



## PL 946 Licence status report

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## Summary

A drill decision in PL946 was to be taken within 02.03.2022. License prospectivity was evaluated based on the new reprocessed survey (EQ19M01), with the Amiata prospect in the Cretaceous Lange Fm. as the main prospect. Conclusion after remapping and extensive analysis on the new data has been that the Amiata prospect and remaining prospectivity in Jurassic has a too low volume potential and/or low probability of geological success to be a business driver for a drill decision in PL946. A drop decision has been agreed in the licence as no drilling candidate can be identified in the licence at this time.

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## 1 Key license history

Equinor Energy AS and Vår Energi AS applied for PL946 during the 2017 APA. The APA application was written by Vår Energi, and the business driver was based on one prospect called Amiata identified in the Cretaceous Lange Formation. The PL946 licence was awarded 2nd March 2018 to Equinor (60% Operator) and Vår (40%) with a Drill or Drop decision to be made within two years.

The initial 2-year work program was to acquire new 3D seismic (PGS16005). The licence concluded that a reprocessing of the PGS16005 data was needed to improve the imaging in the prospective level (Cretaceous). For a successful evaluation of the Cretaceous it was essential to have extensive testing and fine-tuning in the early processing steps which led to a delay of the final reprocessed data. The DoD deadline was therefore extended with one year (2nd March 2021) to be able to complete the evaluation work that were pending on the final reprocessed data. Subsequently, an additional one-year extension (2nd March 2022) was requested to the authorities to have sufficient time to fully integrate the results from well 6507/3-14 T2 (Black Vulture Appraisal) drilled through the Cretaceous by Equinor 2021 since it would impact both prospect de-risking and business case.

The licence PL946 is located on the Dønna Terrace, Norwegian Sea, approximately 30 km north of Norne. The licence covers an area of 36.170 km<sup>2</sup>.

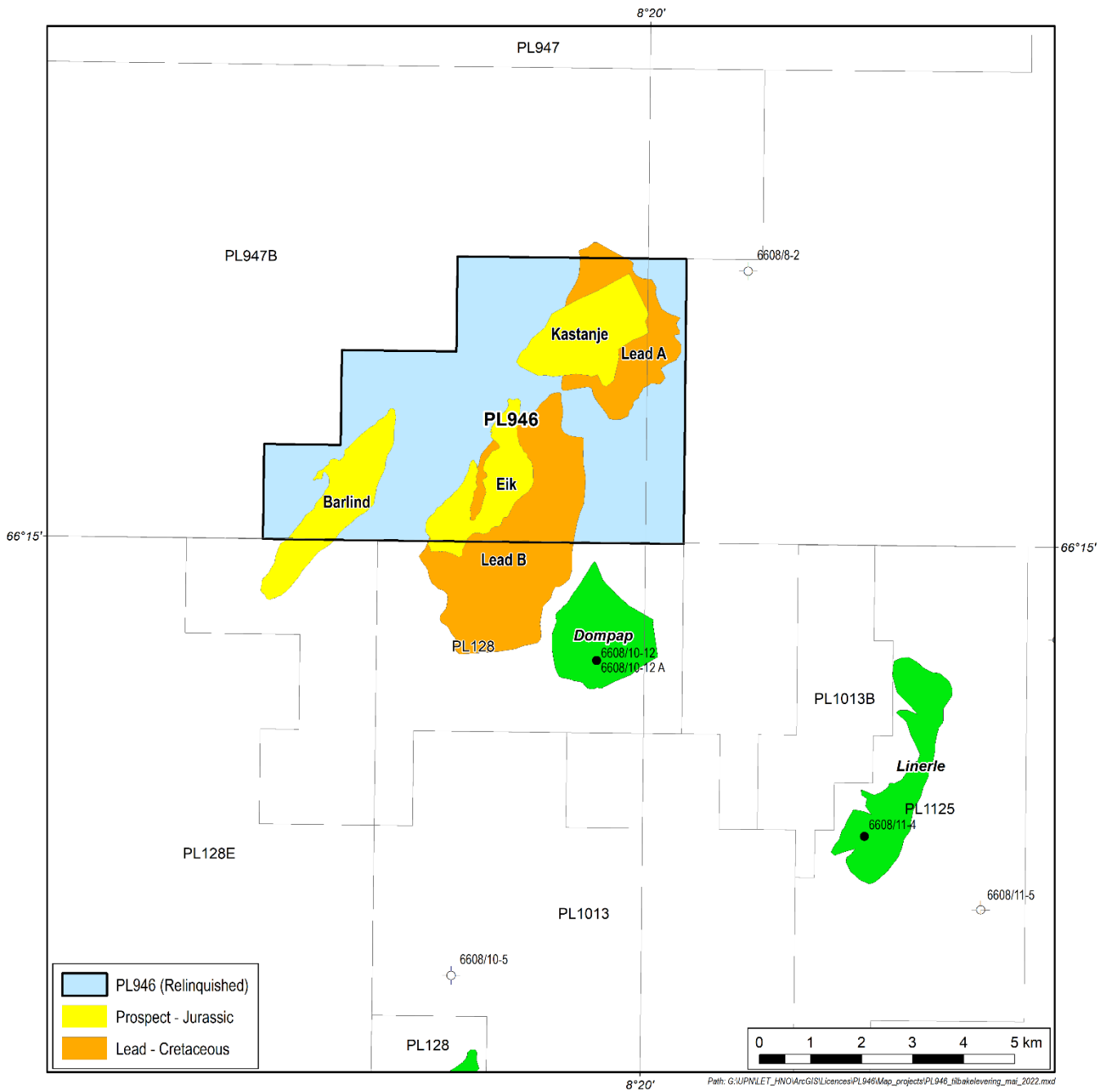
### 1.1 Licence Meetings Held

**Table 1.1** Overview of the licence meetings held in PL946

Date	Meeting
09.03/2018	MC meeting No. 1
20.04/2018	EC work meeting
06.12/2018	ECMC meeting No. 2
12.05/2019	ECMC meeting No. 3
07.02.2020	EC work meeting
22.10/2020	EC work meeting
08.12.2020	ECMC meeting No. 4
21.10.2021	EC work meeting
22.11.2021	ECMC meeting

### 1.2 Reason for surrender

Neither prospect evaluation update on the reprocessed data (EQ19M01) nor the 6507/3-14 T2 (Black Vulture Appraisal) results lifted the Cretaceous potential in the licence. Three Jurassic prospects were identified within the licence but were too small to be of commercial interest. A drop decision for PL946 has been agreed in the licence as no drilling candidate can be identified in the licence at this time.



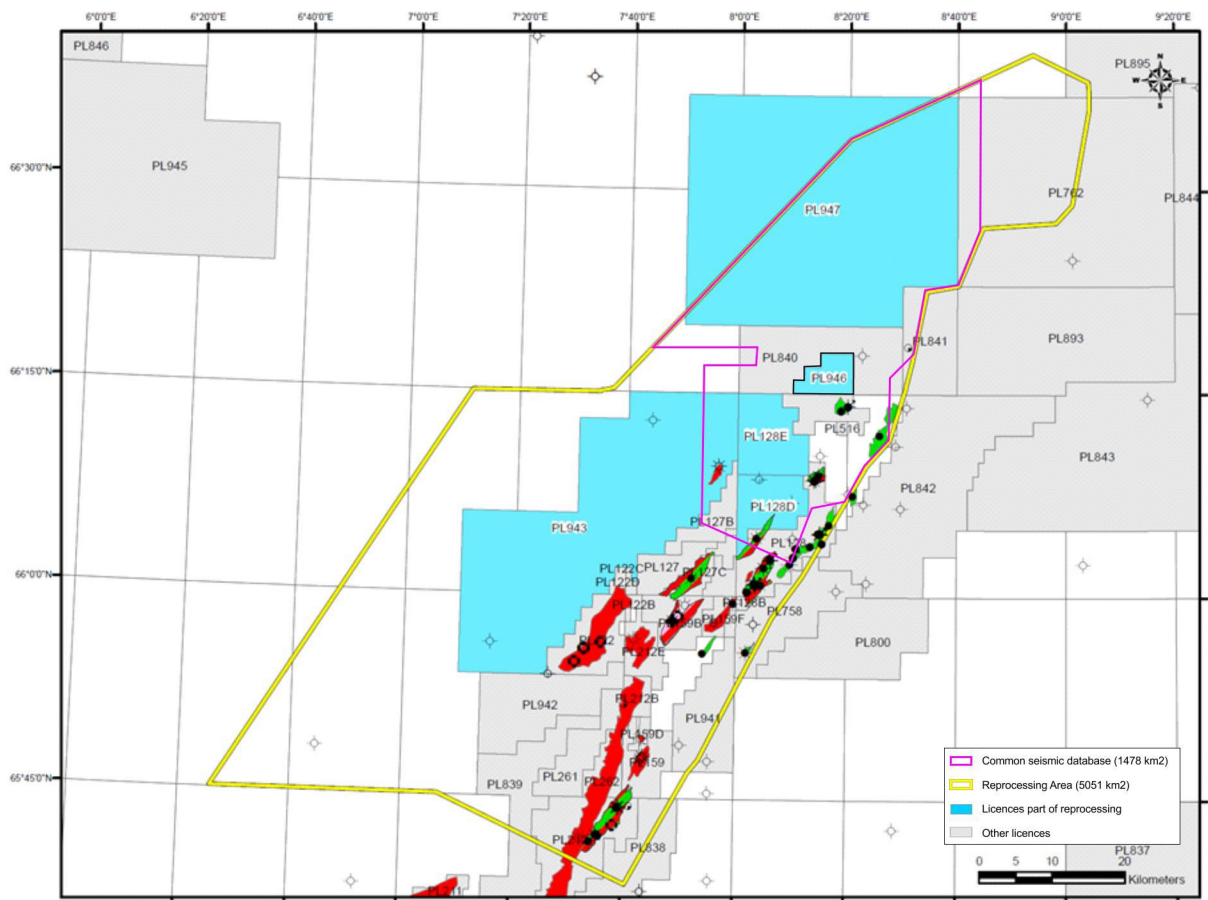
**Figure 1.1** Licence overview. The PL946 licence map with prospect and leads.

## 2 Database

### 2.1 Seismic data

Two seismic datasets have been used to evaluate the licence prospectivity (PGS16005 and EQ19M01). The newly acquired 3D seismic (PGS16005) had consistently better data qualities than other surveys in the area (ST11M01 used in the APA application). However, the Cretaceous level was still challenging and characterized by low seismic reflectivity with relatively high background noise. Equinor proposed a reprocessing of PGS16005 (new survey name EQ19M01) over a large area of the Cretaceous for better imaging and regional understanding of the Play related to the main prospect (Amiata) in the licence.

EQ19M01 covering 5051 km<sup>2</sup> in the Dønna Terrace/Nordland Ridge area (Nordland II) of the Norwegian Sea. The reprocessing was coordinated by Equinor. PL946 participated in the reprocessing and a 1478 km<sup>2</sup> sub-area was included in the Common Database. Whilst the EQ19M01 project included data from 3 different surveys the area included for PL946 used data primarily from the PGS survey PGS16005 (NPDID 8321). The processing was performed by PGS, Lysaker.



**Figure 2.1** Overview map with location of the Licence area, PL946 common seismic database (purple outline), wells, fields and discoveries. EQ19M01 area shown by the yellow outline.

## 2.2 Well data

The common well database comprises the Cape Vulture appraisal well 6608/10-18 and public available data from released wells listed in Table 2.1. The list include well name, NPDID number, content, reservoir unit with HC and formation at TD.

**Table 2.1 Well database**

Well	NPDID	Content	Reservoir with HC	Formation at TD
6507/2-1	911	Shows	Lysing, Lange Fms, Fangst and Båt Gps.	Åre Fm.
6507/2-2	1840	Gas/Cond	Lysing and Lange Fms.	Åre Fm.
6507/2-4	5685	Gas/Cond	Lysing Fm.	Lyr Fm.
6607/12-3	7039	Gas	Lange, Ile and Åre Fm.	Åre Fm.
6607/12-2 S	6642	Oil/Gas	Lange Fm, Fangst and Båt Gp.	Åre Fm.
6608/8-2	2989	Dry	No	Red Beds
6608/10-1	1391	Gas	No	Åre Fm.
6608/10-2	1782	Oil/Gas	Fangst and Båt Gp.	Åre Fm.
6608/10-3	1732	Oil/Gas	Fangst and Båt Gp.	Åre Fm.
6608/10-4	2256	Oil/Gas	Melke and Garn Fms.	Åre Fm.
6608/10-6	3260	Oil	Melke and Åre Fms.	Åre Fm.
6608/10-7	4273	Oil	Melke and Åre Fms.	Åre Fm.
6608/10-8	4439	Oil	Melke, Not, Ile, Tilje and Åre Fms.	Åre Fm.
6608/10-9	4668	Oil	Melke Fm.	Åre Fm.
6608/10-10	4699	Dry	No	Åre Fm.
6608/10-11S	5386	Gas	Not Fm.	Tilje Fm.
6608/10-12	5949	Oil	Åre and Lysing Fms.	Åre Fm.
6608/10-12A	6029	Oil	Åre Fm.	Åre Fm.
6608/10-13	6235	Dry	No	Åre Fm.
6608/10-14S	6306	Oil/Gas	Melke, Ile, Tofte Fm.	Åre Fm.
6608/10-15	7245		Melke and Åre Fms.	Åre Fm.
6608/10-16	7404	Shows	Lange, Garn and Ile Fms.	Åre Fm.
6608/10-17S	8065	Oil/Gas	Lange Fm.	Spekk Fm.
6608/10-18	8506	Oil	Lange Fm.	Melke Fm.
6608/11-1	936	Dry	No	Grey Beds
6608/11-2	4189	Oil	Åre Fm.	Grey Beds
6608/11-3	4630	Dry	No	Grey Beds
6608/11-4	4939	Oil	Tilje Fm.	Red Beds
6608/11-5	5316	Shows	Åre Fm.	Red Beds
6608/11-6	5868	Dry	No	Åre Fm.
6608/11-7S	6701	Dry	No	Red Beds
6608/11-8	7194	Dry	No	Åre Fm.

### 3 Results of Geological & Geophysical Studies

The following geological and geophysical studies were carried out in the licence evaluation:

- Seismic reprocessing
- Seismic interpretation and mapping
- Geophysical observations and AVO assessment
- Prospect evaluation

#### 3.1 Seismic reprocessing

The objectives for the reprocessing were to generate a dataset with consistent and high quality with a particular focus on the Cretaceous interval. The processing sequence was based on that used in the original PGS processing of survey PGS16005 but with modification or re-parameterisation of key steps including but not limited to: deghosting, denoise, demultiple and migration. For denoise the approach focused on generating noise models in multiple domains followed by a subtraction process. The reprocessing started from P-UP shot gathers.

Emphasis was given to improving the signal-to-noise (S/N) in the Cretaceous interval. To this extent two different final products were delivered: data with a more standard noise attenuation workflow based on structural filtering (applied after migration) and data with an innovative method developed by PGS applied pre-migration and based on a dip-scan approach. The latter method is considered to provide the best quality data for AVO analysis but with the caveat that the shallow section has somewhat reduced resolution. Final angle stacks were created for 6 angle bands in addition to a full angle stack.

The velocity model for depth migration used the legacy velocities from earlier PGS processing as the starting point. Both the velocities and the anisotropy framework were updated and 12 wells were used to calibrate and constrain the earth model: 6506/3-1, 6507/5-2, 6507/5-1, 6507/2-4, 6507/3-1, 6507/2-1, 6608/10-9, 6607/12-3T2, 6608/10-16, 6607/12-1, 6608 /8-1, 6608 /8-2

The reprocessed data show improved S/N in the Cretaceous in PL946.

#### 3.2 Seismic interpretation and mapping

Framework interpretation was performed on the new acquired 3D seismic (PGS16005) and the key surfaces/prospect intervals were updated when the final delivery of EQ19M01 was received. Remapping of the Amiata prospect on the new reprocessed data (EQ19M01) has shown that it was challenging to form a trap separating it from the already tested Lange sands in the area. The reservoir interval in Amiata ties directly in to tested Lange sands in 6608/10-12/A (Dompap Appraisal) and/or 6608/8-2 (Bjørk). Well results in more detail in section 4.1

The focus then moved to Jurassic where several reservoir levels in the Middle Jurassic is present in the area (Melke, Ile, Tofte, Tilje and Åre Fms.) Two robust faulted 4-way closures (Eik and Barlind) and a 3-way closure (Kastanje) were mapped within the licence. Ile/Tofte Fm was mapped as the main reservoir. In addition, Tilje and Melke Fms were mapped and evaluated as secondary reservoir segments in Barlind and Eik. High confidence on the interpretation in Viking, Fangst and Båt Gp. in Barlind and Eik area, and some uncertainties towards Kastanje where the Jurassic sequence is more truncated.



A potential larger 3-way closure in Eik was mapped and was dependent on fault/truncation towards the north (separated from Kastanje prospect). Detailed fault mapping concluded that hydrocarbon retention was highly unlikely due to high trap risk and leakage at the apex and at fault intersections. Thus, the most likely scenario was three small closures.

### 3.3 Geophysical observations and AVO assessments

Geophysical observations for Cretaceous (Amiata prospect) and Jurassic (Eik and Barlind prospects) have been performed separately.

A detail geophysical evaluation focusing on Jurassic level has been completed including:

- Fluid substitution modelling within Melke and Ile/Tofte reservoir levels based on the wells 6608/10-16 and 6607/12-3T2,
- AVO evaluation of Eik and Barlind prospects,
- Seismic modelling for Barlind prospect.

It is often the case in siliciclastic environments that AVO analysis becomes increasingly more difficult below a porosity of around 15%.

Fluid substitution modelling based on the wells shows that it is difficult to differentiate the fluid and lithology effects with poorer properties such as Melke reservoir. For the Ile/Tofte reservoir level, there is no evident hydrocarbon response at the top reservoir. However, a distinct amplitude change at the base reservoir for hydrocarbon bearing sands is observed.

A clear amplitude softening with offset (AVO class II-III) within Ile/Tofte level is observed for both Eik and Barlind closures. There is a clear change from strong negative fluid factor (AVO anomaly) at the apex to weak AVO anomaly downflank of the prospects. Amplitude anomalies extracted from the lithology cube (EEI-45) confirm the presence of the quartz rich deposits at this level. Moreover, the reduction of P-impedance not corresponding to the change of S-impedance indicates the presence of hydrocarbons within these closures. However, it is challenging to define specific depth conformant amplitude shut-offs for Eik and Barlind prospects.

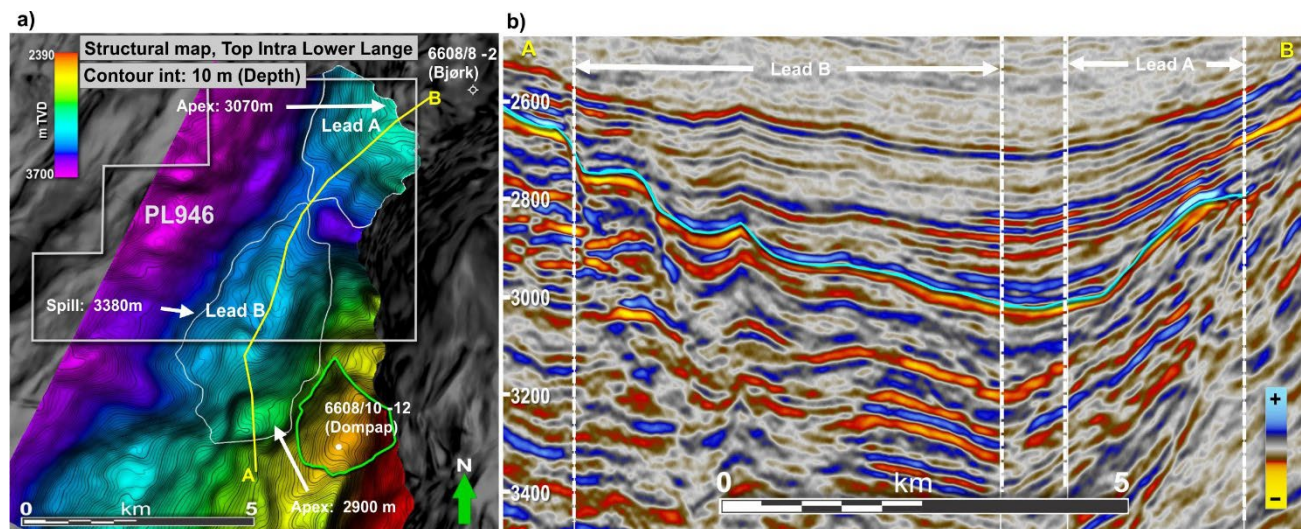
Seismic modelling done for Barlind prospect reflects that the presence of gas in the structure (both high and low saturation) creates a clear amplitude decrease within Ile and Tofte sand packages. Moreover, the gas saturation has the strongest effect at the base of reservoir, as expected from the fluid substitution modelling. However, the hydrocarbon contact is difficult to define, most likely due to rather low porosity.

## 4 Prospect update

### 4.1 Amiata prospect

The reservoir target of the Amiata prospect was the Lange formation with turbiditic sandstones in a stratigraphic-structural combination trap. The reservoir unit was defined by several stacked Lange sands of Turonian age that thinned out rapidly northwards, southwards and eastwards, and with Lyr Formation as bottom seal. Trap definition was regarded as key risk, in addition to moderate risks on seal, reservoir and charge in the APA application.

Based on remapping of the prospect with the latest reprocessed data, it was challenging to identify the prospect as defined in the APA. The shallow Lange amplitudes in the area were attached with high trap risk due to the tested dry well upflank (6608/8-2 Bjørk). The deeper Lange amplitudes above Lyr Fm. ties in to tested 6608/12-A well (Dompap Appraisal). Oil has been sampled at the top of the Lange Formation penetrated by well 6608/10-12 (Dompap) and some oil-filled sandstones were penetrated by two injector wells (6608/10-S-3H and 6608/10-S-1H). However, these are located locally and pinch-out westwards and are not present in the appraisal well downflank (6608-10-12 A). Therefore, the Lower Lange amplitude was defined as two separate Leads (Figure 4.1). Lead A has small volume potential, and fluid/litho cubes show indication of less sand within the lead outline. Lead B has very high trap risk since no clear trap from the dry appraisal well 6608/10-12 A is defined.



**Figure 4.1** a) Structural map of top reservoir for Lead A and B (Intra Lange Fm.) in depth. Lead outlines in white and field/discovery outline in green. b) Seismic section in two-way travel time. N-S seismic line through Lead A and B, EQ19M01 Fluid cube (phase rotation  $-90$  degrees) with interpretation of Top Intra Lange Fm. (Lead A and B reservoir level). No clear trap identified for the shallower Lange amplitudes (Amiata reservoir level) separating it from the already tested Lange sands in the area.

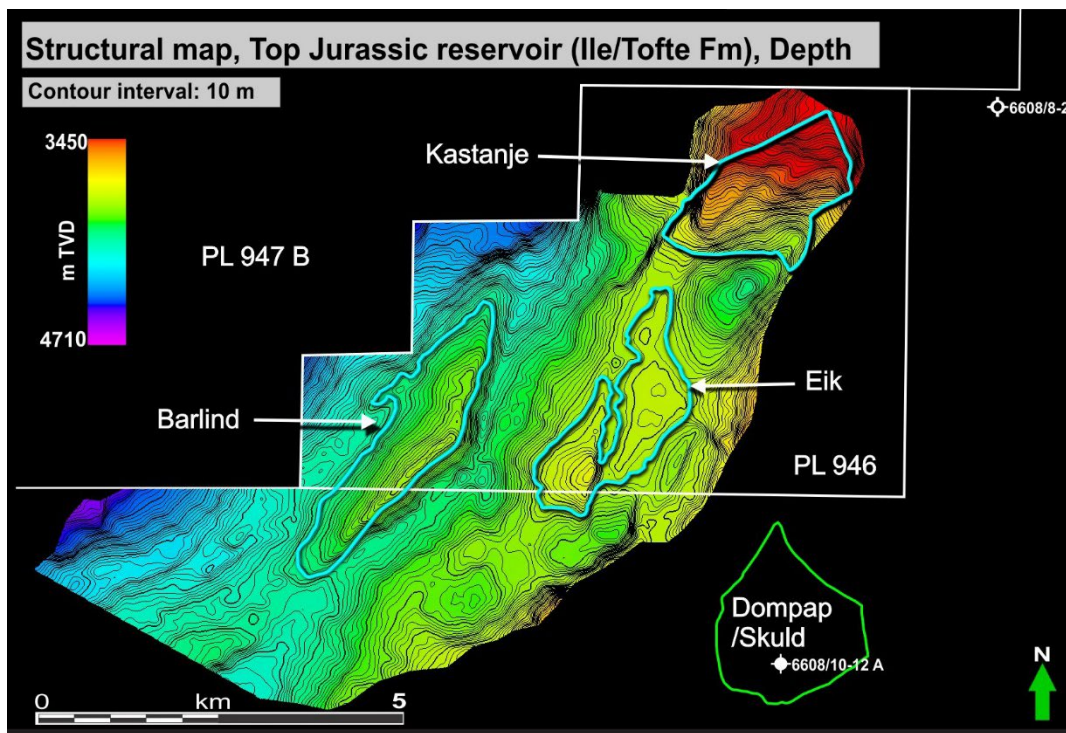
### 4.2 Jurassic Prospectivity

Three small Jurassic prospects have been identified within the licence, Eik, Barlind and Kastanje (Figure 4.2).

Barlind and Eik are Jurassic fault blocks with stacked reservoir potential in the Melke, Ile/Tofte and Tilje formations. Ile/Tofte Formation is regarded as the main reservoir. The key risk is related to reservoir quality with a burial depth at 3710 to 3820 m TVD MSL. Åre Formation is also present but is even deeper and not included in the evaluation since it is not believed to have a working reservoir at this depth. The volume potential in the prospects is limited by small prospect

outlines without a clear DHI uplift: the maximum closure for both prospects at the Ile/Tofte level is around 5 km<sup>2</sup>. Kastanje is a small steep-dipping rotated fault block that is shallower and more truncated than the other two Jurassic structures in the licence. Apex on structure is 3290 m TVD MSL and the key risk is related to trap seal (high fault seal risk).

All three prospects were too small to be of commercial interest. Table 4.1 shows the remaining volume potential in PL946 at time of surrender.



**Figure 4.2** Structural map of top Jurassic reservoir (Ile/Tofte segment) in depth. Jurassic prospects are shown by the blue outlines.

**Table 4.1** Prospective resources considered remaining in PL946 at time of surrender.

Prospect name	Mean In-place (total) MSm <sup>3</sup>	Mean Rec (total) MSm <sup>3</sup>	Mean In-place (oil) MSm <sup>3</sup>	Mean Rec (oil) MSm <sup>3</sup>	Mean In-place (gas) MSm <sup>3</sup>	Mean Rec (gas) MSm <sup>3</sup>	Risk (Pg %)
Barlind Aggregated	2.62	1.6	3.45	0.53	2.08	1.56	53.3
Barlind Melke	1.44	1.06			1.31	0.98	16
Barlind Ile/Tofte	2.55	1.41	3.2	0.5	2.06	1.55	23
Barlind Tilje	1.79	1.32			1.63	1.32	12.8
Eik Aggregated	1.49	0.66	1.49	0.22	0.93	0.7	58.3
Eik Melke	0.54	0.4			0.49	0.28	16
Eik Ile/Tofte	1.47	0.52	1.46	0.22	0.94	0.7	44.8
Eik Tilje	0.93	0.68			0.84	0.63	12.8
Kastanje Ile/Tofte	1.5	0.3	1.46	0.22	0.67	0.47	16.2

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## 5 Conclusions

The work programme for PL946 has been fulfilled. The main prospect (Amiata) and other Cretaceous Lead and Jurassic prospects have been screened/evaluated within the specified time frame and several G&G studies have been completed. Based on lack of attractive prospects (limited volume potential and/or low probability of geological success) the PL946 partnership agreed to drop the licence.

Kind regards

  
PL 946 MC Chairman