

RELINQUISHMENT REPORT

PL 788





Relinquishment Report PL 788

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1 Key Licence History

The Production License PL788 was awarded to Wintershall Norge AS (operator, 50%) and Capricorn Norge AS (50%) at the APA 2014. It became effective on the 6th of February 2015 for an initial period of 7 years (2+2+2+1) with the following major milestones:

- 06.02.2017: Acquire 3D seismic, G&G studies - Drill or Drop Decision
- 06.02.2019: Drill a well and make decision on concretization or drop (Beslutning om konkretisering, BoK)
- 06.02.2021: Decision of Continuation or drop (Beslutning om Videreføring, BoV)
- 06.02.2022: Submit a PDO or drop & relinquishment report

The license covered part of the blocks 34/9 and 35/4-5-7-8-10 in the Northern North Sea for a total area of 471.42 km². The work commitment consisted of G&G studies and acquire new 3D broadband seismic. At the time of relinquishment, the licensees were Wintershall Norge AS (operator, 50%) and Capricorn (50%).

An extensive evaluation work was planned and performed for PL788 license to define and evaluate all individual potential prospects and leads in the Pliocene and Jurassic plays, and to assess all the risk elements associated with those prospects and leads.

The fast track version of the new CGG broadband seismic data was delivered just shortly before the agreed Drill-or-Drop (DoD) decision dated 6th of February 2017. As a result, the remaining time until that DoD date was not enough to interpret and evaluate the new broadband CGG seismic data. Therefore, for a sake of completion of the evaluation exercise in the license, one-year extension has been requested. However, a nine-month extension was eventually granted. Therefore, the new DoD decision was set to 6th of November 2017 accordingly.

Since the awarding of PL788 license, the following license meetings were held:

- 20/04/2015 Kick-off meeting
- 13/10/2015 EC MC meeting
- 14/06/2016 EC meeting
- 03/10/2016 Workshop
- 09/11/2016 EC MC meeting
- 04/04/2017 Workshop
- 11/09/2017 Workshop
- 26/09/2017 EC MC meeting

The prospect evaluation exercise of the PL788 license resulted in defining many prospects and leads in the Pliocene and Jurassic plays. The Morkel prospect and the Kjuke, Scrubb S and Scrubb N leads represent stratigraphic traps with amplitude anomalies in the Pliocene clinoform. The Oak, Caramel, Praline, Glory, Lakris and Småborre prospects represent combined structural-stratigraphic traps in potential Kimmeridgian sands. The Ax prospect represents a combined structural-stratigraphic trap in potential turbidite sands of Oxfordian age. The Alpha, Beta and Pyrite prospects and many other leads (Galena, Gabro, Scoria, Topaz N, Topaz S, Sognefjell and Strynefjell) represent structural traps in Middle Jurassic Brent Group. The Cobalt and Emerald prospects represent structural traps in the Cook Formation from Early Jurassic. Fig. 1.1

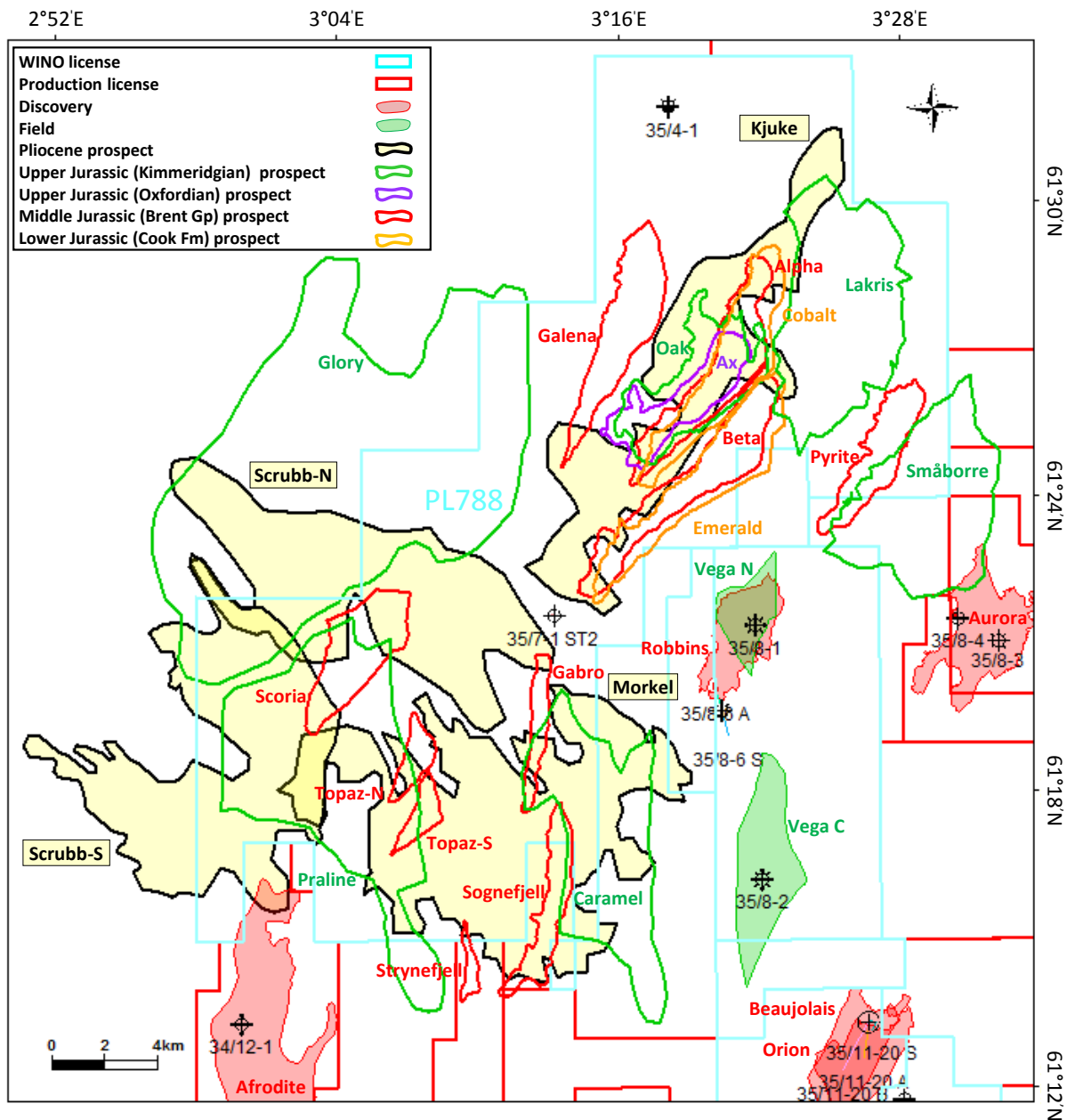


Fig. 1.1 Basemap showing PL788 license with all potential prospects and leads

Wintershall Norge AS (operator) proposed to drill an exploration well to test reservoir and hydrocarbon presence in multiple targets from Pliocene down to Early Jurassic. Those targets are: Kjuke amplitude anomaly of Pliocene age, Oak and Ax prospects of Upper Jurassic (Kimmeridgian and Oxfordian turbidite sands respectively), Alpha prospect from Middle Jurassic (Brent Group) and Cobalt prospect of Lower Jurassic (Cook Formation).

The exploration well was proposed to the licensees, targeting the previously mentioned prospects, however, no support was achieved. Therefore, the license was eventually relinquished in the 6th of November 2017.

2 Database

2.1 Seismic data

The seismic interpretation and evaluation of the PL788 license was performed mainly on two 3D seismic surveys, the PGS-Mega survey and the new broadband CGG Horda 3D survey as listed in Table 2.1 . The outlines of the main surveys with the underlying vintages for the PGS-Mega survey in PL788 license are shown in Fig. 2.1

Table 2.1 PL788 Seismic database

PL788 Seismic Database							
Survey	Underlying vintages	Final stack	Raw field shots	Seismic navmerged shots	Post migrated CDP gathers + raw full/angle stacks + final full stack in time & depth	Velocities - Final depth interval migration velocities + RMS stacking velocities	Comment
PGS Mega survey	MC3D-35/7	x	x	x			Good seismic quality East-West shooting direction
	BPN9301	x	x	x	x	x	Moderate seismic quality East-West shooting direction
	IPN0601	x	x	x	x		
	NH9402	x	x	x	x		Moderate to poor seismic quality East-West shooting direction
CGG Horda 3D		x	x	x	x	x	

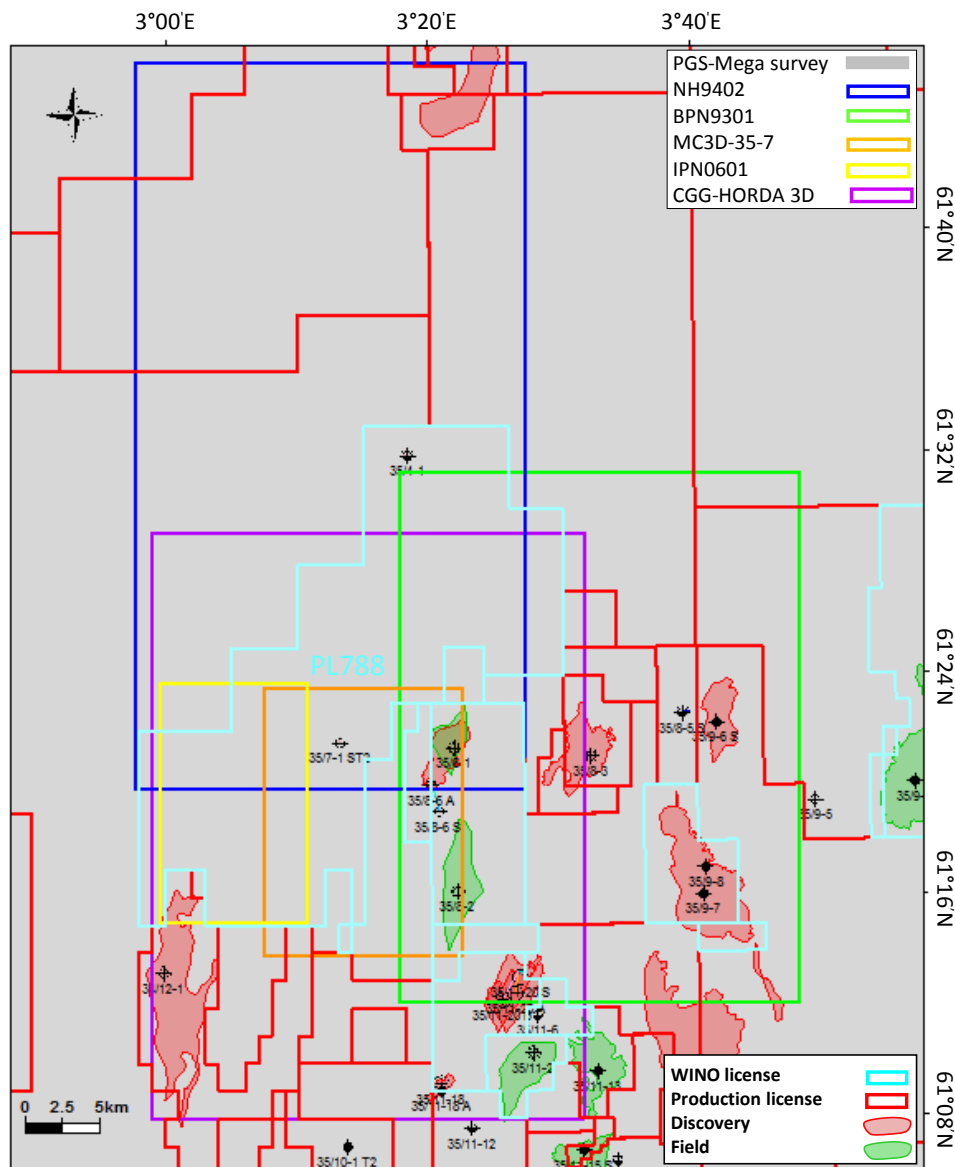


Fig. 2.1 Basemap showing the outlines of seismic surveys and underlying vintages used in PL788 seismic database

The PGS-Mega survey is a merged survey consisting of different vintages with different quality and have been phase matched and merged together by PGS. Although the PGS-Mega survey covers the whole PL788 license, and is good for regional overview, the survey can not be used for detailed reservoir mapping and quantitative geophysics as it is merged by many surveys that all have different acquisition and processing parameters and show abrupt amplitude changes along the merge lines. Better data was needed to optimize the interpretation and evaluation of the PL788 license, and eventually the new CGG Horda broadband 3D seismic was acquired over the license.

2.2 Well data

The well database consists of an initial set of 37 wells, later upgraded with additional well drilled in the nearby area. Table 2.2

Table 2.2 PL788 Well database table

Well Database					
Well	Original Database	Final Database	Wells used in multi-well Ichron study 2010	Wells used in multi-well Ichron provenance study 2014	Regional Sequence Stratigraphic study (Legler 2016/2017, internal Wintershall)
34/3-2 S	x	x			
34/3-3 S	x	x			
34/3-4 S	x	x			
34/3-4 A	x	x			
34/3-5 A	x	x			
34/6-1 S	x	x	x		
34/12-1	x	x	x		x
34/10-22	x	x			
34/10-25	x	x			
34/10-31	x	x			
35/4-1	x	x	x		
35/7-1 ST2	x	x		x	x
35/8-1	x	x	x	x	x
35/8-2	x	x	x	x	x
35/8-3	x	x	x	x	x
35/8-5 S	x	x	x	x	x
35/8-6 S		x			x
35/9-1	x	x	x	x	x
35/9-2	x	x	x	x	x
35/9-5	x	x		x	
35/9-6 S	x	x			
35/9-7	x	x		x	
35/9-8	x	x		x	
35/10-1 T2	x	x	x	x	x
35/10-2 T2	x	x	x		
35/11-2	x	x	x		x
35/11-3S	x	x	x	x	x
35/11-6	x	x	x	x	x
35/11-7	x	x	x		x
35/11-8S	x	x		x	x
35/11-11	x	x		x	x
35/11-12	x	x	x		x
35/11-13 S	x	x		x	x
35/11-15S	x	x		x	x
35/12-1	x	x	x	x	x
35/12-2	x	x		x	x
35/12-3 S	x	x			x
36/7-1	x	x	x	x	

The wells were used mainly for seismic to well tie, petrophysical and rock-physical evaluations, stratigraphic correlations and biostratigraphical reviews used in the subsequent studies. Fig. 2.2 shows the wells included in the license database.

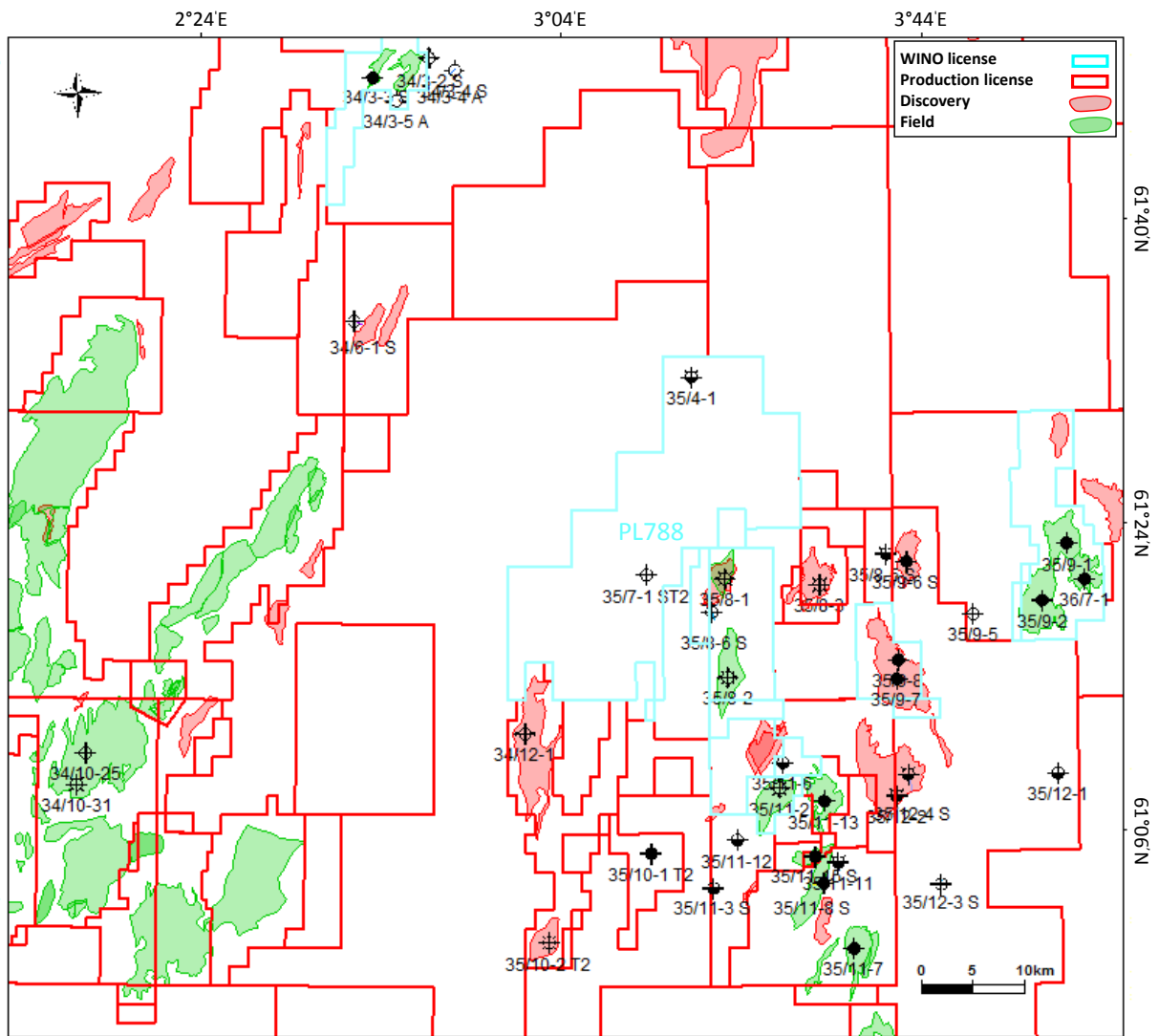


Fig. 2.2 Basemap showing all the wells used in PL788 well database

3 Review of Geological and Geophysical studies

As part of the agreed work commitment in the PL788 license, and to improve the understanding of the depositional system and the distribution of the facies at different play levels in the license, a number of G&G studies have been carried out. The studies aimed to de-risk the related risk elements associated with the prospects of Pliocene and Jurassic age. Those studies included:

- Seismic data conditioning for PGS-Mega survey for seismic image enhancement for the Jurassic section
- 2D-3D detailed structural interpretation and mapping of the Pliocene and Jurassic plays
- High resolution interpretation on Paleoscan software for the shallow Pliocene play
- Seismic screening and attribute analysis of the potential Pliocene amplitude anomalies
- Seal integrity study for the Pliocene play
- Petrophysical analysis for the Pliocene and Jurassic reservoirs
- Seismic sequence stratigraphy study for the Pliocene play
- Fluid substitution and AVO analysis for the potential shallow Pliocene sands
- Feasibility study of potential EM (Electro-Magnetic) data acquisition for the Pliocene play
- Value of information (Vol) exercise for acquiring EM (Electro-Magnetic) data over the Morkel prospect, which is needed to reduce the uncertainty of the gas saturation in the Pliocene play
- Bio-stratigraphic review of Jurassic tops
- Sequence stratigraphic framework and depositional model including the greater Skarfjell and Vega areas for Jurassic play (Bathonian to Tithonian well correlation and mapping of facies distribution within ten biostratigraphically defined time-slices) (Legler 2016/2017, internal report Wintershall)

The Morkel prospect is the main prospect in Pliocene play Fig. 3.1. It represents one among many amplitude anomalies observed in the Pliocene clinoform Fig. 3.2. Those shallow amplitude anomalies are usually considered as drilling hazards, and are eventually avoided while drilling wells. The geological studies focused on mapping all potential amplitude anomalies in the Pliocene clinoform on PGS-Mega survey and later on CGG Horda 3D, and evaluating the presence and quality of potential sands in the Pliocene play. Furthermore, to define the potential risk elements associated with the Pliocene prospects (Morkel) and leads (Kjuke, Scrubb-N and Scrubb-S). The main risks are the trap effectiveness (potential thin thief sand up-dip of the stratigraphic trap), and the second risk is the source rock presence and quality (due to shallow depth). Top seal effectiveness (seal integrity) and reservoir presence and effectiveness represent the lower risks. The geophysical studies which were performed on CGG Horda and PGS-Mega survey 3D seismic, focused mainly on the concept of the defined Pliocene prospects which strongly depends on potential amplitude anomalies. The studies started with seismic sequence stratigraphy exercise for the Pliocene clinoform to understand the depositional environment and facies distribution within the clinoform in relation with seismic. The next study was seismic screening and attribute analysis for all the potential amplitude anomalies, then fluid substitution and AVO analysis to check for any hydrocarbon saturation in those anomalies. In addition, a feasibility study of potential EM (Electro-Magnetic) data acquisition and value of information (Vol) exercise for acquiring electro-magnetic (EM) data has been performed, which is useful to prove the existence of enough gas saturation in the sands of Pliocene age.

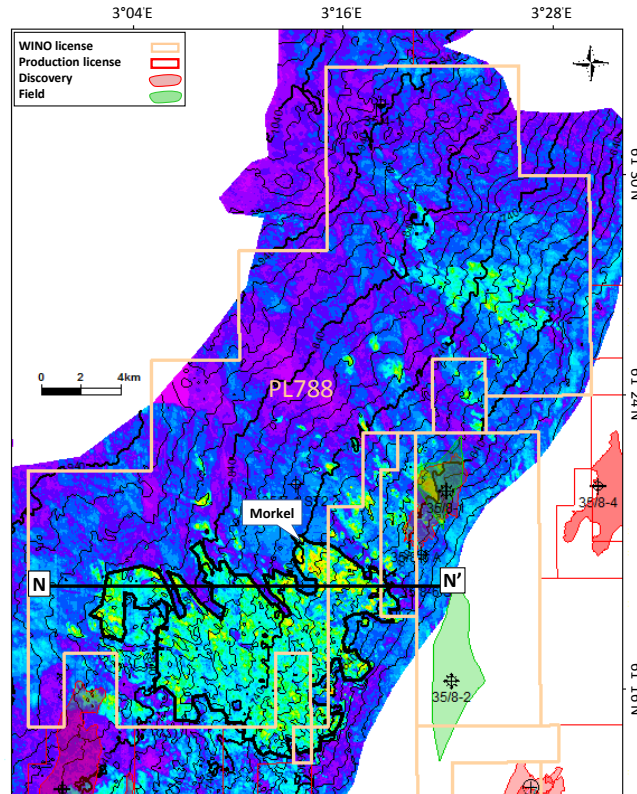


Fig. 3.1 Top Morkel depth map superimposed by extracted max amplitude

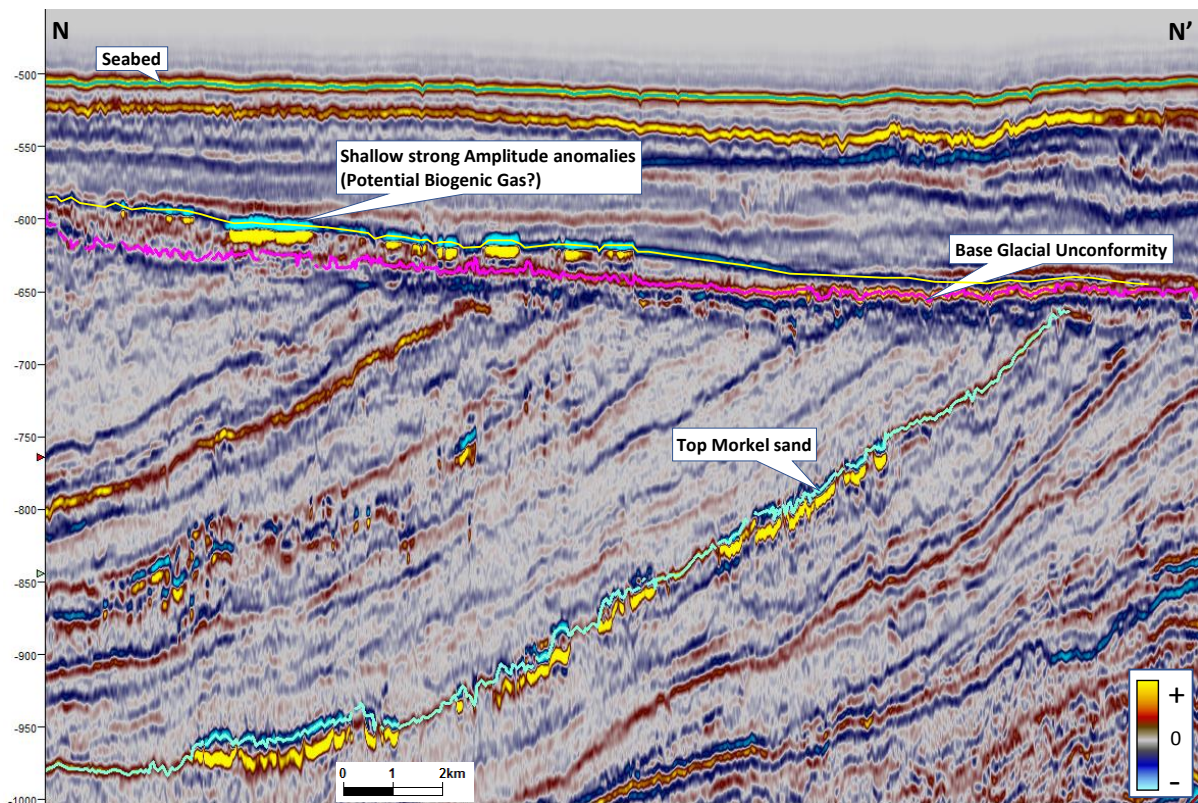


Fig. 3.2 N-N' seismic line showing Morkel prospect as an amplitude anomaly within the Pliocene clinoform

For the Jurassic play, the studies included detailed 2D-3D structural interpretation for the section from base Cretaceous unconformity down to Late Triassic. The work was mainly

focusing on the Brent group from Middle Jurassic which represent the main reservoir in the area Fig. 3.3. The interpretation resulted in defining many prospects and leads at different level of the Jurassic play Fig. 3.4

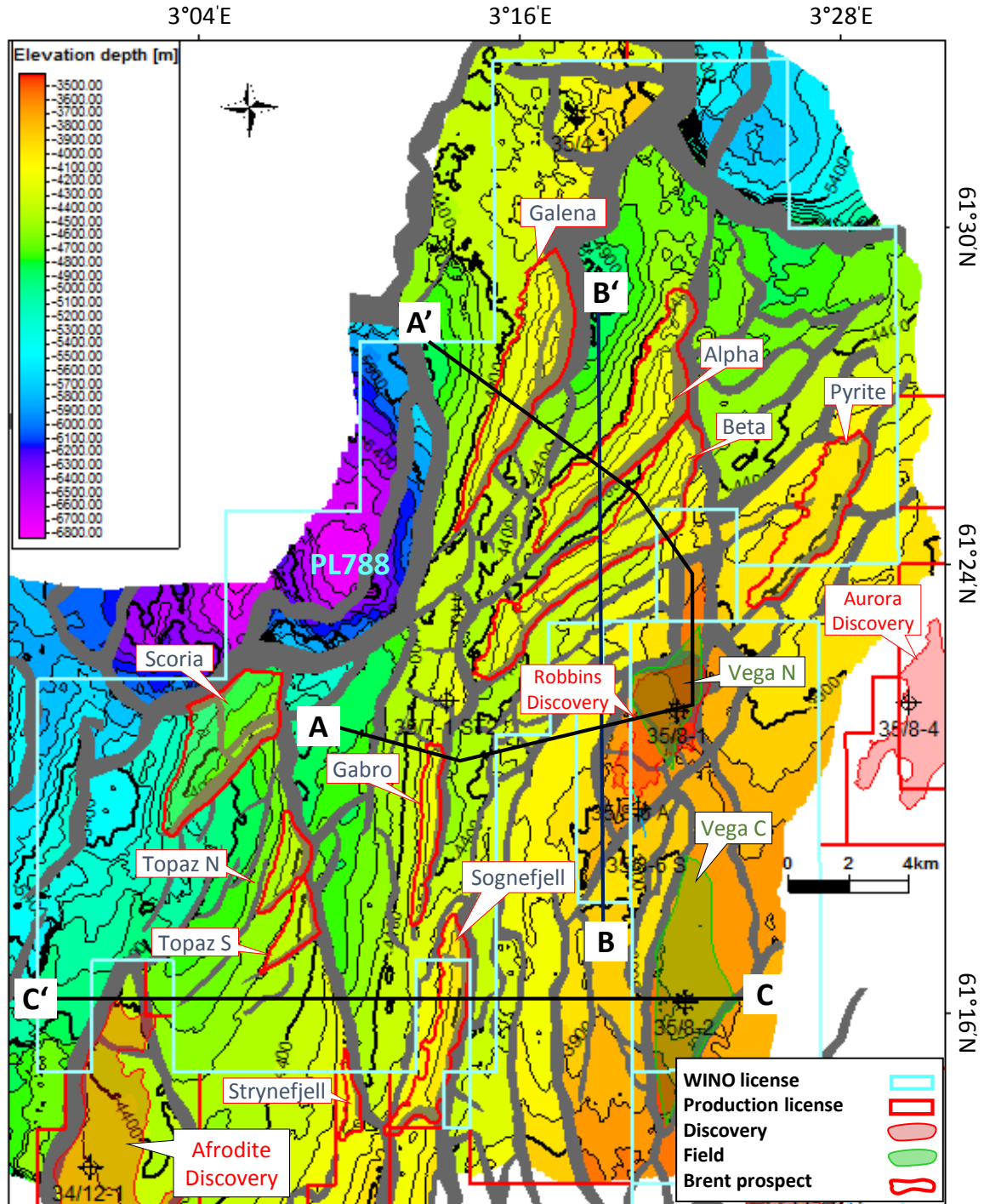


Fig. 3.3 Top Brent depth structure map with all potential Brent leads and prospects outlines
 The direction of the seismic lines are shown on the map

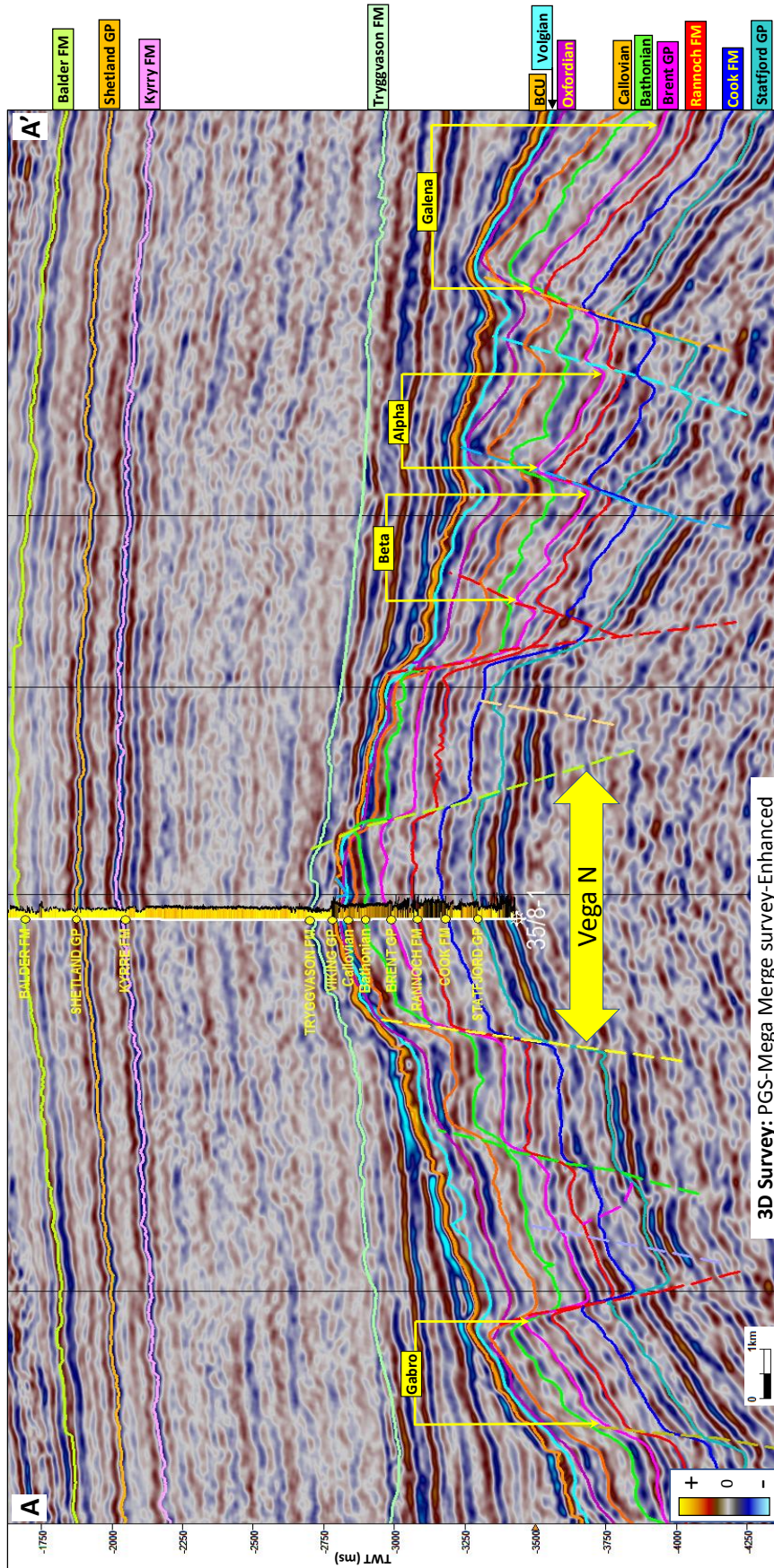


Fig. 3.4 Arbitrary seismic line A-A' showing the structural elements (rotated fault blocks) in the Jurassic level in PL788

The Oak, Caramel, Praline, Glory, Lakris and Småborre prospects represent combined structural-stratigraphic traps at Upper Jurassic level (potential Kimmeridgian sands) Fig. 3.5 . The Ax prospect represents a combined structural-stratigraphic trap at Upper Jurassic level (potential Oxfordian turbidite sands). The Alpha, Beta and Pyrite prospects and many other leads (Galena, Gabro, Scoria, Topaz N, Topaz S, Sognefjell and Strynefjell) represent structural traps at Brent level. The Cobalt and Emerald prospects represent structural traps at Early Jurassic Cook Formation. As a part of prospect maturation at Jurassic level, a biostratigraphic review of the Jurassic tops in the wells has been performed to identify the correct age and differentiate between Kimmeridgian and Oxfordian sand units, furthermore, to define the potential erosional surfaces (especially the Volgian unconformity which is a key truncation) in order to explain the missing sections and potential truncation-based stratigraphic traps. Then a sequence stratigraphic framework and depositional model (which is part of a regional study included the greater Nova and Vega areas) has been completed. In addition, a seismic attribute analysis study has been applied on potential upper Jurassic reservoirs (Kimmeridgian and Oxfordian) to help defining sand fairways and the size of the prospects.

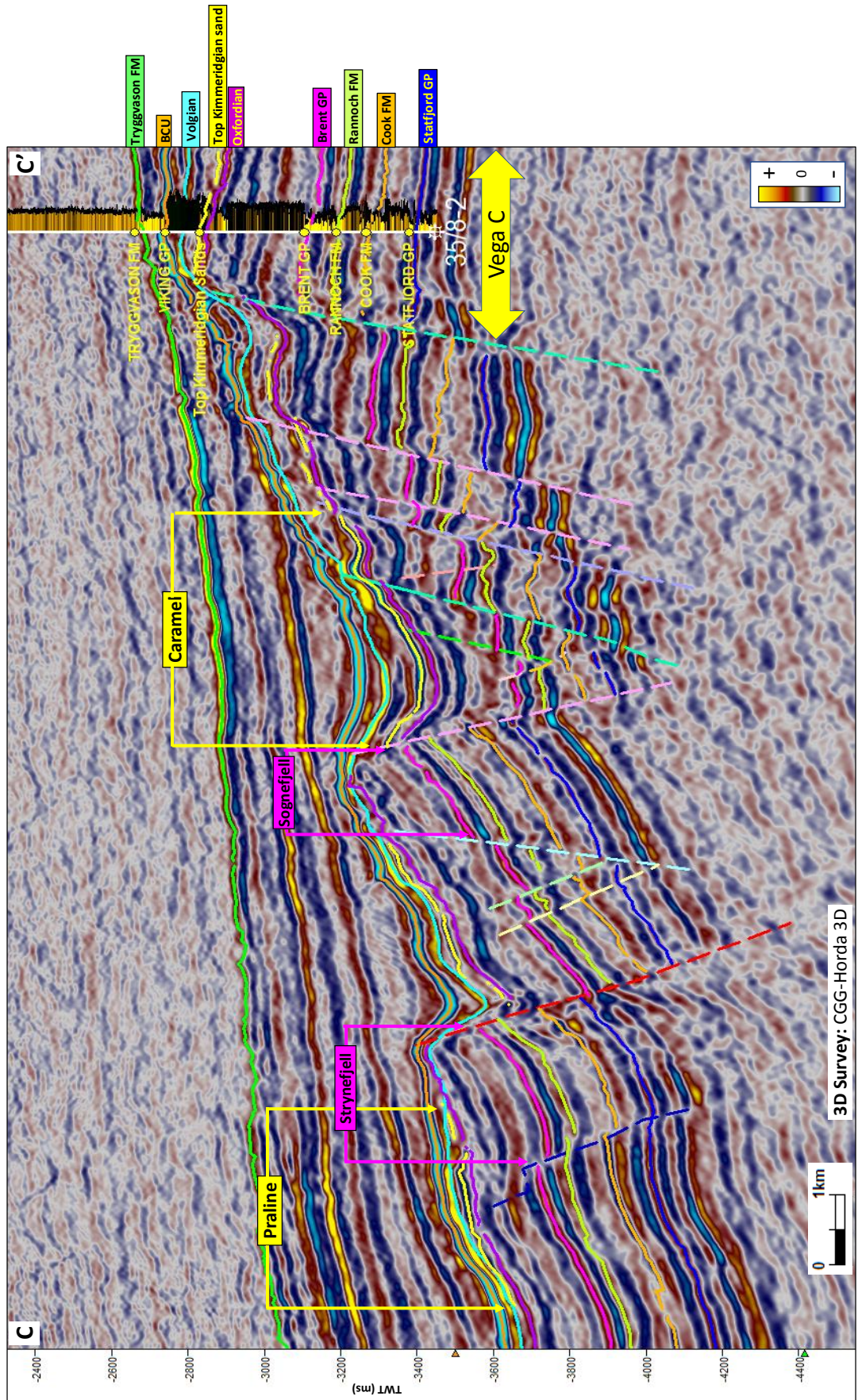


Fig. 3.5 C-C' seismic line showing Caramel and Praline prospects as an example of potential Kimmeridgian prospects

The outcome of the geological studies resulted in better understanding of the depositional system and facies distribution in PL788 license and nearby area (Vega and Nova) by contributing the results and knowledge acquired from the wells (Syrah, Vikafjell-North, Robbins, Antares and Orion), which were drilled recently in the neighbouring licenses during the time of evaluation. In addition, the geophysical and geological studies illustrated better understanding of the seismically-related thickness change and property distribution of the potential upper Jurassic sands especially at Kimmeridgian level.

Finally, for further de-risking of the potential Jurassic prospects, a dry well analysis has been carried out to explain the reasons for failure case for the wells in the license (top seal breach for 35/4-1 well and Brent versus Oxfordian sand-to-sand juxtaposition for 35/7-1 ST2 well). The analysis included fault plane diagrams generation and sand-to-sand juxtaposition analysis.

4 Prospect Update

The Sognefjell and Strynefjell prospects, were the original prospects at the time of application. Those prospects are both rotated fault blocks of Jurassic age. The main reservoirs are Middle to Upper Oxfordian age turbidite sandstones (stratigraphic sequence J52-J56). The crests of both prospects are located within PL293. Only 23 percent and 27 percent of the mean recoverable volumes for Strynefjell and Sognefjell Prospects respectively were within the open acreage applied for. In both prospects, the Brent Group reservoirs are present below the main Oxfordian target and are considered as an upside.

The new prospect evaluation in PL788 led to mature Sognfjell and Strynefjell prospects mainly as Brent prospects. Two additional new prospects (Caramel and Praline), from potential Kimmeridgian sandstones, were matured on top of Sognefjell and Strynefjell prospect respectively.

For the rest of the PL788 license, the prospect assessment (new interpretation and mapping), together with all the performed studies mentioned previously, resulted in defining many prospects and leads at different reservoir levels in Pliocene and Jurassic plays as follow:

- The Morkel prospect with other leads (Kjuke, Scrubb S, Scrubb N) represent stratigraphic traps with amplitude anomalies at Pliocene level (clinoforn).
- The Oak, Caramel, Praline, Glory, Lakris and Småborre prospects represent combined stratigraphic-structural traps at Upper Jurassic level (Potential Kimmeridgian sands), down-faulted from the Vega High, and truncated by the Volgian Unconformity, identified by seismic attribute (minimum amplitude as indication of lithology change and maybe thickness change)
- The Ax prospect represents a combined structural-stratigraphic trap at Upper Jurassic level (Potential Oxfordian turbidite sands).
- The Alpha, Beta and Pyrite prospects and many other leads (Galena, Gabro, Scoria, Topaz N, Topaz S, Sognefjell and Strynefjell) represent structural traps, from Brent Group.
- The Cobalt and Emerald prospects represent structural traps, at Early Jurassic level, from Cook Formation), situated below Alpha and Beta prospects respectively.

The Jurassic prospects and leads represent rotated fault blocks, down-faulted from the adjacent Vega High, to the east of the license Fig. 4.1 .

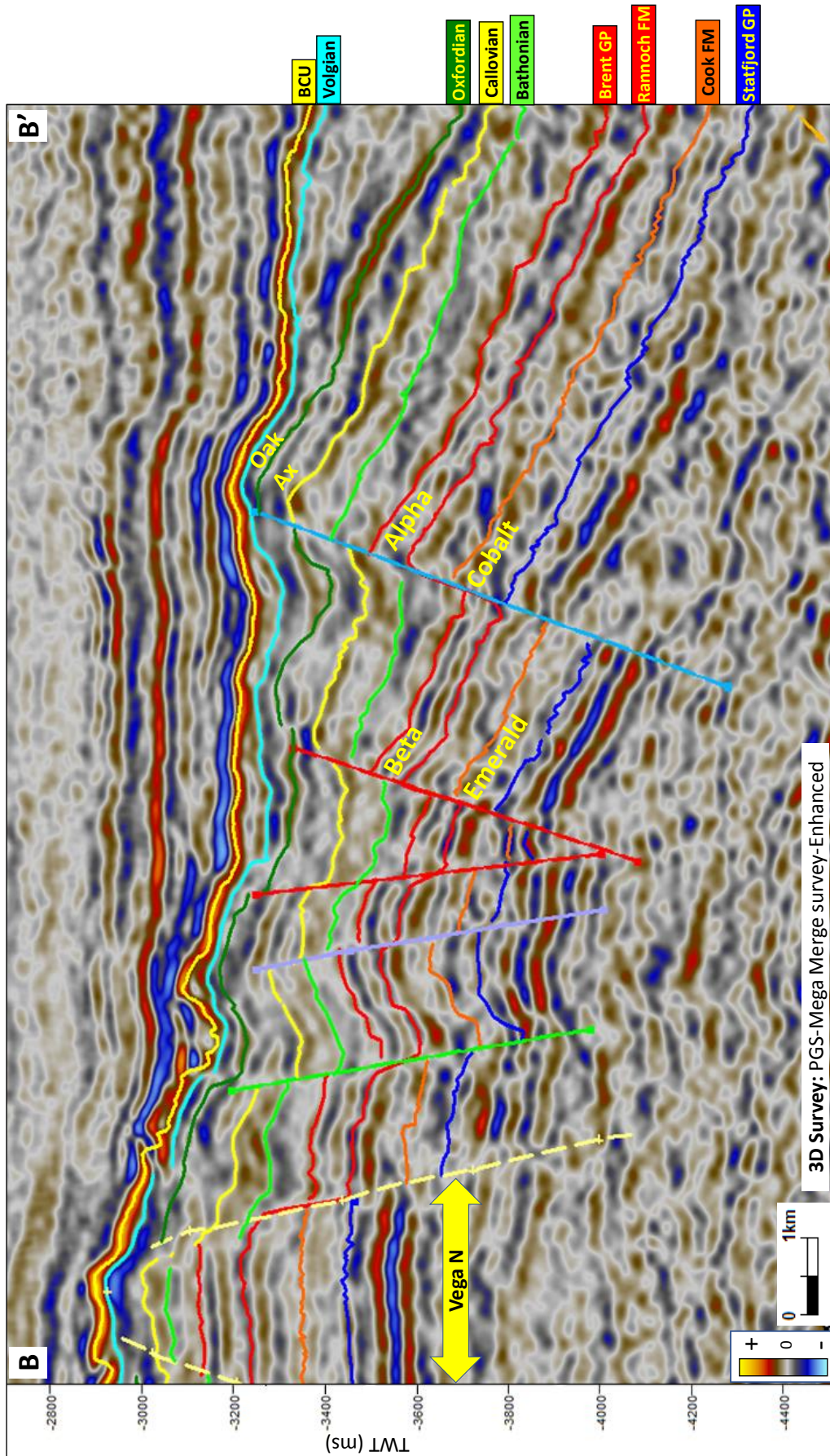


Fig. 4.1 B-B' seismic line showing a stack of four potential prospects at Jurassic level

The main goal, after completing the evaluation work in the license, was to optimize an exploration well at which, multiple targets (prospects) can be tested in one go. So as a result, an exploration well was optimized eventually targeting the Alpha prospect, which was the best candidate to test the Brent reservoir as the prospect is:

- Completely located inside the PL788 license
- The short distance (5 Km) to the nearby facilities in Vega North
- The ability to test multiple targets at different levels such as, Kjuke (Pliocene), Oak (Kimmeridgian), Ax (Oxfordian) and Cobalt (Cook Formation).

So, the proposed exploration well was designed accordingly to meet the planned objectives.

5 Technical evaluations

The technical evaluation of the PL788 showed the attractiveness of the area for exploration, especially in the light of near-field exploration, where even small discoveries can be developed from nearby existing templates. Furthermore, both Kimmeridgian and Oxfordian levels from upper Jurassic are under explored and could have high potential in the area in addition to Brent and Cook reservoirs from Middle and Early Jurassic respectively. The proposed development scenarios to different destinations (Vega North and Gjøa) showed viable economic projects. Nevertheless, apart from Astero, where considerably better reservoir quality is present in the upper Jurassic reservoirs, no flow tests are available for the Oxfordian sandstones within the greater Vega area. This introduces a high uncertainty on the recovery factor. As main operator within the greater area, with existing producing fields in Vega, and new developments in Nova, Wintershall Norge AS is constantly evaluating possible alternatives and synergies to improve recovery factors and allow to connect small scale discoveries to the existing facilities.

6 Conclusions

PL788 license is considered as part of the greater Vega area, with potentially attractive remaining resources in different plays (Pliocene and Jurassic). Those resources should be unlocked to enhance the overall recovery from the Wintershall Norge AS core area.

As previously mentioned, the prospect evaluation exercise in PL788 license resulted in a proposal to drill an exploration well to test reservoir and HC presence in multi-target from Pliocene down to Early Jurassic. Those objective targets are:

- Kjuke lead from Pliocene
- Oak prospect from U.Jurassic (Kimmeridgian)
- Ax prospect from U.Jurassic (Oxfordian)
- Alpha prospect from M.Jurassic level (Brent Group)
- Cobalt prospect from L.Jurassic level (Cook Formation)

Wintershall Norge AS as an operator proposed to drill an exploration well to the licensees, targeting the previously mentioned prospects, however, no support was achieved. Therefore, the license was eventually relinquished in the 6th of November 2017.



