wintershall dea

RELINQUISHMENT REPORT
PL1054

AkerBP

NEPTUNE ENERGY

PL1054 relinquishment report summary

PL1054 (WintershallDea Norge (Op) 40%, Aker BP ASA 30% and Neptune Energy Norge AS 30%) was awarded in February 2020 with an initial work program of G&G studies and acquisition of 3D seismic data to reach a drill-or-drop decision at 14th February 2022. All prospects and leads presented in the APA 2019 document have been re-evaluated based on the newly acquired and pre-stack conditioned seismic CGG18M01. The main prospect Jack Dalton could not be confirmed on the new seismic dataset. The newly defined Gråhegre prospect indicates volumes and risks for which commercial development is challenging. Further remaining potential was remapped, but not considered prospective.

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Summary

PL1054 (WintershallDea Norge (Op) 40%, Aker BP ASA 30% and Neptune Energy Norge AS 30%) was awarded in February 2020 with an initial work program of G&G studies and acquisition of 3D seismic data to reach a drill-or-drop decision at 14th February 2022. All prospects and leads presented in the APA 2019 document have been re-evaluated base on the newly acquired and post-stack conditioned seismic CGG18M01 (Fig. 1). The main prospect Jack Dalton was identified as injected sandstone feature on vintage seismic data. Three additional injectite prospects were mapped in the same interval. Main risk of all identified prospects is trap efficiency and access to charge efficiency.

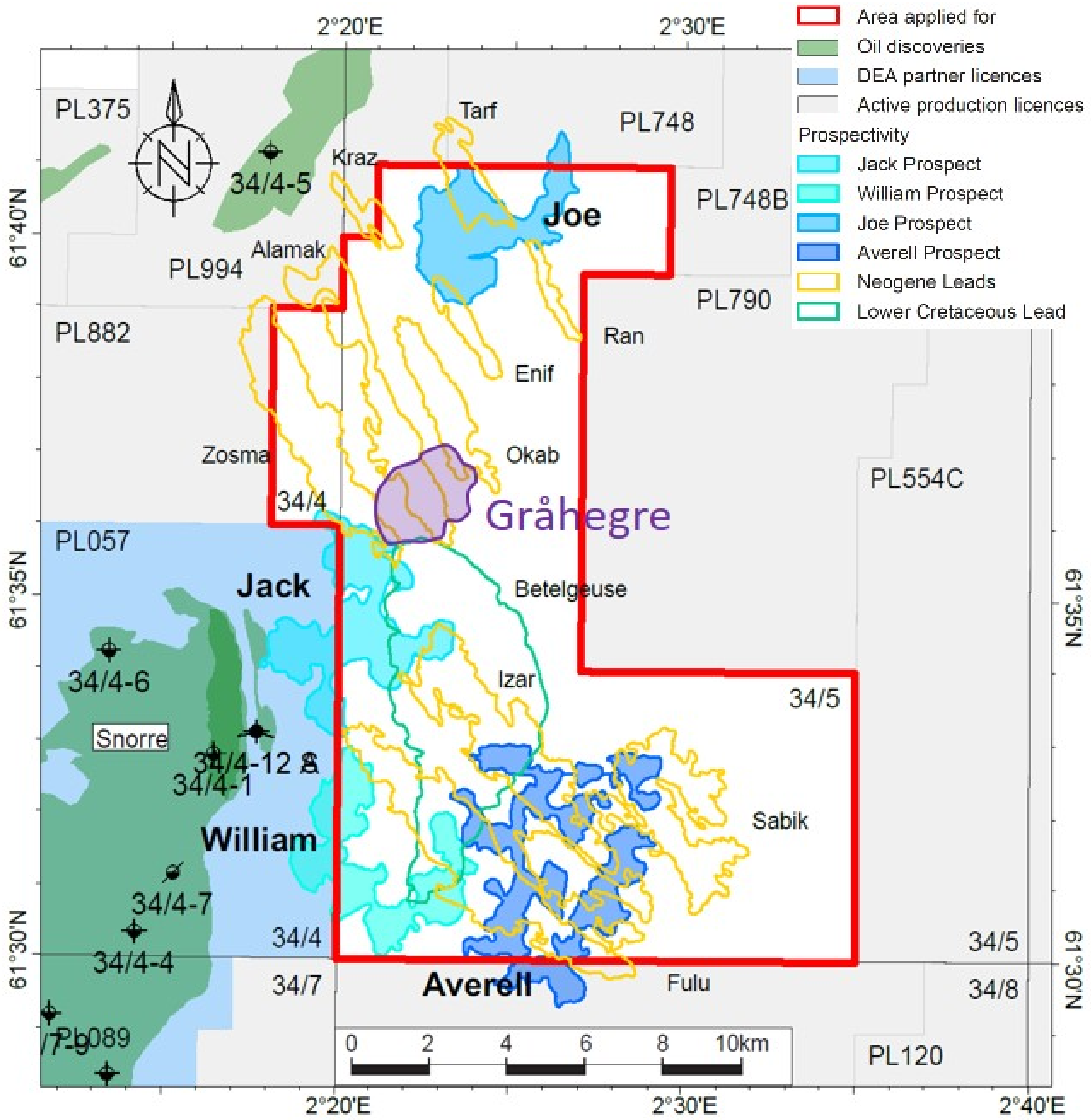


Fig. 1 License overview map

Identified prospects and leads in PL1054 area. Gråhegre prospect marked in lila.

Remapping of the conditioned and EEI inverted new dataset showed that previously mapped features are part of a larger injectite network and can no longer be considered prospects. Using

Machine Learning based interpretation the new, more isolated injectite prospect Gråhegre could be defined at a slightly shallower level. The latest technical evaluations however indicate volumes and risks for which commercial development is challenging.

Remaining prospectivity at Neogene and Cretaceous levels were re-assessed on the new seismic dataset. The Neogene amplitude anomalies could be confirmed, but are due to size and shallow burial not considered prospective. Extensive analysis of the Lower Cretaceous Betelgeuse anomaly showed low frequency energy bleeding from the BCU to interfere with Betelgeuse amplitude response. Accumulation of organic rich claystone is a more likely explanation for the observed Class IV amplitude response.

1 History of the production license

Table 1.1 PL1054 Milestone overview

License	PL1054
Awarded	14.02.2020
License blocks	34/4 & 34/5
License period	Expire 02.03.2026 (DOD 02.03.2021)
License group:	Wintershall Dea Norge AS 40% (Operator) Aker BP AS 30%; Neptune Energy Norge AS 30%
License area	193.598 km2 (Fig. 1)
Work program	Study of geology and geophysics, Reprocessing of 3D seismic, Acquire 3D seismic
Meetings held	01-04-2020 EC/MC startup meeting 01-07-2020 EC geophysical work meeting 07-10-2020 EC geological work meeting 12-11-2020 EC/MC annual meeting 02-06-2021 EC work meeting & final technical evaluation 26-11-2021 EC/MC annual meeting
Work performed	2020: License start-up Seismic data purchase and pre-stack conditioning. Technical evaluation. G&G work: Interpretation of injectite network with ESA machine learning tools, Geologic study on classification and reservoir parameters of injectites, evaluation of APA application prospects and screening for additional prospectivity. 2021: License decision made to drop the license.
Reason for drop	The prospects identified do not present viable drillable targets, based on our current technical understanding and the significant risks due to lack of amplitude support.

2 Database overviews

2.1 Seismic database

Modern CCG18M01 seismic dataset was purchased by WintershallDEA and was included in the common database over PL1054 license outline (Fig. 2.1, Table 2.1). This dataset was used for prospect evaluation (Table 2.1). The CGG18M01 seismic data has been pre-stack conditioned and inverted for fluid and lithology response.

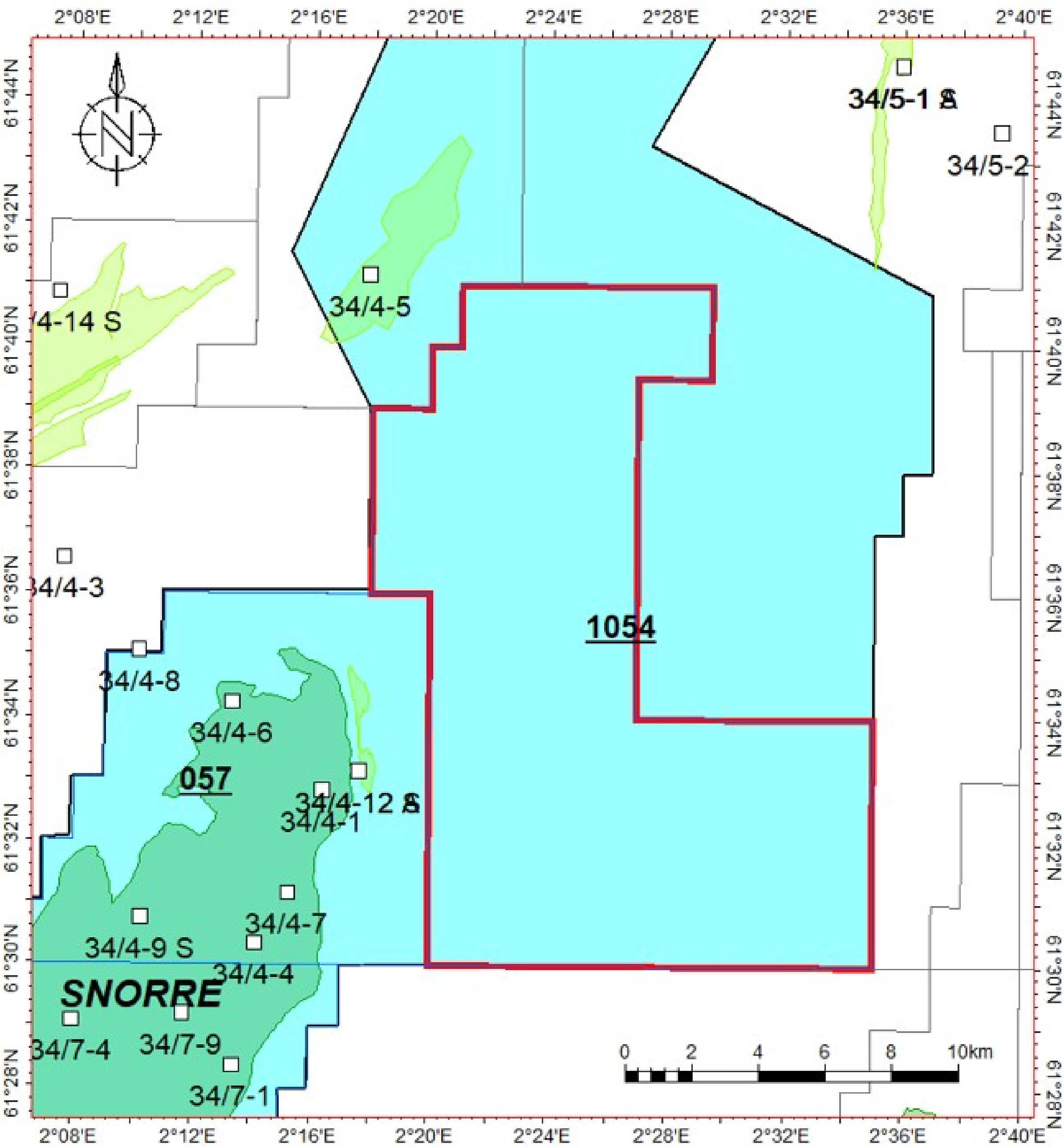


Fig. 2.1 Seismic database

PL1054 license boundary in red. CGG18M01 dataset in blue covers entire license and was included in license database for this area.

Table 2.1 3D seismic survey database list

3D	CGG18M01: PSTM & PSDM Full stack, partial stacks	CGG14006, NPDID for survey 8128; CGG16001, NPDID for survey 8332

2.2 Well database

The wells in the common database are listed in Table 2.2. Log coverage and quality (large bit size and wash-outs) over the shallow (Oligocene/Eocene) zone of interest is generally poor for the injectite prospects, as exploration wells exclusively targeted deeper Jurassic prospects. Any petrophysical evaluation over this interval has a very low level of confidence. A comprehensive regional geological study was conducted including seismic data and analogues to mitigate this and get an estimated range for porosity and N/G.

Table 2.2 Well data base

Table showing the well database and results of geologic study.

Well	Type of injectite	Stratigraphy	Top sst m MD	Base sst m MD	Gross Thickness m	Net thickness estimated m
34/4-7	Stratified	Utsira Fm	1063	1064	1	1
34/4-7	Stratified	Utsira Fm	1064	1091	27	27
34/4-7	Stratified thin sands N:G <25%	Utsira Fm	1091	1171	80	20
34/4-7	Stratified	Utsira Fm	1171	1217	46	46
34/4-7	W-shaped	Grid Fm	1451	1477	26	26
34/6-1 S	Zig Zag thin sands	Grid Fm	1360	1495	135	27
34/6-1 S	ZigZag	Grid Fm	1495	1518	23	23
34/6-2 A	Stratified thin sands	Utsira Fm	1196	1319	123	24.6
34/6-2 A	Zig Zag thin sands	Grid Fm	1440	1448	8	1.6
34/6-2 A	ZigZag	Grid Fm	1448	1469	21	21
34/6-2 A	Thin sands	Grid Fm	1750	1830	80	16
34/6-3 S	Conglomerate	Grid Fm	1500	1525	25	0
34/6-4	Conglomerate	Grid Fm	1500	1580	80	0
34/7-16	Stratified thin sands	Utsira Fm	900	1000	100	20
34/7-16	V-shape	Grid Fm	1271	1307	36	36
34/7-16	V-shape	Grid Fm	1514	1556	42	42
34/7-17	Stratified thin sands	Utsira Fm	930	950	20	4
34/7-17	Stratified	Utsira Fm	949	966	17	17
34/7-17	Stratified	Utsira Fm	974	989	15	15
34/7-17	Stratified thin sands	Utsira Fm	996	1100	104	20.8
34/7-17	V-shape wing	Grid Fm	1256	1265	9	9
34/7-17	V-shape wing	Grid Fm	1289	1330	41	41
34/7-17	V-shape wing	Grid Fm	1404	1423	19	19
34/7-4	Stratified	Utsira Fm	1037	1119	82	82
34/7-4	Injection not on seismic	Grid Fm	1192	1201	9	9
34/7-4	U-shaped base	Frigg Fm	1622	1676	54	54
34/7-9	Stratified	Utsira Fm	1030	1086	56	56
34/7-9	Injections thin sands, not on seis	Grid Fm	1112	1206	94	18.8
34/7-9	Injection not on seismic	Grid Fm	1206	1223	17	17
34/7-9	Injection not on seismic	Grid Fm	1295	1307	12	12
34/7-9	Injection not on seismic	Grid Fm	1318	1330	12	12
34/7-9	Injection not on seismic	Grid Fm	1362	1383	21	21
34/7-9	Injection not on seismic	Grid Fm	1418	1432	14	14
34/7-9	U-shaped wing	Grid Fm	1440	1517	77	77
34/8-6	Stratified thin sands N:G <35%	Utsira Fm	1050	1155	105	36.75
34/8-6	Stratified	Utsira Fm	1166	1177	11	11
34/8-6	ZigZag	Grid Fm	1404	1421	17	17
34/3-5	No comp log	Grid Fm	1649	1652	3	3
34/3-5			1360	1367	7	7
35/4-1	Data OK	Grid Fm	1146	1150	4	4
35/4-1		Grid Fm	1264	1269	5	5
35/4-1		Grid Fm	1501	1504	3	3
35/4-1		Grid Fm	1521	1554	33	33
35/4-1		Grid Fm	1665	1694	29	29
35/4-2	NO data					
35/10-1	Data OK	Grid Fm	1203	1252	49	49
35/10-1		Utsira Fm	911	948	37	37
35/10-2	Poor data Return to sea bed	Grid Fm	1257	1266	9	9
35/10-2		Utsira Fm	850	950	100	100
35/10-3	Data No Comp log	Grid Fm	1248	1269	21	21
35/10-4	No data					
35/10-5	No data					

3 Results of geological and geophysical studies

Four main prospects Jack, William, Averell and Joe Dalton have been identified within the area applied for and are interpreted as injected sandstones in the Tertiary (Eocene-Oligocene) succession (Fig. 1). Aim of the G&G studies was to better understand the injected features using modern seismic data and applying new and innovative interpretation approaches. In addition, a comprehensive regional geological study was conducted to improve the understanding of possible injectite shapes and categorize the injected feature in the greater Snorre area. This helped also to confine the expected reservoir parameters, as CPIs over the interval of interest are not reliable.

Seismic data conditioning was done in Pre-Stack PRO (Sharp Reflections) software package. Main steps applied were denoise/conditioning, colored inversion, acoustic impedance (AI) and gradient impedance (GI) generation and Extended Elastic Impedance (EEI) generation. Absolute inversion was not an option as wells do not have sufficient log data through injectites in the area or analogue injectites. Further, the AVO response of the injectites is unknown. Only general approximations could be applied to estimate a possible AVO response. The same applies for estimation of a CHI angle for EEI. A CHI angle of -60 degrees was used to approximate shear impedance or lithology and an angle of 20 degrees was used for the fluid factor.

Despite of these limitations, an EEI -60 cube provided an excellent image of the injected sand features. This high quality EEI result allows for 3D geobody interpretation and ESA machine learning workflows. Using this approach together with Petrel geomodelling allowed for a complete visualization of the injected sand bodies in three dimensions (Fig. 3.1).

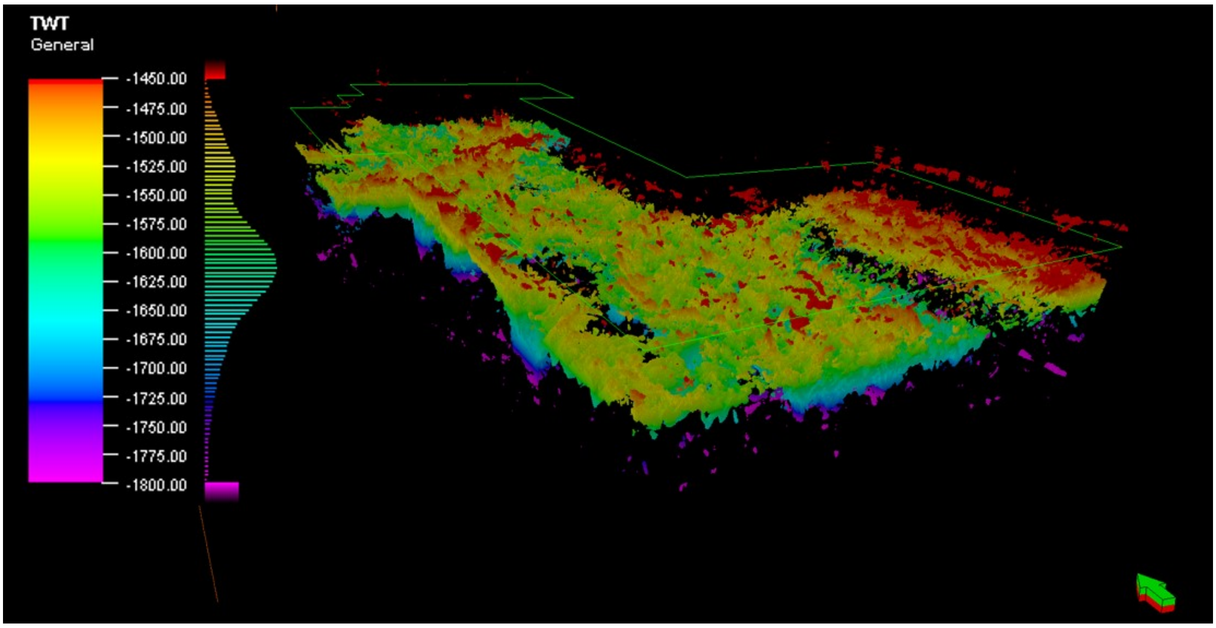


Fig. 3.1 3D view of injectite network over PL1054

Injected geobody interpreted with ESA machine learning and visualized in geomodel with TWT attribute.

As a result the previously mapped sand injectite prospects (Joe, William, Jack and Averell Dalton) where no longer valid. The mapped features on vintage seismic data appear to be part of a larger injectite network. Interpretation focus changed thus to shallower parts of the injectite network. The Gråhegre feature (Fig. 3.2) has a bowl-shaped geometry with wings orientated along a jack-up at Near Top Eocene. It appears to be slightly more isolated than deeper parts of the injectite network. Main injection is towards the North and the sand body in center of bowl is polygonally faulted. Extraction of inversion products on geobody interpretation is an interesting approach to access possible AVO effects, but does not give meaningful results in this setting.

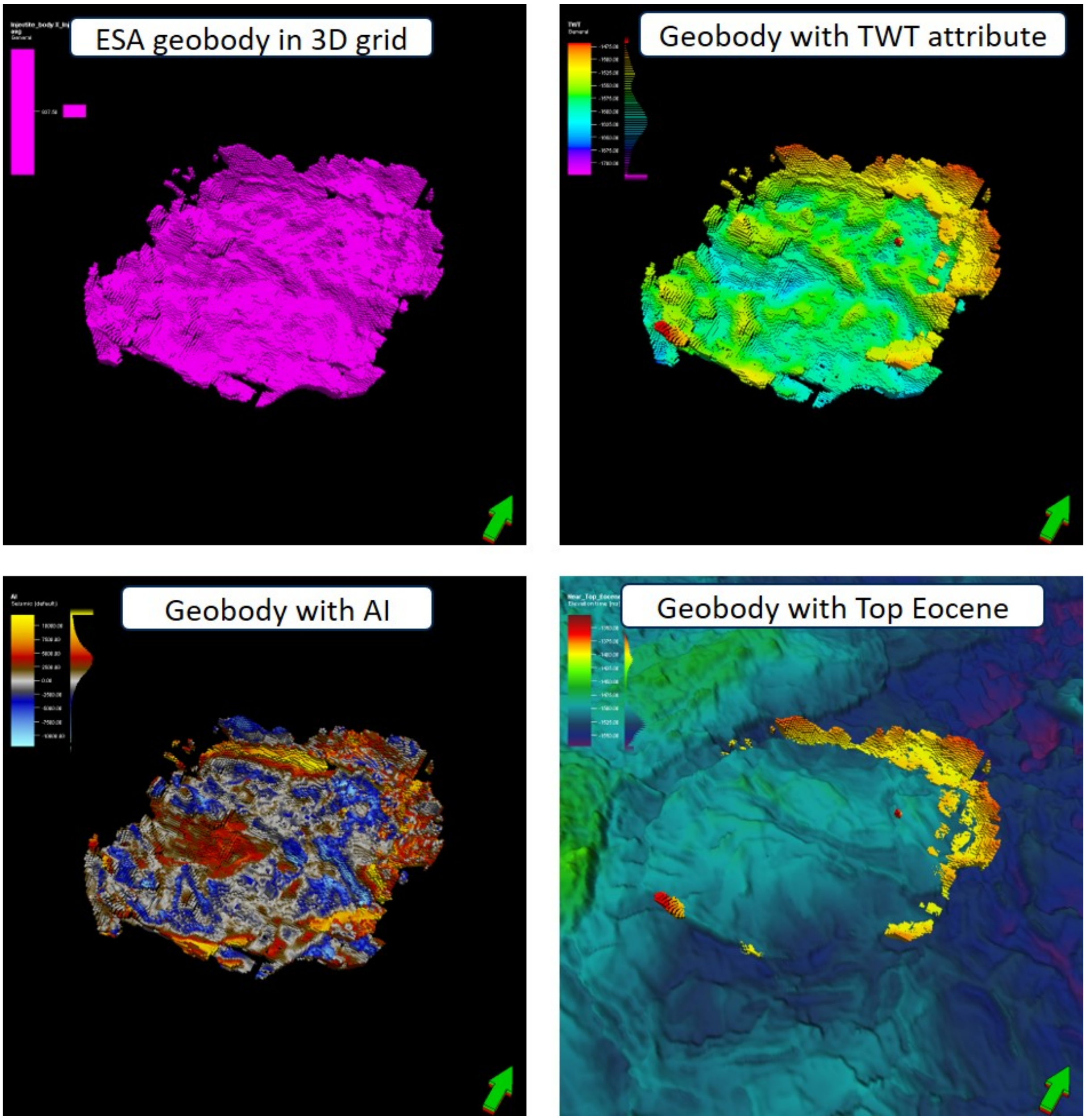
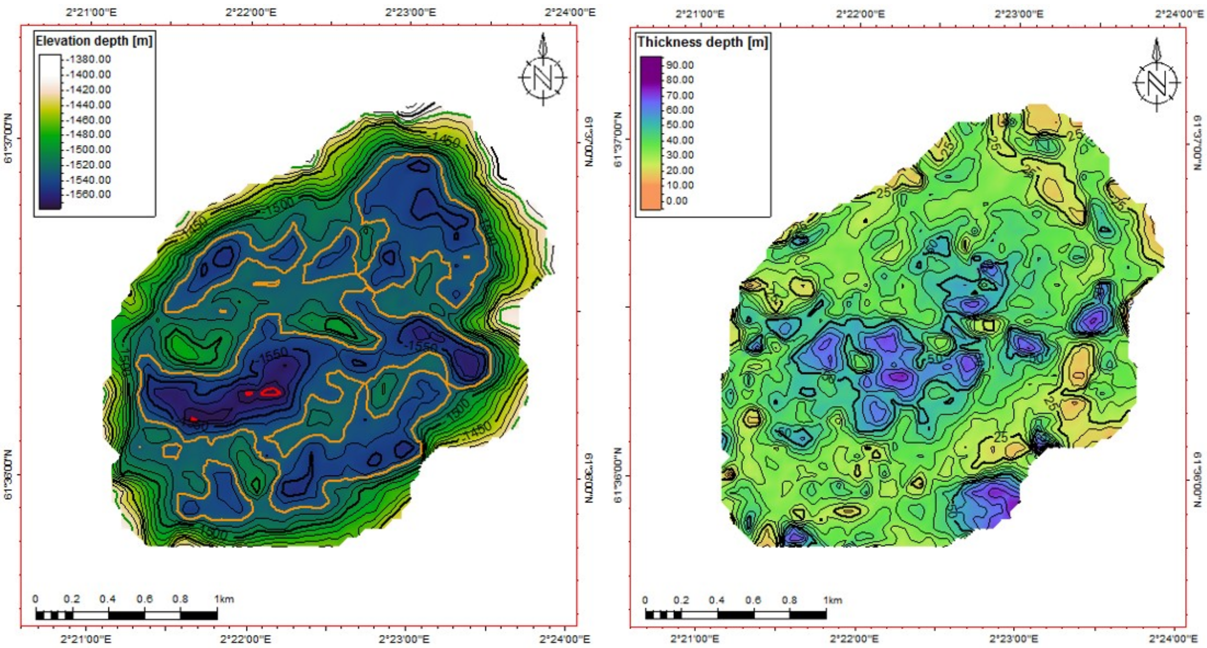


Fig. 3.2 Geobody of Gråhegre prospect

Three dimensional visualization of Gråhegre prospect. Visualization with TWT attribute and Top Eocene surface reveals the expected bowl-like shape with wings orientated along a jack-up.

4 Prospect update report

Gråhegre is the largest of several newly identified prospects. It is structurally less complex than deeper conical injections allowing for manual remapping of top and base reservoir. The upwards thinning wings of the feature are challenging to interpret resulting in uncertainty for the prospect crest. Sub-seismic extension of the wings and sub-seismic crestal intrusion network were difficult to assess. Top and base reservoir were depth converted with a regional velocity model (hiQbe). Fig. 4.1 shows top reservoir depth map with contact scenario and the depth thickness map. Greatest thickness is in the center of the bowl, thinning towards the wings.



Crest:	1380m	HCCH scenario:	
Max spill:	1580m	Min:	1420m
Max HCCH:	200m	Mode:	1530m
		Max:	1580m

Fig. 4.1 Gråhegre top reservoir depth and thickness map

Gråhegre top reservoir depth (left) with contact scenario. Depth thickness map on the right. Greatest thickness is in the center of the bowl, thinning towards the wings.

Main risk elements for Gråhegre prospect are Trap Effectiveness and Access to Charge Effectiveness. Although shallower and slightly more isolated, the tips of injected wings still create possible connections between several injectite features. The wings of the shallower part of the injectite network align with jack-up features visible on Near Top Eocene surface. These jack-up systems were interpreted as sand fairways shed from the west that were subsequently mobilized, and party injected. High risk remains that Gråhegre is part of a shallow injectite network that domes over the Snorre high in the West at Late Eocene levels.

The charge model described in the APA 2019 application is based on possible vertical migration from the Jurassic Draupe source rock and/or by leakage from the Snorre field via reactivated faults. Cretaceous sand lenses with seismic DHI as well as shows and elevated gas reading in several wells over northern Snorre field support this theory. However, no DHI and elevated gas readings or shows are present in the Eocene interval of interest. Pelagic shales of the Rogaland Gp and Lower Eocene appear to effectively disconnect the Late Eocene targets from possible HC migration routes. Lacking any form of AVO response or DHI, WintershallDEA does not see any further potential to de-risk the injectite prospectivity.

Final mean recoverable volumes for the Gråhegre prospect are 23 mmboe with a POSg of 13% (Table 4.1).

Table 4.1 Resource potential

PL1054 remaining volume potential, in place				
	P90 (MMboe)	Pmean (MMboe)	P10 (MMboe)	GPOS(%)
Gråhegre	11.7	47.2	100.6	13

PL1054 remaining volume potential, Recoverable reserves				
	P90 (MMboe)	Pmean (MMboe)	P10 (MMboe)	GPOS(%)
Gråhegre	4.9	23.3	50.8	13

Remaining prospectivity in Neogene and Cretaceous levels (Fig. 1) was re-assessed on the new seismic dataset. The Neogene amplitude anomalies could be confirmed, but are due to size and shallow burial not considered prospective. Extensive analysis of the Cretaceous Betelgeuse anomaly showed low frequency energy bleeding from the BCU to interfere with Betelgeuse amplitude response. Accumulation of organic rich claystone is a more likely explanation for the observed Class IV amplitude response.

5 Technical assessment

The prospect outlines and volumetric assessment has been updated with respect to APA 2019 based on the additional G&G work and interpretation of newly purchased and conditionend seismic data. Remaining risk is significant and the Operator does not see futher potential for derisking. No DHI could be detected in the entire injectite network over PL1054. The relatively low and uncertain volume potential (Table 4.1) together with significant risk result in negative economic potential. Therefore, the partnership has unanimously decided to drop the license.

6 Conclusion

In the view of the partnership, the opportunities identified in license PL1054 do not present drillable targets, based on our current technical understanding and the significant risks of finding an economic accumulation of hydrocarbons.