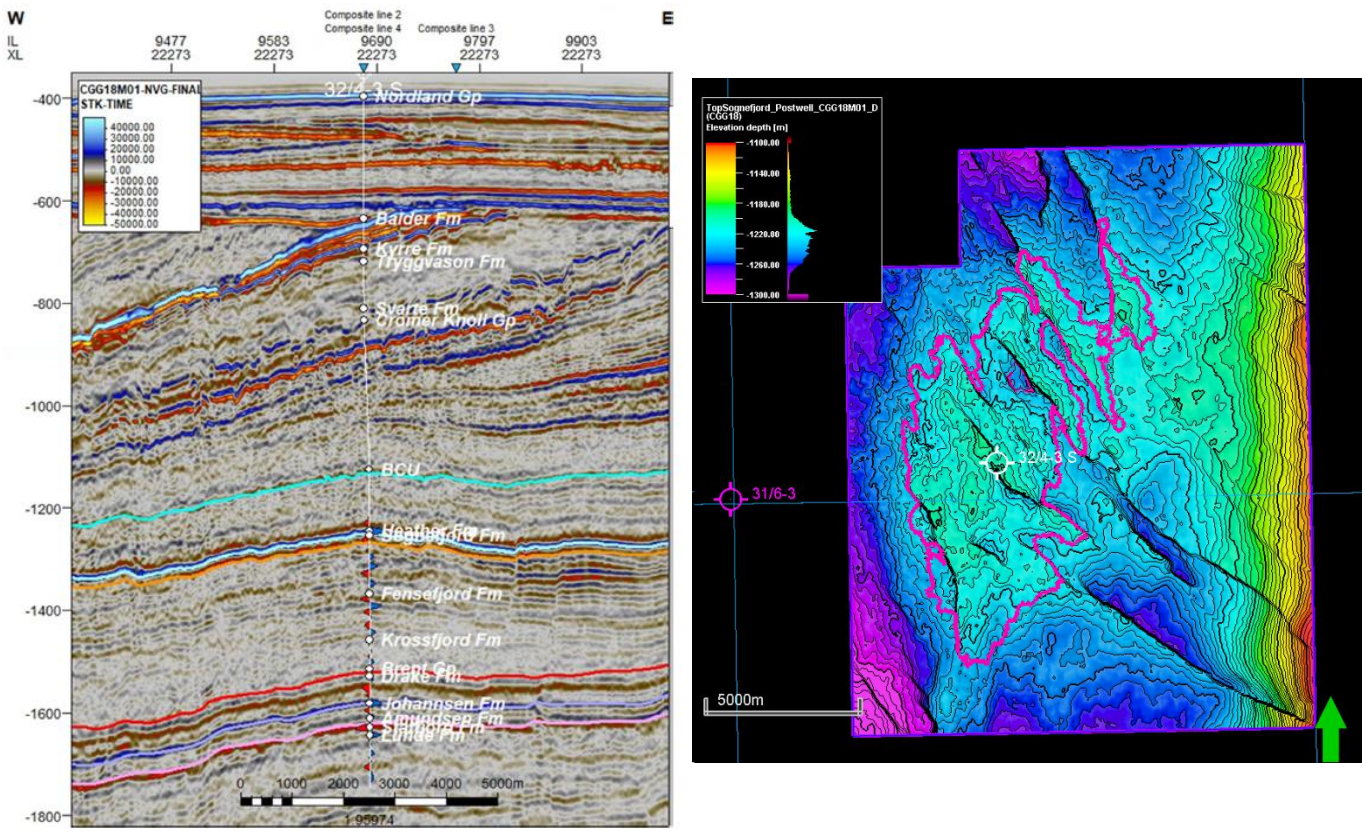

Figure 4.1 Seismic section of CGG18M01-Time crossline 22273 showing the formation picks on the well-tie of 32/4-3 S. To the right is the interpreted Top Sognefjord Fm horizon displayed in depth, converted by CGG18M01-PSDM velocities, and the purple outline of the dry Gladsheim structure.

From post-well work, trap geometry appears similar pre and post-well for all targets. The main risk for the primary target was migration. The well was to test a new migration concept, where oil migrates from the Viking Graben in the Eocene times, which later fills Troll West. In the Neogene, significant uplift and tilting occurs, whilst gas then fills the remaining Troll structures, displacing the oil from the south-eastern corner of Troll East and into Gladsheim.

As the well 32/4-3 S is dry, as of now, the main failure reason for the Gladsheim prospect is most likely the migration. Geochemical analysis is still ongoing to confirm whether there was a migration route or not in the Sognefjord Fm. The formation pressures show a negative difference to the hydrostatic pressure, suggesting communication with the Troll field.

The deeper targets were to test evidence of lean gas, from a deeply buried, unproven, gas source. A low-organic Triassic source, as well as the Statfjord Gp and Drake Fm shales were considered as possible sources. However, no evidence of a gas discovery was observed.

Changes in resource volume and probability estimates can be seen in the following Table 4.2.

Table 4.2 Summary of recoverable in-place volumes and probability of the Gladsheim target, pre- and post-well 32/4-3 S.

Target Formations	Pre-well					Post-well				
	Fluid	In-place Volumes (O:10^6Sm^3, G:10^9Sm^3)			Risk	Fluid	In-place Volumes			Failure Risk
		P90	Mean	P10			P90	Mean	P10	
Sognefjord Fm	Oil	16.3	57.4	110.3	0.16	Brine	N/A	N/A	N/A	Migration
Brent Gp	Gas	1.88	7.65	14.6	0.05	Brine	N/A	N/A	N/A	Source & Migration
Johanssen Fm	Gas	3.04	5.8	8.68	0.05	Brine	N/A	N/A	N/A	Source & Migration
Statfjord Fm	Gas	0.823	2.77	4.94	0.05	Brine	N/A	N/A	N/A	Source & Migration

5 Technical evaluation

Due to the dry outcome of the re-spud well 32/4-3 S, no post-well valuations were carried out for the Gladsheim prospect.

6 Conclusion

The Gladsheim prospect in PL921 was dry in all the stratigraphic targets. The hydrocarbon migration was the main risk and most likely the primary reason for failure, yet still awaiting results from geochemistry analysis to confirm.

No further prospectivity of interest is highlighted in the license area for Jurassic targets and therefore would like to surrender PL921.