PL650 Relinquisment Report

Table of Contents

List of Figures

List of Tables

1 Key License History

Introduction
DEA Norge, as the operator for the PL650, has decided together with the license partners to surrender the license at the BoK decision point 3rd February 2017. The PL650 license is located 5 km north-east of the Skarv Field and 5 km south-east of the Norne Field (Figure 1.1). Following the result of the 6507/3-11S well the partnership considers the remaining volume potential and geological risk in the license to not be of commercial interest.

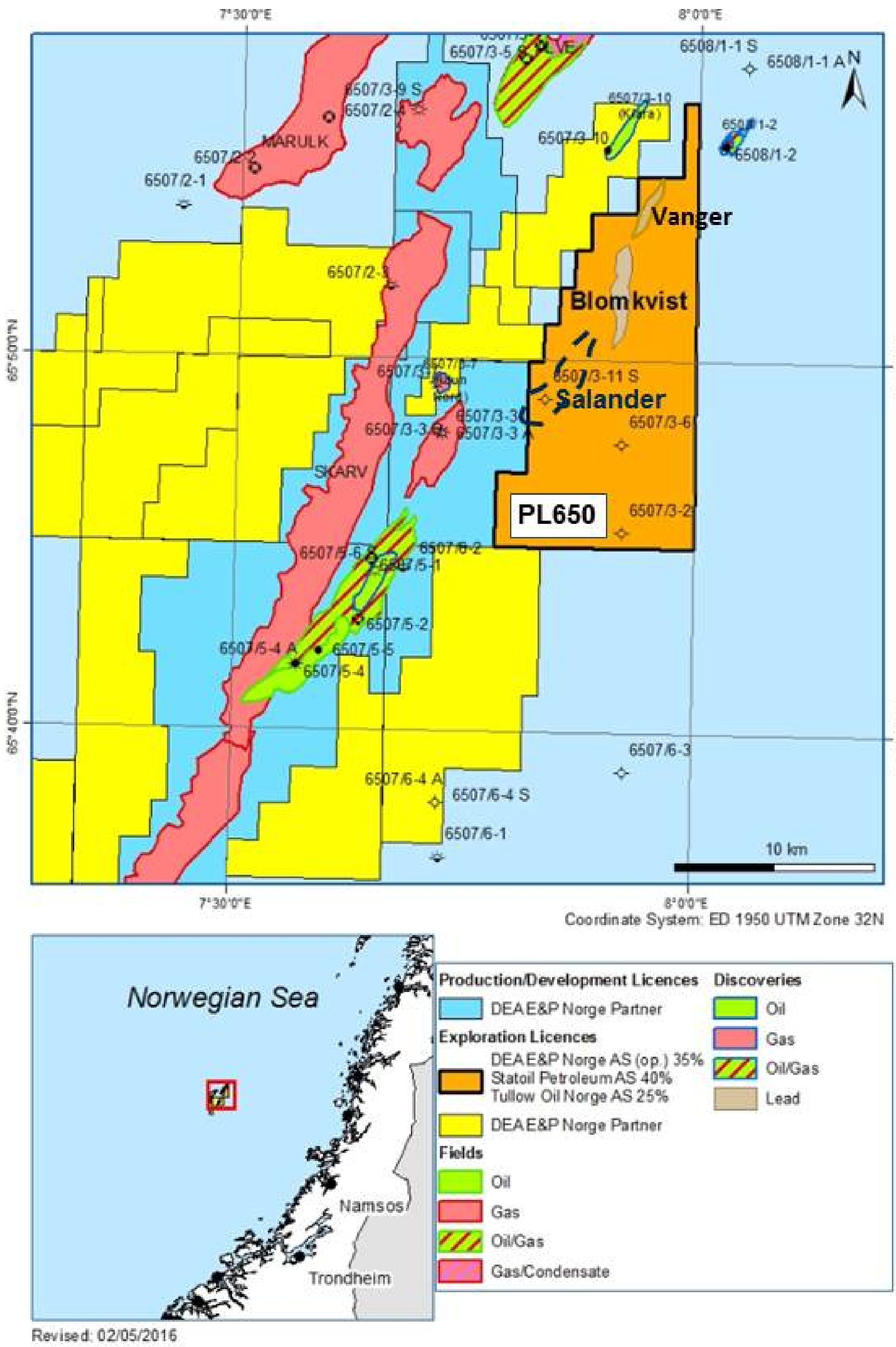


Figure 1.1 PL650 license map

Key license history

The PL650 license was applied for in the APA 2011. It was awarded on 3rd February 2012. E.ON E&P Norway was awarded the operatorship with 60% equity together with Statoil Petroleum with 40% equity as partner. Tullow Oil Norge officially took over 25% of E.ON's interest in September 2015. As part of the DEA Norge acquisition of E.ON E&P Norway in December 2015 DEA Norge took over as Operator and all of E.ON E&P Norway equity in PL650. In November 2016 Tullow Norge AS signed an agreement for the sale of their shares (25%) to AkerBP ASA.

Initial work obligations and work periods

Within 2 years of the award (by 3rd February 2014)

- G&G studies
- Seismic reprocessing
- Drill or Drop decision (DoD)

Within 4 years from the award (by 3rd February 2016)

- Drill exploration well
- Concretize or Drop decision (BoK)

Within 6 years from the award (by 3rd February 2018)

- Concept studies
- Decision to prepare a plan for development (BoV)

Due to a delay in the reprocessing of the 3D data and waiting for the result of a key well in the PL159C license, the 6507/3-10 Klara well, the license applied for a 4 months extension of the drill or drop decision. The extension was approved by the MPE the 21st November 2013. The new DoD decision date was extended to 3rd June 2014.

At that time the exploration well was expected to be drilled Q1/Q2 2016 and the license applied for an extension of the BoK to drill the well and have sufficient time to evaluate the well result before the BoK decision. The BoK decision date was extended to 3rd February 2017.

PL650 Meeting overview

EC/MC Meeting 26th April 2012

EC Work Meeting 31st May 2012

EC/MC Meeting 27th November 2012

EC Work Meeting 30th September 2013

EC/MC Meeting 26th November 2013

EC Work Meeting 11th March 2014

EC/MC Meeting 14th November 2014

MC Meeting 27th January 2015

EC Work Meeting 30th January 2015

EC Work Meeting 18th March 2015

EC/MC Meeting 18th November 2015

EC/MC Meeting 8th November 2016

Reason for relinquishment

The license partners evaluated the prospectivity in the PL650 license and the Salander prospect was identified as the main target with the best volume potential and with highest chance of success. The 6507/3-11S well was drilled during summer 2015 and tested the Salander prospect. The well proved the prospect to be dry at the well location. The reason for failure is believed to be retention or lack of sufficient amount of charge into the structure. The remaining prospectivity in the PL650 license has been evaluated. After evaluating the result of the Salander well, none of the remaining leads have sufficient volume potential or chance of success to be considered as a drill candidate. The decision to surrender PL650 is unanimously supported by the license partners.

2 Database

2.1 Seismic database

No new seismic data was acquired over the license during the license period. But the EN0804 3D dataset was reprocessed by CGGVeritas from November 2012 to September 2013. The reprocessing of the EN0804 3D seismic dataset was a part of the work program in the license. The result of the reprocessing, the EN0804R13, has been used as the main seismic dataset when mapping the prospects in the PL650 license. In addition the Mega Merge 3D MC3D-HGV2012, the 3D time data ST08M08Z, the depth data ST11M08Z, and the base 3D for the reprocessing, the EN0804, have been used in the seismic interpretation (see Figure 2.1).

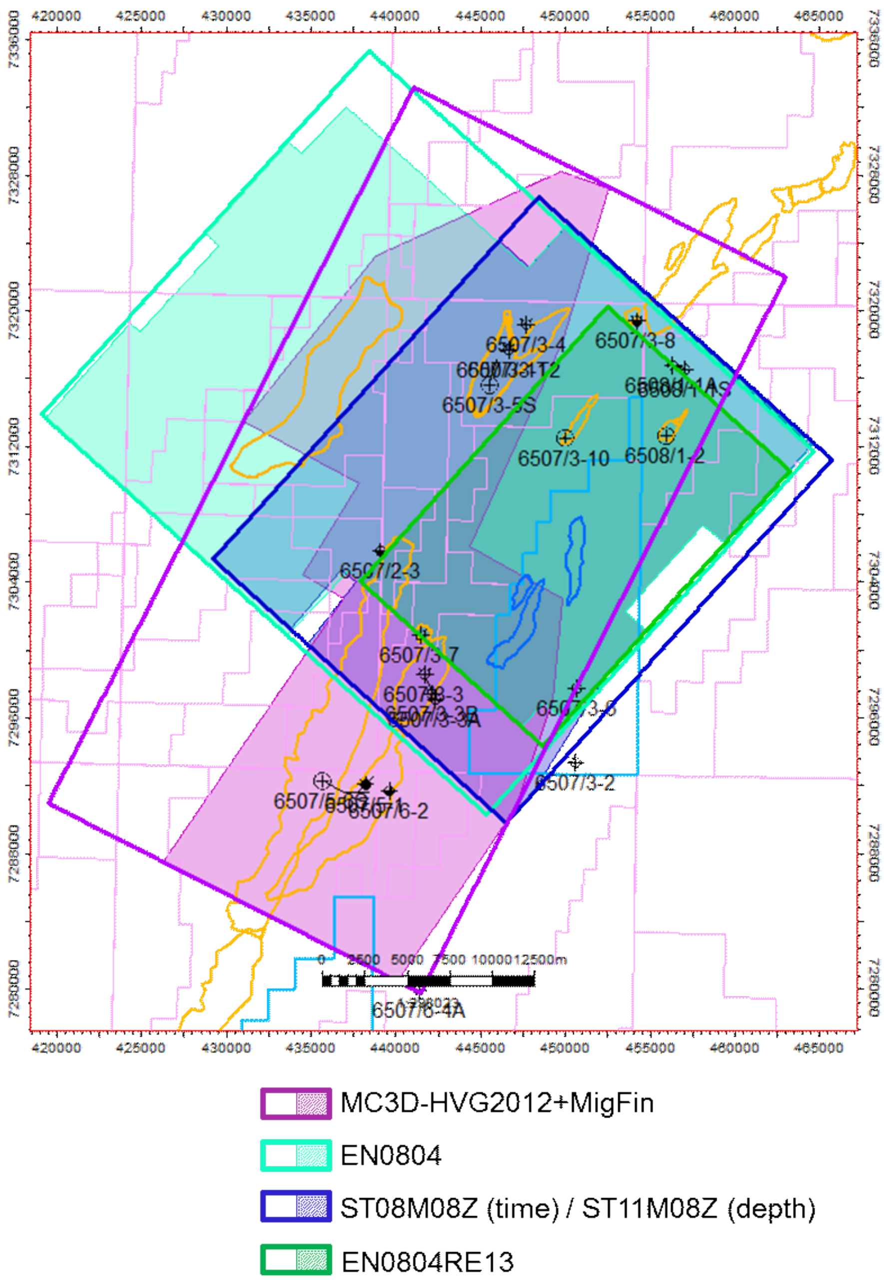


Figure 2.1 PL650 database

2.2 Well database

Two wells have been added to the common database of the license; the 6507/3-10 Klara well and the 6507/3-11S Salander well. The result from both wells were used as key information in the license evaluation.

Table 2.1 Well database.

WELL	Wellbore Completion Date	License	Total depth (mRKB)	Status
6507/2-3	14/03/94	PL122	3972	Oil shows
6507/3-1	27/4/1997	PL159	2032	Gas/Cond
6507/3-2	27/4/1997	PL159	2032	Biogenic gas in Fangst Gp.
6507/3-3	16/06/99	PL159	4275	Gas/Cond
6507/3-4	30/04/04	PL159	4092	Gas Shows
6507/3-6	23/06/09	PL383	1650	Dry
6507/3-7	22/7/2009	PL159D	3855	Gas, Jurassic sst.
6507/3-8	15/12/09	PL159B	2990	Oil/Gas
6507/5-1	05/03/1998	PL212	4224	Oil/Gas/Cond
6507/5-2	23/9/1999	PL212	3897	Gas/Cond
6507/5-4	15/4/2001	PL212	3812	Oil/Gas
6507/5-5	14/2/2002	PL212	3948	Oil
6507/6-1	23/8/1986	PL123	4040	Biogenic gas, Åre Fm.
6507/6-2	16/07/91	PL123	4354	Oil shows
6507/6-3	24/11/08	PL212C	1850	Dry
6507/6-4	16/11/11	PL350	1333	Dry
6508/1-1	29/08/99	PL213	2750	Dry
6508/1-2	09/12/2011	PL482	1810	Oil/Gas
6608/10-2	29/01/94	PL128	3678	Oil/Gas
6608/10-4	03/06/1994	PL128	2800	Oil/Gas
6608/10-9	18/02/2003	PL128	2400	Oil
6507/3-10	13/08/2013	PL159C	3455	Oil
6507/3-11S	15/08/2015	PL650	2470	Dry

3 Review of geological and geophysical framework

In connection with the license work the following geological and geophysical studies and results were used in the evaluation of the prospectivity of PL650:

- Reprocessing of the EN0804
- Basin modelling
- AVO
- The 6507/3-10 Klara well drilled in PL159C
- The 6507/3-11S Salander well drilled in PL650

EN0804 Reprocessing details
A FFA noise reduction and spectral enhancement were performed on the EN0804 seismic, unfortunately not resulting in significant improvement of the seismic quality. The imaging of low angle faults was still problematic. Better imaging was achieved by a PSDM reprocessing, resulting in reduced interpretation uncertainty associated with the Salander structure. Specific areas for improvement were multiple attenuation and the velocity model used in the PreSDM.

Input to the reprocessing was the EN0804 SEG-D data and acquisition report, the processing grid and migration velocities from ST11M08, EN0804 far-field signature, interpreted horizons and check shots, deviation and sonic logs from key wells.

Basin modelling
The main objectives of the 3D basin modelling study were to assess the potential source rocks in the drainage area of the prospects, their thickness, lateral extent and organic richness and to investigate the burial, thermal and maturity evolution and the timing of petroleum generation and calculate the generated and accumulated HC volumes. The study area covered the Blocks 6507/1-12 and 6508/1-3, including the Snadd, Skarv, Marulk and Alve Fields and their respective drainage areas in addition to the PL650 license area.

The 3D model included three potential source rocks: the late Kimmeridgian to Ryazanian Spekk, the late Callovian to early Kimmeridgian Melke and the Rhaetian to Sinemurian Åre Fm. coals and shales. The mentioned units were assessed regarding their thickness, organic richness, kerogen type and observed maturity in the 17 wells in the focus area. The 3D basin model was built up using 12 regionally interpreted depth surfaces, from the Top Naust Fm. to Top 2nd Evaporite unit (within Åre Fm.). More than 300 temperature data points from 40 wells and 200 vitrinite measurements from 6 wells have been utilized to model the temperature evolution.

The modelled heat-flow evolution was calibrated to the observed temperature data to achieve the best fit with 48-54 mW/m2 present-day basal heat flow. Oil generation starts at 3000 m BMSL and peak generation is at 3800-4400 m BMSL, depending on kerogen type. Migration modelling was carried out using the detailed, 250 m resolution depth maps and fault polygons/ fault planes in PetroMod Hybrid Migration.

The migration modelling successfully reconstructed the proven Jurassic and Cretaceous discoveries in the area, and predicted the Salander and Blomkvist Prospects to be hydrocarbon filled (Figure 3.1), if sealed by updip faults. The main HC migration pathway to the Salander Prospect could have been the Top Spekk (=BCU) surface, which is draping the fault blocks in the western areas. Additional HC migration pathways could have been the Lange and Lysing sands and the potential fill-spill route from the 6507/3-3 Idun Field, which is filled to spill.

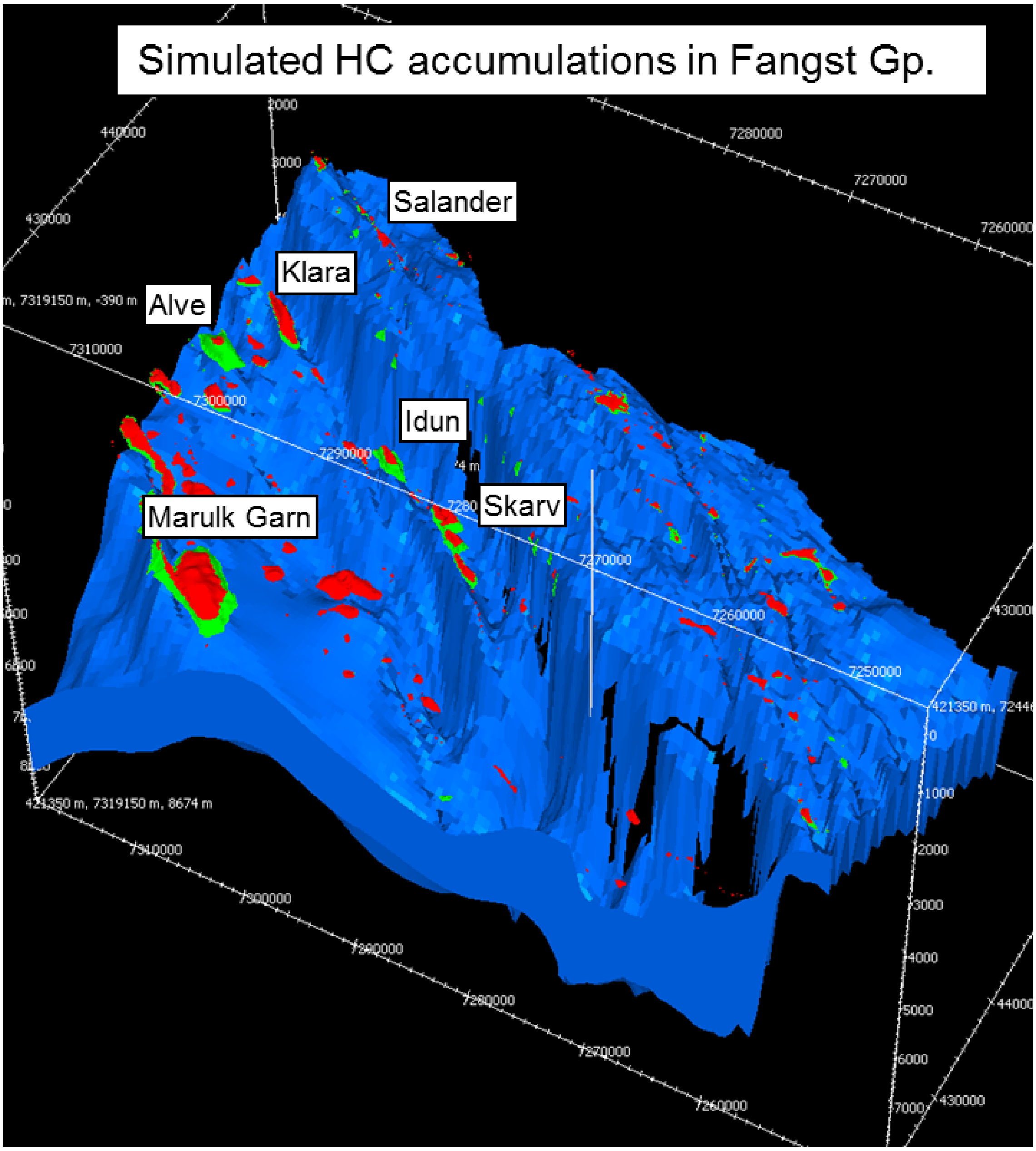


Figure 3.1 Simulated hydrocarbon accumulations in the Fangst Group

During the HC migration modelling, it was observed, that the fault zone representing the eastern, north-eastern sealing fault of the Salander Prospect has a very important role: if that fault was not sealing, then Salander Prospect was not filled (Figure 3.2).

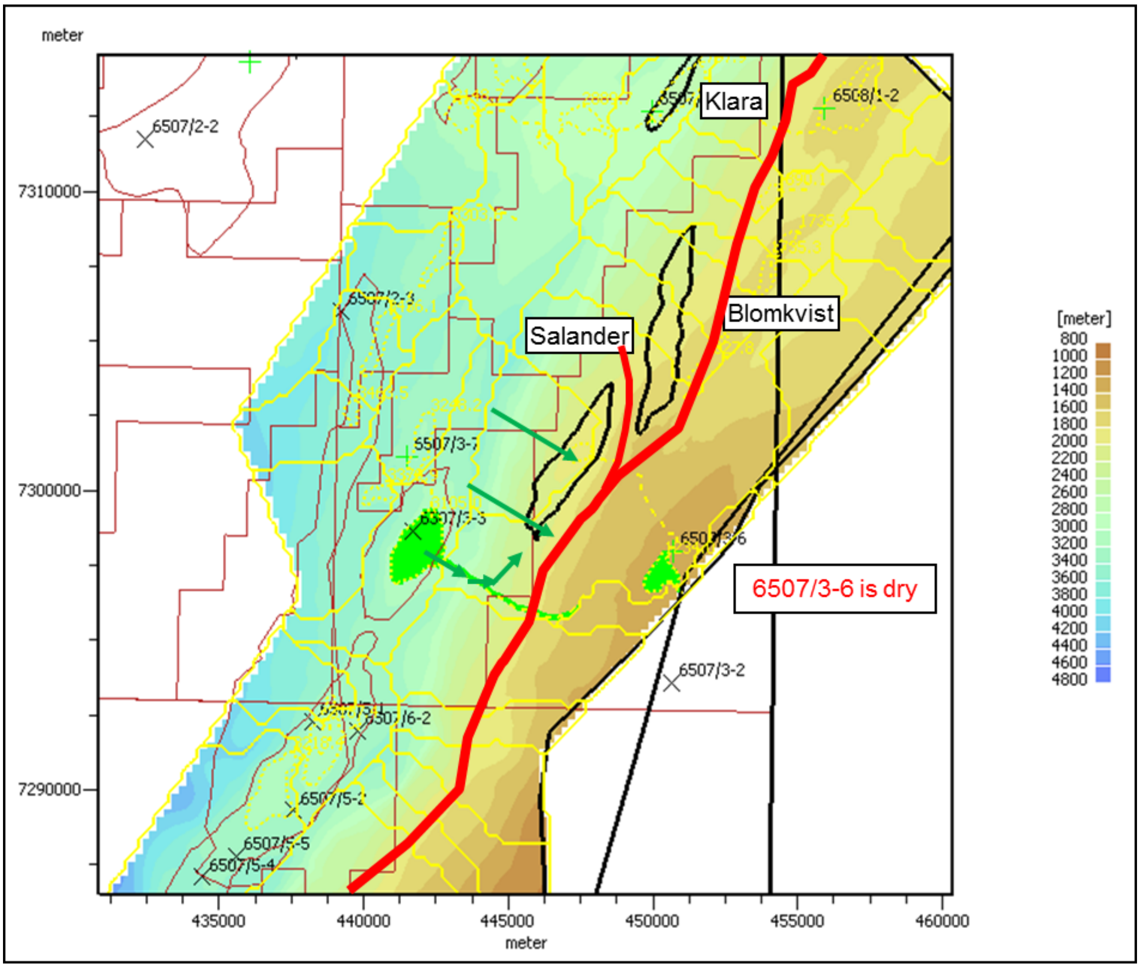


Figure 3.2 Primary hydrocarbon migration from kitchen to Salander.

AVO study

Pre-drill QI and DHI assessment of the Salander prospect was performed by the license. The study was challenging. The Kirchhoff PSDM seismic cubes were too noisy to use for structural interpretation. This forced the interpretation team to use the Amplitude-Preserving Controlled-Beam Migration (APCBM) PSDM cubes, which demonstrated better structural imaging and were assumed to have more a reliable AVO response. The structural complexity of the prospect was high, with possible Fangst Gp interference with Cretaceous/Spekk/Melke, possible wedges, thin layers, and strong faulting.

A rock physics study performed by IKON Science on the neighbor wells indicated that one might expect class IIp/IIn for brine-filled Garn and class IIn/III for oil-filled Garn in the Salander prospect.

The pre-drill QI study revealed a spatially varying AVO response, seemingly with down-flank amplitudes becoming stronger with increasing angle (class III) (Figure 3.3). Close to the apex the amplitude was weaker. The near and mid stacks were clearly affected by multiples and imaging issues.

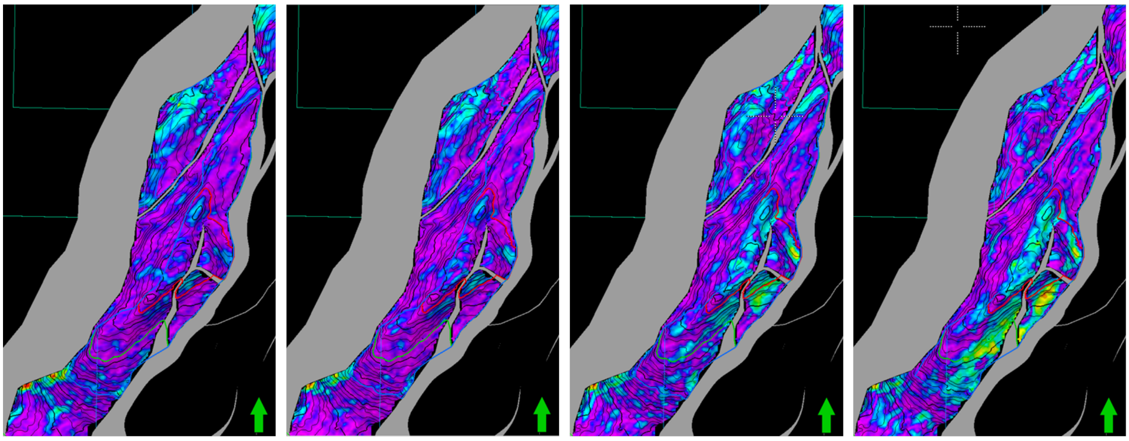


Figure 3.3 RMS amplitude maps on Salander

Amplitude maps from cross-plots and EEI (fluid factor) volumes show scattered responses with poor structural conformance. The result of the pre-drill AVO studies led to no DHI uplift on the pre-drill probability of discovery, and the prospect was not strictly amplitude-driven.

The post-drill evaluation indicates that Top Garn should be a weak class IV in the brine case and stronger (more negative) class IV in the oil case, contrary to the expected class II/III expected pre-drill. It has been shown that this is likely caused by the lower part of Melke Fm having different properties than expected (i.e. much lower Vp/Vs – lower than in Garn Fm).

6507/3-10 Klara well

During the license period the 6507/3-10 Klara well was drilled in the PL159C located direct towards north of the PL650. The Klara prospect is located west of the Revfallet Fault Complex, in a transition zone between the Nordland Ridge and the Dønna Terrace. The well targeted the Mid-Jurassic Fangst and Båt Groups in the Klara prospect. The well encountered a small oil column in the Garn Formation with reservoir characteristics as expected. The discovery is considered non-commercial. The 6507/3-10 Klara well was included in the common database in the PL650 license.

6507/3-11S Salander well

The main well information for the PL650 license since the award is the 6507/3-11S Salander well drilled within the PL650 license in July 2015 (Figure 1.1). The well targeted the Mid-Jurassic Fangst and Båt Groups. The Salander prospect is a 3-way closure on a rotated fault block along the Revfallet Fault Complex. The well was proven to be dry.

The reservoir quality was one of the main risks when evaluating the Salander prospect, as none of the offset wells have tested the Jurassic section in the same structural setting within the Revfallet Fault Complex. The 6507/3-11S Salander well proved the presence of the Middle Jurassic Garn, Ile, Tilje and Åre Formations with very good reservoir quality within the Revfallet fault Complex (see Figure 3.4). The well was dry, with no shows, but the post well geochemical study did show presence of thermogenic gas in the cuttings. This indicates migration of hydrocarbons through the structure. The volumes seen were not large, therefore charge and migration still remain a risk in the area.

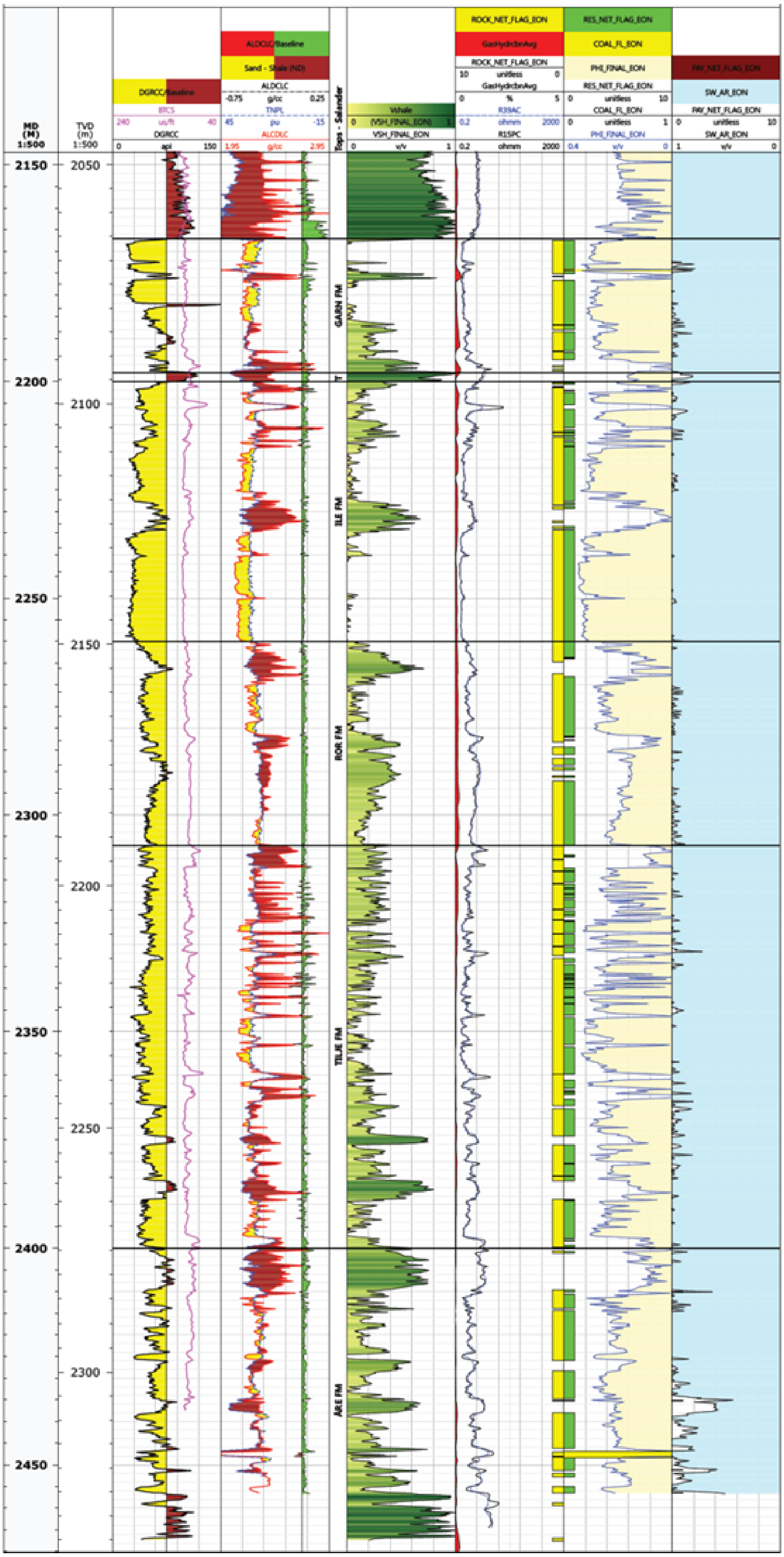


Figure 3.4 CPI from the 6507/3-11 S Salander well.

4 Prospect update

The prospects described in the license application were Salander and Blomkvist, both Middle Jurassic structures. Salander was described as the main prospect and the Blomkvist structure was describes as a lead.

The main prospect in PL650, Salander, is located in the western part of PL650 (Figure 1.1). The structure is a breached relay ramp within the Revfallet Fault Complex and located up-flank of the Idun and Skarv Fields (Figure 4.1). The primary reservoir target was sandstones in the Fangst Group; the Garn and Ile Formations. Secondary target was sandstones in the Båt Group; the Tilje and Åre Formations.

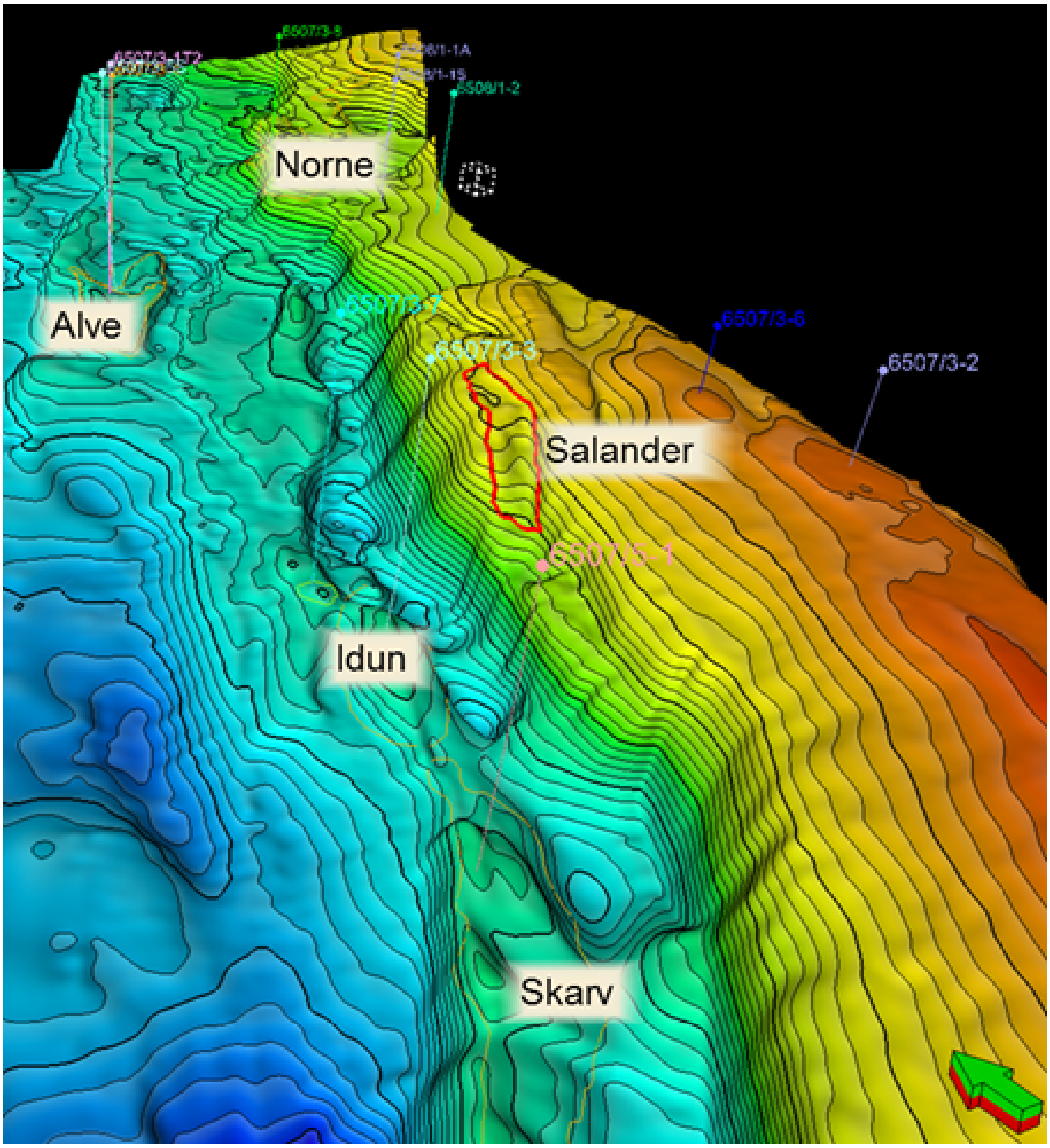


Figure 4.1 The Salander location in relation to the Idun and Skarv Fields.

The main risk on the Salander prospect in the license application was reservoir presence, as no wells had been drilled in the same structural setting within the Revfallet Fault Complex. In addition it was challenging to make a seismic tie to the offset wells. One possible outcome was that the Salander structure did contain Lower Jurassic and Triassic reservoir rocks. In addition to reservoir presence, both charge and trap seal were considered to be relatively high risk in the prospect evaluation.

Both in the license application, and within the PL650 license group, the Salander prospect was considered the structure with best potential in the license. A drill decision was made in June 2014, and the Salander prospect was drilled in July 2015. The well was designed to test the minimum economic volumes, and was drilled down-flank on the structure, leaving a small, uncommercial 4-way closure on all reservoir levels un-tested (Figure 4.2). The well was dry in both the Fangst and the Båt Groups. The well was plugged and abandoned, and no sidetrack was drilled.

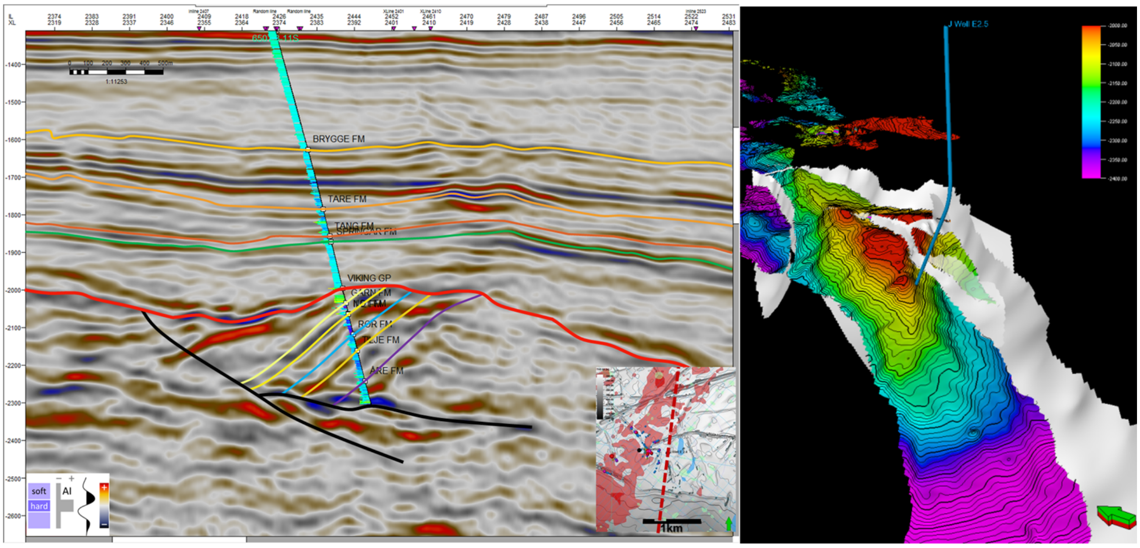


Figure 4.2 6507/3-11 S Salander well location and post well seismic cross section.

The interpretation of the well results indicates that there are no significant hydrocarbons present in the well. The reservoir quality in the well is good, and the presence of thermogenic gas in the cuttings indicates the charge into the structure has been present. The most likely reason for the prospect failing is the presence of seal capacity. Seal was assumed to be one of the main pre-drill risks for the prospect.

Pre well the Top Garn, Tilje and Åre were interpreted whereas top Not, Ile and Ror were estimated using isochore data from the wells in the vicinity. Most formation tops were within the uncertainty range, except from the Top Åre Fm which was encoutnered 72m (TVD) deeper than prognosed.

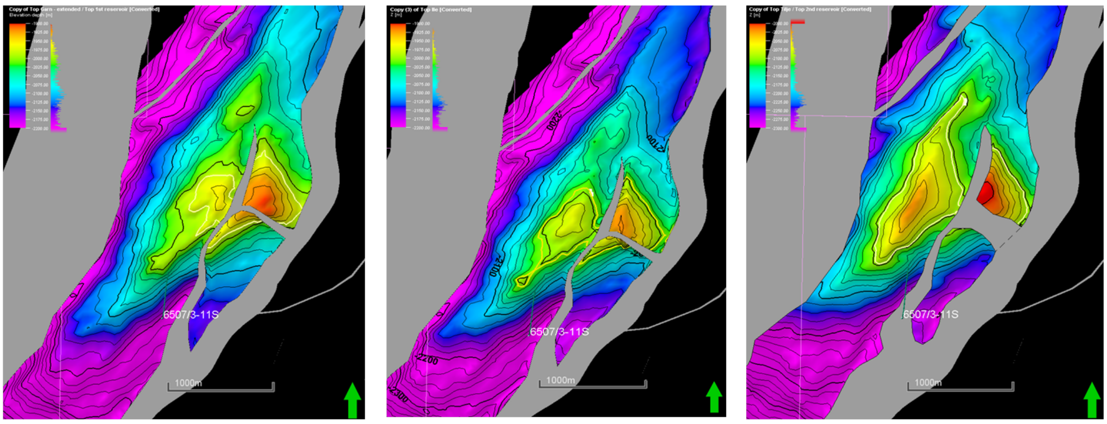
The Fangst Group was found to consist of medium to coarse-grained, well-sorted sandstones in the Garn Formation and a highly heterogeneous sandstone-rich facies in the Ile Formation. The Garn and Ile Formations are separated by the Not Formation mudstones. The Tilje Formation secondary target within the Båt Group is highly aggradational and sand-prone with frequent lagoonal mudstone in the lower part.

The reservoir quality and thickness seen in the well were in general better than expected (see Table 4.1).

Table 4.1 Salander prospect properties comparison pre and post well values.

	Gross thickness m		Net thickness m		N/G		Porosity	
	Pre well	Post well	Pre well	Post well	Pre well	Post well	Pre well	Post well
Garn Fm	24	31	17	16	0.7	0.51	0.25	0.28
Ile Fm	18	60	12	47	0.7	0.78	0.25	0.29
Tilje Fm	51	123	16	60	0.63	0.49	0.25	0.24

The 4-way closure in Salander was not tested in the well. If charge and migration have worked, but the trap seal has failed in Salander attic volumes could be trapped within the 4-way closure (Figure 4.3). Volumes and probability of discovery for an attic oil accumulation have been calculated and are listed in Table 4.2. The volumes calculated assume the oil-water contact is at the 4-way closure, with no spread in contact. The spread in volume is due to uncertainty in the other parameters. The volumes in Table 4.2 can be considered as the maximum possible remaining volumes in the Salander structure. The probability of success and the volume potential in the Salander 4-way closure is considered to be too low to be considered as a future drill candidate in PL650.



Top Fangst post well (CI 20m) | Top Ile post well (CI 20m) | Top Tilje post well (CI 20m)

Four-way closure Max contact at 1980m TVDSS | *Four-way closure Max contact at 2010m TVDSS* | *Four-way closure Max contact at 2095m TVDSS*

Figure 4.3 Salander 4-way structure at Top Fangst, Top Ile and Top Tilje Fms levels.

Adjacent to the Salander structure is the Middle Jurassic Blomkvist lead (Figure 4.4 and Figure 4.5). The Blomkvist lead is at similar depth as the Salander structure, but is smaller and was considered to have higher risk than the Salander prospect initially. The Blomkvist lead was described in the license application. The structure was considered to be dependent on a fill-spill route through the Salander structure to be charged. Based on the well result from the Salander well the access to charge is considered as the main risk on Blomkvist, in addition to a high risk on trap validity.

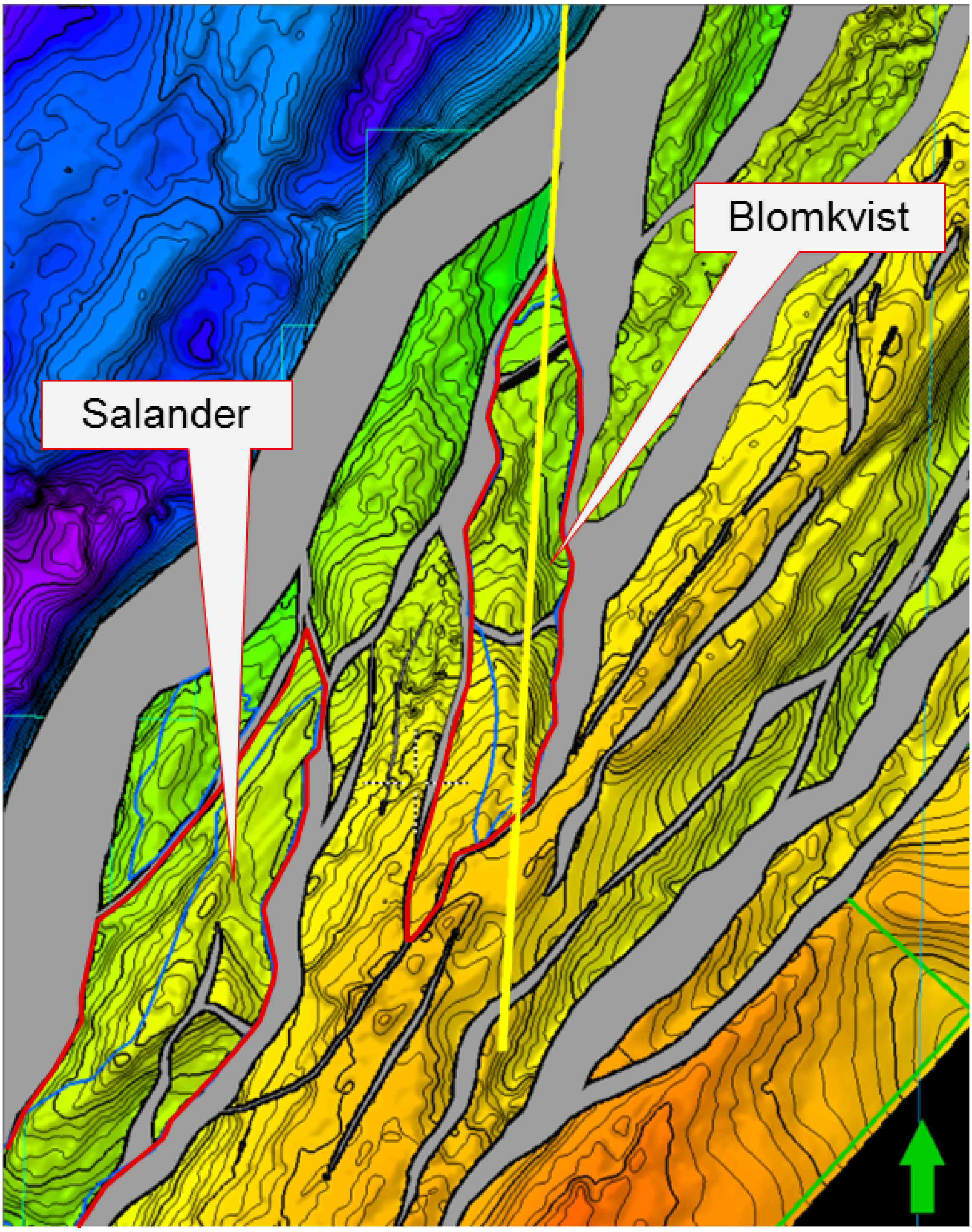


Figure 4.4 Top Fangst reservoir depth map. Yellow line shows location of Figure 4.5.

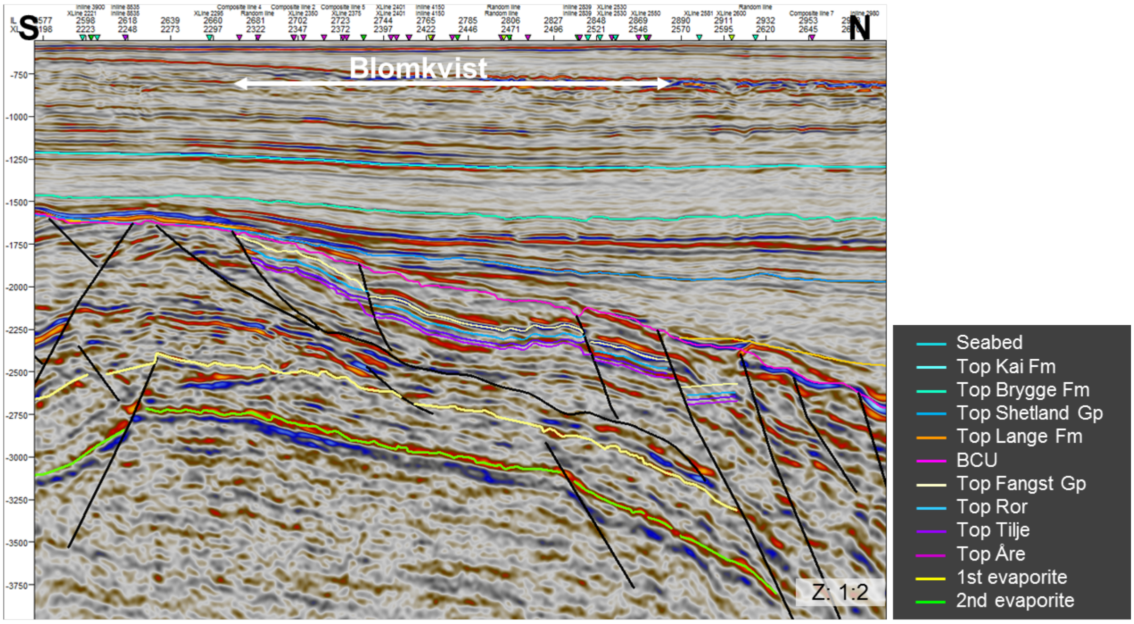


Figure 4.5 Seismic line through the Blomkvist structure.

No volume calculation was performed in connection to the license application on the Blomkvist lead. The current volumes and risk numbers are listed in Table 4.2. The volume potential in the Blomkvist structure is of medium size, but the probability of success is too low to be considered as a drill candidate in PL650.

During the license period the Vanger structure was mapped (Figure 4.6 and Figure 4.7). Vanger is a Middle Jurassic lead and was considered as a possible follow-up candidate to a discovery in the Salander well. The Vanger lead is located in the northern part of PL650, at the western limit of the Revfallet Fault Complex. The structure is located adjacent to the Klara technical discovery in PL159C. The Vanger lead is defined by a bright amplitude at Top Fangst level on both Near, Mid and Far stack data (Figure 4.8).

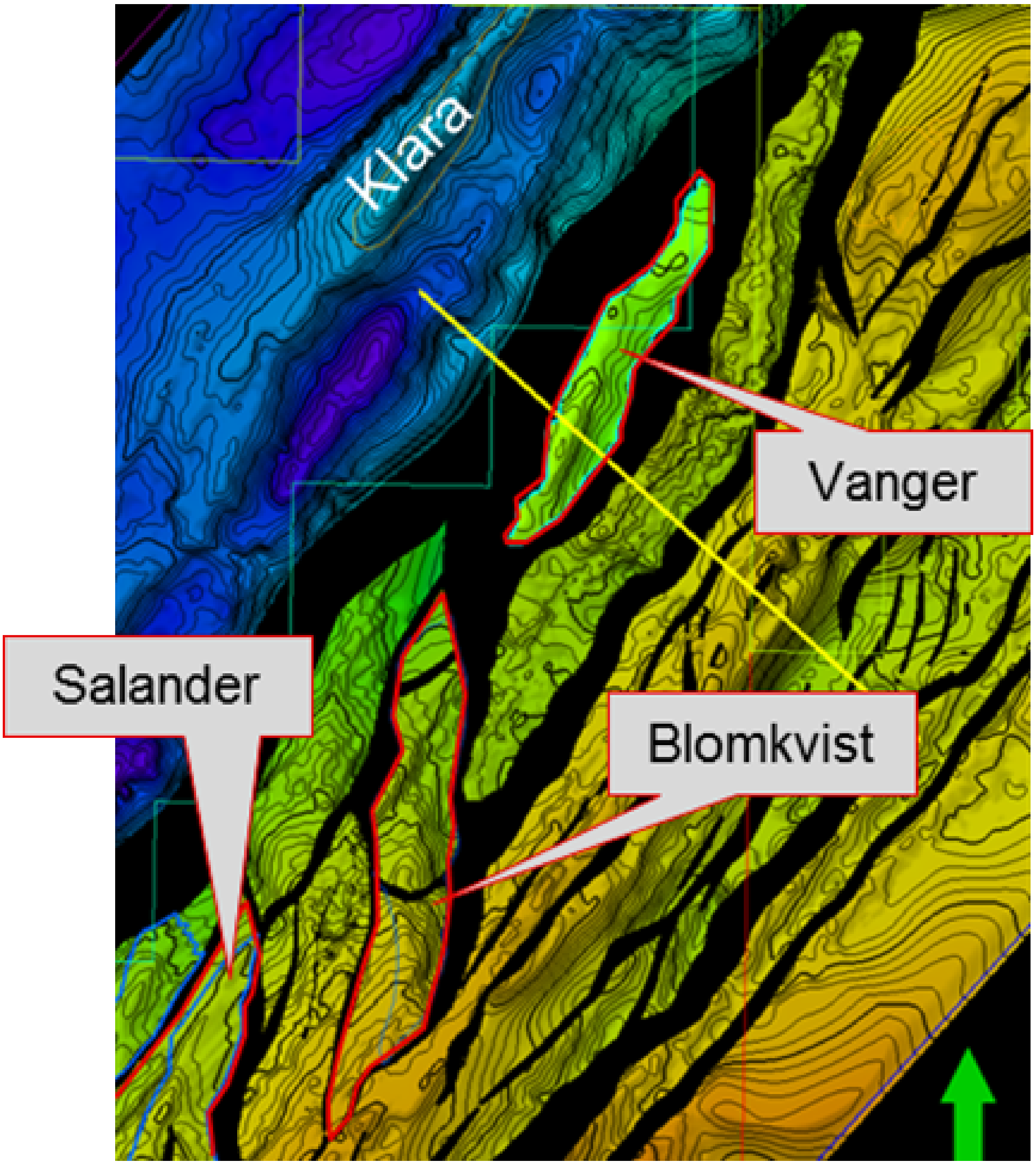


Figure 4.6 Top Fangst reservoir depth map. Yellow line shows location of Figure 4.7

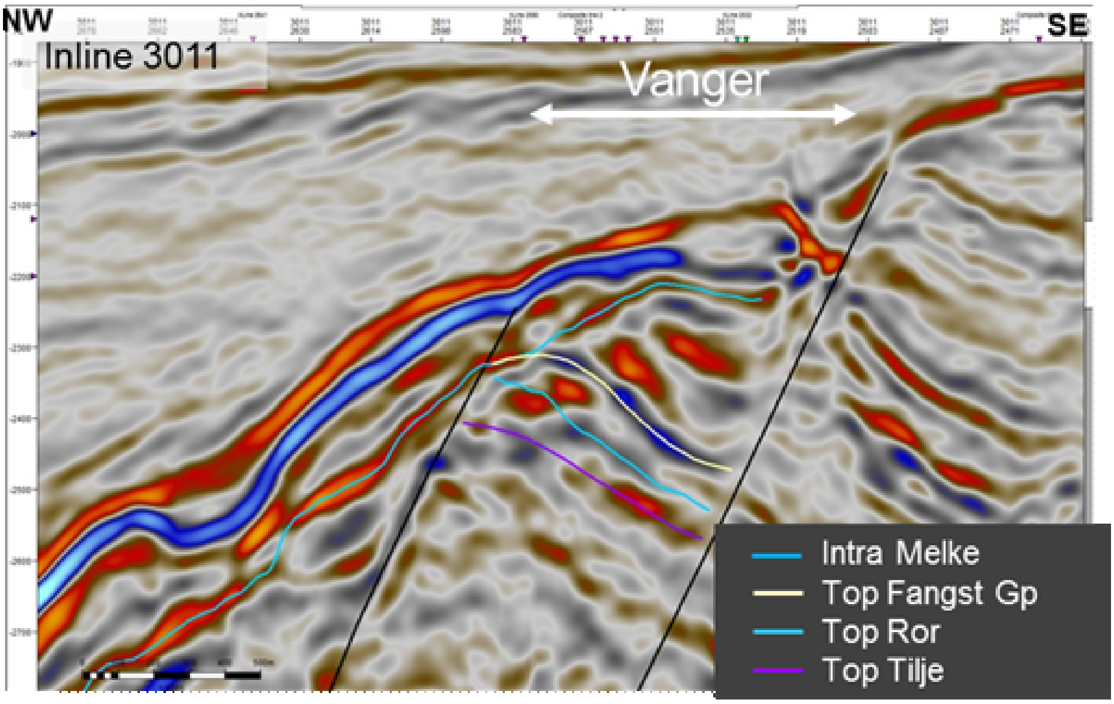


Figure 4.7 Seismic line through the Vanger structure.

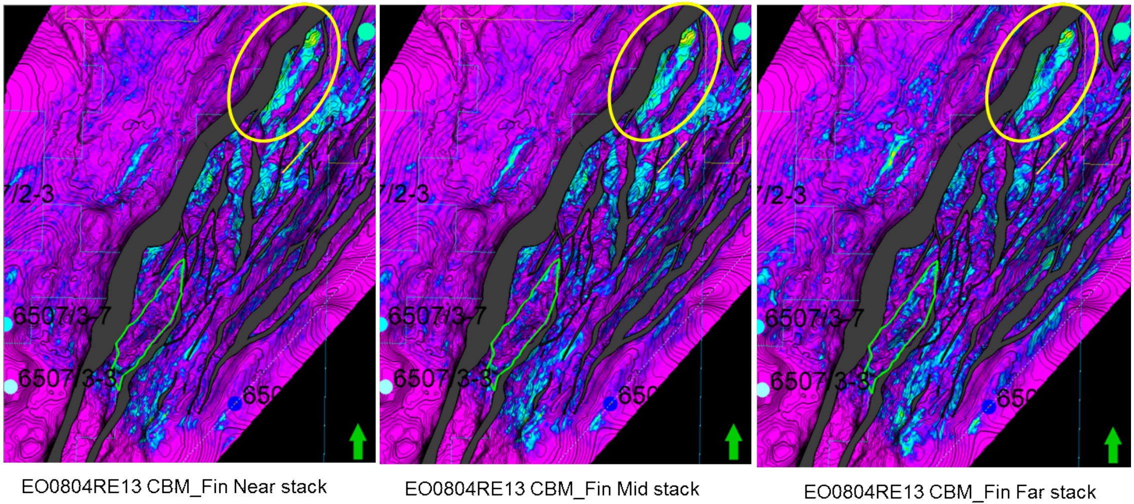


Figure 4.8 Top Fangst RMS amplitude map (±8ms). Vanger location is marked by a circle.

Table 4.2 PL650 volumes and probability of discovery. Salander pre and post well.

	Inplace mmboe				Recoverable mmboe				Probability of discovery
	Pmean	P90	P50	P10	Pmean	P90	P50	P10	
Salander in the application	241.1	54.9	209.7	474.9	72.2	15.4	60.2	146.9	16%
Salander 4-way	19.2	4.3	18.6	31.0	7.1	2.1	6.7	11.7	13%
Blomkvist	117.6	45.0	107.5	208.1	44.4	14.7	38.9	82.7	12%
Vanger	62.7	27.0	56.9	107.5	24.5	8.6	22.3	43.6	17%

The main risk on Vanger is access to charge/migration and trap validity. The migration pathway to the Vanger structure can be different than the pathway for the Salander and Blomkvist structures. The current volumes and risk numbers on Vanger is listed in Table 4.2. The volume potential in the Vanger structure is considered to be low, and combined with a low probability of success the Vanger lead is not considered as a drill candidate in PL650.

It is only the Middle Jurassic play that is considered to be prospective in PL650. The Paleocene Tare and Tang Fms and the Miocene Kai Fm have been evaluated it has not been possible to define prospects or leads at these levels.

5 Technical evaluation

The technical evaluations regarding a possible development of PL650 were performed prior to the drilling of the Salander structure and are based on a possible discovery in Salander. Two hosts were considered as possible for a PL650 development; the Norne or the Skarv Fields, where Norne is located 25km north of the Salander structure and Skarv is located 16km south-west of the Salander structure (Figure 5.1). Both are FPSO. The Skarv Field was considered as the preferred candidate.

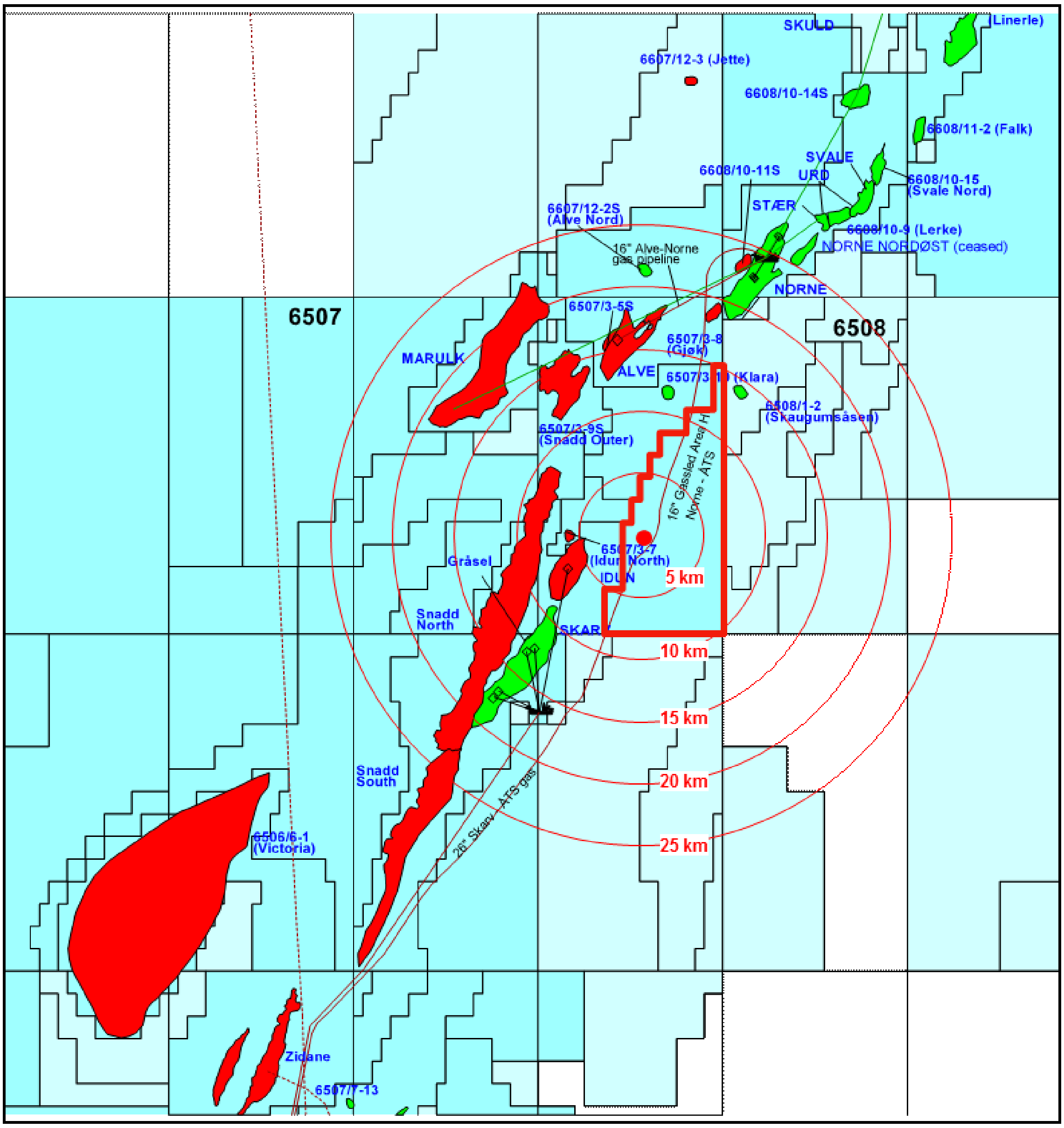


Figure 5.1 Distace from the potential Salnder discovery to the Skarv Field

The P50 solution for Salander is assumed to have been a subsea tie-back to Skarv with dual flowlines for regularity / flow assurance. The solution assumes ullage at Skarv, and available risers at Skarv. The development could be influenced by the timing of the Snadd development, as Snadd would come in before any Salander development. The technical solution suggested includes a 6-slot central template, with three producers and two gas injectors (Figure 5.2). For pressure support it was planned to use gas re-injection from Skarv, with a late-life gas blowdown.

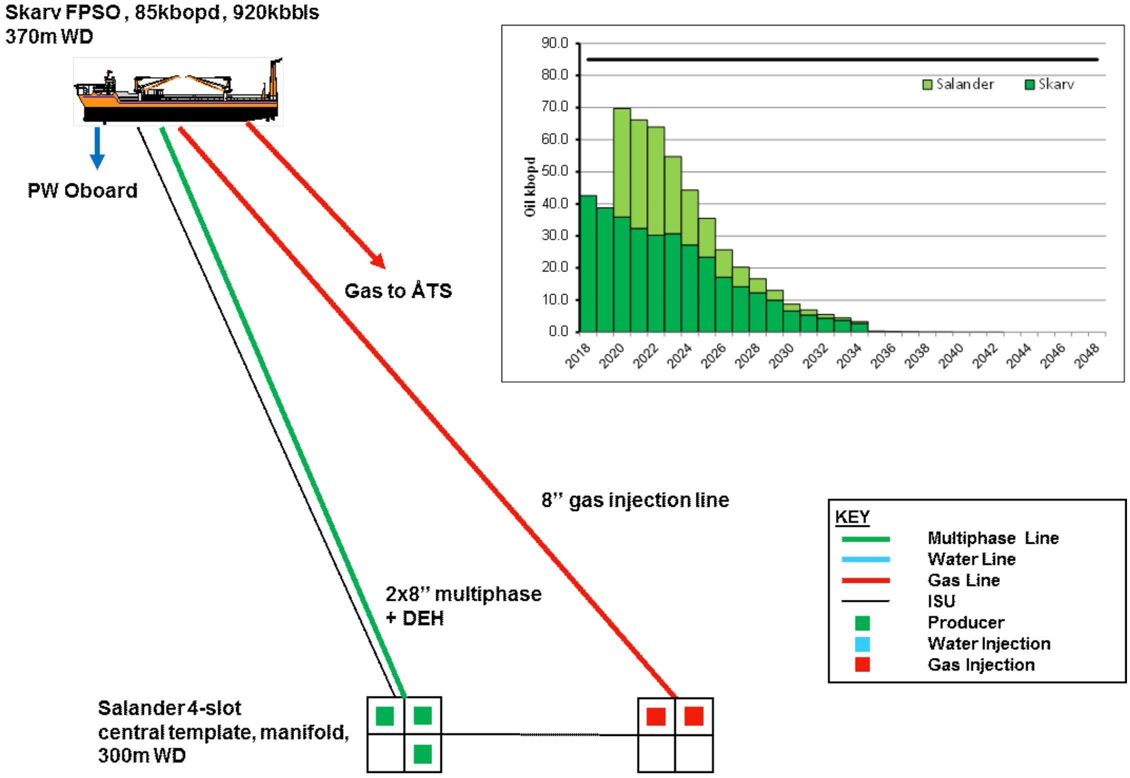


Figure 5.2 Development solution and P50 production profile for Salander.

For a P10 solution, a subsea tie-back to a new-build semi-sub facility was considered.

6 Conclusion

The PL650 work commitment has been fulfilled, and a well has been drilled in the license.

It is not possible for the license to move forward with a BoK in the PL650 based on the remaining potential in the license. The decision to surrender the license is unanimously supported by the partner in the PL650 license.