PL 1169 – Licence status report

Summary

PL1169 was applied for and granted in APA 2021. The license included acreage within block 7220/5, located 15 km east of the Johan Castberg field (Figure 1).

No wells have been drilled within the PL1169 acreage previously, but discoveries are made both to the west (Skrugard, Nunatak, Skruis) and to the east (Neiden) of the licence. All discoveries in the area have clear seismic DHIs and the same is to be expected if hydrocarbons are present within PL1169.

PL1169 has a similar geological setting as the Johan Castberg main field, with well-defined rotated fault blocks. However, present day burial depth is significantly shallower across the area of PL1169, and young erosion is affecting some of the Jurassic and Triassic reservoirs. Trap seal is hence regarded as the key risk in this area where fault seal is evaluated to be the main failure mechanism.

High-quality 3D seismic data covers the entire licence acreage as well as reference discoveries, but no drilling candidates have been identified. Several prospects have been defined but with the lack of seismic DHIs the risk assessments give low probabilities of success.

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1 Licence history

Licence:	PL1169	
Awarded:	11.03.2022	
License period:	Initial period: 11.03.22-11.03.28	
License group:	Equinor Energy AS	50 % (Operator)
	Vår Energi	30 %
	Petoro	20 %
License area:	103 km^2	

Work programme:
Geological and geophysical studies.
Drill or drop decision within 1 year from award. Extended 1.5 years while awaiting delivery of reprocessed seismic data.
Geological and geophysical evaluation of prospects has been finalized. Work obligations are fulfilled within new drill or drop deadline 11.09.24.

Meetings held:

08.04.2022	EC/MC startup meeting
07.06.2022	EC/MC meeting
23.11.2022	EC/MC meeting
07.03.2023	EC/MC meeting
13.06.2023	EC meeting
02.11.2023	EC workshop
05.12.2023	EC/MC meeting
06.03.2024	EC/RC meeting
06.06.2024	EC/MC meeting

Work performed:
Substantial geological and geophysical evaluation of several prospects and leads, as presented in the APA application, were conducted to fulfil licence obligations. Both original and reprocessed 3D seismic data were studied in detail especially focusing on AVO assessment.

Reason for surrender:
The partnership decided to let the licence lapse on the expiry of the initial period on 11.09.2024. Despite promising geological structures with good volume potential, no geophysical support for commercial hydrocarbon volumes have been detected. A DFI downgrade is applied in the risking giving low probability of discovery for all expect one prospects. The only prospect with positive AVO observations is very limited in terms of volume and no further technical work is likely to demonstrate positive economy.

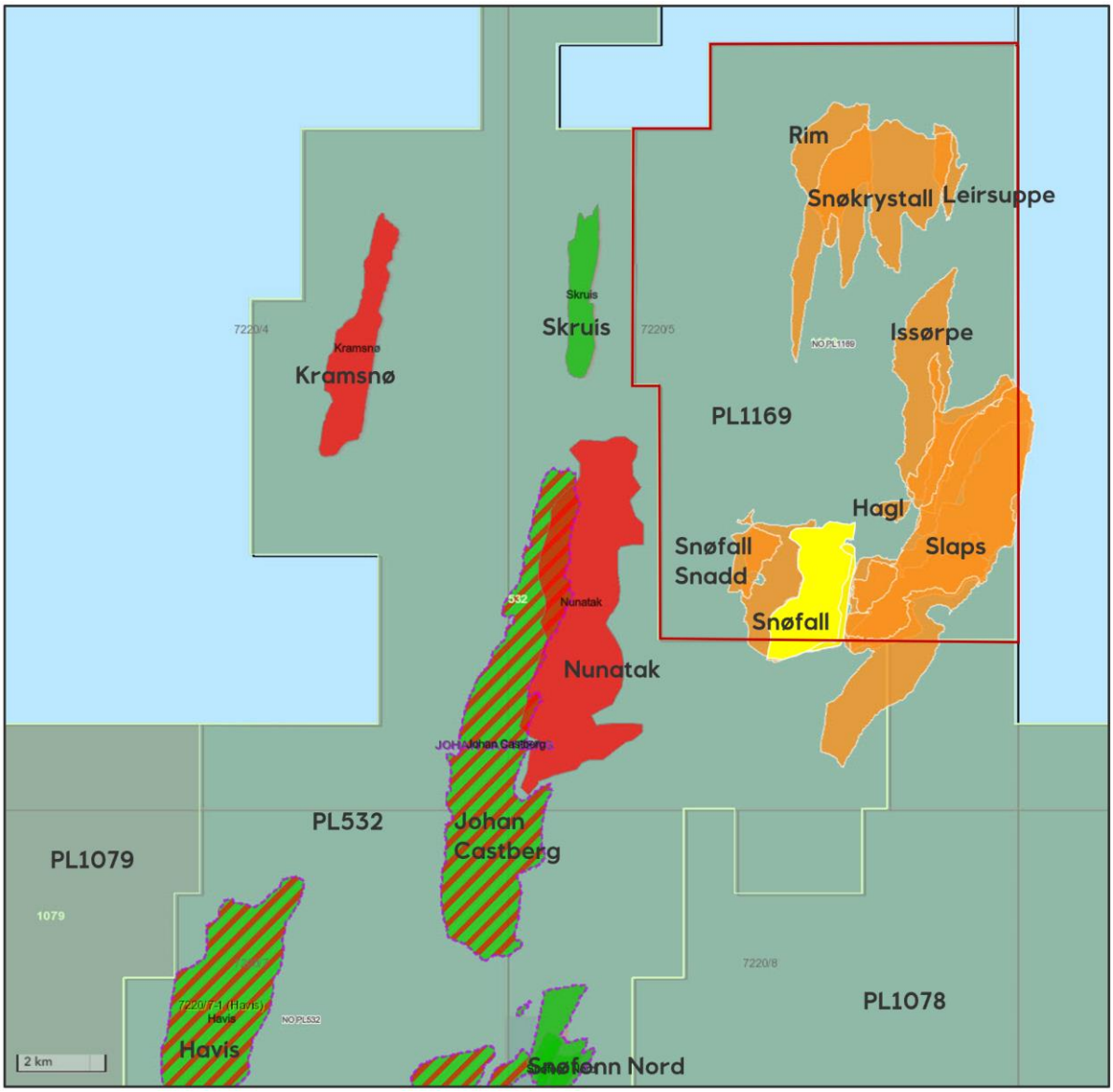

Figure 1 Licence map showing PL1169 and surrounding licences and discoveries. The main prospect, Snøfall, in the licence is indicated by the yellow outline.

2 Database overviews

2.1 Seismic data

The seismic database (Table 1) consists of released 2D data and two 3D-surveys covering the licence (Figure 2).

Table 1 Overview of 2D and 3D seismic database.

Seismic survey	Operator	2D/3D	Year	Comment
CGG19002	CGG Multiclient	3D		
CGG19002EQR23	CGG Multiclient	3D		
ST13M07	Equinor ASA	3D	2013	Merge and reprocessing of WG08, WG09, LN11003 and SG9810
WG08	WesternGeco	3D	2008	Full survey
WG09	WesternGeco	3D	2009	Parts of survey (see map)
LN11003	Lundin Norway AS	3D	2011	Parts of survey (see map)
SG9810	Equinor ASA (Saga Petroleum)	3D	1998	Full survey
NBR06	Fugro-Geoteam AS	2D	2006	
NBR07	Fugro-Geoteam AS	2D	2007	
NBR08	Fugro-Geoteam AS	2D	2008	
NBR10	Fugro Multi Client Services AS	2D	2010	
NBR11	Fugro Multi Client Services AS	2D	2011	
BARE05	NPD (Fugro)	2D	1973-1986	Reprocessed in 2005
ST17333	Equinor ASA	2D	2017	Skruis site survey
ST12308	Equinor ASA	2D	2012	Nunatak site survey
ST11304	Equinor ASA	2D	2011	Skrugard site survey
ST09323	Equinor ASA	2D	2009	Skrugard site survey

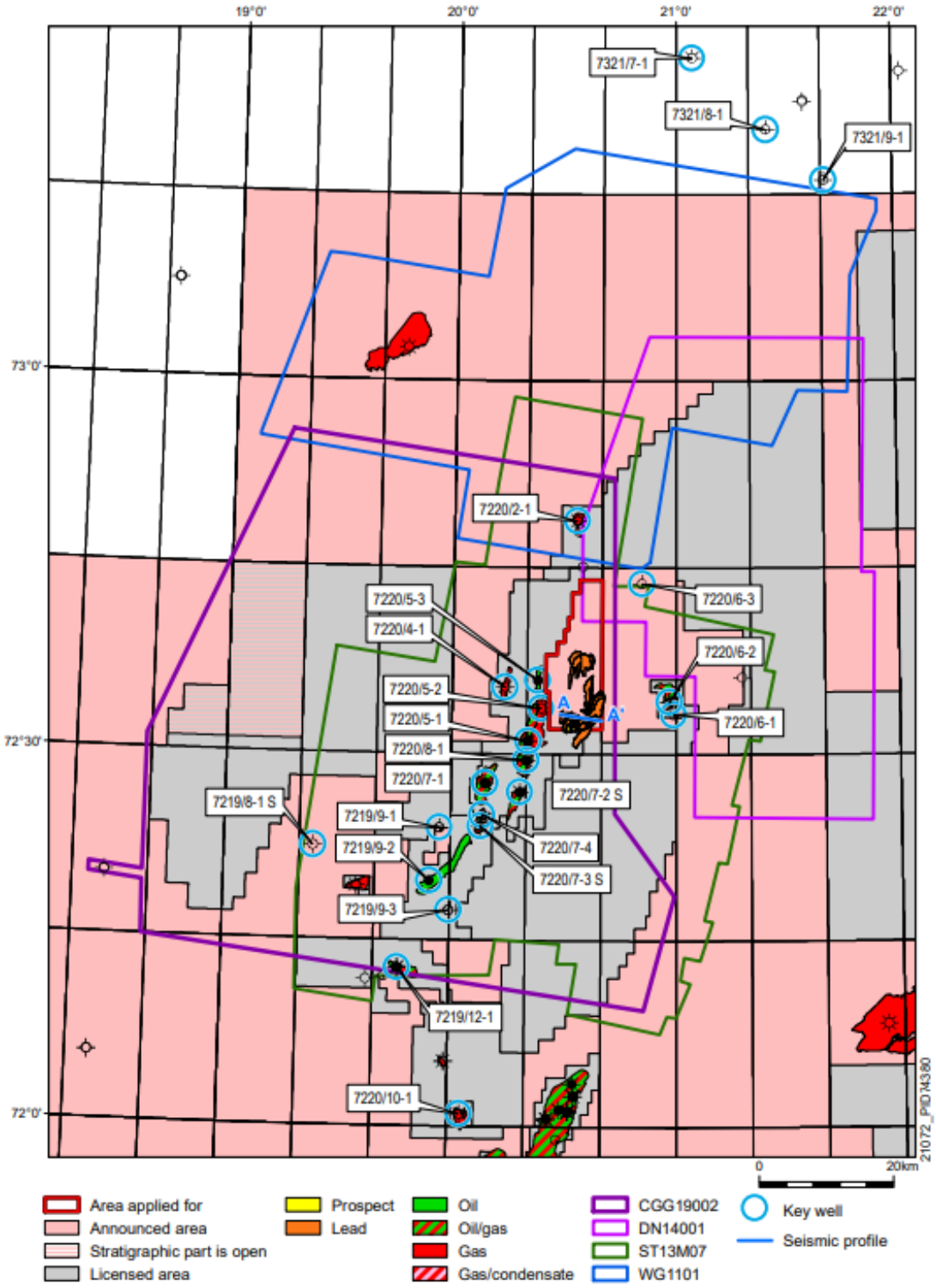

Figure 2 Map view of key 3D seismic surveys for PL1169. Key wells are marked.

2.2 Well data

The common well database consists of released proximal exploration wells on the same geological trend as the prospects. Discovery wells are drilled on the same geological play as is the main play model in PL1169. Since APA 2021, relevant drilled wells are 7220/8-2 S and 7220/8-3, which proved oil in the same reservoir formations as make up the prospectivity in PL1169. These wells are highly relevant as they similarly are situated in a shallow setting. Other very relevant wells are 7220/5-1, 7220/5-3 and 7220/8-1 again proving the working play model, including reservoirs, source and migration. All discoveries are covered by the same seismic survey as PL1169 and hence comparison and calibration of prospects towards reference wells can be done with large confidence.

Table 2 Overview of well database.

Well	Year	Operator	Well name	Status	Age at TD
7220/2-1	2014	Equinor AS	Isfjell	Gas	Late Triassic
7220/4-1	2013	Equinor AS	Kramsnø	Gas	Triassic
7220/5-1	2012	Equinor AS	Skrugard	Gas, oil	Late Triassic
7220/5-2	2013	Equinor AS	Nunatak	Gas	Early Jurassic
7220/5-3	2018	Equinor AS	Skruis	Oil	Late Triassic
7220/6-1	2005	Norsk Hydro	Obelix	Shows	Pre-devonian
7220/6-2, 6-2 R	2015	Lundin AS	Neiden	Gas, oil	Basement
7220/6-3	2017	Lundin AS	Børselv	Shows	Carboniferous
7220/7-1	2012	Equinor AS	Havis	Gas, oil	Late Jurassic
7220/7-2 S	2013	Equinor AS	Skavl	Gas, oil	Triassic
7220/7-3 S	2014	Equinor AS	Drivis	Gas, oil	Late Triassic
7220/7-4	2021	Equinor AS	Isflak	Oil	Early Jurassic
7220/7-ZA-1H, 4H	2020	Equinor AS	Havis WI	Water injector	Early Jurassic
7220/8-1	2011	Equinor AS	Skrugard	Gas, oil	Late Triassic
7220/8-2 S	2022	Equinor AS	Snøfonn N	Oil	Late Triassic
7220/8-3	2022	Equinor AS	Skavl Stø	Oil	Late Triassic
7220/10-1	2012	Ein Norge	Salina	Gas	Late Triassic
7219/8-1 S	1992	Saga Petroleum		Dry	Early Jurassic
7219/8-2	2013	Equinor AS	Iskrystall	Gas	Late Triassic
7219/9-1 T2	1988	Norsk Hydro	Råk	Shows	Late Triassic
7219/9-2	2017	Equinor AS	Kayak	Oil	Middle Jurassic
7219/9-3	2020	Equinor AS	Mist	Dry	Late Triassic
7219/11-1	2021	Lundin AS	Bask	Dry	Early Cretaceous
7219/12-1 A	2017	Lundin AS	Filicudi	Gas, oil	Late Triassic
7219/12-2 A	2017	Lundin AS	Filicudi appr.	Dry	Early Jurassic
7219/12-2 S	2017	Lundin AS	Filicudi appr.	Gas	Late Triassic
7219/12-3 S	2018	Lundin AS	Hurri	Shows	Late Triassic
7321/7-1	1988	Mobil Exploration	Beta	Gas shows	Middle Triassic
7321/8-1	1987	Norsk Hydro	Alpha	Shows	Late Permian
7321/9-1	1988	Norsk Hydro		Shows	Late Triassic

3 Results of geological and geophysical studies

The understanding of the prospectivity in PL1169 is briefly summarized in the section below.

Source and migration

The late Jurassic Hekkingen Formation source rock is the main source for hydrocarbons in PL1169. The source rock is of very good quality. On the Polhem Sub-Platform, at the location of the prospects, the Hekkingen Formation is immature at maximum burial with respect to oil generation. To the west of the licence, within the Ringvassøy-Loppa Fault complex, the source rock is early- to late oil mature at maximum burial but is rapidly burned out towards the Tromsø Basin. The prospects seem to be sub-optimally positioned for migration at the inner fault terrace.

Reservoir quality

Sandstones of the Realgrunnen Subgroup form the main reservoirs in the area. Delta plain deposits and scattered distributary channels in the upper Fruholmen Formation are truncated below laterally persistent fluvial and marginal marine strata in the Tubåen Formation which in turn is overlain by heterolithic pro-delta and delta front deposits in the Nordmela Formation. The Stø Formation rests erosively on the underlying unit and comprises basal sections of marginal marine high-energy shoreline and mouth bar sandstones, capped by finer grained offshore-transition zone/shoreface deposits.

The Snøfall prospect consists of several mapped segments; one within each of the Realgrunnen Sgp. formations. The Fruholmen Fm. is in turn divided into at least three zones. Stø, Nordmela and Tubåen fms. are tested in all reference wells and are proven to be good to excellent reservoir rocks. The depositional environment of the Fruholmen Fm. makes it a more variable reservoir, but still of moderate to good quality. Present day burial at the Snøfall prospect is between 600m and 800m TVD MSL. Maximum burial is estimated to approximately 2000m, and hence reservoir properties are well preserved.

Trap and seal

The main prospectivity is related to rotated and truncated fault blocks within PL1169. The traps are defined by faults and occasionally Albian erosion at the crest of the fault blocks. The Early Cretaceous Kolmule Fm. forms the ultimate top seal. The Cenozoic Torsk Fm. is also present as part of the overburden. Jurassic shales of Fuglen and Hekkingen fms. are present at parts of the structures and form local lateral seals.

Faults defining the traps mostly have sand-sand juxtaposition, giving a high trap seal risk. Hydrocarbon communication between sands on each side of the fault is regarded very likely. Leakage along the fault planes is also possible at these shallow burial depths.

Geophysical studies

AVO workflows are performed on original CGG19002 survey as well as the smaller reprocessed CGG19002EQR23 volume. The conventional survey (CGG19002) is a KPSDM processing, while the reprocessed one is a FWI processing with constructed angle variant amplitudes. Both surveys

demonstrate small, local AVO anomalies but plot slightly differently on the AVO classification. Nevertheless, they both give the same picture and understanding of the hydrocarbon potential in the area based on the produced attribute volumes (litho and fluid cubes). AVO studies give geophysical support for a few, but very limited, hydrocarbon accumulations. These are present within the local 4-way closures where the accumulations are independent of sealing faults. Overall, traps with fault dependent columns lack geophysical support for hydrocarbons in this area indicating that the trapping mechanism is insufficient.

CSEM data are available across the acreage and across relevant reference discoveries. Dedicated sensitivity studies indicate that hydrocarbon presence should produce a CSEM anomaly, but no clear anomalies can be identified on real data and hence there is no support for hydrocarbons from CSEM data either.

4 Prospect update report

The prospects from APA 2021 have been updated, where Snøfall ended up as the most promising one in the license. Snøfall has several prospective reservoir zones and the largest volume potential (Figure 3). A summary of the resource assessment for the different scenarios is presented in Table 3. Overall, the prospects show good volume potential, but they all have low probability of success based on the trap seal risk and lack of geophysical support.

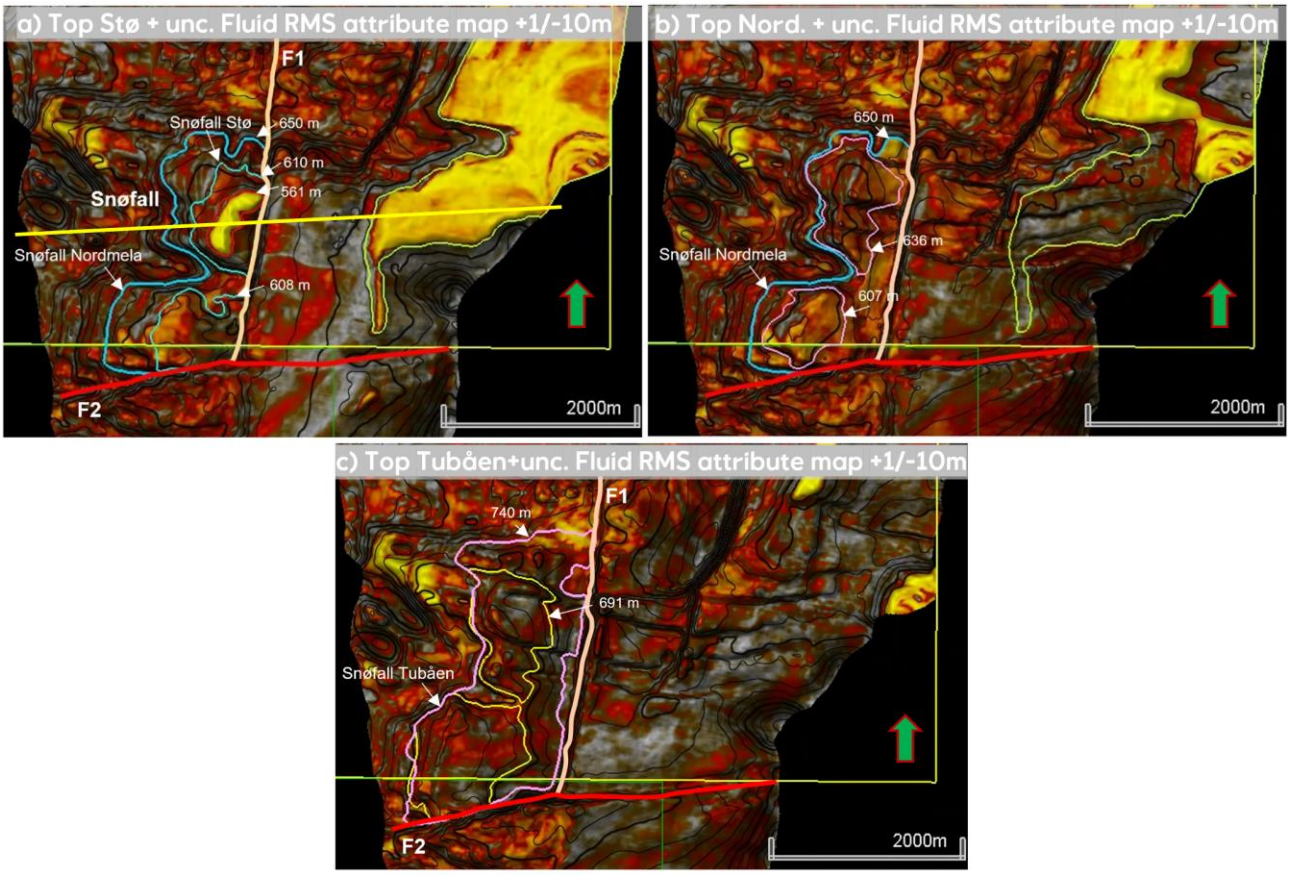

Figure 3 Structural depth maps with fluid attribute overlay at a) Top Stø Fm./Top Realgrunnen Subgroup, b) Top Nordmela Fm./Top Realgrunnen Sbg., c) Top Tubåen Fm./Top Realgrunnen Sbg. Segment outlines indicated and annotated for each reservoir unit. Bounding faults to the south (red fault F2) and to the east (yellow fault F1) indicated on maps. Attribute extraction window is +1m/-10m. The green outline in a) and b) maps corresponds to the Slaps prospect.

Table 3 Overview of resource potential within PL1169. Volumes are listed as this is the business case for the area.

Prospect	Lithostrat	Depth at apex [m TVD MSL]	HC phase	In place, oil [MSm^3]			Recoverable oil [MSm^3]			Pg [%]	P oil [%]
				P90	Mean	P10	P90	Mean	P10		
Snøfall	Stø*	545	Gas [GSm^3]	0.002	0.047	0.091	0.009	0.029	0.05	76	0
Snøfall	Stø*	545	Gas + oil	1.6	5.2	9.9	0.9	2.8	5.4	4.5	4.5
Snøfall	Nordmela	576	Oil	4.3	12.6	24.4	1.9	5.6	10.9	4.5	4.5
Snøfall	Tubåen	623	Oil	5.5	10.2	16.5	3.0	5.6	9.1	10	10

** Snøfall Stø is calculated as two different cases based on the presence of DHIs. See explanation below.*

The different segments of Snøfall are shown in Figure 4 by the geoseismic section indicating reservoir units and sealing elements. Snøfall sits at a rotated and truncated fault block dependent on fault seal in two directions. The key risk is trap seal, related to sand-sand juxtaposition across the prospect bounding faults.

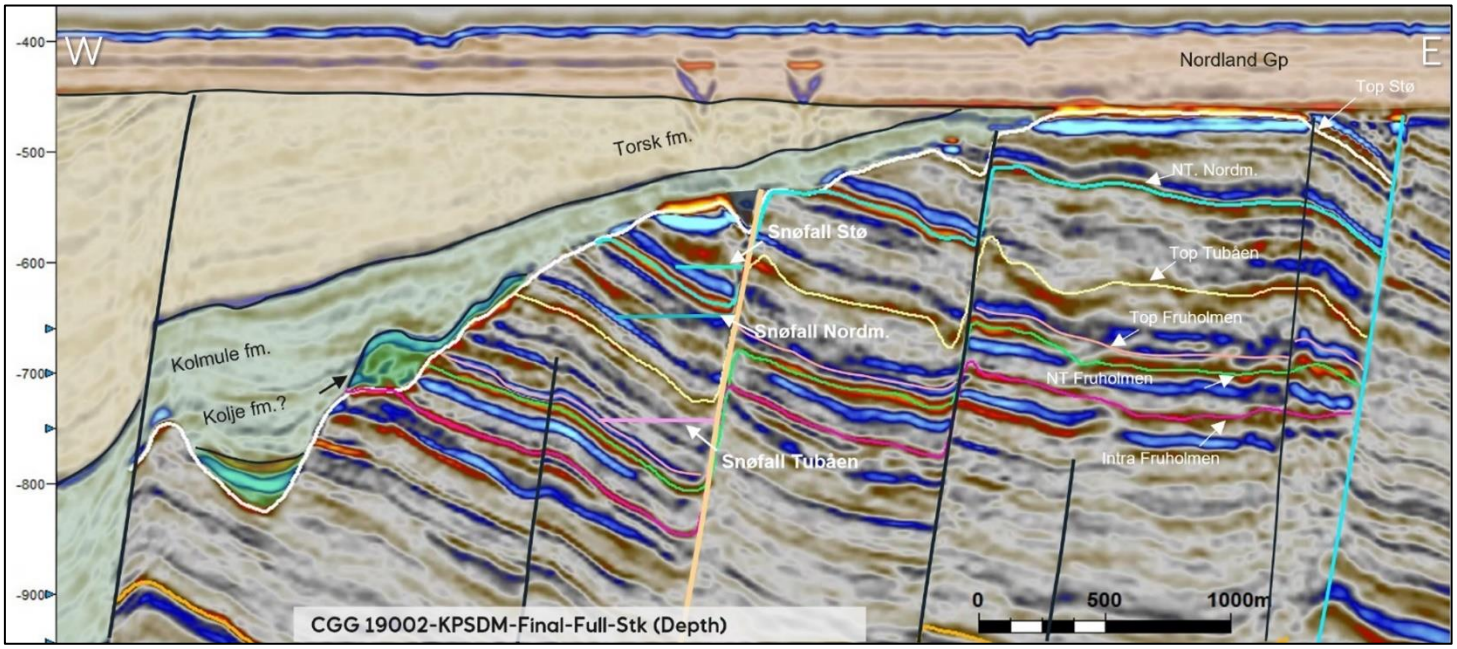

Figure 4 Snøfall prospect with all three reservoir levels indicated. The seismic is full stack in depth (m TVD MSL). The yellow fault in the east is the critical one with respect to trap seal. A possible hydrocarbon column in Stø and Nordmela fms. will depend on a working seal along this fault and/or at fault F2 as shown in Figure 3. Direction of seismic line is also shown in Fig. 3a).

Snøfall Stø (Figure 5) is calculated as two different cases based on the presence of DHIs. The first case is a small gas only case where the hydrocarbon column is restricted to the DHI that is seen within the 4-way closure at the crest of the structure. Although it's given a DFI upgrade based on seismic it has a very limited gas volume as shown Table 3. The second case is a gas and oil case, where an oil column is added below the observed DHI (interpreted as gas). This gives a fair oil volume potential, but it lacks geophysical support and is assigned a low probability. A DFI downgrade is applied for this scenario.

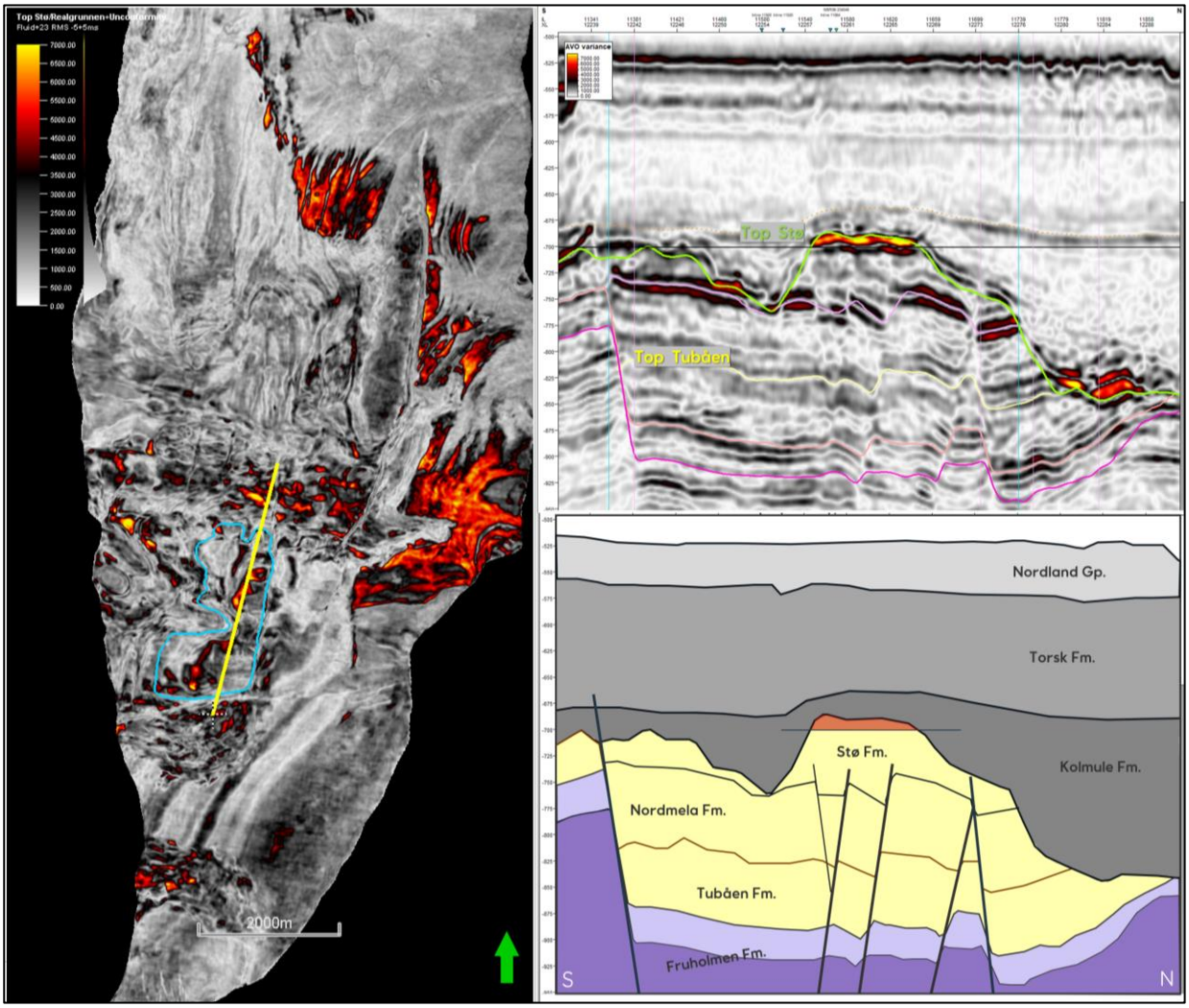

Figure 5 Snøfall Stø segment illustrated by AVO anomaly strength attribute map (left). Seismic section in TWT (ms) (upper right) and corresponding geosection (lower right) are shown. DHI clearly visible both on the seismic and on the structural map. Line is oriented approximately S-N through apex of the structure. Line position is marked by the yellow line on the map. The AVO response at Slaps is seen at the eastern side of the attribute map.

The Nordmela (Figure 6) and Tubåen (Figure 7) segments are calculated as pure oil cases as there are no seismic indications of gas being present in these reservoirs. With the lack of seismic evidence of an OWC, the contacts depths were modelled as uniform distributions above the structural spill points. The demonstrated volume potential is larger in these two segments than in the Stø Fm., but again DFI downgrades are applied. This is reflected in Table 3. Tubåen Fm. has a slightly higher probability than Nordmela Fm. as the column in Tubåen Fm. is independent of the fault and hence the apriori trap seal risk is less in the Tubåen Fm.

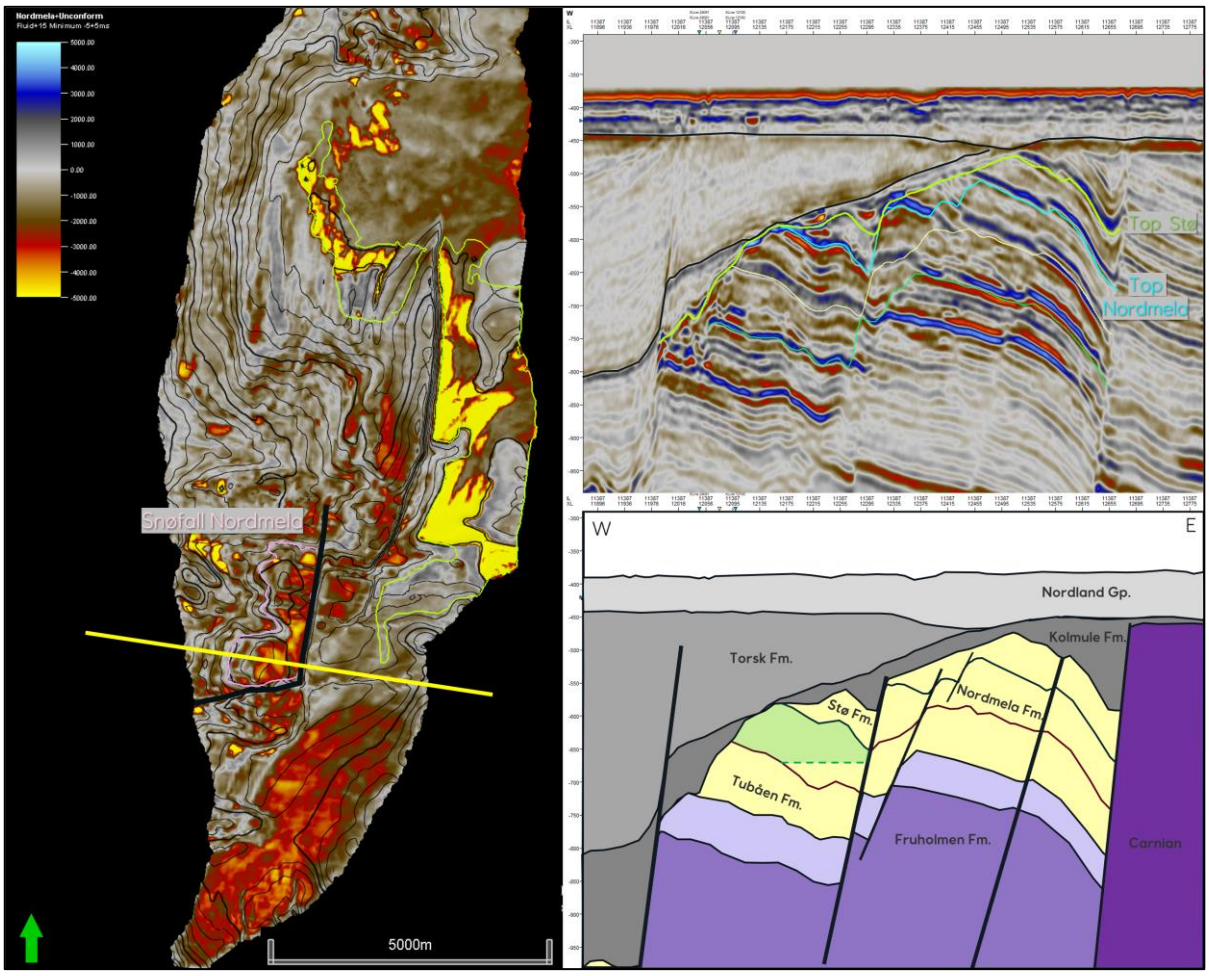

Figure 6 Snøfall Nordmela segment illustrated by fluid attribute map (left). Seismic section (EEI+15 deg fluid attribute) in TVD (m) (upper right) and corresponding geosection (lower right) are shown. No clear DHIs are visible on seismic nor attribute map. Seismic and geosection lines are oriented approximately E-W; marked by the yellow line on the map.

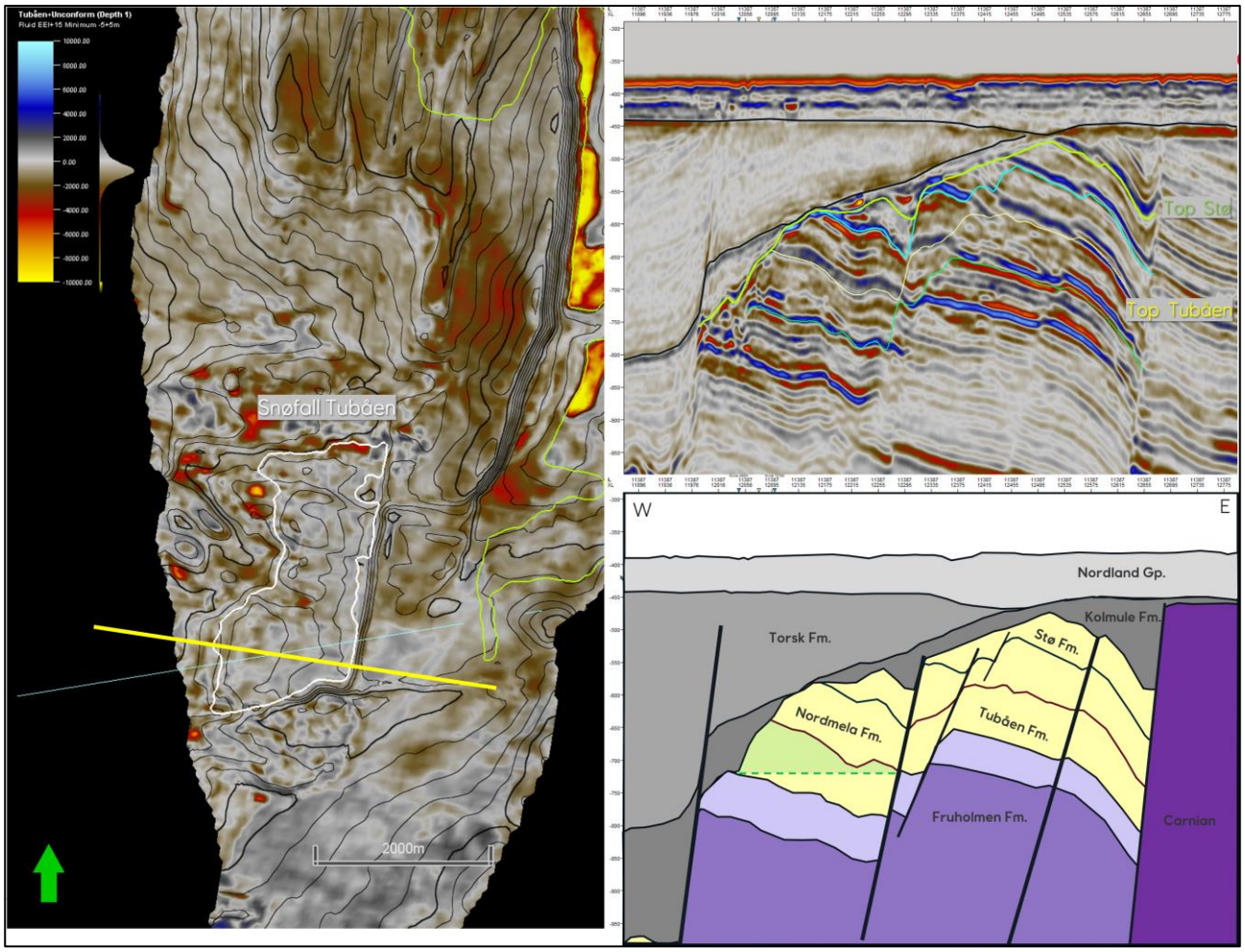

Figure 7 Snøfall Tubåen segment illustrated by fluid attribute map (left). Seismic section (EEI+15 deg fluid attribute) in TVD (m) (upper right) and corresponding geosection (lower right) are shown. No clear DHIs are visible on seismic nor attribute map. Line is oriented approximately E-W; marked by the yellow line on the map.

Fruholmen Fm. might be prospective in the license area, as demonstrated by the results from wells drilled in the vicinity proving internal working seals and stacked hydrocarbon columns in this formation. There are similar indications at the Snøfall structure (Figure 8). However, the lateral extent of the DHIs is limited, giving a small volume potential. The heterogeneous nature of the formation brings additional challenges to recovering such small volumes and small hydrocarbon columns, and hence larger volumes are required for a feasible development solution for the Fruholmen Fm.

The fact that DHIs are present in both Stø and Fruholmen fms. around Snøfall further strengthens the expectation that DHIs should be seen with presence of hydrocarbons in any formation in this area.

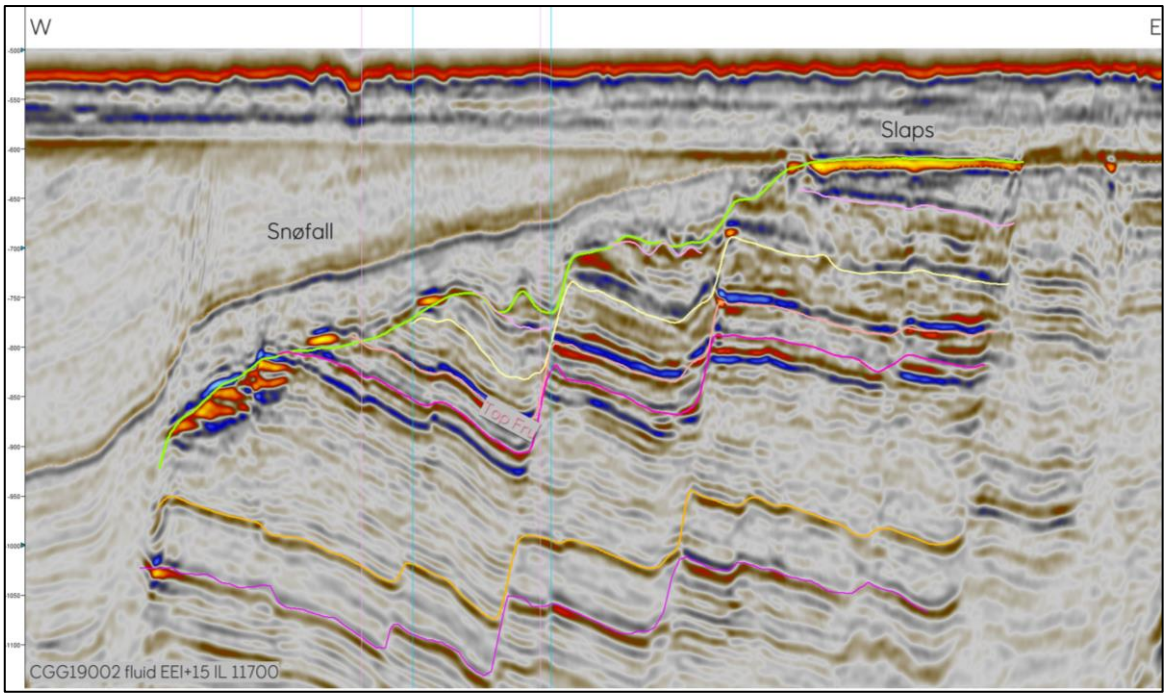

Figure 8 Fruholmen Fm. DHIs seen along the erosional truncation of the formation. The stacked nature of the DHIs indicate internal working sealing within the formation, as also seen in reference discovery wells. However clear DHIs, the extent and volume potential of these Fruholmen Fm. anomalies are very limited. The amplitude response at Slaps prospect can be seen at the uppermost fault terrace in the east.

At the time of APA application in 2021, other leads like Slaps, Hagl, Issørpe, Snøkrystall, Leirsuppe and Rim were also considered. Out of these, Slaps is the closest structure to Snøfall with a DHI. However, Slaps has a very shallow present-day burial. In combination with a limited/thin hydrocarbon column, it is very challenging to find a suitable technical solution. AVO studies indicate that the hydrocarbon phase is likely to be gas, and hence both inplace and recoverable volumes are very limited. Outlines of the Slaps prospect and its amplitude response can be seen in the attribute maps in Figures 3 and 5. Seismic lines running through the structure are displayed in Figures 4 and 8.

5 Technical evaluation

The total volume potential of the Realgrunnen Subgroup prospects was regarded as feasible to be tied back to Johan Castberg main field or via the Cluster 1 infrastructure. However, the very low probabilities for discovery does not give realistic believes in these prospects and no valid business case. The low probabilities bring a very high risk to any possible investments in this acreage.

6 Conclusion

The licence partnership has unanimously decided to relinquish the licensed acreage at the drill or drop deadline on 11.09.2024 due to the limited prospectivity and lack of a drilling candidate.

References

Equinor (2021). Application Part of blocks 7220/5 - APA2021, Norwegian continental shelf.

Appendices

1. Shapefile Snøfall Stø, Nordmela and Tubåen segments.
2. Shapefile Slaps prospect.
3. NPD Table 5 Prospect data status-report-surrender – Snøfall Stø
4. NPD Table 5 Prospect data status-report-surrender – Snøfall Nordmela
5. NPD Table 5 Prospect data status-report-surrender – Snøfall Tubåen