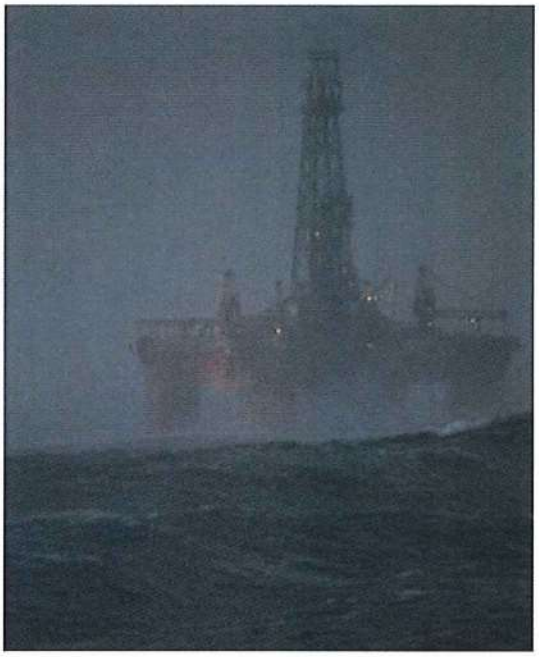
MAERSK OIL NORWAY AS

Relinquishment Report

PL431



License:	431
Date:	9th of January, 2014
Status:	Final

Authors

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1 Key License History

Production License 431 (PL431) comprised parts of blocks 6406/2, 6406/3 and 6506/12. It was situated in a very prolific hydrocarbon province offshore Norway (Figure 1.1), surrounded by major Jurassic producing fields and discoveries like Åsgard, Smørbukk, Kristin and Trestakk. The license was awarded in the APA 2006 Licensing Round in February 2007 to the following group:

- Centrica 40% (operator)
- PetroCanada 30%
- Faroe Petroleum 30%

The initial terms and work programme for License 431 consisted of seismic 3D reprocessing and relevant G&G studies (fulfilled), and a decision by January 2009 whether to commit to the drilling of a well or relinquishing the license. An extension of six months to this decision was granted by the government in order for the operator to do further work. In early 2009 Centrica and PetroCanada (now Suncor) decided to leave the license and with effect from the 27th of August 2009, Maersk Oil Norway AS took over as operator of PL431. The license equity situation changed to:

- Maersk Oil Norway 70% (operator)
- Faroe Petroleum 30%

License PL431 was then fully committed to the drilling of a well.

Well 6406/3-9 was spudded by the Transocean Winner semi-submersible rig on the 9th of November 2011. The drilling operations were affected by long periods of very poor weather but a total depth of 4183 m MD was reached after encountering only minor amounts of hydrocarbons in the two target zones of Cretaceous age. The well was plugged and abandoned on the 26th of March 2012 as a minor non-commercial discovery.

License PL431 was formally relinquished on the 16th of August 2012.

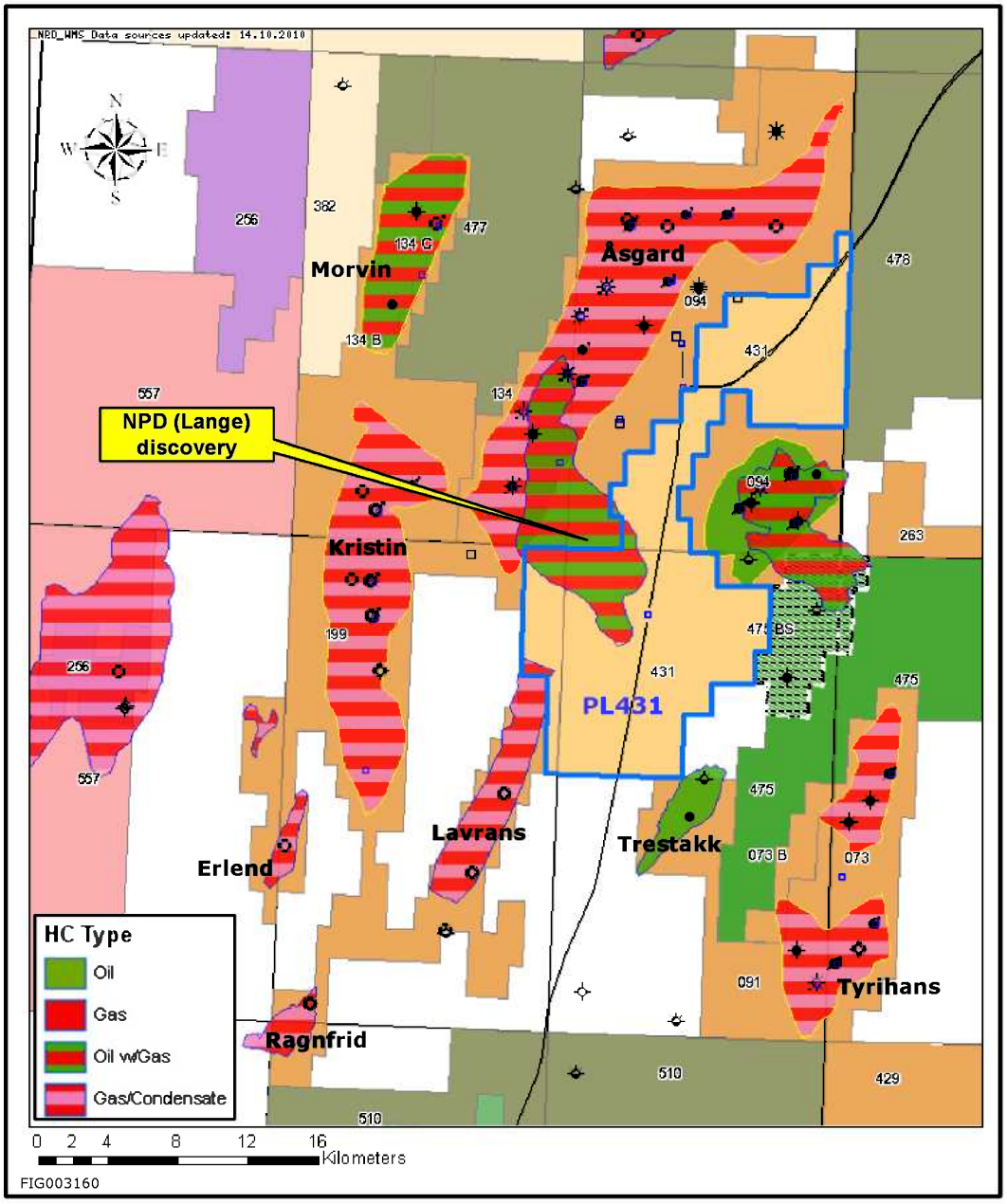

Figure 1.1 PL431 location map

2 Data Base

After the award of PL431 in February 2007, a common seismic data base was set up consisting of regional 2D data and various 3D surveys covering the license and the adjacent fields and discoveries. As part of the license work commitment a large reprocessing project resulted in a new merged CE08M1 data set built from four older 3D seismic data sets. Subsequent processing from gathers by SIP resulted in further data sets derived from this reprocessing project. Figure 2.1 and Table 2.1 below describes the 3D seismic data sets used in the license work.

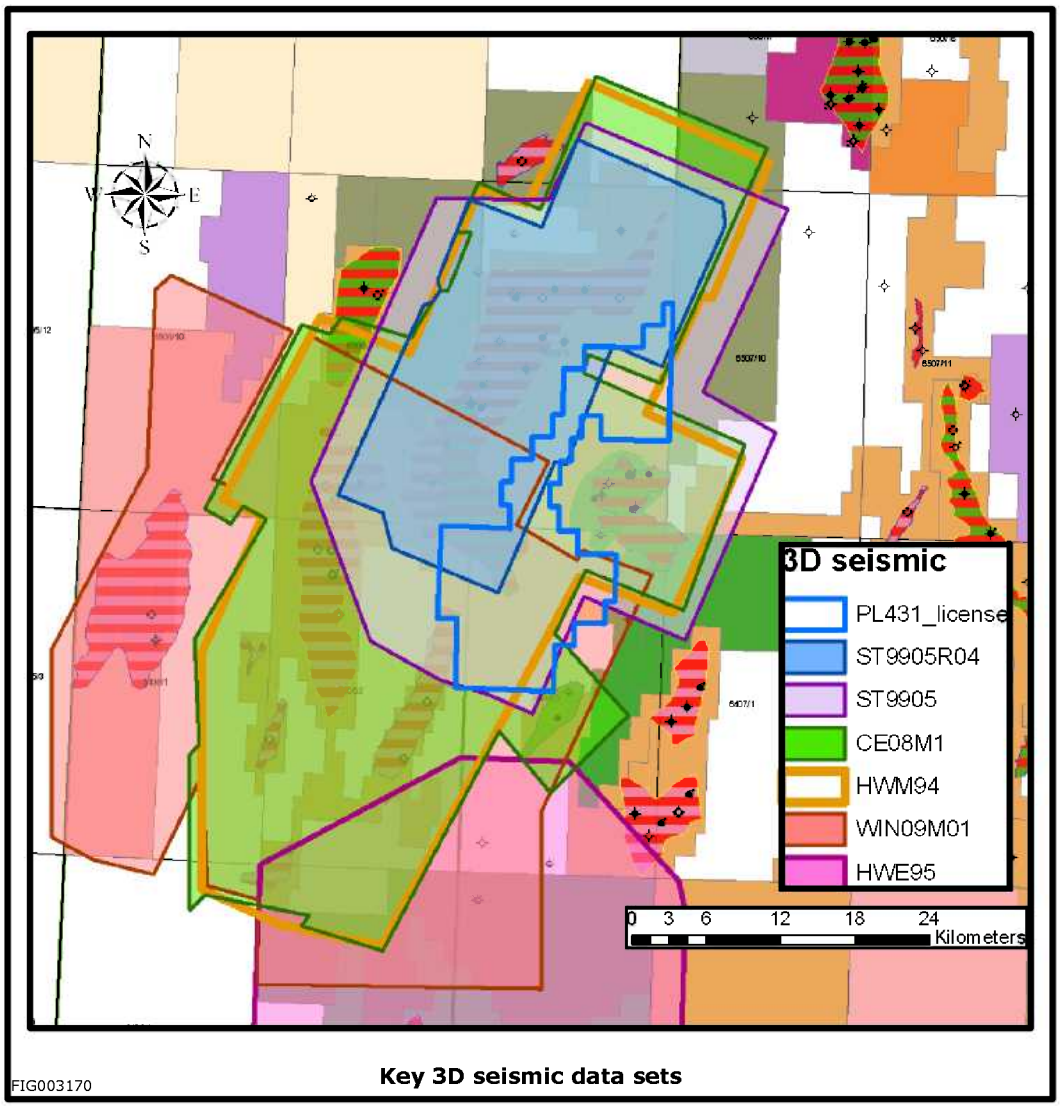

Figure 2.1 Key 3D seismic data sets

Table 2.1 Key 3D seismic data sets

Seismic data set	Type	Description
CE08M1	3D merge	The seismic volume has an area of 1675km2 and is a merge of 5 individual surveys done during re-processing. The original surveys were acquired between 1987 and 1993 with various acquisition geometries and survey orientations. The largest survey, SG9312, was used as the master survey, with additional surveys being ST8701, ST8801, ST8905 & ST9313.
ST9905R04	3D	Reprocessing of a sub-set of the Statoil survey ST9905 done in 2004.
SIP	3D merge	Seismic processing inversion project attempting to improve resolution of Lange interval in particular. The final products include fluid & lithology enhancement volumes (Lambda-Mu-Rho and Extended Elastic Impedance volumes) in addition to the primary inversion output volumes (Zp, Zs, Vp/Vs, and Density). Input seismic is CE08M1 pre-stack time migrated gathers.
WIN09M01	3D merge	Wintershall reprocessing
HWM94	3D	Older vintage 3D
HWE95M	3D merge	Older vintage 3D
MC3D-HB-MEGA	3D merge	PGS Mega-survey of older released seismic surveys
Various	2D seismic	The area is covered with numerous vintage 2D seismic surveys, all practically made redundant by the 3D data coverage available

FIG003171

Numerous wells drilled in the vicinity of PL431 are included in the license well data base. See Table 2.2 below. In addition, all other wells penetrating Lysing and Lange Fm strata have been included to capture the regional extent of this depo-center.The "Issue" column highlights why a particular well was of special interest and relevance to the drilling project, this being in the form of drilling problems or data collection.
A Cretaceous sedimentology study by Geolink was commissioned by the PL431 license during the initial phase.

Table 2.2 Wells in PL431 area of importance to drilling project

Well	Issue
6406/1-2	None. MDT and SWC in Lange. Mud contamination.
6406/1-3	Between 2330 and 2396 m the BHA got stuck.
6406/1-4	Well with primary target in Cretaceous Lange Fm.
6406/2-1	Well with primary target in Cretaceous Lange Fm.
6406/2-3	Well control problems. Sidetrack from 2800m. Lange Fm cores.
6406/3-4	Pressure build up (expected) in Paleocene.
6406/3-5	Shallow gas 570m - 813m. Lost circulation 1116m and 1340m.
6406/5-1	Kick below Base Tertiary at 2600m. HC flow to surface.
6407/1-2	Problems setting 20" casing. Lost circulation 1817m. Reaming in Paleocene and Cretaceous section.
6506/11-1	Shallow gas problems. DST in Lange Fm.
6506/11-2	13 3/8" casing stuck. Sidetrack. DST in Lange Fm and Lysing Fm.
6506/11-3	Cores in Lysing and Lange Fms. FMT sample in Lange Fm.
6506/11-4S	Cores in Lange Fm. Fluid sample in Lange Fm.
6506/12-1	20" and 13 3/8" casing leaks. Cement squeeze to fix.
6506/12-2	Shallow gas. Water flow and lost circulation.
6506/12-4	Shallow gas with flow. Lost circulation. Cores in Lange and Lysing Fms. DST in Lysing Fm.
6506/12-5	Lost circulation in top hole. DST in Lysing Fm.
6506/12-10	Boulders. Stuck 22" underreamer. Gas flow in 12 1/4" pilot hole.

FIG003162

3 Review of Geological Framework

The Cretaceous reservoirs in the Haltenbanken area are of turbidite nature and have been penetrated by a considerable number of wells. The regional depositional models are fairly well established. However, most wells have been drilled with Jurassic highs as targets and these highs were pronounced also during deposition of the Cretaceous section. The PL431 license area is straddling the area between the Smørbukk and Smørbukk South highs and it is assumed that the syncline between was a sediment fairway with deposition of thicker and better quality sands. Wells 6506/11-2 and 6506/11-4S would therefore not be representative of the sand quality to be expected in the central part of the system.

In well 6506/11-2 oil was discovered in a 40 meters gross section with 7.9 meters net pay. A DST produced 860 BOPD at 41° API. In well 6506/11-4S oil was discovered in a 48 meters gross section with 6.4 meters net pay. Only a segregated FMT oil sample was recovered in the Lange sands. Neither of these two wells found an oil-water contact.

Well 6406/3-9 tested the Smørbukk syncline with the expectation that thicker and better quality sands than found in offset wells 6506/11-2 & 6506/11-4 would be encountered. However, the well encountered substantially poorer quality and quantity sandstones over both the Lange and Lysing intervals.

Updated Lysing and Lange Fm depth structure maps and a seismic cross section are presented in Figure 3.1 and Figure 3.2.

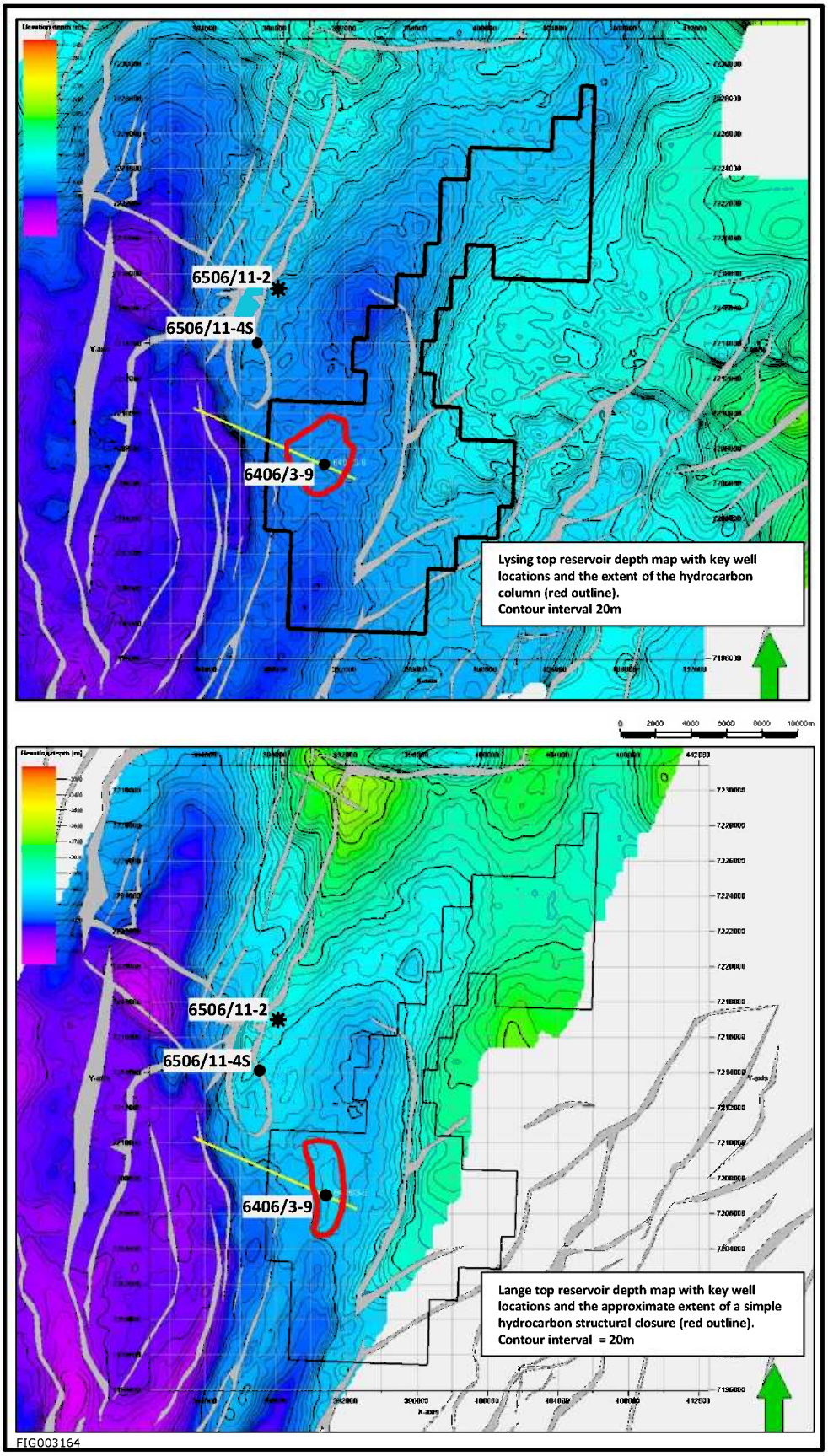

Figure 3.1 Depth Structure Maps. *Top Lysing reservoir (top)*
Top Lange reservoir (bottom)

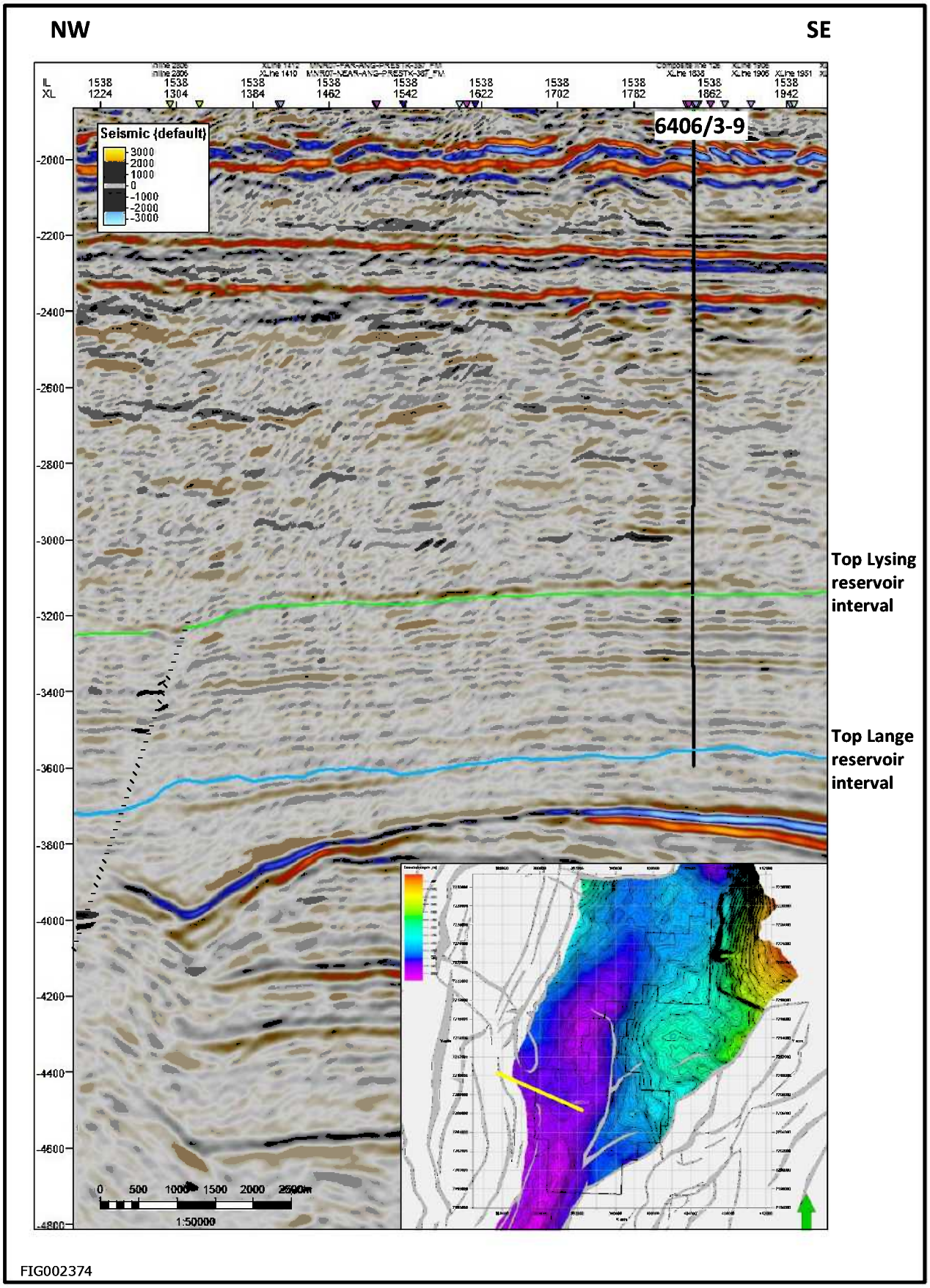

Figure 3.2 In-line 1538 of ST9905R04 3D seismic through well location.

4 Prospect Update

The 6406/3-9 well proved oil in both Lysing and Lange reservoirs and this section presents the volumetric assessment of the discoveries.

Lysing Formation
Based on the petrophysical analysis done for the Lysing Formation in the well, Table 4.1 lists the key parameters governing the stochastic volumetric calculation done with GeoX software as well as the P90, Mean and P10 in-place oil volumes. The top reservoir depth surface is shown in Figure 3.1. It is here assumed the accumulation is restricted to the local four-way dip closure indicated in the figure.

Lange Formation
Based on the petrophysical analysis done for the Lange Formation in the well, Table 4.1 lists the key parameters governing the stochastic volumetric calculation done with GeoX software as well as the P90, Mean and P10 in-place oil volumes. The top reservoir depth surface is shown in Figure 3.1. In line with the initial geological model we have assumed a potentially larger areal extent with a mean of 20 km^2, however, the reservoir thickness would make a body of a large extent implausible.

For both discoveries the in-place oil volumes are small and the reservoir properties are of such poor quality that commercial production is considered impossible. Please note the prospects and leads as presented in the original license application is not known to Maersk Oil Norway.

Table 4.1 Hydrocarbon volumes in place

Parameter	Lysing Fm	Lange Fm
Net pay (m)	1.5	0.8
Porosity (%)	16	21
Water saturation (%)	41	81
HC column indicated from pressure data (m)	10	10
Structural relief of dip closure (m)	12	12
Area constraint (km^2)	9.1	20.0
P90 case STOIIP (10^6 m^3)	0.46	2.00
Mean case STOIIP (10^6 m^3)	0.67	2.80
P10 case STOIIP (10^6 m^3)	0.86	3.70

FIG003193

5 Technical Evaluations

Petrophysical Evaluation

Best estimate

The petrophysical averages for the Lysing and Lange sandstones were calculated using a porosity cut-off of 10 p.u. for the Lysing and 15 p.u. for the Lange sandstone, a water saturation cut-off of 50% and a shale volume cut-off of 50%. The porosity value was selected after review of the core analyses data, which indicated that 1 mD air permeability corresponds to these porosity cutoffs.
The best estimate case is shown in the top part of Table 5.1.

High case

Uncertainty exists on the actual cut-offs to use for the petrophysical averages and therefore a "high-case" summation table has been generated. If very optimistic porosity cut-offs are selected, the porosity cut-off for Lysing could be 6 p.u. and potentially as low as 10 p.u. for the Lange sandstone. As discussed above, the water saturation is uncertain due to the vertical resolution of the resistivity log and the formation water salinity being unknown. The water saturation cut-off in the "high-case" summation table has therefore been selected as 60% and the shale volume cut-off as 70%.
The high case is shown in the lower part of Table 5.1.

Table 5.1 Petrophysical summary tables

Best estimate table

	Top Depth (MD)	Bot Depth (MD)	Gross Interval	Net Res Interval (TVD)	Res/Gross (Res)	Avg Phi (Res)	Net Pay Interval (TVD)	Pay/Gross Ratio	Avg Phi (Pay)	Avg Net Sw (Pay)	HPVH (Pay)
Lysing	3395	3500	105	13.1	0.13	0.13	2	0.02	0.16	0.42	0.2
Lange	4079	4135	56	2.6	0.05	0.19	2.4	0.04	0.2	0.29	0.3

High case table

	Top Depth (MD)	Bot Depth (MD)	Gross Interval	Net Res Interval (TVD)	Res/Gross (Res)	Avg Phi (Res)	Net Pay Interval (TVD)	Pay/Gross Ratio	Avg Phi (Pay)	Avg Net Sw (Pay)	HPVH (Pay)
Lysing	3395	3500	105	26.7	0.25	0.11	10.7	0.1	0.13	0.52	0.7
Lange	4079	4135	56	5.2	0.09	0.16	2.6	0.05	0.19	0.3	0.3

FIG003180

Reservoir Engineering

Formation pressure

Formation pressures were recorded in the well with a wireline formation tester.

Two good pressure measurements were achieved in the Lysing formation, which corresponds to a gradient of 0.27 psi/ft. Samples acquired at 3457.5 m MDRT confirm this to an accurate oil gradient.

Several pressure measurements were attempted in the Lange sandstones, but the resulting readings do not correspond to a realistic gradient. Samples taken at 4102.1 m MDRT - although highly contaminated by mud filtrate - confirm the presence of oil.

Oil samples

Oil samples were taken using the wireline formation tester. In the Lysing formation, samples were acquired at one station at 3457.5 m MDRT. In the Lange formation, samples were taken at the depth of 4102.1 m MDRT in two subsequent wireline runs (standard probe and dual-packer).

PVT analysis of the MDT oil samples were undertaken (single stage separation, constant mass expansion, and differential liberation for both Lysing and Lange, as well as three stage separation for the Lysing oil sample).

Dual-packer mini-DST

A mini-DST was conducted using the dual packer MDT set across the interval 4102-4103 m MDRT in the Lange formation. Following 6 hours pump-out, stable radial flow was reached after 3 hours pressure build. An average kh-m of ca 0.9 mD-m was estimated from the data assuming fluid viscosity 1 cP. Depth of investigation was ca 30+ metres. Oil viscosity determined in the PVT analysis is 0.3 cP, indicating that the above analysis of kh-m for the reservoir sand is optimistic.

Reservoir Quality

Geology of cored interval

The 50.4 m of cored Lange interval is thought to record deposition of four 3-4m thick, erosive based, fining upward, deep water channel fills, against a background of basinal mudrocks and muddy debrites.

Reservoir quality

Petrographic analyses of the 8 Lange core samples and 15 Lysing side wall core samples show a similar diagenetic history for both intervals, although the Lysing samples are less compacted due to shallower burial. Early development of quartz overgrowth in the 'cleaner' sandstones inhibited compaction. Most of the Lange samples contain abundant ductile material (mainly detrital clay and mudclasts). They lack significant quartz cement and are strongly compacted. Post-compactional calcite (and minor dolomite) cements occlude most of the porosity that survived compaction. Post-compactional grain dissolution formed minor secondary pores, which tend not to be connected to the primary pore network.

Geochemical Evaluation

Migration and trap

Cretaceous gravity flow sandstones between Smørbukk and Smørbukk Sør provide the stratigraphic trap. The drainage area extends west into block 6402, where the source rocks are in the condensate maturity window. Expelled hydrocarbons enter the Cretaceous via fault zones and are trapped in the carrier sandstones.

Source maturity

Well 6406/3-9 was completed in the Cretaceous and no Jurassic was penetrated. No source rock analysis was therefore performed. Mud gas isotope analysis shows that there is an increasing thermogenic signature to methane with increasing depth, and gas samples from the Lange and Lysing reservoirs suggest hydrocarbons originate from oil to condensate mature sources.

HC origin

Light oil samples (API 42°-44°API) were retrieved via MDT from the Lysing and Lange formations. The very similar carbon isotopic composition of the oil fractions suggests a very light signature indicative of Spekk origin. Except for certain maturity related indicators, bio-marker composition likewise is very similar for the Lysing and Lange fluids. This points to a marine shale source

consistent with the Spekk Fm either completely without or with only minor contributions from a coaly (Åre) source.

Bio-marker based maturity indicators provide an inconsistent picture, possibly due to facies dependence of some of the indicators used or mixing of fluid charges representing different maturity stages. Overall saturate bio-marker data suggest origin of the fluid from a late stage of main to early condensate window, where a mature source is corroborated by aromatic maturity indicators.

Compositional differences of the fluids can be attributed to secondary alteration processes. Whole oil gas chromatograms of the samples show no sign of significant biodegradation, but evaluation of light hydrocarbons distribution shows significant depletion of water soluble compounds, which suggests oil alteration due to water washing.

Biostratigraphy

A report from RPS presents the results of wellsite micropalaeontological analyses carried out during December 2011 - February 2012 over the interval 2300m - 4183m (TD) on the Maersk Oil operated T-Rex well 6406/3-9. 273 micropalaeontological analyses were carried out at the well site including 247 cuttings and 26 core chips over the intervals 4114m to 4126.14m (core #2) and 4126m to 4134.30m (core #3).
24 ditch cutting samples were analysed routinely for micropalaeontology post TD from the interval 3395m - 3494m.
Results are presented on micropalaeontological data distribution charts of the report.

6 Conclusions

An oil discovery was made by well 6406/3-9 in license PL431 situated to the east of the Åsgard and Kristin fields on the Halten Terrace. Maersk Oil Norway has been the operator of the license during the period following the decision to drill an exploration well. Maersk Oil's interest has been 70% whereas Faroe Petroleum has been the partner with the remaining 30% equity. PL431 was awarded as part of the APA2006 Licensing Round in February 2007.

The primary objective of well 6406/3-9 was to determine the presence of commercial amounts of moveable hydrocarbons in developable reservoirs in the Lange Formation. In addition the objective was to acquire sufficient and good quality well data. A secondary objective was to test the presence of hydrocarbons in the Lysing formation.

The key uncertainties were thought to be reservoir thickness, quality, continuity, connectivity and hydrocarbon column.

Discoveries of oil were made in both the Lysing and the Lange formations, however, interbedded sandstones with low reservoir quality and thicknesses were found to be much poorer than anticipated. MDT tests at both levels clearly indicated limited flow capabilities rendering further work in this area unjustified.

For both discoveries the in-place oil volumes are very small and the reservoir properties are of such poor quality that commercial production is considered impossible. Any further technical evaluations have therefore not been done.

Given the lack of any structural closures and the proven lack of working stratigraphic traps, Maersk Oil Norway and partner Faroe Petroleum do not see any further petroleum potential within the PL431 license.

The PL431 license was subsequently relinquished on the 16th of August 2012.