

# PL 656 Relinquishment Report

## Table of Contents

<b>1 Key Licence History</b> .....	<b>1</b>
<b>2 Database</b> .....	<b>3</b>
2.1 Well Database.....	3
2.2 Seismic Database.....	3
<b>3 Review of Geological and Geophysical Framework</b> .....	<b>5</b>
<b>4 Prospects Update</b> .....	<b>7</b>
<b>5 Technical Evaluation</b> .....	<b>13</b>
<b>6 Conclusions</b> .....	<b>15</b>

## List of Figures

2.1 PL656 Seismic database .....	4
4.1 Prospects and leads map as defined after licence award in 2012 .....	7
4.2 Prospects and leads map after PL656 evaluation in 2016 .....	8
4.3 Toutatis prospect map and illustration.....	9

## List of Tables

1.1 Overview of held meetings .....	1
2.1 Well database used in licence prospectivity evaluation .....	3
3.1 Special studies performed for PL656 prospectivity evaluation .....	5
4.1 Main prospects applied for in APA 2011 by licencees .....	7
4.2 Prospect and leads after PL656 evaluation .....	8
4.3 Toutatis resource volumes and probability estimates.....	10

# 1 Key Licence History

## Introduction

The PL656 licence is located 150km north east of the Norne field, 100km west of the city of Bodø. DEA E&P Norge, as operator for the PL656, together with all the licence partners, decided to relinquish the licence at the drill or drop decision point on 3rd of February 2016.

## Key licence history

### *Summary of award and participants*

PL656 was originally awarded as part of the APA 2011, on the 3rd of February 2012. E.ON, now renamed DEA E&P Norge, was appointed operator of the licence with a 30% share and the remaining ownership was distributed as follows : Dong E&P Norge 20%, North Energy 20%, Repsol Norge 20%, Petoro 10%. The partnership distribution remained unchanged from the award to the drill or drop decision. The initial drill or Drop decision date was set up the 3rd of February 2015.

### *Initial work obligations and work periods*

Within three years of the award (initially by the 3rd of February 2015) :

- Acquisition of a minimum 400sq.kilometers of 3D seismic
- Reprocessing of existing 3D seismic
- Perform geological and geophysical studies
- Consider electromagnetic methods
- Decide to drill or drop the licence

Within 5 years of the award (initially by the 3rd of February 2017) :

- Drill an exploration well, decide to concretize (BoK) or drop the licence

Within 7 years of the award (initially by the 3rd of February 2019) :

- Perform conceptual studies, decide to continue (BOV) or drop the licence

Within 8 years of the award (initially by the 3rd of February 2020) :

- Prepare and submit PDO (Plan for development and Operations) or drop the licence

### *Any applications and grants for extension of deadlines*

E.ON E&P Norge as operator of PL656 applied for a one-year extension in October 2014. One-year extension was granted by the authorities in January 2015. The reason for applying for an extension was one-year delay in the acquisition of the 3D seismic because of operational restrictions in Norland V area.

### *Overview of meetings held*

The table below contains the list of meetings held during the licence period :

**Table 1.1 Overview of held meetings**

Combined EC/ MC meeting #1	Establishing the licence, building the common database, sharing the views on prospectivity, acquisition of the 3D ST9404 reprocessing made by
-------------------------------	---

	Western Geco (NOR12001M12), planning the 3D seismic acquisition, budget and work program.
08/03/2012	
Work meeting	Sharing the study results from Norsar on seismic acquisition direction, plan 3D seismic acquisition.
06/11/2012	
Combined EC/ MC meeting #2	Status on seismic interpretation, EM feasibility study by EMGS, planning of 3D acquisition, budget and work program.
22/11/2012	
Combined EC/ MC meeting #3	Summary of the 3D seismic acquisition (EO13002 by Dolphin), status of the processing by Geotrace (3D and 2D repro), status of seismic interpretation, budget and work program.
20/11/2013	
Work meeting	Status on seismic processing (EO13002 and 2D repro by Geotrace), status on geophysical studies performed on NOR12001M12 by IKON, status on seismic interpretation.
27/05/2014	
MC meeting	Licence extension discussion and budget.
17/09/2014	
Work meeting	Status of seismic processing (EO13002 and 2D repro by Geotrace), E.ON basin modelling results, status on seismic interpretation.
16/10/2014	
Combined EC/ MC meeting #4	Final results 3D EO13002 processing, prospects resources estimate, budget and work program.
18/11/2014	
Work meeting	Prospects ranking, definition of a drilling candidate, consider exploration well.
17/06/2015	
MC meeting	Licence plan, budget and work program
19/08/2015	
Combined EC/ MC meeting #5	Technical drilling recommendation from the operator, well preparation, Dong view on prospectivity, budget and work program
29/10/2015	

### Reason for relinquishment

A full mapping of the licence prospectivity has been performed and showed to the partners in June 2015. The resulting prospect ranking led to the definition of what is believed to be the most attractive prospect of the licence : Toutatis, a well defined Lower Jurassic truncated fault block. After volumetrics, risking and reservoir profiles building, field development and economic studies were performed leading to the following figures : Geological chance of success : 27%, holding 25,7 MSm3 of recoverables resources of oil equivalent (P50). The Toutatis prospect is assumed to contain mainly oil with the possibility of a gas cap. The key geological risk is linked to the thickness and effect of the Top Seal and its ability to retain the trapped hydrocarbons during the uplift period in Tertiary.

During Q3 2015 (ECMC #5), the operator made a technical recommendation to the partners to drill the main prospect of the licence : Toutatis. However, due to the risk vs reward of the prospect, the licence partnership was unable to commit to a drill decision. DEA E&P Norge, therefore, recommended to relinquish the licence in January 2016.

## 2 Database

### 2.1 Well Database

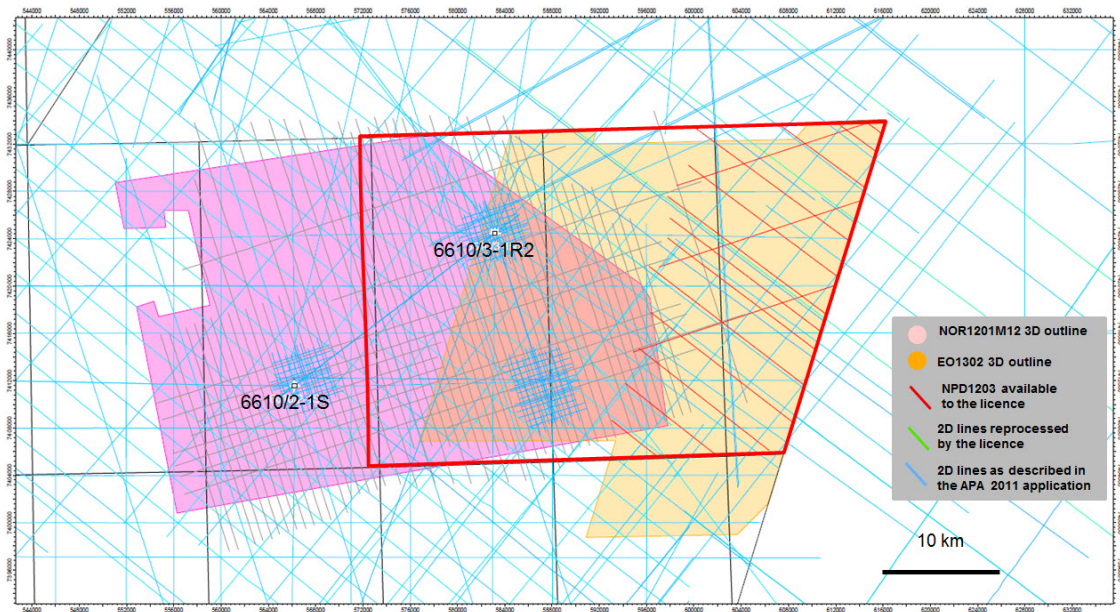
During the PL656 activity, no wells were drilled or released in the vicinity of licence. At regional scale, the well 6610/10-1 was drilled by Statoil in 2013 and the results included in the evaluation. The table below is listing the wells used in the licence prospectivity evaluation.

**Table 2.1 Well database used in licence prospectivity evaluation**

Well	Operator / drilling year	TD depth (mMD) and age	Results	Main use in licence evaluation
6610/3-1R, -R2	Statoil, 1993-96	4200, Upper Triassic	dry with O&G shows	Seismic well-tie, petrophysical evaluation of Lower Tertiary, Upper Cretaceous and Lower Jurassic sediments. Calibration of the Upper Jurassic source rock properties
6610/2-1S	Statoil, 1996	2673, Upper Triassic	dry with O&G shows	Seismic well-tie, petrophysical evaluation of Lower Tertiary, and Lower Jurassic sediments.
6710/10-1	Statoil, 2000	2267, Upper Cretaceous	dry, no shows	Petrophysical evaluation of Lower Tertiary sediments.
6609/6-1	Norsk Hydro, 2007	2733, Upper Triassic	dry, no shows	Petrophysical evaluation of Upper Cretaceous sediments.
6609/5-1	Statoil, 1984	3600, Mid Triassic	dry with gas shows	Petrophysical evaluation of Upper Cretaceous sediments.
6610/7-2	Statoil, 1984	4215, Mid Triassic	dry, no shows	Petrophysical evaluation of Lower Jurassic sediments.
6610/7-1	Statoil, 1983	3333, Upper Triassic	dry with oil shows	Petrophysical evaluation of Lower Jurassic sediments, calibration of the Upper Jurassic source rock properties.
6610/10-1	Statoil 2013	3006, Upper Triassic	dry, no shows	Petrophysical evaluation of Lower Jurassic sediments, Calibration of the Upper Jurassic source rock properties.
6608/10-12	Statoil, 2009	2953, Lower Jurassic	O&G discovery in Upper and Lower Jurassic	Petrophysical evaluation of Lower Jurassic sediments, calibration of fluid properties.
6608/11-4	Statoil, 2004	2317 Upper Triassic	Oil discovery in Lower Jurassic	Petrophysical evaluation of Lower Jurassic sediments, calibration of fluid properties

### 2.2 Seismic Database

The most recent mapping of the licence is done on the NOR1201M12 (3D), EO1302 (3D), MNR (2D) and NPD1203 (2D) surveys within and in the vicinity of PL656. Figure 6.1 shows the location of those surveys. The surveys EO1302, NOR1201M12 and NPD1203 are new dataset that have been made available to the licence during its evaluation.



- The 3D survey EO1302 was acquired as part of the licence work commitment during the summer 2013. The survey was acquired by the Dolphin vessel "Artemis Arctic" on a proprietary basis. The area covered is approximately 933 sq.km and the seismic acquisition took 29 days. The processing was done by Geotrace from September 2013 to October 2014. A fasttrack cube was made available in January 2014 and was immediately used to interpret main surfaces and build the migration velocity model. The final PSTM data was delivered in October 2014.
- The 3D survey NOR1201M12 was bought by the licence to North Energy as part of the licence work commitment. This survey is a proprietary reprocessing of the vintage cube ST9404 made by WesternGeco for North Energy prior to APA2011 application.
- The 2D survey NPD1203 was acquired by NPD in the Nordland IV and V areas during summer 2012. The NPD made the part of the lines covering the licence available to the PL656 partnership during July 2013, before any 3D was available in this part of the licence.



## 3 Review of Geological and Geophysical Framework

### Studies performed

In connection with the licence work and the preparation of the drill or drop decision, the following geological and geophysical studies were undertaken.

**Table 3.1 Special studies performed for PL656 prospectivity evaluation**

Year	Study name	Author
2012	Ray tracing and illumination for seismic acquisition design	NORSAR
2012	1D EM acquisition feasibility	EMGS
2012	Seismic interpretation of NOR1201M12	E.ON
2013	Review of Lower Jurassic petrophysical properties	E.ON
2013	Semi regional basin modelling	E.ON
2013	Relevant well fluid substitutions modelling	IKON
2014	Seismic interpretation of EO1302 fastrack volume	E.ON
2014	Semi regional scale basin modelling	E.ON
2014	Inversion and AVO studies on NOR1201M12	IKON
2015	Seismic interpretation of EO1302 final volume	E.ON
2015	Tertiary uplift and erosion assesment	E.ON
2015	Prospect scale basin modelling	E.ON
2015	AVO studies on EO1302 volume	E.ON
2015	Exploration well planning and preparation	E.ON

### Results of block evaluation and major changes compared to original licence application

The work carried out over the course of the initial licence period was primarily to illuminate the structural geology of the Eastern border of the licence through the acquisition of the EO1302 3D survey and assess its prospectivity. The licence kept an open mind in its review of the prospectivity and considered potential targets the Tertiary, Cretaceous, Upper and Lower Jurassic plays equally within all the licence surface. The new structural picture provided by the reprocessing of ST9404 and the acquisition of EO1302 were a key factor in the evaluation of the prospectivity. Used as an input for detailed and confident mapping, conclusive AVO studies and constrained basin modelling, they allowed the licence to define the most prospective area in PL656 to its southern border : the prospects defined by the last Lower Jurassic sediments lying against the Triassic sediments of the Nordland ridge and partially truncated by the BCU. This particular position on the ridge is a focal point for the HCs to migrate from the mature basin. The relative shallow depth of the prospects (<2000mSS) is leading to a good AVO response and good prognosed petrophysical properties. The screening of the Cretaceous and Tertiary leads turned negative, because of size and remaining risks, the evaluation of the Upper Jurassic prospect was negative because of the remaining risk.

- The EM feasibility study demonstrated the possibility to expect an EM response for the prospects shallower than 2500m. No further EM investigation or acquisition was performed later.
- The first basin modelling study performed at semi regional scale confirmed the potential of the Upper Jurassic source rock. It is able to generate oil and gas in a timing conform with the traps formations. It also demonstrated the low impact of the Tertiary uplift on the generation system and the importance of a fine geometry for migration routes definition.

- The second basin modelling study was carried out at prospect scale in order to rank the prospects between them.
- The rock physics modelling done on surrounding wells illustrated the possibility for the Lower Jurassic sandstones to generate an AVO response in presence of hydrocarbons. This AVO response was observed over some of the prospects (Toutatis, Belenos, Cernunnos) on both datasets EO1302 and NOR1201M12. The inversion study performed on NOR1201M12 was not conclusive mainly because of the combination of data quality and distance to relevant calibration points.

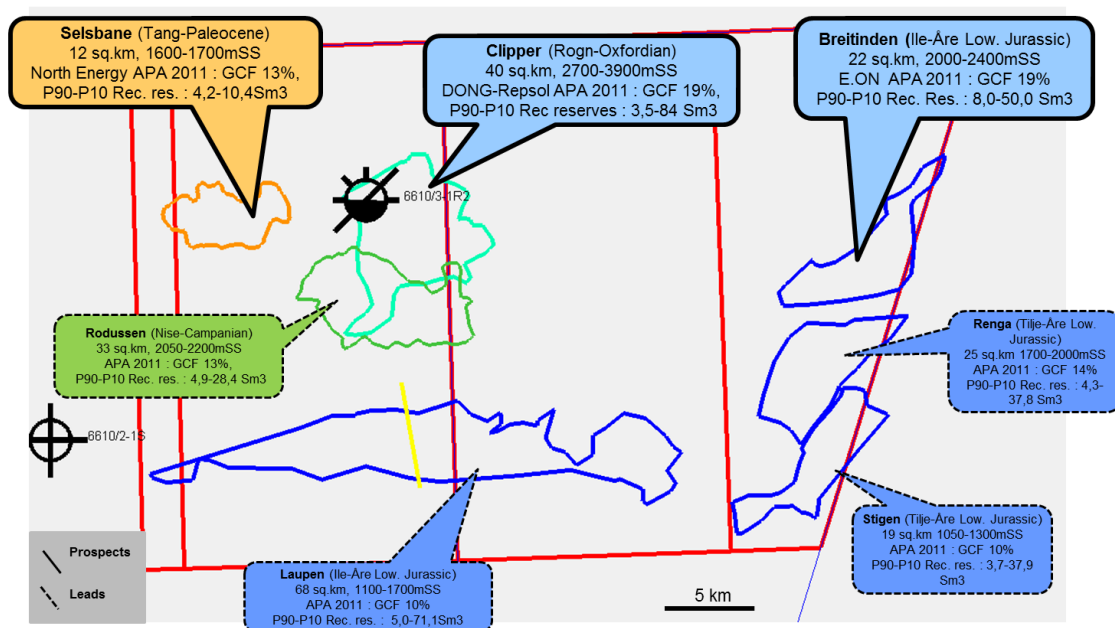
## 4 Prospects Update

### Prospects originally presented in licence application

The PL656 licence lies on the northern flank of the Nordland ridge, covering the southern side of the Vestfjorden basin. The work carried on during the licence period focused on the evaluation of the exploration potential of the Lower Jurassic prospects and on leads in the Tertiary, Upper Cretaceous and Upper Jurassic levels. The five companies gathered in the licence identified different prospects at the time of APA 2011 application. They are summarized in the table below and illustrated in Figure 8.1.

**Table 4.1 Main prospects applied for in APA 2011 by licensees**

Company	Main identified prospect for APA 2011	Age	Status after licence evaluation
E.ON	Breitinden	Lower Jurassic	Discarded after 3D seismic acquisition
Repsol	Clipper	Upper Jurassic	Difficult to derisk further
North Energy	Selsbane/ Rakflesa	Tertiary	Discarded by combination of risk and size
Dong	Clipper	Upper Jurassic	Difficult to derisk further
Petoro	Unknown	Unknown	N/A



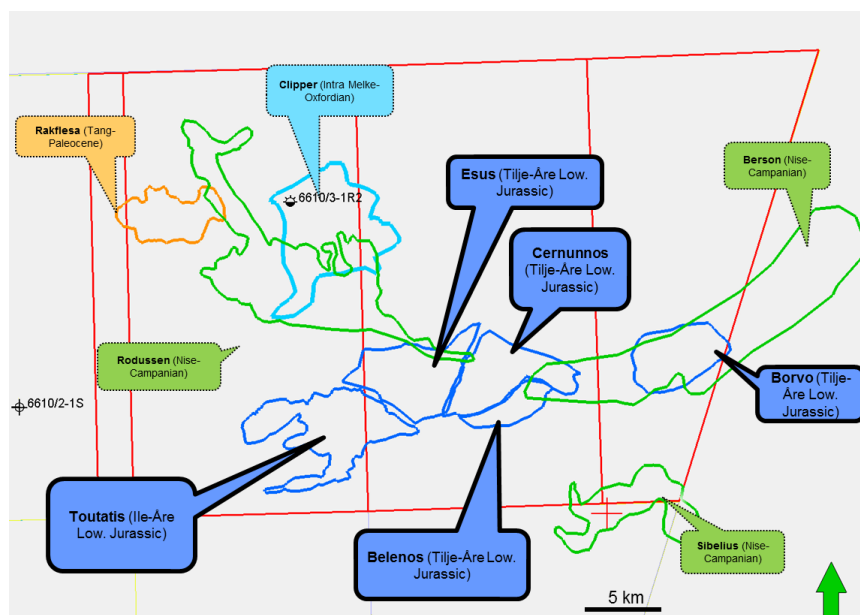
Following the reprocessing of ST9404 and the acquisition and EO1302, the licence was able to conduct the evaluation of objects initially classified as leads and mature them into a prospect status. In the same trend, thanks to this new data, some previously identified prospects were downgraded as leads. Originally, during APA 2011 application, E.ON identified Breitinden as being the main prospect of the licence. The prospect was defined by 2D seismic as a rotated fault block containing Lower Jurassic sandstones on the eastern side of the block. The 3D picture provided by the acquisition of EO1302 discarded this geometry. The attention was then turned to other possibilities, including the Toutatis prospect (identified as a lead called Laupen at application time).

## Overview of PL656 prospectivity

The prospectivity of PL656 after evaluation is summarized in the table 8.2 and illustrated in figure 8.2

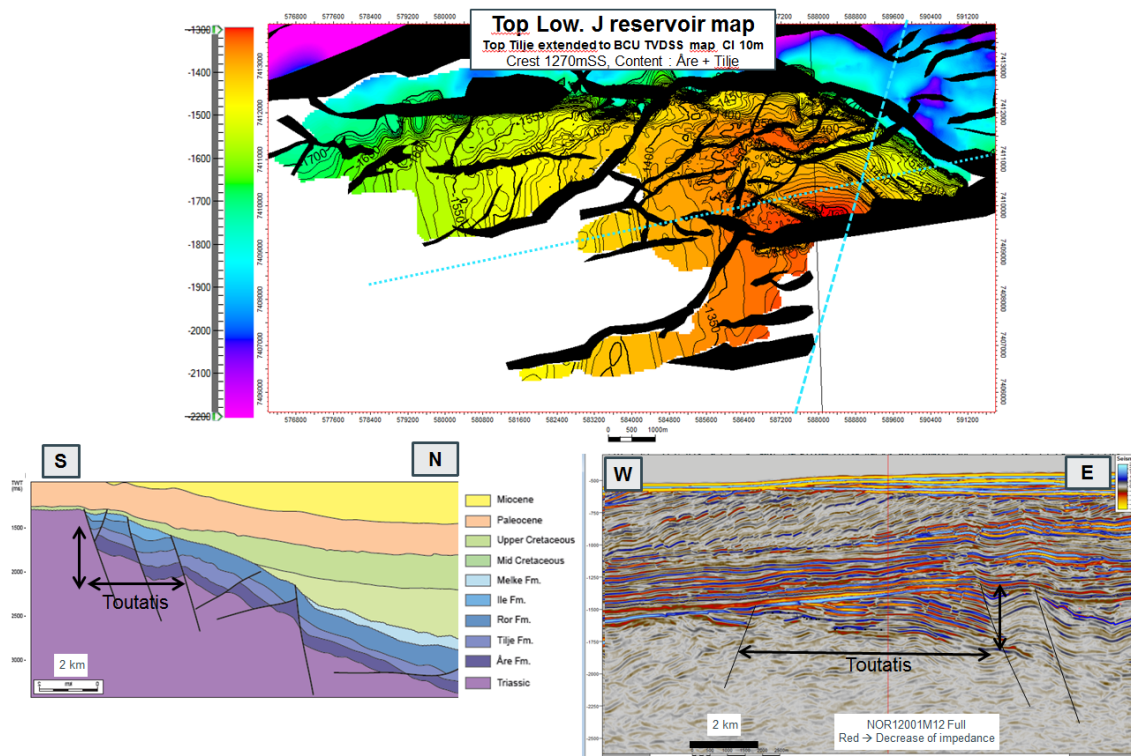
**Table 4.2 Prospect and leads after PL656 evaluation**

Prospect name	Status	Age of reservoir	Depth of crest (mSS)	Geological chance of success	Exp. fluid	P90-P50-P10 total recoverable volumes (Msm <sup>3</sup> )
Toutatis	Main prospect	Lower Jurassic	1300	27% (retention and seal)	O&G	4,1-25,7-94,6
Esus	Prospect	Lower Jurassic	1700	25% (retention and charge)	O&G	4,0-18,1-64,9
Belenos	Prospect	Lower Jurassic	1300	25% (retention and seal)	O&G	1,2-5,8-20,3
Cernunnos	Prospect	Lower Jurassic	1900	25% (retention and charge)	O&G	1,0-7,7-29,0
Borvo	Prospect	Lower Jurassic	1600	22% (retention and charge)	O&G	2,4-9,8-33,6
Clipper	Lead	Upper Jurassic	3000	12% (seal and trap)	OorG	4,0-11,9-33,5
Rodussen	Lead	Upper Cretaceous	2000	17% (seal and trap)	Gas	1,9-8,0-23,0
Berson	Lead	Upper Cretaceous	1150	9% (seal, trap and seismic coverage)	Gas	1,2-7,5-28,9
Rakflesa	Lead	Lower Tertiary	1600	11% (charge)	Gas	1,7-3,2-8,9
Sibelius	Lead	Upper Cretaceous	950	9% (seal, trap and seismic coverage)	Gas	1,5-4,0-8,7



### Toutatis prospect

The Toutatis prospect is a truncated trap made by the Lower Jurassic sediments (Båt Gp) in lateral contact with the Triassic sediments of the Nordland ridge to the south. See Fig. 8.3. Part of the prospect is eroded by BCU making a vertical contact between Lower Jurassic sandstones as reservoirs and Upper Cretaceous shales as top seal. The prospect is also fault bounded towards the north and towards the south. The regional geology and the wells 6610/2-1S and 6610/3-1R give good confidence to have the shoreface sandstones of the Båt Group present with good properties (NTG ranging from 40 to 70%). The prospect is lying between 1300 and 1800mSS, allowing to expect properties in the Båt Gp similar to the ones discovered in 6610/2-1S (23-25% average porosity). The prospect is ideally located regarding the migration, as it is a focal point for the hydrocarbons generated in the Vestfjorden basin. The main risk for this prospect is linked to the retention of the HCs through time as the area is affected by late Tertiary uplift generating the erosion of 500-600m of most recent sediments. The chance of success to find hydrocarbons in this prospect is estimated to be 27%. The AVO response on the Toutatis prospect is positive. The other prospects defined in the Lower Jurassic section (Belenos, Esus, Cernunnos, Borvo) are similar to Toutatis in terms of reservoir, trapping mechanism, charge and risk but with smaller size.



Attached is the table 8.3 illustrating the parameters, resource volumes and probability estimates of the Toutatis prospect in an oil with gas cap case.



### **PL656 Remaining prospectivity**

- The Tertiary lead defined as Rakflesa is a 4-way closure made of injectites from the Tang Formation (Paleocene). It is considered as a lead because of its small size and the basin modelling is suggesting mainly gas to possibly migrate into it.
- The Cretaceous leads (Rodussen, Berson and Sibelius) are defined as stratigraphic traps of turbiditic sandstones from the Nise Formation. Rodussen is considered as a lead because of the seal risk and basin modelling suggests mainly gas can migrate into it. Sibelius and Berson are considered as leads as they extend in areas where 3D seismic is not available.
- Clipper is a stratigraphic trap in the Rogn/Intra Melke Formations. It has not been possible to further derisk the reservoir presence.

## 5 Technical Evaluation

E.ON, then DEA E&P Norge, has performed a full evaluation regarding a possible development in case of discovery for Toutatis. Due to distance to existing infrastructures (closest liquid facility is Norne, 150km to the SW), the considered development is a stand alone FPSO. Gas is re-injected and water injection is used for pressure support Economic analysis suggest that a discovery in the P70+ size range could lead to a positive economy.



## 6 Conclusions

During the licence period operated by E.ON E&P Norge, then DEA E&P Norge, extending from 3rd of February 2012 to 3rd February 2016, the partnership of PL656 has evaluated what is believed to be the exploration potential of the blocks. Based on this technical work, Toutatis is considered as being the main prospect of the licence and the best candidate to be drilled in order to derisk further prospectivity in the Lower Jurassic play (5 additional prospects identified in the block). Toutatis oil and gas case was run providing recoverable resources of approximately 27,4 10<sup>6</sup> SM<sup>3</sup> OE and geological chance of finding hydrocarbons of 27%. The main risk is linked to the top seal and its ability to retain hydrocarbons during the Late Tertiary uplift period affecting the area.

Despite the identified prospectivity and technical recommendation from the operator to drill, the risk/reward balance for the main prospect (Toutatis) was such that the partnership was unable to reach agreement on a drill decision. E.ON, then DEA E&P Norge, recommend to relinquish the licence. This recommendation was supported by all partners.