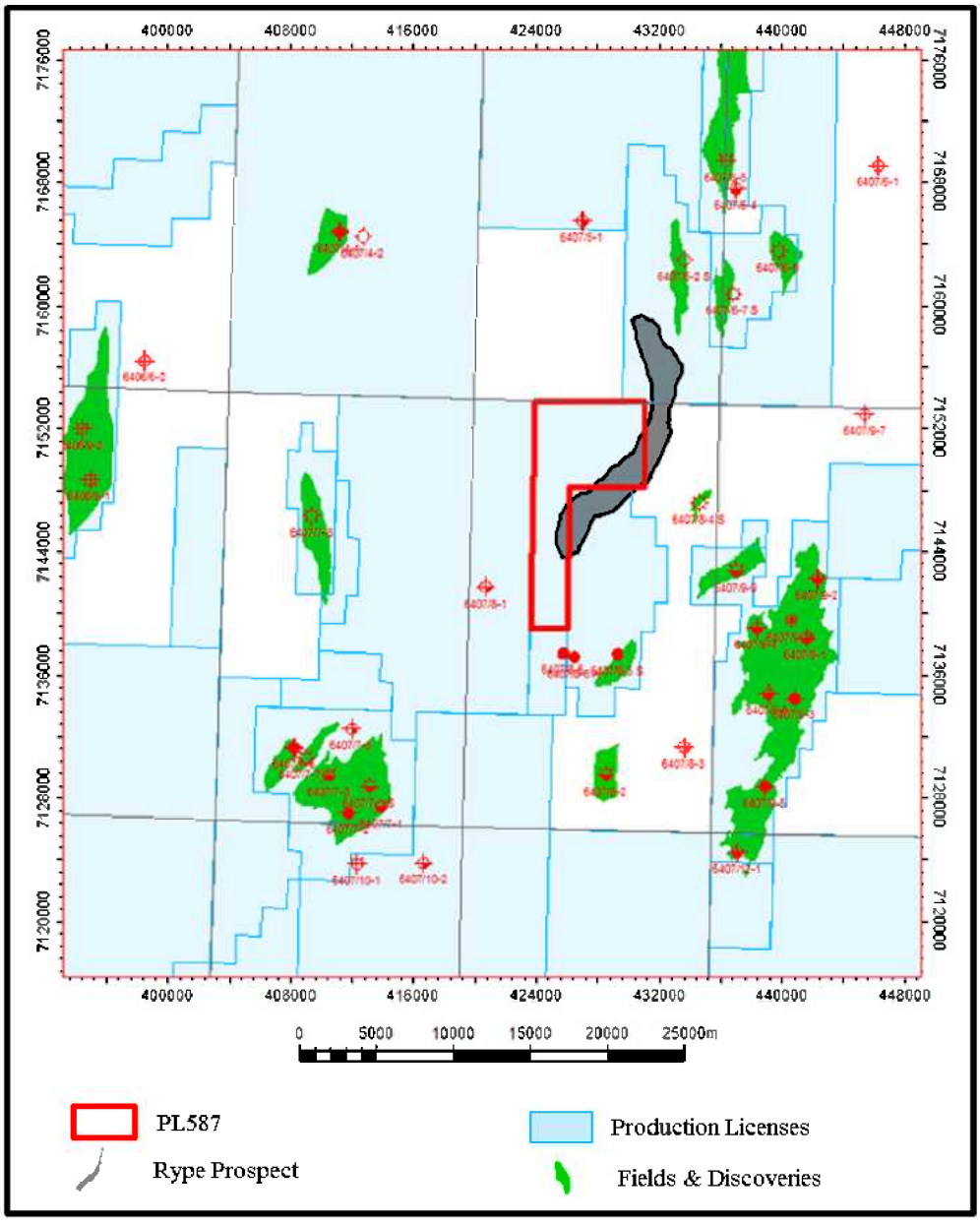
Edison Norge

# PL 587

# Relinquishment Report

## April 2015



# PL 587 Relinquishment Report - Contents

# 1. License History

## *1.1 Executive summary*

PL 587 (fig. 1.1) is located in the Norwegian Sea (Halten area), positioned to the NE of the Njord field and 15 km to the NW of the Draugen field. The area is close to the new oil discoveries 6407/8-6 & 6407/8-6A (Snilehorn).

The play concept at the Rype Prospect is defined by a hanging wall trap formed at the western margin of the Bremstein Fault Complex, were the Jurassic sands within the Gimsan Basin are juxtaposed to Triassic and older basement rocks; the closure in the strike direction to the SW and NE is provided by a rollover. The main reservoir target is expected to be the shoreface sands of the Garn Fm. Ile, Tilje and Åre Fms. are considered as secondary targets. Top seal is provided by the Upper Jurassic Melke and Spekk Fms. The trap effectiveness and the reservoir quality are considered as the main risks.

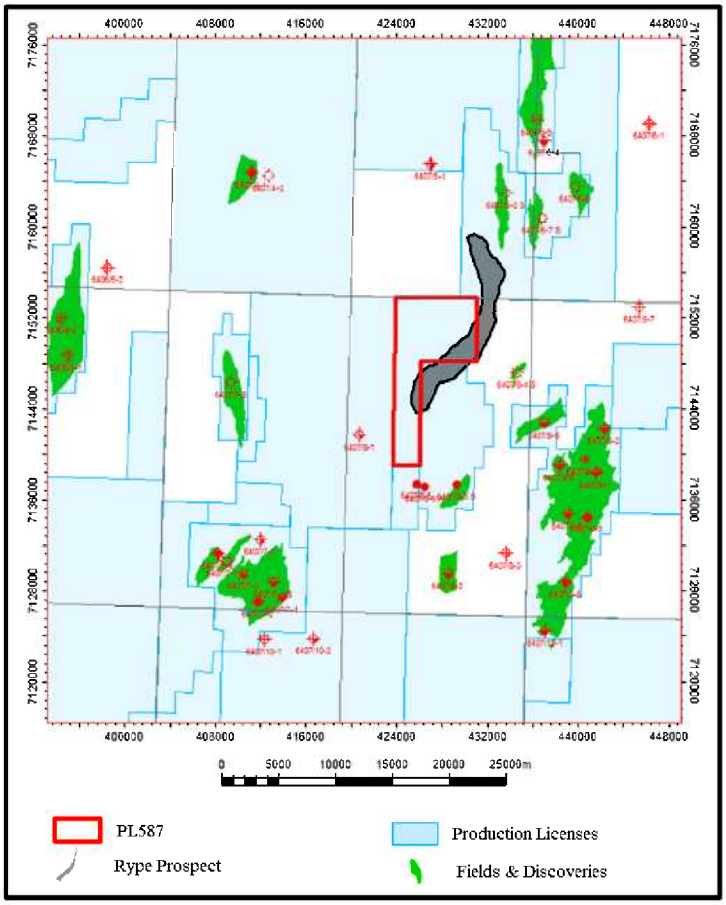



**Fig. 1.1** *Map showing the current PL 587 licensed area, nearby licenses and discoveries. The evaluated Rype prospect is outlined in the figure.*

The area was applied for in APA 2010 and PL 587 was awarded in February 2011. Several comprehensive studies have been performed on the license in order to decrease the main risks related to trap seal and retention, as well as to the reservoir quality.

The license work program is listed in section 1.2. The work program has been fulfilled and the main objectives were to obtain new data and conduct studies in order to reduce risk and improve the understanding of the prospectivity. The licensee applied for a one year postponement of the drill or drop decision to incorporate the results of the Snilehorn well (6407/8-6 and 6407/8-6A) in the evaluation of the license and in particular the Rype prospect. 6407/8-6 and 6407/8-6A (drilled in 2013, in the neighbouring PL 348 license) have proven several oil columns in formations dating from the Jurassic

and Triassic ages. The estimated volume of the discovery is in the range of 55-100 million barrels of recoverable oil equivalent.

The evaluation has indicated that the likely P50 case recoverable reserves in the Rype total structure is 1,56 * $10^6$ $Sm^3$ of recoverable oil for Garn Fm. and 0,84 * $10^9$ $Sm^3$ of recoverable gas for Ile, Tilje and Åre Fms. Also, only 25% of this volume lies within PL 587, with the remainder lying in the Statoil operated PL 348. The Cretaceous and Upper Jurassic potential have been evaluated but it has not been possible to identify reservoirs and valid traps. Edison believes that this volume does not constitute an economically viable accumulation, and does not warrant proceeding to the 2nd term of the licence. This is the basis for the application of a full relinquishment of the license.

### *1.2 Work program and duration*

PL 587 was awarded in February 2011 with Edison Norge as the Operator (60%) and North Energy as a partner (40%). License history, applications and deadlines can be summarised as follows:

- License History:
  - Acquired directly in APA 2010
  - Application for extension accepted in December 2013, New DoD February 2015
  - Recommendation to license partner for full relinquishment in September 2014 as the technical work of the license indicates no prospectivity of commercial value in the license.
- Initial Commitments & Restrictions:
  - Acquire 3D seismic over the license area and conduct G&G studies
- Initial period of 8 years:
  - DoD decision by 4.2.2015
- License Meetings
  - 2 EC/MC meetings per year from license award
  - 1 License Work meeting from license award

The main part of the work program was performed between February 2010 and September 2014.

# 2. Database

### *2.1 Seismic database*

The original interpretation was based on GES11 3D survey (Fig. 2.1 a)). This survey was acquired in 2011, it covers 120 km$^2$ and was processed in conjunction with a re-processing and merge of the GRANAT06 survey to produce one merged pre-stack time migrated volume with 2 tie lines covering 64 km$^2$. The GRANAT06 survey was acquired in 2006 by PGS and covered 224 km$^2$. In 2014 the Operator decided to re-process these data with PssGeo to try to remove the residual multiples and noise in the data. This re-processing was completed in September 2014. In the vicinity of the license, other public 3D cubes (ST0809, Carmot Merge, BPN9501, SH9002) give additional coverage.

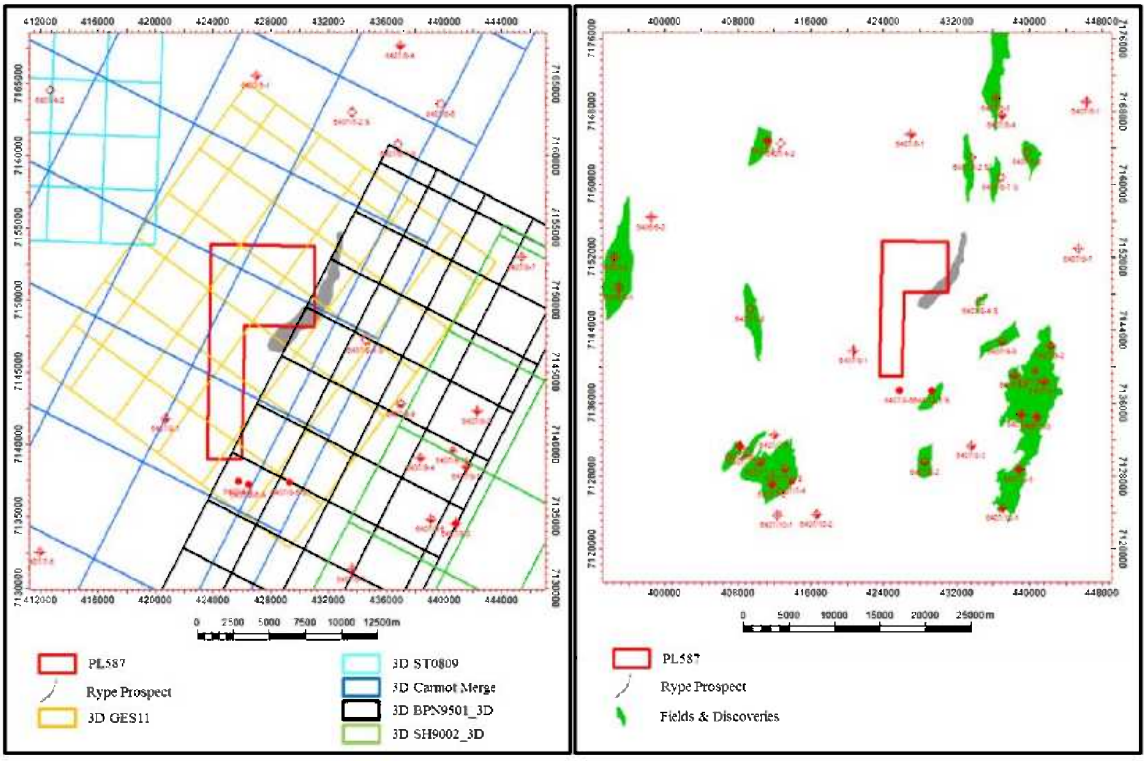



**Fig. 2.1** *a) Seismic database map; b) Well location map.*

### *2.2 Well database*

The key wells used for seismic to well tie, depth conversion, stratigraphic and petrophysical analysis are listed in Table 2.1. Fig. 2.1 b) shows the location of these wells.

| WELL | FIELD | WELL | FIELD | WELL | FIELD | WELL | FIELD | WELL | FIELD |
|---|---|---|---|---|---|---|---|---|---|
| 6406/6-2 | | 6407/6-4 | | 6407/7-5 | NJORD | 6407/8-5S | HYME | 6407/9-6 | DRAUGEN |
| 6406/9-1 | LINNORM | 6407/6-5 | MIKKEL | 6407/7-6 | NJORD | 6407/8-6 | | 6407/9-7 | |
| 6406/9-2 | LINNORM | 6407/6-6 | | 6407/7-7S | NJORD | 6407/8-6A | | 6407/9-9 | |
| 6407/4-1 | | 6407/6-7S | | 6407/7-8 | | 6407/9-1 | DRAUGEN | 6407/9-10 | DRAUGEN |
| 6407/4-2 | | 6407/7-1S | NJORD | 6407/8-1 | | 6407/9-2 | DRAUGEN | 6407/10-1 | |
| 6407/5-1 | | 6407/7-2 | NJORD | 6407/8-2 | | 6407/9-3 | DRAUGEN | 6407/10-2 | |
| 6407/5-2S | | 6407/7-3 | NJORD | 6407/8-3 | | 6407/9-4 | DRAUGEN | 6407/12-1 | DRAUGEN |
| 6407/6-1 | | 6407/7-4 | NJORD | 6407/8-4S | | 6407/9-5 | DRAUGEN | | |

**Table 2.1** *Common well data base for PL 587.*

In 2014, two exploration wells (6407/8-6 and 6407/8-6A) were traded in order to evaluate the possible impact of these discoveries in the license.

# 3. Review of geological Framework

### *3.1 Studies*

Several comprehensive studies have been performed on the license since it was awarded. The purpose of these studies has been to gain the confidence in the geological and geophysical understanding of potential in the area. An overview of the studies performed on PL 587 is listed below:

- Structural validation and Fault Seal Analysis (in-house)
- Geological and sedimentological framework study (in-house)
- Reservoir study (Ichron Ltd)
- Petrophysical analysis (in-house)
- Basin modelling (IGI)
- Pore pressure evaluation (in-house)

### *3.2 Results of Block Evaluation*

For the initial evaluation done for the APA 2010, the probability of discovery was estimated as 0,19 for Garn Fm., 0,13 for Tilje Fm. and 0,10 for Åre Fm., where the main risks were associated with the integrity of the Bremstein Fault Complex and its risk of leakage both across and up the fault. The reservoir quality as well, was considered a main risk factor.

A structural validation and fault seal analysis were performed in order to assess the sealing potential of the prospect's bounding fault, Bremstein Fault Complex. A structural model for the study area has been created and validated by the restoration of selected cross-sections. The analysis shows a high sealing potential due to the large displacement along the fault and the high shale content in the stratigraphic sequence. However, two main uncertainties also affect the analyses:

- Fault architecture definition, due to the poor imaging of the faults on the seismic data.
- The lack of knowledge of the Triassic stratigraphy within the footwall.

The aim of reservoir study was to map reservoir facies bodies in a number of stratigraphic intervals across the area in the vicinity of PL 587, and predict the possible effects of significant volumes of authigenic chlorite on the preservation of permeable reservoir sandstones in deeply buried prospects. As well, CPI from 20 wells, including Snilehorn discovery, in the vicinity of PL 587 were performed. The results of these studies are summarized in Table 3.1.

| | Depositional environment | Porosity | N/G | Chlorite presence |
|---|---|---|---|---|
| **Garn** | High wave energy embayed shoreline | **0-14%** (Uncertain, lack of data) | **0.5-0.6** | **Trace amounts in 6407/8-4 S** Locally expanded and replaced by pyrite |
| **Ile** | Prograding deltaic shoreline and tidal delta | **9-13%** | **0.1-0.2** | **Up to 1.0%, mean 0.1%** Minor amounts in 6407/4-1, 6407/7-2 & 6407/7-8 |
| **Tilje** | Tidally influenced shoreline & estuarine system | **8-13%** | **0.4-0.6** | **Up to 22.5%, mean 6.3%** Present in all samples. Finely crystalline hexagonal chlorite plates. Locally displays two generations: 1) enclosed by quartz overgrowths & blocky kaolinite 2) enclosed siderite crystals & quartz overgrowths. Formed after deposition |
| **Åre** | Fluvial channels and flood plain | **9-10%** | **0.4-0.6** | **Up to 0.5%, mean 0.1%** Chlorite is rare. Occurring as finely crystalline plates which may be intermixed with blocky kaolinite and locally fill primary intergranular pores |

**Table 3.1** *Reservoir properties and depositional environment for Rype prospect.*

The main conclusions from the geochemistry and Basin Modelling are:

- Spekk & Åre Fm. are the dominant sources in the area.
- Results show that Ile, Tilje & Åre are likely to contain gas condensate sourced by the Åre Fm., and Garn is likely to contain oil sourced from the Spekk Fm.
- The Rype Prospect cannot be charged without faulting.

A pressure analysis of 41 wells and preliminary reservoir gradient maps for Garn and Ile Fms. was conducted. The main results from this study are:

- The PL 587 license lies in an overpressure area, with a likely gradient between 1,2 and 1,3 bar/10 m.
- The risk of breaching is very low.
- The sealing potential of the Garn Fm. seems to be high in terms of pressure.

After the studies performed in the area, the trap effectiveness and the reservoir quality are still considered as the main risks. The final COS is:

- Garn Fm.: 0,31
- Ile, Tilje and Åre Fm (dependent segments): 0,43

# 4. Prospect Update

At the time of application, based on 2D seismic interpretation, Jurassic Rype prospect was estimated in the order of 16,4 * $10^6$ $Sm^3$ of recoverable oil for Garn Fm. and 5,9 * $10^9$ $Sm^3$ of recoverable gas for Tilje and Åre Fms. (most likely phase) (Table 4.1). Following the award of PL 587, Edison carried out a full G&G technical evaluation, including the acquisition of a 3D survey covering the prospective acreage and seismic reprocessing to improve imaging of fault architecture. This review has indicated that the likely P50 case recoverable reserves in the Rype total structure is 1,56 * $10^6$ $Sm^3$ of recoverable oil for Garn Fm. and 0,84 * $10^9$ $Sm^3$ of recoverable gas for Ile, Tilje and Åre Fms., only 10% of the initial estimate. Also, only 25% of this volume lies within PL 587, with the remainder lying in the Statoil operated PL 348. The new calculated recoverable resources for the Rype Prospect are tabulated below (Table 4.2). The reserves of the Ile, Tilje and Åre reservoirs have been combined as dependent segments.

| Discovery/ Prospect/ Lead name | D/ P/ L | Unrisked recoverable resources | | | | | | Probability of discovery | Part in acreage applied for % | Reservoir | | Distance to infra-structure (km) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Oil $10^6Sm^3$ | | | Gas $10^9Sm^3$ | | | | | Litho-/ Chrono-stratigraphic level | Reservoir depth (m MSL) | |
| | | Low | Base | High | Low | Base | High | | | | | |
| Rype, Garn | P | 7.70 | 16.40 | 68.20 | 1.99 | 5.83 | 11.00 | 0.19 | 63 | Garn, Middle Jurassic Bajocian | 3300 | 15 |
| Rype, Tilje | L | 4.47 | 10.20 | 17.30 | 1.29 | 4.54 | 9.09 | 0.13 | 78 | Tilje, Lower Jurassic Pliensbachian | 3800 | 15 |
| Rype, Åre | L | 1.03 | 2.53 | 4.42 | 0.33 | 1.34 | 2.78 | 0.10 | 100 | Åre, Lower Jurassic Hettangian-Sinemurian | 4300 | 15 |

**Table 4.1** *Rype Resource Estimate APA2010.*

| Prospect name | Case (Oil/Gas/Oil&Gas) | Unrisked recoverable resources | | | | | | COS |
|---|---|---|---|---|---|---|---|---|
| | | Oil ($10^6Sm^3$) | | | Gas ($10^9Sm^3$) | | | |
| | | Low (P90) | Base (P50) | Low (P10) | Low (P90) | Base (P50) | Low (P10) | |
| Rype - Garn Fm. | O | 0,04 | 1,56 | 6,14 | 0,00 | 0,13 | 0,50 | 0,31 |
| Rype - Ile, Tilje, Åre Fms. | G | 0,02 | 0,64 | 3,03 | 0,02 | 0,84 | 3,53 | 0,43 |

**Table 4.2** *Updated Rype Resource Estimate.*

After the new interpretation, based on 3D and the Snilehorn wells results, the main conclusions about the area are:

- Rype Prospect clearly reveals a more complex structure than the one that came out from 2D interpretation for APA 2010 and it is evident that the main difference is given by the fault trace, located more to the east, inside the PL 348 licence. (Fig. 4.5)
- The Rype prospect and the Snilehorn discovery are not related due to the fact that 6407/8-6 is located in the footwall area while Rype prospect is located in the hangingwall of the Bremstein Fault Complex (BFC). (Figure 4.5)
- The Snilehorn structure does not extend into the PL 587, except a small portion of the downdip of Åre formation.
- The Jurassic section is present in the area:
    - Åre Fm. is mapped in the area. (Fig. 4.4)
    - Tilje Fm. is present in the area with small erosion patches. (Fig. 4.3)
    - Ile & Garn Fms. are eroded along the BFC. (Fig. 4.2 & 4.1)

Also the Cretaceous and Upper Jurassic potential have been evaluated but it has not been possible to identify reservoirs and valid traps.

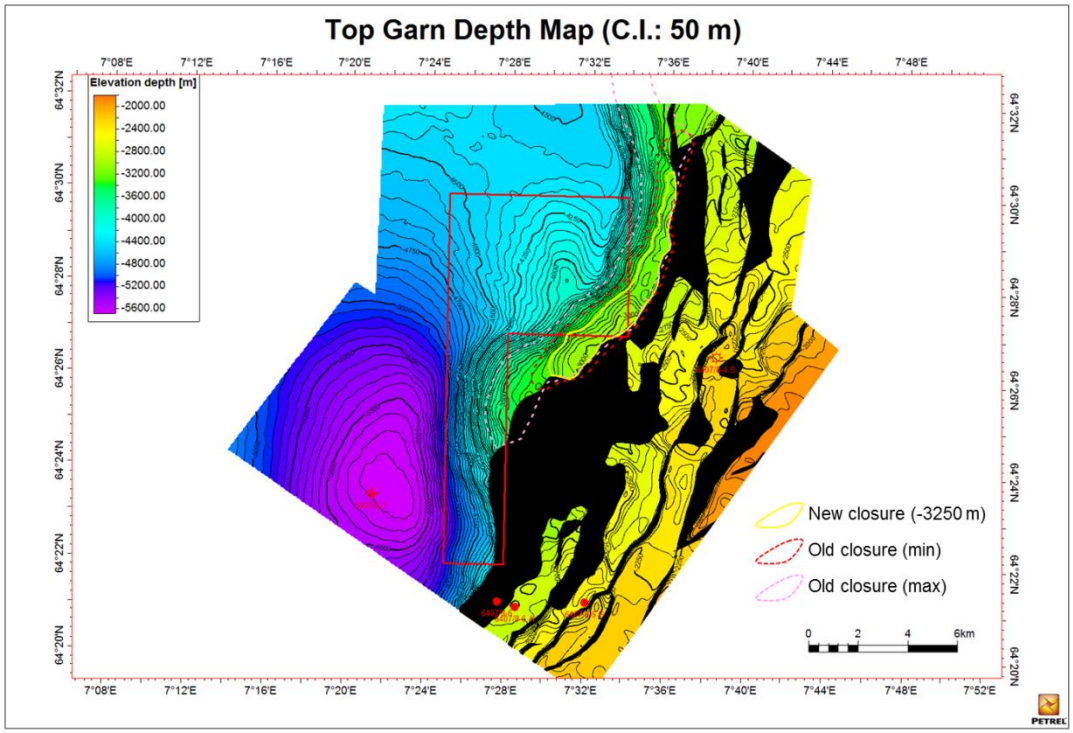



**Fig. 4.1** *Depth map of the Garn formation showing the Rype prospect.*

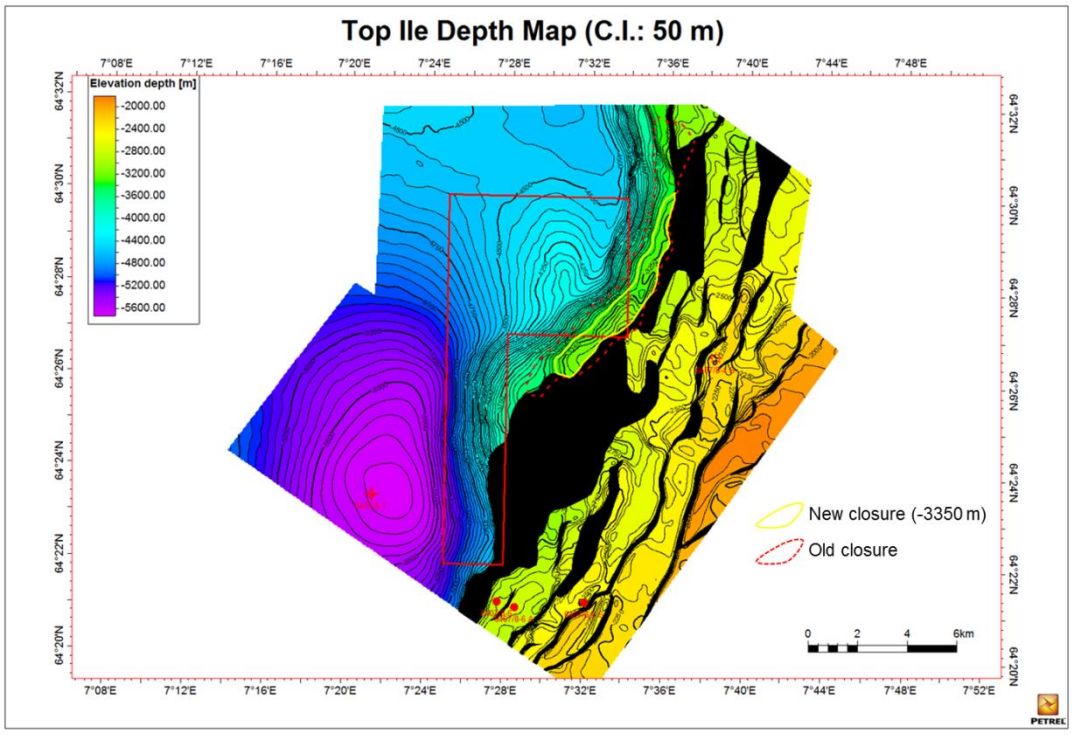



**Fig. 4.2** *Depth map of the Ile formation showing the Rype prospect.*

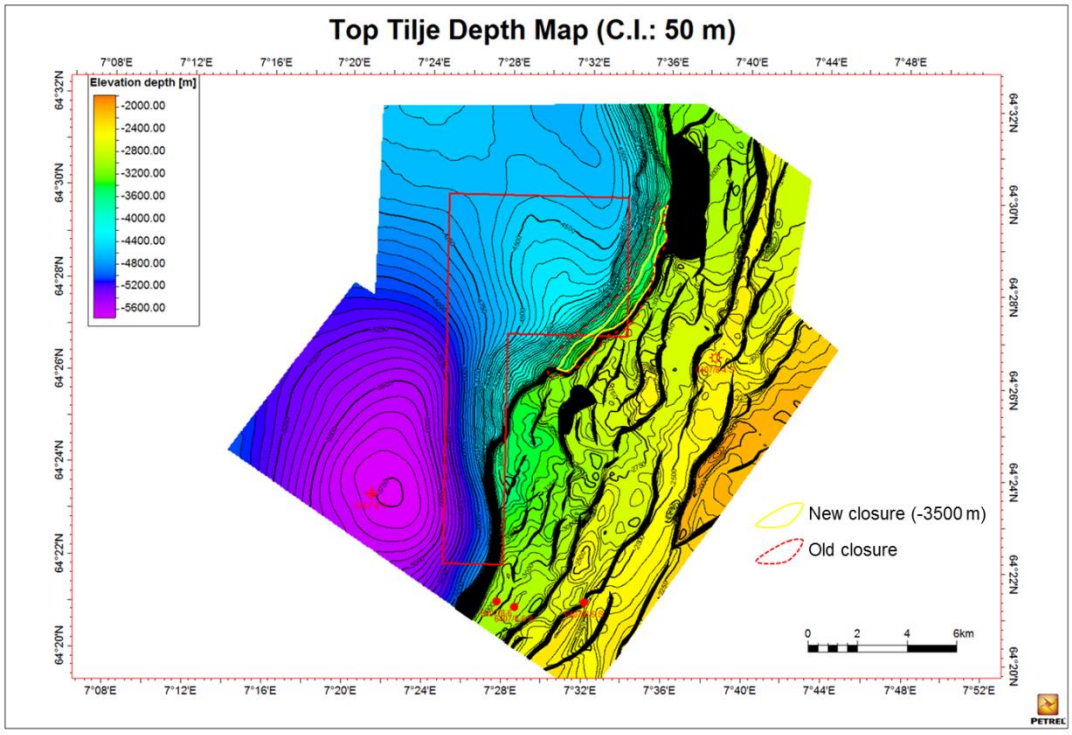



**Fig. 4.3** *Depth map of the Tilje formation showing the Rype prospect.*

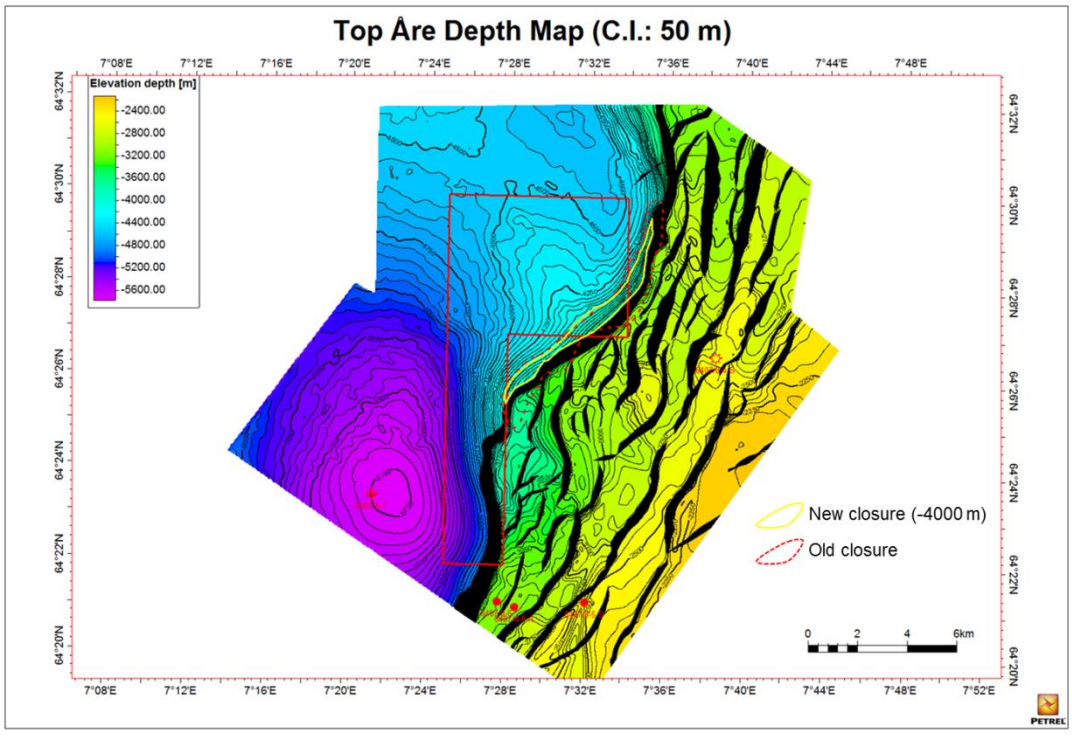



**Fig. 4.4** *Depth map of the Åre formation showing the Rype prospect.*

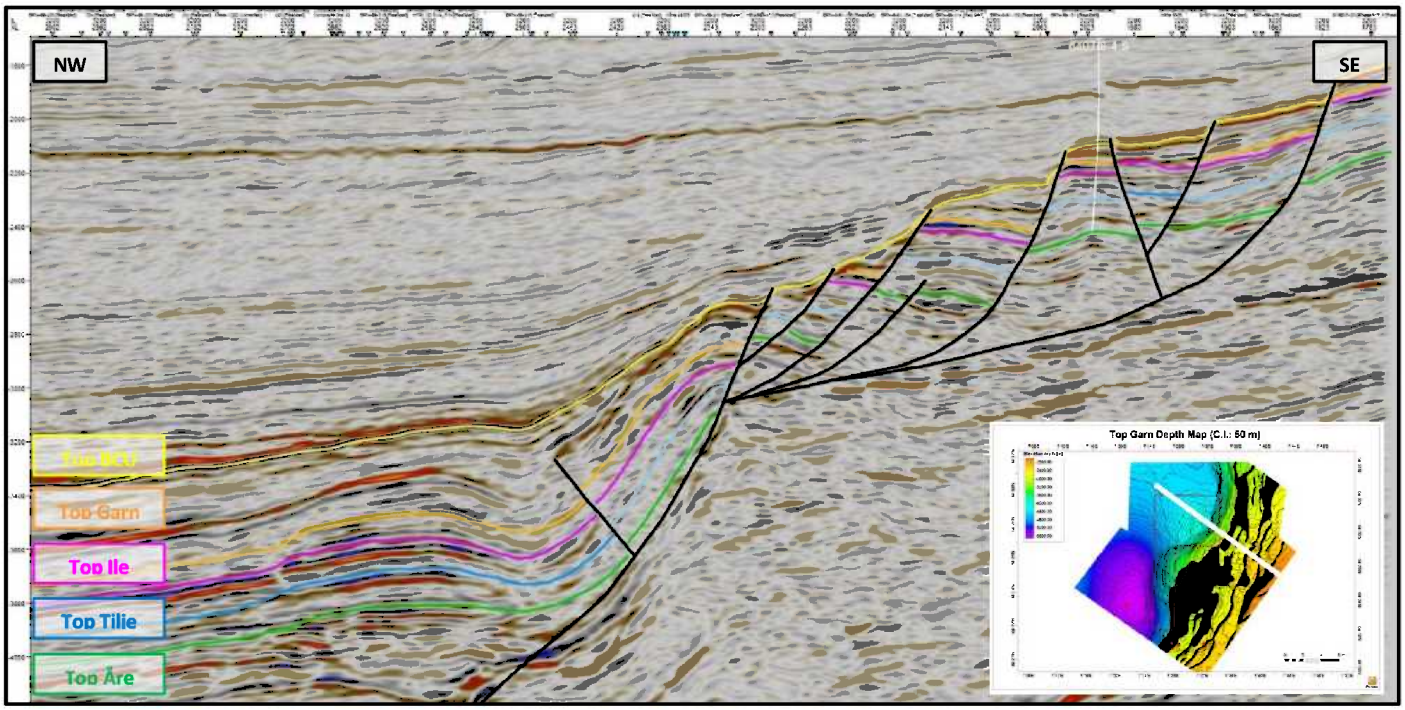



**Fig. 4.5** *Seismic section of the Rype prospect showing the main targets Garn, Ile, Tilje and Åre Fms.*

# 5. Technical Evaluation

PL 587 water depth is between 260 and 290 m over the Gimsan Basin, in a quite mature area of the Norwegian Sea, not far from existing infrastructure. The nearest existing oil and gas processing facility is the Draugen platform located 18 km away, to the south east of the prospects. Alternative oil and gas processing is available at the Njord field. Semi Submersible is located 20 km, south west of the prospect. No direct export for oil exists within this region other than tanker offloading.

To set a possible development scenario, the following considerations have been taken into account:

- The Garn reservoir is overlying the Ile, Tilje and Åre reservoirs.
- Garn Fm. reservoir is oil bearing.
- Ile, Tilje and Åre as gas & condensate bearing.
- Ile, Tilje and Åre are dependent segments.
- The basic reservoir assumption is that the Ile, Tilje & Åre are stacked reservoir's with combined flow potential.
- Not significant $CO_2$ or $H_2S$ is expected.
- Natural depletion is assumed for both prospects.

The following two scenarios have been identified to be assessed for this license:

- Scenario 1: Oil Development of Garn reservoir.
- Scenario 2: Combined oil and gas development of Garn reservoir and Ile, Tilje and Åre reservoirs (assuming that the prospect production is the combined flow from all 3 of the overlying reservoirs).

The Njord facility has a high gas handling capacity this would make it preferable to the Draugen facility.

# 6. Conclusion

The full G&G technical evaluation carried out by the operator has indicated:

- Remarkable decrease of the total recoverable resources, 1,56 * $10^6$ $Sm^3$ of recoverable oil for Garn Fm. and 0,84 * $10^9$ $Sm^3$ of recoverable gas for Ile, Tilje and Åre Fms. Only 10% of the initial estimate for the APA2010.
- Only 25% of this volume lies within PL 587, with the remainder lying in the Statoil operated PL 348.
- Limited potential targets for the Cretaceous and Upper Jurassic within the license.
- The main risk elements are still associated with the trap effectiveness and the reservoir quality.

The recommendation to relinquish is based on this evaluation and concludes that there are no viable exploration targets within PL 587 acreage.