

# Relinquishment Report for License PL671

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## RELINQUISHMENT REPORT PL671

### Contents

<b>Key License history</b> .....	<b>3</b>
<b>Database</b> .....	<b>4</b>
<b>Review of geological framework</b> .....	<b>7</b>
<b>Prospect update</b> .....	<b>9</b>
<b>Technical evaluations</b> .....	<b>14</b>
<b>Conclusions</b> .....	<b>15</b>

### LIST OF FIGURES:

Figure 1 Seismic Database.....	5
Figure 2 Depositional environment map time series .....	8
Figure 3 Top Bryne Depth Map .....	10
Figure 4 Interpreted Seismic Section Through The Tosca Prospect .....	11
Figure 5 Fault Seal Analysis Tosca .....	12
Figure 6 Interpreted seismic section through the Ninjini High .....	12

## KEY LICENSE HISTORY

PL671 was awarded in the APA2012 licensing round to licensees Maersk Oil Norway AS (operator, 60%) and Explora Petroleum (40%). The license is situated in the Egersund Basin, approximately 25km to the east of the Yme field, see Figure 1. The targeted prospects are in the Upper / Middle Jurassic play njl, jm-2.

Explora Petroleum applied for the acreage as the only applicant, and were asked by the authorities to find a qualified operator as partner. Maersk Oil entered into the license after a data room viewing.

The operator has held five EC/MC meetings, as well as three workshops with partner present. All meetings are documented on L2S.

With reference to the work obligations in the license agreement the licensees have undertaken the following commitment

- within 2 years, re-process 3D data and carry out relevant geological and geophysical studies
- within 2 years make a drill or drop decision
- within 4 years make a decision if they will participate in a Concretisation Decision (BOK)
- within 6 years make a decision if they will prepare a development plan (BOV)
- within 8 years decide if they shall submit a PDO.

The licence has fulfilled the work commitment under items 1 and 2.

The initial drill or drop decision date for PL671 was 08.02.2015, the license has subsequently been awarded a 12 months extension to the initial period. At the time of application for extension, the development scenarios and oil price led the operator to consider none of the prospects that were originally described in the APA2012 application, to be economic. The extension was awarded to allow time for the partnership to evaluate a Rotliegendes High which had promising scoping volumes. Efforts have been made to investigate reservoir presence in the Upper Jurassic, as well as the charge potential for this structure, both from the Tau Fm. and a potential Carboniferous source rock.

Both internal work and the results of nearby well 10/4-1, has led the partnership to believe the Ninjini High to have limited prospectivity. At the current time, the license is considered not to contain any prospects that are economic. The partnership is therefore not willing to commit to a well. The decision to drop PL671 is unanimous in the partnership and the Ministry of Petroleum and Energy was notified of this decision on the 18<sup>th</sup> November 2015.

## DATABASE

The wells used in the assessment of the prospects and leads in the East Egersund Basin are listed with relevant information in Table 1 and displayed in Fig. 1. Biostratigraphic and petrophysical interpretation has been performed on a number of wells during the license period; these wells are indicated in Table 1.

**Table 1 Well Database**

Well	Year	Oldest Penetrated Age	Content	Reservoir	Biostrat	CPI
8/3-1	1966	Pre Devonian	Dry			Y
8/3-2	1982	Late Triassic/Skagerrak Fm.	Dry		Y	Y
9/1-1S	2011	Late Triassic	Dry	Sandnes Fm.	Y	
9/2-1	1987	Late Triassic/Skagerrak Fm.	Oil	Sandnes Fm.	Y	Y
9/2-2	1987	Late Triassic/Skagerrak Fm.	Oil Shows		Y	
9/2-3	1990	Middle Jurassic / Bryne Fm.	Oil	Sandnes Fm.	Y	Y
9/2-4S	1994	Middle Jurassic / Bryne Fm.	Oil	Sandnes Fm.	Y	
9/2-5	1995	Middle Jurassic / Bryne Fm.	Oil	Sandnes Fm, Bryne Fm.		
9/2-6S	1996	Middle Jurassic / Bryne Fm.	Oil	Sandnes Fm.		
9/2-7S	1997	Middle Jurassic / Bryne Fm.	Oil	Sandnes Fm, Bryne Fm.	Y	
9/2-8S	1998	Late Permian / Zechstein Gp	Dry			
9/2-9S	1999	Middle Jurassic / Bryne Fm.	Oil	Sandnes Fm.		
9/2-11	2010	Middle Jurassic / Bryne Fm.	Dry			
9/3-1	1986	Triassic/Skagerrak Fm.	Dry		Y	Y
9/3-2	2005	Triassic/Skagerrak Fm.	Dry			
9/4-1	1968	Permian / Zechstein Fm.	Shows	Sandnes Fm.		Y
9/4-2	1970	Triassic/Skagerrak Fm.	Dry			
9/4-3	1972	Triassic/Skagerrak Fm.	Dry			Y
9/4-4	1977	Triassic/Skagerrak Fm.	Dry		y	Y
9/4-5	2006	Carboniferous	Dry		Y	Y
9/8-1	1968	Late Permian / Zechstein Gp	Oil Shows	Sandnes Fm.		Y
10/5-1	1976	Late Permian / Zechstein Gp	Dry			
10/7-1	1992	Late Permian / Zechstein Gp	Dry		Y	Y
10/8-1	1971	Late Permian / Zechstein Gp	Dry			
17/12-1	1972	Late Triassic/Skagerrak Fm.	Oil	Sandnes Fm.	Y	Y
17/12-2	1973	Devonian	Oil	Sandnes Fm.	Y	Y
17/12-3	1980	Late Triassic/Skagerrak Fm.	Dry		Y	
18/10-1	1980	Late Triassic/Skagerrak Fm.	Oil	Sandnes Fm, Bryne Fm.		
18/11-1	1974	Pre-Devonian	Dry		Y	Y

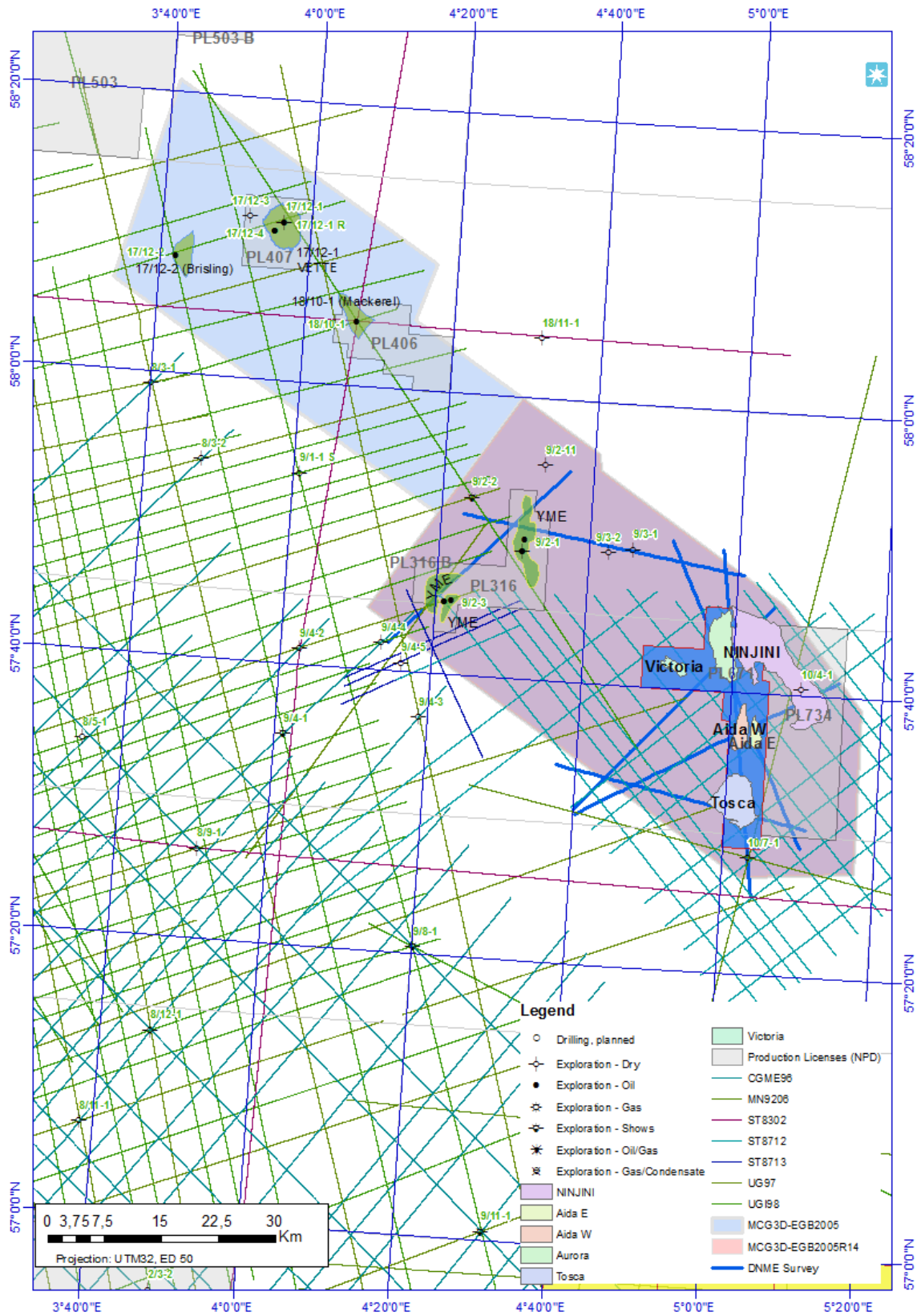


Figure 1 Seismic Database

Figure 1 shows the outline of the seismic data in the common license database. PGS survey MC3D-EGB2005 has been reprocessed as part of the work programme for the license. Detailed prospect mapping for Tosca and Ninjini prospects has been performed on this new data. The reprocessing was performed by PGS. The data was put through a PSDM workflow and resulted in a considerable uplift in imaging quality in the structural complex areas and made an impact on the decision making in the license.

The license acquired a 200km DNME survey (Differential Normalized Method for Electrical Prospecting) covering the prospect and tying the Yme field. This is a new electromagnetic method that measures polarizability of the overburden and is supplied by ORG Geophysical. The method is based on the theory that most hydrocarbon accumulations will have micro seepage into the overburden. The seepage plume is claimed to be detectable by DNME due to the polarizability of associated precipitated micro-granular pyrite differing from the background. The results from this study were somewhat inconclusive. The method is immature, and ORG demonstrated little in the way of persuading PL671 partners that the results were trustworthy. However, taken at face value, the results showed an anomaly close to the Yme field, and no anomalies above any prospects, indicating no accumulation of hydrocarbons in any of the identified prospects.

## REVIEW OF GEOLOGICAL FRAMEWORK

The PL671 partnership has performed the following studies as part of the prospectivity evaluation:

- A new basin modelling study has been performed in Petromod and Trinity
- Elastic Inversion Study
- Paleogeography study
- Deeper basin screening study

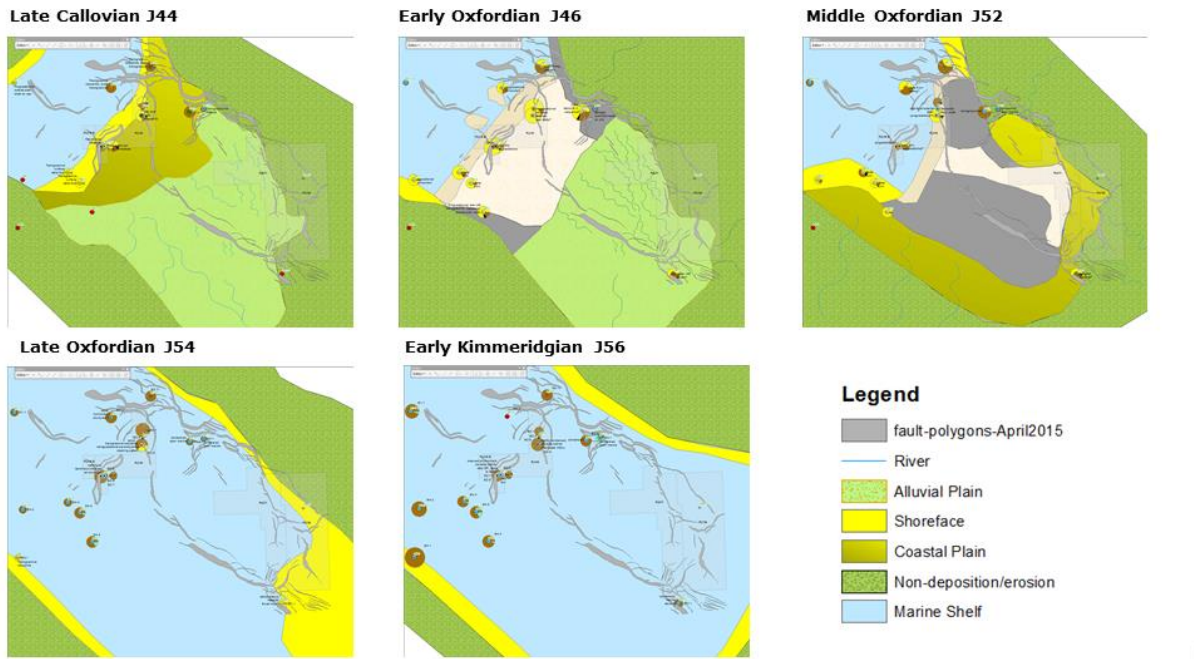
In addition, the following studies have been purchased:

- The "1997 NORWEGIAN DANISH BASIN SURFACE GEOCHEMISTRY STUDY" from CGG Fugro Geolab
- APT studies "Petroleum Systems of the Bream-Brisling-Yme area", and "Geochemistry of oils from Bream, Brisling and wells 18/10-1, 3/7-4, 2/2-1, 2/2-5, and 2/6-5"

The basin modelling study reaffirmed that all prospects in PL671 rely on long distance migration from the mature Yme kitchen. The northernmost prospects (Aurora, Aida, and Ninjini) are depending on charge from the northern part of the basin where less hydrocarbon have been expelled. The southern prospect, Tosca, is modelled to have access to a more prolific part of the basin. In the northern part of the Basin the Egersund Fm. is thickening, possibly resulting in a reduced downward migration into Sandnes Fm. carrier beds. This could explain the dry wells in block 9/3, which according to the basin model should have direct access to mature source rock.

Potential Field data and seismic interpretation show evidence of pre-Permian sediments in the area. Both to the south and east of the Basin margins there seems to be an anomalously deep basement, with possibly deposition of Carboniferous source rock. However, no well or seismic data show any indication of this being a working petroleum system in this area. The 1997 NORWEGIAN DANISH BASIN SURFACE GEOCHEMISTRY STUDY of sea bottom cores was purchased from CGG Geolab. This study is composed of geochemical analysis of seabed sediment, and is meant to help de-risk charge access by indicating seepage of hydrocarbons. The study showed no significant indications of seeped hydrocarbons from prospects in PL671, neither did the DNME data.

An in-house study on the paleo geographical development during the Middle to Upper Jurassic was initiated to study the reservoir distribution and development. Integrating well data, biostratigraphy and seismic interpretation, the paleogeography was modelled in a sequence stratigraphic context. Focusing on Ninjini high, it showed that reservoir development is likely to occur during the Late Oxfordian with a possible deposition of open marine shoreface sands during late stage flooding of the local basement high. This study also showed that shoreface wave-reworked sandstone is unlikely in the Callovian times due to the interpreted embayed nature of basin (See Figure 2).



**Figure 2 Depositional environment map time series**



## PROSPECT UPDATE

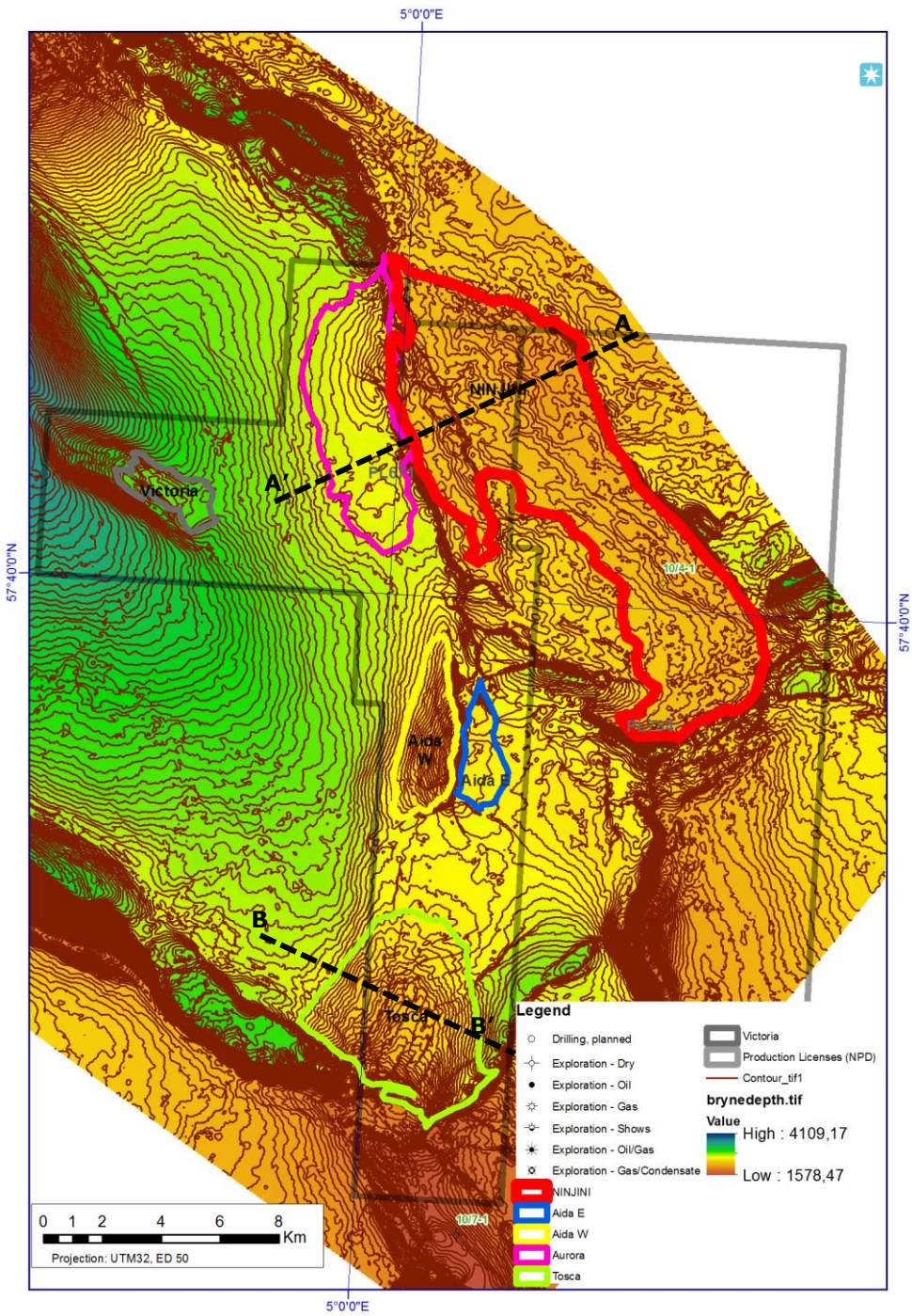
Table 2 shows a summary of the volume and risks of the prospects in PL671.

**Table 2 Summary of volumes and risks**

	P90	MEAN	P10	Main Risk	Pg
<b>Aida West</b>	1,86	6,61	12,8	Charge	0,18
<b>Tosca</b>	3,23	36,6	92,8	Retention	0,09
<b>Ninjini</b>	5,4	72,2	178	Charge	0,22

### **Aida West, Aida East, Victoria, and Aurora**

In the APA2012 application, one prospect (Aida West) and four leads (Aida East, Aurora, Tosca and Victoria) were described. During the prospect maturation work and based on the results of the Basin Modelling study, Tosca was high-graded to prospect status in 2014. All leads and prospects suffer from relying on a fetch cell in the least prolific part of the basin, resulting in a higher risk on charge. Compared to Aida West, Tosca is located in a more favourable position in regard to charge access. In addition the un-risked volumes in the identified prospects are considered to be sub economical.

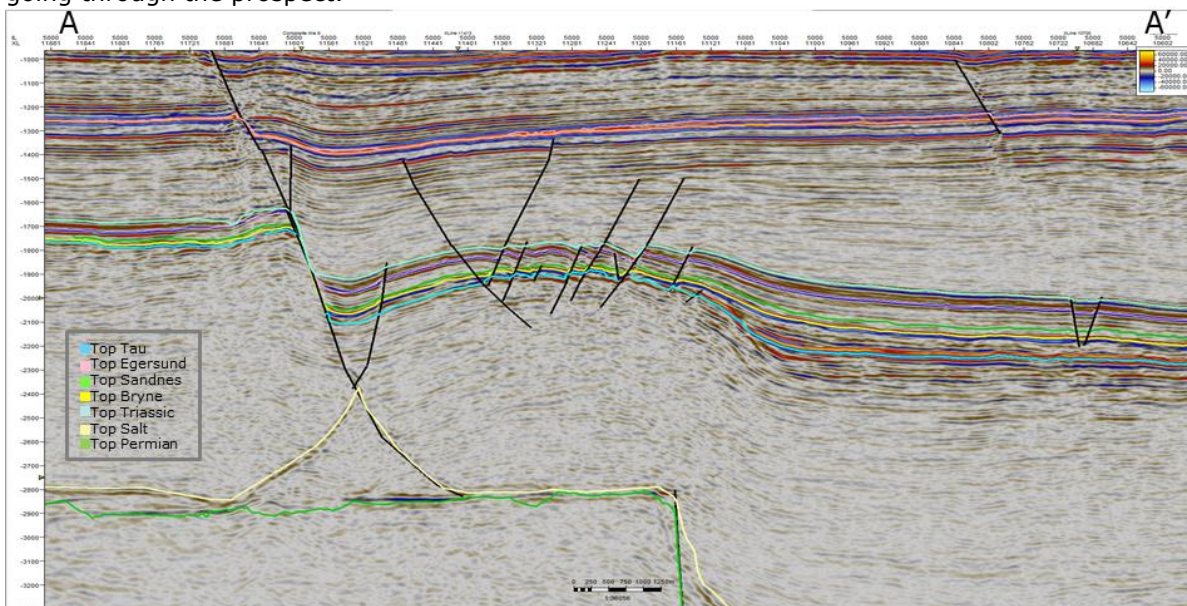


**Figure 3 Top Bryne Depth Map**

**Tosca**

The Tosca prospect is the regional focus of a large drainage area. The Tosca fetch cell is the only one in PL671 area with access to the assumed sweet spot around the Yme Gamma kitchen, and so has the least risk for charge out of all leads and prospects in PL671.

Estuarine / shoreface sandstones of the Sandnes Formation are the main reservoir in the Yme field and are encountered by the majority of wells in the western Egersund Basin. The resource estimate of the Tosca prospect is based on the presence of this reservoir. If present in a shoreface facies, the reservoir will have a sheet like distribution with good lateral connectivity. However, the interpreted embayed nature of the eastern Egersund Basin in Callovian times reduces the chances of having shoreface sediments at the Tosca location. This could result in lower net to gross and reservoir quality than what is found in the Yme area. Figure 4 shows an interpreted cross section going through the prospect.

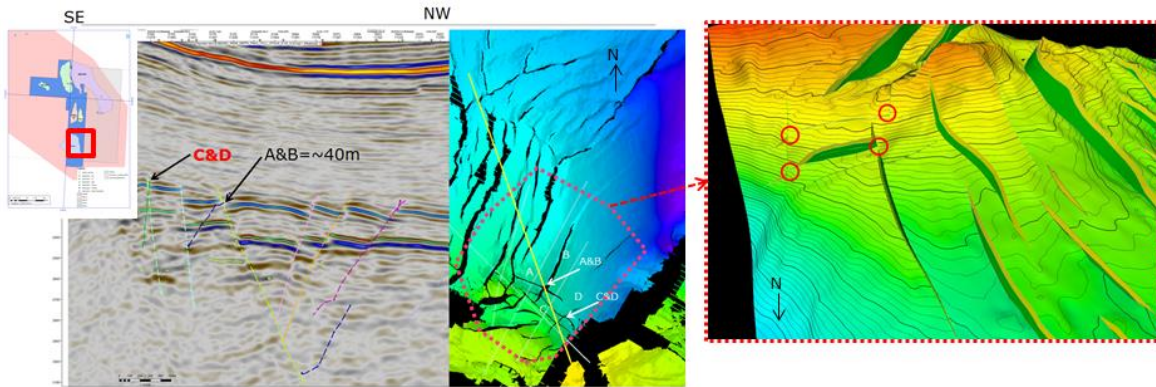


**Figure 4 Interpreted Seismic Section through the Tosca Prospect**

The trap is defined as a 3-way dip closure against a fault ramp between two major basin-bounding faults. The structure is highly faulted, and must be assumed to be compartmentalized. The area of the fault ramp is structurally complex, and was initially poorly imaged by seismic. On the reprocessed seismic this area has received a considerable uplift, however it remains structurally complex and difficult to map confidently.

There is a lack of well control on stratigraphy which makes fault seal analysis highly uncertain. An effort has been made by assuming simple reservoir-seal juxtaposition. An example from this at the base of the critical fault ramp can be seen in Figure 5. Potential leak points are highlighted by red circles. Lack of throw at fault junctions and generally small throws at Sandnes level on the fault ramp, suggest that the ramp is not sealing.





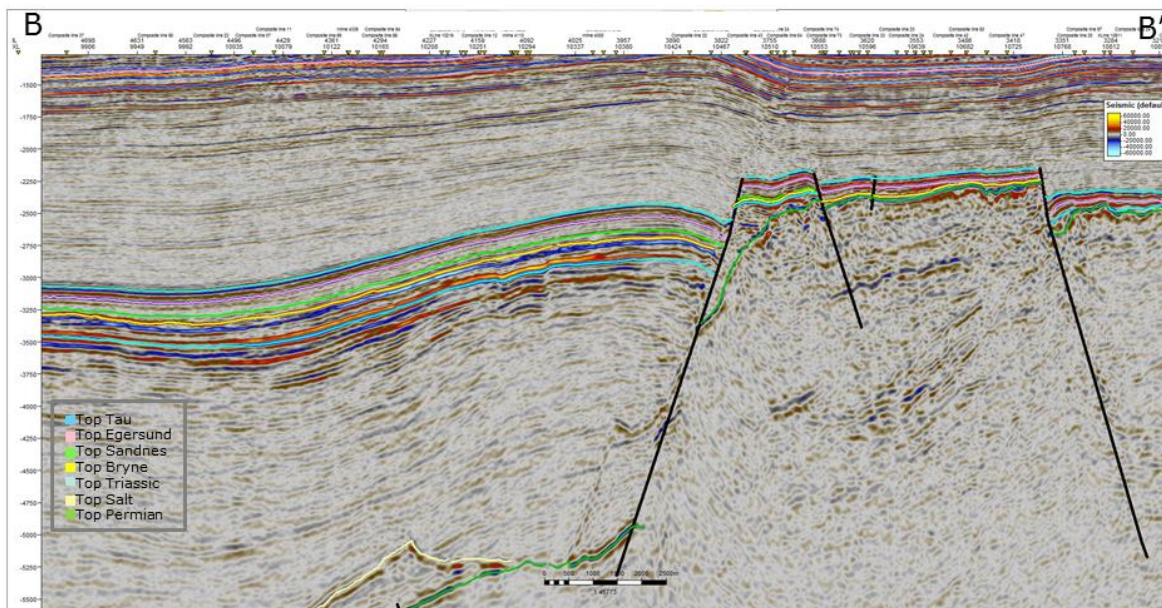
**Figure 5 Fault Seal Analysis Tosca**

As the seismic section in Figure 5 shows, there is very little throw at the junction between fault C and D, whereas there is approximately 40m throw at the A/B intersection. This suggests that the segment defined by this intersection forms the eastern limit of the Tosca closure. For calculation of resource estimates, the P10 outline has been kept larger, allowing the C/D intersection to be sealing, and thereby capturing the upside of the Tosca prospect.

The mean volume estimate for Tosca fails to meet the operators Minimum Economic Field Size (MEFS). This is largely due to the fact that it would have to be a standalone development, and that the complex nature of the structure would increase the number of necessary wells significantly.

### Ninjini High

The Ninjini High is a large Rotliegendes high that is partly located within PL671 and partly within neighbouring PL734. Initial scoping volumes for the structure were promising, making this a possible stand-alone project. An interpreted section going through the Ninjini High is displayed in Figure 6.



**Figure 6 Interpreted seismic section through the Ninjini High**

At the time of APA2012, it was interpreted that active faulting in the Jurassic made this a paleo-high shut off from sedimentation in the Mid / Upper Jurassic. However, new interpretation on reprocessed data indicates that the north-eastern fault was inactive at this time, allowing Triassic sediments from the hinterland being deposited on the high. Work done in the paleogeography study show therefore that there is potential for well-developed Upper Jurassic sand across the high. The 10/4-1 well which was drilled in July 2015 on the Ninjini High, tested the prospect and found a reported 90m of good quality reservoir sands.

Although Ninjini is a regional high, and therefore has a potentially large drainage area, any Jurassic charge would rely on fill-spill paths from the Yme kitchen. There is evidence for pre-Permian sediments in the Egersund Basin, however there are no indications a working Carboniferous petroleum system exists in the area.

The 10/4-1 well was dry and had no hydrocarbon shows. This significantly reduces the potential of the Ninjini prospect. The PL671 partnership has not traded the well, but based on the press release from NPD, it is possible to assess the remaining updip potential in Ninjini, see Table 1.

The Partnership in PL671 regards the remaining potential in the Ninjini prospect to be sub economic.

## TECHNICAL EVALUATIONS

An up-to-date technical evaluation that has been performed is for the Tosca prospect. The field development strategy here would be to establish independent production consisting of a FPSO, with subsea templates, analogue to UK Catcher or Knarr field in Norway.

No operational infrastructure exist closer than 120-130km, this means oil must be exported by shuttle tankers to the market. Gas would be reinjected.

The closest analogue to a prospect in PL671 is the Yme field. Yme shows a compartmentalised reservoir with different pressures between compartments, similar to what is expected at Tosca. Average peak well rates at Yme was around 4800 - 5500 bopd. With similar reservoir geometry, well-rates and well count better than what was seen at Yme cannot be justified. Horizontal wells may potentially improve the recovery from the reservoir due to better sweep efficiency, but they will not achieve significantly higher individual well rates. In effect, the well-count must be assumed to remain high. Table 3 shows an overview of number of wells necessary for varying volumetric cases for the Tosca prospect.

**Table 3 Overview of well count**

Rec Oil MM bbl	Init Well rate bopd	No Prod Wells	No Inj Wells
20	3000	4	2
50	4000	7	2
100	5000	10	3
500	7000	35	10
2000	7000	65	15

Due to high well count, the MEFS for the Tosca prospect is calculated at 140MMbbl recoverable.

## **CONCLUSIONS**

All prospects and leads in PL671 carry significant risk; the northernmost prospects by access to charge, and the southern Tosca prospect by retention. The entire area suffers from lack of infrastructure, and the fact that any discovery will have to be large enough to make it as a standalone development.

The Ninjini high was the only prospect that had the potential to be economical as a stand-alone development. This prospect was recently tested by the 10/4-1 well, and was found dry with no hydrocarbon shows.

The partnership of PL671 regards all prospects in the license to be sub economic. This has led the partnership to a unanimous drop decision.