

Status Report License Surrender PL774

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1 Key license history

The production license 774 (PL774) was awarded to Tullow Oil Norge AS (40%, operator), Concedo ASA (30%, partner) and Petrolia Norway AS (30%, partner) in the APA2014 which became effective the 6th of February 2015. The license group was awarded additional acreage in the APA2015 which became effective February 2016, named PL 774B. The milestone deadlines were aligned with PL774 and the naming 'PL774' will be referring to both PL774 and PL774B in this status report for license surrender. The license covers part of blocks 16/7 and 16/10 and comprises of 136.11 km², see Fig. 1.1.

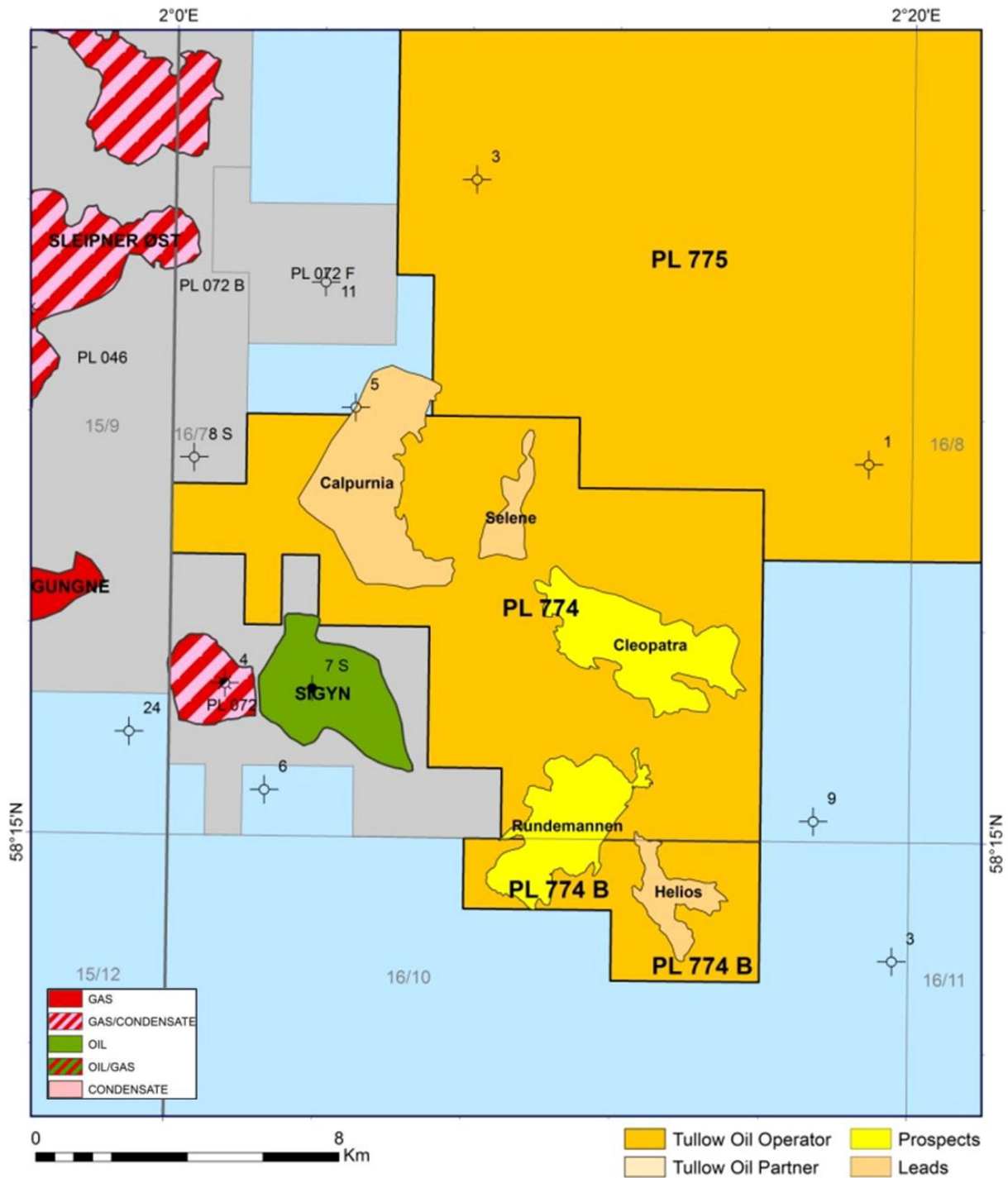


Fig. 1.1 Overview of the updated prospectivity in PL774

The work commitment of the license included G&G studies. PL774 have however decided to extend the work program further to also include reprocessing of 3D seismic data, acquisition of an induced polarization (IP) survey and to perform relevant geological and geophysical studies, which have been fulfilled. The DoD decision to be made before 6th of February 2017.

The reprocessing project of 3D seismic data, a merge based on released data, was done in cooperation with PL776 (Tullow operator) and PL775 (Tullow operator), and cover a large areal extent for a good regional overview. The work was performed in-house by Tullow Oil Norge AS (Tullow).

The license did an acoustic inversion (Tullow in-house) to look at potential geophysical effects to de-risk the prospectivity further. No significant geophysical anomalies have been observed. Seven IP lines were acquired by ORG Geophysical, primarily for evaluating this new exploration tool. As the technology and results so far is poorly understood, the IP results have not been used to de-risk the prospectivity. The observed IP response are not consistent with structures and regarded as inconclusive.

There were conducted geochemical studies for well 16/7-3 and well 16/7-9 by Prof. Dag A. Karlsen. Both studies are important for finding evidence of thermogenic hydrocarbons relevant to improve understanding of the petroleum system in the region.

Three formal combined Exploration Committee (EC) and Management Committee (MC) meetings have been held in the license. Minutes and presentations from the meetings are filed on L2S.

The Jurassic-Triassic prospect Rundemannen is considered to have the most attractive potential in the license and is used as the base case for the resource, risk and technical-economical evaluation. The results of the work performed in PL774 have concluded that the probability of proving commercial quantities of oil is too low to justify a decision to drill an exploration well.

An unanimous decision to relinquish the licence has been taken by the Management Committee, recommended by the Exploration Committee, and the Ministry of petroleum and Energy was notified by letter dated 04.01.2017.

2 Database

Seismic data

The license group have merged a large 3D dataset which also cover the neighbour licenses PL775 and PL776. This work is done in cooperation with all three licenses in the area operated by Tullow (PL776-PL775-PL774). The reprocessed/merged dataset is named TUN15M01 and consists of 14 different public 3D surveys from the area, see Table 2.1. The TUN15M01 has formed the base for the technical work. An acoustic inversion has been generated based on the TUN15M01. In addition, an IP survey covering the license have been acquired, named ORG15252-4 (Table 2.1).

Table 2.1 Seismic and IP (DNME) database for PL774

Survey	Comment	NPD ID	Owner	Acquired Year	Reprocessed/ Merged Year	Type
TUN15M01	PL774 merge		PL774		2015	3D
ES9401	Part of TUN15M01	3642	Esso	1994		3D
LN0803	Part of TUN15M01	4558	Lundin	2008		3D
ST98M3 (ST98)	Part of TUN15M01	3951	Statoil	1998		3D
LN0703	Part of TUN15M01	4441	Lundin	2007		3D
ST0611	Part of TUN15M01	4388	Statoil	2006		3D
ST11012	Part of TUN15M01	7467	Statoil	2011	(ST11012-LN0902STR12) 2012	3D
LN0902	Part of TUN15M01	7004	Lundin	2009	(ST11012-LN0902STR12) 2012	3D
UP96	Part of TUN15M01	3835	WesternGeco	1996		3D
ST04M11 (ST0411)	Part of TUN15M01	4272	Statoil	2004		3D
ST0208	Part of TUN15M01	4192	Statoil	2002		3D
MC3DQ15	Part of TUN15M01	3659	PGS	1994		3D
ES9402RE98	Part of TUN15M01	3643	Esso	1994	1998	3D
ST9511	Part of TUN15M01	3742	Statoil	1995		3D
UH3D95	Part of TUN15M01	3742	Norwegian Exploration Services	1995		3D
ORG15252-4	IP survey	8227	ORG Geophysical	2015		2D

Well data

The wells used to evaluate the prospectivity of the PL774 are listed in Table 2.2.

Table 2.2 Well database in PL774

Well	NPD ID	Year	Fm/Gp/Age at TD	TD (m TVD MSL)	Reservoir/age with HC	HC type
16/7-3	75	1982	Rotliegend Gp	3141	Hugin Fm	Oil shows
16/7-4	91	1982	Skagerrak Fm	2757	Skagerrak Fm and Intra Draupne Fm sst	Gas/condensate
16/7-5	134	1984	Smith Bank Fm	2876	None	Dry
16/7-6	3067	1997	Skagerrak Fm	2701	None	Dry
16/7-7 ST2	3244	1997	Skagerrak Fm	2706	Skagerrak Fm and Intra Draupne Fm sst	Oil
16/7-8 S	4612	2003	Skagerrak Fm	2621	None	Dry
16/7-9	6382	2011	Smith Bank Fm	2641	None	Dry
16/10-3	2703	1996	Smith Bank Fm	2809	None	Dry

Special studies

TUN15M01 is a post-stack merge processing performed by Tullow (in-house).

Tullow carried out an acoustic inversion based on the TUN15M01 (in-house).

The velocity model used for the key depth surfaces in PL774 have been through an in-house depth conversion project.

The license group have included one IP survey acquired by ORG Geophysical in 2015.

There were conducted two geochemical studies by Prof. Dag A. Karlsen; one for each of the wells 16/7-3 and 16/7-9.

3 Review of Geological and Geophysical studies

The following studies have been performed as part of the PL774 work obligations.

- The seismic data TUN15M01 underwent a post-processing merge by Tullow (in-house), consisting of 14 different public 3D's. The seismic products have been important to be able to identify, interpret, evaluate and de-risk the main risk elements, and to improve the regional understanding of the Jurassic-Triassic structural setting.
- To mature the prospects further, the license conducted an acoustic inversion study by Tullow (in-house). The aim was to increase resolution for improved map-ability and look for any AVO response within the target zones in the Jurassic-Triassic and the Paleocene strata. The data is of limited quality and has not been used for de-risking the presence and quality of reservoir.
- A Tullow depth conversion study (in-house) has been carried out. This project resulted in a preferred conversion model used for the key surfaces in the license. The latest defining surfaces have caused a negative effect of the estimated prospect resources, mainly due to change of geometry (paleo-topography) which have resulted in reduction of the gross-rock-volumes for the P10/P90 definition in the prospects.
- The license group have included one induced polarization (IP) survey acquired by ORG Geophysical in 2015. The results partly match the Sigyn Øst Field, however there are also observed anomalies outside the structures within the basins. As the technology and results so far are poorly understood, the IP results have not been used to de-risk the prospectivity within the license.
- A geochemical study of the dry well 16/7-3 was performed by Prof. Dag A. Karlsen. The aim was to identify proof of thermogenic hydrocarbons, their source affinity and clues of the petroleum migration in the region. The well have a number of interesting observations and is concluded to contain oil shows most likely from several pulses of migration, and charged from west.
- A geochemical study of the reported dry well 16/7-9 was performed by Prof. Dag A. Karlsen. The aim was to find evidence of thermogenic hydrocarbons, their source affinity and clues of the petroleum migration in the region. Unfortunately due to a large degree of contamination the results from the investigation are inconclusive.
- An in-house fault throw analysis between the Rundemannen prospect and the Helios lead have been carried out using a SGR triangle plot based on two critical wells in the area. They show that the defining fault between the Rundemannen prospect and the Helios lead most likely is open. No sealing capacity causes a negative effect on the resource volumes.
- The reports and documentation from the geological and geophysical studies are posted on L2S either as reports or reported in EC meetings.

4 Prospect update report

Fig. 1.1 shows the updated outlines of prospects and leads in PL774 after the final evaluation process.

The main prospects are the Rundemannen and Cleopatra. The Rundemannen prospect is used as the base case both for the resource and risk evaluation and the technical-economical evaluation, thus worked up in greater detail. A technical review will be presented of; 1) the original prospect applied for and 2) the updated prospect evaluation after finalized work program (DoD). An overview of the resources, both original and updated, for all the prospects and leads are presented in Table 4.1. The license concluded negative to a drill decision for the Rundemannen prospect, which also implies that the Cleopatra prospect is no drill candidate. The other prospectivity are sub-commercial leads with high risk and low reward potential.

The Rundemannen prospect

Review of Original Definition - The Rundemannen Prospect

The Rundemannen prospect is a 8.5 km² large, fault bounded 3-way dip closure located along a potential eastwards spill route from the Sigyn Øst Field. The prospect is segmented by several cross-cutting faults separating it in 3 structures, see depth map Fig. 4.1 and Fig. 4.3. The main central horst segment have steeply dipping normal faults to the NW, NE and SE (Fig. 4.3 and Fig. 4.2). The prospect apex at 2472m is located on the central horst. The mapped prospect spill point at 2618m is towards south, with an alternative spill point at 2623m towards north and the Cleopatra prospect. The defining fault towards the east represents a westward dipping normal fault, separating the Rundemannen prospect on hanging block from the Helios lead on the foot block. The reservoir is expected to be sandstones within the Triassic Skagerrak Fm (Hegre Gp) and Middle Jurassic Hugin Fm (annotated as Viking Gp in Fig. 4.2), either separately or in combination. The lateral seal along the eastern 2 km long bounding normal fault towards the Helios lead is regarded as the main risk. The critical fault throw varies from 40m to 15m. Based on petrophysical analysis of the surrounding wells the probability of sand-sand juxtaposition across the fault is high, suggesting communication between the Rundemannen prospect and the Helios lead. If this is the case, the Rundemannen spill point is moved shallower resulting in negative effect on the estimated volumes. The top seal consisting of Draupne Fm and Cromer Knoll Gp shales are considered good. No major faults intersects younger sediments than the Cromer Knoll Gp indicating no major risk for breach from fault reactivation. The most likely migration model to the Rundemannen prospect is spill from the oil-filled Sigyn Øst Field. There is an discussion if the Sigyn Øst Field is actually filled down to the eastern spill point towards the Rundemannen prospect mapped at 2616m, 19m deeper than reported to NPD, however the uncertainty is regarded to be within the resolution of the velocity model.

Review After Final Evaluation - The Rundemannen Prospect

No major change to the way the Rundemannen prospect is defined, interpreted and the expected reservoir (Fig. 4.1 show the updated definition of the prospects). The main risk is still lateral seal. However, due to the updated velocity model used to depth convert the key horizons, the surface geometry (paleo-topography) have changed. The consequence are altered spill points for the Rundemannen prospect, and also the other prospects in the license. This have had a negative effect for the gross-rock-volumes, and therefore the prospect resources.

The main mapped spill point for the Rundemannen prospect at 2631m is now defined to be towards NE with spill towards the structure tested by well 16/7-9 (Fig. 4.1 and Fig. 4.3). There are also mapped two alternative spill points; one towards south at 2634m, as originally presented, and one

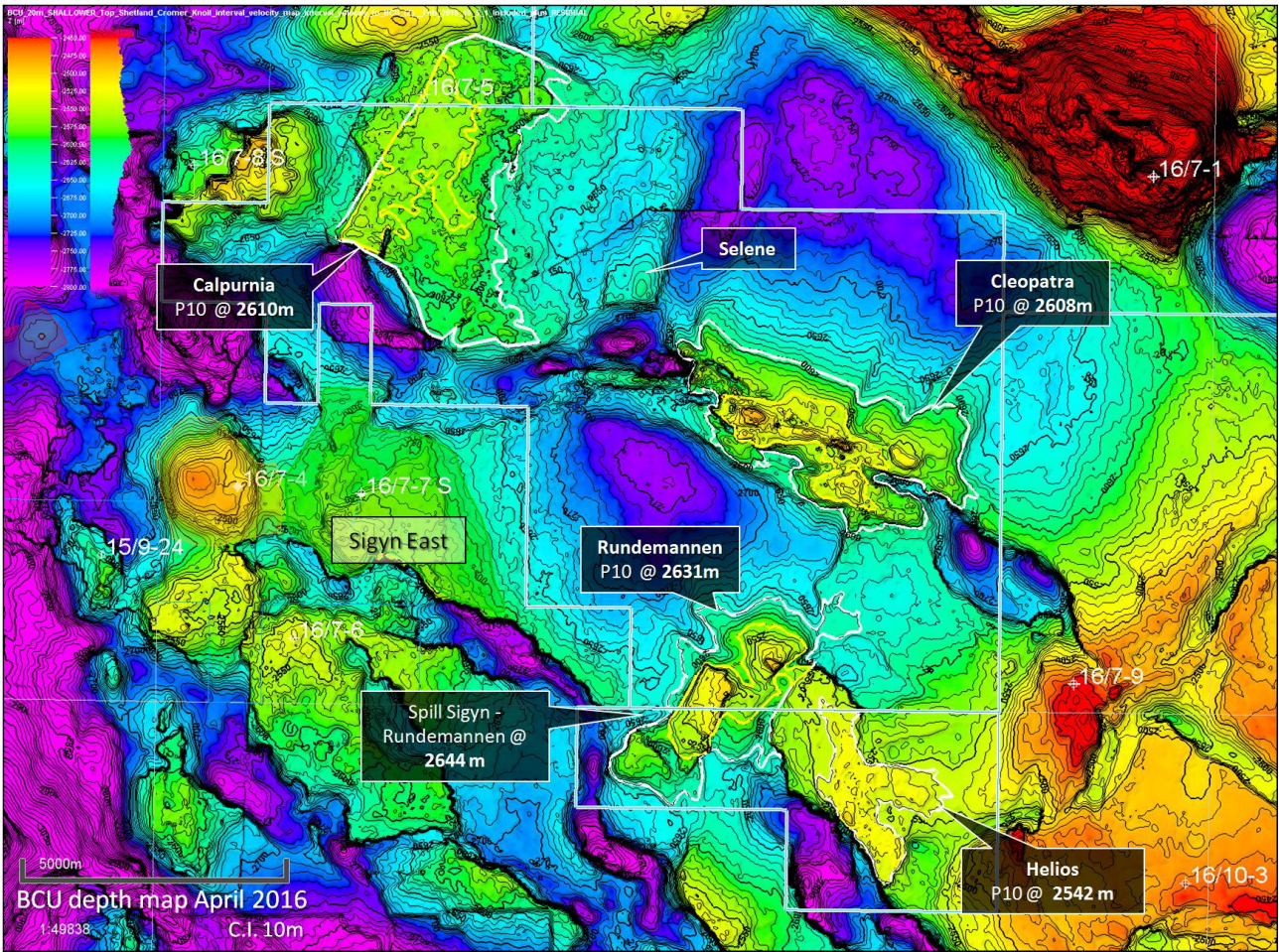


Fig. 4.1 Depth map Base Cretaceous Unconformity (BCU). The prospects in PL774 are shown with white polygons on the depth map, defined by the P10 contour. The defined P90 outlines are shown with yellow polygons

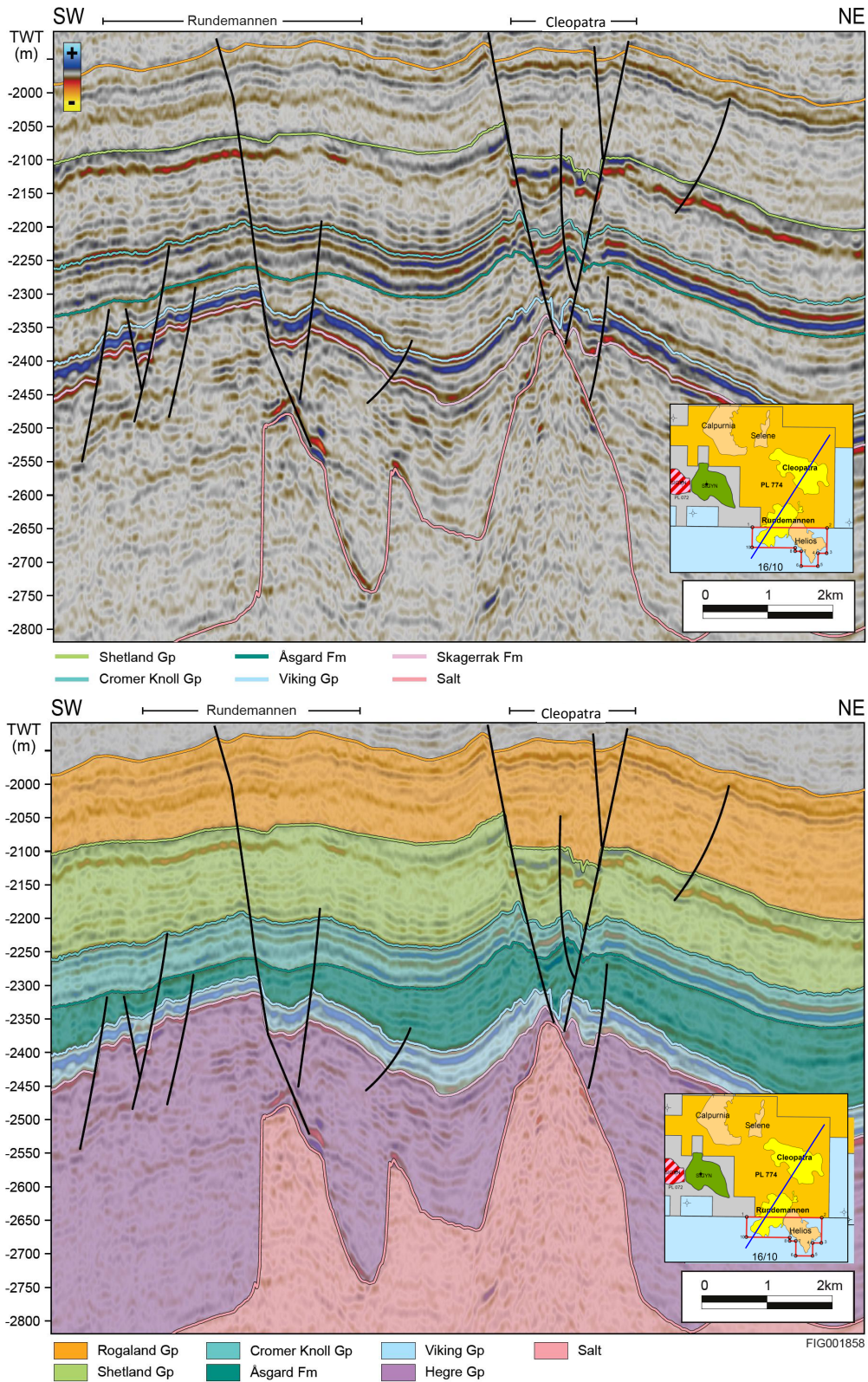


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Fig. 4.2 SW-NE geoseismic section. Seismic section and geoseismic profile across the Rundemannen and the Cleopatra prospects

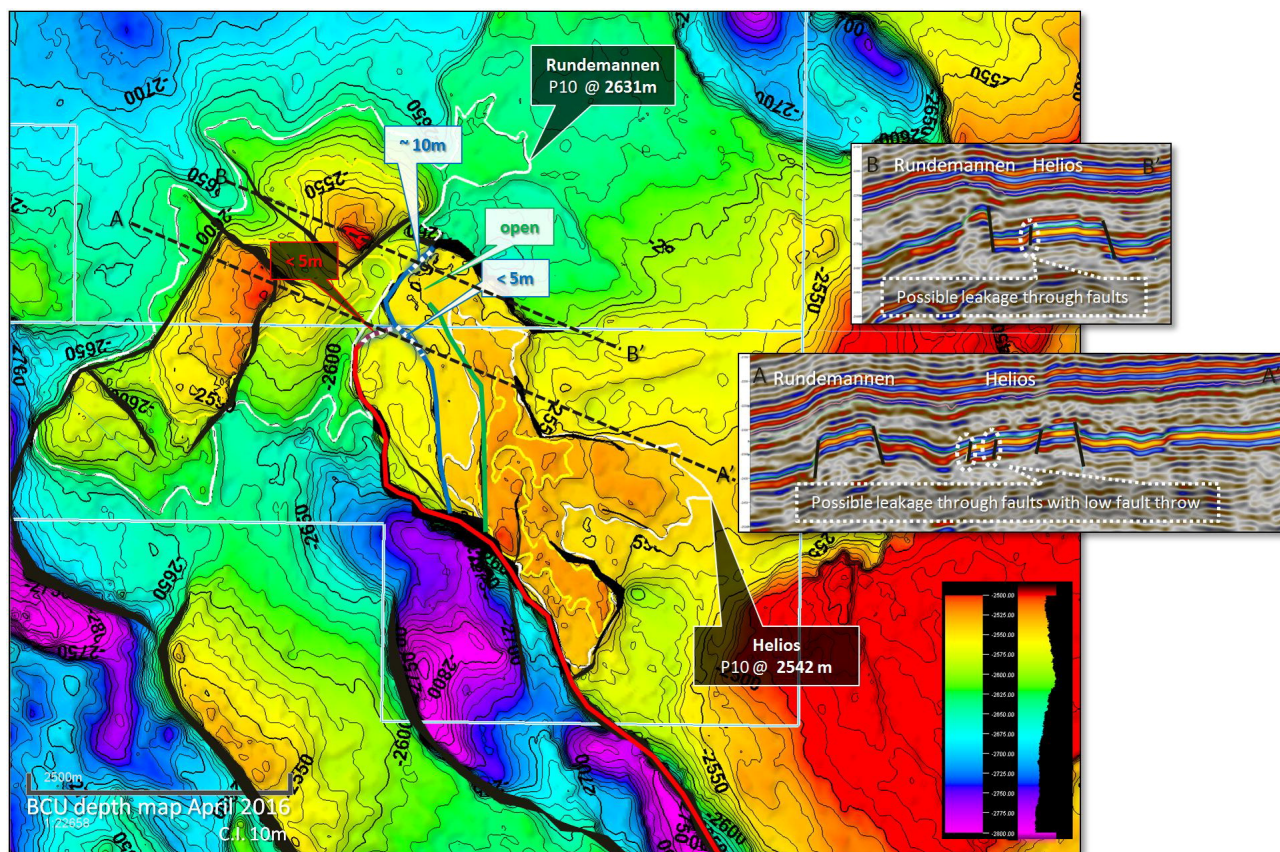


Fig. 4.3 Depth map with main faults of the BCU. The map shows the structural definition of the Rundemann prospect and the Helios lead. The Rundemann and Helios P10 and P90 definitions are respectively shown in white and yellow polygons. The main faults on the eastern bounding fault for the Rundemann prospect, are mapped in detail with annotated lowest fault throw and two seismic sections for illustration.

towards the Cleopatra prospect at 2638m. All the mapped spill points are within 7m which is within the uncertainty of the datapoints used for depth conversion, therefore, any of the mapped spill points may work. However, they all are dependent on the bounding fault towards east to seal. The apex for the Rundemann prospect is moved to the northern segment at 2486m, located on a fault depended dip closure (Fig. 4.3). The critical bounding normal fault towards east, and the Helios lead, has been through a fault throw analysis and a shale-gouge-ratio (SGR) evaluation based on key wells. The results of this fault seal evaluation clearly suggest that the critical parts of the fault where the throw is as low as 5-10m (Fig. 4.3), will not be able to hold any hydrocarbon accumulation. Therefore, the Rundemann prospect cannot depend on the eastern bounding fault to seal. Any fill beyond the Rundemann closure, defined by the P90 contour in Fig. 4.3, will most likely migrate directly to the Helios lead, and then spill further eastwards. A re-definition of the Rundemann prospect will reduce the estimated volumes to be further below the commercial threshold. The fault seal evaluation results actually obliterate the mapped spill points and the chance to have hydrocarbon migration towards the Cleopatra prospect. A re-definition of the P10 and P90 outlines for the Rundemann prospect have not been done.

The proposed charge is most likely dependent on a fill-spill scenario from the Sigyn Øst Field to the Rundemann prospect and then most likely eastwards. The latest depth maps suggest a spill between Sigyn Øst and Rundemann to be at 2644m with the BCU used as a mapped carrier-bed. The free water level in Sigyn Øst is at 2597m, indicating that the present situation is 47m under-filled suggesting that the Sigyn oil accumulation has not reached the proposed spill point towards the Rundemann prospect (Fig. 4.1).

No seismic amplitudes or inversion anomalies are observed across the Rundemannen prospect. The IP survey from 2015 do not either show any positive response. The results of the IP survey are considered inconclusive for the area and have not been used to de-risk the Rundemannen prospect, nor other prospectivity in PL774.

The geochemical work executed on well 16/7-3 prove that there are oil shows across a 30m interval in the Hugin Fm sandstone, most likely linked to several migration pulses. The hydrocarbons in well 16/7-3 correlate best to Lower Draupne or Heather Fms with close affinity to Gudrun-Dagny-Frøy-Johan Sverdrup Fields and Discoveries, and not Loke-Gungne-Sigyn Fields and Discoveries. The most likely migration pathway is now interpreted to be from west, and not as earlier expected, from south, via the Rundemannen and Cleopatra prospects. A Geochemical study has been performed on cuttings from well 16/7-9, which unfortunately was too contaminated to give any reliable results. A petrophysical analysis of the well 16/7-9 however indicate weak shows in the top part of the Draupne or Hugin Fms sandstone, which support the reported traces of residual fluorescence.

The resource volumes for the Rundemannen prospect have changed during the PL774 work process (Table 4.1). In the APA2014 application by Petrolia the Rundemannen prospect was first defined. The mean recoverable resources was estimated by Petrolia to be 10.3 MSm³ o.e. In the application for additional acreage APA2015 the operator revised the resource volumes in the Rundemannen prospect to be 3.4 MSm³ o.e. (Table 4.1). The latest resource volume after final evaluation is estimated to be 2.8 MSm³ o.e., which is the basis for the technical-economical evaluation.

The Cleopatra prospect

The Cleopatra prospect is a 4-way dip closure segmented by a complex fault system, a structural collapse due to halokinesis (Fig. 4.1 and Fig. 4.2). The dividing fault trend is NW-SE. The seismic expression is structurally more complex than the Rundemannen prospect, several segments with high risk of compartmentalization. The main reservoir units are predicted to be the M-U Jurassic Hugin-Intra Draupne Fms (shown as Viking Gp in Fig. 4.2) and Triassic Skagerrak Fm (Hegre Gp), likely varying from segment to segment across the Cleopatra prospect. The reservoir quality is assumed good, referring to the nearby wells in the Sigyn area. The main risk is migration. Based on the lateral seal evaluation of the Rundemannen prospect, assumed high risk for the oil to migrate through the Helios lead and further eastwards, the migration risk has increased to 30% probability of success. The likelihood of a technical discovery is low, 15%, thus defined as a lead. The resource volume for Cleopatra is close to the Rundemannen, estimated to be 2.8 MSm³ o.e., but with a higher geological risk of success. The Cleopatra prospect is regarded as sub-commercial. A Cleopatra development case is regarded as more challenging and costly than for the Rundemannen case, mostly due to the expected additional number of producers as a consequence of increased risk of compartmentalization.

Other Middle-Upper Jurassic and Triassic leads

The Helios, Calpurnia and Selene leads defined in PL774 all have in common that the risked base case resources become very small, not sufficient to do a detailed technical-economical evaluation, and are regarded as sub-commercial. The work program have not been able to lower risk or lift resource potential (Table 4.1).

Review of Changes in Resource Volumes and Probability Estimates

The conclusion based on the work program and the technical evaluation of the prospectivity in PL774 is that there are no potential commercial development prospects. A review of the changes in resource volumes and probability estimates are presented in Table 4.1 for all the prospects and leads.

Table 4.1 Review of changes in resource volumes and probability estimates

Original APA2014-2015 Discovery/prospect/lead name	D/P/L	Unrisked recoverable resources			Probability of Discovery (%)					Resources in acreage applied for (%)	Reservoir		Reference
		Oil 10 ± 5m3 o.e.			Technical (oil+gas+oil&gas)	Reservoir (P1)	Trap (P2)	Charge (P3)	Retention (P4)		Litho-/Chrono-stratigraphic level	Reservoir depth (m MSL)	
		Low	Base	High									
Rundemannen (APA2014)	P	6.1	10.3	14.8	29	70	70	60	100	100	Hugin/I.Draupne/Skagerrak	2525	As applied for by Petrolia APA2014
Rundemannen (APA2015)	P	1.4	3.4	6.2	19	90	40	60	90	100	Skagerrak/Hugin	2472	As applied for in APA2015 - application for additional acreage by PL774
Cleopatra (Concedo/Tullow APA2014)	L		12							100	Intra Draupne	2452	As applied for by Concedo/Tullow APA2014
Lyshornet (Petrolia APA2014)	P	9.8	14.3	19.2	25	70	90	40	100	100	Skagerrak/Hugin	2520	As applied for by Petrolia APA2014 - Cleopatra-Lyshornet
Helios	L		0.8							100	Intra Draupne	2534	As applied for by Concedo/Tullow APA2013
Selene	L		0.6							100	Intra Draupne	2618	As applied for by Concedo/Tullow APA2014
Calpurnia	L		7.9							90	Intra Draupne	2556	As applied for by Concedo/Tullow APA2015
Post evaluation 2017													
Rundemannen	P	1	2.8	5.4	19	90	40	60	90	100	Hugin/I.Draupne/Skagerrak	2486	PL774 ECOM meeting 2016-10-18 & License surrender report PL774
Cleopatra	P	0.7	2.9	6.5	15	80	70	30	90	100	Hugin/I.Draupne/Skagerrak	2467	PL774 ECOM meeting 2016-10-18 & License surrender report PL774
Helios	L	0.1	0.2	0.5	19	90	50	50	90	100	Skagerrak	2550	PL774 ECOM meeting 2016-10-18 & License surrender report PL774
Selene (As APA2014 Concedo/Tullow)	L		(0.6)		(<15)					100	Intra Draupne	-2618	Selene lead considered too small to warrant new volume estimates
Calpurnia	L	0.2	0.8	2	3	50	20	40	90	90	Intra Draupne	2552	PL774 ECOM meeting 2016-10-18 & License surrender report PL774

5 Technical evaluations

A technical-economical evaluation regarding possible development for the Rundemannen prospect was performed for the APA2015 application for additional acreage. Part of this work is still valid and has been utilized in the review. The basis for the technical evaluation is the Rundemannen prospect estimated to mean recoverable resources of 17 mmboe and a probability of technical success of 19%.

The proposed development solutions for Rundemannen are either a Sigyn daisy chain or Sleipner tie-back with two vertical/deviated producers. The selected drainage strategy is depletion, as in the Sigyn Øst Field. The reservoir quality and compartmentalization are regarded as the main uncertainty in the development. Recovery efficiencies could be poorer than anticipated if net-to-gross and permeability are significantly overstated. In case of more segmentation than expected, extra producers might be needed for the development.

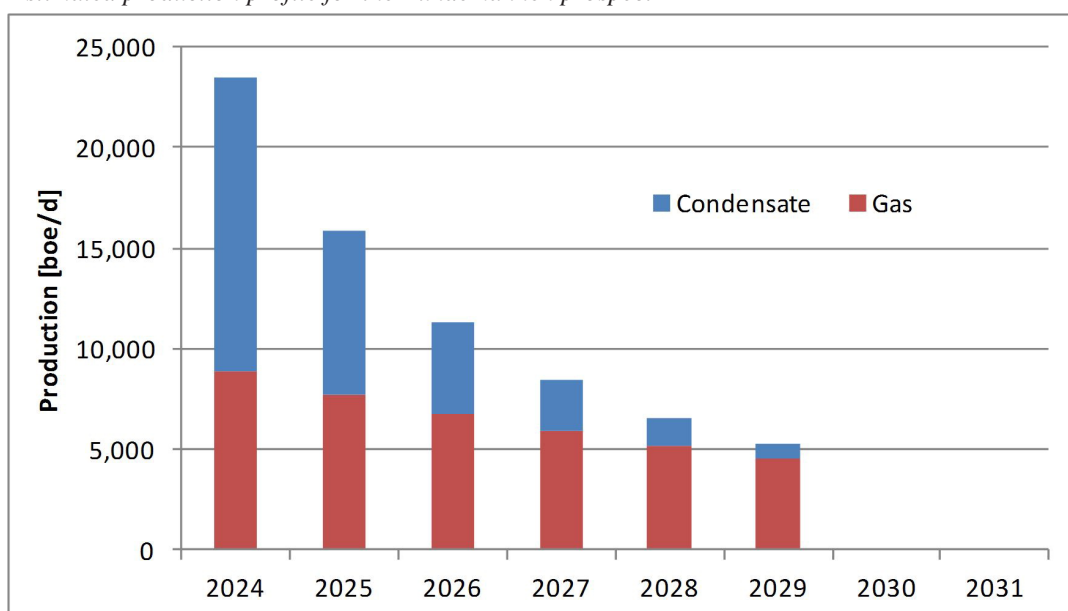
A daisy chain back to Sigyn Øst Field is regarded as the most cost efficient solution, estimated to a total CAPEX of 2 900 MNOK, reflecting a minimum economic field size (MEFS) of 19 mmboe recoverable in a 70 USD/bbl regime, see Table 5.1. When compared to a subsea tie back to the Sleipner Field which is estimated to a total CAPEX of 4 400 MNOK, the MEFS is 26 mmboe recoverable in the same USD/bbl regime. Given the operator's mean resource volumes for the Rundemannen prospect, the NPV and the EMV are calculate to be negative (Table 5.1).

Table 5.1 Economic performance for the Rundemannen prospect

	Economic performance at 70 USD/bbl									Upside case at 70 USD/bbl			
	IRR	NPV	MEFS	Break even oil price	EMV	Failure cost	Pc	Pc Pg	P10	Economic mean	IRR	NPV	Break even oil price
	%	MNOK	mmboe	USD/bbl	MNOK		%	%	mmboe	mmboe	%	MNOK	USD/bbl
Sigyn	9.1%	-51	19	74	-51	-37	6.5%	34%	35	27	15.9%	339	53
Sleipner	5.2%	-348	26	96	-96	-37	5.2%	20%	35	37	17.0%	526	51

The production profile assumes first oil in 2024 with a decline to end production 2029 (Table 5.2). The condensate have a rapid decline, while the gas have a more moderate decline. Analysis of a discovery case predicts a 6.5% probability to have a commercial project (Pc) in the Sigyn daisy chain solution, while the Sleipner tie-back have a 5.2% (Pc) (Table 5.1).

Table 5.2 Estimated production profile for the Rundemannen prospect



Taking into account the economic performance (Table 5.1), the relatively high geological risk and the possibility for increased number of producers, the license concluded that the Rundemannen prospect is sub-commercial and do not warrant a development.

6 Conclusions

The estimated in-place volumes of oil in all the prospects within PL774 have through the license work program been reduced. The key work leading to this conclusion are the 3D merge which have resulted in improved confidence in the seismic interpretation, and the velocity evaluation and analysis improving the quality and control of the depth conversion. The results of prospect maturation and evaluation in combination with the performed geological studies and the technical-economical work has concluded that the probability of proving commercial quantities of hydrocarbons are too low to justify a decision to drill an exploration well.

The evaluated mean recoverable resources are estimated to be 17 mmmboe in the Rundemann prospect, slightly below the commercial threshold. When all the key technical uncertainties for the prospect are added, there was an unanimous conclusion to surrender the license. The geological and geophysical work resulted in a reduction to 19% probability of a discovery. The lateral seal is still the key risk element. In addition, there is a compartmentalization concern between the observed three segments (Fig. 4.3). This could potentially require more producers and increase the overall development cost, therefore, further reduce the chance of commercial success.

The Cleopatra prospect is regarded as having resource potential similar to the Rundemann prospect, the mean recoverable resources are estimated to be 18 mmmboe. However, due to a higher geological risk, estimated to be 15% chance of success, and a higher chance of compartmentalization, the Cleopatra prospect is concluded to be sub-commercial and not considered a drill candidate.

The other leads, Calpurnia, Helios and Selena, all have small volumes and are not of economic interest and not considered to be drill candidates.

The partnership in the PL774 has in good cooperation evaluated and concluded on the exploration and commercial potential, and an unanimous decision to surrender the license was taken December 2016.