Status report at licence expiry PL 550

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1 Key license history

Production license 550 comprises 468.956 km² and cover parts of blocks 31/1 and 31/2. The license was awarded on 19th February 2010 for a six year initial period with a drill-or-drop decision on 19 th February 2012. The area applied for was awarded as two Production Licenses, PL550 and PL551, respectively. Initial partners in the license were Wintershall Norge (Operator, 60%) and Spring Energy (40%). The commitments for the initial period were to reprocess 3D seismic and to carry out G&G studies, which have been fulfilled. Several prospects were identified in the submitted application in 2009, see Fig. 1.1 and Fig. 4.1

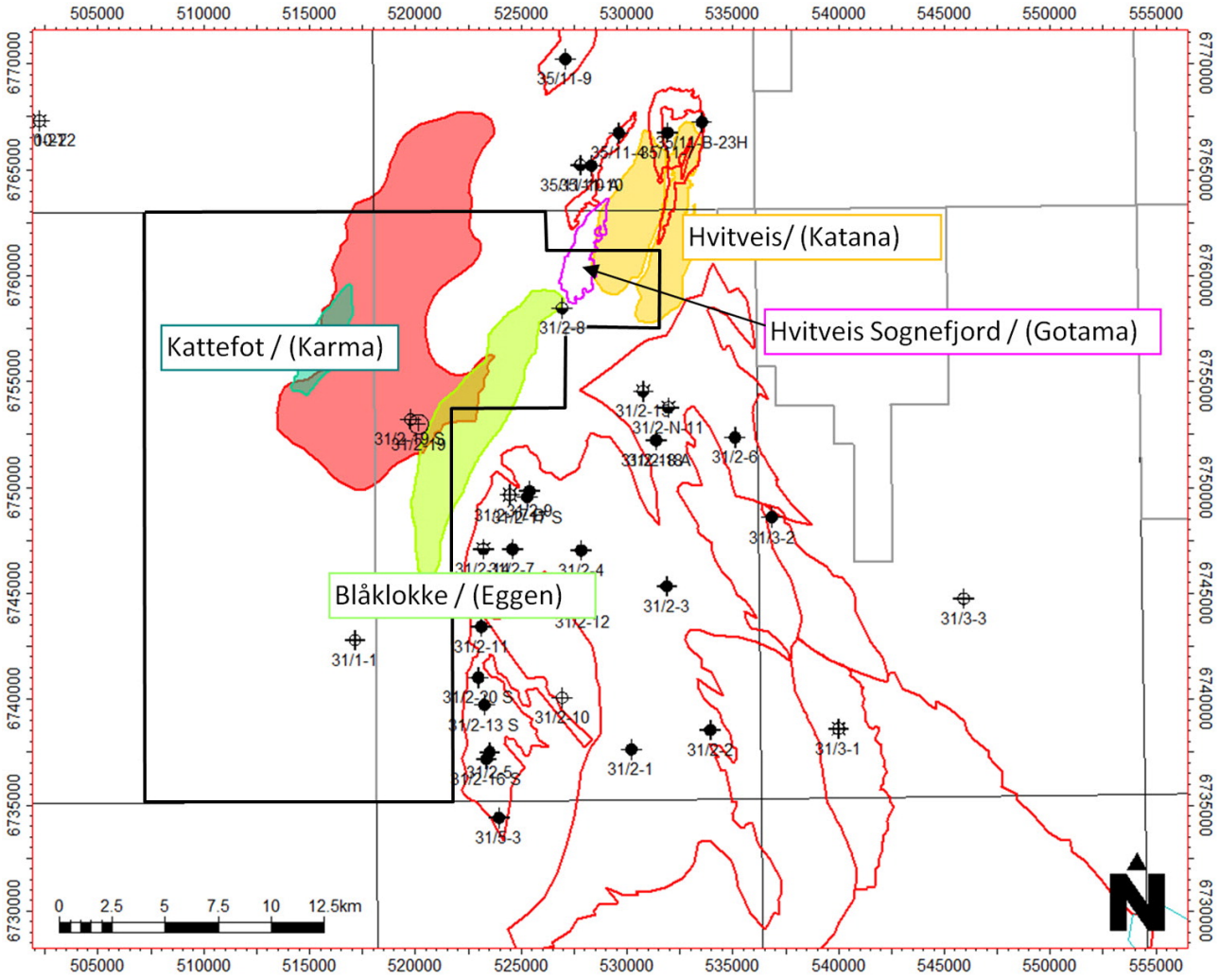

Fig. 1.1 PL550 Prospect map at time of application.. *Prospect names as in the 2009 Application. The names in the parentheses are the prospect names referred to in this report.*

All prospects and leads were located around the northern rim of the Troll Field, a drill decision was taken on the Upper Jurassic Draupne Gotama prospect in 2012. Wintershall farmed out its interest to Spring Energy. Det Norske farmed into the license with a 10% share. Tullow Oil took over Spring Energy's obligations after aquistion of the company January 2013. In 2014 VNG farmed into the license with 10% share. The license group consists of Tullow Oil (80%) , Det Norske (10%), and VNG (10%) at the time of reliquishment. After drilling of the dry 31/2-21 S (Gotama) well, the license group applied for an extension of the decision to continue (BOV).
The license group was granted a two year extension of the decision to continue (BOV) in a letter from MPE dated 11.09.2014. The "BoV" is 19.6.2017. The reason for the extended deadline was to fully integrate the results from well 31/2-21 S in the evaluation of the remaining resource potential.

Nine formal MC meetings have been held in the license and fifteen EC meetings including EC workshops. Minutes and/or presentations from the meetings are on L2S.

The Middle Jurassic Karma prospect and the Upper Jurassic Alpha lead were regarded as the most attractive potential in the license. A technical-economical study for the Karma prospect was carried out, but the evaluation concluded that the hydrocarbon resource potential was not sufficiently robust.

Technical work performed by the operator could not define the upside potential which could support a commercial Karma development project.

A unanimous decision to relinquish the license was recommended by Exploration Committee and supported by the Management Committee, and the Ministry of petroleum and Energy was notified by letter dated 26.09.2016.

2 Database

2.1 Seismic data

Geophysical database comprising seismic & CSEM database is shown in Fig. 2.1

SEISMIC_SURVEY	NPD ID	PROCESSING_YEAR	SURVEY_TYPE	OWNER
NH9401WIM11	3674	2011	3D	PL550
NH9401TUNR13	3674	2013	3D	PL550
SEN12302	7722	2012	2D SITE SURVEY	PL550
MN9201R05-NH9401R05	3596 / 3674	2005	3D	Marathon
TrollMC14	-	2014	3D CSEM	PL550

Fig. 2.1 Seismic and CSEM (EM) database for PL550

2.2 Well data

The wells used to evaluate the prospectivity of the PL550 license is listed in Table 2.1

Table 2.1 Well database PL550. Well 31/2-21S was drilled in the license period

WELL NAME	NPD ID	COMPLETION DATE	TD	LITHOSTRATIGRAPHY	HC DISCOVERY
31/1-1	5765	15/02/2008	2920	STATFJORD FM	DRY
31/2-8	78	18/08/1982	3375	HEGRE GP	OIL SHOWS
31/2-9	88	01/10/1982	1770	FENSFJORD FM	OIL/GAS
31/2-14	106	21/06/1984	1725	FENSFJORD FM	OIL/GAS
31/2-15	439	15/11/1984	1677	FENSFJORD FM	OIL/GAS
31/2-17 S	1885	20/01/1992	2220	FENSFJORD FM	OIL/GAS
31/2-19 S	2798	13/07/1996	4114	STATFJORD FM	DRY
31/2-N-11 H	5102	24/08/2005	4275	BRENT GP	OIL/GAS
35/10-1	1822	16/01/1992	3986	STATFJORD FM	OIL
35/10-2	2783	22/08/1996	4677	STATFJORD FM	GAS
35/10-3	3719	15/07/1999	2223	JORSALFARE FM	DRY
35/11-4	1523	27/01/1992	3127	STATFJORD FM	OIL/GAS
35/11-5	1780	03/11/1991	3769	STATFJORD FM	OIL/GAS
35/11-7	1979	29/09/1992	2895	STATFJORD FM	OIL/GAS
35/11-8 S	2772	11/05/1996	3624	DRAKE FM	OIL/GAS
35/11-10	3042	23/06/1997	2928	COOK FM	OIL/GAS
35/11-11	3356	22/05/1998	3225	DRAKE FM	SHOWS
35/11-B-23 H	5641	13/01/2008	3653	COOK FM	OIL
31/2-21 S	7416	04.06.2014	3217	COOK FM	DRY
35/11-10 A	3151	14.07.1997	3259	MIDDLE JURASSIC	OIL SHOWS
35/12-3 S	6516	16/02/2011	2807	ETIVE FM	DRY
35/11-14 S	5365	07.12.2006	3306	HEATHER FM	OIL
35/11-16 S	7303	18.03.2014	3554	LATE JURASSIC	OIL

2.3 Special studies

TUN12001 was a post-stack merge processing work carried out to gain better regional understanding of the Upper Jurassic structural evolution.
The NH9401R13 was a pre-stack depth migration processing aiming at improving seismic imaging close to the Troll faults.

The 3D CSEM acquisition and processing, TrollMC14, was used to assess Paleocene potential.

3 Review of Geological and Geophysical studies

The following studies has been performed as part of the PL550 work obligations as relevant to the prospect evaluation of the licence area.

- The report: "Gotama Prospect Well 31/2-21 S. Geological interpretation of AFR borehole image logs (LWD)" by Eriksfiord October 2014 concluded that the Oxfordian / Kimmeridgian sandstones were deposited as shoreface facies belts, i.e. Sognefjord FM. The structural dips interpreted from the logs suggest that the seismic imaging of the key reflections were imaged correctly.

- A 2D structural reconstruction study performed by shared between licences PL550, PL551, PL681, and PL744 performed by Badleys in July 2015 suggest that Karma area developed from a half graben in the early Oxfordian to a horst block during the Kimmeridgian. The study also suggested that water depths in the graben east of the Karma prospect were around 200-400 meters allowing for (potential) sediment gravity flows to deposit. This was relevant for the Alpha depositional model.

- A PaleoScan study, a semi-automatic seismic interpretation product, was carried out to get higher level of detail in the seismic surfaces and isochrones. The study did not result in any positive observations supporting the Alpha depositional model.

- A geochem study of headspace gases from 31/2-21 S indicate thermogenic oil associated gases in the Brent and Draupne Fms. These gases have a maturity of ~1.2 %Ro eq, indicative of migrated hydrocarbons and not been generated in-situ from local sources.

- Rock-Eval study of the cuttings samples from 31/2-21 S indicate oil prone source rocks in both Draupne and Heather Fms shales, but these are of immature to start oil window maturity, at well position.

- A FIS (Fluid Inclusions Stratigraphy) study in the 31/2-21 S well indicate HC migration in Sognefjord and Brent/Cook, however only rare white fluid inclusions were documented in Sognefjord Fm from thin section analysis, indicative of migration of high API (> 40^{o} API) oil/condensate.

- In-house seismic data analysis and rock physics modelling has been carried out to conclude on the expected AVO response of an hydrocarbon filled Alpha prospect.

The reports for the abovementioned studies are posted on L2S either as separate reports or reported in EC-meetings.

4 Prospect update

Fig. 4.1 shows the updated prospect and leads map after dry well 31/2-21S, Gotama.

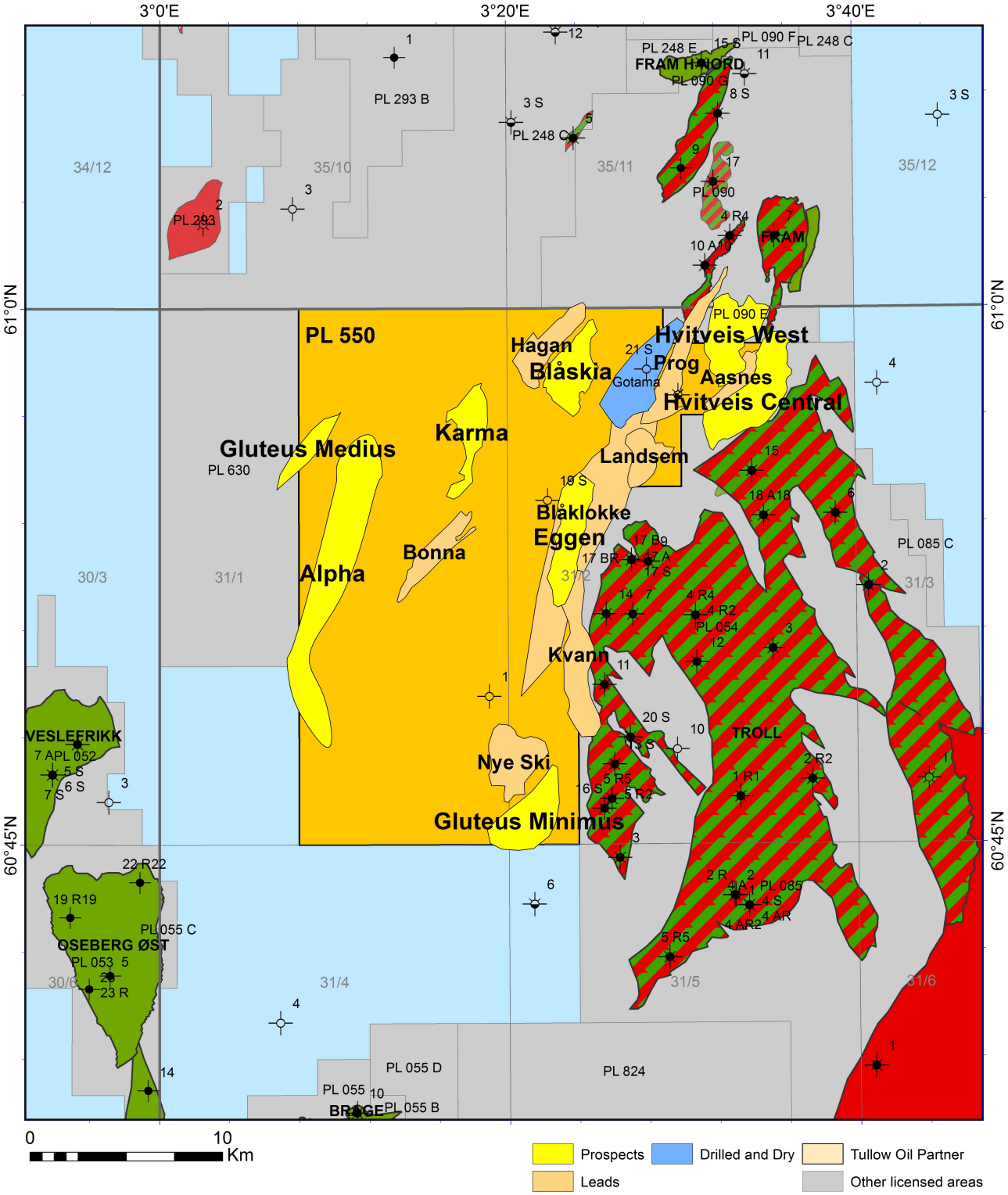

Fig. 4.1 Updated prospects and leads map for PL550

The technical failure of the Gotama Draupne prospect was lack of reservoir presence. The seismic response which was interpreted to be hydrocarbon charged Draupne sandstone was actually the response of a Draupne Fm organic rich shale. The lack of hydrocarbons in the Sognefjord Fm and the Brent Gp was most likely lack of lateral seal that was regarded as main risk for the these prospective levels. The FIS data show probably HC migration trough the Sognefjord Fm and the pressure in the formation showed a depletion of 12.9 bars compared to the initial Troll aquifer pressure. This suggests that Sogefjord Fm in the 31/2-21S well position is in pressure contact with the producing Sognefjord Fm of the Troll Field. Well 31/3-4 (Kuro, PL551), also drilled in 2014, showed a strong pressure depletion in the Sognefjord Fm too. The FIS data suggest probably HC migration for the other secondary targets, Fensfjord Fm, Brent Gp, and the Cook Fm. The pressures in these secondary targets are hydrostatic and could be part of the the greater Troll aquifer.

The implication for the remaining hanging wall Sognefjord Fm and Brent Gp prospects is higher risk on the effective lateral seal.

The main prospects in the licence after Gotama were the middle Jurassic Karma (Kattefot) prospect and the newly defined Upper Jurassic Alpha lead. The Eggen lead was initially thought to be same play as Gotama and was downgraded after the 31/2-21 S well results.

Karma prospect

The Karma prospect comprises a rotated fault block with three mid Jurassic reservoirs which are producing in the nearby fields (Upper Brent, Oseberg and Cook Fms). Hydrocarbon phase is the largest risk, set to 70% probability for an oil case. The likelihood of a technical discovery is very high, 36%, being located in a highly prolific province. However the size of the prospect is too small to meet the commercial threshold.

The structural depth map is shown in Fig. 4.2 together with a cross-section of depth converted seismic and well 31/2-19 S. The technical evaluation which is briefly summarized in 5 Technical evaluations, shows that the Karma volume potential is too low to become a robust commercial development project.

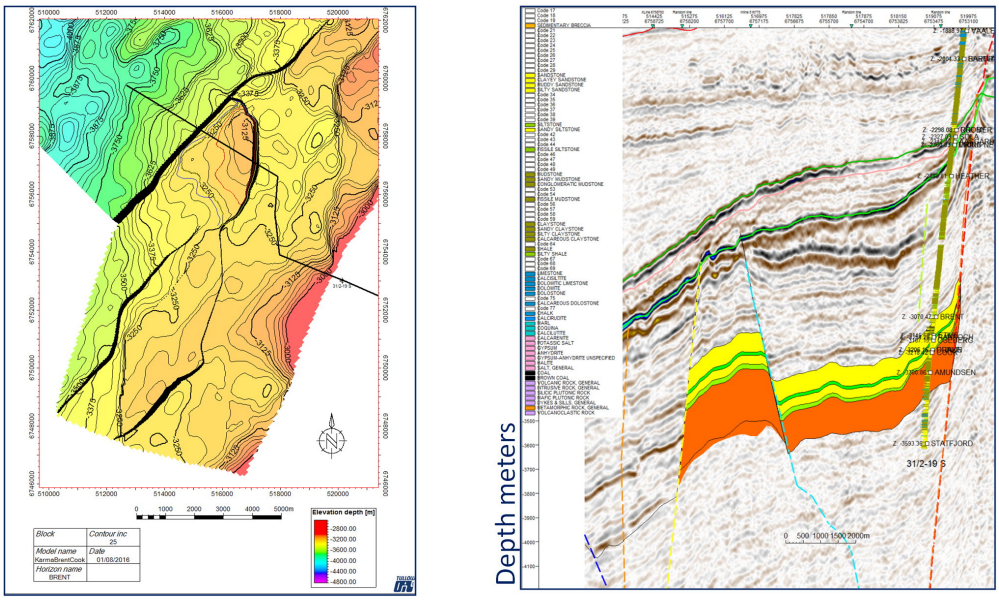

Fig. 4.2 Karma prospect. *Left: Top Brent structural depth map in meters. Right: Depth converted seismic section with Karma Brent Model and well 31/2-19S*

Alpha

A new prospect/lead has been identified in the graben structure West of the Karma horst (Fig. 4.3), it belongs to North Sea Upper Jurassic play, nju-1 with Fram H-Nord (discovery well 35/11-15 S) as analogue. The full-stack response in the Alpha area is similar to hydrocarbon-filled Heather Fm sandstone in well 35/11-15 S.

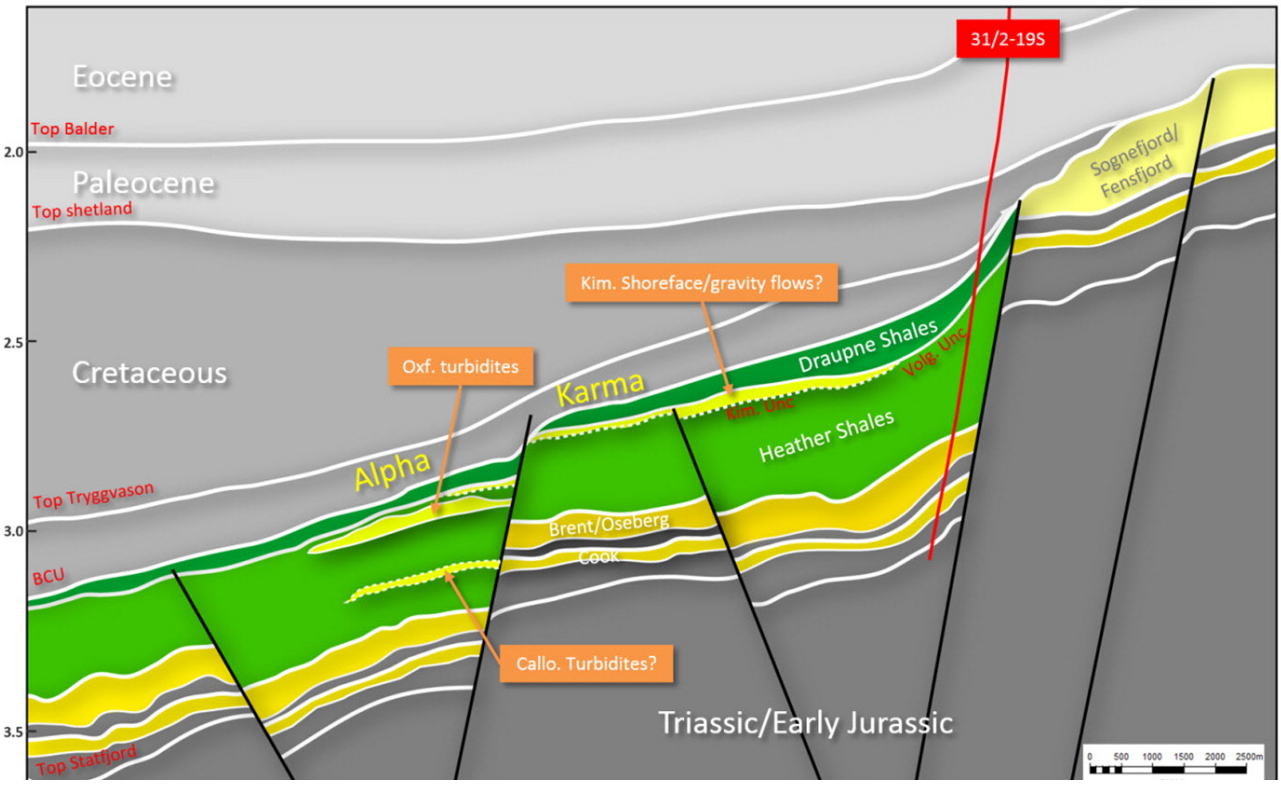

Fig. 4.3 Geoseismic section of the seismic cross-section in Fig 4.3. *Vertical scale is two-way travel-time in seconds.*

The 2D structural reconstruction study suggests that the Karma Horst was initially an half-graben in Callovian to early Oxfordian times. Seismic isopachs show an N-S trending graben west of the Karma structure. The reservoir could consist of Callovian to Kimmeridgian gravity flows sourced from the Troll delta system. The source rock would be Heather and/or Draupne oil prone shales. The trap is a combination of structural (faulted) and stratigraphic pinch-out.

The main challenge with Alpha is to define its extent. There is an ambiguity on expected AVO response. Rock physics modelling suggests that a Heather gas-charged sandstone capped by a Heather shale at 3100 meter burial depth should produce a drop in acoustic impedance and almost no contrast in Vp/Vs ratio.
In the AVO products this translates to a negative intercept with a almost zero gradient. However if there is a Draupne gas-charged sandstone capped by Draupne shales the result would be opposite for the acoustic case.

There is a risk that amplitude anomalies in Alpha actually represent Draupne or Heather shales with high organic content as was the case with the Draupne Fm in well 31/2-21 S. Detailed automatic seismic mapping (PaleoScan, and using isopachs from very thin intervals) in the target area has not revealed any geometrical patterns that are distinct of gravitational processes. Detailed inspection/ manual interpretation of the travel time seismic sections has not helped to define the system.

Blåklokke Lead

The elongate Blåklokke lead is located just northwest of Troll in block 31/2, see Fig. 4.4. The Blåklokke lead consists of a seismic anomaly (soft event) in the Paleocene just above the BCU (Fig. 4.4). The reservoir was thought to consist of reworked Sognefjord sandstones coming from the western Troll platform or to consist of sandy layers in a chalk succession. AVO analysis shows that the mapped soft event dims with offset, whereas a gas fill would cause a brightening (AVO class 3). The soft event seems to brighten towards the southeastern fault close to Troll, but this brightening is not conform with the time structure. Therefore, the anomaly is most likely the base of a hard (limestone) layer without hydrocarbon charge underneath, and Blåklokke is therefore no longer regarded as a valid prospect.

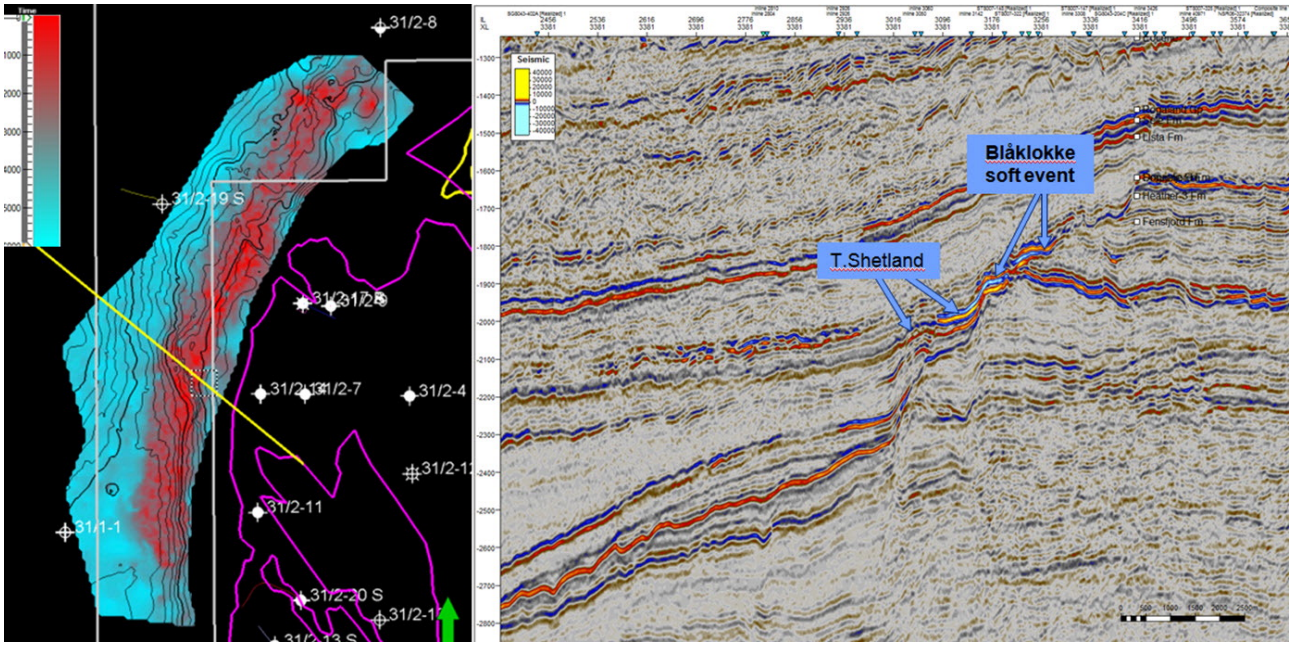

Fig. 4.4 Blåklokke. *Amplitude extraction map of Blåklokke event (left) and seismic cross section (right)*

Other Brent prospects/leads

Blåskia, Gluteus Medius, Gluteus Minimus, Nye Ski, Hagen,and Bonna all have in common that the risked resources become too small.

The reviewed resource potential in PL550 is listed in Table 4.1

Table 4.1 Resource potential PL550. Gross recoverable resources.

Lead/Prospect	Gross P90 (MMboe)	Gross PMean (MMboe)	Gross P10 (MMboe)	Hydrocarbon Type	Water Depth (m)	Reservoir Depth Crest (m)
Alpha	23.2	90.5	198.4	Oil	340	3100
Karma Brent&Cook	10.7	30.3	54.4	Oil/Gas	340	3070
Blåskia	14.6	24.5	21.9	Oil/Gas	340	3060
Eggen Brent	37.7	47.2	56.6	Oil/Gas	350	2000
Eggen Draupne	48.3	60.4	72.5	Oil	350	1800
Gluteus Medius	15.6	19.5	23.4	Oil/Gas	350	4000
Gluteus Minimus	38.7	48.4	58.1	Oil	350	4000

5 Technical evaluations

A brief technical evaluation was carried out on the Karma prospect using mean recoverable resources of 30 mboe and a probability for technical success of 48% as basis. This resource base comprises pay in Tarbert Fm, Oseberg Fm and the Cook Fm. Both oil and gas cases have been evaluated.

A subsea tie-back to Troll B, 18 km away from the assumed Karma spud position, was considered. Three deviated producers and two water injectors have been assumed to drain the reservoirs. The production profiles assumes first oil in 2023 with a short plateau before rapidly declining to end of production in 2029, see Fig. 5.1.

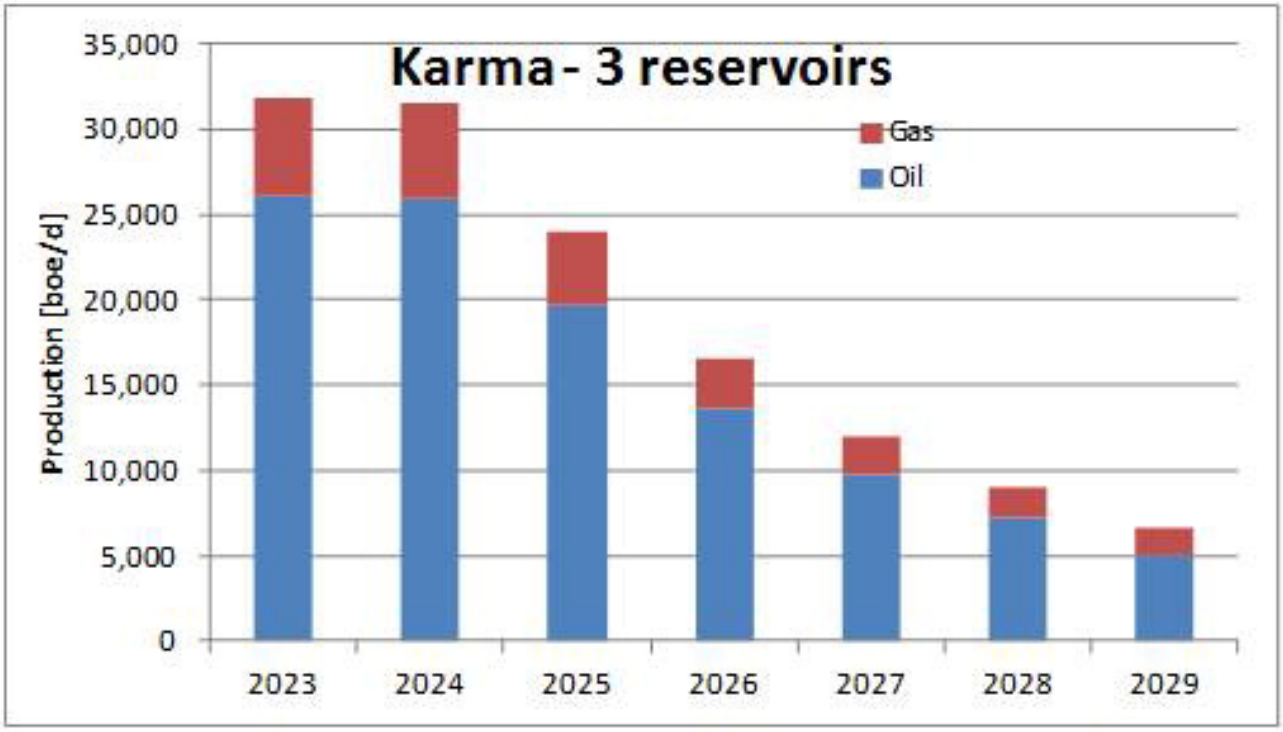

Fig. 5.1 Estimated production profile for the Karma prospect.

Analysis of a case with discovery in three reservoir zones predicts 23% probability to have a commercial project. It is to be noted that the P90 resource estimate is not economic and that mean economical field size is close to the mean of the multi-zone distribution. From a development point of view there is a high risk that a possible appraisal of Karma could be inconclusive and that the resulting resource base too uncertain to warrant a development.

6 Conclusions

The Karma prospect have a high probability of technical success, but because of the limited hydrocarbon volume potential the technical and economical evaluation concludes that the Karma prospect alone is not sufficient as basis for a robust commercial development project.
The operator has evaluated possible additional prospect and leads to strengthen the resource basis for a potential Karma development without success.

Exploration well 31/2-21 S was key for the evaluation of the remaining prospectivity in PL550.

The partnership of the PL550 has in good cooperation evaluated and concluded on the exploration and commercial potential in the license, and a unanimous decision to drop the license was taken in September 2016.