PL980 relinquishment report

2021

vår energi

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1 History of the production licence

- Awarded 01.03.2019
- Block 16/4, 63,905 km^2
- Vår Energi AS operator 60%, Suncor Energy Norge AS 40%
- Work program:
  - Acquire seismic. Drill or drop decision by 01.03.2021
  - BoK 01.03.2023
  - BoV 01.03.2025
  - PDO 01.03.2026
- Management and Exploration committee meetings overview
  - MCEC meeting # 1: 26.03.2019
  - MCEC meeting # 2: 26.11.2019
  - MCEC meeting # 3: 09.12.2020

The PL980 license was awarded 01.03.20189 to Vår Energi AS and Suncor Energy Norge. Vår Energi was granted the operator-ship with 60% of the equity and Suncor Energy the remaining 40% (Fig. 1.1).

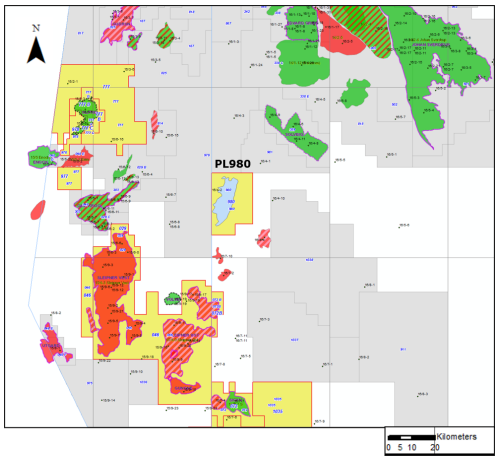

Fig. 1.1 License overview
The PL911 license map with Store Blind and Lille Blind prospects.

The initial 2-year work program was to purchase new 3D seismic. PGS had acquired new broadband data in the area in 2016. The 560 km^2 PGS16M03-16902VIK dataset was purchased over the license area.

The PL980 license was acquired based on two prospects identified in the Jurassic, Humppa and Hot Pot prospects. The Humppa prospect was defined as fault dependant stratigraphic trap, and the Hot Pot prospect on the footwall side of the fault was defined as a possible Upper Jurassic stratigraphic trap.

The new 3D seismic improved the resolution over the license. However, the imaging of the Humppa prospect was still challenging. Specifically this was an intra Lista event not seen on the vintage data. The Intra Lista reflector showed the thickness anomaly identified between top chalk and the top Sele Fm to be present in the Upper Paleocene post the influx of Heimdal/Ty turbidites from the East Shetland basin. Thus, proving NPD pinch-out line of the play.

Based on the mapping of the new 3D broadband dataset, both prospects were no longer valid. The license group believe the chance of finding Paleocene reservoir deposited in the license very limited to impossible and therefore recommend relinquishing the acreage.

2 Database overviews

2.1 Seismic data

The PL980 license acquired 560km² of the PGS16M03-16902VIK dataset (Fig. 2.1). The broadband data was Pre Stack Depth Migrations of good quality. For regional work the MegaSurvey consisting of released 3D seismic was used.

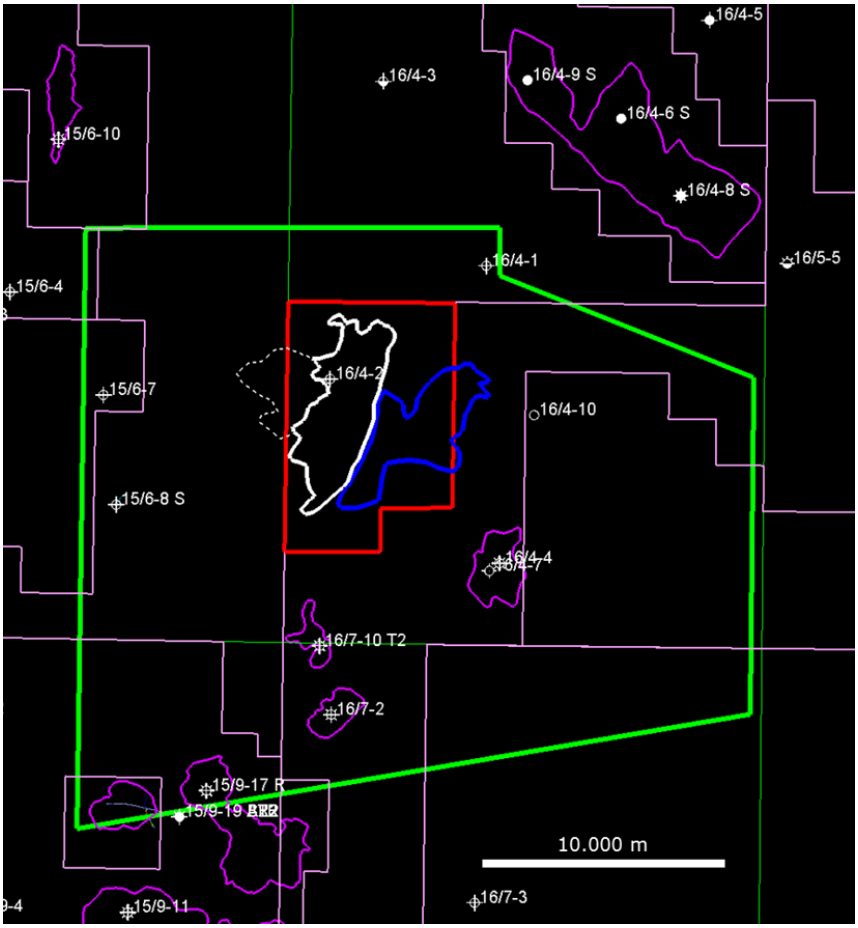

Fig. 2.1 Seismic database
The outline of the 765 km2 broadband data

2.2 Well data

- Listing of all the wells in the common well database with drilling year and results.

Table 2.1 Well databse

Well Name	Completion year	NPD well ID
15/3-4	1982	314
15/3-5	1984	52
15/5-1	1978	315
15/5-2R	1979	1250
15/5-3	1980	207
15/5-7	2008	5842
15/6-2	1971	317
15/6-4	1976	319
15/6-5	1977	320
15/6-7	1993	2084
15/6-8S	1997	3014
15/6-9S/A/B	2007	5494
15/6-10	2009	6030
15/6-11	2010	6488
15/6-12	2011	6518
15/6-13	2015	7667
15/9-9	1981	328
15/9-11	1981	329
15/9-15	1982	74
15/9-16	1982	79
15/9-17	1983	60
15/9-19A	1997	3145
15/9-19B	1998	3251
15/9-22	2006	5174
16/4-1	1984	229
16/4-2	1990	1560
16/4-3	2000	4194
16/4-4	2007	5441
16/4-5	2010	6216
16/4-6S	2013	7098
16/4-7	2013	7208
16/4-8	2014	7415
16/4-10	2016	7731
16/5-5	2013	7285
16/7-2	1982	40
16/7-3	1982	75

3 Content of relinquishment report

3.1 Results of geological and geophysical studies

The license did several studies to reduce the risk on the Humppa prospect.

One of the concerns was the source migration effectiveness. Most of the wells on the Utsira High east of the Humppa prospect (16/4-1, 16/4-7, 16/4-10, 16/7-1, 16/7-2, 16/7-3 and 16/8-1) are dry in the Jurassic. Also the two closest wells to the prospect testing the Hugin Fm, 15/6-7 and 15/6-8 S were dry. The license bought FIT studies for two wells: 15/6-7 and 16/4-10. The FIT study for the 15/6-7 well did not identify any fluid inclusions with petroleum in the Jurassic. The 16/4-10 well had more encouraging results. The Sleipner Formation showed patchy chemical hydrocarbon indications, white and blue fluorescence and contained moderate gravity oil inclusions, which would suggest migration of oil through the Sleipner Formation. Blue fluorescent oil inclusions homogenized at quite low temperatures and have measured API gravity of 40-42°. These would likely produce a wet gas or condensate at reasonable reservoir conditions. No proximity to pay registered by the FIS analysis, so no up-dip potential from the well location in this structure. These observations could mean the following for the Humppa prospect:

1. There is a working migration system on this part of the Utsira High
2. The patchy appearance of the shows in the Sleipner Fm suggests limited amount of HC migrated (the 16/4-10 tested a valid stratigraphic trap which most likely would have been an accumulation given sufficient filling).
3. The Heather Fm overlaying the Humppa prospect is most likely mature, but the fetch area is potentially too small.
4. The Humppa fault has leaked in the past, is still leaking or has a dynamic seal depending on the HC column height in the Humppa prospect.

Two inversion approaches were tested on the dataset: PCube+ and Crava. They are both part of the a software called PreStack Pro and they are Bayesian based inversion algorithms. Bayesian statistics uses prior geological knowledge to limit the resolution space (Draupne Fm is stratigraphically younger than the Sleipner Fm is one example). The PCube+ inversion algorithm is a one step inversion which estimate probability for lithology and fluid classes (LFC's) using seismic data and geological constraints. The algorithm try all possible LFC combinations along the seismic trace and select the one that match the seismic best. To define the LFC's, the nearby wells were tried out first (15/6-7, 15/6-8S, 16/4-7 and 16/4-7). This resulted in poor prediction of the lithology in the Humppa prospect. The next step was to identify a better analogue for the Humppa prospect. The choice fell on the Volve field and the surrounding area. LFC's were defined based on a selections of exploration, appraisal and production wells (Fig. 3.1). The PCube+ set up with focus on Jurassic defining a set of LFC's between the Top Zechstein salt surface and the BCU (Fig. 3.2). The inversion results improved considerately using the Volve field as an analogue, but the still the lithology probabilities were ambiguous (Fig. 3.3).

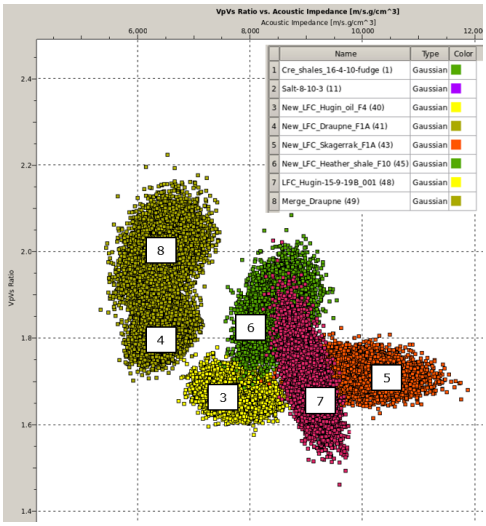

Fig. 3.1 Litho Fluid Classes defintion

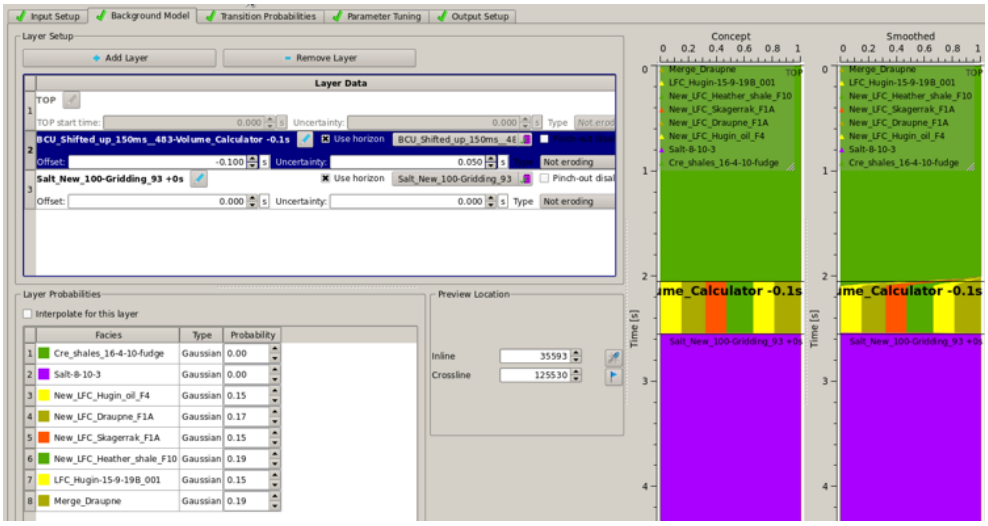

Fig. 3.2 PCube+ set up

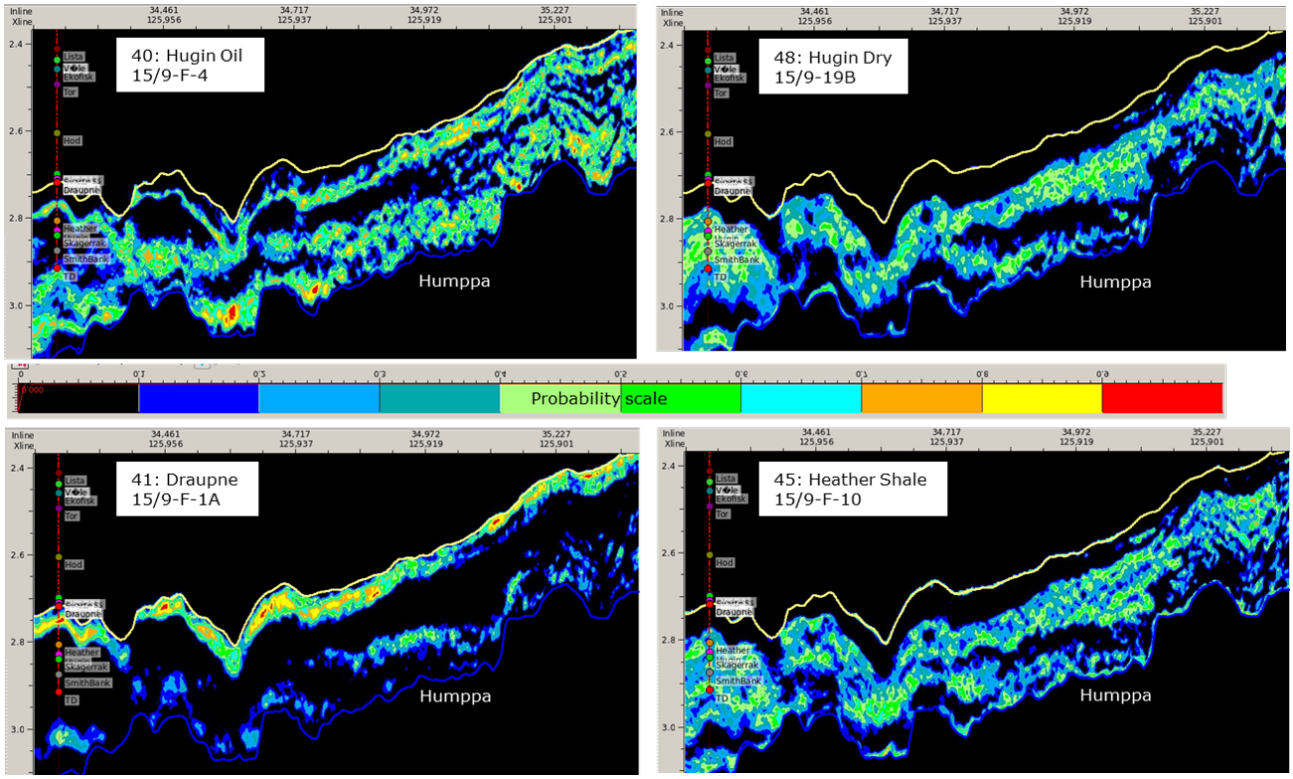

Fig. 3.3 PCube+ results
This picture shows 4 of the LFC's inverted for.
1. Top left Hugin with oil
2. Top right Hugin with brine
3. Bottom left Draupne shale
4. Bottom right Heather shale
The probabilities are ranked from 0 to 100% where the warmer colors represents the highest probabilities. The conclusions one can draw from this is that the inversion result is anbiguous with probabilities mostly around 50%. The Draupne shale is predicted with higher confidence. There are several factors contributing to the uncertainty in this prediction such as some overlap between the LFC's defined and that the Volve analogue is not representing the facies in the Humppa prospect.

The Crava inversion is set up in a more traditional way using some key wells (15/6-7, 16/4-7 and 16/4-10) to build a background trend models for Vp, Vs and density. Two of the outputs from this inversion were relative Mu-Rho (chi angle rotation for lithology) and Lambda-Rho volumes (chi angle rotation for fluid). The Mu-Rho volume was of particular interest. This was the only seismic attribute outlining a feature in the Humppa prospect area resembling something close to the geological model for the prospect. The depositional model for Humppa was originally shallow marine shoreface facies. However, the shape mapped out on the Crava inversion Mu-Rho attribute suggests a more deltaic facies (mouth bars, tidal flats, channel fills etc) like the southern part of the Sleipner Vest field (Fig. 3.4).

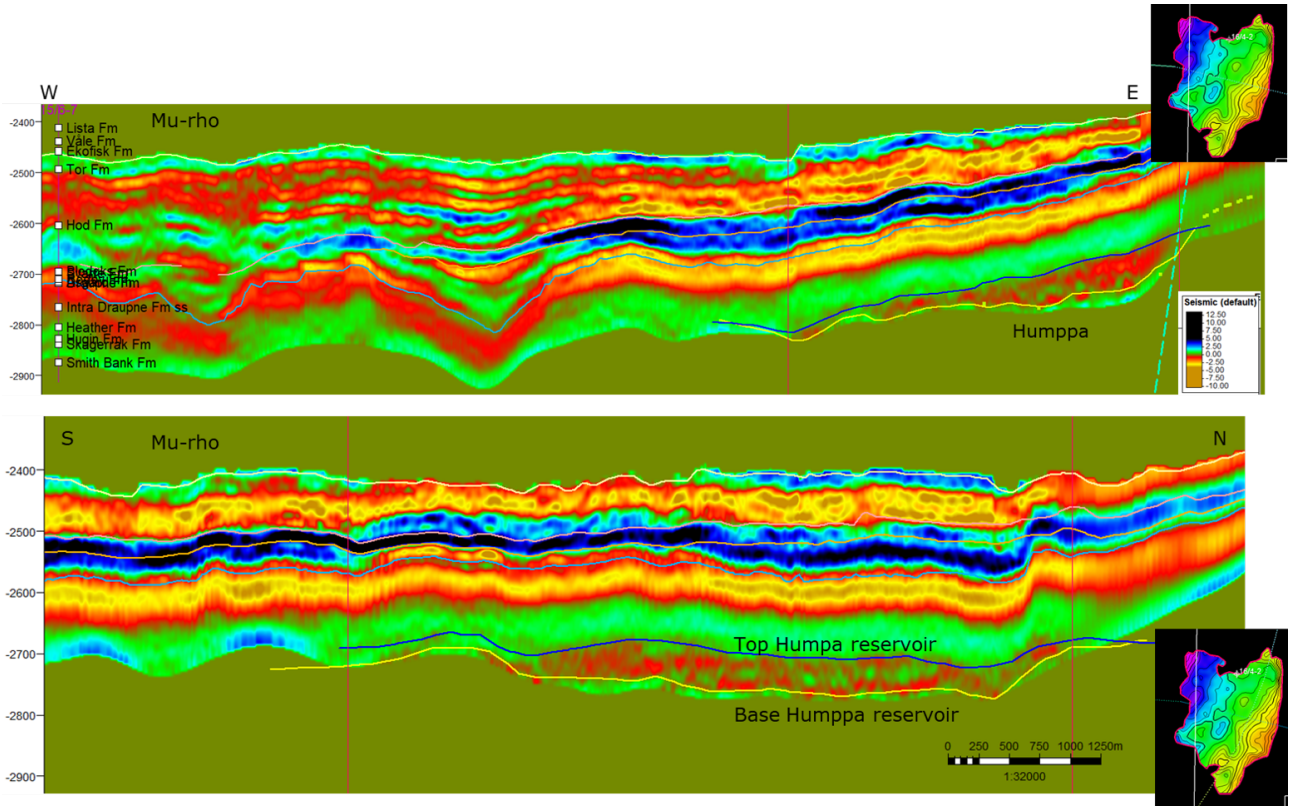

Fig. 3.4 Crava inversion results

The Humppa prospect is dependant on a sealing or at least partly sealing fault to the east. The mapping had identified a potential incision on the footwall side of the fault. Incised valleys are often associated with sand fill, especially at the base. To quantify the risk the operator conducted a fault seal analysis (FSA). To represent the Humppa prospect reservoir properties the Hugin Fm (N/G ratio of 89% and an average porosity 21%) of the 15/9-19 BT2 well was chosen, and to represent the incised valley fill the sandy part of the Heather Fm (N/G ratio of 48% and an average porosity of 16%) from the same well was used. The result of the FSA was disappointing. There was identified a sand-sand juxtaposition where the Humppa reservoir overlapped with the base of the incision (Fig. 3.5). Based on the proxy used to represent the Humppa prospect reservoir and the incised valley fill, the conclusion was that there was i high probability of a sand-sand juxtaposition which most likely could not hold more than 30-40m of HC column. it should be noted that the FSA result is highly dependant on the properties of the input data. Another set of input parameters might lead to a more positive outcome.

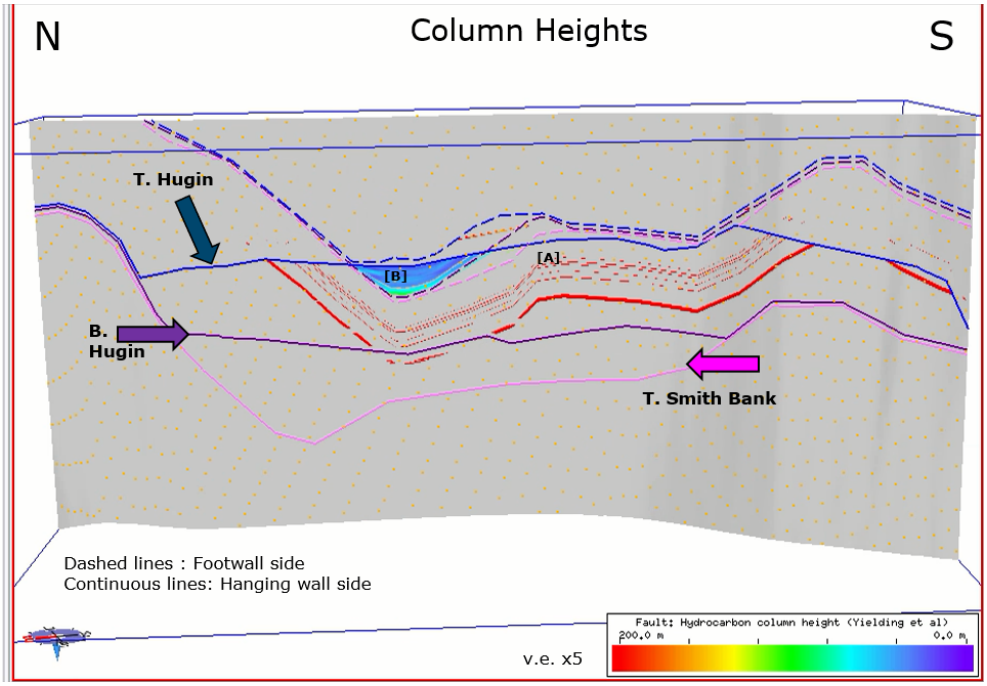

Fig. 3.5 Fault Seal Study HC column heights prediction
The Hugin Fm overlapping with Smith Bank Fm on the footwall side can hold at least 200 m of HC column. However, the small Hugin self-juxtaposition can only support HC columns of 30-40 m.

3.2 Technical assessment

The re-interpretation of PL980 has concluded that of the three original prospects only the Humppa prospect remain. The Hot Pot and Hubi prospects do not currently have valid traps. The Hummpa Prospect resource potential are reduced from 20,6 MSm3 HIIP (Application document 2018) to the current 4,25 MSm3 HIIP. The probability of success are 12%. The suggested development scenario is to use the Gina Krog platform, located 21 km to the west of Humppa, as the host. A four-slot template with three producers and one injector will be used with production to start in 2031 and to end in 2034. The short field life is due to the planned shut-down of Gina Krog in 2034, consequently closing Humppa at the same time. At that time 1.03MSm3 mmboe will have been produced, giving a recovery rate of 24%. This is clearly below the economic threshold and the PL980 partnership has therefore decided to stop further activity on the Humppa prospect and to drop the license.

4 Prospect update report

There were two prospects identified in the PL980 license in the APA2018: Humppa and Hot Pot.

The main focus in the license was the Humppa prospect. This was identified as a thickness anomaly on the constructed Hugin Fm (assigned 12.5% of the Sleipner to BCU isochore to the Hugin Fm (based on wells in the Greater Sleipner Area). The prospect has stratigraphic components to the west, north and south and is dependant on a working fault seal to the east. One major problem with Middle Jurassic prospectivity in this area is to identify the Top Hugin seismic marker. Most of the time this reflector is weak and varying impedance contrast with the overlying Heather Fm (Fig. 4.1). The interpretation work instead focused on what could be interpreted.

Well	HC filled	Brine filled
15/9-19A	weak AI+	
15/9-19BT2		weak AI-
15/9-F-4	AI-	
15/9-F-1A		weak AI+
15/9-F-10		AI+

Fig. 4.1 Hugin Fm impedance contrasts in from Volve field wells

Mapping of the Permian was important to understand the timing of the Triassic and Jurassic deposition. The Permian fault trend proved to steer Early Triassic Smith Bank Fm fluvial deposition which again influence the subsequent Skagerrak Fm and Sleipner Fm fluvial systems. The Utsira High, east of the "Humppa" fault, a reflector identified as a Triassic Unconformity marking the transition between Smith Bank and Skagerrak Fms. This is a reflector that can be tracked with high confidence in areas where the salt was thick during the early to middle part of Triassic, and with less confidence where the top of the thick Smith Bank Fm mini-basins have been eroded. The resulting Triassic Unconformity surface is one of the key maps in the prospect evaluation (Fig. 4.2). The isochrone between the Top Zechstein salt and the Triassic Unconformity shows where the main Smith Bank Fm deposition was (Fig. 4.3). The Triassic Unconformity to BCU isochrone map highlights the Late Triassic and Early Jurassic fluvial depositional trends (Fig. 4.4). The Triassic Unconformity to BCU isochrone shows the significant accommodation space in west of the "Humppa" fault.

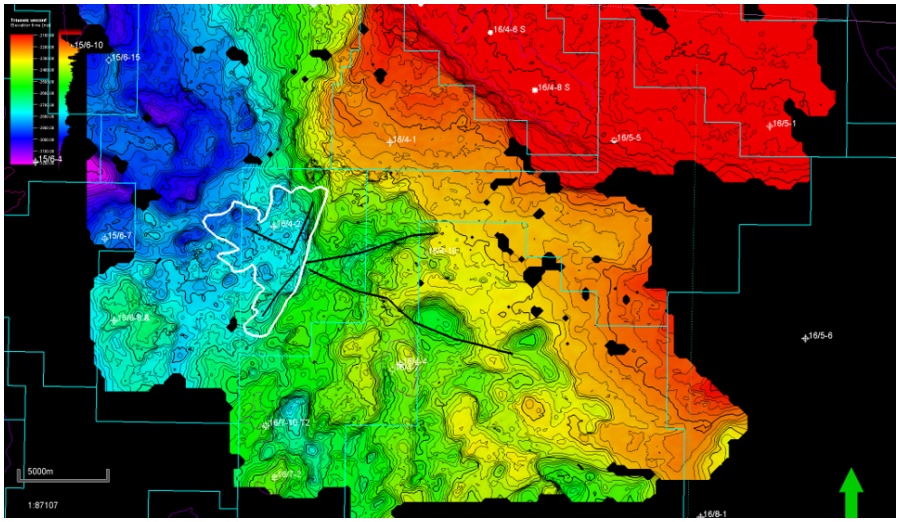

Fig. 4.2 Triassic unconformity time map
The Triassic Unconformity surface represents the top of the Smith Bank Fm. It can be mapped with confidence on the Utsira High east of the "Humppa" fault, but with low confidence on the western side of the fault.

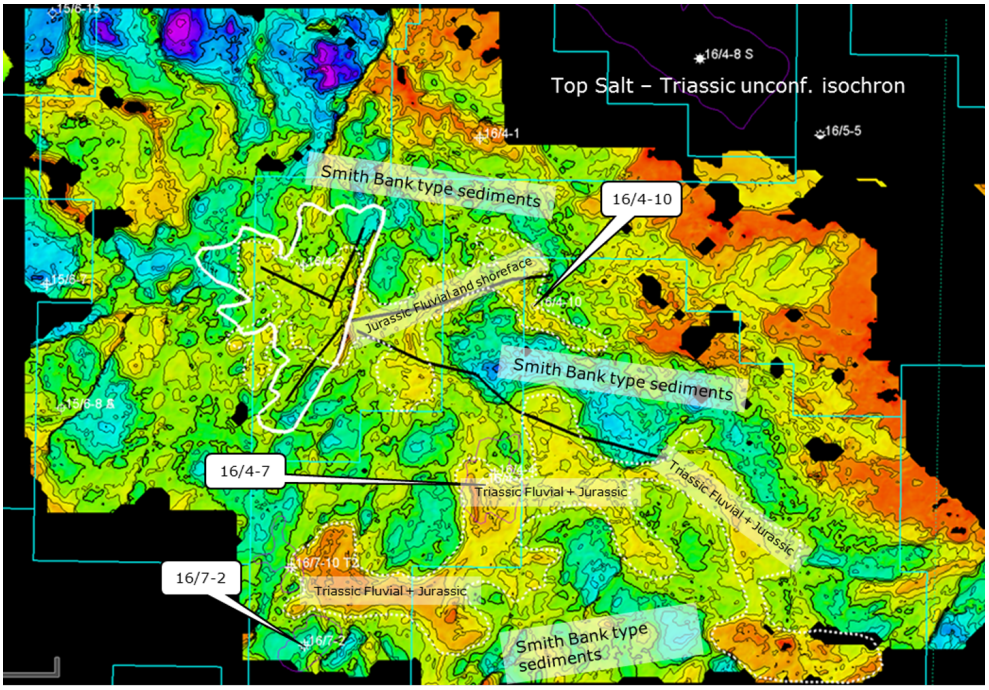

Fig. 4.3 Top Zechstein salt to Triassic Unconformity isochron
The cold colors show thick Smith Bank Fm, and the warmer colors where there still are salt walls present. Superimposed the Permian fault patterns

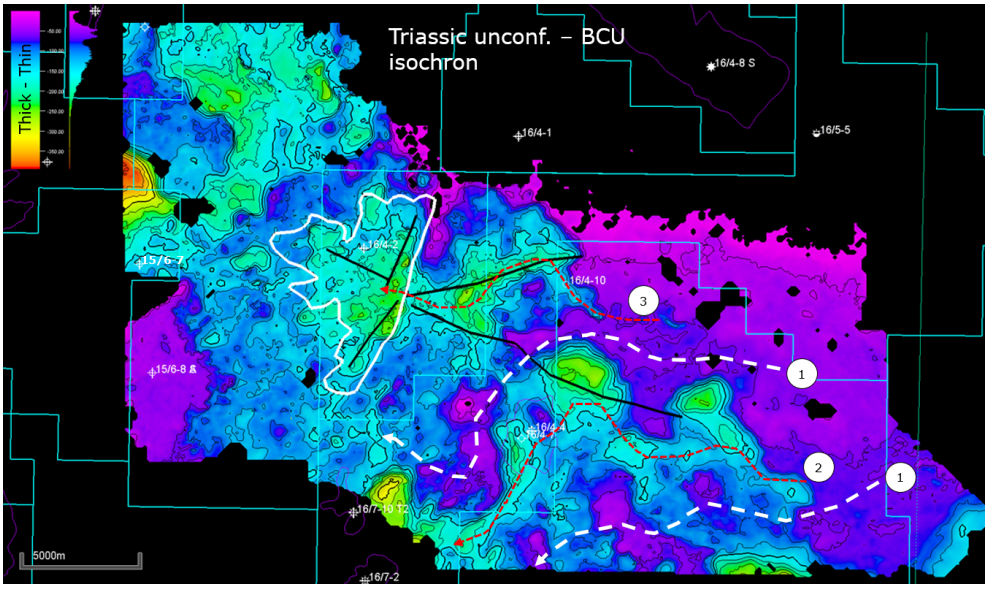

Fig. 4.4 Triassic Unconformity to BCU isochron
The warmer colors shows where the Late Triassic to BCU accommodation space is.
1. This is Early Triassic fluvial systems filling in silty, shaly and occasional sand of the Smith Bank Fm
2. This is a sand rich fluvial system of the Skagerrak Fm exemplified by the 16/4-7 well.
3. This is the youngest fluvial system ranging from Latest Triassic (Statfjord Fm) to the Sleipner Fm. This is confirmed by the 16/4-10 well.

The sand presence in the Humppa prospect is not only dependant on accommodation space, but also timing of the Middle Jurassic shallow marine transgression and the when the "Humppa" fault moved. Plotting the biostratigraphic data for the Hugin Fm in the area shows

that shoreline is most likely present in the Humppa prospect area in the Callovian to Early Oxfordian (Fig. 4.5). The Volve wells 15/9-19 A and 15/9-19 BT2 show that the Jurassic rifting commenced in the Early Oxfordian. The is supported by the 15/6-9 S, A and B wells on Gina Krog. This indicates that the "Humppa" fault was active from Early Oxfordian and through the Kimmeridgian at least, thus increase the confidence of a shallow marine environment in the Humppa prospect area.

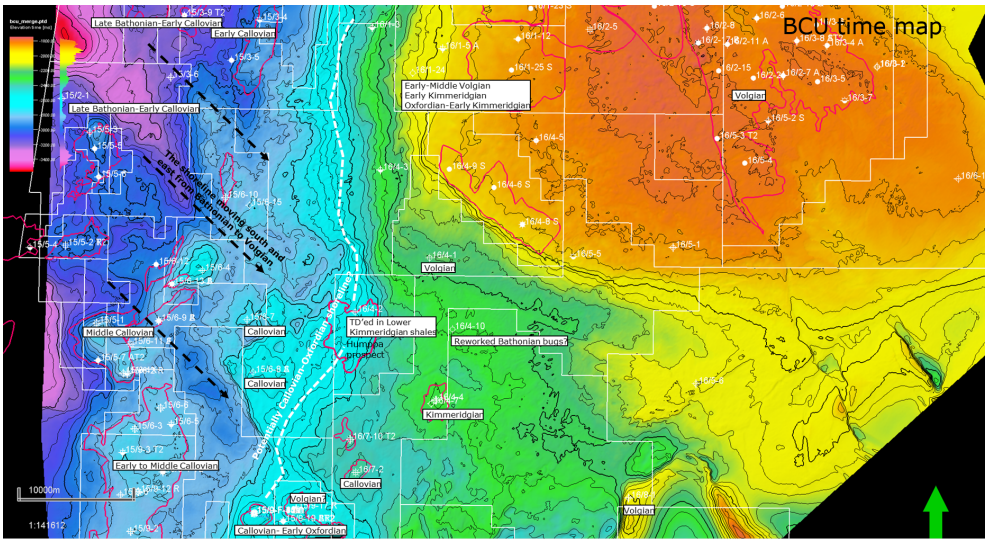

Fig. 4.5 Jurassic shallow marine transgression
The well data show that the shoreline has transgressed south-southeast from Bathonian to Volgian times in the Greater Sleipner Area.

A seismic line from the 15/6-7 well via 16/4-2 and to the 16/4-10 well shows the challenging imaging of the Jurassic stratigraphy (Fig. 4.6). The Triassic Unconformity surface is associated with more uncertainty on the hanging wall side of the "Humppa" fault. The 16/4-10 well found sand in the Statfjord Fm (very rear to find this formation in the area), Sleipner Fm and possibly a shallow marine deposit of uncertain age (most likely Kimmeridgian) in the uppermost 6 m of the Jurassic section. West of the well there are seismic reflections that could be interpret as clinoforms. However, this is unlikely based on the timing. Clinoforms would infer a large lake in the area with significant depth. A more likely scenario is that the reflectors represents fluvial deposits on the flank of a salt wall. The salt has later been washed away. The Humppa prospect is difficult to define on the seismic (Fig. 4.6). The Jurassic isochrone map suggests a depocenter (Fig. 4.4) associated with a fault that was active in the Jurassic. The only attribute that identified a marine deposit in the prospect area was the relative Mu-Rho attribute from the Crava inversion (3 Content of relinquishment report). The depositional model for Humppa was originally shallow marine shoreface facies. However, the shape mapped out on the Crava inversion data suggests a more deltaic facies like the southern part of the Sleipner Vest field. This could explain the incision observed on the footwall side of the fault and the extent and shape of the Humppa anomaly (Fig. 4.7). The fact that the reservoir is very difficult to map on the seismic may fit the deltaic model. The impedance contrasts may be low and rapid change from one facies to another (shoreface, mouth-bars, tidal flats and tidal bars) lead to less continuous events visible on the seismic.

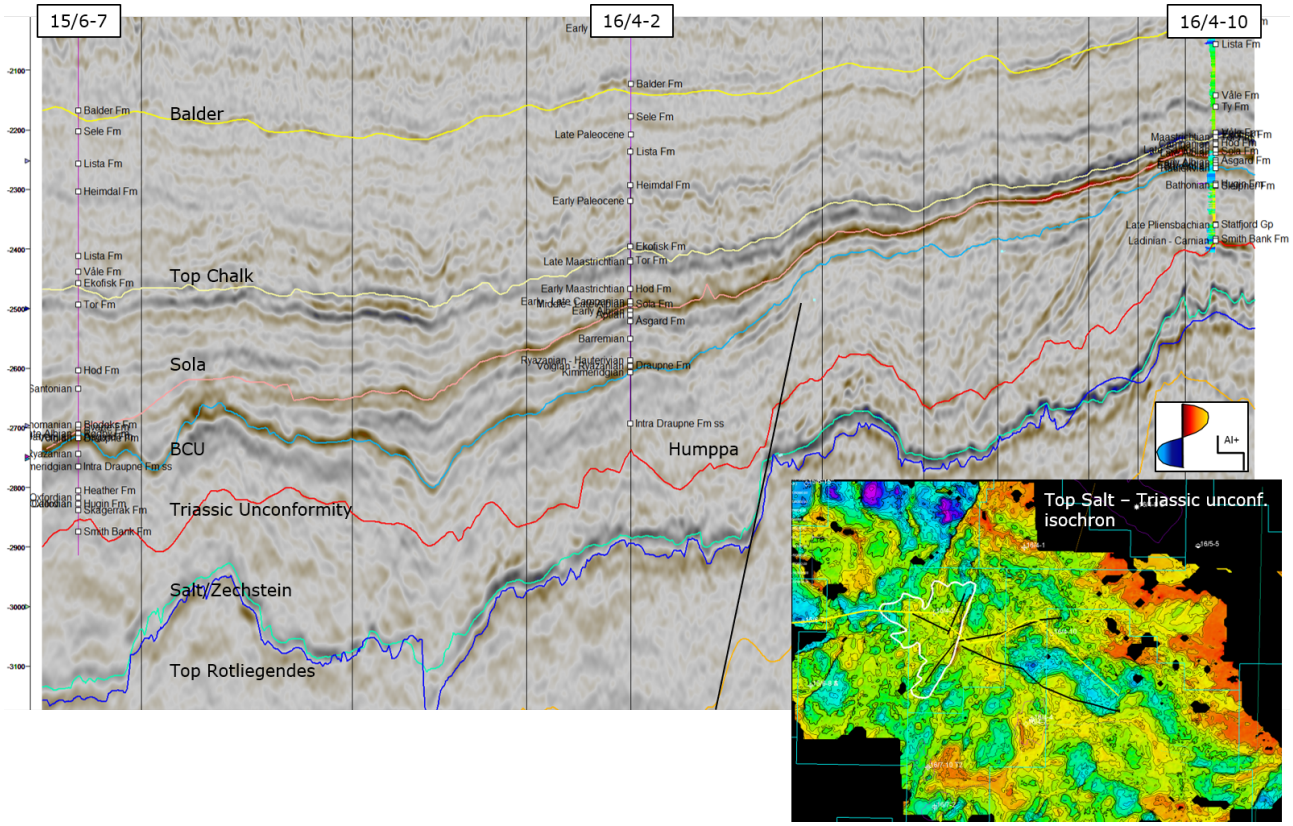

Fig. 4.6 Seismic line from 15/6-7 to 16/4-10
West of the "Humppa" fault, the interpretation is more uncertain. The seismic have less clear continues events and also lack clear acoustic contrasts.

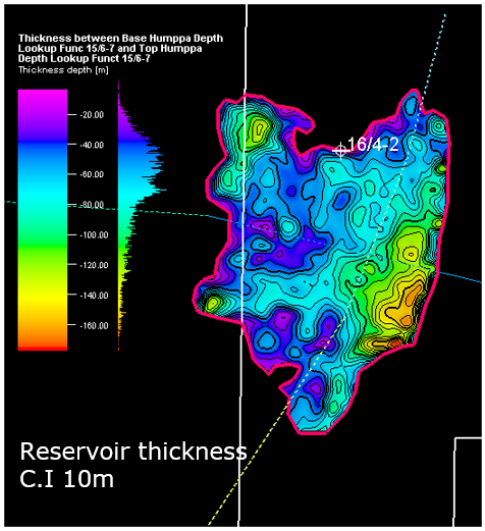

Fig. 4.7 Humppa reservoir isochore
The warmer colors shows the thicker parts are close to the input next to the fault. This fits a deltaic model.

The prospect volumes has been reduced considerably since the APA application (). The reason being the sealing potential of the "Humppa" fault. The fault seal study showed that the fault

could hold a 40 m hydrocarbon column. This scenario was given the most weight. In addition, column heights of 100 m and 200 m was used. The result was 26.8 mboe of hydrocarbon in place on the trap with a risk of 12% (Fig. 4.8).

Table 4.1 Discovery and prospect data (NPD Table 4)
Updated Table 4 after license evaluation.

Table 4: Discovery and Prospect data (Enclose map)

Block	16/4	Prospect name	Humppa	Discovery/Prosp/Lead	Prospect	Prosp ID (or New!)	NPD will insert value	NPD approved (Y/N)	
Play name	NPD will insert value	New Play (Y/N)		Outside play (Y/N)					
Oil, Gas or O&G case:	Oil	Reported by company	Point Resources	Reference document				Assessment year	
This is case no.:	1 of 1	Structural element	Utsira High	Type of trap	Stratigraphic	Water depth [m MSL] (>0)	93	Seismic database (2D/3D)	3D
Resources IN PLACE and RECOVERABLE		**Main phase**				**Associated phase**			
Volumes, this case		Low (P90)	Base, Mode	Base, Mean	High (P10)	Low (P90)	Base, Mode	Base, Mean	High (P10)
In place resources	Oil [10^6 Sm^3] (>0.00)	0.18	1.54	2.96	7.94				
	Gas [10^9 Sm^3] (>0.00)					0.00	0.08	0.38	1.20
Recoverable resources	Oil [10^6 Sm^3] (>0.00)	0.05	0.61	1.08	3.57				
	Gas [10^9 Sm^3] (>0.00)						0.03	0.15	0.54
Reservoir Chrono (from)	Callovian	Reservoir litho (from)	Hugin Fm	Source Rock, chrono primary	Kimmeridgian	Source Rock, litho primary	Draupne Fm	Seal, Chrono	Oxfordian/Kimmeridgian
Reservoir Chrono (to)	Oxfordian	Reservoir litho (to)	Ula Fm	Source Rock, chrono secondary	Oxfordian	Source Rock, litho secondary	Heather Fm	Seal, Litho	Draupne & Heather
Probability [fraction]									
Total (oil + gas + oil & gas case) (0.00-1.00)	0.16	Oil case (0.00-1.00)	0.60	Gas case (0.00-1.00)	0.10	Oil & Gas case (0.00-1.00)	0.30		
Reservoir (P1) (0.00-1.00)	0.65	Trap (P2) (0.00-1.00)	0.40	Charge (P3) (0.00-1.00)	0.80	Retention (P4) (0.00-1.00)	0.75		
Parametres:	Low (P90)	Base	High (P10)	*Comments*					
Depth to top of prospect [m MSL] (> 0)		2985							
Area of closure [km^2] (> 0.0)	0.3	1.4	4.5						
Reservoir thickness [m] (> 0)	15	40	55						
HC column in prospect [m] (> 0)	50	115	250						
Gross rock vol. [10^9 m^3] (> 0.000)									
Net / Gross [fraction] (0.00-1.00)	0.20	0.55	0.90						
Porosity [fraction] (0.00-1.00)	0.12	0.18	0.25						
Permeability [mD] (> 0.0)	40.0	150.0	500.0						
Water Saturation [fraction] (0.00-1.00)	0.15	0.25	0.30						
Bg [Rm3/Sm3] (< 1.0000)									
1/Bo [Sm3/Rm3] (< 1.00)	0.54	0.58	0.62						
GOR, free gas [Sm^3/Sm^3] (> 0)									
GOR, oil [Sm^3/Sm^3] (> 0)	218	250	282						
Recov. factor, oil main phase [fraction] (0.00-1.00)	0.35	0.40	0.45						
Recov. factor, gas ass. phase [fraction] (0.00-1.00)	0.35	0.40	0.45						
Recov. factor, gas main phase [fraction] (0.00-1.00)									
Recov. factor, liquid ass. phase [fraction] (0.00-1.00)				For NPD use:					
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Pressure, top res [bar] (>0)	350			Dato:	NPD will insert value	Registrert Dato:	NPD will insert value	Kart dato	NPD will insert value
Cut off criteria for N/G calculation	PHIE > 15%	Vclay < 30%	3					Kart nr	NPD will insert value

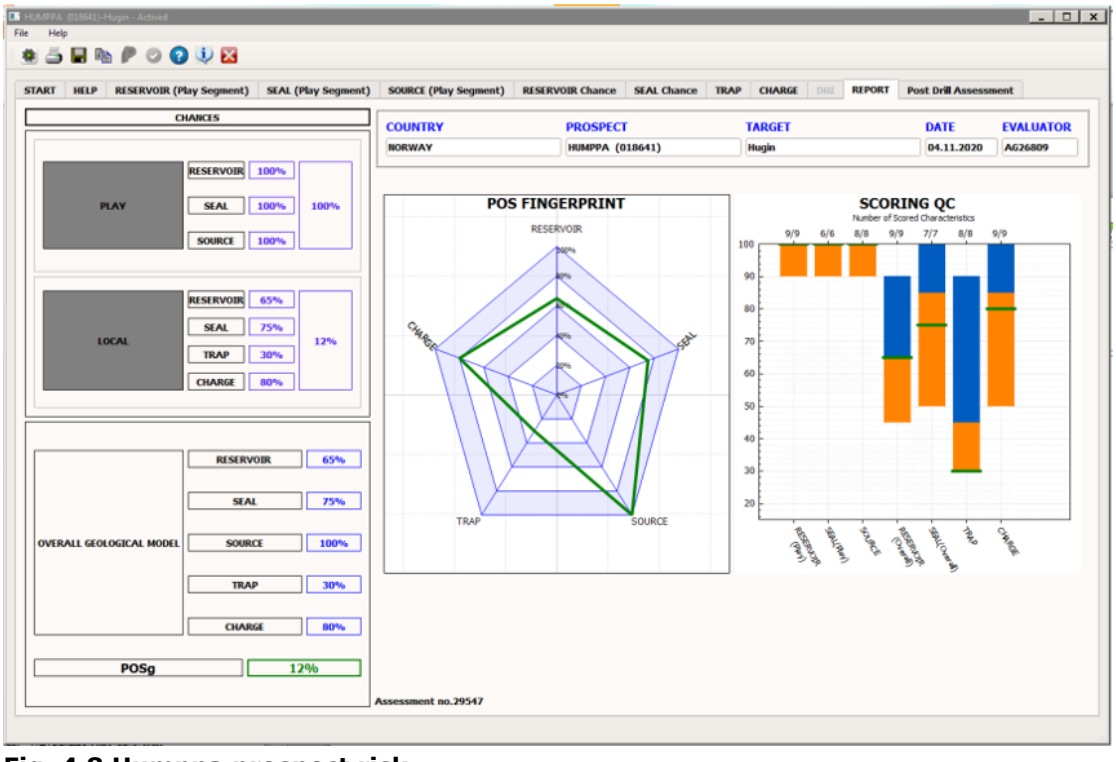

Fig. 4.8 Humppa prospect risk
The main risk is the trap. This is set to 30%.

The Hot Pot prospect was quickly ruled out because of the trap risk due to low probability for a competent seal between the prospect and the 16/4-10 well.

5 Conclusion

Based on the technical work done in the PL980 licenses the partner group has decided to relinquish the area.

The prospect is challenging with a reservoir that is hard to define and a very high trap risk. This combined with limited volumes resulted in a negative outcome. Minimum economic field size (MEFS) estimated by the operator for the area is around 15 mboe. The estimated in-place volumes for the Humppa prospect is 26.8 mboe. Applying a range of recovery factors typical for oil in the Hugin Fm the Humppa prospect does not pass the economic threshold.