PL846

Surrendering Report

NO-PL846-REP-FRP-0001

Table of Contents

List of Figures

List of Tables

1 KEY LICENSE HISTORY

Production License (PL) 846, is located in the Vøring Basin, Norwegian Sea and comprise parts of blocks 6605/6 and 6606/4 (Figure 1.1). The license was awarded on Febuary 5th, 2016, as a part of the Awards in Predefined Areas (APA) 2015. The original Drill-or-Drop (DoD) decision deadline was by February 5, 2018. This decision deadline was extended to August 5, 2019 with two separate extensions.

The license partnership consisted of OMV (Norge) AS (Operator) and Equinor Energy AS. The license interest between the companies was as follows:

- OMV (Norge) AS - 60%
- Equinor Energy AS - 40%

The initial work programme to evaluate the license was as follows:

- Phase 1 - Within two years (by Febuary 5th 2018) re-process 3D seismic data and make drill or drop decision. Due to the license extensions, the drill or drop decision was intially extended to August 5th 2018, and later to August 5th 2019.
- Phase 2 - Within four years (by Febuary 5th 2020) drill one exploration well & decide to Concretise (BoK) or drop. Due to the license extensions, the decision to concretise (BoK) was intially extended to August 5th 2020, and later August 5th 2021.

The work programme for the initial phase of the license was fulfilled by the reprocessing of the Vøring Basin Tile 1 (VBT-1) 3D seismic survey and performing prospectivity evaluation studies. The final reprocessed PSDM 3D seismic survey, VBT1OMV17, was a license specific reprocessing, an approximately 287 km^2 subset of the VBT-1 seismic survey. The reprocessing was specifically targeting the reservoir interval within the Maastrichtian Springar Formation to highlight and improve imaging of the reservoir. Through the prospectivity evaluations in the license, additonal prospectivity was identified in the Campanian Nise Formation, both as part of the PL846 license area and in adjacent open area. The first six month license extension was granted in order to complete the evaluation of the observed prospectivity in Nise Fm. The prospective area outside PL846 was applied for and it was awarded as a new license (PL945) in the Awards in Predefined Areas (APA) 2017 (Figure 1.1). The second license extension was granted in order to address the key uncertainties with respect to reservoir thickness and reservoir quality of the Late Cretaceous age sandstones. The extension was required to incorporate the results from the recent 6604/5-1 (Balderbrå) well which completed drilling on March 22nd 2018 and proved the presence of Upper Cretaceous reservoir sandstones in a similar depositional setting as the Haydn prospect, main prospect of PL846.

During the lifecycle of PL846 a number of meetings were held between the licensees. A list of these meetings can be found below:

- 18.03.2016 - EC/MC meeting
- 14.09.2016 - EC work meeting
- 13.12.2016 - EC/MC meeting
- 19.12.2016 - EC work meeting
- 15.06.2017 - EC work meeting
- 27.09.2017 - EC work meeting
- 09.11.2017 - EC/MC meeting
- 26.06.2018 - EC/MC meeting
- 08.11.2018 - EC/MC meeting
- 23.01.2019 - EC work meeting
- 28.02.2019 - EC work meeting
- 22.05.2019 - EC/MC meeting

The initial phase of the work programme was completed by creating a high quality 3D seismic survey through reprocessing. The Operator has also conducted several G&G studies on behalf of the partnership, including: rock physics modelling, seismic gather conditioning and analysis, seismic modelling through fluid substitution, fault seal analysis and regional depositional and tectonic studies. One attractive prospect and one lead were identified and assessed within the license, however, the volume potential currently recognized within the PL846 is not sufficient for a positive drill decision within the license, the license Management Committee has therefore concluded to surrender the license.

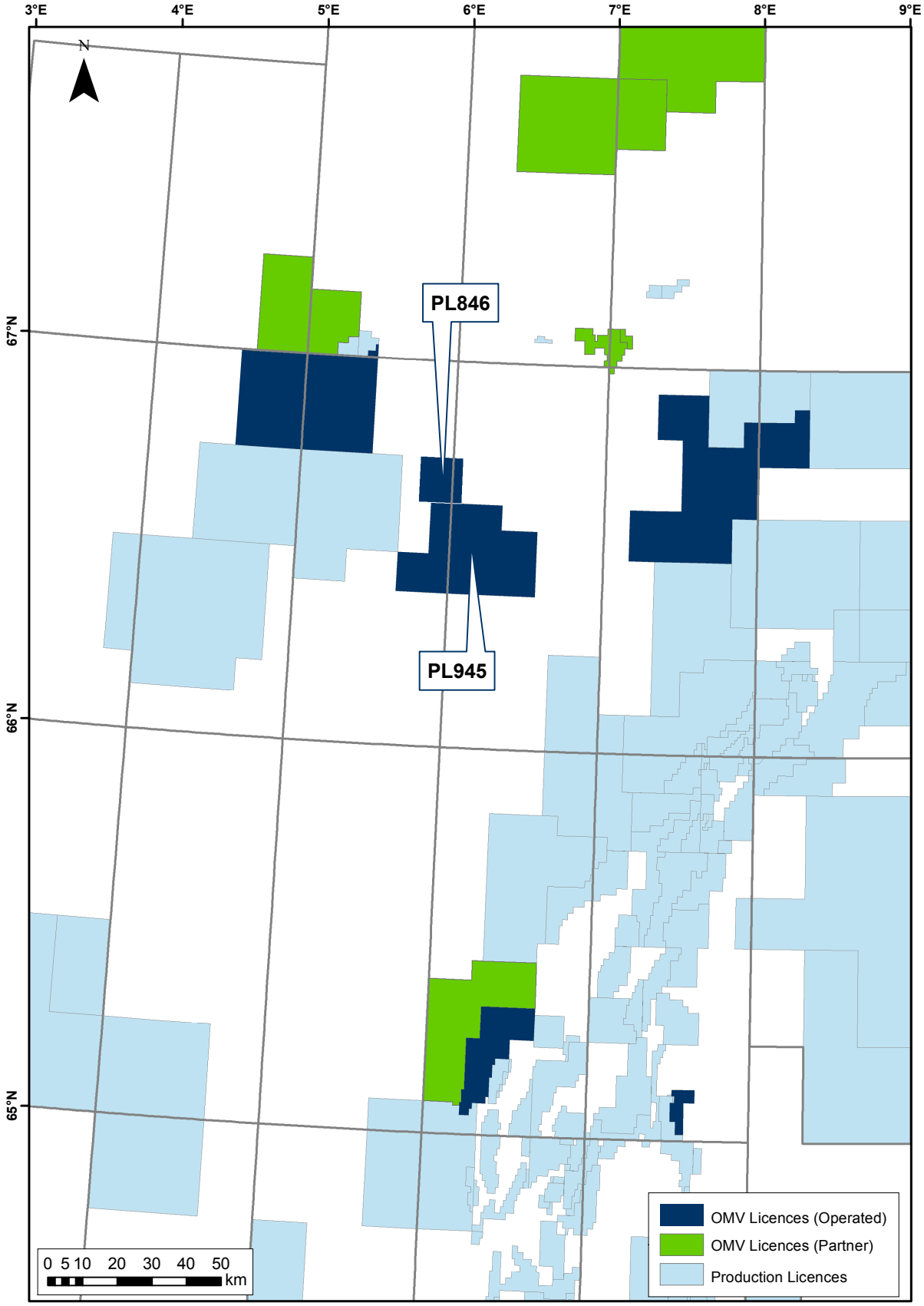

Figure 1.1 Overview Map Norwegian Sea

2 DATABASE

The common seismic and well database was approved the 14th of September 2016. The complete list of seismic surveys in the common database can be found in Table 2.1 and the location of the surveys in Figure 2.2. The key dataset is the reprocessed VBT1OMVR17, the data quality is considered to be good to excellent. The VBT1OMVR17 covers an area of approximately 287 km^2. The common database includes an approximately 504 km^2 cropped version of the VBT-1 survey (Figure 2.2). The input survey for the reprocessing was the VBT1 CGG16 shot gathers.

The well database is summarized in Table 2.2 with the locations in Figure 2.1. Several wells were essential to understand the stratigraphy in the area, in particular 6705/10-1 (Asterix), 6605/1-1 (Obelix), 6604/10-1 (Gro I), 6707/10-1 (Luva) and 6607/5-2 (Amundsen II) were key for understanding the prospectivity in the license. The Gro wells (6603/12-1 and 6604/10-1) were key in constraining the geophysical studies carried out in the license such as seismic modelling and AVO analysis.

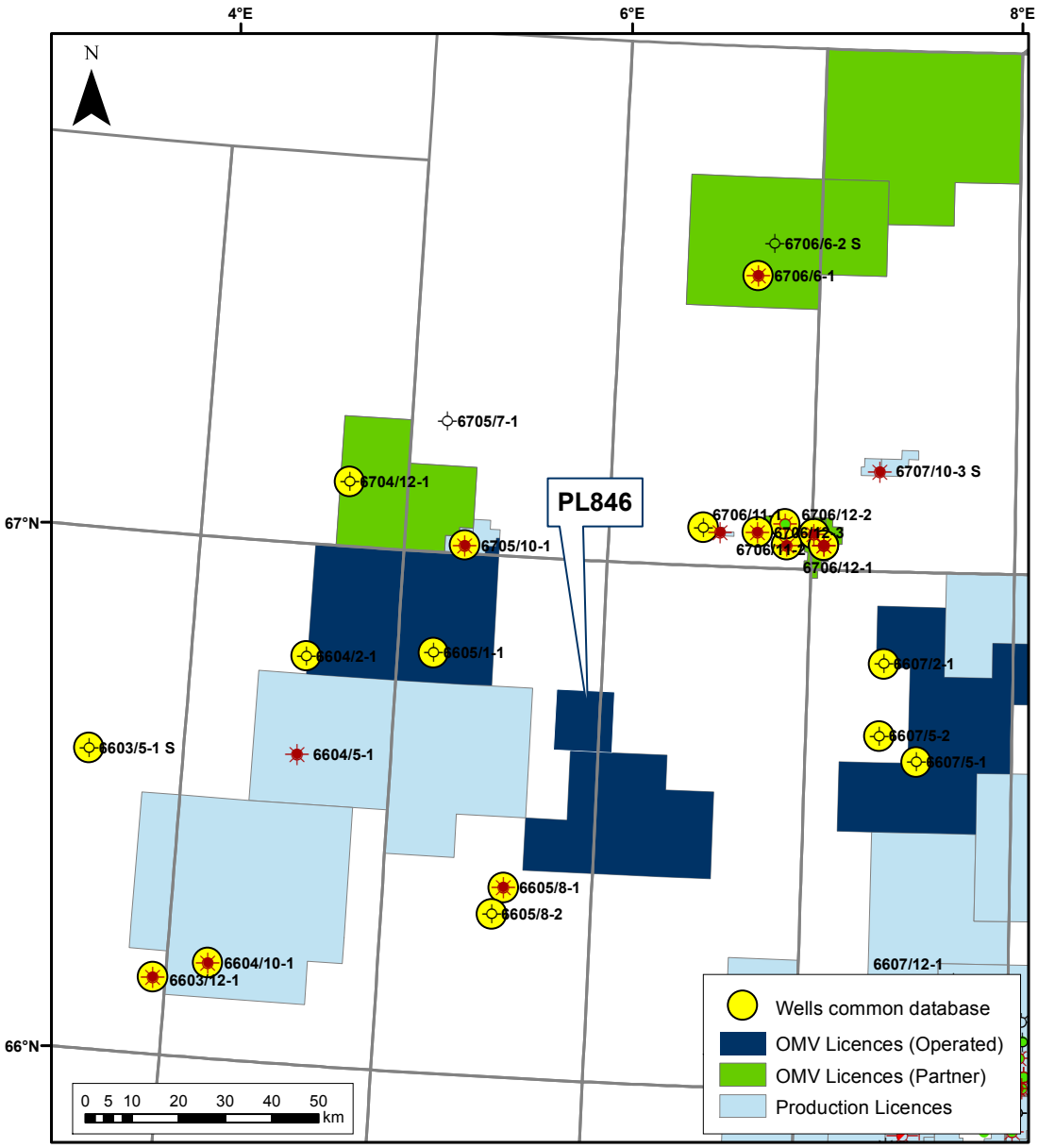

Figure 2.1 Wells Common Database Location Map

Table 2.1 Seismic Database

Survey	Survey Input	NPDID	Market Availability	Vintage	Area/Length	Quality
3D - VBT1OMVR17	CGG2016 VBT1	7196	License Owned	2017	287 km^2	Good - Excellent
3D - VBT-1	-	7196	Multiclient	2011	504 km^2	Good
2D - GVF2000	-	4044	Multiclient	2000	3035 km	Fair - Good

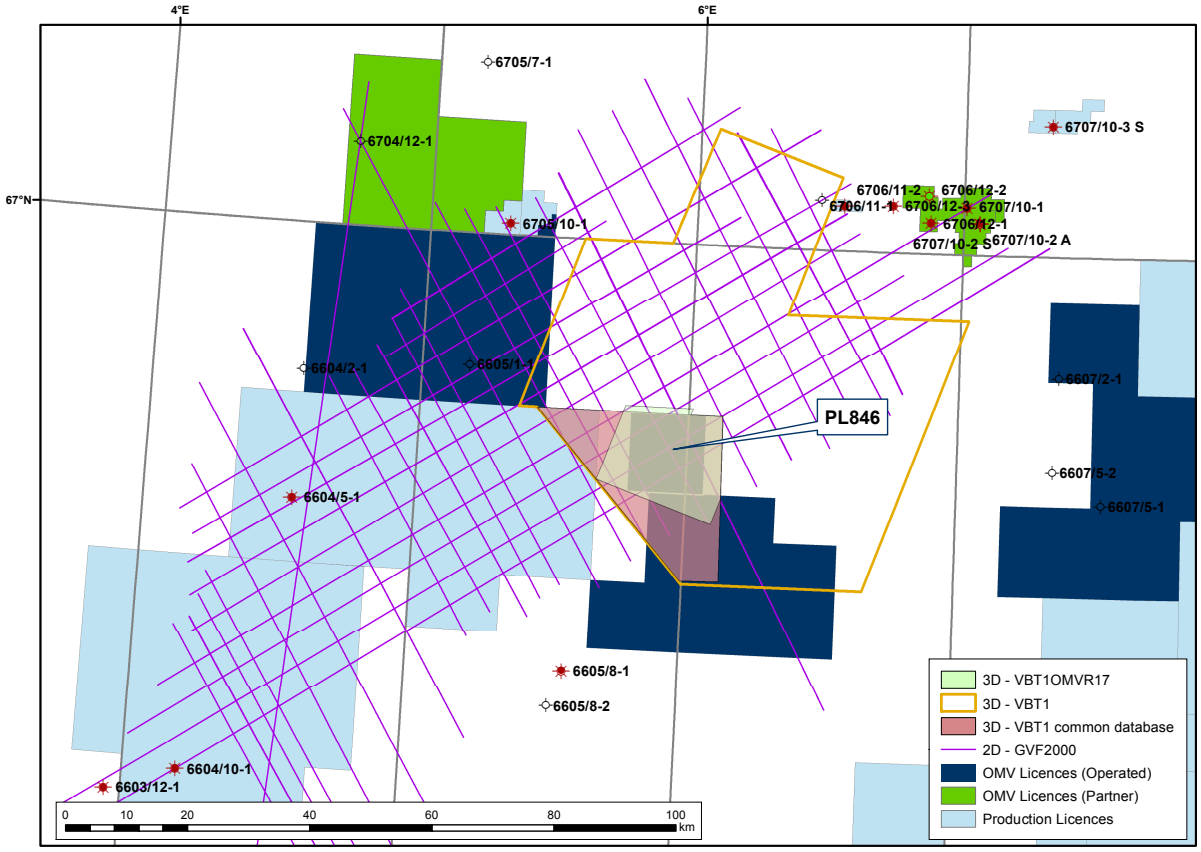

Figure 2.2 Seismic Common Database Location Map

Table 2.2 Well Database

Well Name	NPDID	Prospect Name	Drilled	TD TVD m RKB	Oldest Pentrated Formation	Oldest Penetrated Age	Hydrocarbons	Operator
6603/12-1	5985	Gro II	2009	3830	Springar Formation	Late Cretaceous	Gas	A/S Norske Shell
6603/5-1 S	6348	Dalsnuten	2010	5068	Lange Formation	Late Cretaceous	Dry	A/S Norske Shell
6604/10-1	6356	Gro I	2010	3715	Springar Formation	Late Cretaceous	Gas	A/S Norske Shell
6604/2-1	6568	Gullris	2011	3551	Springar Formation	Late Cretaceous	Dry	BG Norge AS
6605/1-1	5979	Obelix	2008	3944.5	Nise Formation	Late Cretaceous	Dry	StatoiHydro
6605/8-1	4984	Stetind I	2005	4508	Lange Formation	Late Cretaceous	Gas	Norsk Hydro
6605/8-2	5812	Stetind II	2008	4196	Lange Formation	Late Cretaceous	Dry	StatoilHydro
6607/5-1	1064	Amundsen I	1987	3805	Lange Formation	Late Cretaceous	Dry	Esso E&P Norway
6607/5-2	1789	Amundsen II	1991	4666	Kvitnos Formation	Late Cretaceous	Dry	Esso E&P Norway
6607/2-1	5471	Cygnus	2007	3526	Springar Formation	Late Cretaceous	Dry	Eni Norge
6704/12-1	3759	Gjallar	1999	4094	Nise Formation	Late Cretaceous	Dry	Saga Petroleum
6705/10-1	6044	Asterix	2009	3775	Lange Formation	Late Cretaceous	Gas	StatoilHydro
6706/11-1	3202	Vema/Ægir	1997	4306	Lange Formation	Late Cretaceous	Dry	Den norske stats oljeselskap
6706/12-1	5867	Snefrid Sør	2008	3949	Kvitnos Formation	Late Cretaceous	Gas	StatoilHydro
6706/12-2	7651	Snefrid Nord	2015	2754	Nise Formation	Late Cretaceous	Gas	Statoil Petroleum
6706/12-3	7666	Roald Rygg	2015	3335	Kvitnos Formation	Late Cretaceous	Gas	Statoil Petroleum
6707/10-1	3075	Luva	1997	5026.5	Kvitnos Formation	Late Cretaceous	Gas	BP Norway
6707/10-2A	5931	Haklang	2008	4325	Kvitnos Formation	Late Cretaceous	Gas	StatoilHydro
6706/6-1	4705	Hvitveis	2003	3450	Springar Formation	Late Cretaceous	Gas	Esso E&P Norway

3 REVIEW OF GEOLOGICAL AND GEOPHYSICAL STUDIES

Prospect and lead definition within PL846 was largely driven by seismic amplitude anomalies. Consequently, the main component of the license's geological and geophysical work programme was focussed on seismic reprocessing, interpretation and analysis. Utilizing this reprocessed data set several geophysical studies were undertaken, including: rock physics modelling, seismic attribute generation, 2D seismic modelling and prestack seismic interpretation. Geological studies were catered towards the main prospect in the license which was Haydn, this mainly consisted of fault seal analysis and reservoir depositional studies.The regional geological framework for PL846 is described in the application for the norhern parts of blocks 6605/6 and 6606/4, as well as well as the regional structural study.

New geological/geophysical studies consist of interpretation on new PSDM 3D reprocessed seismic data (VBT1OMVR17), petroleum system analysis and a semi-regional structural and depositional studies. New interpretation work includes seismic horizon interpretation, quantitative geophysical analysis and structural mapping (fault mapping) of the Haydn prospect. Data quality of the reprocessed seismic is regarded as very good and an improvement, especially on structural imaging.

A 3D fault seal study was carried out to derisk the the fault bounded structure by addressing the sealing capacity. Well 6604/10-1 was applied in the modelling study (Allan diagram). This study concluded that the fault seal is not critical for the Haydn prospect. However, main unceratinty is the lithology variarions as the distance to the offset well applied in the study is 95 km from the prospect.

1D seismic modelling was undertaken within the area in order to assess reservoir quality and the appearance of different degrees of hydrocarbon saturation on seismic. Various levels of hydrocarbon saturation, porosities and reservoir thicknesses were used in order to compare the alternative cases with the result of the reprocessed seismic data. A reasonably good comparison can be made between the actual seismic and the model (Figure 3.1). In addition, results of a 2D synthetic seismic E-W line through the Haydn prospect supports the seismic response of pinch-out area to the west. Results of the seismic modellig suggests that within the Haydn prospect an imprint of tuned amplitudes are observed. The reservoir thickness in Haydn is approxemately 30 meters and within tuning range. Prestack seismic analysis inside Haydn indicates a heterogeneous reservoir with variation in reservoir quality. A vertical seismic resolution limit at 20 meters makes it difficult to distinguish between poor reservoir quality and thin reservoir of good quality (Figure 3.2). The seismic gathers of the reprocessed seismic dataset were analysed in Prestack Pro software in order to de-risk the Haydn prospect. The seismic amplitude response shows an AVO class II/III.

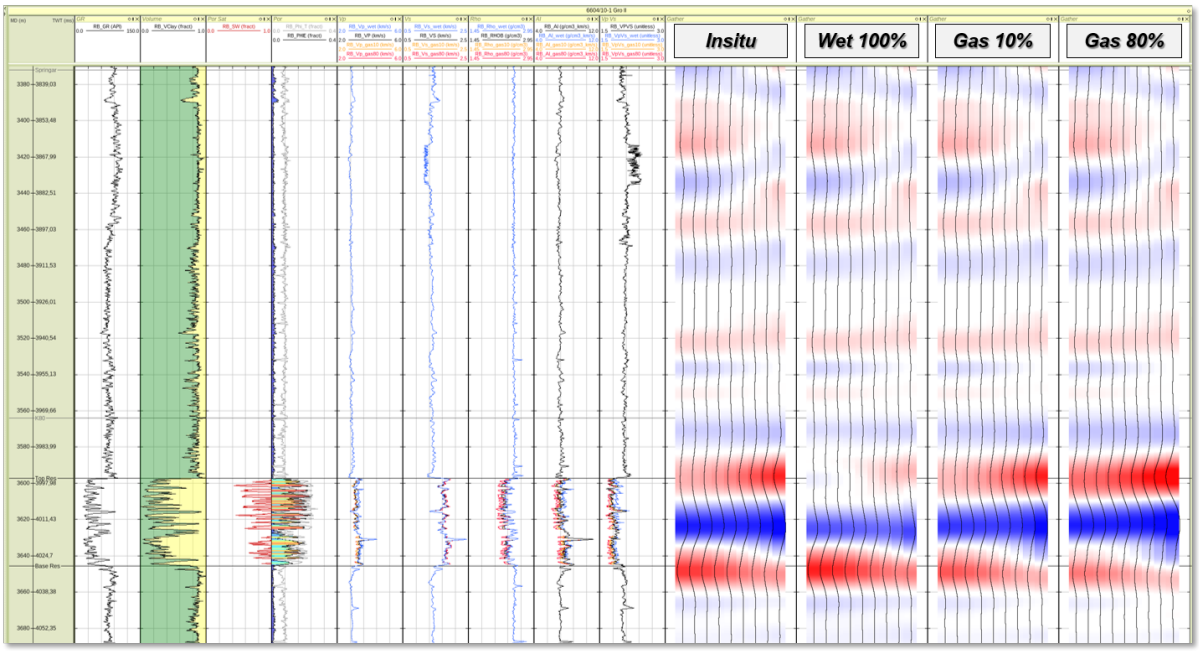

Figure 3.1 1D Seismic Modelling Results

1D seismic models with variation in fluid and saturation

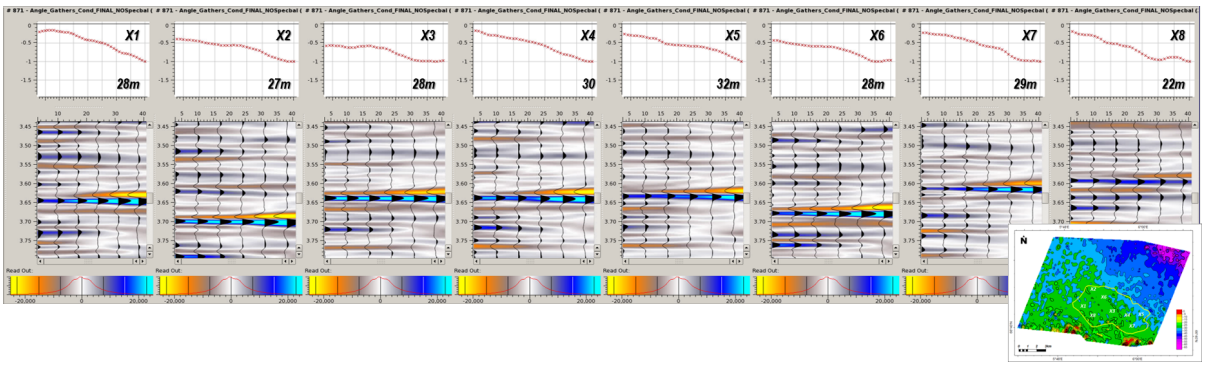

Figure 3.2 Prestack Seismic Analysis

The gathers picked at different locations within the Haydn prospect shows class II/II AVO and corresponds with the 1D modelling results.

4 PROSPECT UPDATE

The Haydn prospect was the sole prospect identified in the APA 2015 application. The prospect is located in the Vøring Basin approximately 40 km southeast of the 6705/10-1 (Asterix) gas discovery well (Springar Formation reservoir) and 60 km southwest of the Aasta Hansteen gas development (OMV (Norge) AS holdes 15% equity in PL218/PL218B).

The Haydn prospect is a combined structural and stratigraphic pinch out trap in the Springar Formation. An overview of the Haydn prospect is shown in Figure 4.1. The prospect is clearly identified on 3D seismic data with a strong amplitude response (Figure 4.2, Figure 4.3). By analysing the seismic gathers of the reprocessed data it is clear that the Haydn prospect exhibits an AVO class II/III and an AVO class IIp outside the prospect in the water wet sand. The amplitude anomaly is interpreted to be derived from hydrocarbon-bearing sandstones, and based on AVO modelling and seismic studies the hydrocarbon type is expected to be gas.The reprocessed 3D seismic dataset has improved the seismic imaging at the prospect level, ensuring a higher confidence in both hydrocarbon presence, prospect outline and trapping mechanisms. However, key uncertainties still remain with respect to reservoir thickness and reservoir quality (Table 4.1).

Through the G&G evaluations of the PL846 acreage, the Partnership identified an additional lead called “Monn” in the stratigraphically deeper Nise Formation (Figure 4.2, Figure 4.3).The Monn lead is a combination of stratigraphic shale-out of reservoir sands and structural fault closure at the crest. However, critical issues are fault throw and sealing.

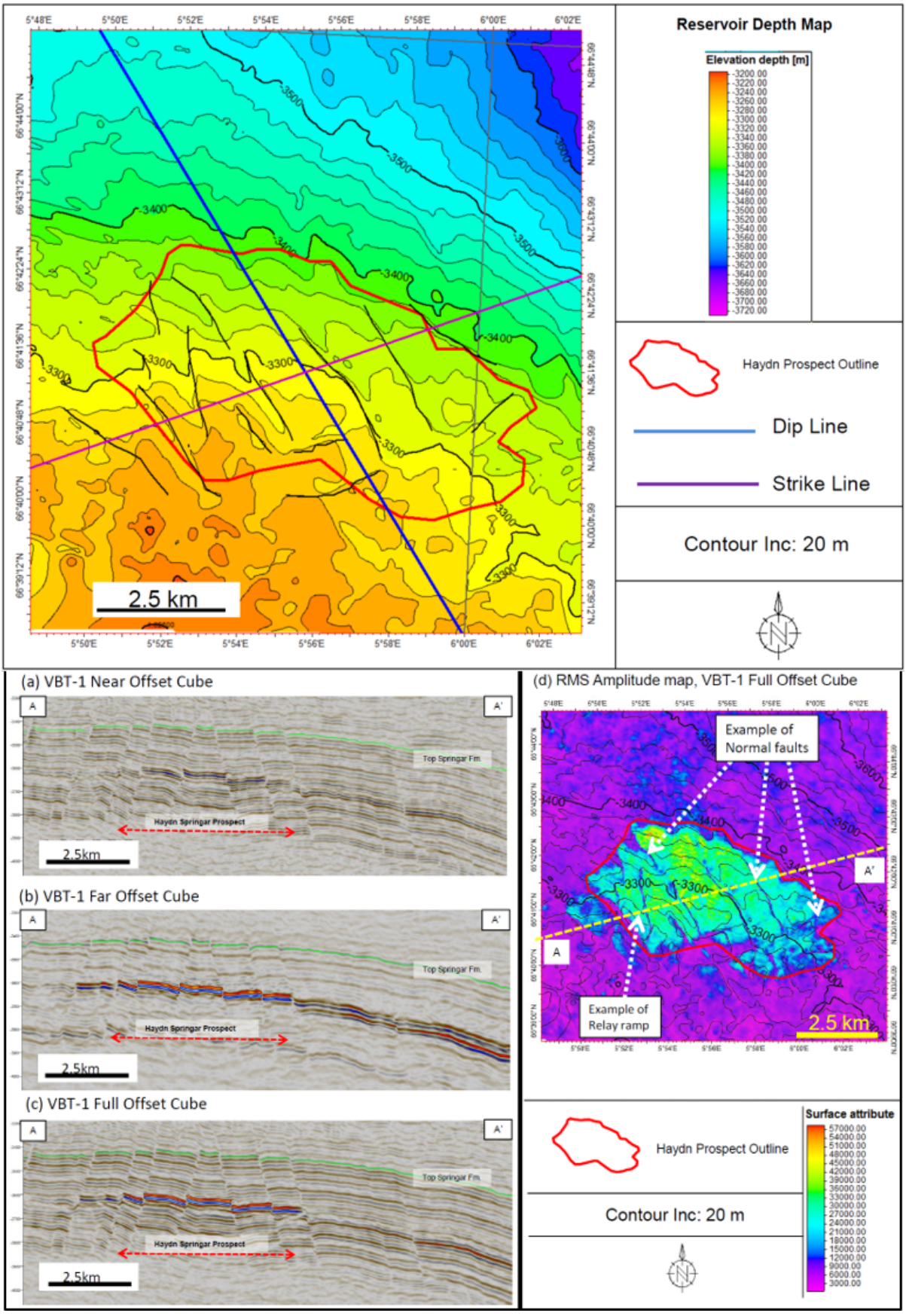

Figure 4.1 Haydn Prospect Summary

Haydn depth map, associated top reservoir RMS amplitude and partial stack seismic sections across the prospect.

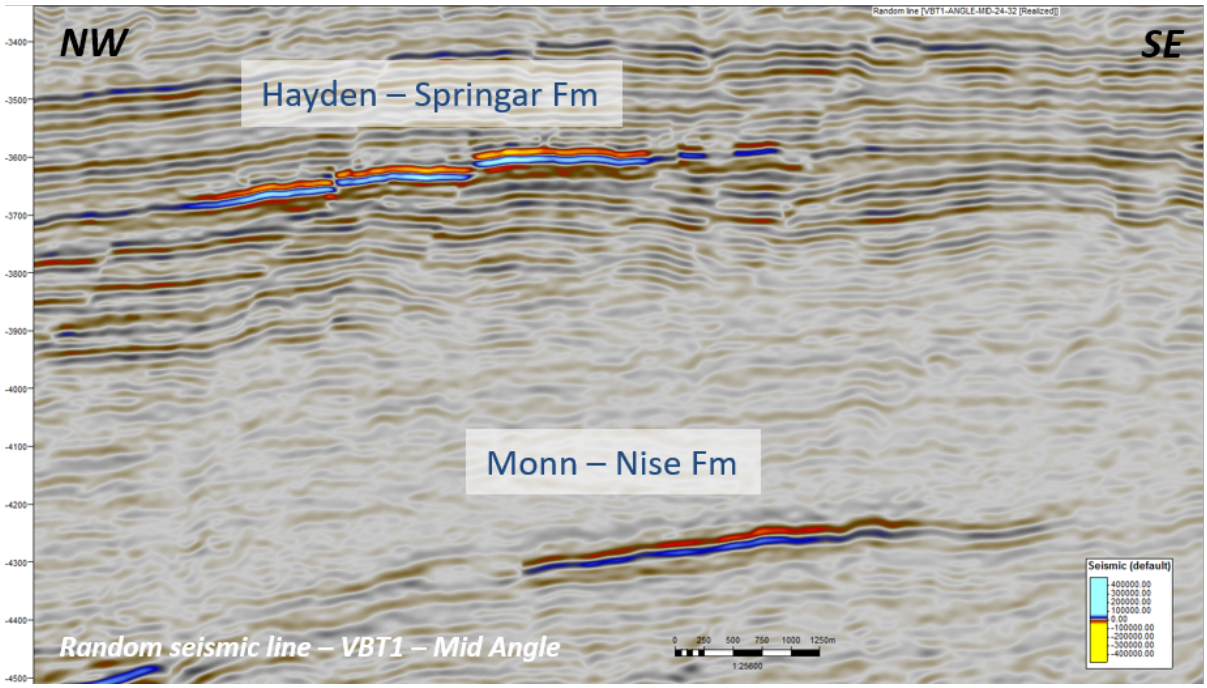

Figure 4.2 Seismic Example Line Showing the Haydn Prospect and Monn Lead

The Haydn prospect and Monn lead are located in the Upper Cretaceous Springar and Nise Formations, respectively.

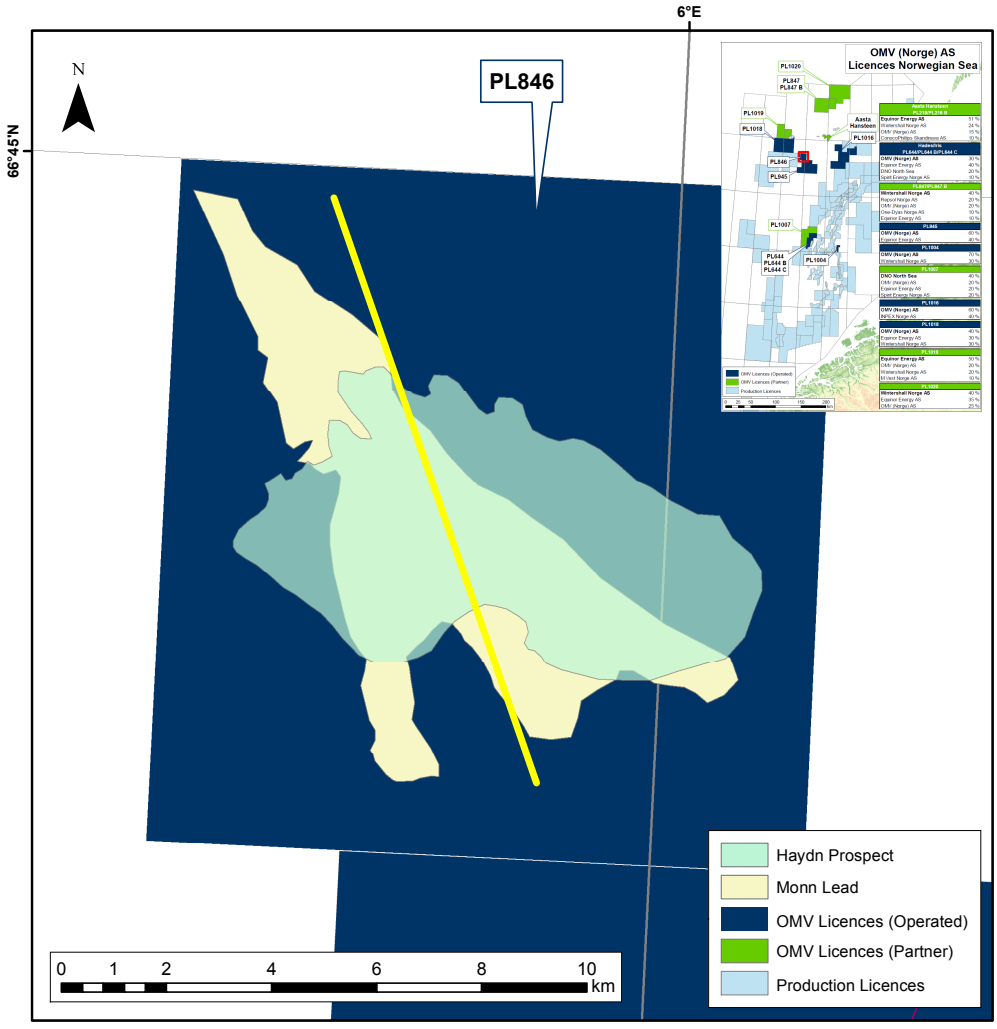

Figure 4.3 Map with Haydn Prospect and Monn Lead Outlines

Table 4.1 Haydn Prospect Data Sheet (NPD)

Table 5: Prospect data (Enclose map)

	Block	6605/6, 6606/4	Prospect name	Haydn	Discovery/Prosp/Lead	Prospect	Prosp ID (or Newl)	NPD will insert value	NPD approved (Y/N)	
	Play name	NPD will insert value	New Play (Y/N)		Outside play (Y/N)					
Oil, Gas or O&G case:		Gas	Reported by company	OMV (Norge) AS	Reference document				Assessment year	2018
This is case no.:		1 of 1	Structural element	Vøring Basin	Type of trap	Structural Stratigra	Water depth [m MSL] (>0)	1050	Seismic database (2D/3D)	3D
Resources IN PLACE and RECOVERABLE			**Main phase**				**Associated phase**			
Volumes, this case			Low (P90)	Base, Mode	Base, Mean	High (P10)	Low (P90)	Base, Mode	Base, Mean	High (P10)
In place resources		Oil [10^6 Sm^3] (>0.00)								
		Gas [10^9 Sm^3] (>0.00)	8.46	16.10	17.50	28.10	0.21	0.75	0.88	1.69
Recoverable resources		Oil [10^6 Sm^3] (>0.00)								
		Gas [10^9 Sm^3] (>0.00)	5.29	10.80	12.00	20.40	0.10	0.43	0.53	1.06
Reservoir Chrono (from)		Maastrichtian	Reservoir litho (from)	Springar Fm	Source Rock, chrono primary	Cenomanian-Turon	Source Rock, litho primary	Blålange Fm	Seal, Chrono	Maastrichtian
Reservoir Chrono (to)		Maastrichtian	Reservoir litho (to)	Springar Fm	Source Rock, chrono secondary		Source Rock, litho secondary		Seal, Litho	Springar Fm
Probability [fraction]										
Total (oil + gas + oil & gas case) (0.00-1.00)			Oil case (0.00-1.00)		Gas case (0.00-1.00)		Oil & Gas case (0.00-1.00)			
Reservoir (P1) (0.00-1.00)		0.63	Trap (P2) (0.00-1.00)	0.90	Charge (P3) (0.00-1.00)	0.70	Retention (P4) (0.00-1.00)	0.65		
Parametres:		Low (P90)	Base	High (P10)	*Comments*					
Depth to top of prospect [m MSL] (> 0)			3240							
Area of closure [km^2] (> 0.0)		16.8	22.9	29.4						
Reservoir thickness [m] (> 0)		19	34	50						
HC column in prospect [m] (> 0)		155	170	185						
Gross rock vol. [10^9 m^3] (> 0.000)		481.000	872.000	1302.000						
Net / Gross [fraction] (0.00-1.00)		0.62	0.73	0.83						
Porosity [fraction] (0.00-1.00)		0.17	0.20	0.23						
Permeability [mD] (> 0.0)										
Water Saturation [fraction] (0.00-1.00)		0.40	0.30	0.20						
Bg [Rm3/Sm3] (< 1.0000)		0.0039	0.0038	0.0036						
1/Bo [Sm3/Rm3] (< 1.00)										
GOR, free gas [Sm^3/Sm^3] (> 0)										
GOR, oil [Sm^3/Sm^3] (> 0)										
Recov. factor, oil main phase [fraction] (0.00-1.00)										
Recov. factor, gas ass. phase [fraction] (0.00-1.00)										
Recov. factor, gas main phase [fraction] (0.00-1.00)		0.55	0.68	0.81						
Recov. factor, liquid ass. phase [fraction] (0.00-1.00)		0.38	0.60	0.78	For NPD use:					
Temperature, top res [°C] (>0)		80			Innrapp. av geolog-init:	NPD will insert value	Registrert - init:	NPD will insert value	Kart oppdatert	NPD will insert value
Pressure, top res [bar] (>0)		335			Dato:	NPD will insert value	Registrert Dato:	NPD will insert value	Kart dato	NPD will insert value
Cut off criteria for N/G calculation		1	2	0.1	3				Kart nr	NPD will insert value

5 TECHNICAL EVALUATIONS

Both technical evaluation and economic analysis were performed for the Haydn prospect. Haydn is considered as a potential tie-back candidate to the Aasta Hansteen development. However, due to the uncertainty in reservoir thickness and quality, the commerciality of the associated resource potential in Haydn is still an issue.

6 CONCLUSIONS

The PL846 partnership has placed considerable effort in evaluating the prospectivity of the license. As a consequence of the work programme, the license stakeholders now have a much greater understanding of the prospectivity in the license. The PSDM 3D seismic reprocessing of the multiclient (VBT-1) dataset has improved the delineation assessment of the prospect and lead. Through the interpretation of the VBT1OMVR171 dataset, the Haydn has become a robust trap structure.

All license commitments have been fulfilled. The main reasons for surrendering the license are listed below:

In December 2017, OMV (Norge) AS recommended to progress the PL846 into a drill decision. At that time, OMV believed that the only way to further de-risk the main identified prospect (Haydn) was to drill it. Statoil (now Equinor) did not support this recommendation and an extension to the Drill-or-Drop decision was requested to perform additional G&G studies and to incorporate the results of an offset exploration well (6604/5-1) which was drilled in 2018. The outcomes of this well confirmed the risk associated to the reservoir quality. The G&G studies performed in the license were not able to de-risk the reservoir quality in the main identified prospect to an acceptable level. Figure 6.1 depicts the prospect and lead for the license.

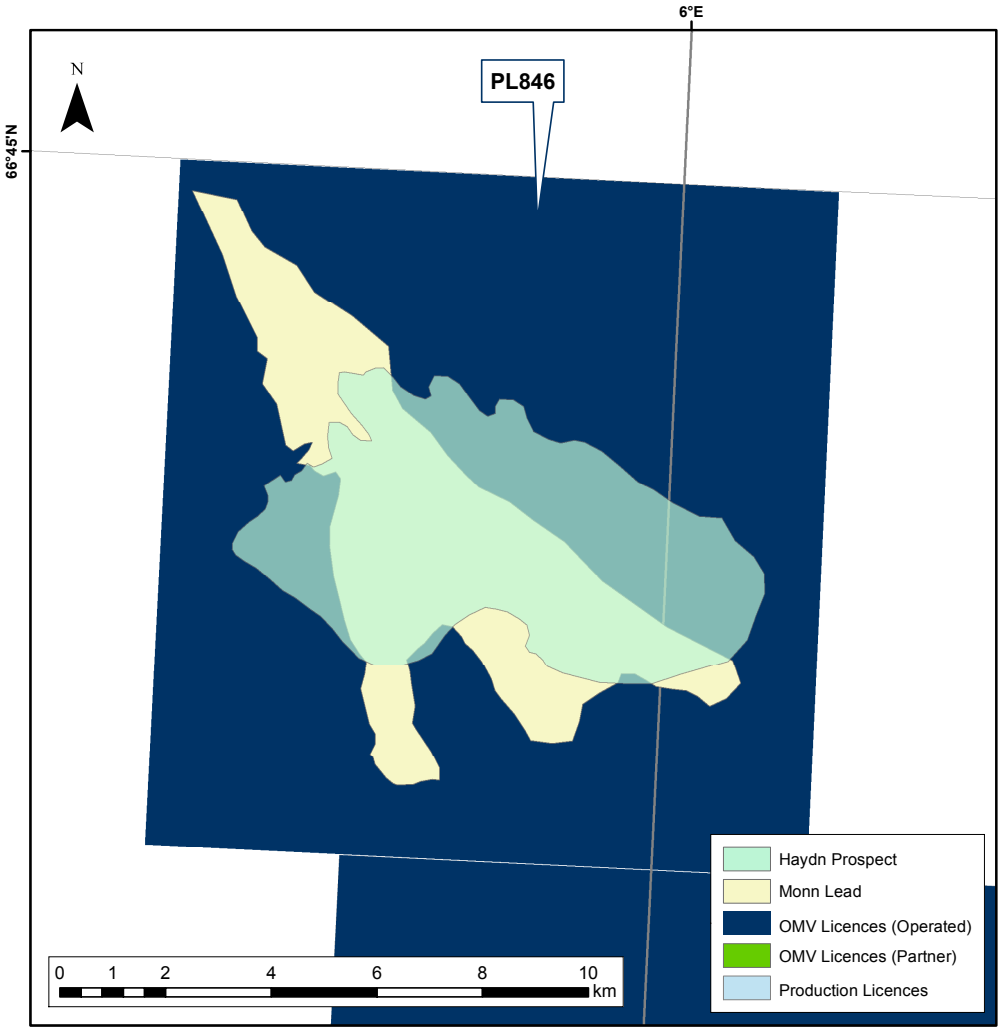

Figure 6.1 PL846 Prospectivity