Relinquishment report for PL755
Blocks 6507/8 and 6507/11

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Introduction

The work programme of PL755 includes relevant geological and geophysical studies leading up to a Drill or Drop decision within 7th of February 2016. Studies have been performed and the license partnership has decided to drop the license based on the unanimous decision not to drill the Epsilon prospect. The Epsilon prospect is considered to be a large horst container with fair confidence in a reservoir presence- and quality, as well as trap definition and seal. Migration has a very high risk and thus the overall probability for success for Epsilon is only 14% (21% when applying a DFI -direct fluid indicator -upgrade).

1 Key license history

PL755 was awarded 7th of February 2014 to Statoil Petroleum AS (Operator) 40%, Tullow Oil Norge 20%, Noreco Norway AS 20% and Centrica Resources Norge AS 20%. The license is located in blocks 6507/8 and 6507/11 with an area of 136 km^2 (figure 1). The license acreage is east and south of the Heidrun field in the Cretaceous horst- and graben terrain of the Grinda Graben. Work obligations were G&G studies and Drill or Drop within two years of award.

2 Database

The common data base for the license has been the seismic survey ST08M07 together with the key wells 6597/8-2 (Theta), 6507/8-8 (Ronaldo) and 6507/11-9 (Natalia).

3 Review of geological framework

The Epsilon prospect is a well-defined N-S trending fault bounded horst (figure 2). Reservoir presence of Fangst Gr. (not subdivided) and Tilje/ Åre Fm. and the quality of these, as well as trap has low risk. The key risk is migration. Although the prospect has a high migration risk, the prospect has a weak DFI upgrade related to a faint AVO anomaly in favour of an oil leg (Heidrun analogue) and the resulting P(g) with DFI uplift is 21%. The business case is based on mean recoverable 8 MSm^3 oil with 1.7 GSm^3 gas cap/ associated gas, P(oil) is 14%.

Epsilon is the last undrilled prominent horst at the shallowest end of the Grinda Graben. The failure of Theta (1985) is considered mainly due to migration failure and for Ronaldo (2011) also trap failure by reactivation into Tertiary. Neither of these failure mechanisms can be ruled out for Epsilon.
Several possible migration routes, all with low probability, have been proposed to contribute towards the filling of Epsilon; the main routes are through Jurassic (Fangst Fm.) and Cretaceous (Lysing, Lange, Kvitnos, Nise Fms.) sands as carrier layers. The Jurassic migration route into the Epsilon structure is complex and has to rely on fill and spill through several closures from a mature source rock kitchen ~50km away (Figure 3). Hydrocarbons from short distance Åre Fm. sourced migration may also contribute. However, only the Top Fangst migration route is supported by a hard data point; the 6507/11-9 Natalia gas/condensate discovery on the fill-spill route. Recent geochemistry studies performed on core and cuttings from the Natalia gas discovery well showed no convincing trace of *oil* phase in the well, not as a paleo column in current gas zone (possible gas flushing) nor as paleo column or migration indication in deeper sand intervals (Ile and Tilje Fms.). A negative data point for the Cretaceous migration route is the 2007 well 6507/11-7 that targeted the Cretaceous Lysing and Lange Fm. of the Zita prospect. The well proved no hydrocarbons and calcite cemented sand without any communication with the Lysing Fm. sands in the region. An effort has been made to understand the overall possibility for migration in Cretaceous carrier layers in the area surrounding Epsilon. The main conclusion is that there is a general lack of Cretaceous sands in the wells and the reflectors that represent Cretaceous sand are very difficult to map out. The reported shows in Cretaceous intervals in the 6507/8-8 Ronaldo well have been looked into and they are believed to represent a short migrated immature hydrocarbon. This is a negative observation for the possible long distance Cretaceous migration route into Epsilon. The overall migration of oil into Epsilon from the mature source kitchen in the southern parts of Grinda graben has been given the very low probability for success of 0.2.

Detailed AVO work has been performed on the sandy intervals of the Epsilon prospect and Heidrun is considered an analogue. The AVO amplitudes are patchy over the Epsilon prospect and the amplitudes are semi depth-conformant (figure 4). However, that is also the signature for the AVO response over the Heidrun discovery and oil-brine is not expected to be a strong change in amplitude. AVO work concludes that a thin gas zone is expected to be present in the top of the structure, in sandy intervals of the Fangst Gr. and there are indications of an oil-water contact in the Tilje Fm. A small DHI uplift is applied to the prospect probability based on this. Gas-oil and oil-water contact distributions have been set according to AVO findings. The AVO results are confirmed on three different seismic surveys.

The evaluation of the only drillable prospect in the license, Epsilon, has not changed since the APA application (see tables 1 and 2). A revisit of risking for the main risk element; migration, resulted in the same conclusions as in 2013 APA.

4 Technical evaluation and development solution

The proposed field development solution consists of two four slot templates with a total of three producers with gas as artificial lift and three water injectors. The template is tied back to Heidrun. Start of production for Epsilon is assumed to be 2020. Substantial liquid capacity is available on the platform. The gas handling capacity on the Heidrun platform is limited, and available capacity for export is expected in Q1/2025. Available gas transport capacity is expected in ÅTS from 2021. Epsilon has the potential to be developed following a Fast Track schedule. Because of the large volume potential of the structure the economic valuation at decision point is positive with a ~50$ break even.

5 Conclusions

PL755 mid-Jurassic prospects Halen, Leppard and Kennedy identified by Centrica (figure 1) in the basin surrounding Epsilon have been screened for AVO indications- supporting only limited gas potential. In addition to lack of AVO-support for significant volumes, these leads/ prospects will have similar, or higher, risk for migration than Epsilon (local source kitchen is not mature). The largest structure Halen has a P50 recoverable 8,4 MSm3 OE and second largest Leppard a P50 recoverable 4,3 MSm3 OE. P(g) for both of these is expected to be less than 10%. Upper Jurassic prospectivity in the license has not been evaluated further due to the very negative results of the 2015 6507/11-11 Zumba well.
The partnership agreed to Epsilon being the prospect to take the Drill or Drop decision on because of its large volume potential. The partnership, however, also agrees that the main risk always has been and still is; migration of economically interesting volume of hydrocarbons into the trap. The risk factor for migration is considered too high for a positive drill decision.

Appendix

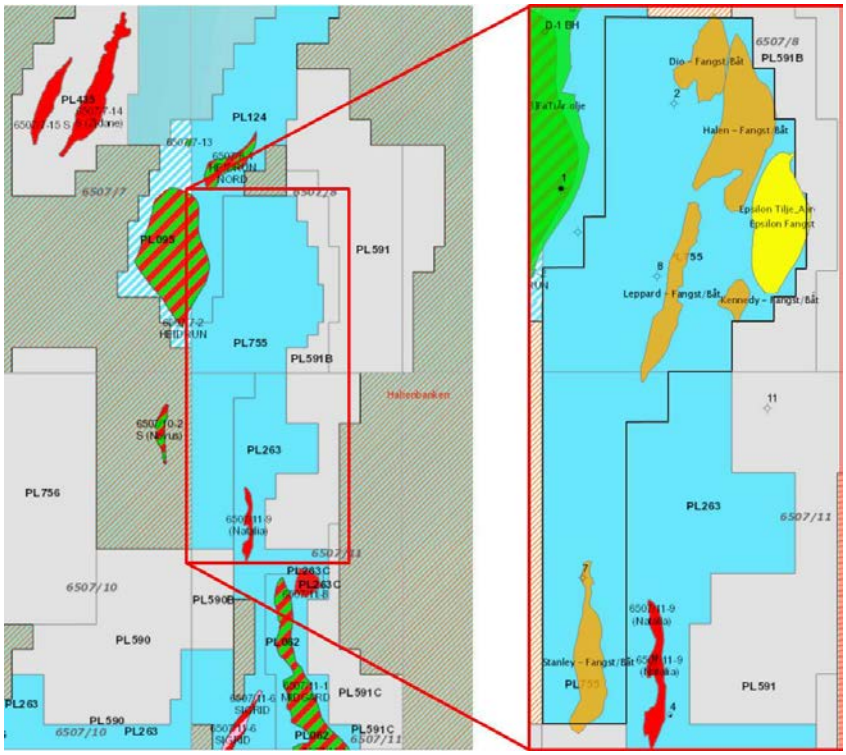

Figure 1: PL755 location and prospect and lead inventory.

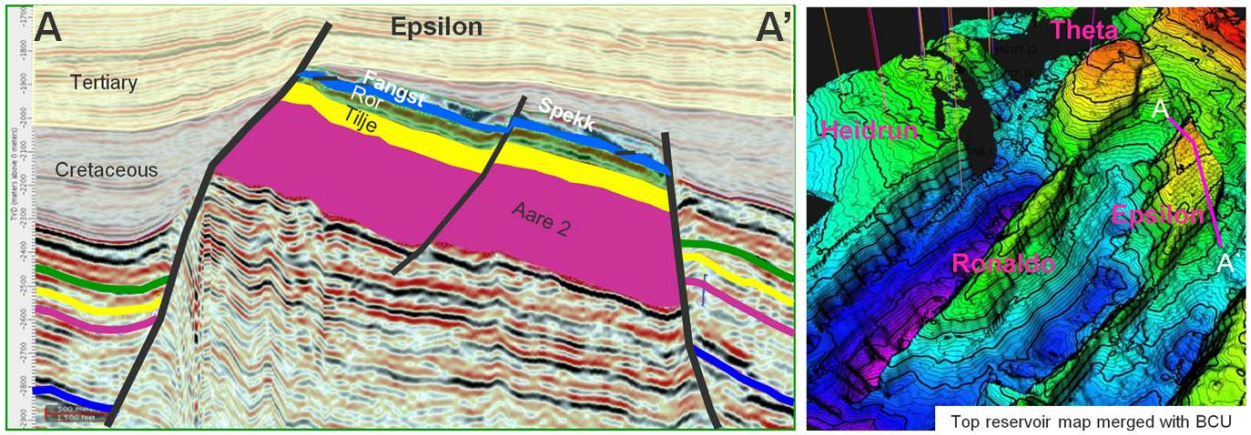

Figure 2: The Epsilon prospect evaluated for the Drill or Drop decision in PL755.

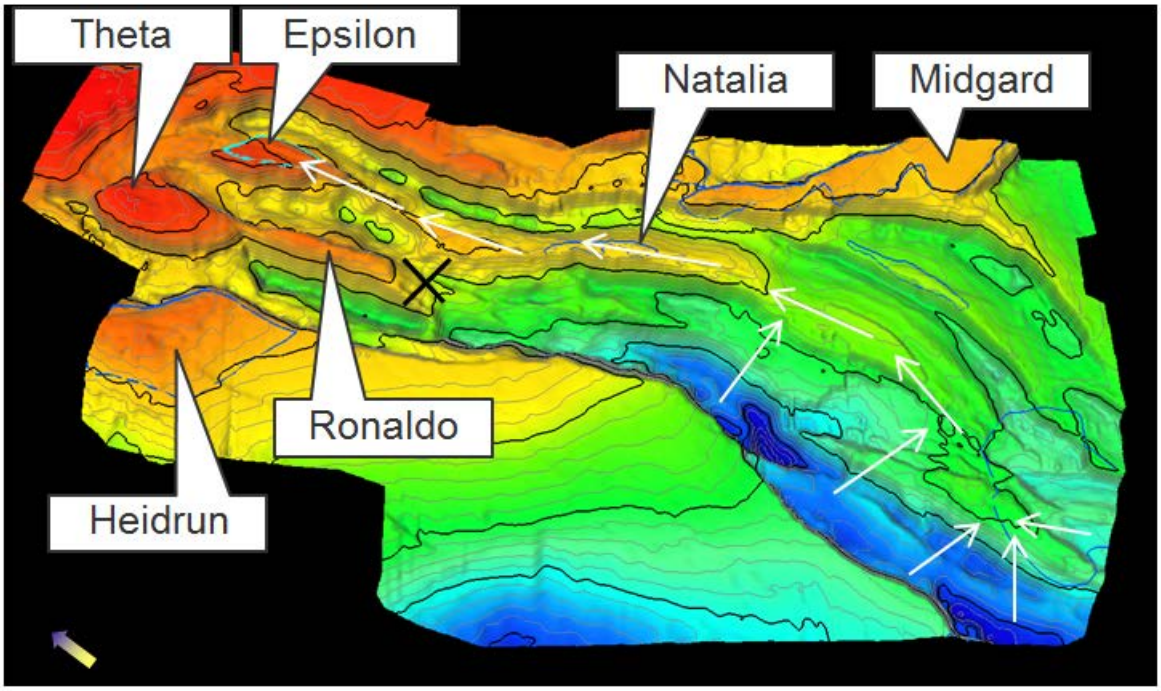

Figure 3: The Jurassic fill-spill route from deeper, mature parts of Grinda Graben along structural highs to Epsilon (displayed on Jurassic depth map). Dry wells east of Epsilon, 6507/8-2 Theta and 6507/8-8 Ronaldo are expected to be in shadow for Jurassic migration.

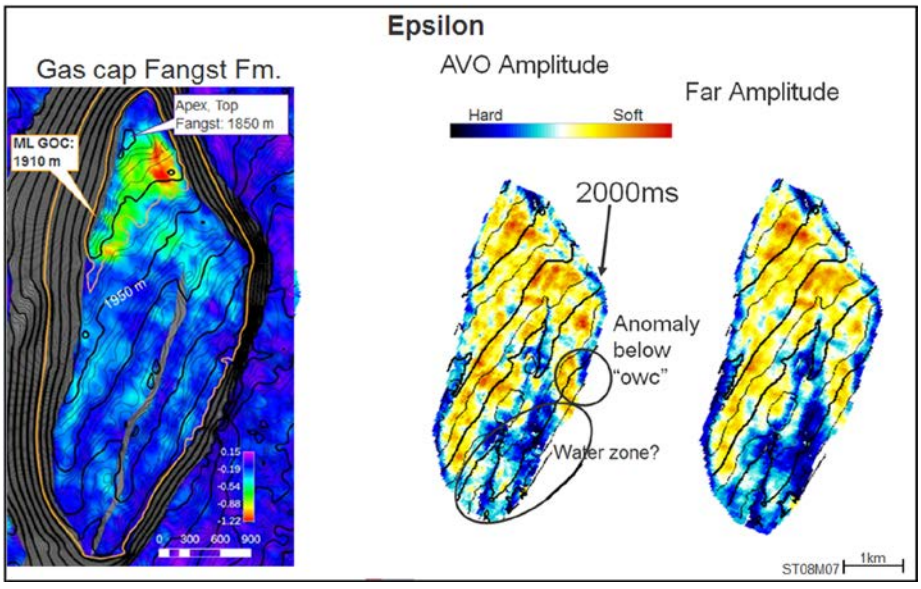

Figure 4: AVO anomalies with fair confidence in a gas cap in Fangst Fm. of Epsilon and indications of an oil leg in Tilje Fm. AVO indications of gas cap and oil leg has been used when choosing hydrocarbon-water contacts for the evaluation.

Table 1: Prospect data Epsilon Fangst Gr.

Block	6507/8	Prospect name	Epsilon Fangst	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&Gas	Reported by company	Statoil	Reference document				Assessment year	2015
This is case no.:		Structural element	Grinda Graben	Type of trap	Horst	Water depth [m MSL] (>0)	325	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)	3,91		7,47	11,00	0,64		1,28	1,98
	Gas [10^9 Sm^3] (>0.00)	0,39		1,63	4,24	0,18		0,80	2,01
Recoverable resources	Oil [10^6 Sm^3] (>0.00)	1,76		3,44	5,10	0,29		0,59	0,91
	Gas [10^9 Sm^3] (>0.00)	0,23		0,99	2,59	0,09		0,40	1,03
Reservoir Chrono (from)	Alenian	Reservoir litho (from)	Ile	Source Rock, chrono primary	Upper Jurassic	Source Rock, litho primary	Spekk	Seal, Chrono	Cretaceous
Reservoir Chrono (to)	Bathonian	Reservoir litho (to)	Garn	Source Rock, chrono secondary	Lower Jurassic	Source Rock, litho secondary	Åre	Seal, Litho	Cromer Knoll
Probability [fraction]									
Total (oil + gas + oil & gas case) (0.00-1.00)	0,11	Oil case (0.00-1.00)	0,10	Gas case (0.00-1.00)	0,60	Oil & Gas case (0.00-1.00)	0,30		
Reservoir (P1) (0.00-1.00)	0,80	Trap (P2) (0.00-1.00)	1,00	Charge (P3) (0.00-1.00)	0,20	Retention (P4) (0.00-1.00)	0,70		
Parametres:	Low (P90)	Base	High (P10)						
Depth to top of prospect [m MSL] (> 0)	1840	1850	1860						
Area of closure [km^2] (> 0.0)	8,0	10,0	12,0						
Reservoir thickness [m] (> 0)	20	25	30						
HC column in prospect [m] (> 0)	150	236	340						
Gross rock vol. [10^9 m^3] (> 0.000)	0,041	0,126	0,178						
Net / Gross [fraction] (0.00-1.00)	0,70	0,80	0,90						
Porosity [fraction] (0.00-1.00)	0,20	0,25	0,30						
Permeability [mD] (> 0.0)	100,0		10000,0						
Water Saturation [fraction] (0.00-1.00)	0,20	0,35	0,50						
Bg [Rm3/Sm3] (< 1.0000)	0,0043	0,0045	0,0050						
1/Bo [Sm3/Rm3] (< 1.00)	0,58	0,65	0,72						
GOR, free gas [Sm^3/Sm^3] (> 0)									
GOR, oil [Sm^3/Sm^3] (> 0)	100	170	250						
Recov. factor, oil main phase [fraction] (0.00-1.00)	0,18	0,30	0,40						
Recov. factor, gas ass. phase [fraction] (0.00-1.00)	0,18	0,30	0,40						
Recov. factor, gas main phase [fraction] (0.00-1.00)	0,40	0,50	0,65						
Recov. factor, liquid ass. phase [fraction] (0.00-1.00)	0,30	0,40	0,55	For NPD use:					
Temperature, top res [°C] (>0)	70			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)	180			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.	3.					Kart nr	NPD will insert value

Table 2: Prospect data Epsilon Tilje/Åre2 Fm.

Block	6507/8	Prospect name	Epsilon Tilje/Åre2	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&Gas	Reported by company	Statoil	Reference document				Assessment year	2015
This is case no.:		Structural element	Grinda Graben	Type of trap	Horst	Water depth [m MSL] (>0)	325	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)	9,99		23,90	41,20	1,62		4,13	7,23
	Gas [10^9 Sm^3] (>0.00)	0,06		4,12	13,60	0,03		1,97	6,48
Recoverable resources	Oil [10^6 Sm^3] (>0.00)	3,22		8,07	13,60	0,54		1,27	2,38
	Gas [10^9 Sm^3] (>0.00)	0,03		2,22	7,20	0,01		0,87	2,77
Reservoir Chrono (from)	Sinemurian	Reservoir litho (from)	Åre2	Source Rock, chrono primary	Upper Jurassic	Source Rock, litho primary	Spekk	Seal, Chrono	Cretaceous
Reservoir Chrono (to)	Pliensbachian	Reservoir litho (to)	Tilje	Source Rock, chrono secondary	Lower Jurassic	Source Rock, litho secondary	Åre	Seal, Litho	Cromer Knoll
Probability [fraction]									
Total (oil + gas + oil & gas case) (0.00-1.00)	0,14	Oil case (0.00-1.00)	0,10	Gas case (0.00-1.00)	0,60	Oil & Gas case (0.00-1.00)	0,30		
Reservoir (P1) (0.00-1.00)	1,00	Trap (P2) (0.00-1.00)	1,00	Charge (P3) (0.00-1.00)	0,20	Retention (P4) (0.00-1.00)	0,70		
Parametres:	Low (P90)	Base	High (P10)	*Total P(g) 0,207 is due to a DFI upgrade from 0,14. AVO anomalies indicate gas cap over oil leg. DFI upgrade is only applied for Epsilon Tilje/Åre2 segment.*					
Depth to top of prospect [m MSL] (> 0)	1840	1850	1860						
Area of closure [km^2] (> 0.0)	8,0	10,0	12,0						
Reservoir thickness [m] (> 0)	40	60	80						
HC column in prospect [m] (> 0)	150	236	340						
Gross rock vol. [10^9 m^3] (> 0.000)	0,525	0,290	1,183						
Net / Gross [fraction] (0.00-1.00)	0,45	0,65	0,85						
Porosity [fraction] (0.00-1.00)	0,16	0,20	0,25						
Permeability [mD] (> 0.0)	5,0		1000,0						
Water Saturation [fraction] (0.00-1.00)	0,20	0,36	0,50						
Bg [Rm3/Sm3] (< 1.0000)	0,0043	0,0045	0,0050						
1/Bo [Sm3/Rm3] (< 1.00)	0,58	0,65	0,72						
GOR, free gas [Sm^3/Sm^3] (> 0)									
GOR, oil [Sm^3/Sm^3] (> 0)	100	170	250						
Recov. factor, oil main phase [fraction] (0.00-1.00)	0,18	0,30	0,40						
Recov. factor, gas ass. phase [fraction] (0.00-1.00)	0,18	0,30	0,40						
Recov. factor, gas main phase [fraction] (0.00-1.00)	0,40	0,50	0,65						
Recov. factor, liquid ass. phase [fraction] (0.00-1.00)	0,30	0,40	0,55	For NPD use:					
Temperature, top res [°C] (>0)	70			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)	180			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.	3.					Kart nr	NPD will insert value