Wintershall Norge AS

PL633 Relinquishment Report

November 2015

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PL633 Relinquishment Report

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PL633 Relinquishment Report

1. Key license history

PL633 was awarded on 3rd February 2012 as a result of the APA 2011 application and consists of parts of blocks 34/8, 34/9, 34/11 & 34/12 covering a total area of 1048km^2. Wintershall Norge AS (40%) was the operator with Bayerngas Norge AS (30%) and Suncor Energy Norge AS (30%) as partners.

The initial work obligations, which were reprocessing of existing seismic data and re-evaluation of the prospectivity, are fulfilled. The initial period until a drill or drop decision had to be made was two years.

A one-year extension of this initial period was granted by the Ministry of Petroleum and Energy with a DoD decision to be made by the 3rd February 2015. The background for this extension was the partnerships' initial very different views on the prospectivity and hence delayed planning of the extensive 3D seismic reprocessing project.

In November 2014 the partnership applied for an additional one-year extension of the initial period based on late delivery (July 2014) of phase 2 of the seismic reprocessing product. Only a four-month extension was granted by the Ministry of Petroleum and Energy this time and therefore a DoD decision had to be made by June 3rd 2015.

EC/MC meetings were held at least once a year, in addition there were work meetings.

The license area is located in the axial part of the Magne Sub-Basin of the North Viking Graben and is flanked by the Visund and Kvitebjørn Fields to the west and the 34/12-1 Afrodite discovery to the east (Fig. 1). At the time of the license award, the combined prospectivity defined by the partnership included the Jurassic Ulv/Shougham Prospect, the Eocene Copenhagen Prospect and the Oligocene Stockholm Lead. The Jurassic play was eventually given up as studies showed that cementation at the relevant significant depth would cause poor reservoir quality and make a discovery non-commercial. After detailed prospect evaluation work based on the reprocessed seismic data, three Paleogene prospects, Reykjavik, Copenhagen and Helsinki constitute the main prospectivity in the license. Potential volumes are significant, however all prospects rely on stratigraphic trapping and in addition have high risks on both reservoir and hydrocarbon migration and hence carry low chances of success.

In this scenario, the license partners agreed not to drill and the license was relinquished as of 3rd June 2015.

2. Database

The initial seismic database described in the APA 2011 application was extended by the reprocessed WIN13M04 data set. The reprocessing was done in two phases, the first consisting of two input survey volumes, NVG2000 and NX0801 (Fig. 2). This phase covered the Copenhagen and Ulv/Shougham Prospects defined by the partnership at the time of the application. In the second phase of reprocessing two additional input survey volumes were added, namely the TQ34-12 and the ST9303. This brought the total reprocessing area to 1583km^2.

The objectives for the seismic reprocessing varied with the target stratigraphy. Main objectives for the Jurassic target were:

- Fault imaging enhancement (capturing lateral velocity variations)
- Improved imaging of fault blocks (improved control of velocities in the overburden)
- Noise attenuation

Main objectives for the Paleogene target were:

- Amplitude preservation for all offsets for AVO studies and inversion
- Preservation of high frequencies to facilitate stratigraphic interpretation
- Attenuation of multiples

The final products are:

- Kirchhoff PreSDM Migration Gathers (time)
- Kirchhoff PreSDM Stack Volumes (time): Full offset stack, Near angle, Far angle
- Beam PreSDM Stack Volume in time: Full offset stack
- PreSDM Migration and Stacking velocity models

In addition to the seismic database Robertson carried out a comprehensive reservoir quality study. The study report “Reservoir Quality Evaluation of Brent Group Reservoirs in Vicinity of Licence Area PL633” is also part of the common database.

3. Review of geological framework

The reprocessed seismic has been used in geophysical and geological evaluation of the license area. This includes seismic mapping of all relevant horizons and faults, amplitude analysis and, for the Paleocene section, AVO analysis, high-resolution thickness variations as well as spectral frequency decomposition. Geological studies have covered reservoir quality preservation with

depth, a regional Paleogene stratigraphic study, hydrocarbon charge studies and resource and risk assessments for the prospect evaluation.

The reservoir quality preservation study performed for the licence by Robertson (*Reservoir Quality Evaluation of Brent Group Reservoirs in Vicinity of Licence Area PL633*) concluded that the deep (>5100m) Jurassic Brent Group prospect Ulv/Shougham would have a reservoir porosity of less than 5% with permeabilities below 0.05mD. A profitable development of a discovery with these reservoir characteristics is not likely to be achieved. In addition, the very high expected pressure and temperature would cause well operations to be very expensive and technically challenged.

The regional Paleogene stratigraphic study aimed at getting an understanding of the spatial distribution of sands in Paleocene – Early Eocene times. This study was based on 70 wells in the region and included a revision of biostratigraphic and lithostratigraphic tops, correlation of sequences and integration with seismically defined units. The outcome is a series of sequence based sand distribution maps.

The shallow Oligocene Stockholm Lead was given up because of high risk on top- and lateral seal due to the widespread occurrence of Miocene Utsira Fm sands in the area.

Based on the reprocessed seismic, detailed mapping of the Paleogene deep water systems lead to the definition of three additional prospects, Oslo, Helsinki and Reykjavik. Based on their volume potential the latter two prospects constitute, with the Copenhagen Prospect, the main prospectivity in the license. All the Paleogene prospects are however considered as high risk. This relates to the stratigraphic trapping nature of the structures plus risks on reservoir and charge migration. Significant de-risking would be difficult to achieve without drilling for these targets.

4. Prospect update

Copenhagen

The Copenhagen Prospect is defined as an amplitude anomaly related to a single cycle seismic event in the lower Eocene section. The seismic event seems to pinch out further to the east but can otherwise be mapped in an extensive area to the north, south and west. The amplitude anomaly covers ca 200km^2 and is elongate north south and the structural highest area is to the north (Fig. 3). For the volumetric calculation, the max column height is down to the deepest structural point (extreme south) within the prospect outline. The potential reservoir in the Copenhagen Prospect is most likely a Ypresian age Frigg type sand deposited on the basin floor with an easterly provenance. The Frigg depositional system is evident in this region as a sand rich shelf slope in the area to the east of the Copenhagen Prospect (in Block 35/7 and eastward) where thick Frigg sands are penetrated by several wells. However, the

seismic character of Copenhagen (Fig.4) (very high amplitude single cycle seismic event) is somewhat enigmatic in relation to a potential reservoir lithology. In addition, AVO modeling of the anomaly seems to indicate the effect of a different lithology rather than a shale-sand interface AVO behavior. Main risks are reservoir (30%) and trap (48%). The Copenhagen Prospect holds the largest volumes (recoverable mean 65.8*10^6 Sm^3 Oil). Volumes are smaller than presented in the application (recoverable mean 90.7*10^6 Sm^3 Oil) mainly due to a revised HC contact distribution. The Copenhagen Prospect GPOS has also been reduced, from 17% in the application to the current 7%. This change is based on higher risk estimates on both reservoir, trap and charge migration.

Reykjavik

The Reykjavik trap is defined as an up-dip pinch-out trap along the margins of a deep marine fan system. This fan system is derived from the west and there is strong evidence that the prospect area constitutes the distal eastern sand prone part of this system before a total shale-out further to the east (Fig. 5). The overall crest of the prospect is expected to be in Block 35/7 in an area not currently covered by 3D seismic. The trap is bounded by a dip closure at 1965m, the lowest closing contour before the trap would spill towards the west. The Reykjavik depositional system can be traced on seismic (Fig. 6) as an Upper Paleocene (Early Thanetian) fairway to the west where it is has been drilled and Intra Lista (Heimdal) sands have been proven. This deep-water turbidite system has travelled eastward from a slope setting in the UK sector. In PL633 this system is mapable as a fan geometry with a distinct seismic facies and amplitude character and showing compensational stacking in an overall forward (eastward) stepping style. Individual sand units are thought to be relatively thin (~30m) and reservoir quality is unknown. Main risks are trap and reservoir, both at 48%.

The Reykjavik Prospect volume estimate is recoverable mean 16.0*10^6 Sm^3 Oil.

Helsinki

The Helsinki Prospect is defined as a thickness anomaly in the Sele Fm. This thickness anomaly has an elongate oval shape in map view and thins in all directions (Figs. 7 & 8). The trap outline is defined as the 26ms isochron between the top and base surfaces (Top Sele and Top Lista respectively) which approximates a regional shale thickness. The crest of the prospect is in the east. For the volumetric calculation, the max column height is down to the deepest structural point (towards the southwest) within the prospect outline. The possible intra Sele deep-water reservoir in the Helsinki Prospect would be of Late Thanetian to Early Ypresian age. No detectable depositional system seems to feed the Helsinki thickness anomaly so if sandstones are present they would have reached the prospect area via by-pass. Well based sequence stratigraphic work suggests that potential sands in the Helsinki area would have an easterly

provenance. An overlying Intra Balder depositional feature is deposited across the thickest part of Helsinki and this observation serves as an indirect negative indicator of sand presence in Helsinki as one would expect a compensational stacking pattern in sandy systems. Main risks are reservoir (24%) and trap (48%).

The Helsinki Prospect volume estimate is recoverable mean 14.2*10^6 Sm^3 Oil.

An overview of resource volumes, input parameters and risk probabilities of the Paleogene main prospectivity in the license is given in Tables 1-3.

5. Technical evaluations

A combined production, facility and economic evaluation was completed for each of the Copenhagen, Reykjavik, and Helsinki prospects. To reach a P(50) oil production level the following well count scenarios were established. Copenhagen: 11 oil producers and 5 water injection wells. Reykjavik: 4 oil producers and 2 water injection wells. Helsinki: 3 oil producers and 1 water injection well. Production profiles are shown in figs. 9, 10 & 11. The Copenhagen P(50) case is considered developed as stand-alone with an FPSO concept, while the equivalent Reykjavik and Helsinki cases would be tied back to the Gullfaks Field. The development schedules following a 2016 discovery well would have an execution phase in 2021-23 for Tie-back cases and in 2021-24 for Stand-alone cases.

6. Conclusions

Despite comprehensive work, including reprocessing of a large 3D seismic data set and thorough G&G evaluation it was not possible to reduce the prospect risk to an acceptable level for a drill decision.

The decision to relinquish PL633 was taken unanimously in a licence MC meeting on May 28th 2015.

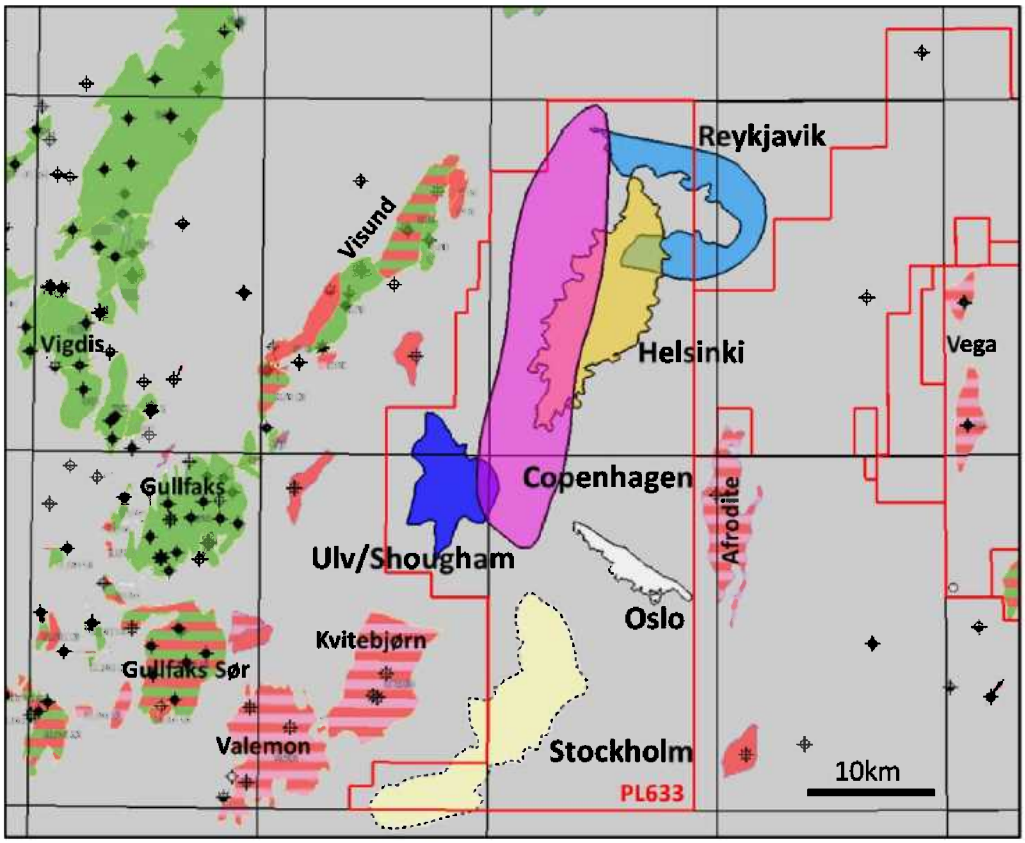

Fig. 1: PL633 location map with prospect outlines.

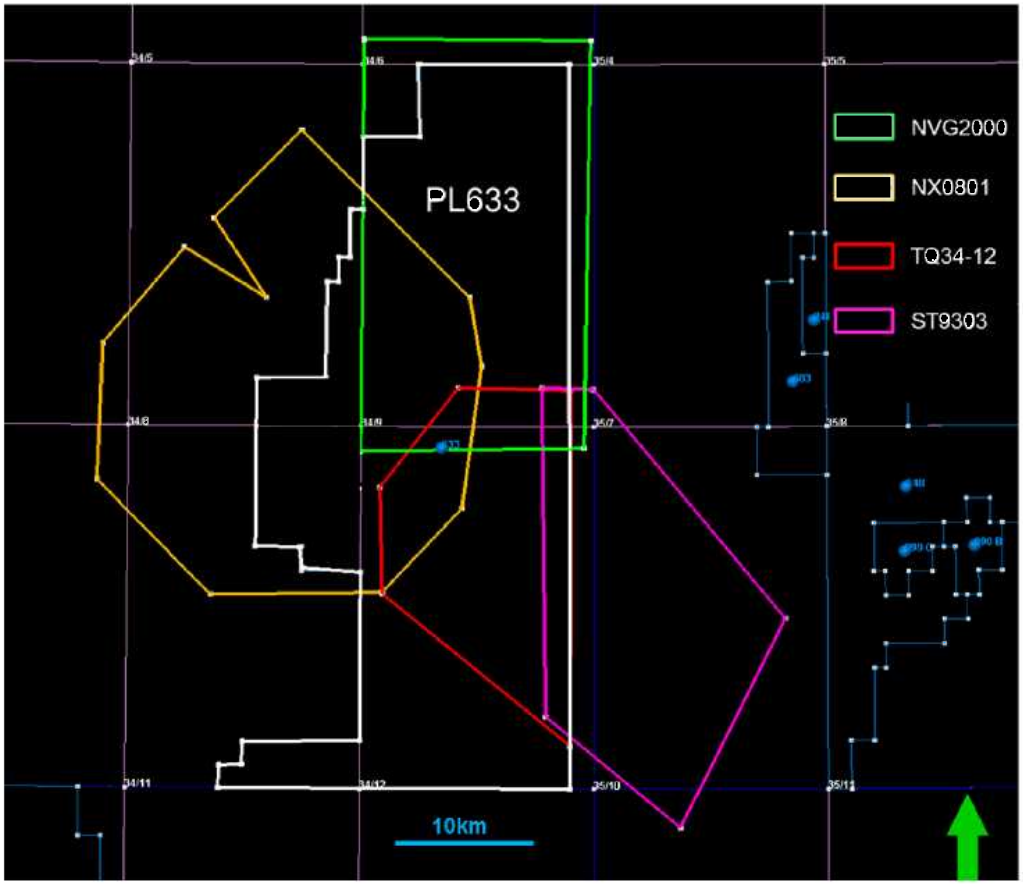

Fig. 2: Seismic database. Outlines of individual input survey volumes used in reprocessing project.

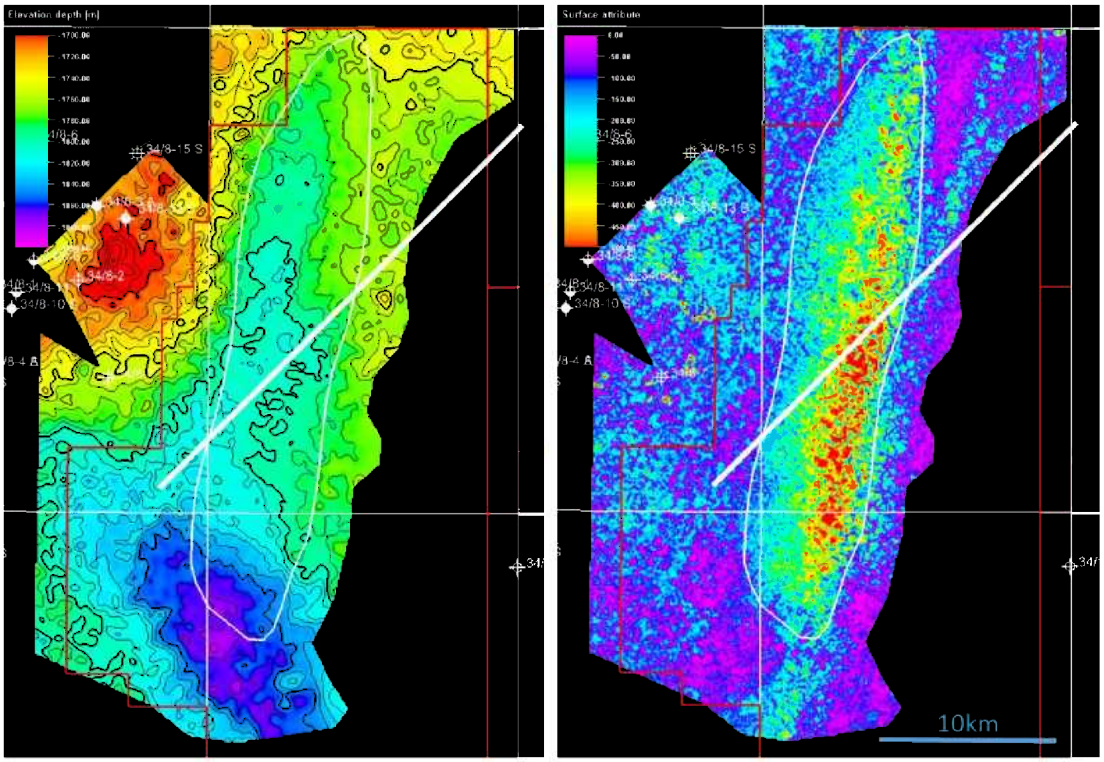

Fig. 3: Copenhagen Prospect. *Left:* depth structure map. CI=10m. The prospect/trap outline is defined as the extent of the amplitude anomaly. *Right:* Minimum amplitude of top reflector. Red is high amplitude, purple is low. White line shows position of seismic line shown in figure 4.

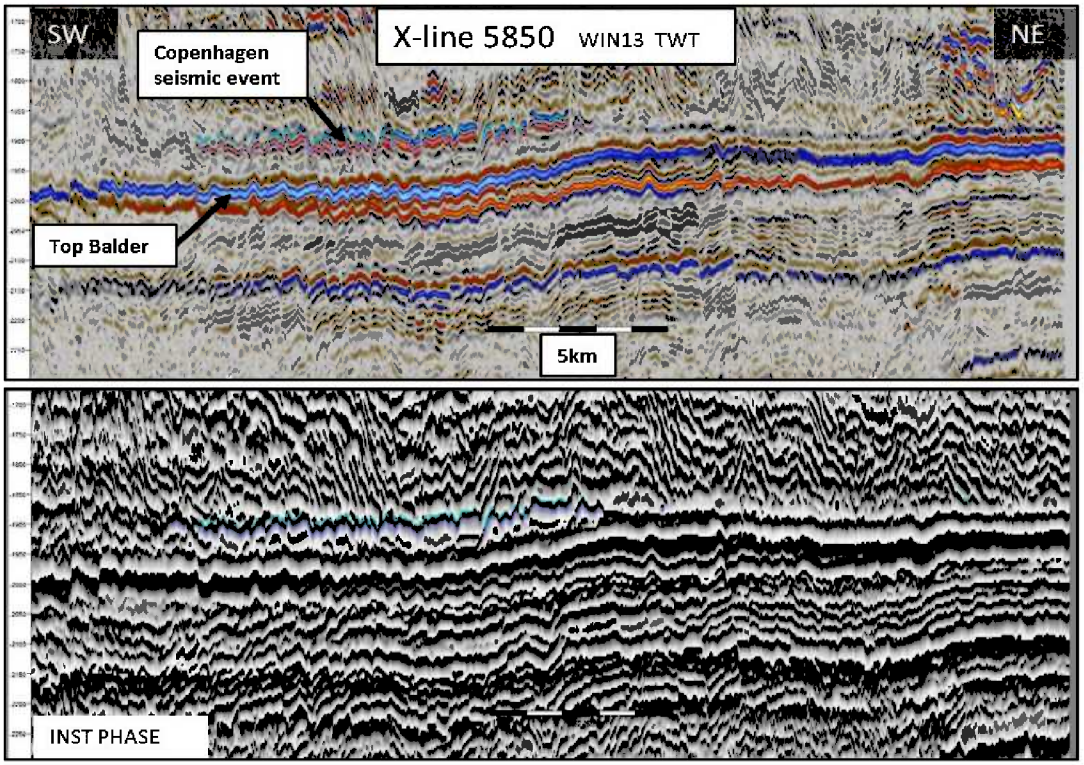

Fig. 4: Seismic line (WIN13 X-line 5850) across the Copenhagen Prospect. See fig. 3 for line location. *Top:* Full offset TWT seismic. *Base:* Instantaneous Phase display.

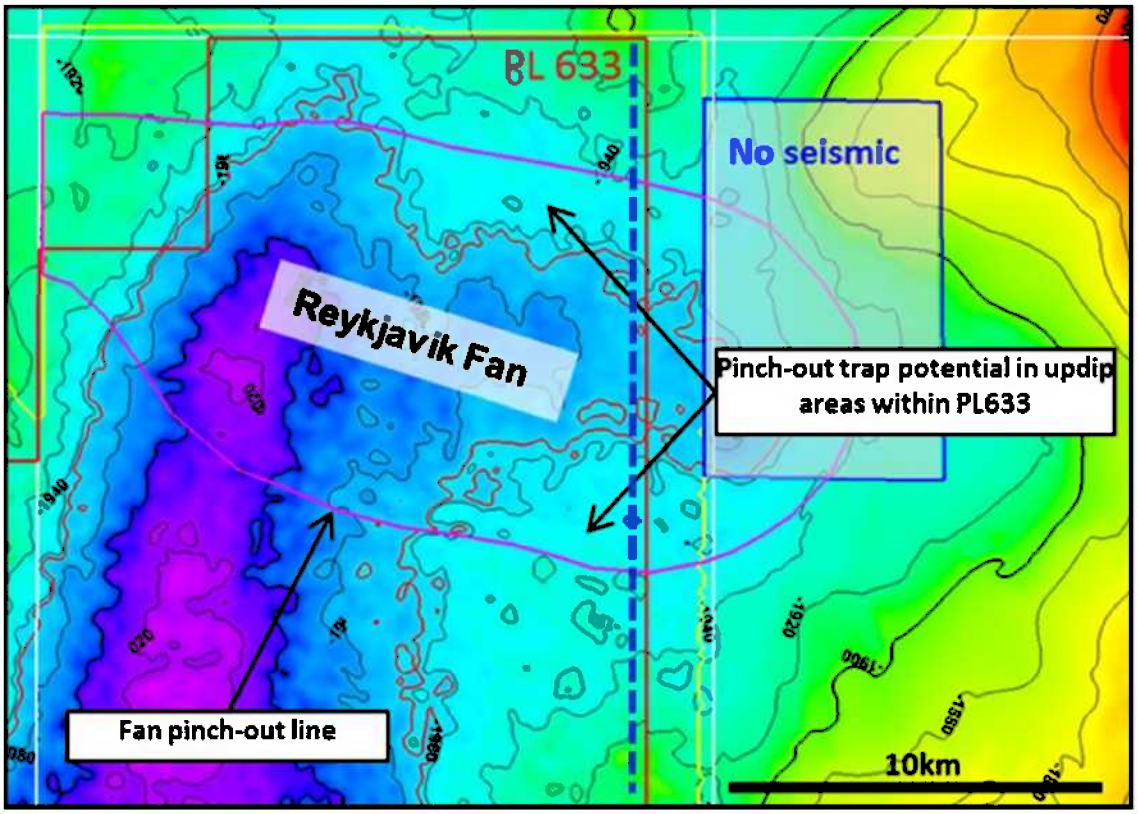

Fig. 5: Reykjavik Prospect. Depth map of the top reservoir surface. CI=20m. Dashed blue line shows position of seismic line shown in figure 6.

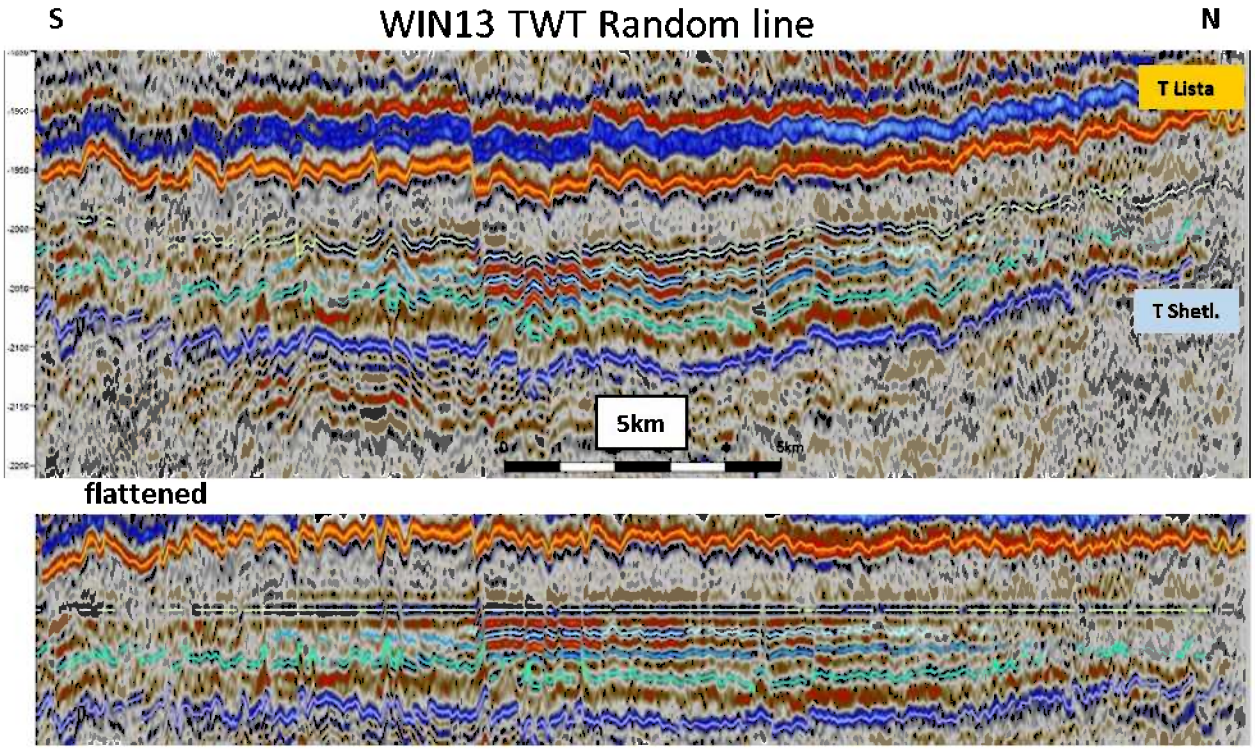

Fig. 6: South to north random seismic line across the Reykjavik Prospect showing intra Lista thickening and amplitude anomaly. Bottom display is flattened at Intra Lista marker. See fig. 5 for line location.

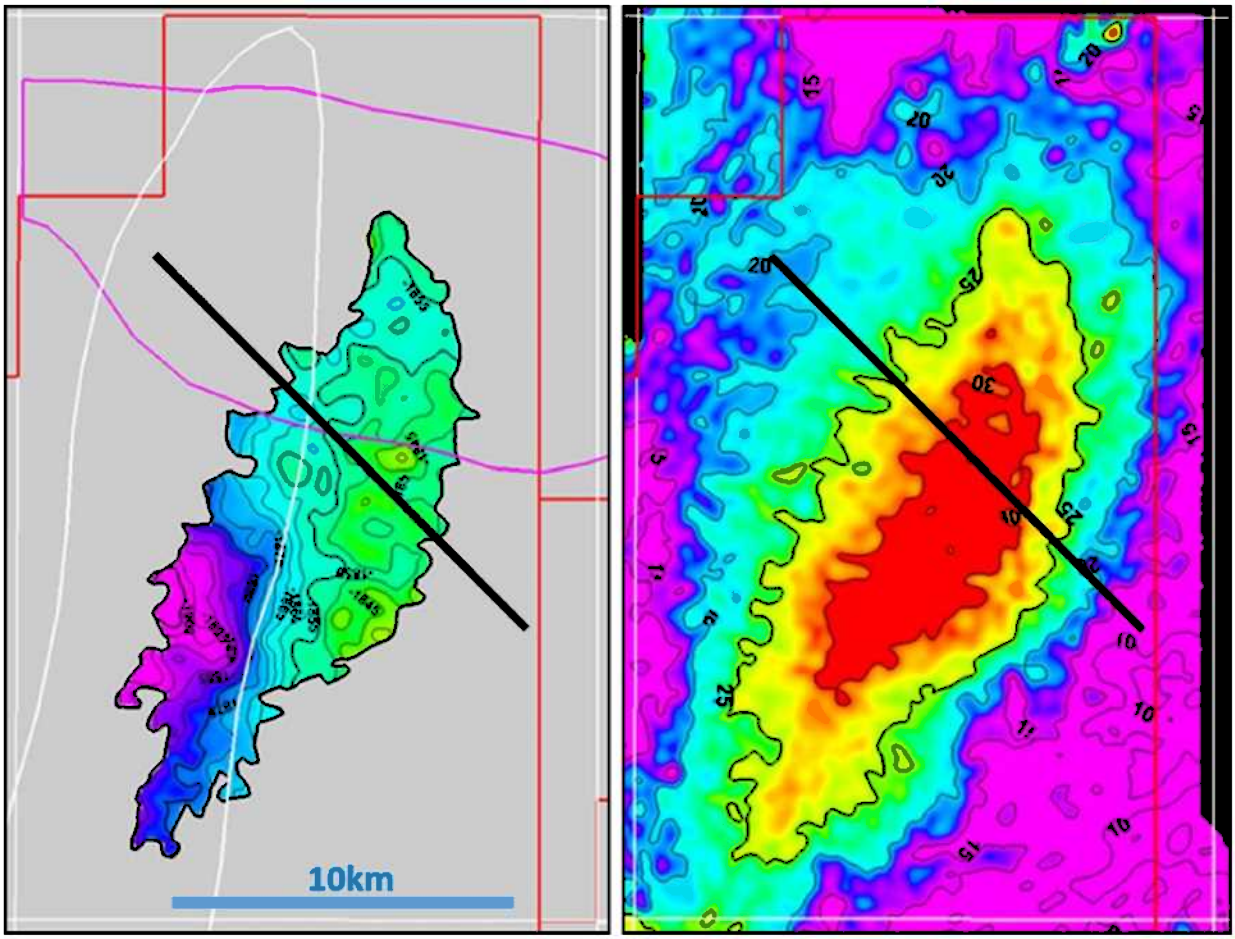

Fig. 7: Helsinki Prospect. *Left:* depth structure map. CI=5m. The prospect/trap outline is defined as the 26ms isochron between top and base surfaces. White and pink polygons represent outlines of Copenhagen Prospect and Reykjavik fan respectively. *Right:* isochron map between top and base surfaces. Red is thick, CI=5ms. Black line shows position of seismic line shown in figure 8.

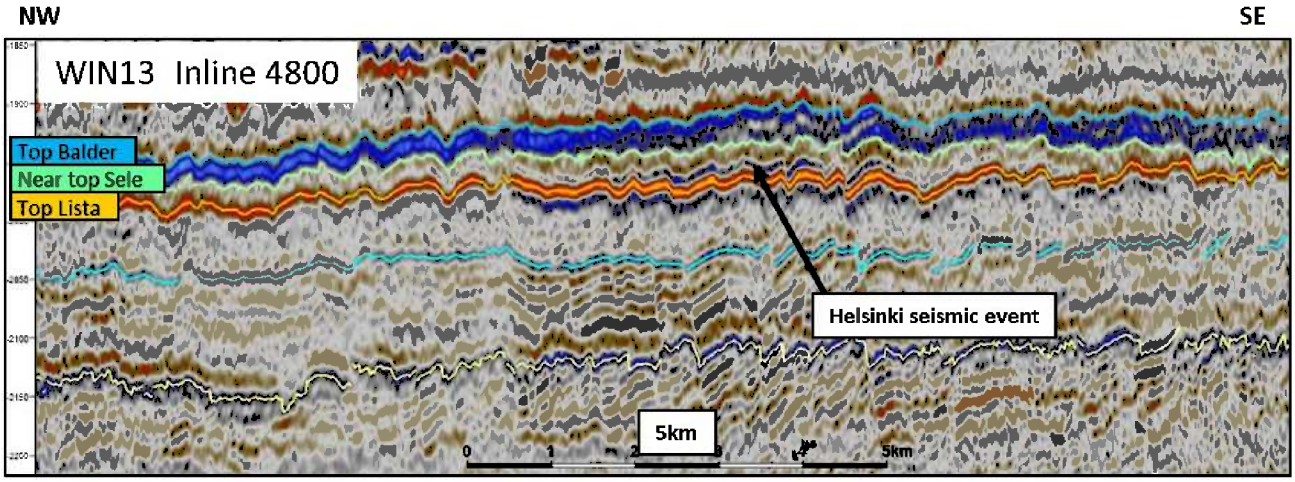

Fig. 8: Seismic line across the Helsinki Prospect. See fig. 7 for line location.

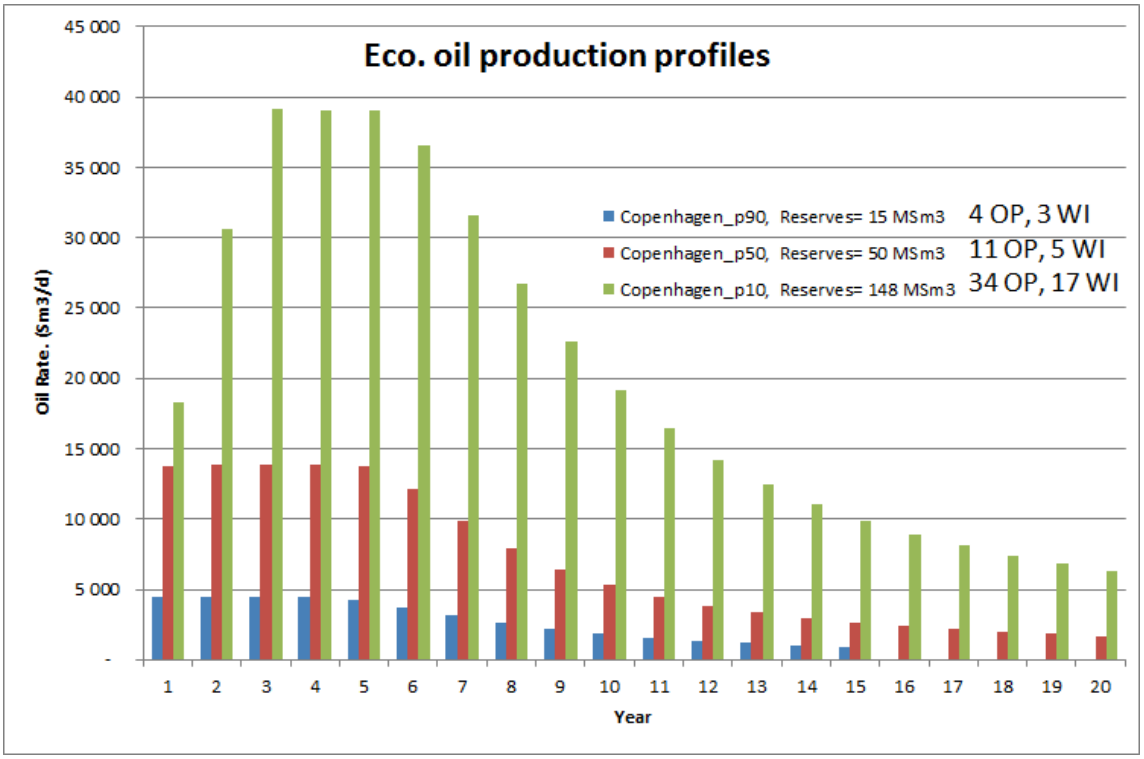

Fig. 9: Oil production profile for the Copenhagen Prospect.

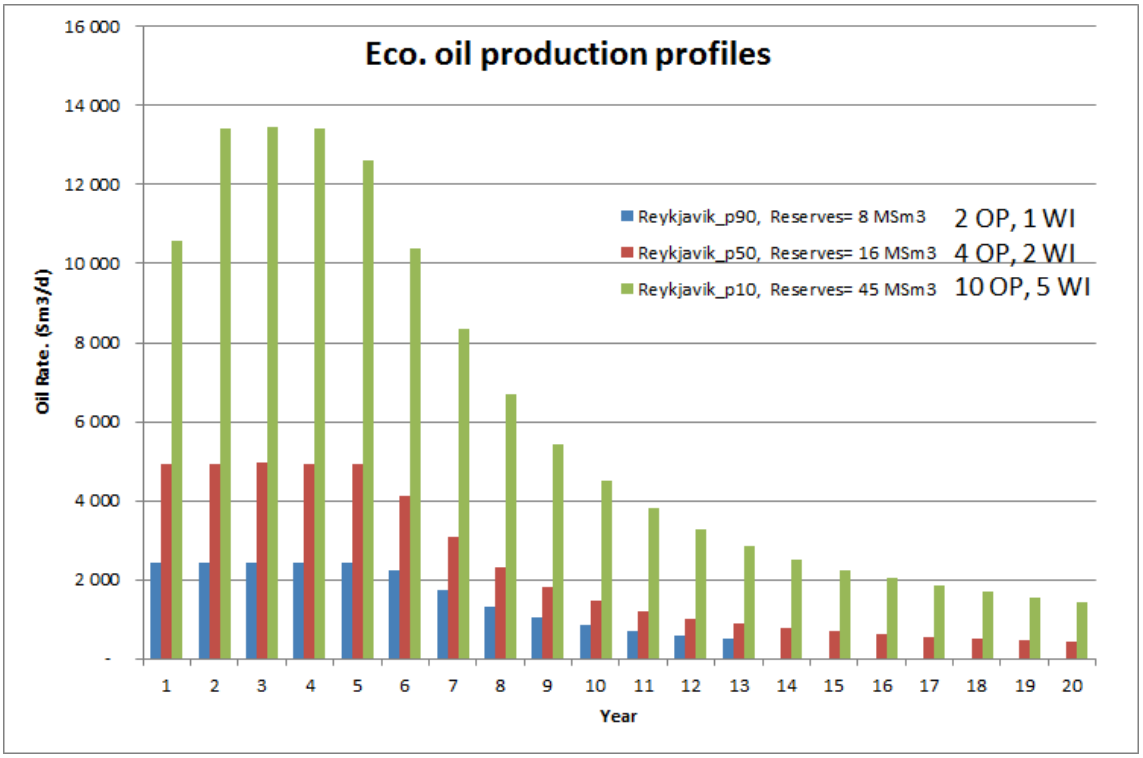

Fig. 10: Oil production profile for the Reykjavik Prospect.

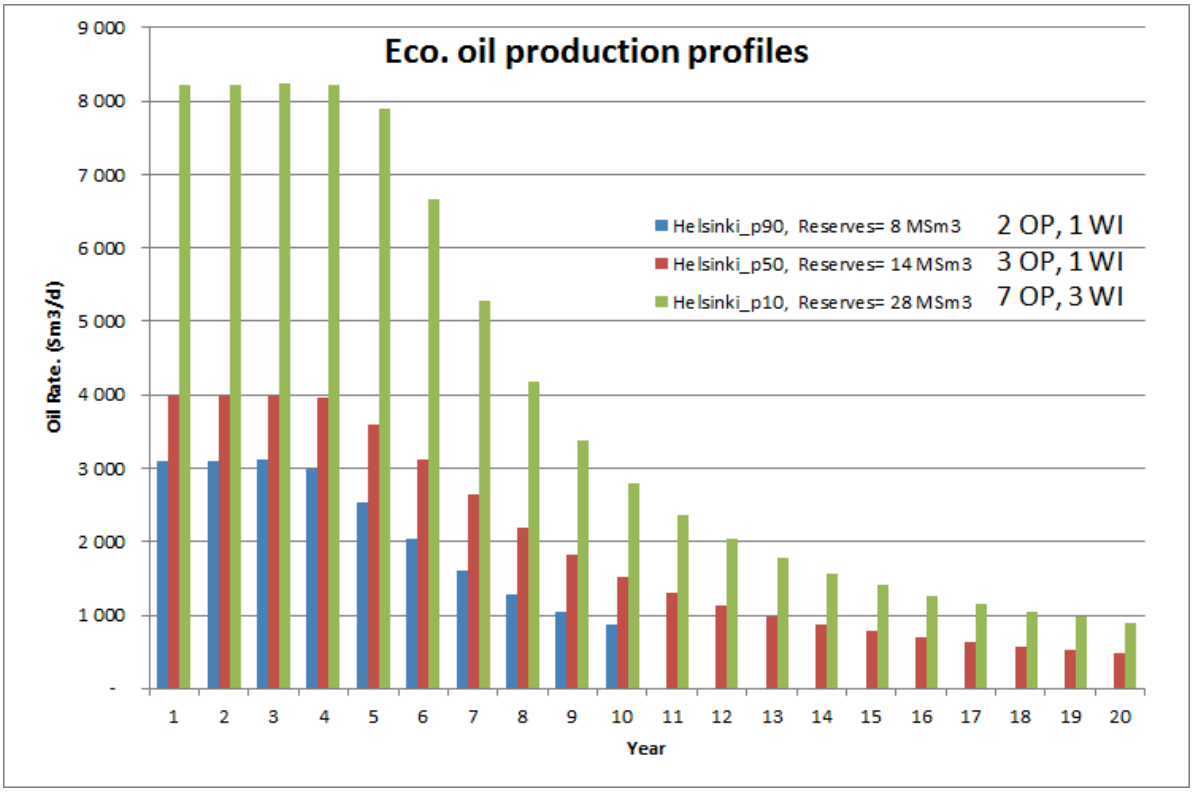

Fig. 11: Oil production profile for the Helsinki Prospect.

Block	34/9 & 34/12	Prospect name	Copenhagen	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	Wintershall	Reference document				Assessment year	2015
This is case no.:	1 of 1	Structural element	North Viking Graben	Type of trap	Stratigraphic	Water depth [m MSL] (>0)	380	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)	57,49	242,46	286,85	563,01				
	Gas [10^9 Sm^3] (>0.00)					1,97	9,37	13,16	28,20
Recoverable resources	Oil [10^6 Sm^3] (>0.00)	10,07	46,87	65,84	143,60				
	Gas [10^9 Sm^3] (>0.00)					0,34	1,81	3,01	7,00
Reservoir Chrono (from)	Ypresian	Reservoir litho (from)	Frigg	Source Rock, chrono primary	Kimmeridgian	Source Rock, litho primary	Draupne	Seal, Chrono	Eocene
Reservoir Chrono (to)		Reservoir litho (to)		Source Rock, chrono secondary		Source Rock, litho secondary		Seal, Litho	Horda Fm
Probability [fraction]									
Total (oil + gas + oil & gas case) (0.00-1.00)	0,07	Oil case (0.00-1.00)	0,07	Gas case (0.00-1.00)		Oil & Gas case (0.00-1.00)			
Reservoir (P1) (0.00-1.00)	0,30	Trap (P2) (0.00-1.00)	0,48	Charge (P3) (0.00-1.00)	0,50	Retention (P4) (0.00-1.00)	1,00		

Parametres:	Low (P90)	Base	High (P10)	*Comments*
Depth to top of prospect [m MSL] (> 0)		1770		
Area of closure [km^2] (> 0.0)	152,0	178,0	208,0	
Reservoir thickness [m] (> 0)	15	26	40	
HC column in prospect [m] (> 0)		94		
Gross rock vol. [10^9 m^3] (> 0.000)				
Net / Gross [fraction] (0.00-1.00)	0,40	0,60	0,84	
Porosity [fraction] (0.00-1.00)	0,14	0,21	0,29	
Permeability [mD] (> 0.0)				
Water Saturation [fraction] (0.00-1.00)	0,34	0,25	0,16	
Bg [Rm3/Sm3] (< 1.0000)				
1/Bo [Sm3/Rm3] (< 1.00)		0,83		
GOR, free gas [Sm^3/Sm^3] (> 0)				
GOR, oil [Sm^3/Sm^3] (> 0)		46		
Recov. factor, oil main phase [fraction] (0.00-1.00)	0,10	0,23	0,40	
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 [°C] (>0)		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)		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 1: Copenhagen Prospect data

Block	34/9 & 35/7	Prospect name	Reykjavik	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	Wintershall	Reference document				Assessment year	2015
This is case no.:	1 of 1	Structural element	North Viking Graben	Type of trap	Stratigraphic	Water depth [m MSL] (>0)	383	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)	11,21	53,21	70,59	151,93				
	Gas [10^9 Sm^3] (>0.00)					0,45	2,22	3,27	7,29
Recoverable resources	Oil [10^6 Sm^3] (>0.00)	1,99	10,23	16,01	36,16				
	Gas [10^9 Sm^3] (>0.00)					0,08	0,43	0,74	1,72
Reservoir Chrono (from)	Thanetian	Reservoir litho (from)	Heimdal	Source Rock, chrono primary	Kimmeridgian	Source Rock, litho primary	Draupne	Seal, Chrono	Paleocene/Eocene
Reservoir Chrono (to)		Reservoir litho (to)		Source Rock, chrono secondary		Source Rock, litho secondary		Seal, Litho	Sele/Balder Fm
Probability [fraction]									
Total (oil + gas + oil & gas case) (0.00-1.00)	0,12	Oil case (0.00-1.00)	0,12	Gas case (0.00-1.00)		Oil & Gas case (0.00-1.00)			
Reservoir (P1) (0.00-1.00)	0,48	Trap (P2) (0.00-1.00)	0,48	Charge (P3) (0.00-1.00)	0,50	Retention (P4) (0.00-1.00)	1,00		

Parametres:	Low (P90)	Base	High (P10)
Depth to top of prospect [m MSL] (> 0)		1958	
Area of closure [km^2] (> 0.0)	64,0	79,0	95,0
Reservoir thickness [m] (> 0)	20	29	40
HC column in prospect [m] (> 0)		50	
Gross rock vol. [10^9 m^3] (> 0.000)			
Net / Gross [fraction] (0.00-1.00)	0,37	0,58	0,80
Porosity [fraction] (0.00-1.00)	0,14	0,21	0,29
Permeability [mD] (> 0.0)			
Water Saturation [fraction] (0.00-1.00)	0,35	0,27	0,18
Bg [Rm3/Sm3] (< 1.0000)			
1/Bo [Sm3/Rm3] (< 1.00)		0,83	
GOR, free gas [Sm^3/Sm^3] (> 0)			
GOR, oil [Sm^3/Sm^3] (> 0)		46	
Recov. factor, oil main phase [fraction] (0.00-1.00)	0,10	0,23	0,40
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)			
Temperature, top res [°C] (>0)			
Pressure, top res [bar] (>0)			
Cut off criteria for N/G calculation	1.	2.	3.

Reykjavik Prospect has its crest in Block 35/7 in an area currently not covered by 3D seismic data. Resource estimates relate to the entire prospect.

For NPD use:					
Innrapp. av geolog-init:	NPD will insert value	Registrert - init:	NPD will insert value	Kart oppdatert	NPD will insert value
Dato:	NPD will insert value	Registrert Dato:	NPD will insert value	Kart dato	NPD will insert value
				Kart nr	NPD will insert value

Table 2: Reykjavik Prospect data

Block	34/9	Prospect name	Helsinki	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	Wintershall	Reference document				Assessment year	2015
This is case no.:	1 of 1	Structural element	North Viking Graben	Type of trap	Stratigraphic	Water depth [m MSL] (>0)	383	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)	18,57	43,43	48,61	86,42				
	Gas [10^9 Sm^3] (>0.00)					0,52	1,71	2,24	4,56
Recoverable resources	Oil [10^6 Sm^3] (>0.00)	4,39	12,25	14,23	26,50				
	Gas [10^9 Sm^3] (>0.00)					0,14	0,48	0,66	1,37
Reservoir Chrono (from)	Thanetian/Ypresian	Reservoir litho (from)	Sele equiv.	Source Rock, chrono primary	Kimmeridgian	Source Rock, litho primary	Draupne	Seal, Chrono	Eocene
Reservoir Chrono (to)		Reservoir litho (to)		Source Rock, chrono secondary		Source Rock, litho secondary		Seal, Litho	Balder Fm
Probability [fraction]									
Total (oil + gas + oil & gas case) (0.00-1.00)	0,06	Oil case (0.00-1.00)	0,06	Gas case (0.00-1.00)		Oil & Gas case (0.00-1.00)			
Reservoir (P1) (0.00-1.00)	0,24	Trap (P2) (0.00-1.00)	0,48	Charge (P3) (0.00-1.00)	0,50	Retention (P4) (0.00-1.00)	1,00		

Parametres:	Low (P90)	Base	High (P10)
Depth to top of prospect [m MSL] (> 0)		1850	
Area of closure [km^2] (> 0.0)	70,5	82,6	95,4
Reservoir thickness [m] (> 0)		20	
HC column in prospect [m] (> 0)		69	
Gross rock vol. [10^9 m^3] (> 0.000)			
Net / Gross [fraction] (0.00-1.00)	0,34	0,53	0,76
Porosity [fraction] (0.00-1.00)	0,14	0,22	0,30
Permeability [mD] (> 0.0)			
Water Saturation [fraction] (0.00-1.00)	0,40	0,25	0,11
Bg [Rm3/Sm3] (< 1.0000)			
1/Bo [Sm3/Rm3] (< 1.00)		0,82	
GOR, free gas [Sm^3/Sm^3] (> 0)			
GOR, oil [Sm^3/Sm^3] (> 0)		46	
Recov. factor, oil main phase [fraction] (0.00-1.00)	0,20	0,29	0,40
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)			
Temperature, top res [°C] (>0)			
Pressure, top res [bar] (>0)			
Cut off criteria for N/G calculation	1.	2.	3.

For NPD use:					
Innrapp. av geolog-init:	NPD will insert value	Registrert - init:	NPD will insert value	Kart oppdatert	NPD will insert value
Dato:	NPD will insert value	Registrert Dato:	NPD will insert value	Kart dato	NPD will insert value
				Kart nr	NPD will insert value

Table 3: Helsinki Prospect data