Report title:

PL577

Relinquishment Report

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EDOCS #:	Date:

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1. License History

License PL577, covering parts of blocks 36/10, 31/3 (Figure 1) was awarded on February 4th, 2011 in the APA 2010 licensing round. The license was awarded to Wintershall Norge ASA as operator (40%) with Spring Energy ASA (30%) and Talisman Energy Norway AS (30%) as partners. Subsequently, Spring Energy was purchased by Tullow Oil Norge AS.

The initial 7 year period had a drill-or-drop decision after 2 years. The work obligation included acquisition of new 3D seismic data over the license area and G&G work. Unfortunately the acquisition of new 3D, planned for summer 2011 had to be postponed due to delayed acquisition start, which was in conflict with the mackerel fishing. The new seismic 3D data was then acquired in the summer of 2012. Due to the seismic acquisition delay, the drill-or-drop deadline was extended by one year to February 4th, 2014. By that time the work obligation the license area had been fulfilled.

The PL577 application focused on the Upper Cretaceous, Lower tertiary Kopi Luwak prospect with reservoir in a potential new play in the Jorsalfare Formation. The prospect was seen as a combined stratigraphic and structural trap with a strong amplitude anomaly. Additional prospectivity was present in 3 small Jurassic leads: java, Cucuta and Robusta.

All stratigraphic levels above Basement, that directly underlines Lower Jurassic in most part of the license, have been evaluated, including assessment of the prospects and leads included in the applications, plus additional opportunities identified after the award. In all cases these opportunities could not be matured into valid exploration targets. Following completion of the license work program, it is concluded that the small estimated volumes in place and high level of risk due to a combination lack of effective traps (e.g. top and lateral seal) and effective hydrocarbon charge, do not support an explorative drilling program.

The partnership unanimously agreed that prospectivity is no longer recognized within this license and therefore relinquished PL577 at the Drill or Drop date February 4th 2014..

2. Database

At the time of the PL577 application the primary seismic dataset used for interpretation was the 2D RV0801 seismic survey (covering most of the license area). As part of the license work program, a new 3D seismic survey of 510 sqkm, WIN12001, was acquired and processed to provide maximum resolution and 3D coverage of the license prospectively (Figure 2).

One of the primary objectives of the seismic work program was to allow for effective AVO analysis through the generation in-house AVO products including conditioned gathers, angle stacks, intercept and gradient volumes.

In addition the surrounding wells: 35/9-1, 35/9-2, 36/7-1, 36/7-2, 35/12-1, 31/3-3, 32/4-1, 32/2-1 were used to interpret the WIN12001 survey and evaluate the prospectivity of the license.

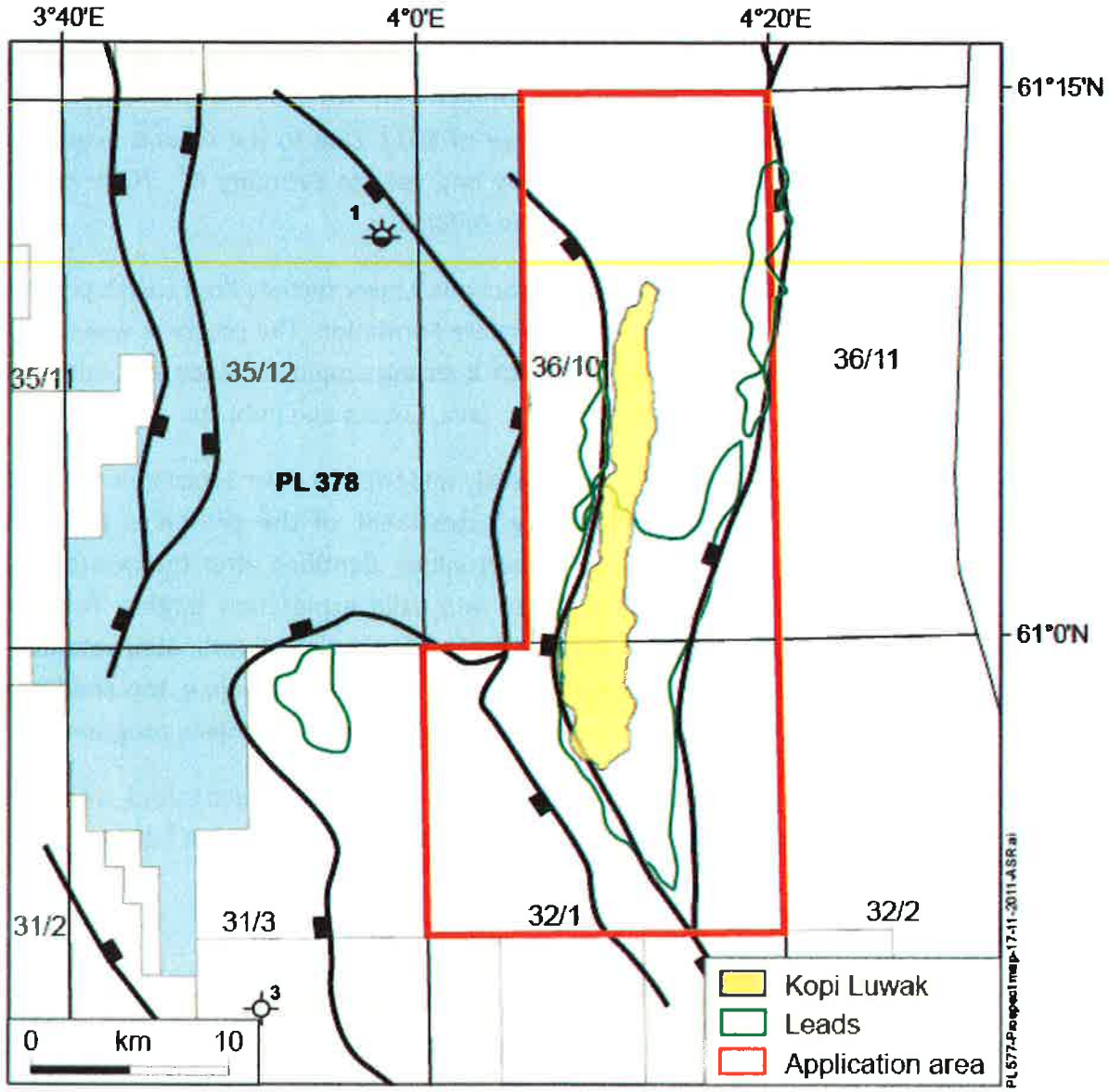

Figure 1. Location map for the PL577 license with prospectivity at the time of the license application.

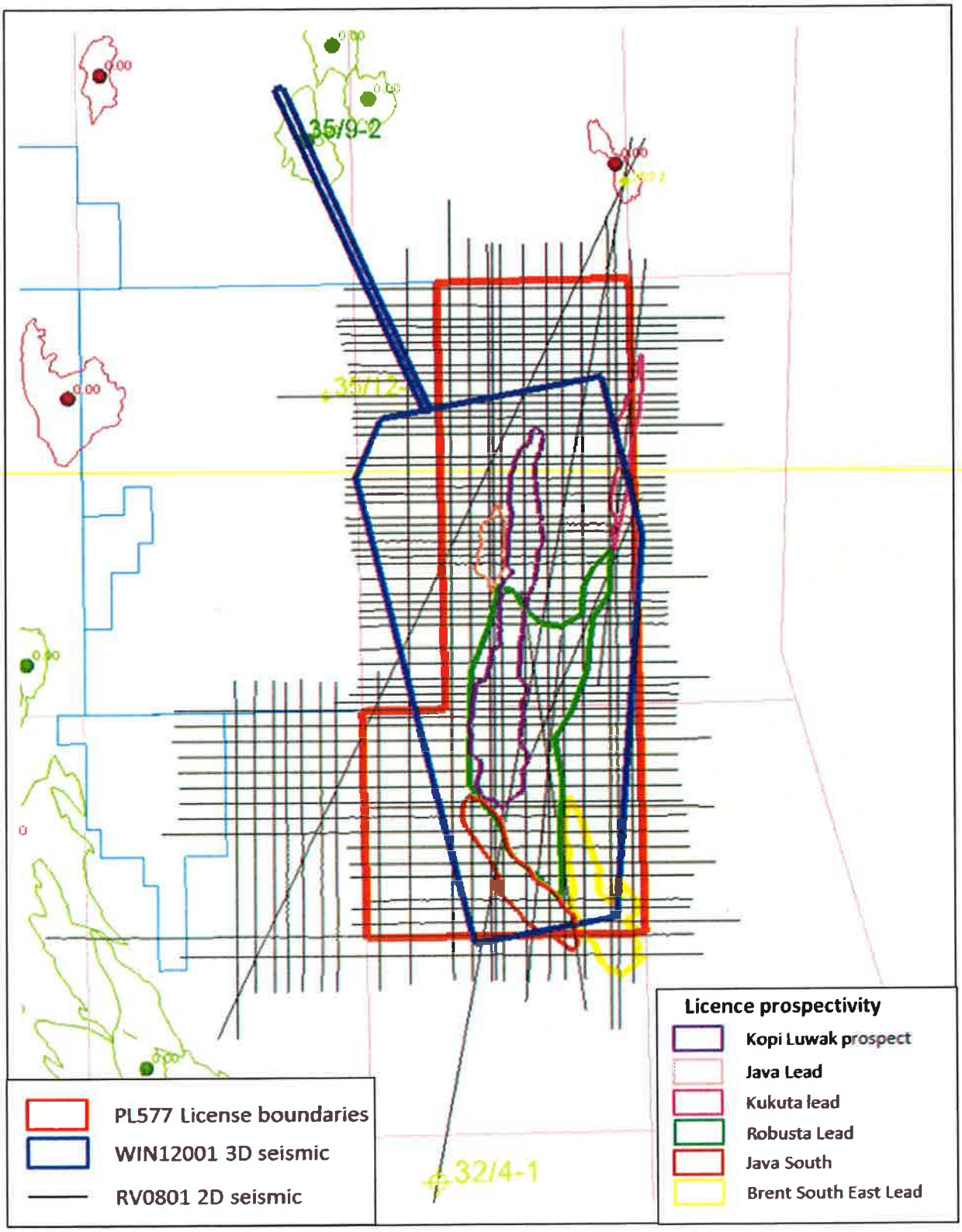

Figure 2. Location map for the seismic database and evaluated prospectivity over the PL577.

3. Geological Framework

The license is located in the NE pat of the NNS and covers part of the Øygaren Faultzone (Fig 3). This fault zone trends roughly N-S and marks the transition from the Pre-Cambian rocks

of the Fennoscandian Shield and the North Sea sedimentary basin. Large volumes of coarse clastic sediments were deposited along this basin margin both in the extensive Sognefjord and Fensfjord Formations during the late Jurassic and as the Sotra and Solund Formations in the Paleocene. One of the intriguing ideas that we were following in the PL577 was that coarse clastic sediments could also have been deposited in the Jorsalfare Formation in the Late Cretaceous potentially sourced from the basemt area east of the Øygaren Fault Zone and transported out into the Basin through old drainage systems such as a pre-glacial Sognefjord.

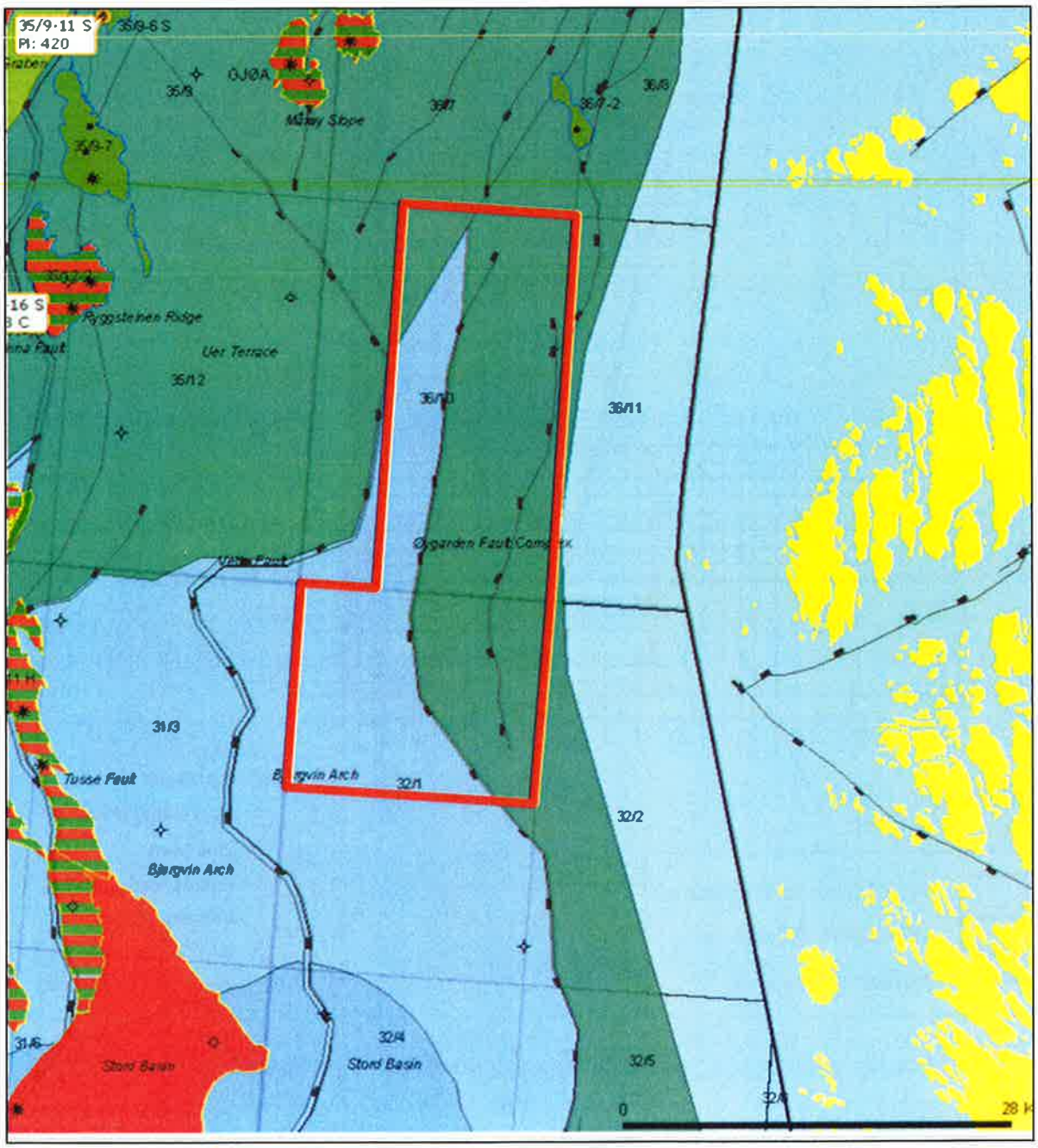

Figure 3. Structural Elements Map. PL577 shown with red frame.

4. License Evaluation

Based on the new seismic data, all prospective horizons have been evaluated in the PL577 licenses using Wintershall's knowledge and experience from nearby licenses along trend (PL378-PL551).

Due to a high risk of charge in the blocks to the East side of Troll which are believed to be in a migration shadow from the main kitchen area in the Viking and Sogn Grabens. The prospectivity of the license has to rely on a local kitchen supply. A strong focus was put on a new basin evaluation as well as Amplitude and AVO modelling to detect hydrocarbon effect. An OBN test was also performed along with the new seismic acquisition to try to isolate information of fluid content from the converted S waves.

The WIN12001 survey proved effective for AVO analysis in order to de-risk reservoir and/or hydrocarbon presence. WIN12001 as well as RV0801 also allowed for ties to the key offset wells to the north, east and south. The Upper Cretaceous and Jurassic section was mapped in detail for evaluation of the trapping mechanism, volume estimation, migration and charge (through amplitude analysis) of the prospect and leads.

In addition to AVO analysis, other geological studies were conducted to address key risk elements:

- In house seismic data conditioning and pre-stack processing (for AVO analysis)
- OBN test line acquired along the 3D seismic to try to isolate information about fluid content from the S waves.
- Basin Modelling to asses maturity of the Jurassic source rock and migration pathways
- New depth conversion model
- Petrophysical analysis of key offset wells

5. Prospect Update

The application for PL577 identified one prospect and three leads. After award, two additional leads were identified. The following is a summary of all opportunities that have been identified (Figure 2), although all have subsequently been downgraded or discarded as viable exploration prospects.

Kopi Luwak Prospect

The Kopi Luwak Prospect is a combined stratigraphic/structural trap possibly in the Upper Cretaceous Jorsalfare Formation but most likely in the Early Paleocene section of Danian age. The reservoir sandstone where thus supposed to be equivalent to the Sotra Member as penetrated in wells further to the west like in 31/2-19S.

The structure is defined by an incision in the Late cretaceous in the shape of a North-south channel like feature highlighted by a clear amplitude anomaly (Figure 4). The trap is defined by a onlap of the package to the South and to the East on the top Shetland but has a dip closure towards the North and West (figure 4).

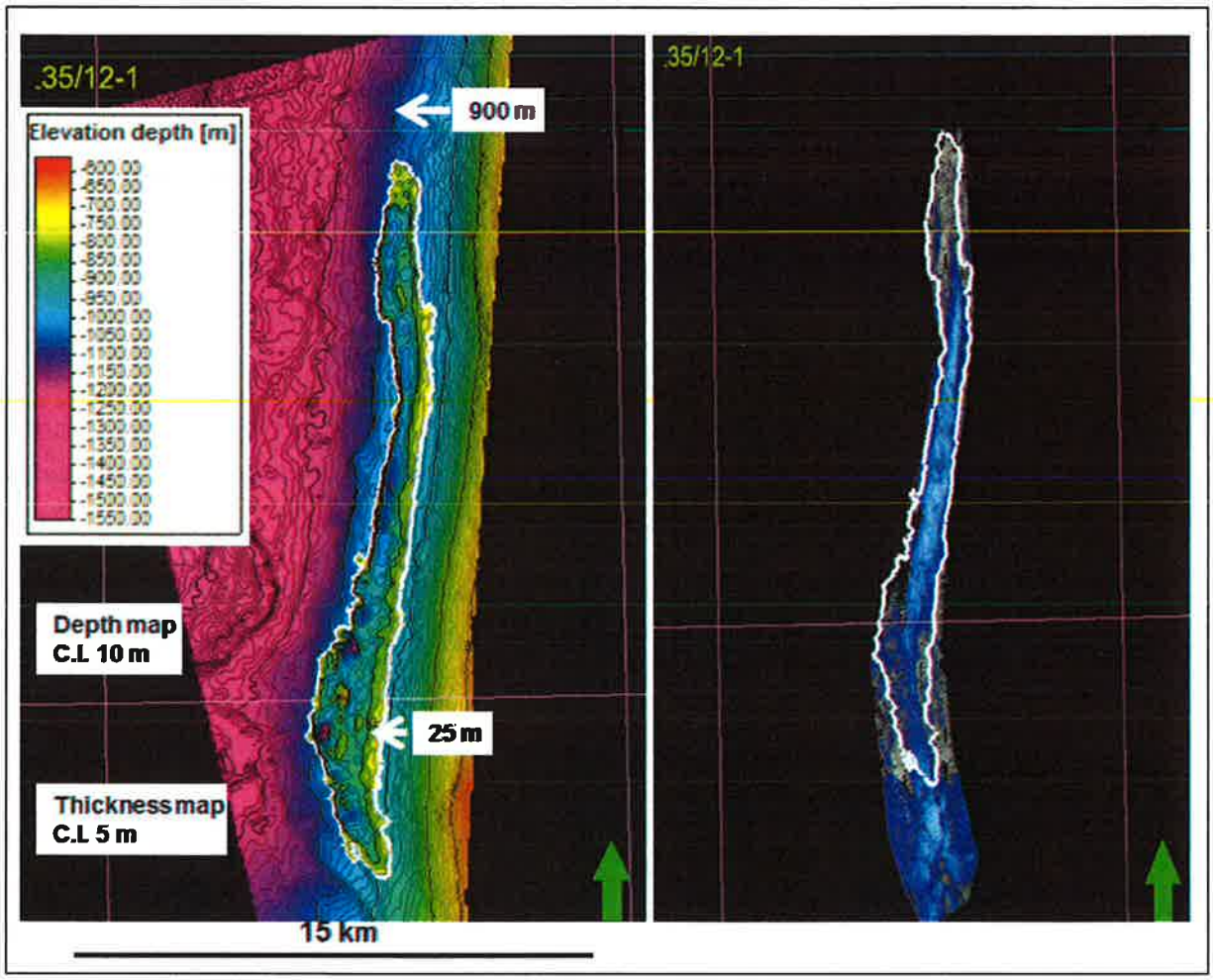

Figure 4. Thickness map of the kopi Luwak prospect overlaid on top Shetland to the Left. The amplitude extraction (right) shows the clear channel like form of the prospect, as well as the amplitude anomaly continuation to the south making the southern pinch out point uncertain.

After evaluation of the structure and the analysis of the amplitude anomaly and AVO response of the prospect, in relation to the equivalent reservoir model derived from the Egga member sandstone present in the Ormen lange field, we came to the following conclusions.

- One of the main risks is the lateral and base seal, which are unlikely to work since the channel incise, up dip to the south, into the Upper Jurassic Sognefjord formation which is sand prone in the area (Figure 5)

- The presence of reservoir is likely. It can either be Sotra Fm sands shed down the continental slope backfilling the channel or Upper Jurassic sands eroded in the South and re-deposited further down-dip in the channel to the north.
- The second main risk of this prospect is the hydrocarbon charge. The local kitchen is immature and do not provide enough volume in the fetch area to fully charge the Kopi Luwak structure (Figure 6).
- The hard response of the top of the prospect compared to the overlying Tertiary shales is in accordance with the presence of a sandstone reservoir at this depth but points towards a water wet reservoir, as corroborated by the absence of AVO type 3 anomaly expected in presence of light oil or gas.

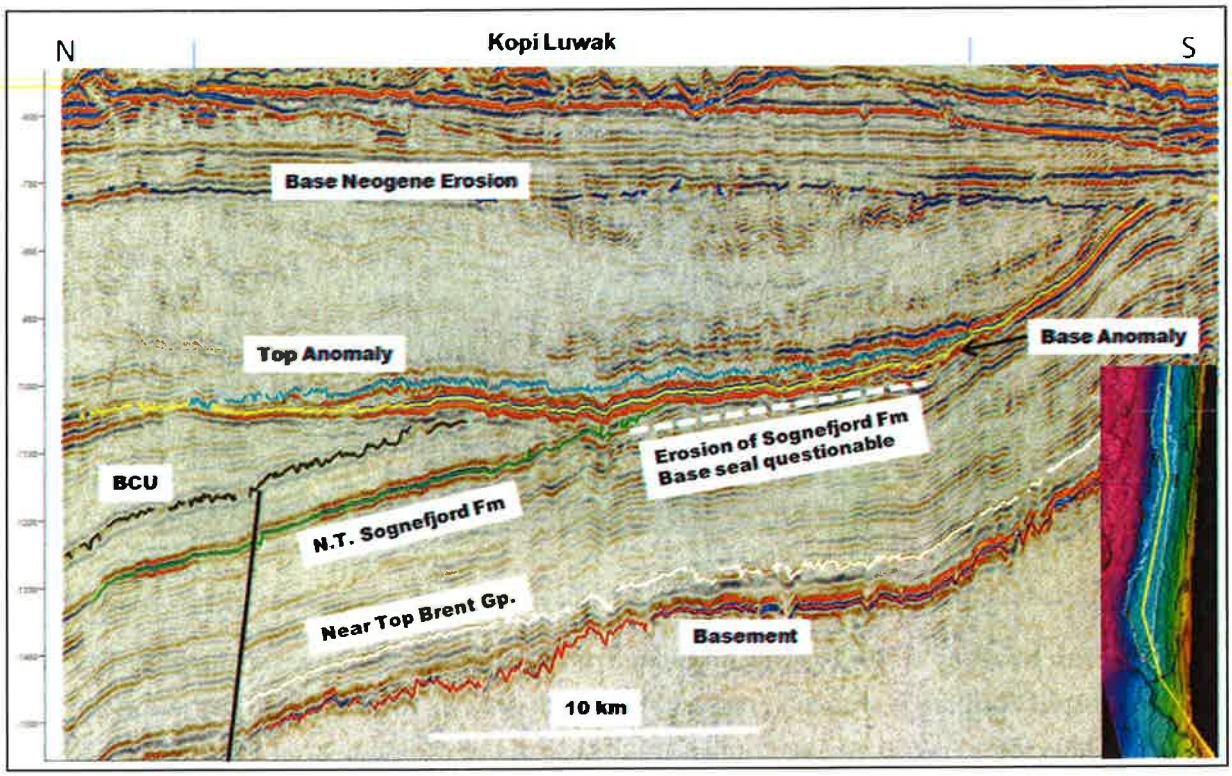

Figure 5. Composite Seismic section through the Kopi Luwak Prospect showing the erosion at the base of the anomaly into the Sognefjord Formation to the south.

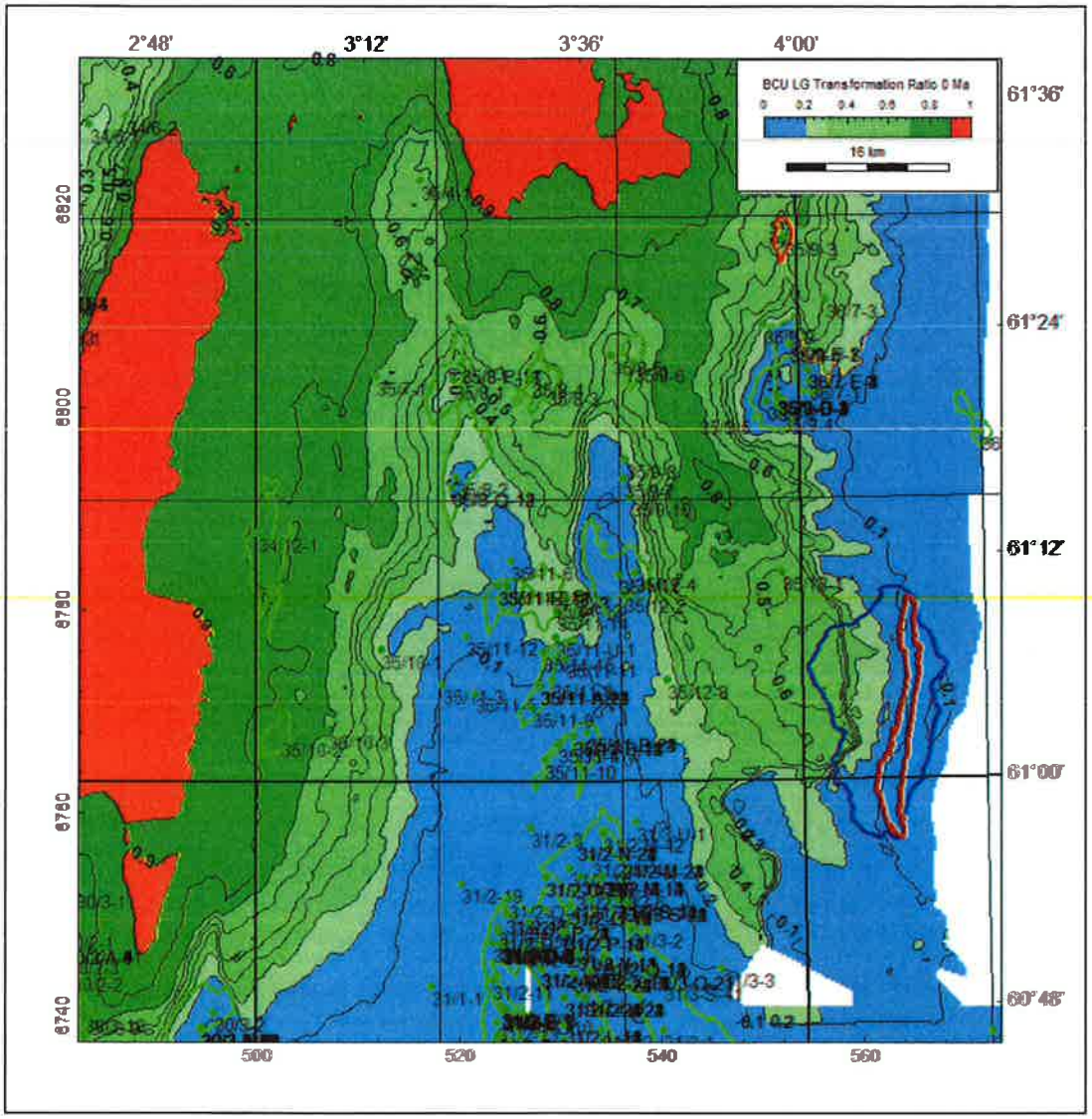

Figure 6. Top Heather Maturity Map, showing transformation ratio in insert legend. The Kopi Luwak prospect outline is shown in red and the fetch area at Top Heather Formation is shown in blue line. As can be seen only a small part of the drainage area (light green) is early mature whereas the majority of the drainage is immature (blue).

Java Lead

The Java lead was interpreted as a 3way dip closure against a main basement fault in the Jurassic, directly overlaying the basement in this area. This Jurassic closure include two main reservoir section: the Sognefjord and the Brent units. Due to the sand to sand juxtaposition of the Sognefjord reservoir across the fault, the prospectivity was recognized only in the Brent formation (figure 6).

The subsequent evaluation of this lead has highlighted very small potential in place volumes as well as a high risk due to the following factors:

- The charge of this lead from the local kitchens is very unlikely since the hydrocarbons generated from the barley mature Jurassic source rock would migrate up dip and by pass the Brent reservoir located deeper. The presence of older source rock has not been proven in this basin and is unlikely.
- The top seal and side seal effectiveness across the basement fault, although likely, was adding to the main uncertainty of this lead being successful.

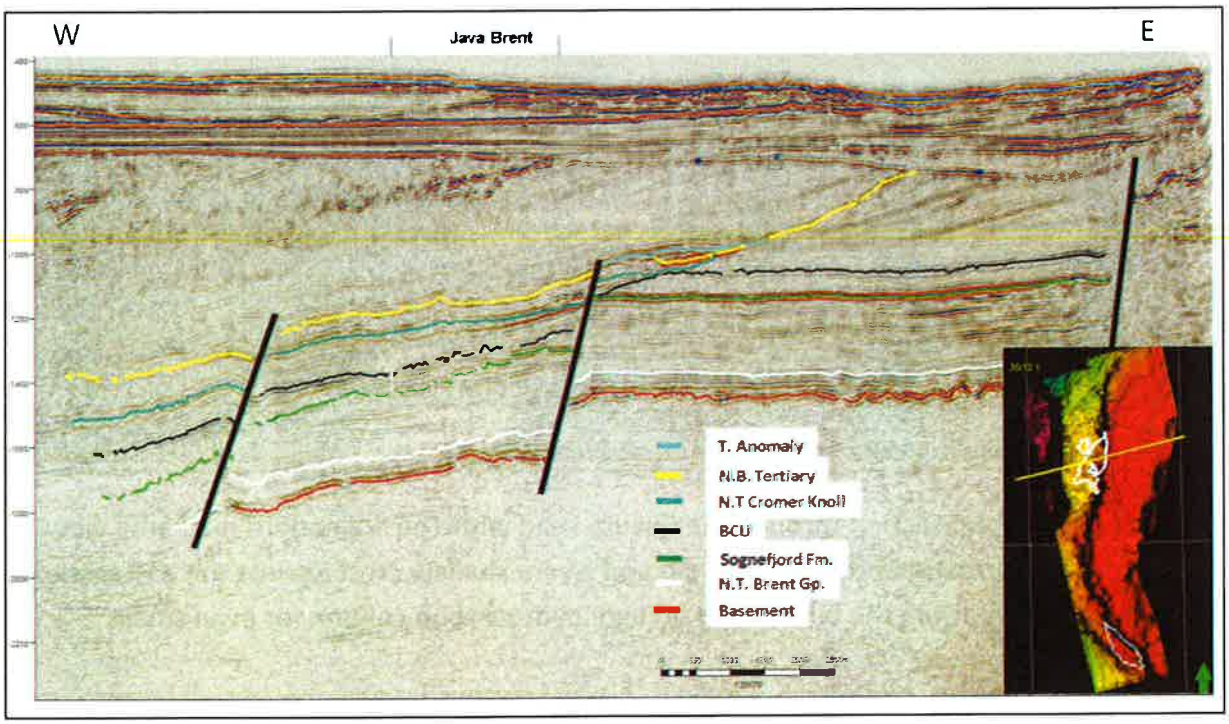

Figure 7. Seismic dip section through the Java Lead with Brent map area view which highlight the dip of the Jurassic package to the west as well as the main faults. The fault that provide the up dip sealing mechanism for the lead is showing a likely sand to sand juxtaposition at Sognefjord level but sand to basement juxtaposition for the Brent.

Cucuta and Robusta leads

The Cucuta lead was a 3 way dip closure against the shallowest basement fault to the east of the block with reservoir in the Upper Jurassic Sognefjord Formation. The lead could not be entirely remapped because it was partly outside of the new 3D data. Nevertheless the lead was re-evaluated and considered very small due to the extreme dip of the Jurassic package in this place. The lead area and volume was thus limited, with a very high maximum possible hydrocarbon column of 800m and a structural crest at 650m. At the crest of the structure it is not clear if the reservoir is still in direct contact with the basement fault or is eroded by the base quaternary, as the extreme dips of the strata are not resolved properly by the

seismic data (figure 8). This is why the very high column joined to a shallow crest and the need of a top and side seal made this lead very unlikely to bear hydrocarbons.

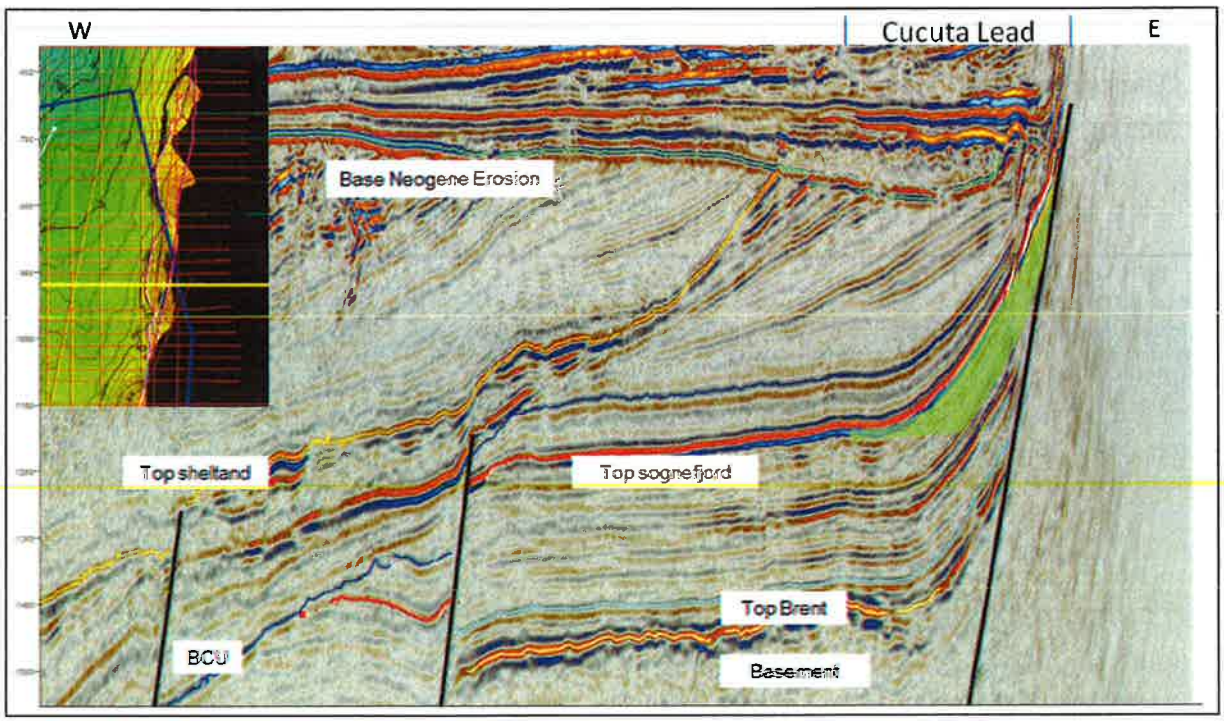

Figure 8. Seismic dip section through the Cucuta Lead with Top Sognefjord map area view. The Sogneford Formation presents high dip and a very shallow crest against the easternmost Basement fault, implying the building up of huge hydrocarbon column for even small volumes.

The Robusta lead was interpreted in the application to be a 4 way dip closure at the Brent level. However the re-mapping of top Brent in the 3D seismic data show the absence of any closure in time as well as in depth (figure 9), but a gently dipping Jurassic strata on this terrace with an up dip pinch out further to the south.

Other Prospectivity & Play Potential

A few additional opportunities have been identified in the Brent and Statfjord Formation within the PL577 license. The lower Jurassic is considered a good reservoir in the area proven by all the wells in the vicinity. The top Brent has been mapped in the entire area but the Statfjord presence directly above the Basement can only be assumed based on the thickness from top Brent to basement.

The Java South lead was identified to be a structure similar to the Java Lead a few km to the north on the same terrace. It is a 3 way dip closure again the same basement fault with reservoir in the Brent and Statfjord Formations which is juxtaposed to Basement rocks along

the fault providing a better trapping mechanism for the Java South than in the Java (North) (figure 10). The possibility of a bigger closure regrouping Java and Java south within the same closing contour was evaluated and abandoned due to some relay ramps in the basement fault (half way between Java and Java South) that would cause the hydrocarbon to escape to the upthrow block through the Brent reservoir. The Java South lead was then reviewed and unanimously discarded by the License because of small volumes and high risk.

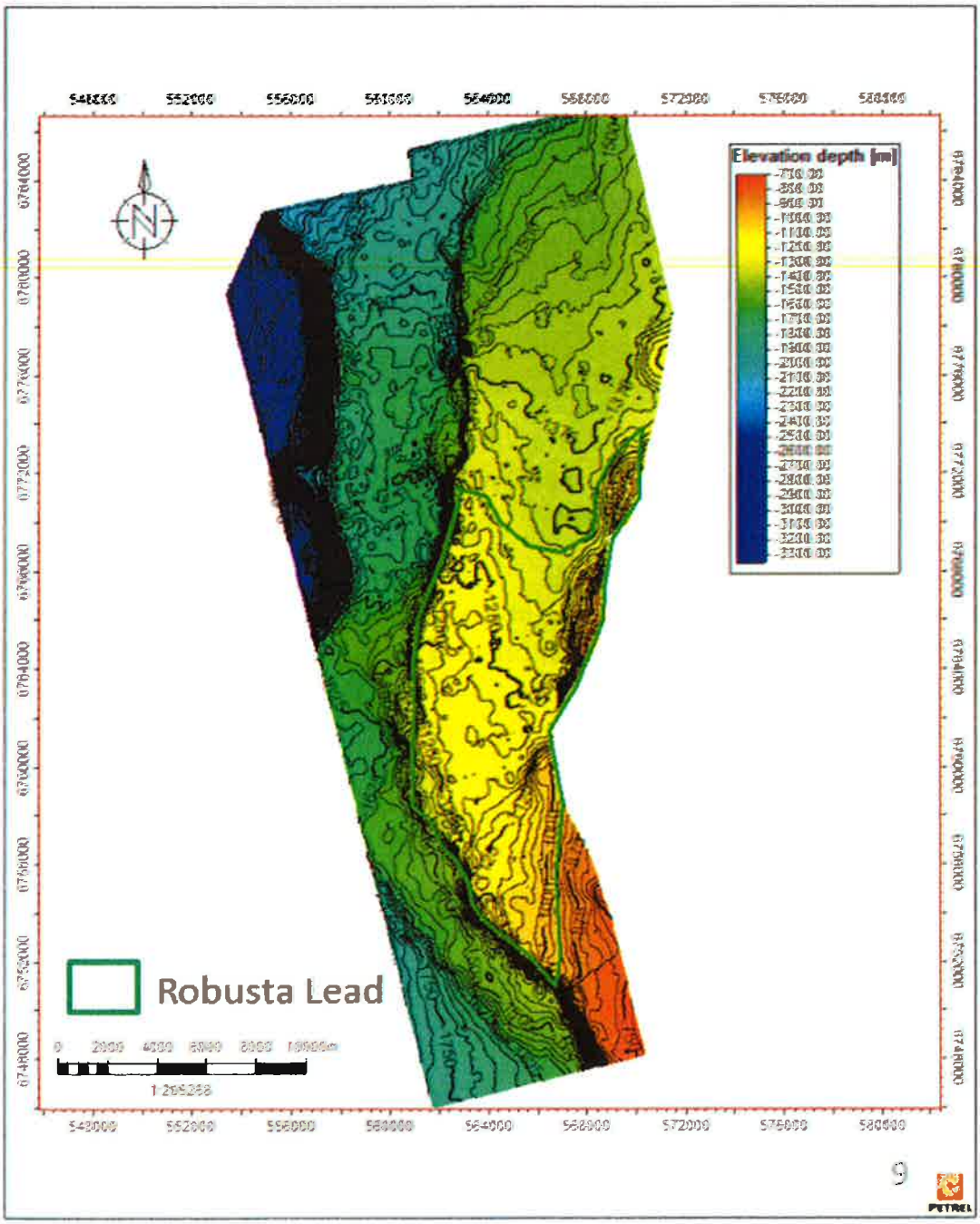

Figure 9. Brent depth map overlay with Robusta lead outline showing that there is no closure at this location but a continuously dipping up Brent formation toward the south.

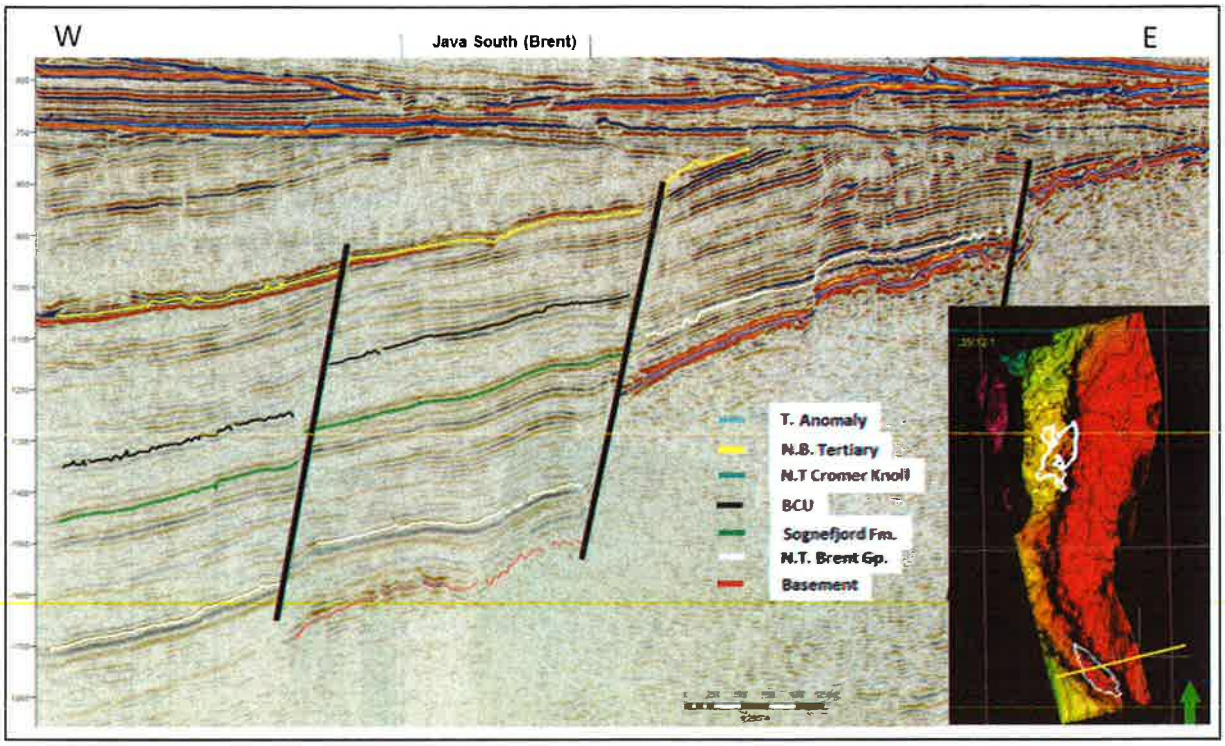

Figure 10. Seismic dip section through the Java South Lead with Brent map area view which highlight the dip of the Jurassic package to the west as well as the main faults.

When evaluating the Robusta lead, it became obvious that the dipping Jurassic strata were causing an absence of closure in the lead but presented an up dip pinch out to the south. This pinch out to the south-East provided the trapping mechanism for a new lead, the Brent South East lead, with a down dip closure to the north and the need of a fault acting as side seal to the South-West in order to fill the Brent formation down to the Basement (figure 11). The in place volume although substantially bigger than the other Brent lead, remained marginal and the high risk of failure due to the trapping mechanism relying on a pinch out and a fault side seal, as well as a high charge uncertainty made the lead unattractive (difficult to map because at the border of the 2D and 3D survey coverage).

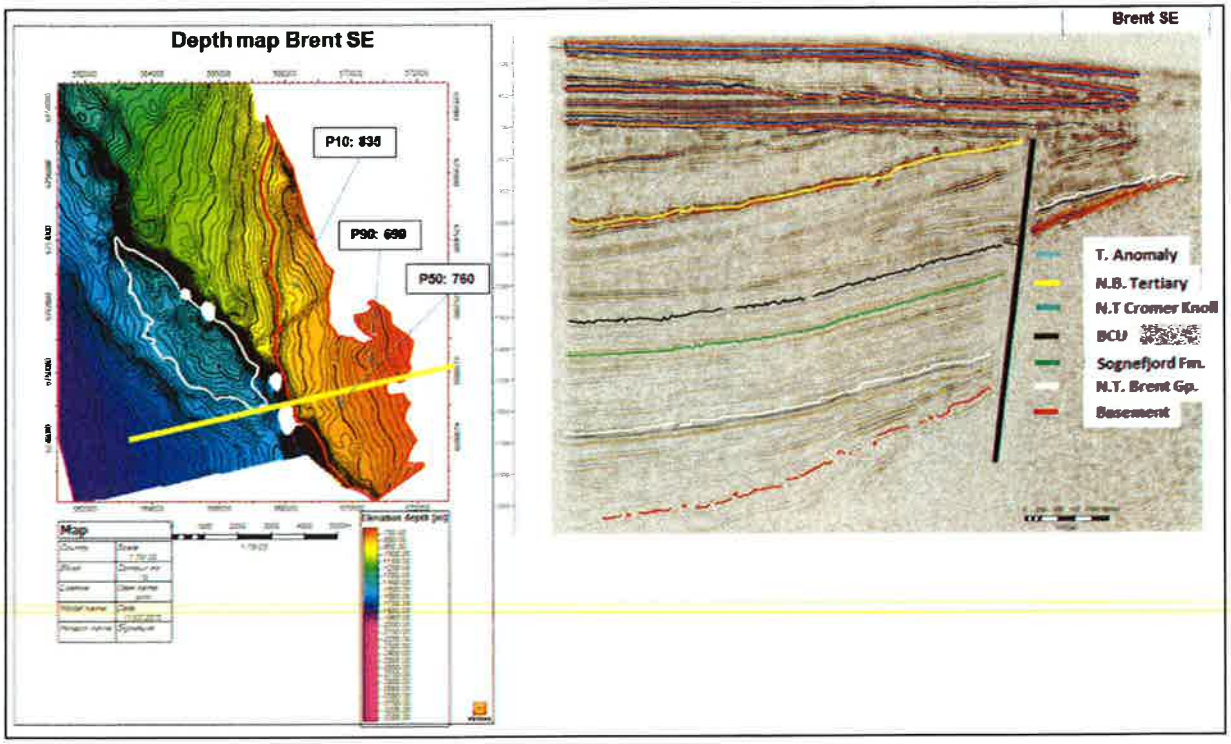

Figure 11. Brent depth map with Brent South-east lead overlay (to the Left) and dip seismic section through the lead (to the right) showing the Brent pinch out against the Basement.

7. Conclusions

The work programme and subsequent technical evaluation has provided conclusive results with regards to the prospectivity in the PL577 license. All earlier identified prospects and leads have been discarded as valid and no other viable prospectivity has been recognised. Based upon these results the decision to relinquish PL577 was agreed unanimously in the license.