PL 553 Relinquishment Report

PL 553 Relinquishment Report

List of figures

List of tables

1 Key license history

License history
The PL553 license was acquired in the APA 2009 and awarded 19.02.2010 to:
Det norske oljeselskap ASA (40%), operator
Svenska Petroleum Exploration AS (35%)
Bayerngas Norge AS (25%)
The work program was geological and geophysical studies with the following decision gates: Drill or drop: 19.02.2011, Decision of continuation 19.02.2013 and Plan for production and operation 19.02.2015.
The work program was full filled during the first year, but since the decision to drill or drop was difficult the license needed more time to evaluate improvement potential in new seismic and reprocessing. An application for one year extension was granted with a new drill or drop decision 19.02.2012. Drilling was decided, but it took some time to acquire a rig and an application for two years extension for decision of continuation and one year extension for the initial license period and plan for development and operation was therefore granted. The well 34/7-36S on the Kvitvola prospect was drilled 28.07 - 17.09.2014.

Area history
The area had earlier been parts of the Snorre and Visund licenses PL089 and PL120 that were acquired in 1984 (license round 8) and 1985 (license round 10A). Parts of these licenses were relinquished in 1994 and 1993 respectively (Fig. 1.1).

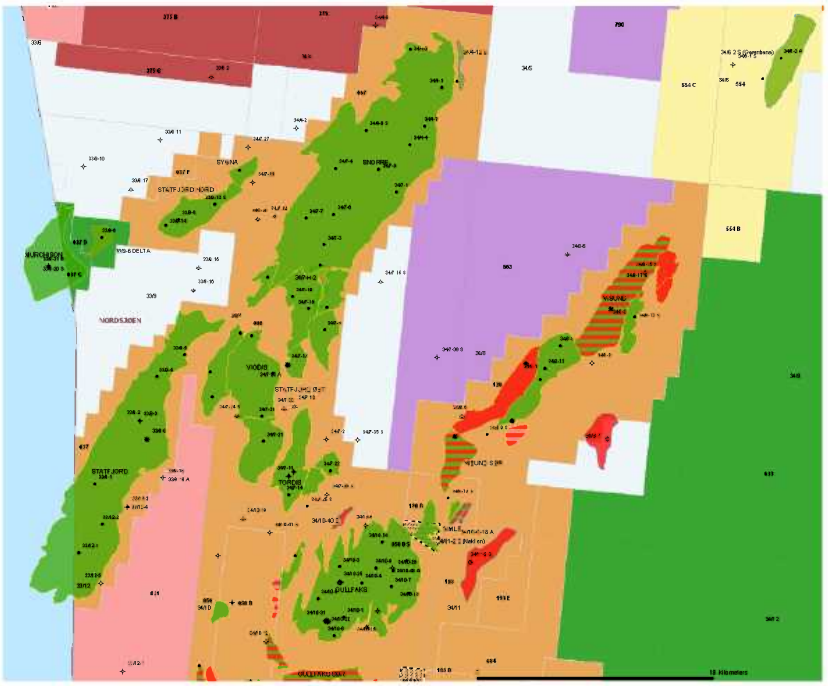

Fig. 1.1 Area overview

The main activity in the PL089 and PL120 license was related to the Snorre and Visund fields, and later also the Tordis, Vigdis and Borg fields in PL089. A lot of wells were drilled, but mainly on the footwall block. Two wells were drilled in the area that should later be acquired by PL553, 34/7-15S and 34/8-6.

Well 34/7-15S was drilled in 1990 with Brent and Draupne sandstones as main targets and Cretaceous as secondary. Shows were observed in the Draupne, Heather and Brent units. The Brent reservoir properties were poorer than expected and only thin sandstone beds encountered in the Draupne and Heather intervals.
Well 34/8-6 was drilled in 1991 with Draupne sandstone as the main target. The mounded structures in Draupne contained no sand. An oil sample was collected in a carbonate stringer in the Kyrre Formation.
Well 34/7-21 drilled in 1993 encountered Draupne sandstones with oil, the Borg discovery, and proved a new exploration model in this area, which was an analog for the main prospect in the PL553 license, the Kvitvola prospect.
The area between the Snorre and Visund fields was acquired by license PL345 in the APA 2004 awarded 17.12.2004 and later relinquished 17.12.2008. No well was drilled in this license.
The same area was awarded as two licenses in the APA 2009, PL552 and PL553.
Well 34/7-35S was drilled in license PL552 in 2012 with targets in the Draupne sandstone and the Brent Group, but was dry with no observation of shows. Draupne sandstones were encountered with reasonable reservoir properties, but the Brent reservoir was poorer than expected.

Kvitvola well 34/7-36S
The well was drilled in 2014 and proved to be dry. There was no sand encountered in the main target intra Draupne. The well was drilled into Brent, which was a secondary target. The well logs indicated some hydrocarbon, but no shows was observed and the reservoir quality was poorer than prognosed. Sand was encountered in the Lista Formation and a water sample collected. The sand had good porosity, but the permeability was poor. There was only one observation of shows in the well, in a limestone stringer in the Kyrre Formation.

2 Database

Seismic data
Initially the seismic database included all the relinquished 3D surveys and some 2D NSR lines with offset data. During the first year of the license period offset data and gathers was acquired from ST07M05 and also several new 2D NSR lines with offset data were added to the database (Fig. 2.1, Table 2.1)

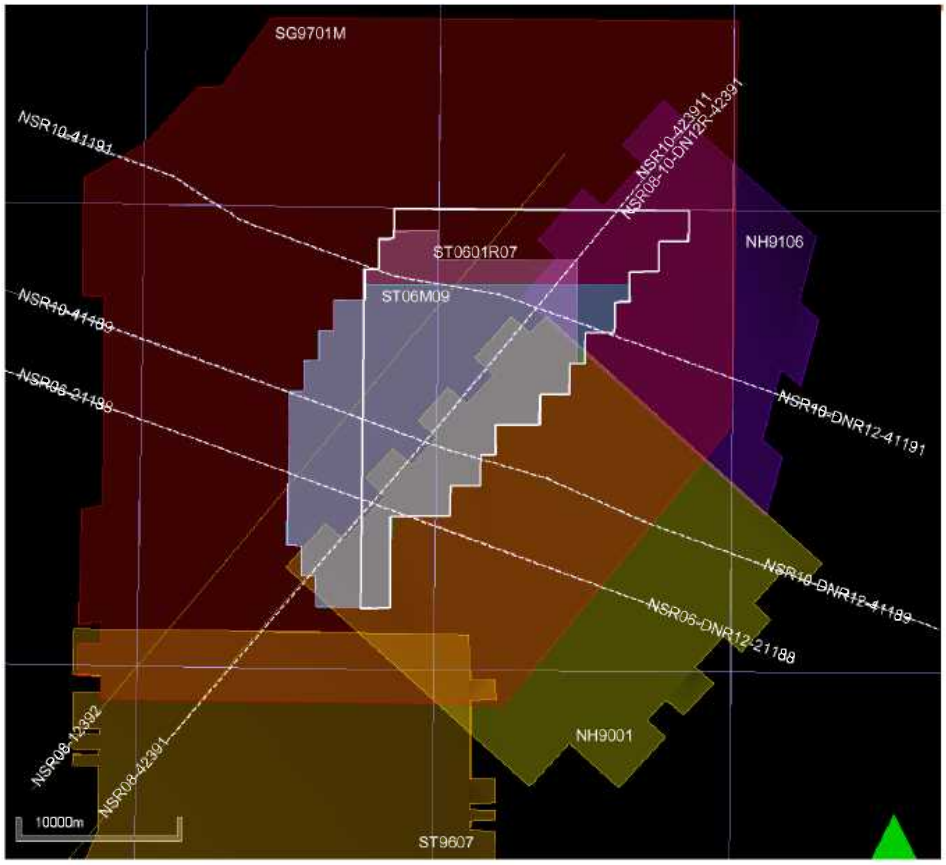

Fig. 2.1 Seismic database

Table 2.1 Seismic database

	Comments
SG9701M	Subregional survey covers Snorre – Visund Merged SG9701, NH9001, NH9107, MN9401
ST06M09	With offset cubes and gathers for AVO studies
ST0601R07	Parabolic radon reprocessing
ST9607	Covers Gullfaks area
NH9001	Slightly better coverage than SG970M towards the Viking Graben
NH9106	Slightly better coverage than SG970M towards the Viking Graben
PGS mega merge	Regional
NSR06-10 (2D)	NSR06-21188, NSR08-12392, 42391, NSR10-41191, 423911, 41189
NSR06-10-DNR12 (2D)	NSR06-DNR12-21188, NSR08-10-DNR12-42391, NSR10-DNR12-41189, 41191

The main survey used in the license mapping was ST0601R07. The survey ST06M09 was applied for the seismic data analysis and other surveys for regional mapping. Regional mapping was important to estimate erosion and available sand volume for the Kvitvola prospect.
The seismic analysis results from the 3D offset data was not conclusive. The cable length was 4 km and the seismic acquisition parameters not considered to be optimal. Rather not the 2D NSR lines with 8 km cable length gave conclusive results. Four of the NSR lines crossing the Kvitvola prospect were therefore reprocessed (NSR-DNR12), but the improvements were small.

Well data
The well database included all relinquished wells in the Tampen Spur area (Fig. 2.2).

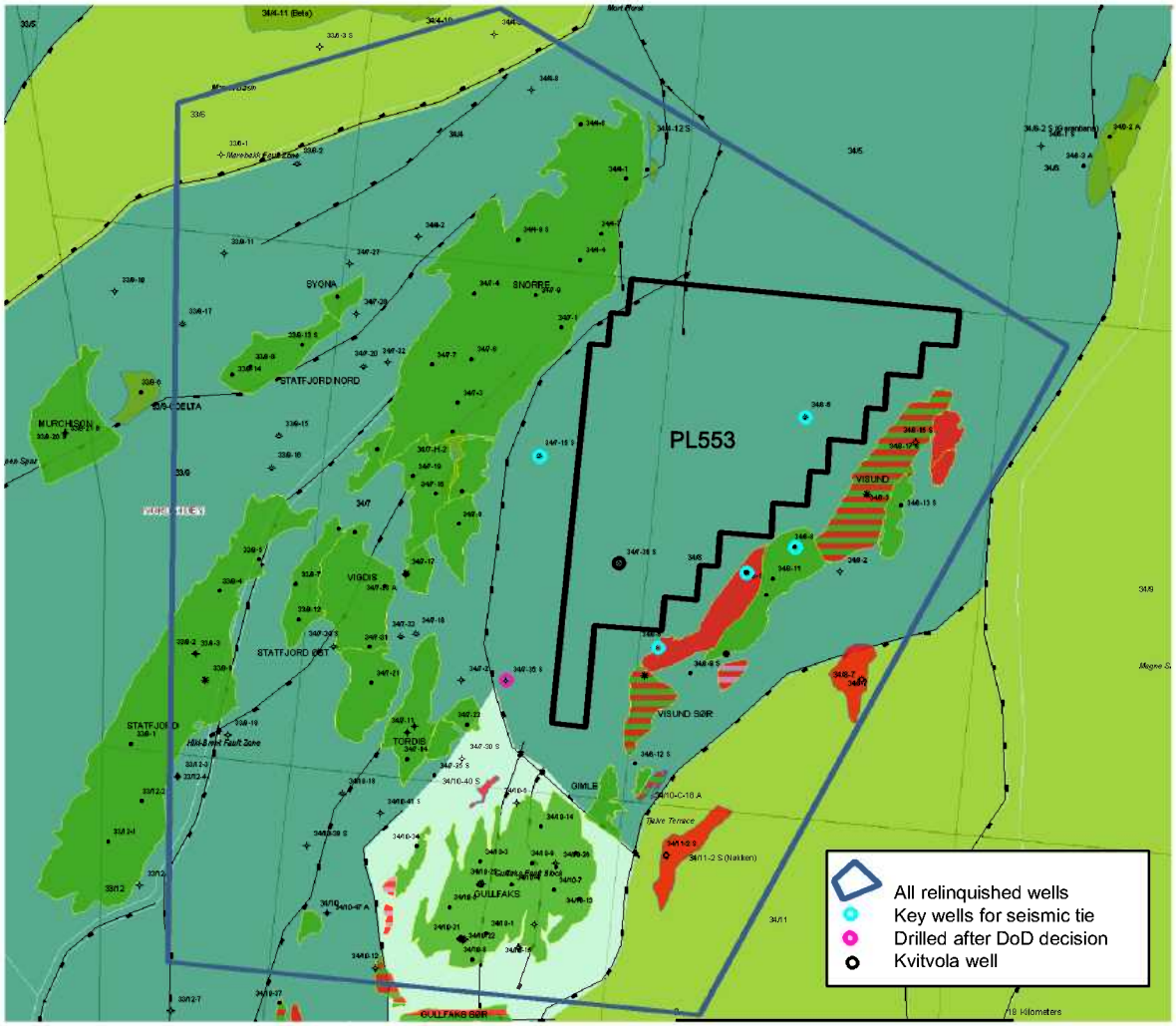

Fig. 2.2 Well database and key wells

Most important wells for the seismic tie and interpretation inside the license area were 34/7-15S and 34/8-6 and also 34/8-1, 3 and 8 for tie to deeper stratigraphy as the Dunlin, Statfjord and Hegre groups. To establish a depositional model and paleogeographic maps for the Late Jurassic sand system a number of regional wells with Late Jurassic sand was reviewed. The calculation of sand volumes included a number of wells from the Visund, Snorre and Gullfaks fault blocks.
The well 34/7-35S was drilled after the PL553 decision to drill and not formally included in the data base, but had been traded by some of the license holders.

3 Review of geological framework

Geological setting

The PL553 license area is located in a half graben between the Snorre and Visund fault blocks (Fig. 3.1). The graben was formed during the Late Jurassic to earliest Cretaceous rifting and is filled in with Late Jurassic sediments of the Heather and Draupne formations. The half graben terminate to the south where the Snorre and Visund faults merge north of the Gullfaks fault block. The merge of the Snorre and Visund faults create complex fault geometries and inversion structures are locally formed.

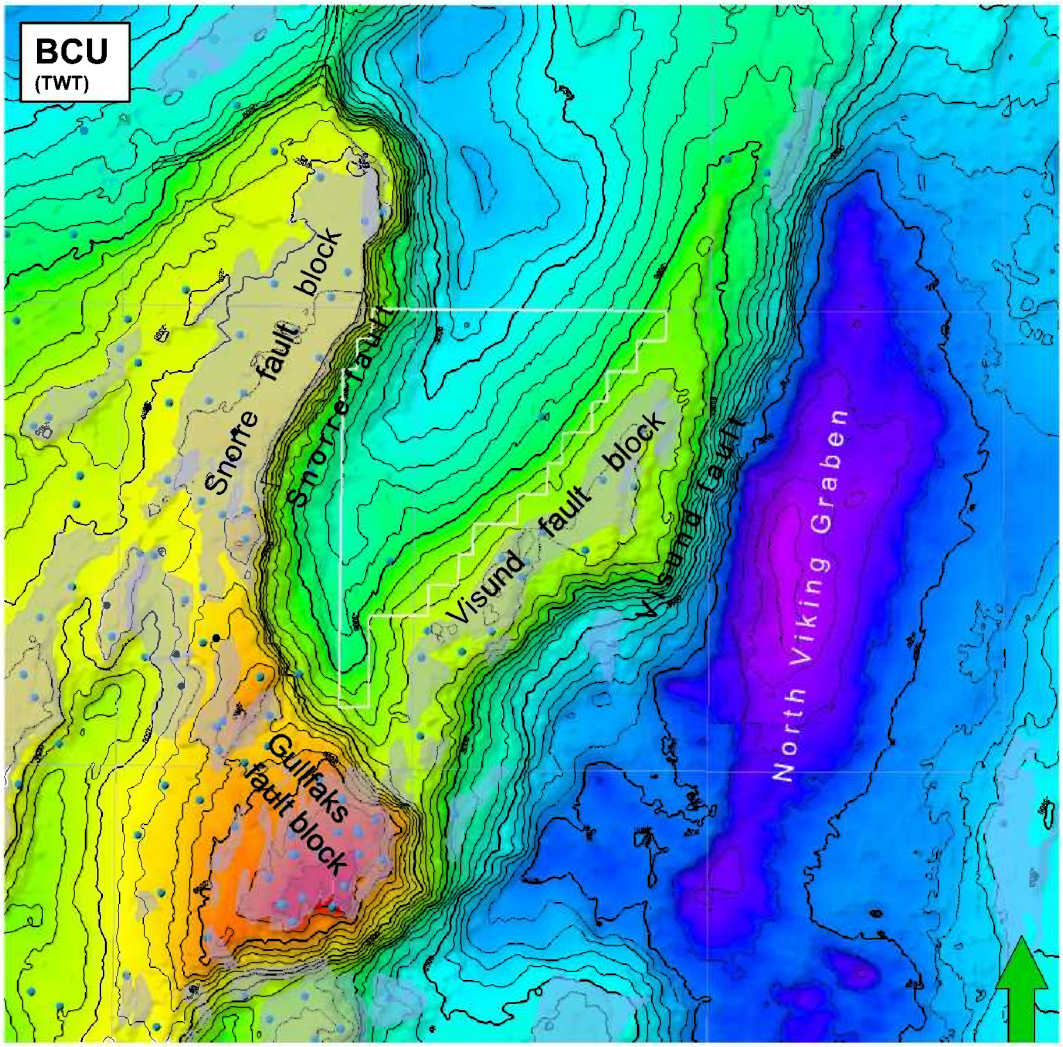

Fig. 3.1 Structural setting PL553 area

Sand was eroded from the crests of the fault blocks and transported into the half graben basin (Fig. 3.2). On the Snorre fault block more than 1 km sediments are eroded in the northern part less is eroded on the Visund and Gullfaks fault blocks. Transport of sand have been both along the stratigraphic dip and across the fault and internal faults and the direction of these have influenced the transport.

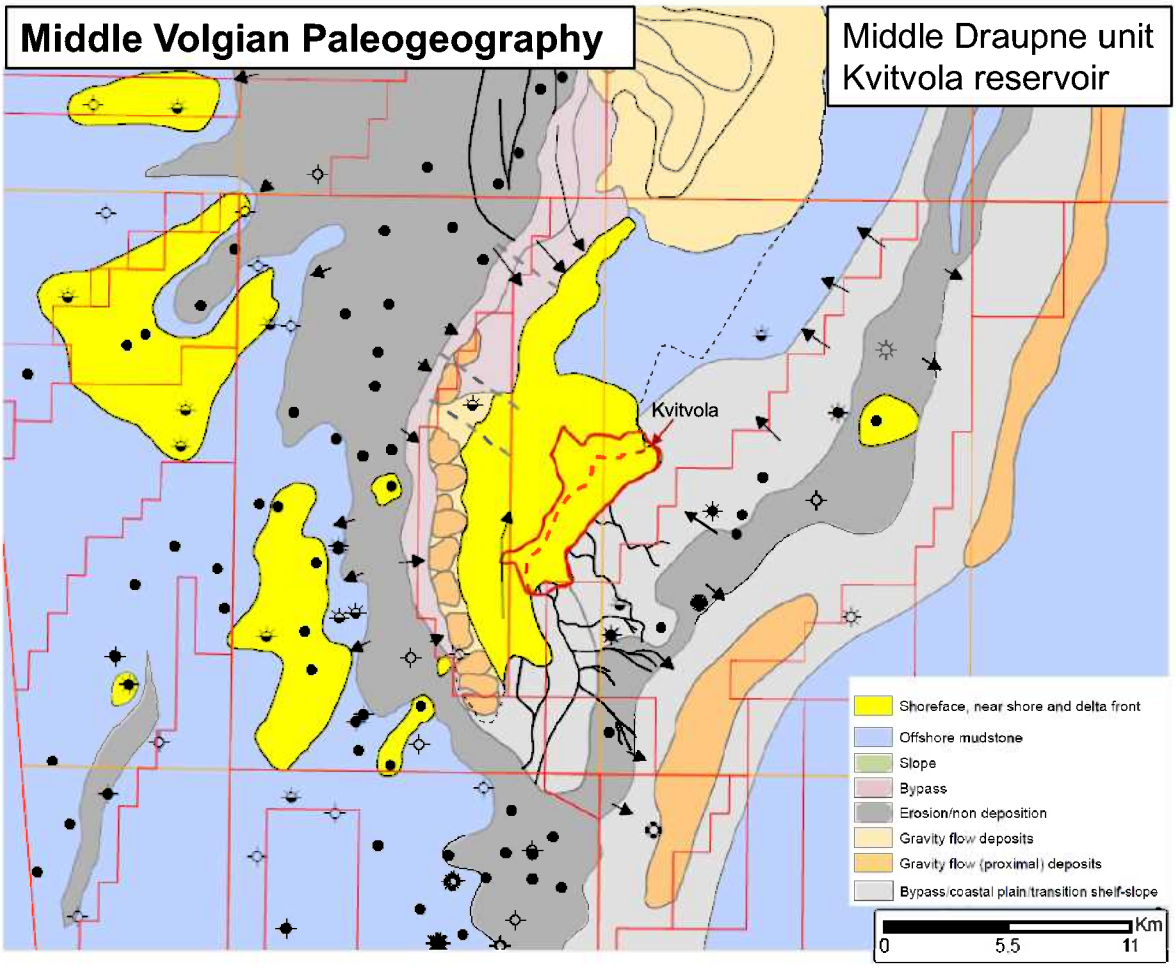

Fig. 3.2 Upper Jurassic sand model, Tampen Spur

Prospects APA

The two prospects in the APA reward were the Kvitvola and the Rødvola. The Kvitvola prospect had a Late Jurassic intra Draupne reservoir model forming a trap with onlap of sand to the east. The Rødvola prospect had an Early Cretaceous reservoir model related to a soft amplitude anomaly. Both prospect could be charged from the Draupne source rock in the half graben basin, which is mainly in the oil window in the southern part of the basin.

License work

During the license period, seismic interpretation and a large number of geological and geophysical studies were carried out, which is the basis for the new evaluation of prospect and leads

The seismic interpretation included a number of horizons in Tertiary, Cretaceous and Jurassic sequences within the license area and on a subregional scale, with relevance for prospect mapping, deposition models, basin modelling and depth conversion. An important part of it was the volume calculation of eroded sand.

The license evaluation had two approaches, a geological approach to establish confident geological models for the reservoir that included erosion, transport and deposition of sand and a geophysical approach to substantiate sand and hydrocarbon phase from the geoghysical data.

The original sand model for the Kvitvola reservoir was transport from the crest of the Visund fault block, which had been eroded. During the license work more exact volumes of the eroded sand was estimated. Sand potential for transported out of this area seemed to be limited and it was questioned if the amount of sand was large enough to constitute the reservoir volume of the Kvitvola prospect that was in the model.

This was negative for the Kvitvola prospect, but as the evaluation of the area continued arguments for transport of sand also from the Gullfaks and Snorre fault blocks were stated. Especially if transport from the Snorre fault block could work, huge volumes of sand was available. The transport path from that fault block was more difficult, but a possible model was found.
The original sand model for the Rødvola Early Cretaceous reservoir was transport from the Gullfaks fault block. This is the only area without the Mime Formation (Valanginian to Barremian) present. The Mime Formation is present in almost all wells in the area and its presence make Early Cretaceous erosion difficult.
Later studies indicated that Mime originally also had been present on the Gullfaks fault block but been eroded during Late Cretaceous. The conclusion was therefore no or little erosion during Early Cretaceous. The Rødvola reservoir model therefore got a very high risk and the prospect was degraded to a lead.
The geophysical studies were not conclusive. It was difficult to differentiate between Draupne sand and Draupne shale and also water and oil. That was also stated from studies of data from the Borg field and inversion and AVO studies gave no anomalies that support sand or hydrocarbons.
The license purchased the gathers and offset cubes from the 3D survey ST07M09 and also 2D NSR data with long offset. Later several of the NSR lines was also reprocessed.

Studies
An overview of studies is listed below:
Seismic tie to key wells
Rock physic modelling
Gathering conditioning and AVOinversion ST07M09
Study of NSR gathers from Borg, Kvitvola and Rødvola
Seismic wedge modelling of the Kvitvola setting
Shear log prediction, reliability study
Spectral decomposition Draupne system
Geological development of Tampen during Middle Jurassic to Early Cretaceous
Upper Jurassic sand deposition and facies in the Tampen area
Sand budgets for the Visund, Gullfaks and Snorre fault blocks and evaluation of transport path
Gullfaks as provenance area for Early Cretaceous sandstone
Early Cretaceous reservoir analogs for Rødvola
Mapping of Cretaceous anomalies
Brent porosity vs. depth
Sealing fault characteristics in the area
Lista sand system in the area
Mime age study on Tampen wells

4 Prospect update

APA application

The APA application included also the acreage awarded as PL552. The PL553 acreage contained the prospects Kvitvola and Rødvola, where only half of Rødvola was inside PL553. In addition, five leads had also been identified of which two only was partly inside (Fig. 4.1, Table 4.1).

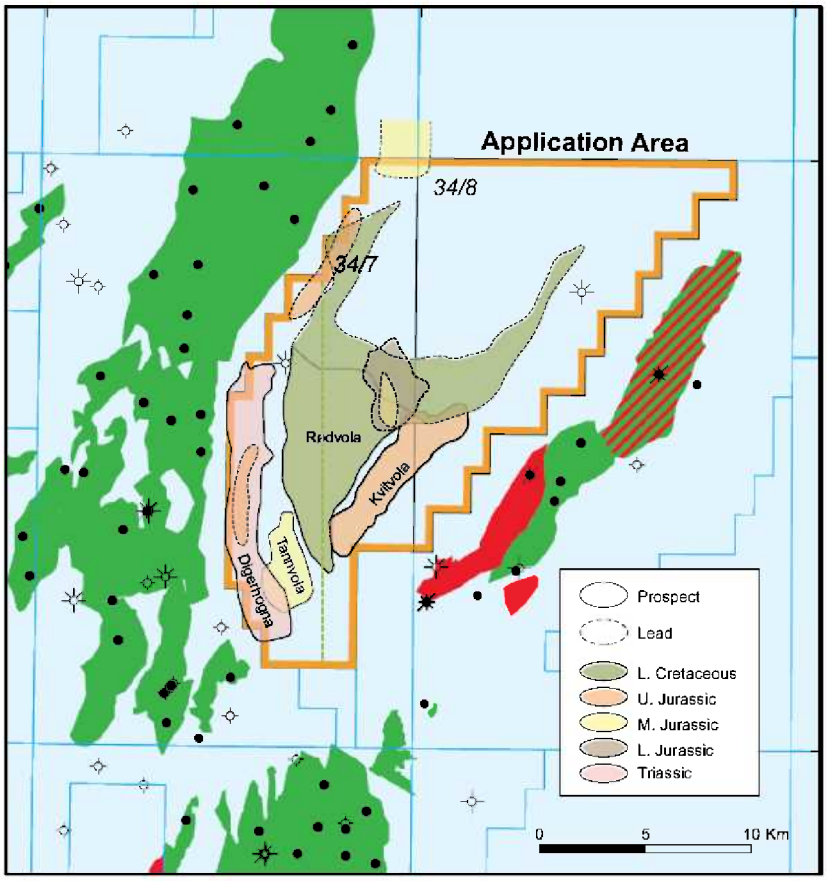

Fig. 4.1 APA 2009 prospect and leads

Table 4.1 APA 2009 prospects and leads

Applicant:	Det norske oljeselskap ASA, Svenska Petroleum Exploration AS, Bayerngas Norge AS							Block(s):	34/7 and 8		
Discovery/ Prospect / Lead name[1]	D/ P / L [2]	Unrisked recoverable resources[3]						Probability of discovery[4]	Reservoir		Distance to infra- structure (km) [6]
		Oil $10^6 Sm^3$			Gas $10^9 Sm^3$				Litho-/ Chrono-stratigraphic level [5]	Reservoir depth (m MSL)	
		Low	Base	High	Low	Base	High				
Digerhogna*	P	21.80	28.60	36.50	4.50	5.60	6.80	19 %	Hegre Group	2865	14 (Gullfaks)
Tannvola*	P	1.90	5.10	8.90	0.50	1.10	1.90	20 %	Brent Group	3640	12 (Gullfaks)
Kvitvola	P	5.30	17.70	32.30	0.80	2.60	4.50	22 %	Viking Group	3230	15 (Gullfaks)
Rødvola	P	0.60	13.20	34.80	0.10	1.90	4.70	14 %	Cromer Knoll Group	3350	15 (Gullfaks)
Statfjord Lead	L	Not estimated			Not estimated				Statfjord Formation		
Brent leads (2)	L	Not estimated			Not estimated				Brent Group		
Upper Jurassic leads (2)	L	Not estimated			Not estimated				Viking Group		
Rødvola north lead	L	Not estimated			Not estimated				Cromer Knoll Group		

Prospects

The Kvitvola trap was also reinterpreted with a slightly different reservoir pick and onlap line, but the structure was very much the same as in the APA application. The implementation of new GRV and adjustments of the reservoir parameters lead to a decrease in mean volumes of recoverable hydrocarbons from 20.3 to 14.0 MSm3 oe. New risk evaluation reduced COS from 22 to 20%.

The Rødvola prospect had originally a mean volume for recoverable hydrocarbon of 15.1 that was reduced to 5.5 MSm3. The main reason for the volume change was a different approach to implementation of the amplitude anomaly. Both the area and the thickness decreased. In addition, the COS was reduced from 14 to 5%. The reduce in COS was related to small possibility to deposit an Early Cretaceous reservoir in this area. The former Rødvola prospect was therefore reduced from a prospect to a lead.

Leads

An overview of the mapped leads is given in Fig. 4.2 and Table 4.2. Several leads have been added to the list since the APA application, but it is difficult to mature any of the leads to drillable prospect or prospects.

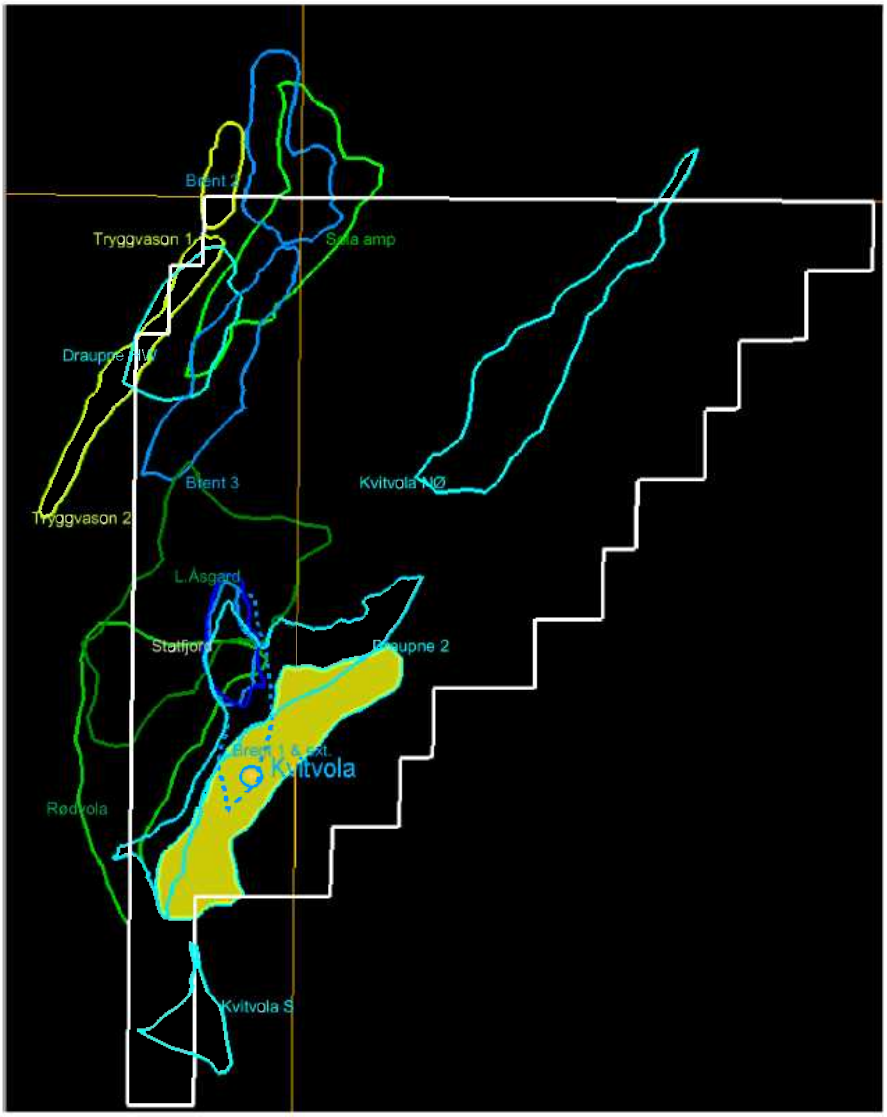

Fig. 4.2 PL553 leads

Table 4.2 PL553 leads with volume potential

Lead	Volume (MSm3)	Main Risk	Apex (m)	HC col (m)	Comment
Rødvola	2.7 – 8.3	Res Dep.	3390	180	Amp. anom., ~50% PL553
L.Åsgard	8.8	Res Dep.	3430	330	Amp. anom., 83% PL553
Draupne 2	4.7		3620	200	
Kvitvola NØ	4.4		3680	210	
Kvivola S	2.0-3.0	Res. Dep.	3060	280 -340	~50% in PL553
Brent 1	2.2		3670		
Brent 2	6.6 – 14.3		3459	300 - 450	16% in PL553
Brent 3	5.0 – 11.8	Diag/Mig	4125	275 - 400	Deep
Statfjord	2.9	Mig/Diag	4010	165	Deep
Draupne HW	6.4 – 13.1	Seal/Dep	3150	300 - 400	Lateral facies change
Sola amp. an.	4.1 – 8.2	ResDep	3040 ms	310 ms	~60% in PL553
Tryggvason amp 1	1.5	ResDep	2680 ms	140 ms	~30% in PL553
Tryggvason amp 2+	3.5	ResDep	2660 ms	170 ms	~30% in PL553

The Brent2 lead is one of the most interesting. The trap is a hang block in the Snorre fault, but only a small part, 16%, is in PL553. The Brent1 lead is a structural closer and could be drilled together with the underlying Statfjord lead, but the volumes are small and not commercial. The Statfjord reservoir is also in the HPHT regime. Brent3 are deep fault blocks that need sealing faults. The Brent reservoir properties in this basin has in general been poorer than expected in all the four wells drilled.
Kvitvola NØ and Kvitvola S leads has the same reservoir model as Kvitvola, but is considered to have a less favorable position for deposition of sand. Draupne2 is a deeper Draupne unit not penetrated by well 34/7-36S and based on an onlap trap. An interesting lead is the Draupne HW (hanging wall), it is mainly based on a thickness anomaly and is at the assumed transport path of sediments from the Snorre fault block. It has some internal amplitude pattern, but the reservoir facies is difficult to predict and the seal risk is high.
Rødvola and L. Åsgard are Cromer Knoll leads, but the soft amplitude anomalies are supposed to be related to shales rather than hydrocarbon bearing sandstone reservoirs, since the geological model indicate small chance of Cretaceous reservoir in the area.
Tryggvason1, Tryggvason2 and Sola amplitude anomalies in Cretaceous are most like caused by interbedded limestone and shale lithologies.

5 Technical evaluations

No hydrocarbon volume was proved by the the Kvitvola well.
The remaining exploration potential in the license is considered none commercial and has not been technically evaluated.

6 Conclusions

The Kvitvola prospect proved to be dry and there is no other drillable prospects in the license. Relinquishment was therefore the option.
The license was relinquished from 19.02.2015.