

# PL887

## Status Report at License Lapse

PGNiG Upstream Norway AS

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Petrolia Noco



June 2020

# **PL887 Status Report at Licence Lapse**

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- EC/MC Meeting No5 - 21.11.2018
- EC Meeting No6 - 12.04.2019
- EC/MC Meeting No7 - 22.10.2019

The license work obligations have been fulfilled. One seismic survey of 100 square kilometers was purchased (parts of MC3D-HVG2011) and G&G work including seismic data conditioning and inversion were performed.

In 2019 PGNiG Upstream Norway AS, on behalf of PL887 license obtained 1 year extension with a work program to purchase and analyse electromagnetic data, and conduct additional seismic inversion on FP13M1 and additional geological studies.

Based on the results from the studies and the internal work, the Operator recommended to partners to drill a well on Novus East Prospect in the license. The partners however did not support the Operator's recommendation.

The Operator then applied for an additional 4 months license extension to secure new partners that could support a drill decision. Despite the Operator's efforts, no new partners who could support a drill decision were found.

A recommendation to relinquish the PL887 license was supported by all partners in May 2020.

The license lapsed on 1<sup>st</sup> June 2020.

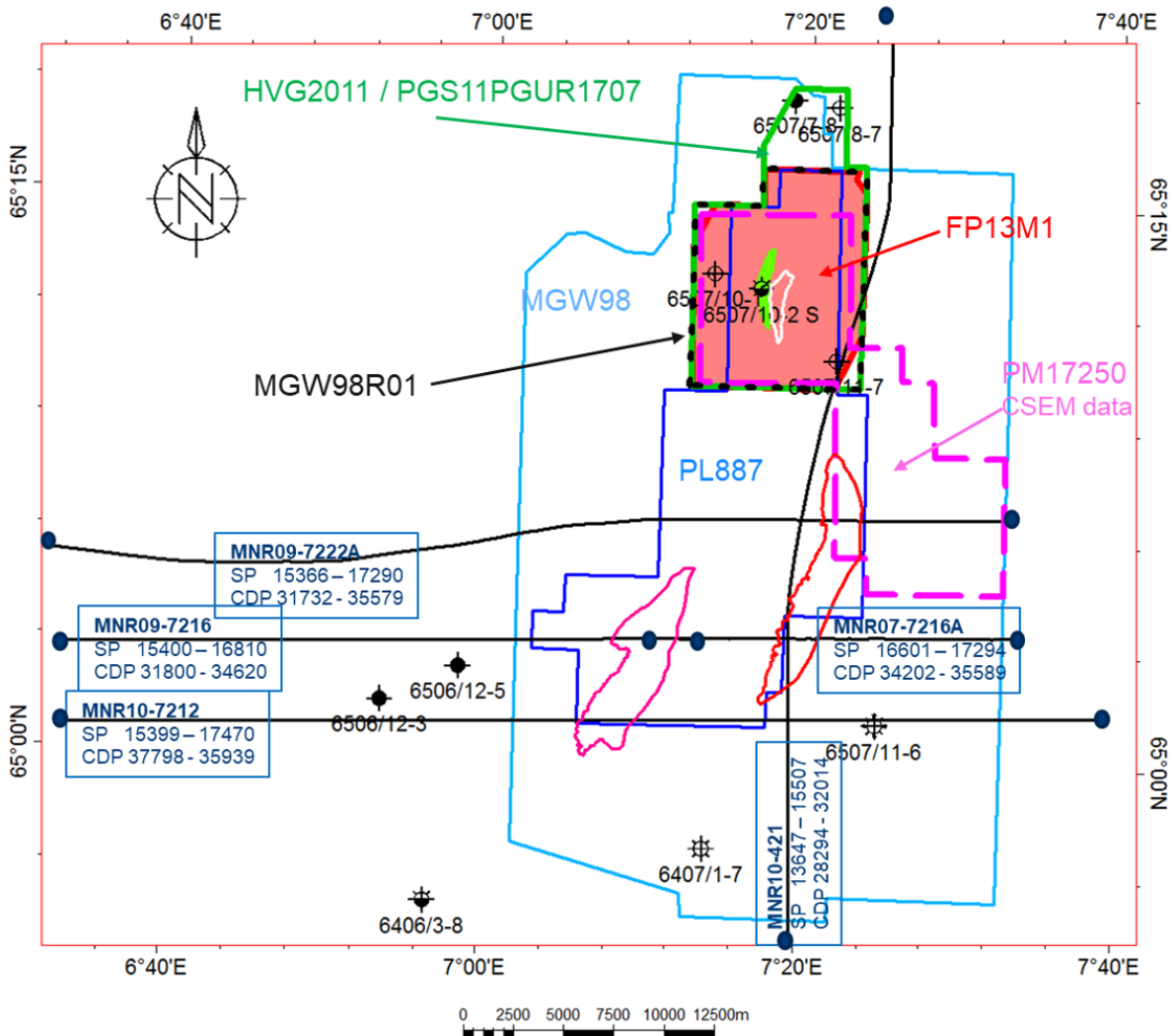
## 2 Database overviews

### 2.1 Seismic data

To image the prospectivity in the license parts of the multi-client 3D seismic dataset MC3D-HVG2011 was purchased from PGS. The dataset is a modern broadband seismic dataset of good quality, that was used both for interpretation, AVO and inversion studies in the license. Other seismic datasets that were used for regional work are shown in **Table 2.1** and **Fig. 2.1**.

**Table 2.1 Seismic database**

	NPIDID	Area (km2)	Original Data	Year	Public	Quality	Comments
<b>3D Seismic Datasets</b>							
MC3D-HVG2011	7379	100	HVG2011	2011	NO	High	Recent 3D seismic broadband technology from PGS
PGS11PGUR1707		98.5	HVG2011	2017	NO	High	Conditioned datasets and inversion project
FP13M1PGUR19		98,5	HVG2011	2019	NO	High	Conditioned datasets and inversion project
MGW98	3914	881	MGW98	1998	YES	Poor to good	Conventional survey, used for regional interpretation
MGW98R01		86	MGW98	2001	NO	Good	Part of MGW98, reprocessed by PGS in 2001
FP13M01		83	MGW98, CN-86, ST9102, BPN0002	2014	NO	Poor to good	Merged survey, reprocessed by PL645 before drilling Novus West well
<b>2D Seismic Datasets</b>							
MNR07	4450	4 lines appr. 50 km each		2007	No	Good	Regional 2D survey, used for preliminary AVO evaluation of the Jurassic and Lange leads
MNR09	7001			2009	NO		
MNR10	7224			2010	NO		
<b>CSEM</b>							
PM17250		140		2017	NO		EM data acquired by PetroMarker using static VED source and receiver in time domain.



**Fig. 2.1 Seismic and well database**

The preconditioned seismic cubes and important inversion cubes have been reported to Diskos. EM data will also be reported to Diskos.

## 2.2 Well data

The well database includes the key wells, especially around the Novus discovery - 6507/10-1 and 6507/10-2S Novus West.

In addition the Heidrun wells - 6507/7-8 and 6507/8-7, were included in well database.

The wells have been studied to evaluate the reservoir parameters for the Novus East prospect. The wells were the subject of several external and internal studies, which were performed for the licence (**Table 2.2**).

**Table 2.2 Well database**

Well	NPDID	Name	Water depth m	Year	TD m MD RKB	Fm/Gp at TD	Operator	Status	Raw data availability
6507/10-1	81		297	1982	3693	Åre Fm.	BP	Dry	Public
6507/10-2S	7300	Novus	297	2014	3020	Åre Fm.	Faroe	Oil/Gas	Public
6507/7-8	1071		332	1987	2855	Åre Fm.	Conoco	Oil/Gas	Public
6507/8-7	4854		333	2004	2975	Tilje Fm.	Statoil	Dry	Public

### 3 Results from Geological and Geophysical studies

The following studies, internal and external, have been performed to evaluate the prospectivity in the license:

- Detailed mapping within Jurassic and Cretaceous;
- AVO modelling;
- Two seismic inversion studies and joint interpretation of HVG2011 and FP13M01 results - WesternGeco 2017 and 2019;
- Petrophysical study;
- Depth conversion;
- Fault seal analyses;
- Pressure analysis;
- CSEM feasibility study - Rock Solid Images;
- EM analyses, modelling and 2D inversion - PetroMarker;
- Geo-model building and reservoir modelling - cooperation with Ross Offshore;
- Well and development cost benchmarking - Ross Offshore and Wood.

This section summarizes the main results of the geological and geophysical work and external studies carried out on the licence.

#### Seismic interpretation

A detailed interpretation of several Jurassic horizons (BCU, Melke, Garn, Ile, Ror, Tilje, Åre, Åre Coal Marker) was carried out at the Novus West discovery and Novus East prospect based on the HVG2011 seismic survey (**Fig. 3.1**), (**Fig. 3.2**). The seismic interpretation was tied to wells within the seismic survey (6507/10-1, 6507/10-2S, 6507/7-8, 6507/8-7). Extensive fault interpretation was carried out to aid in definition of the trap geometry.

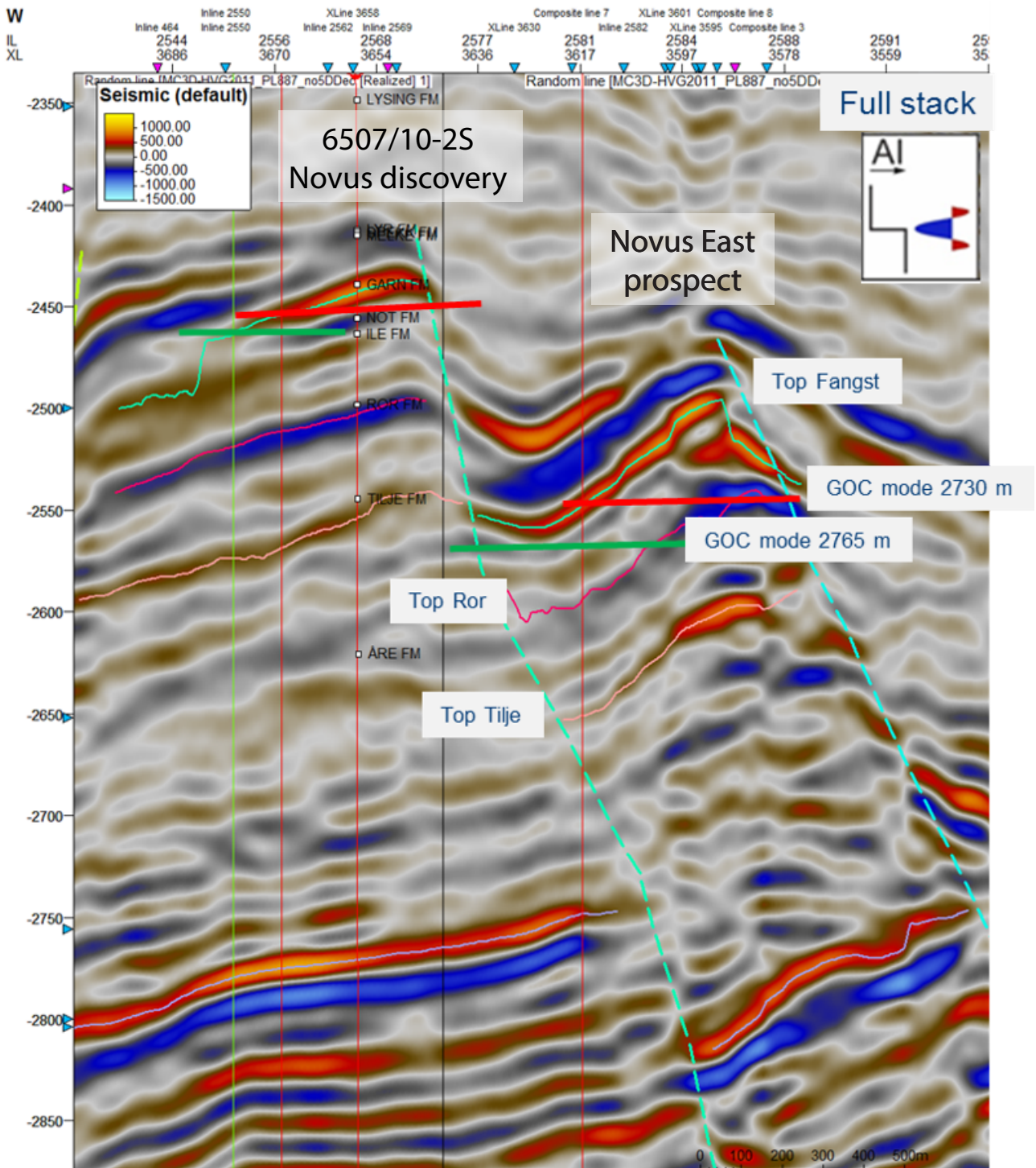


Fig. 3.1 Seismic interpretation

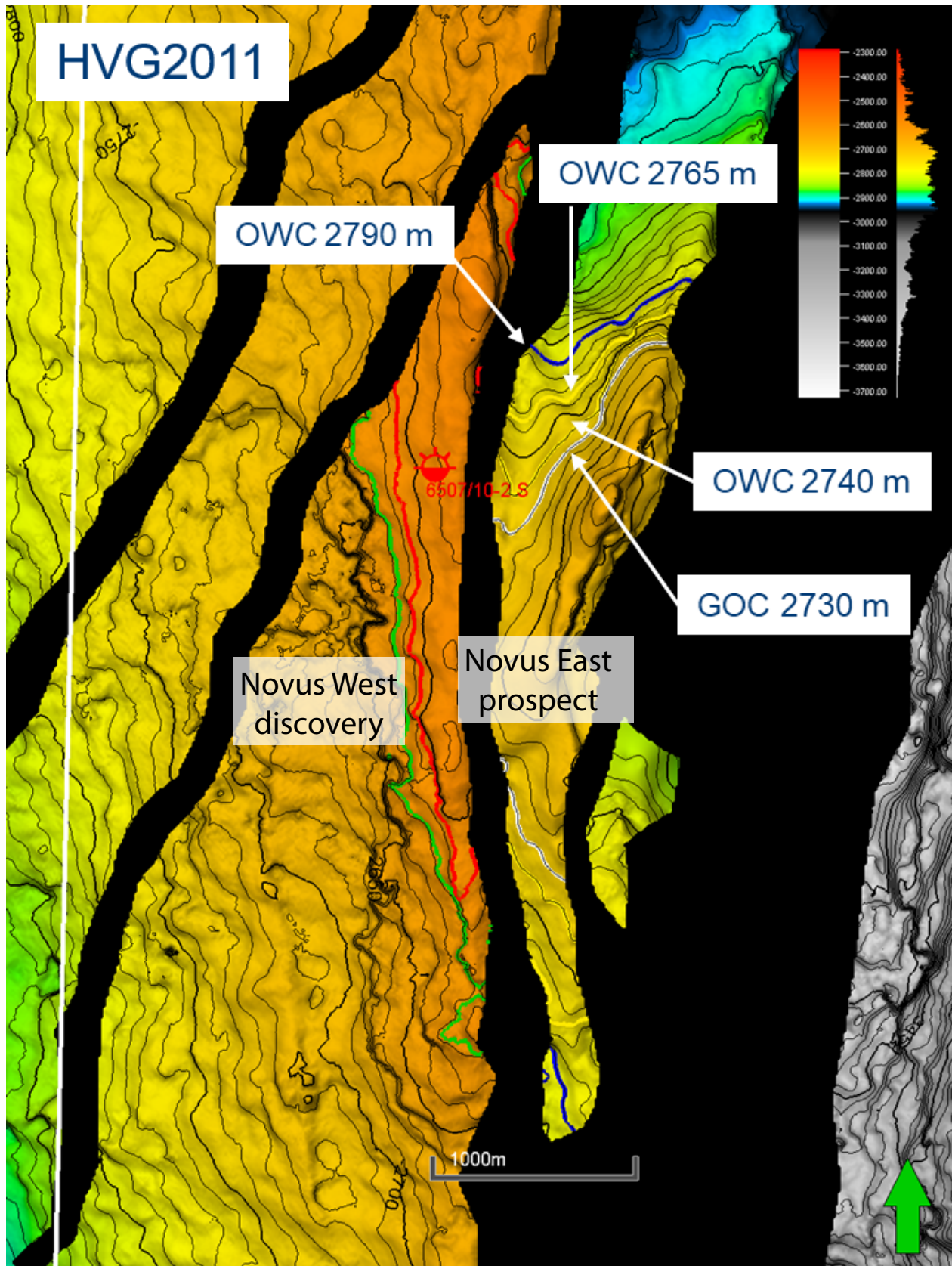


Fig. 3.2 Top Fangst structural depth map Assumed contact distribution for the Novus East is presented on the structural depth map.

In addition, the Cretaceous Lysing and Top Lange horizons were interpreted to map out possible thief sands juxtaposed with the Jurassic reservoir.

The interpretation was used for Fault Seal Analysis (FSA) and as input to the inversion studies.

In parallel, extensive mapping of Early Cretaceous and Jurassic horizons was performed on MGW98 to cover southern part of the license. These horizons were used in the CSEM study and for mapping prospectivity south of the Novus area.

An AVO study was performed to identify HC content and contact distribution in the Novus East prospect.

The AVO study's results are as follows:

- AVO class II/III is present over the Novus West discovery;
- AVO class II/III and IV is seen over the Novus East block;
- Class II/III on the northern flank of the Novus East is interpreted as HC-bearing Garn Fm. sandstones;
- Class IV on the flank is interpreted as water-bearing Garn Fm. sandstones;
- Class IV at the crest is possibly an effect of Melke Fm. shales on top of the Ile Fm. sandstones (thin Garn or lack of Garn Fm. in crestal position)(Fig. 3.3).

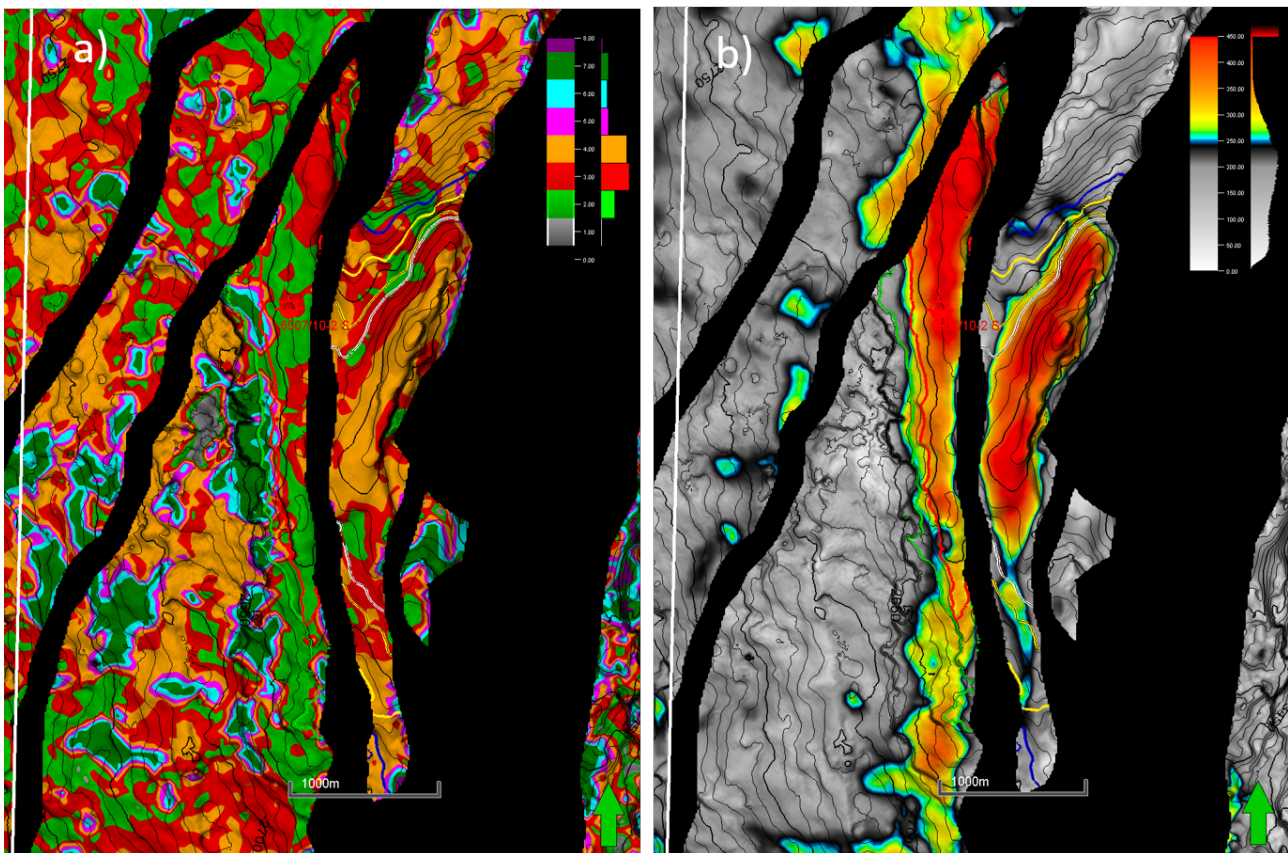
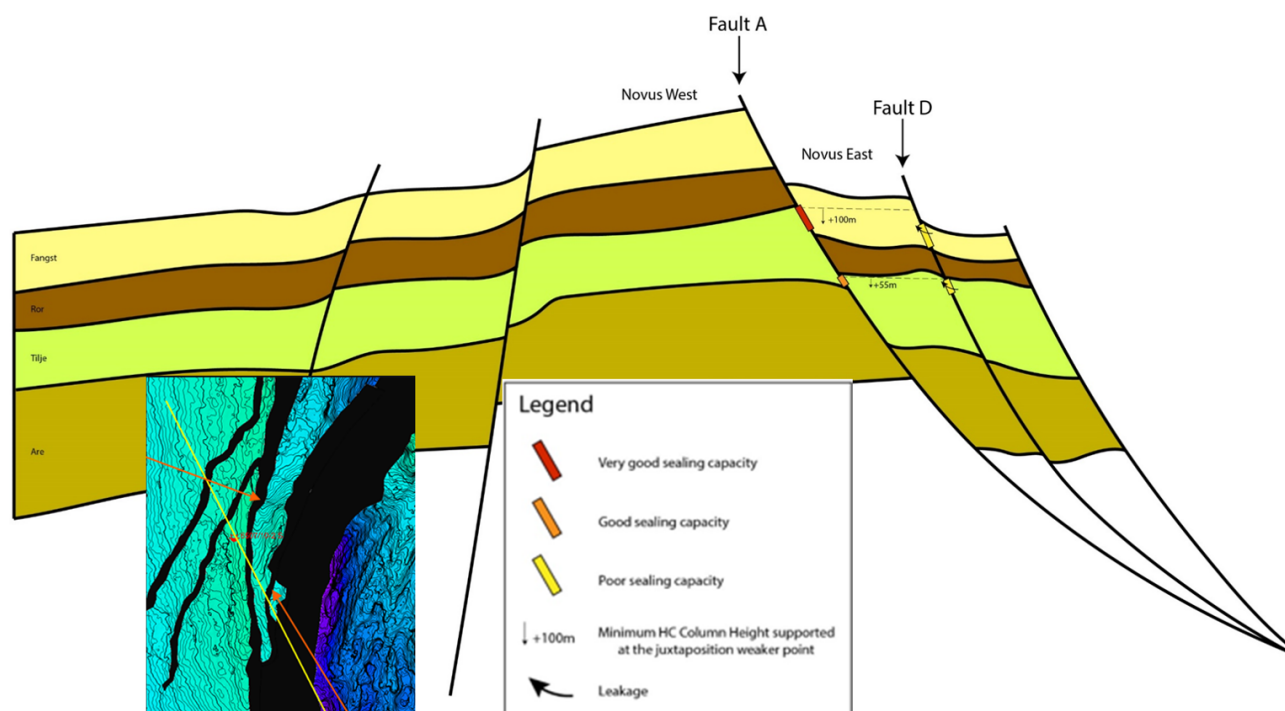


Fig. 3.3 AVO analysis AVO performed on HVG2011

- a) AVO classes
- b) Fluid factor

**Fault Seal Analysis (FSA)** was performed in-house, using TrapTester 7 software. Four wells were used in the fault seal analysis to estimate the shale content (6507/10-1, 6507/7-8, 6507/8-7 and the 6507/10-2S).

The analysis determined the sealing properties of the fault separating the Novus West and Novus East structures (Fault A) in juxtaposed intervals Tilje-Fangst and Tilje-Tilje. It also allowed determination of the minimum HC column height which can be held in the Fangst Gp and Tilje Fm. (**Fig. 3.4**).



**Fig. 3.4** Fault Seal Analysis

### External studies

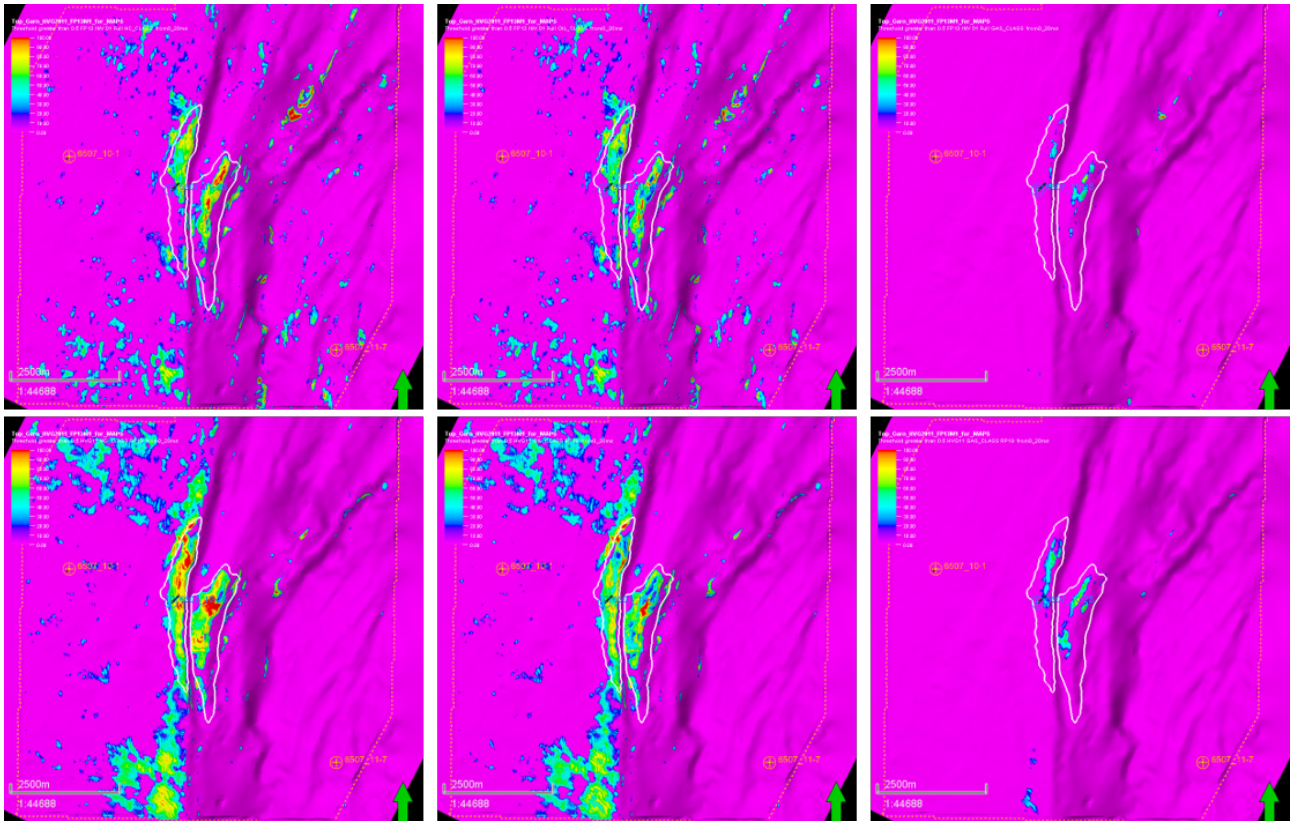
**Seismic inversion studies** were performed by the WesternGeco (WG) in 2017 and 2019.

The objective of the first study was to:

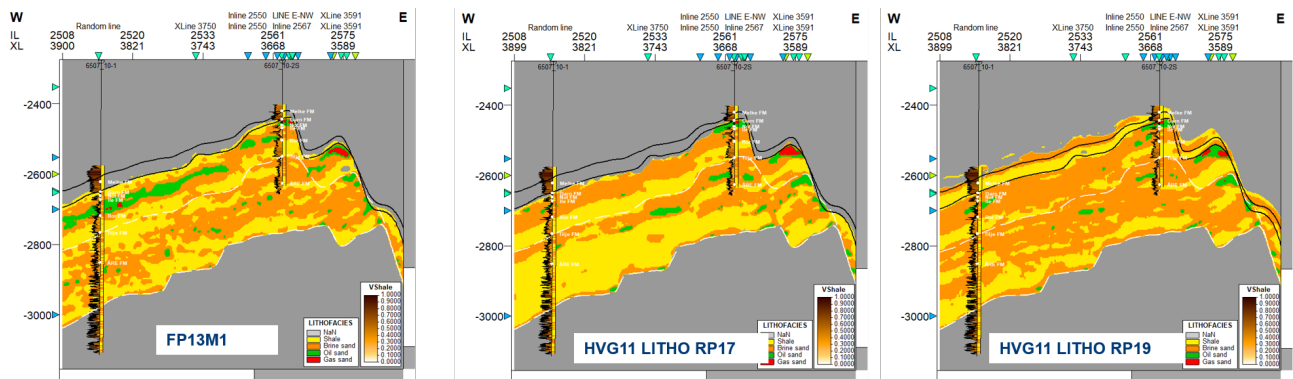
- identify and prove an oil leg in the Novus East prospect, in the Fangst and Båt Gps.
- indicate reservoir parameters
- identify any HC effects for all the prospective levels.

The final inversion (performed on HVG2011 dataset) suggested the presence of hydrocarbons in the Fangst Gp and also in the Tilje Fm. Bayesian lithology classification was able to separate HC sands, and even gas and oil saturated sands. It did not, however, confirm a very deep HCW contact in Novus East structure, as anticipated based on earlier analysis (PL645 work and the Application phase).

To solve the question of contact distribution and presence of oil leg beneath gas cap in the Novus East prospect, a second inversion project was run by WG (2019) on two datasets - HVG2011 and FP13M1, to derive a single, comprehensive interpretation of the fluids distribution in the reservoir (**Fig. 3.5**), (**Fig. 3.6**).



**Fig. 3.5 Inversion - lithology classification on the two datasets** Upper maps - FP13M1, Lower maps - HVG11 LITHO RP19; HC cumulative class (left), Oil class (middle), Gas class (right).



**Fig. 3.6 Lithology classification - seismic sections RPM used for litho-class analysis (2017 vs 2019)**

The conclusions of the analysis are as follows:

- The two datasets lead to similar prospect interpretations, although the HVG2011 data seems to be superior for prospect characterization;
- The inversion outcomes and corresponding lithology classifications do not provide a clear indication of the type of hydrocarbon at Novus East;
- Further evaluation of the AVO outcomes (intercept/gradient, inversion and classification results), based on the calibrated rock model, supports interpretation of the absence of Garn Fm. and presence of oil sand in the Ile Fm. at Novus East;

- The nature of the AVO anomaly south of Novus West is compatible with presence of hydrocarbon. The lateral extend of the hydrocarbon sands south of Novus West, requires further geological evaluation.

**EM studies** were carried out to investigate the HC presence in the Novus East structure with a focus put on the indication of possible deeper HC contacts.

Rock Solid Images (RSI) performed a sensitivity modelling study and synthetic inversion.

PetroMarker performed more extensive work including:

- Sensitivity study in 2D (several scenarios) and 3D (4 models);
- Reprocessing of Petromarker CSEM data;
- New 2D inversion of real data for 7 CSEM lines covering the Novus area;
- 2D inversion of synthetic scenarios.

Results:

- The sensitivity study performed by RSI showed an anomaly of ~10% for Novus East (with deeper OWC at 2750 m). This is a lot higher than what Petromarker presented (the 2D and 3D sensitivity study indicated sensitivity of 2-4% for Novus East);
- From 2D unconstrained and constrained, and 3D constrained inversion, increased resistivity appears below the BCU. Laterally, the strongest anomaly is observed in the area of Novus West;
- Other factors that might explain a response similar to the one observed from the 2D and 3D inversion are the geological background structure (with no strong resistors) and antimodels like high-resistive coal and salt;
- In addition, the survey geometry, e.g. receiver/transmitter density may also have an impact on the inverted response;
- Factors related to data quality and inversion methodology may also be an issue in this case with very low sensitivity to the target.

In conclusion, Novus East was too narrow to be resolved using PetroMarker EM technology.

As a result, PGNiG did not recommend to use Petromarker data to de-risk Novus East.

## 4 Prospect update report

Previously the area was awarded as PL645 (block 6507/10) in 2012 to Skagen44, Faroe Petroleum Norge AS and Centrica Resources (Norge) AS as part of the APA 2011 round. The main target was the Novus Prospect, which consists of two structures, the Novus West and Novus East, both supported by strong amplitude anomalies. The discovery well 6507/10-2 S was drilled on the Novus West prospect in 2013 and targeted reservoirs of the Middle Jurassic Fangst Group (Garn and Ile Fms) and Tilje Fm. The well proved gas with an oil leg in the Garn Fm. The well drilled both the GOC and the OWC (the 2-meter lowermost part of the Garn Fm. is water bearing).

The Novus East prospect was the main object of investigation in the in PL887 license. The Prospect is located on a westward dipping downfaulted segment. The trap is defined as an 3-way closure, limited by faults to the west and east. The major fault to the west separates the Novus East prospect from Novus West, and is assumed to be sealing. The southern part is limited by the two faults merging into one. A similar Jurassic sequence in the Novus East was expected as in the Novus discovery, with the same excellent reservoir properties to those proven by well 6507/10-2S. This is due to the nearby location, and that the Jurassic sequence was deposited before down-faulting and rotation of the Novus East segment. The top seal consists of Upper Jurassic shales of the Spekk and Melke Fms.

Novus East amplitude anomalies indicate HC presence in the Garn, Ile and Tilje Fms.

Mapping of the main horizons (Garn, Ile, Ror, Tilje) showed thickness variations in the Novus structures with smaller thickness of the Fangst Gp in Novus East area.

AVO analysis showed different AVO classes in Fangst Gp between the Novus prospects (see Section 3). The assumed explanation was possible thickness reduction of the Garn Fm.

The main challenge was to determine the HC contact distribution for Novus East. The inversion studies and AVO analysis (described in Section 3) indicated shallower contacts than assumed in Application. The final HC column height distribution is 80 - 105 - 130 m (Min-Mode-Max) compared to 260 - 280 - 300 m (P90-P50-P10) in Application, which decreased the in-place resources compare to original calculations (**Table 4.1**), (**Table 4.2**).

**Table 4.1 Volume update**

In-place	Oil (MSm3)				Non-ass. Gas (BSm3)				TOTAL (MSm3)				COS %	
	Mean	P90	P50	P10	Mean	P90	P50	P10	Mean	P90	P50	P10		
Application														
NE Fangst	25.3	19.2	24.2	31.8										20
NE Tilje	10.1	2.55	3.01	20.4										20
PL887 evaluation														
Novus East Fangst	5.74	3.53	5.66	8.05	1.46	0.71	1.47	1.71	8.71	5.96	8.61	11.6		57
Novus East Tilje oil case	4.18	0.83	2.79	9.69					5.02	0.99	3.35	11.6		42
Novus West	1.58	1.41	1.59	1.72					2.65	2.42	2.66	2.85		100



The High Chance of Success (CoS=57%) is an effect of application of the SAAM methodology (geological CoS is 27% plus 30% DHI uplift).

### Other prospectivity

**The Grøneskaret** lead is a structural trap located in southern part of PL887 license, in the Grinda Graben (**Fig. 4.1**) The lead is defined as 3-way dip closure with fault seal towards the East. Top reservoir (probably Garn Fm., but presence of Garn Fm. is not certain) is a depth conformant amplitude anomaly, dimming up-dip (**Fig. 4.2**), (**Fig. 4.3**). Geophysical analysis were not performed as preliminary calculations did not show promising volumes (**Table 4.3**). The lead was considered as rather risky object due to structure depth and uncertainty of the reservoir interpretation (**Table 4.4**).

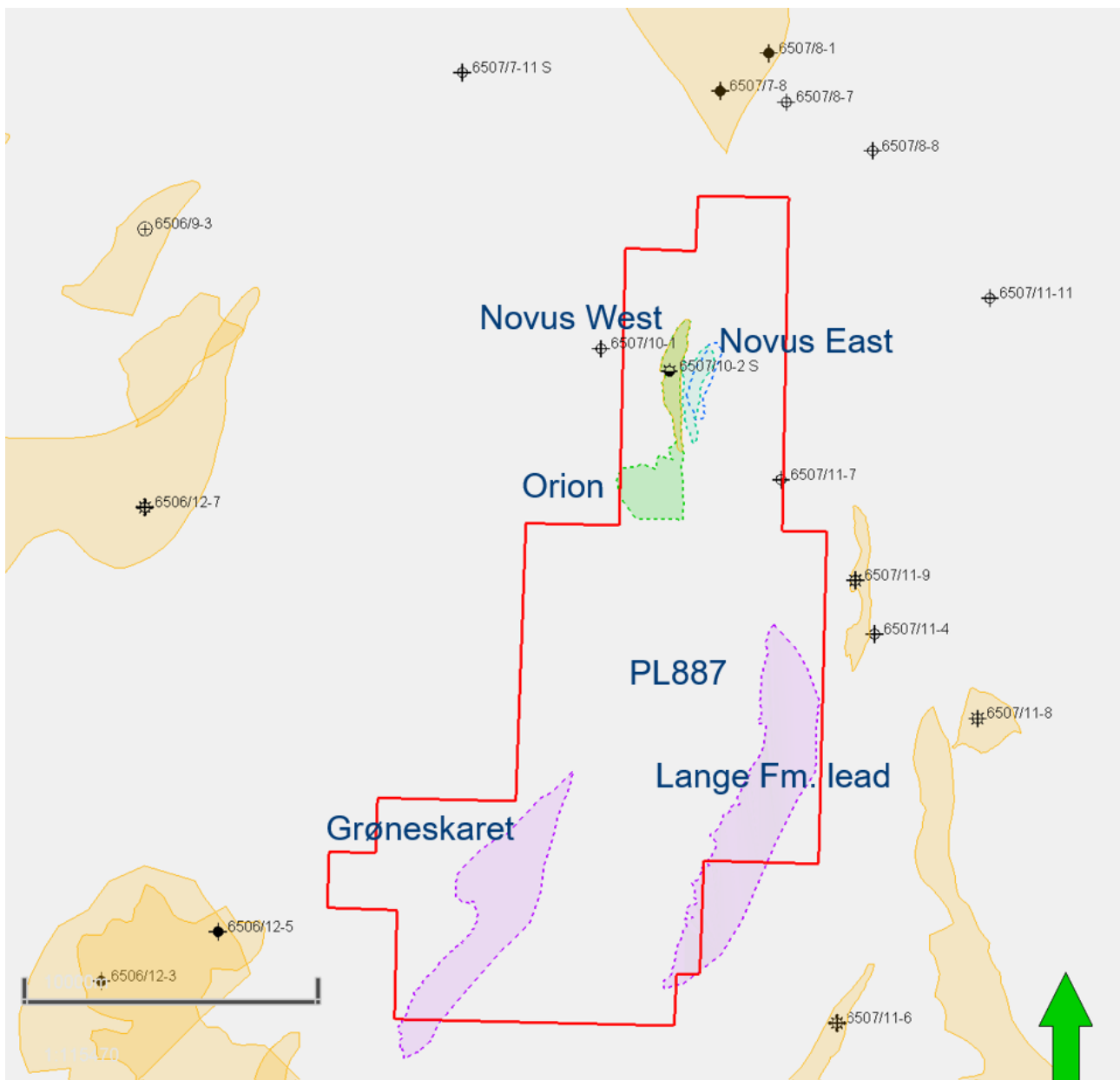
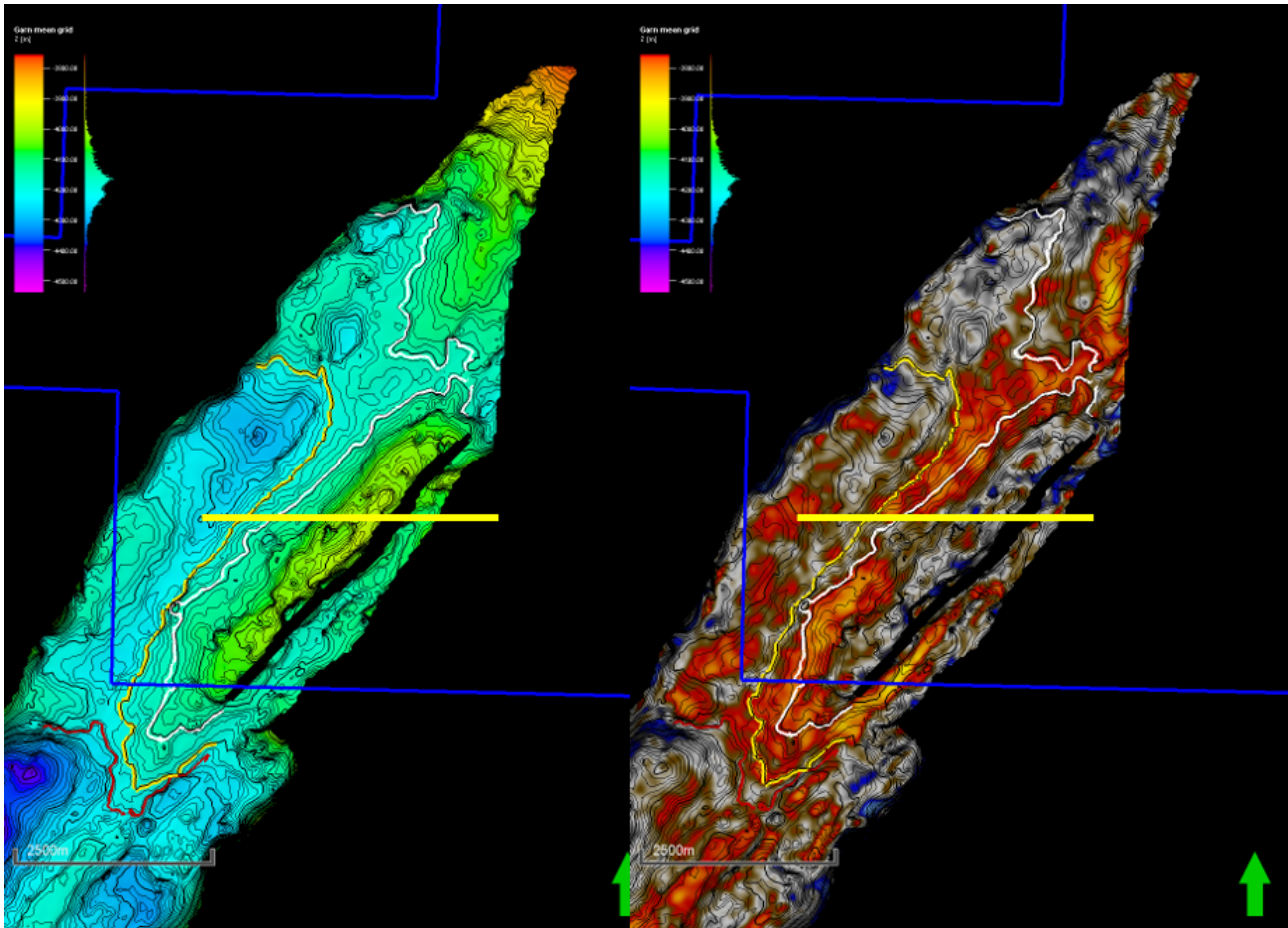
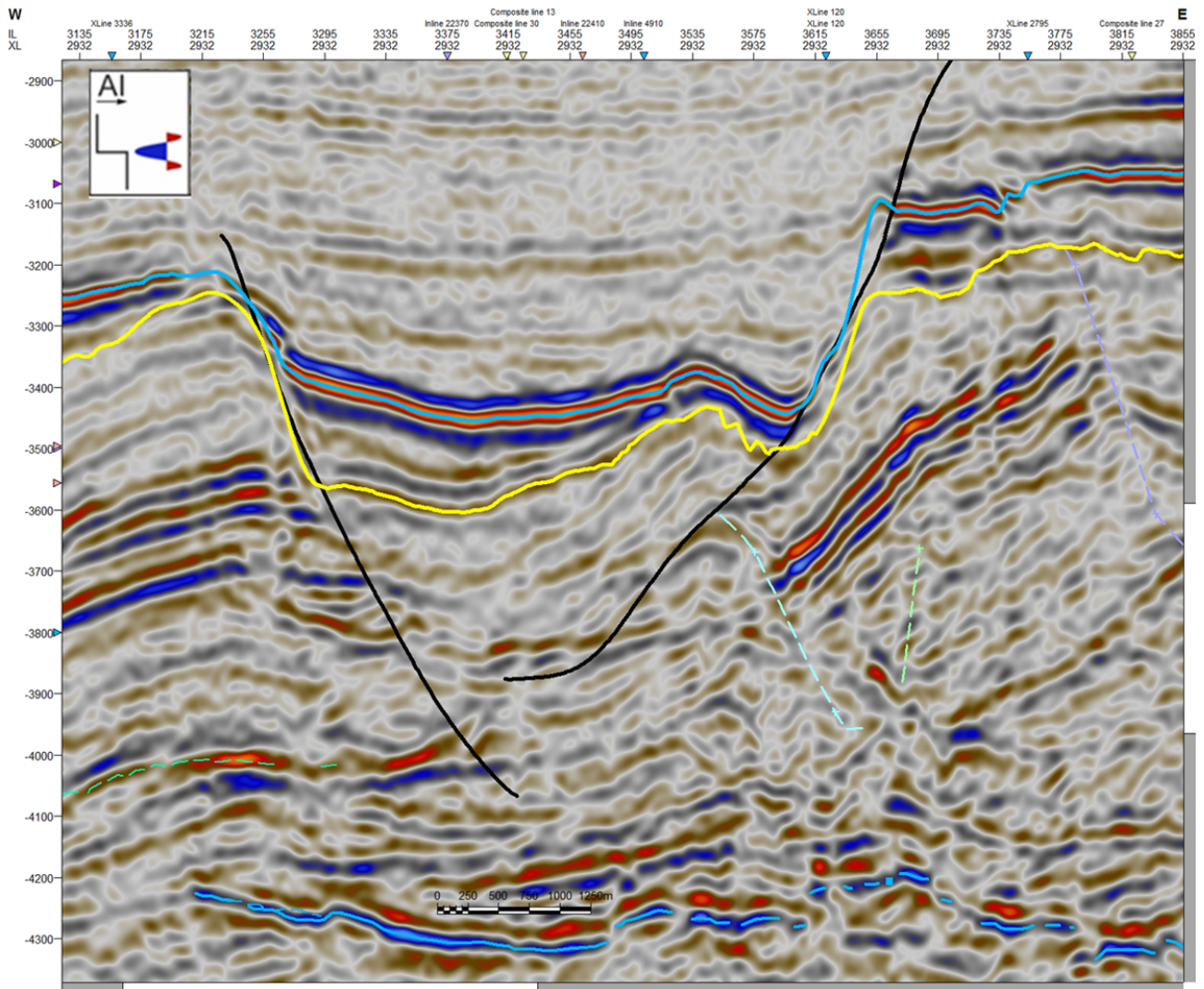


Fig. 4.1 PL887 prospectivity



**Fig. 4.2 Grøneskaret** Left - structural map of Top Reservoir.  
Right - amplitude extraction from Top Reservoir horizon.  
Contacts used for preliminary volume calculation are shown on the maps.  
The northern structure is included in volume evaluation in max case.



**Fig. 4.3 Grøneskaret** Seismic section line marked on the map above. Top reservoir interpretation is shown as a yellow horizon.

**Table 4.3 Grøneskaret volume calculation**

<b>Oil MSm<sup>3</sup> rec</b>	<b>P90</b>	<b>P50</b>	<b>P10</b>
Prospect analysis	0.19	0.93	2.38
Southern structure	0.88	1.75	3.13
Northern structure	0.84	1.68	3.01
Max case	4.18	8.45	15.15

**Table 4.4 Risking for the Grøneskaret lead**

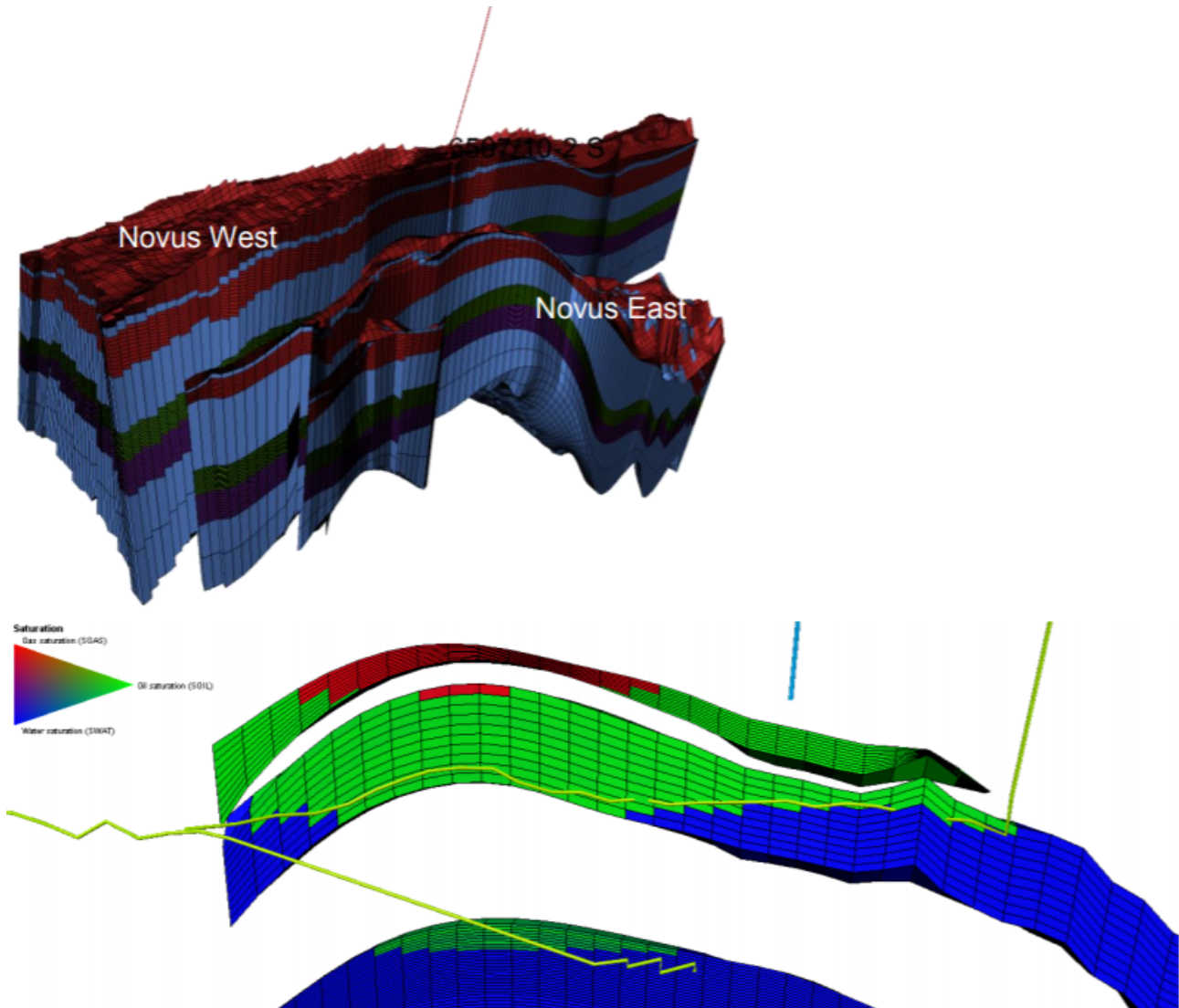
<b>Risk factor</b>	<b>P(segment)</b>
Trap Geometry	0.7
Trap Seal	0.75
Reservoir Presence	0.8
Reservoir Quality	0.6
Source Presence	0.85
Source Migration	0.8
<b>CoS</b>	<b>0.17</b>

**The Lange Fm. lead (Fig. 4.1)** was defined as a non-depth conformant amplitude anomaly. The anomaly was visible as a hard response (increase of acoustic impedance) on full stack MGW98 dataset. The amplitude was assessed, by comparison to 6507/11-7 Zita well, as reflection from possibly tight sands. The lead was not further evaluated.

**The Orion lead (Fig. 4.1)** is located south of Novus West discovery. The lead was identified in final stage of the Novus East evaluation as an amplitude anomaly at top of the Garn Fm. The Orion lead is complex structural trap with a stratigraphic component. The latest inversion results and modelling performed by WesterGeco for the Novus area indicate good reservoir with possible oil saturation for Orion. Relation between the Novus West and Orion is not clear: one of analysed scenarios assumed connection between them which would require that the 2 m water column in discovery well is a perched water, instead of a free water level being present. Further in-house AVO analysis and rock-physics modelling did not give unequivocal results and did not allow for conclusion on trap definition and HC content.

## 5 Technical evaluation

A technical evaluation and an economic analysis were performed for the Novus East prospect. In-place volumes were generated in GeoX, and the permeability range was populated from petrophysical analysis of offset wells (**Fig. 5.1**). A tie-back to the Heidrun field (12 km away) was considered, as volumes were too small to justify a stand-alone development. The prospect would be developed as a subsea tieback, utilizing subsea templates.



**Fig. 5.1 Simulation model** Overview of the simulation model. Upper figure giving a 3D overview of the two prospects and the lower figure giving a 2D overview of the Garn, Ile and Tilje formations in Novus East.

The Operator's economic evaluation of Novus East shows that the EMV of the prospect was positive in late 2019. NPV was positive both for the Mean and P10 cases.

## 6 Conclusion

An extensive work was done to evaluate HC potential of the Novus East prospect. One of the goals of the performed analysis was to document a deeper HC contact. As the analysis do not confirm deeper contacts, the Novus East prospect is considered as a small prospect with high geological CoS.

Despite the small volumes, the Novus East prospect turned out to be economically viable and a drill decision was recommended by the Operator.

Reasons for negative decision:

Based on the geological and geophysical evaluation, and positive economical analysis, the Operator recommended to drill the Novus East prospect. The license partners did not support the drill decision. An attempt to find new partners was unsuccessful.

According to voting rules the license was therefore dropped.

## References

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