PL 875 & 875 B Lapse report

Part of blocks 29/9, 30/7 & 10

PL 875 & 875 B Lapse Report

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1 History of the production licence

Summary

PL 875 (Figure 1.1) was awarded as part of the APA 2016 licence round on the 10th of February 2017. The initial period was set to 7 years (2+2+2+1), of which the first decision, drill or drop, is due on the 10th of February 2019.

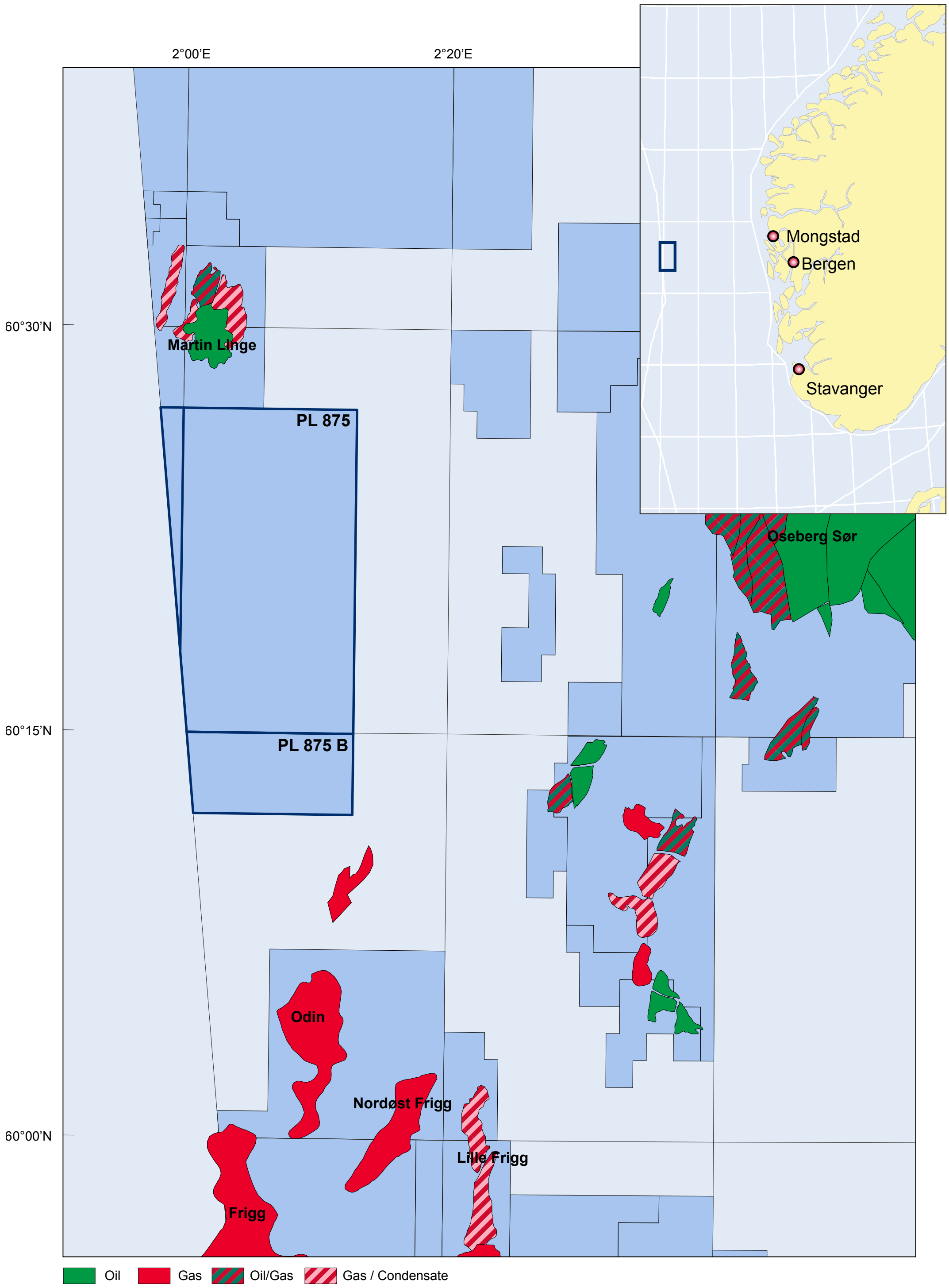

Figure 1.1 ***PL 875 and 875 B location map***
Part of blocks 29/9, 30/7 and 30/10 in the North Sea.

Additional acreage, PL 875 B (Figure 1.1), was awarded as part of the APA 2017 licence round on the 2nd of March 2018. The work programme and the associated periods were the same as for PL 875.

Based on the licence work the primary prospectivy in the Paleocene-Lower Eocene is interpreted to be of high risk and no secondary prospectivity has been identified in the licence area. The partnership unanimously decided to let PL 875 and PL 875 B lapse in regards to the drill decision on the 10th of February 2019.

Participants

Suncor Energy Norge AS, with 60% equity, is operator of the licence with partner Capricorn Norge AS, with 40% interest.

Work Commitment

The work commitment of acquiring 3D seismic has been fulfilled by purchasing part of the CGG NVG Tampen BroadSeis 3D survey (CGG17M01).

Meetings held

MC meetings were held at least once and EC meetings twice a year, in accordance with JOA article 2.1. These meetings were combined ECMC meetings and in addition several EC work sessions have been organized. Below is a list of the meetings held during the licence term:

1. ECMC start-up meeting on 16/03/2017 at Suncor office in Stavanger
2. Work meeting regarding application for additional acreage on 23/06/2017 at Suncor office in Stavanger
3. ECMC meeting on 08/11/2017 at Suncor office in Stavanger
4. Core workshop on 25/01/2018 at NPD core facilities in Stavanger
5. EC work session on 07/06/2018 at Suncor office in Stavanger
6. ECMC meeting on 04/10/2018 at Suncor office in Stavanger

Reasons for licence lapse

The primary prospectivity in the Paleocene-Lower Eocene has been re-evaluated based on newly acquired and reprocessed seismic and geological and geophysical studies during the licence period. Breaching of seals was initially seen as the key risk for the prospectivity. Both the new seismic and the special studies proved that retention of HC's within the prospectivity is highly unlikely. The Paleocene-Lower Eocene reservoir sands seem to be connected through sand injectites and sand to sand juxtaposition along faults. If charged, hydrocarbons would likely leak up to the shallowest sands and updip outside the licence area.

The new seismic interpretation and the performed special studies align and highlight the risk of breaching seals. It is believed that no more technical work can be done on the existing data to further de-risk the licence primary prospectivity.

No secondary prospectivity is interpreted to be present within the licence area based on screening of shallower and deeper intervals.

2 Database overviews

2.1 Seismic data

The seismic data used during the APA 2016 application consisted of merged 3D seismic surveys (PGS MegaSurvey) covering the licence acreage.

To fulfill the licence obligation the common database was extended with part of the CGG17M01 3D survey. This survey is broadband PSTM data acquired in 2016. Final migrated full stack, angle stacks, stacking and migration velocities of the survey were purchased. Part of the survey covering the licence area (~340 km^2) was included in the common database. Owners agreed to purchase a full licence to a large enough area to properly evaluate the prospects, i.e. including offset wells and the Martin Linge Field, resulting in ~800 km^2 of data.

Further gather and stack conditioning was performed by DownUnder Geosolutions (DUG) and the final products of this proprietary study were PSTM full stack and angle stacks by the name of SUN17M01R18.

The seismic datasets are listed in Table 2.1 and shown in Figure 2.1.

Table 2.1 ***PL 875 and 875 B seismic database***

Seismic Survey	Merged surveys within AOI	NPDID	Survey Type	Survey Year	Processing Company	Processing	Status	Comments
SUN17M01R18	CGG16001	8 332	3D	2018	DUG	Gather & stack conditioning	Licence owned	Gather and stack reprocessing of CGG17M01; full stack and angle stacks.
	TO1301ML (infil)	7 767						
CGG17M01	CGG16001	8 332	3D	2017	CGG	PSTM	Multi-client	Full stack, angle stacks and velocities.
	TO1301ML (infil)	7 767						
PGS MegaSurvey			3D		PGS	PSTM	Multi-client	Full stack.

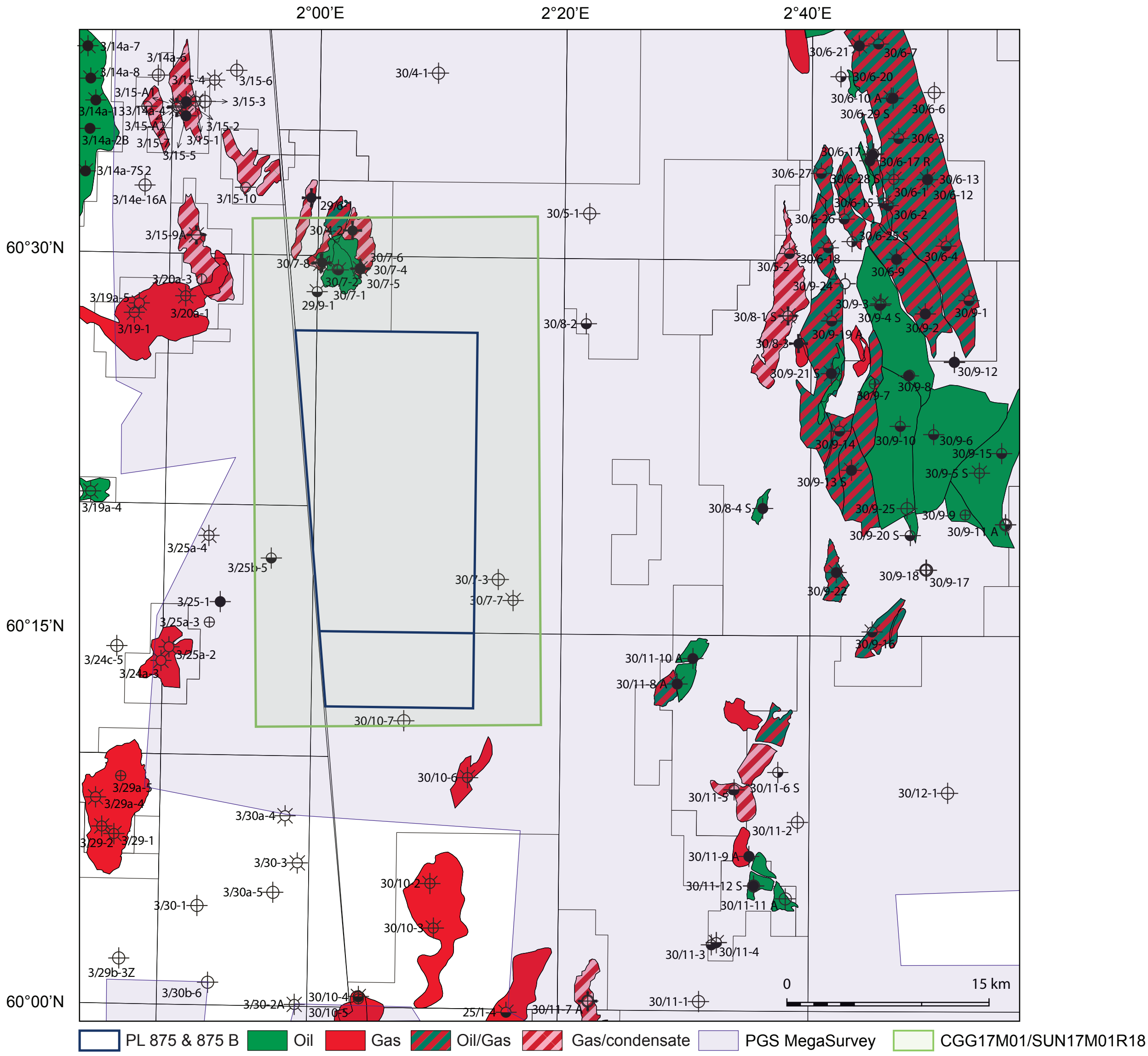

Figure 2.1 ***PL 875 and 875 B seismic database***

The map shows the different seismic surveys used for the prospect development and evaluation in the licence area. Locations of wells used in the evaluation are shown as well.

2.2 Well data

All well data in the vicinity of the licence, both in the UK and Norwegian sector, have been released and therefore no wells needed to be purchased/traded for the common database.

Wellbores that have been used in the evaluation of the licence prospectivity are listed in Table 2.2 and their locations are shown in Figure 2.1.

Table 2.2 ***PL 875 and 875 B well database***

Sector	Well	NPDID
NOR	29/6-1	375
NOR	29/9-1	31
NOR	30/4-1	377
NOR	30/4-2	378
NOR	30/4-A-3	7537
NOR	30/4-A-7	7540
NOR	30/4-D-1 AH	6229
NOR	30/4-D-1 H	6228
NOR	30/5-1	379
NOR	30/7-2	385
NOR	30/7-3	386
NOR	30/7-6	389
NOR	30/7-7	390
NOR	30/7-8	216
NOR	30/8-2	2723
NOR	30/10-2	392
NOR	30/10-3	393
NOR	30/10-6	1816
NOR	30/10-7	2015
NOR	30/10-A-4	660
NOR	30/11-3	62
NOR	30/11-4	98
NOR	30/11-8 S	6540
NOR	30/11-8 A	6611
NOR	30/11-10	7595
NOR	30/11-10 A	7602

Sector	Well
UK	3/14d-18
UK	3/15-9 A
UK	3/15-11
UK	3/15-12
UK	3/15a-16 Z
UK	3/19-1
UK	3/19a-4
UK	3/20a-1
UK	3/24c-5
UK	3/25-1
UK	3/25a-2
UK	3/25a-4
UK	3/25b-5
UK	3/29-1
UK	3/29a-5
UK	3/30-3
UK	3/30a-4
UK	4/26-2

Well data have been used for:

- Seismic-well ties
- Sedimentology and stratigraphy study for reservoir presence and seal integraty evaluation
- Petrophysical evaluation
- Rock physics and geophysical modelling
- Mud gas analysis and petroleum system analysis

3 Results from geological and geophysical studies

Several proprietary studies have been performed as part of the licence work to evaluate the prospectivity in PL 875 and 875 B. The geological and geophysical studies are described below with the integration of the findings at the end.

- **Petrophysical evaluation and log conditioning (DUG, 2017)**
  Full petrophysical analysis of eight key wells has been undertaken. The petrophysics is used in conjunction with rock physics to derive a series of rock property trends for a variety of lithology types. Synthetic curves were generated where elastic logs were missing.
- **Rock physics and stochastic forward modelling (DUG, 2017)**
  A comprehensive rock physics study was carried out to derive depth-dependent elastic rock property trends for various lithologies and provide a quantitative interpretation (QI) model. The study includes examination of lithology and fluid discrimination, expected interface reflectivity, AVO responses and AVO stack rotation modelling. The study focused on the primary reservoir targets in the Paleocene–Lower Eocene interval.
- **Seismic reprocessing – seismic QC analysis and gather processing (DUG, 2017)**
  Gather and stack processing was performed to clean and optimize the seismic data for AVO screening and potential inversion. The following processing steps were applied:
  Gather processing - denoise, parabolic radon attenuation, residual moveout and trim statics. Stack processing - post-stack denoise applied to angle stacks in order to preserve AVO fidelity, bespoke full stack processing standardised and healed aspects of the different vintages of seismic.
  Gather quality improved after reprocessing, but quality is still questionable to detect subtle AVO effects. Only minor uplift on the full and angle stacks were observed.
- **AVO modelling and screening (DUG, 2018)**
  Fluid substitution was performed within the Frigg, Balder, Hermod and Heimdal fms sands in four key wells. This produced different AVO responses. Oil would give a weak response, but gas was modelled to give a strong response (mainly class III AVO). Gas in sand beds as thin as 8 m were modelled to be detectible. The gather conditioned seismic was screened for class II/III AVO responses within the Paleocene-Lower Eocene interval over the entire licence area. The AVO attribute maps showed a number of strong anomalies, but anomalies looked patchy and do not conform to any structure. Additionally, a false positive was proven by AVO features that appeared to intersect a dry well.
- **Integrated stratigraphic and depositional study of the Paleocene and Lower Eocene succession (Skolithos, 2017-18)**
  This project is a review of the Paleocene to Lower Eocene in 44 selected wells adjacent to the licensed acreage. Core and log data were studied to interpret facies associations. Spatial and stratigraphic variation in injected, remobilised and in situ sandstone reservoirs in Paleocene to Eocene succession were determined. Facies distribution maps were generated for predicting reservoir presence/quality and seal integrity over PL 875 and PL 875 B.
- **Mud gas analysis (GeoProvider, 2017)**
  Mud gas data from six wells adjacent to the licence area have been systematically analysed for hydrocarbon bearing and sealing zones.

Imaging of the reservoir and sealing intervals within the Paleocene-Lower Eocene improved with the procured CGG17M01 3D seismic. Faults and injectites breaching the sealing intervals can be interpreted in the new seismic. In addition, studied core data and log data of the Paleocene-Lower Ecoene succession showed widespread post-depositional deformation of the sands in the form of remobilisation and injectivity. The geophysical modelling found that expected gas would be visible as an AVO class III response in the seismic. AVO screening of the gather conditioned seismic did not show any anomalies conform to structure, resulting in a DHI downgrade. Based on these findings it has been concluded that HC retention within the prospects is highly unlikely.

4 Prospect update report

The main opportunities in the APA 2016 application were the Eocene Heng South and Heng North prospects (Figure 4.1). The Paleocene Rallar prospect to the south was the reason for the application for additional acreage during the APA 2017 round (Figure 4.1). After further prospect evaluation during the licence period the prospect concepts remained but the Heng trap geometries slightly changed and the Rallar prospect was downgraded to a lead due to low confidence in mapping of the trap geometry.

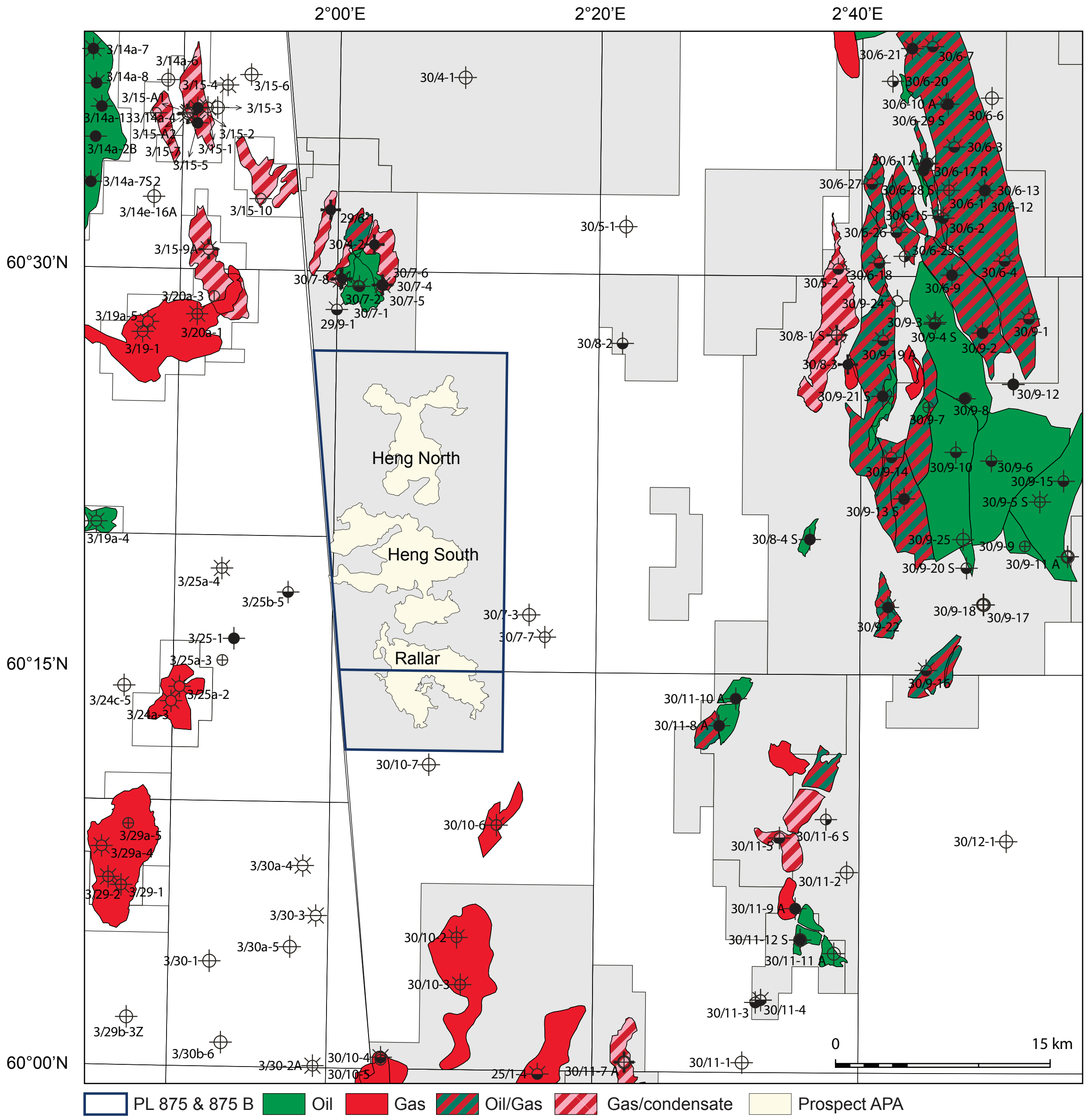

Figure 4.1 ***Original prospectivity in PL 875 and 875 B***
*Original P10 prospect outlines from APA 2016 and 2017. After further prospect evaluation during the licence period the prospect concepts remained but the best estimate Heng trap geometries slightly changed (*Figure 4.4*) and the Rallar prospect was downgraded to a lead.*

Heng prospects

The Heng prospects consist of mounds of Lower Eocene Hermod Fm deepwater sands. The Hermod Fm reservoir is part of the T40-45 sequence (Figure 4.2), deposited in submarine fan systems sourced from the Shetland Platform to the west (Figure 4.3). The Hermod Fm has been encountered in most wells surrounding the licence area and the probability of reservoir presence in the prospects is anticipated to be very high.

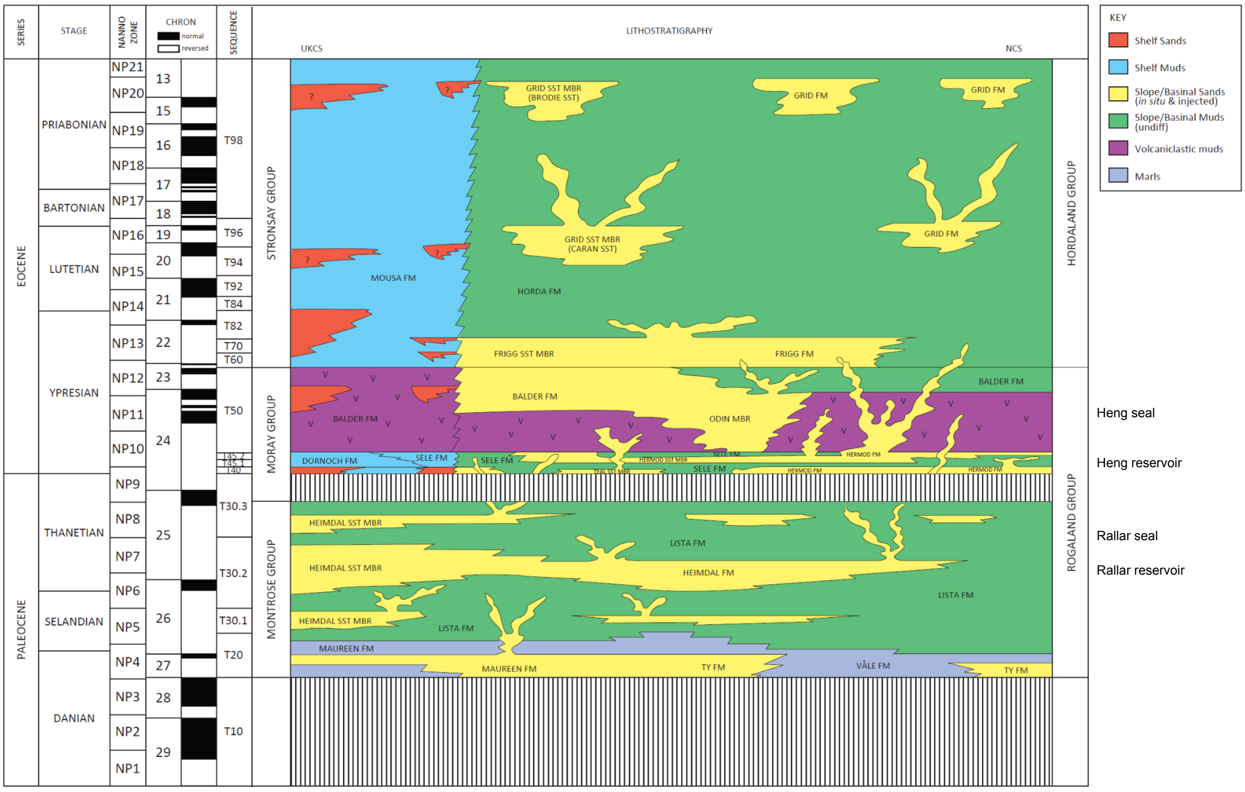

Figure 4.2 ***Chronostratigraphic scheme***

Stratigraphic summary of Paleocene to Lower Eocene strata in the East Shetland Basin and Viking Graben (Skolithos, 2018).

a)

b)

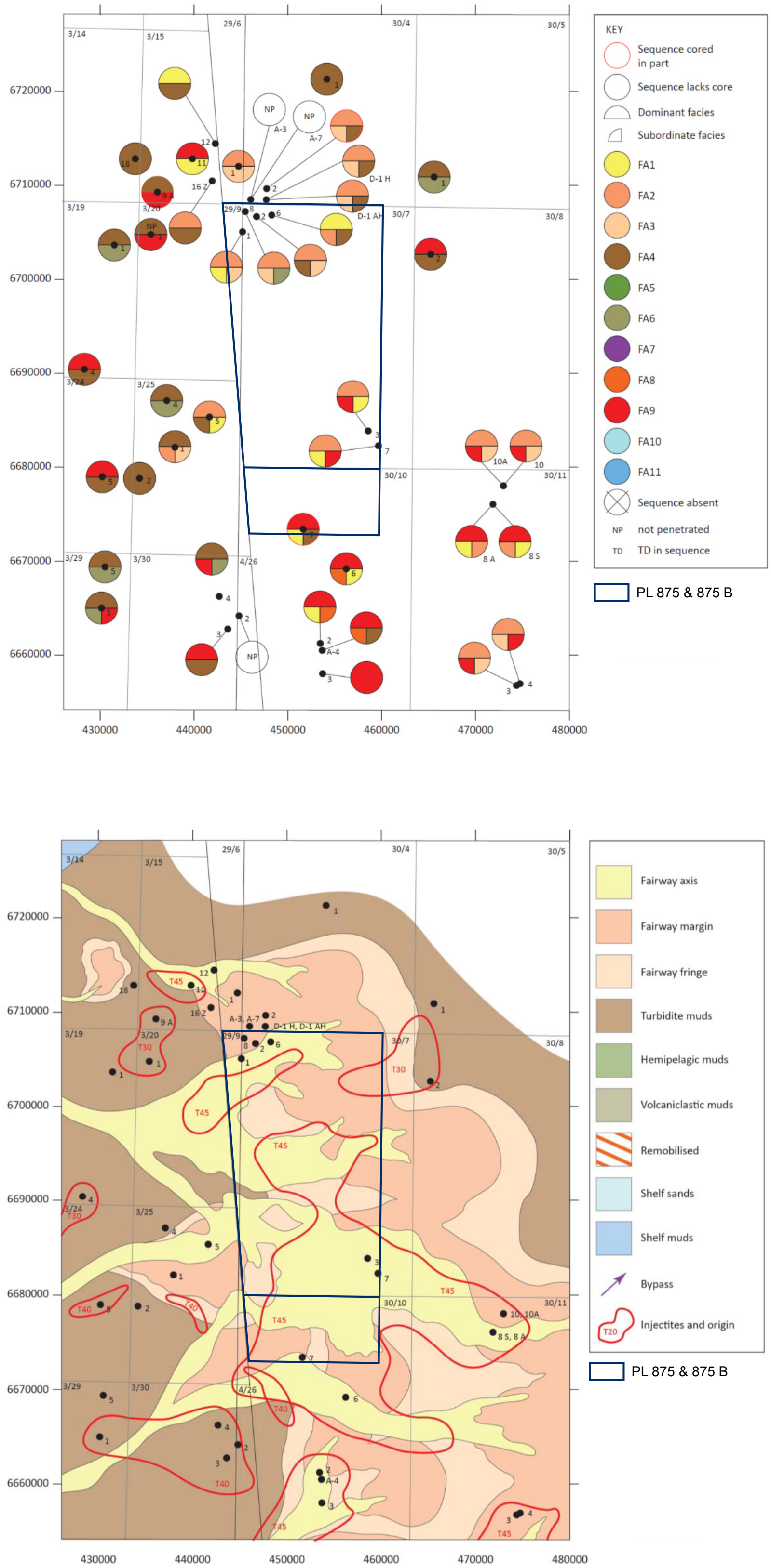

Figure 4.3 ***Facies observations and GDE maps of the T45 sequence (Upper Hermod Fm)***
a) Lower Eocene Upper Hermod Fm facies observations in core and log data of wells surrounding the licence area.
b) GDE map of Upper Hermod Fm based on well observations and seismic thickness map. Well-developed and good quality Hermod Fm fairway axis sands have been deposited in the licence area. Sand injectivity sourced from the Hermod Fm is associated with these fairway axis sands (Skolithos, 2018).

The mounds likely formed by deposition of fairway axis sands, accentuated by post-depositional decompaction and sand remobilisation. Originally the larger mounds were connected by closing contours and in the P10 case defined as Heng South and Heng North (Figure 4.1). The Heng prospects have been confidently re-mapped on the new seismic. The Near Top Hermod Fm (top reservoir) has been picked on a prominent soft event which can be tied to offset wells. The mapping resulted in multiple small four-way dip closures of varying sizes (~area 1-10 km^2 with relief of ~10-100 m), as can be seen on the depth map of the Near Top Hermod Fm (Figure 4.4). Due to the relatively simple overburden the depth conversion seems to have little impact on the trapping geometries. The trap risk is considered low, but the traps seem segmented and small.

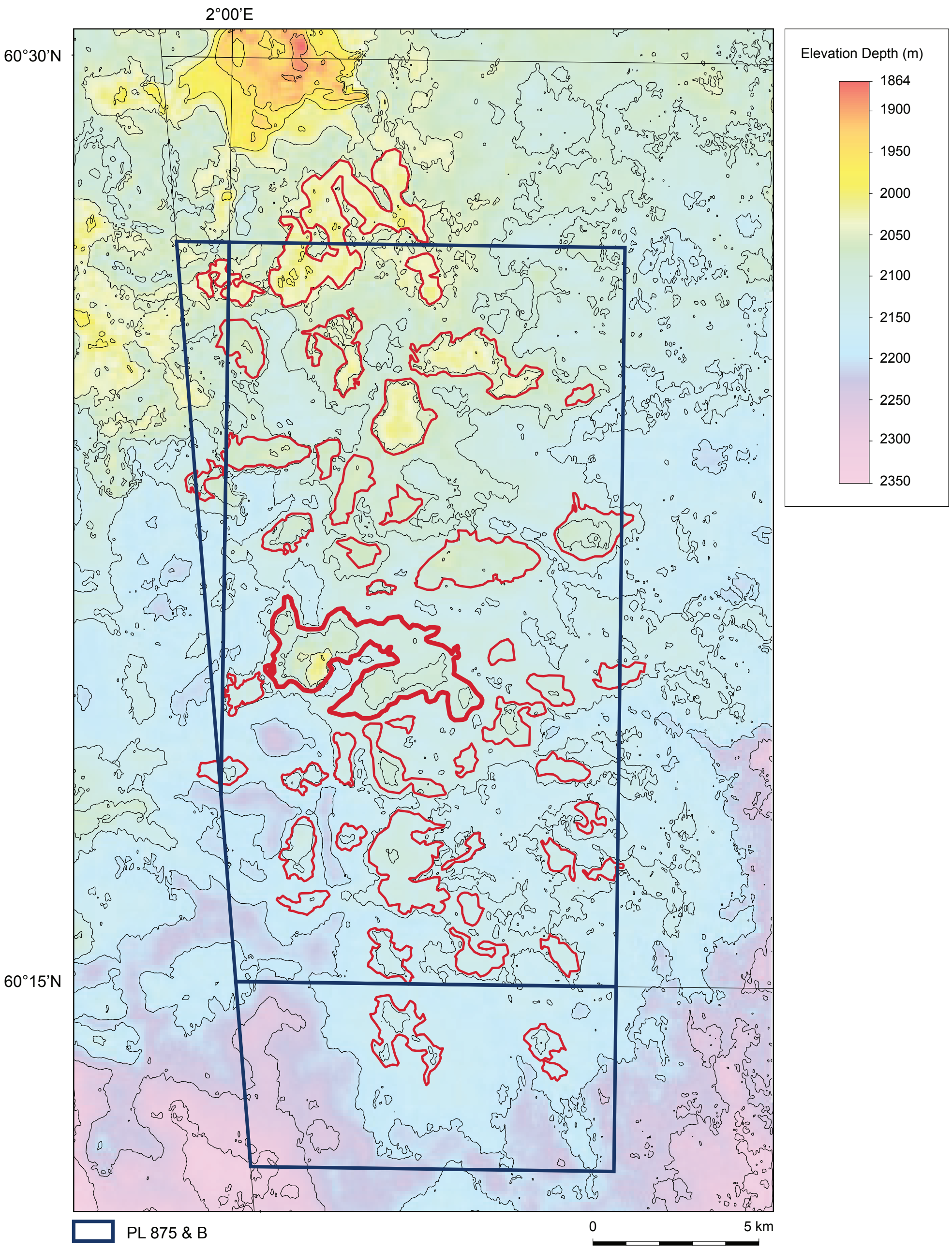

Figure 4.4 ***Top reservoir depth map with closures***
*Best estimate Near Top Hermod Fm depth map with associated closures. Closures represent best estimate traps, in comparison to the APA prospect outlines which clustered several mounds in P10 outlines. The thicker polygon outlines the largest closure, part of the original Heng South prospect. Volumes and risking are assessed for this closure (*Table 4.1*).*

Initially effectiveness of the seal was considered as the main risk. Shales and tuffs of the Balder Fm (T50) form the top seal of the Heng prospects. Imaging of the reservoir and sealing intervals within the Paleocene-Lower Eocene improved with the new seismic. Faults and injectites breaching the Balder Fm cap rock can now be interpreted. In addition, studied core data and log data of the Paleocene-Lower Ecoene succession in the area showed widespread post-depositional deformation of the sands in the form of remobilisation and injectivity. Communication is therefore likely via injectites between Hermod Fm reservoir and Lower Frigg Fm sandstones above 'blown' Balder Fm seal, resulting in upwards migration of hydrocarbons into the Frigg Fm and subsequent up-dip loss due to lack of traps at this level in the licence area. Figure 4.5 shows a seismic section through the mounds of Heng South and the closest offset wells. The cartoon displays the compensational stacking of the different Paleocene/Eocene sands and the connectivity between the sands through injectites. Based on the above results the probability of petroleum retention in the prospects is interpreted to be low.

The charge model is vertical migration along Jurassic highs and lateral migration through the Tertiary. In the area charge up to the Tertiary is proven by the Eocene Nuggets fields to the west in the UK, the HC accumulation in the Eocene of the Martin Linge Field to the north and HC shows in the Paleocene in offset wells to the east. HC charge into the prospects is considered of medium risk, mainly due to the uncertainty of lateral migration through the Paleocene/Eocene towards the prospects. In case of HC migration into the prospects the expected fluid phase would be medium-heavy oil with a gas cap, comparable as the proven hydrocarbons in the Eocene interval of the nearby Martin Linge Field.

According to geophysical well modelling Hermod Fm gas filled reservoir should be visible in seismic, both on full stack and far offset data, as an AVO class III response. Oil would be more difficult to differentiate from brine due to the expected medium-heavy oil (Figure 4.6, a). Even after gather conditioning the seismic quality is questionable for fluid detection, although gas is modelled to have such a a large effect that it should be detectable. The gather conditioned seismic was screened for class II/III AVO responses, but AVO anomalies seemed patchy and not conformable to the mounded structures (Figure 4.6, b), which therefore unlikely contain gas.

In case an exploration well would have been drilled the closure with the largest area and relief, part of the original Heng South (Figure 4.4), would have been targeted and volumes and risk are only calculated for this closure (Table 4.1). Although the licence area has a larger resource potential than only this closure, the risk is believed to be too high.

Rallar lead

For the APA 2017 application the concept of the Rallar prospect was similar to the geological model of the Heng prospects; four-way dip closure formed by mounding of basin floor fan sands. In case of Rallar the reservoir is Paleocene Heimdal Fm sands (T30 sequence) encased in Lista Fm shales, slightly older than the Heng reservoir and sealing interval (Figure 4.2).

In the new CGG17M01 3D seismic it was difficult to confidently map the top Heimdal Fm event. Well 30/10-7 to the south of the Rallar prospect encountered ~90 m of Heimdal Fm sandstone. The seismic tie to this well shows little AI contrast at the top of the sand. Upper Heimdal Fm sandstone in offset well 3/25b-5 (~50 m) gives a weak positive AI response, which is barely visible in seismic. In addition, remobilisation of sands and associated injectivity makes it even harder to distinguish the top Heimdal Fm reservoir in seismic. Due to this low confidence in mapping of the top reservoir and lack of proper trap definition the Rallar prospect has been downgraded to a lead.

Regardless of the downgrade to a lead Rallar has still been evaluated as part of the Paleocene-Lower Eocene stratigraphy and sedimentology study and the AVO modelling and screening. The results of this evaluation are the same as for the Heng prospects. Reservoir presence is highly probable and charge seems to be of medium risk. The key risk is retention, as also the Heimdal Fm is associated with large

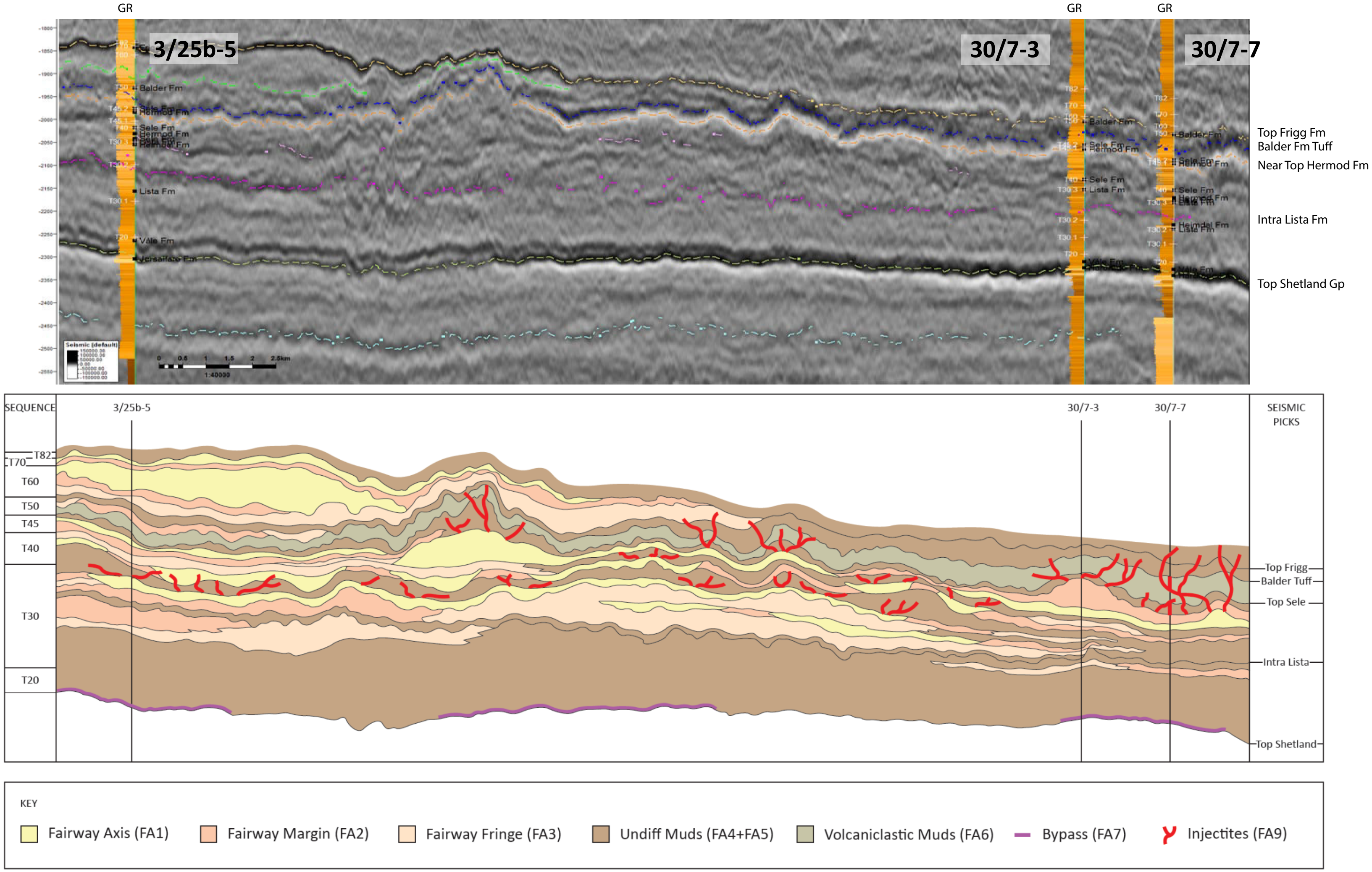

Figure 4.5 ***West-east cross section through Heng South and offset wells***
Seismic section (CGG17M01) and cartoon correlation with interpreted lateral facies relationships through Heng South prospect. Note potential communication via injectites between different Paleocene and Lower Eocene sands, resulting in upwards migration of hydrocarbons into the shallowest sands and subsequent up-dip loss due to lack of traps at this level in the licence area (Skolithos, 2018).

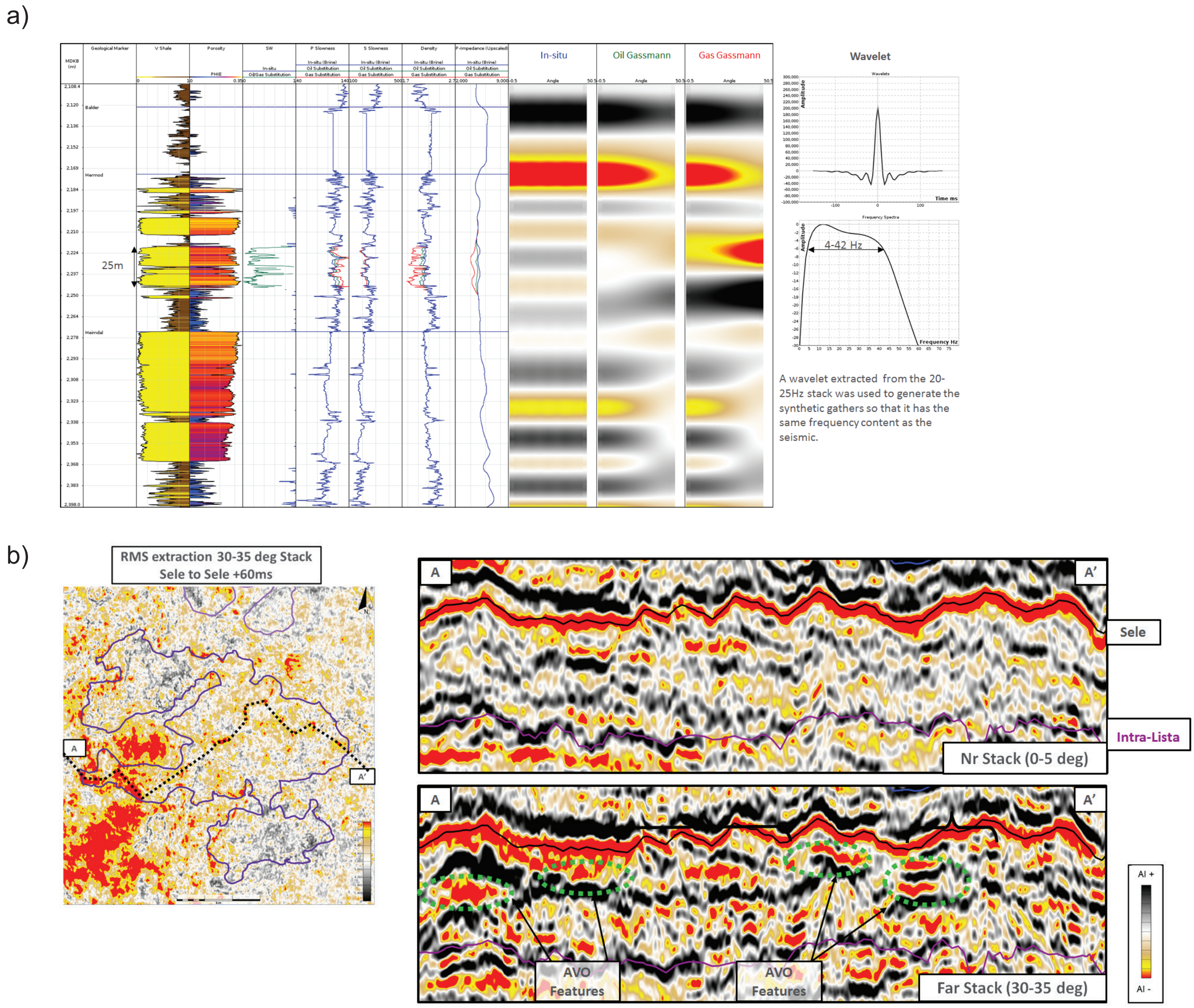

Figure 4.6 ***AVO modelling and screening***
a) Fluid substitution was performed within the Frigg, Balder, Hermod and Heimdal fms sands in four key wells and their responses were modelled. Here is an example of fluid substitution within the Lower Hermod Fm (~25 m) in well 30/10-7. The modelling shows for the gas case a clear brightning with offset both at the top and base of the Hermod Fm.
b) The licence area has been screened for AVO class II and III responses within the Paleocene-Lower Eocene interval. Here is an example of an AVO attribute over Heng South with a section through it comparing the near and the far offsets. AVO anomalies seem patchy and not conformable with mounds (DUG, 2018).

scale sand remobilisation and injectivity and seal breach and connectivity with shallower sands is likely (Figure 4.5). Also no obvious AVO anomalies conform to structure have been observed in the Heimdal Fm, resulting in a DHI downgrade.

Secondary prospectivity

Besides the Paleocene-Lower Eocene succession shallower and deeper intervals have been screened for prospectivity. In the Oligocene, potential submarine fans were mapped, but the main closure seemed to be in the UK sector outside the licence area. Charge and biodegradation are also considered risks at this shallow depth. The Eocene was screened for any sand injectivity sourced from and above the Frigg Fm, but both well data and seismic did not support this model. Lower Cretaceous sands potentially eroded from local Jurassic highs seem not present within the licence area, as no well-developed Cretaceous sands have been observed in surrounding wells. Wells on local highs encountered Draupne and Heather fms shales, proving that highs were drowned during Late Jurassic/Early Cretaceous time and seismic

Table 4.1 ***Revised prospect data (NPD table 5)***

*Volumes and risking for the largest Hermod Fm closure, originally part of Heng South (*Figure 4.4*). An oil case with associated gas has been modelled, since gas was not detected by the AVO screening.*

Block	30/7	Prospect name	Heng	Discovery/Prosp/Lead	Prospect	Prosp ID (or New!)	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:	Oil	Reported by company	Suncor Energy Norg	Reference document	PL 875 & 875 B Lapse Report			Assessment year	2018
This is case no.:	1 of 1	Structural element	Viking Graben	Type of trap	4WD	Water depth [m MSL] (>0)	100	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)	0,80	1,18	9,49	24,35				
	Gas [10^9 Sm^3] (>0.00)								
Recoverable resources	Oil [10^6 Sm^3] (>0.00)	0,27	0,41	3,45	8,81				
	Gas [10^9 Sm^3] (>0.00)					0,02	0,02	0,31	0,79
Reservoir Chrono (from)	Ypresian	Reservoir litho (from)	Hermod Fm	Source Rock, chrono primary	Oxfordian-Ryazania	Source Rock, litho primary	Draupne Fm	Seal, Chrono	Ypresian
Reservoir Chrono (to)	Ypresian	Reservoir litho (to)	Hermod Fm	Source Rock, chrono secondary	Callovian-Oxfordiar	Source Rock, litho secondary	Heather Fm	Seal, Litho	Balder Fm
Probability [fraction]									
Total (oil + gas + oil & gas case) (0.00-1.00)	0,09	Oil case (0.00-1.00)	1,00	Gas case (0.00-1.00)	0,00	Oil & Gas case (0.00-1.00)	0,00		
Reservoir (P1) (0.00-1.00)	0,90	Trap (P2) (0.00-1.00)	0,80	Charge (P3) (0.00-1.00)	0,60	Retention (P4) (0.00-1.00)	0,20		
Parametres:	Low (P90)	Base	High (P10)	*Comments:*					
Depth to top of prospect [m MSL] (> 0)	2000	2000	2000						
Area of closure [km^2] (> 0.0)	0,5	1,5	11,8	*Base parameters: P50 values*					
Reservoir thickness [m] (> 0)	75	106	150						
HC column in prospect [m] (> 0)	43	81	120						
Gross rock vol. [10^9 m^3] (> 0.000)	0,010	0,044	0,259						
Net / Gross [fraction] (0.00-1.00)	0,40	0,60	0,80						
Porosity [fraction] (0.00-1.00)	0,20	0,25	0,30						
Permeability [mD] (> 0.0)	75,0	600,0	1250,0						
Water Saturation [fraction] (0.00-1.00)	0,30	0,20	0,10						
Bg [Rm3/Sm3] (< 1.0000)									
1/Bo [Sm3/Rm3] (< 1.00)	0,74	0,79	0,86						
GOR, free gas [Sm^3/Sm^3] (> 0)									
GOR, oil [Sm^3/Sm^3] (> 0)	129	90	52						
Recov. factor, oil main phase [fraction] (0.00-1.00)	0,25	0,37	0,55						
Recov. factor, gas ass. phase [fraction] (0.00-1.00)									
Recov. factor, gas main phase [fraction] (0.00-1.00)									
Recov. factor, liquid ass. phase [fraction] (0.00-1.00)				For NPD use:					
Temperature, top res [^oC] (>0)	75			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)	195			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.Vshale<=0,40	2.Porosity>=0,10	3. Permeability>=0,01					Kart nr	NPD will insert value

facies are interpreted as passive infill rather than submarine fans. In contrary in the Upper Jurassic, some pay has been encountered in Intra Draupne Fm sands in well 3/25b-5. Sands are thin and of poor quality and believed to be in the distal part of a submarine fan system. Sands probably shaled out before reaching the licence area and no stratigraphic or structural traps are present at this level. In the licence area reservoir is present within the Brent Gp, but likely too deep (>5000 m) to preserve good reservoir quality. In conclusion, no secondary prospectivity seems to be present in the licence area to give some upside potential.

5 Technical evaluation

A complete technical evaluation regarding economical value and possible development solution is not performed due to the low chance of success for the Heng prospects and downgrade of Rallar from a prospect to a lead.

6 Conclusion

The Heng prospects and the Rallar lead are re-evaluated based on interpretation of the acquired and reprocessed seismic data, along with the integration of the geological and geophysical studies performed during the licence period.

The geological chance of success of the Heng prospects is 9%, which is regarded too low to justify a drill decision by the partnership. Seal effectiveness is identified as the key risk element. Additionally, traps seem small and segmented with a P90-P10 range in recoverable volumes of ~2-60 mmboe for the largest closure.

The top reservoir of Rallar is hard to define on the available seismic data and thus the trap definition is uncertain. Rallar is therefore downgraded to a lead.

The partnership is aligned that no more technical work can be done on the existing data to further de-risk the Heng prospects and Rallar lead.

No further upside potential is recognised in the licence.

Due to the low chance of geological success, combined with moderate recoverable volumes, the partnership is aligned on a negative drill decision in PL 875 and 875 B. Hence the area is fully relinquished to the authorities.