

Relinquishment Report PL 680

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1 Key license history

PL680 was awarded on 8. February 2013 (TFO2012) to a group of Concedo ASA (40% working interest) and Tullow Oil Norge AS (Operator, 60% working interest). The license area covers in total 691.404 km² and covers blocks 31/6, 32/4, 32/5, and 32/7. (Fig. 1.1).

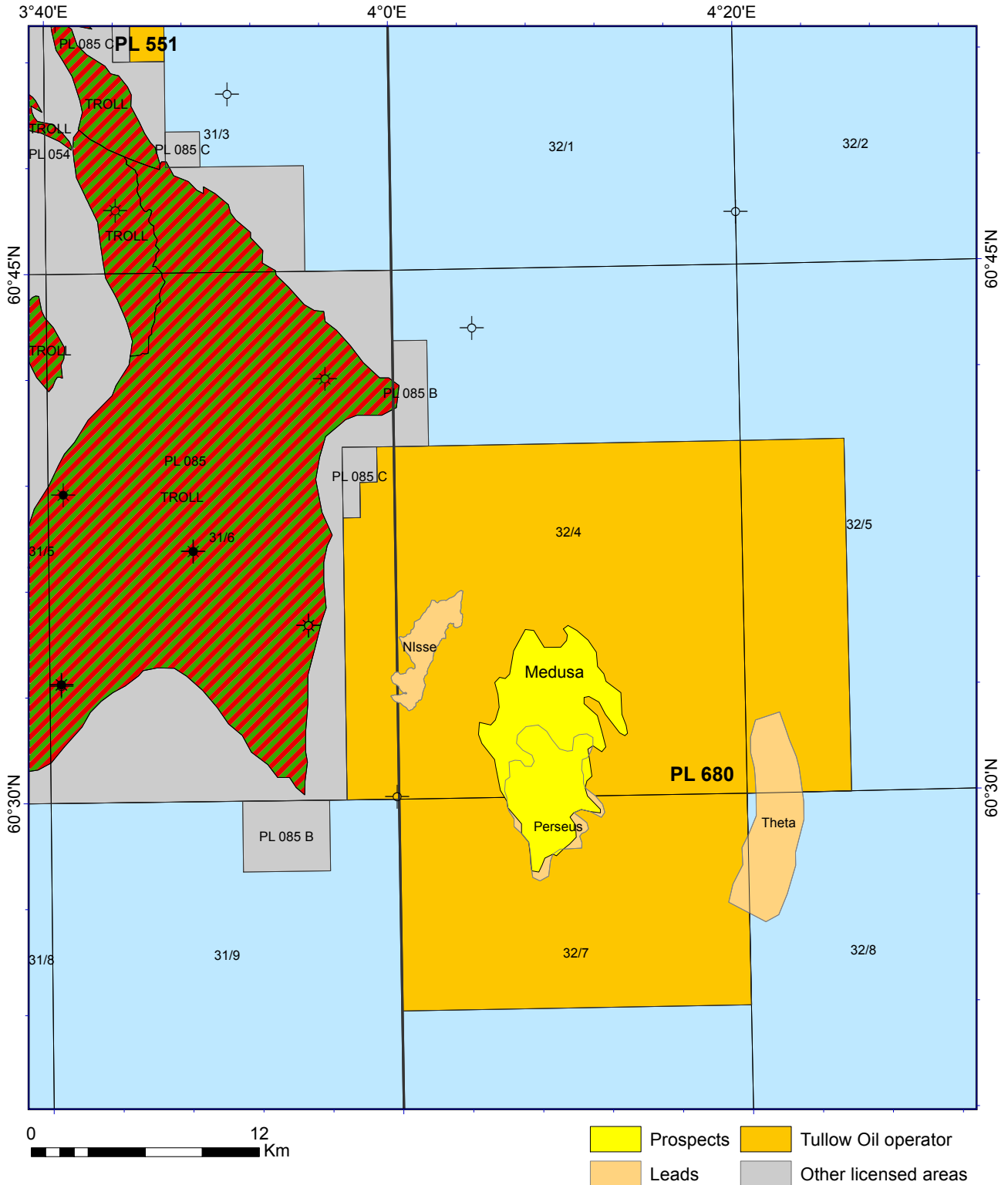


Fig. 1.1 License prospect and lead map. *The Medusa prospect and the Perseus lead were reported in the APA2012 application.*

The first phase of the work program was to perform G&G studies and after one year decide to acquire 3D seismic or to drop the license. The expiry date was 8 February 2014 and The Ministry of Petroleum and Energy was notified by letter dated 29 January 2014.

Four meetings have been held in the license, two formal ECMC meetings and two work-meetings (EC members). Minutes and/or presentations from the meetings are found on the license to shear (L2S) system.

The PL680 partnership has studied the exploration potential in the license through geochemical analysis of wells and seabed samples in combination with re-interpretation the seismic data. The conclusion is that the probability of proving hydrocarbons is too low within the license. The main risk element is hydrocarbon charge into the mapped prospect. The partnership's view is that a new 3D seismic survey will not help to significantly lower this substantial hydrocarbon charge risk. Both licensees agree to relinquish the license.

2 Database

Well database

The PL680 well data base includes extended geochemical studies which is described in detail in Chapter 3 Review of geological framework and shown in Table 2.1

Table 2.1 Well data base

Wells	Completion Log	Well Correlation Panel	Conventional core analysis	Test data	Core photos	CPI	Final Well Report	Geochem studies
31/2-3	X		X		X		X	
31/2-6	X				X		X	
31/3-1	X				X		X	
31/3-2	X				X		X	
31/3-3	X				X		X	
31/6-1	X				X		X	
31/6-2	X	X	X		X		X	X
31/6-3	X	X	X		X	X	X	X
31/6-5	X				X		X	
31/6-6	X	X	X	X	X	X	X	
31/6-8	X				X			
32/2-1	X	X				X		X
32/4-1	X	X	X		X		X	X

Seismic database

In addition to the seismic data base used for the APA application, additional data from NSR-31178 and all data from the DN0909 survey have been purchased. Table 2.2 shows the PL680 seismic database.

Table 2.2 Seismic database

Seismic survey	2D/3D	Version	Year	Quality	Length/Area	Coverage	Comments
SG8043, SG8043-R91	2D	MIG FIN	1991	moderate-good	615 km	Troll and eastern Horda Platform	
SH8001, SH8001-R92	2D	MIG FIN	1980/1992	moderate	1886 km	Troll and eastern Horda Platform	
NH8202	2D	MIG RAW	1983	moderate	1091 km	Medusa prospect, Eastern Horda Platform	
MN9103	2D	MIG FIN	1991	moderate-good	132 km	Eastern Horda Platform	
GNSR-91	2D	MIG FIN	1991	moderate	45 km	Eastern Horda Platform	Tie to well 31/3-3
DN0909	2D	Raw shots, Offset stacks	2010	good	2105	Medusa prospect, Troll East Fault Zone	A pseudo 3D cube has been generated
NSR06-31178	2D	Raw shorts, Offset stack	2006	very good	50 km	Medusa prospect, Troll East	Reprocessed in 2013
SG9202	3D	MIG FIN	1992	good	950 km ²	Troll East	Part of Fugro Terra Cube, PGS MegaMerge

3 Review of geological framework

The main risk for the Medusa prospect was effective charge of hydrocarbons into the trap. To mitigate the risk two key studies were carried out; one geochemical study and a seismic lithology and fluid prediction study.

The 2D seismic line NSR-31178 was reprocessed for amplitude versus offset analysis. The line also covers the Troll East Gas Field where a very clear flatspot is evident. There are no amplitude with offset changes over the Medusa prospect nor any sign of a flat event (HC-contact).

The geochemical studies consisted of a fluid inclusion study of four wells and a surface sampling dataset. The fluid inclusion study and the fluid inclusion stratigraphy (FIS) were carried out at two different contractors to ensure data redundancy in the reservoir formations. The overall conclusions from the subsurface geochemical study is that there has been minor migration of hydrocarbons, but no paleo hydrocarbon columns is evident in any of the wells.

The reports from the studies are listed below.

Surface Geochemical Survey Report Stord Basin - Troll East Re-Interpretation 2013 (Fugro)

One conclusion from the re-interpretation of the Geolab Nor data is that only adsorbed gas is detected across the Medusa prospect which could be indicative of recent gas leakage. Wetter HC-components occur close to major faults, the Vette (West of Medusa) and Øygarden fault complex, which points to leakage along the steep faults.

A Stratigraphic Reconstruction of Bulk Volatile Chemistry from Fluid Inclusions in 31/6-2

The fluid inclusion stratigraphy (FIS) indicate charge to Upper Jurassic sands. Sognefjord Fm. does not show any liquid petroleum inclusions (no oil charge prior to gas). Rare occurrences in Fensfjord Fm.

A Stratigraphic Reconstruction of Bulk Volatile Chemistry from Fluid Inclusions in 31/2-1

The fluid inclusion stratigraphy shows very low concentrations in all hydrocarbon classes. One hydrocarbon fluid inclusion is found in a Sognefjord FM. sample.

A Stratigraphic Reconstruction of Bulk Volatile Chemistry from Fluid Inclusions in 32/4-1

Very low FIS concentrations in the Sognefjord FM, but there are rare traces of oil migration in Krossfjord/Brent.

A Stratigraphic Reconstruction of Bulk Volatile Chemistry from Fluid Inclusions in 31/6-3

FIS indicate charge to Upper Jurassic sands, however no fluorescent inclusion identified. There are some HC inclusions in Johansen Fm. There is no evidence of Paleo oil column in any interval.

Fluid Inclusions East of Troll. Wells 31/6-2R, 31/6-3, 32/2-1 and 32/4-1 (IRIS)

The objective of the study was to do extra thin section analysis and characterize fluid inclusions in the known reservoir levels. The conclusions are that there are very little to few hydrocarbon fluid inclusions, except for the calibration well 31/6-2.

4 Prospect update

Re-evaluation of the Medusa prospect.

The Medusa prospect has been interpreted using all the DN0909 2D lines. The structure is not a gentle four-way dip closure, but consists of several smaller fault compartments. In addition the choice of depth conversion method has a large impact on the gross rock volumes. The reprocessed NSR-31178 line does not show any change in amplitude with offset over the Medusa, nor any signs of a hydrocarbon contact. Internal rock physics modeling shows that a hydrocarbon pore-fill effect is expected in the area (Using wells 32/2-1, 32/4-1, and 31/6-3). AVO analysis of all DN0909 2D seismic lines has also been carried out. No depth consistent AVO responses is detected over the prospect and leads.

The seismic observations together with the conclusions from the geochemical study put a very high risk on effective hydro carbon charge into the system. There is also a risk on the trap since detailed mapping shows that Medusa is divided into several fault compartments. The structural-spill point is also sensitive to choice of time to depth conversion. A re-interpretation of the Top Sognefjord FM. was carried out in order to find a robust structural spill-point from the Troll East Gas Field. In theory a very recent charge from Troll could explain an oil charged Medusa prospect and at the same time not violating the negative charge conclusion from the geochemical study. Fig. 4.1 shows the structural spill-routes from the Troll East Gas field, both in time and depth and structural-spill pre-Quaternary. The robust spill-point is to the south and such a spill violates the observations in well 31/6-3.

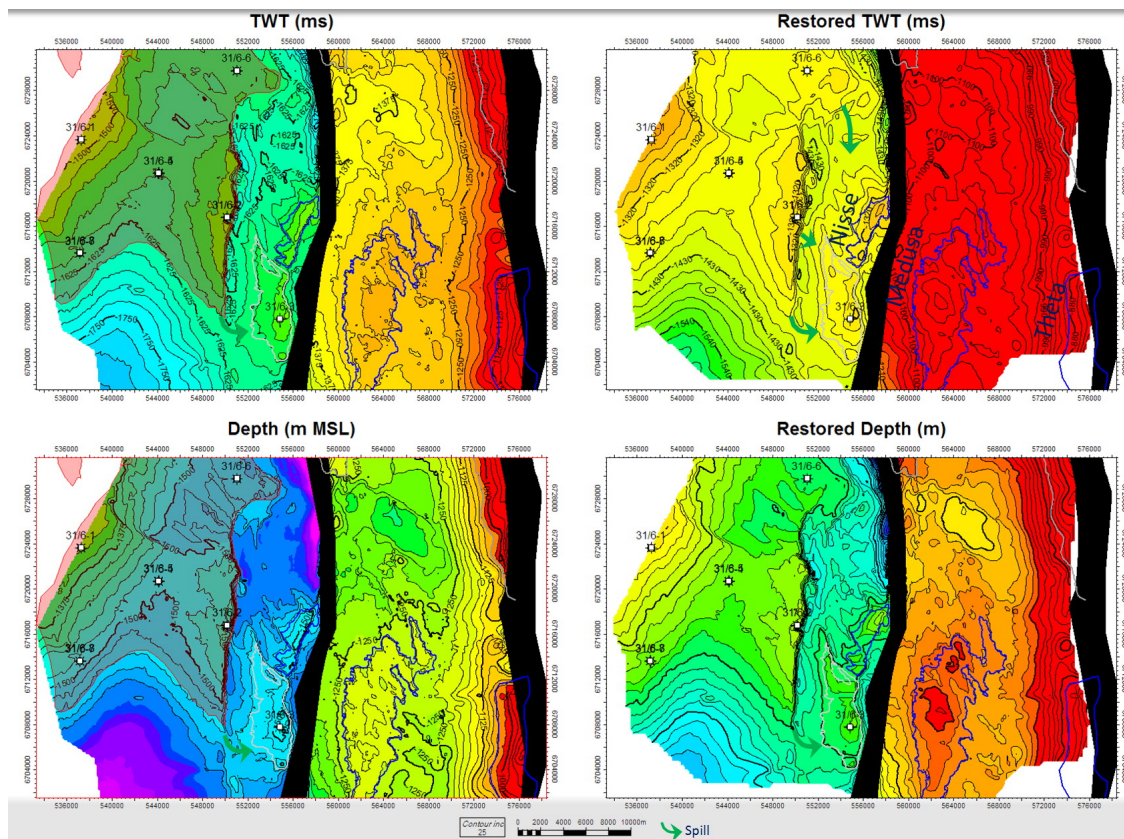


Fig. 4.1 Possible Top Sognefjord FM. structural spill-points from Troll East Gas Field. *Top left: Top Sognefj. TWT map. Bottom left: Top Sognefj. depth map. Upper right: Top Sognefj. TWT map restored to pre-Quaternary. Lower right: Top Sognefj. depth map restored to pre-Quaternary.*

The risk of effective charge of the hydrocarbons into the trap is by far the most significant factor and is set to 25% chance of success. The trap risk is set to 60% due to challenges with mapping and depth conversion. The hydrocarbon surface samples also indicate a risk of leakage along the steep faults. Another interpretation of the hydrocarbon surface samples could be migration along dipping strata away from the Troll Fields. The revised risk on the Medusa prospect is summarized in Table 4.1.

New leads

Two new leads were identified and analysed during the license period, the Theta structure and the Nisse structure, see Fig. 4.1

The Theta lead is a hanging wall closure toward the Øygarden fault complex with possible hydrocarbon traps in the Sognefjord - and Brent FM. However the structure has the same AVO response (using the offset stacks from DN0909) as the dry 32/2-1 well. The main risk is effective charge where the probability of success for the lead is less than 10%.

The Nisse lead has Sognefjord FM as reservoir and is a three-way structural closure with fault seal. Structural spill-point analysis points to a robust spill-point to the south of the Troll East Gas Field and thus has to pass the dry 31/6-3 well. The main risk is effective charge and lateral seal which puts the probability of success to less than 10%.

Table 4.1. NPD Table 5 for the updated Medusa prospect.

Oil, Gas or O&G case:	Block 32/4 and 32/7	Prospect name	Medusa	Discovery/Prospect/Lead	Prospect	Prospect ID (or New/)	NPD will insert value	NPD approved (Y/N)
This is case no.:	Play name	New Play (Y/N)	No	Outside play (Y/N)	Prospect	Prospect	NPD will insert value	Assessment year
	Structural element	Reported by company	Tullow Oil Norge AS	Reference document	APA 2012 application	Water depth [m MSL] (>0)		Seismic database (2D/3D)
Resources IN PLACE and RECOVERABLE								
Volumes, this case								
In place resources	Oil [10 ⁶ Sm ³] (>0.00)	Base, Mode	Base, Mean	Base, Mean	High (P10)	Low (P90)	Base, Mode	Base, Mean
	Gas [10 ⁶ Sm ³] (>0.00)	67.30	67.30	67.30	89.90			High (P10)
Recoverable resources	Oil [10 ⁶ Sm ³] (>0.00)	23.60	23.60	23.60	32.20			
	Gas [10 ⁶ Sm ³] (>0.00)							
Reservoir Chrono (from)	Oxfordian	Reservoir litho (from)	Sognefjord SST	Source Rock, chrono primary	Kimmeridge	Source Rock, litho primary	Draupne	Seal, Chrono
Reservoir Chrono (to)	Kimmeridgian	Reservoir litho (to)	Sognefjord SST	Source Rock, chrono secondary	Volgian	Source Rock, litho secondary	Draupne	Seal, Litho
Probability [fraction]								
Technical (oil + gas + oil & gas case) (0.00-1.00)	0.11	Oil case (0.00-1.00)	1.00	Gas case (0.00-1.00)		Oil & Gas case (0.00-1.00)		
Reservoir (P1) (0.00-1.00)	0.90	Trap (P2) (0.00-1.00)	0.60	Charge (P3) (0.00-1.00)	0.25	Retention (P4) (0.00-1.00)	0.80	
Parameters:								
Depth to top of prospect [m MSL] (> 0)	1225	Base	High (P10)					
Area of closure [km ²] (> 0)	30.0	1250	1275					
Reservoir thickness [m] (> 0)	120	46.0	55.0					
HC column in prospect [m] (> 0)	20	25	30					
Gross rock vol. [10 ⁹ m ³] (> 0.000)	417.000	521.000	625.000					
Nel / Gross [fraction] (0.00-1.00)	0.62	0.78	0.86					
Porosity [fraction] (0.00-1.00)	0.22	0.28	0.32					
Permeability [mD] (> 0)	0.30	0.25	0.20					
Water Saturation [fraction] (0.00-1.00)	0.78	0.85	0.93					
Bg [Rm3/Sm3] (< 1.0000)								
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)	0.30	0.35	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)	40							
Pressure, top res [bar] (>0)	125							
Cut off criteria for NiG calculation	1.	2.	3.					

The reported parameters are the same as reported in APA 2012, except for Trap and Charge. The critical factor is Charge.

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5 Technical evaluations

No new technical evaluations regarding possible developments have been performed since the APA2012 application.

6 Conclusions

The partnership has in good cooperation reviewed the exploration potential in the license, and the operator's opinion is that the risk of proving hydrocarbons is too high. The main risk element is charge and effective migration.

The following observations based on well data and seismic data have increased the risk of effective charge:

- Fluid inclusion study of three dry wells reveals very few hydrocarbon inclusions and generally very low charge indications with the exception of the dry 31/6-3 well. None of the wells reveal any sign of a paleo oil-column
- Seismic observations on 2D long-offset lines over the prospects/leads are negative. The seismic lines clearly show the hydrocarbon effect over the Troll Field, but show no indications of hydrocarbons over the structures in the license. Rock physics modelling shows that it is expected to observe hydrocarbon pore-fill effects on the seismic data in the license area.

Spill-point analysis based on detailed re-interpretation and depth conversion shows that the robust spill-route from the Troll Field is through the southeastern corner of the field, but then has to pass the dry 31/6-3 well in order to reach the PL680 leads/prospects.

The overall conclusion is that a new 3D seismic survey will not de-risk the charge problems in the license.