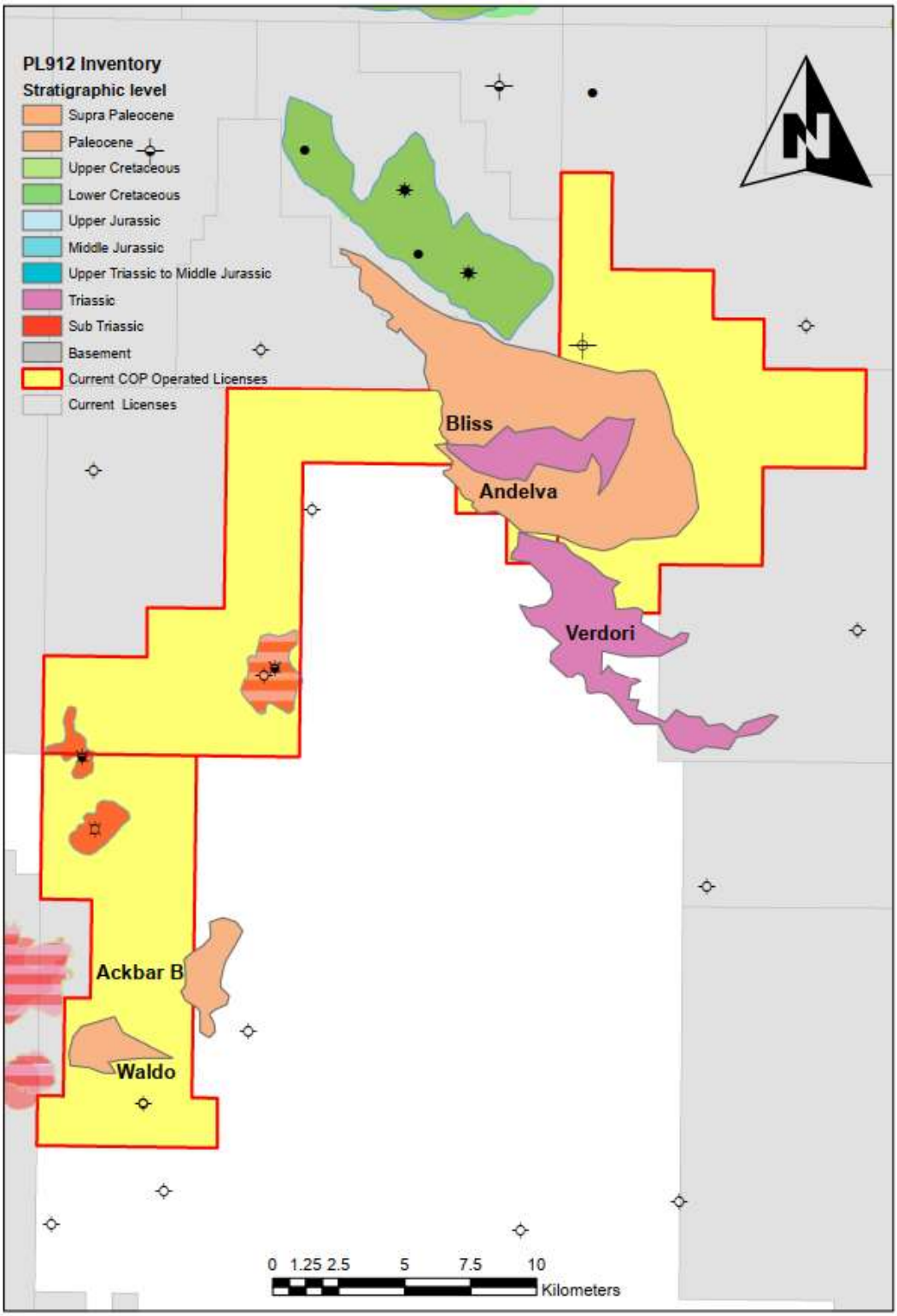
PL912 Relinquishment Report



Prepared by ConocoPhillips 2020

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1 Key License History

Production license PL912 is located on the southwestern part of the Utsira High next to the prolific Viking Graben (Fig. 1.1). It consists of parts of block 16/4, 16/5, 16/7. The license was awarded on the 2nd March 2018 to a partnership of ConocoPhillips, Point Resources (now Vår Energi) and Pandion Energy and covers a total area of 298.19 km^2.

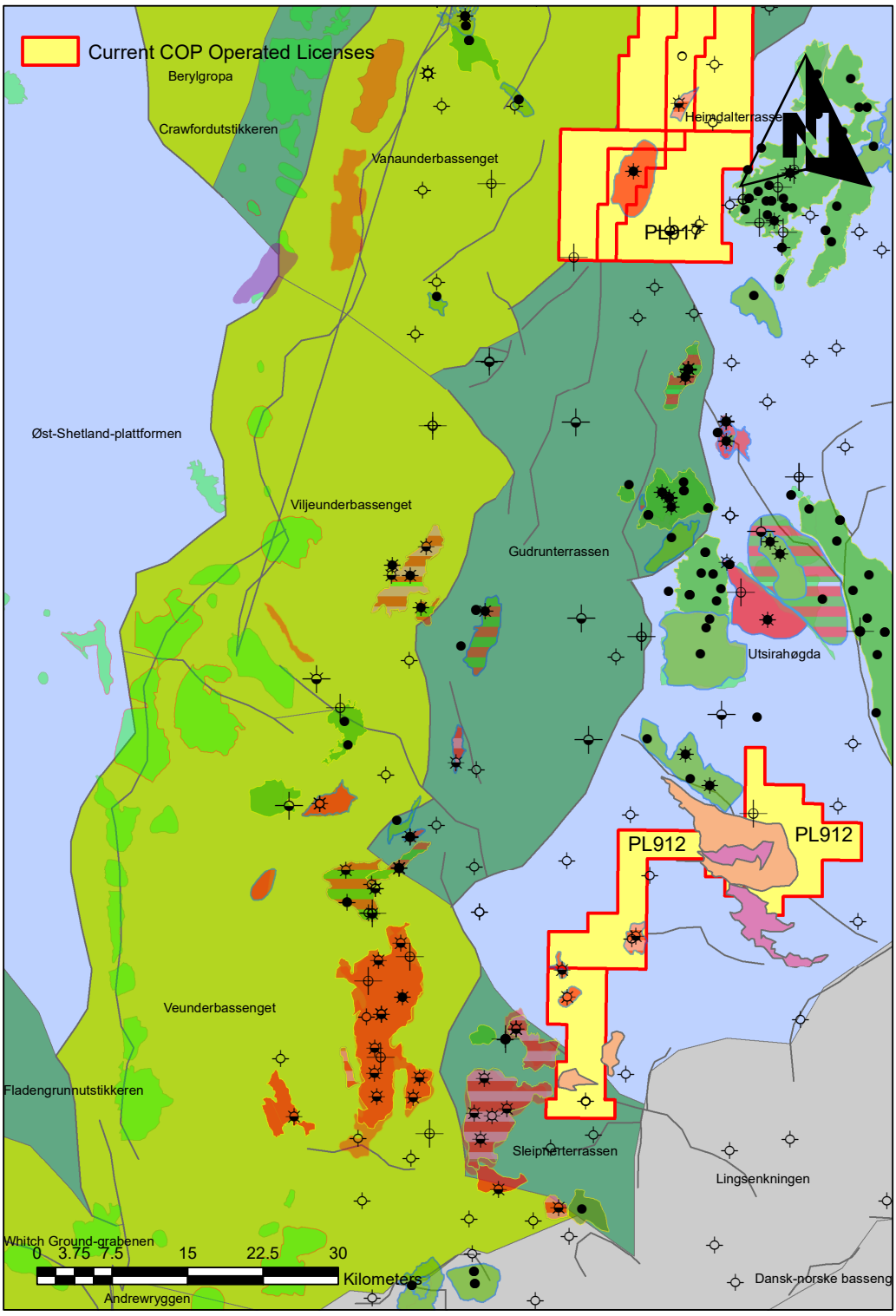


Fig. 1.1 PL912 License location map

The partnership in PL912 consists of

- ConocoPhillips Skandinavia AS 40%
- Vår Energi AS 30%
- Pandion Energi AS 30%

The work program for the initial phase consisted of reprocessing or acquiring 3D seismic data over most of the license. The obligation was fulfilled by the license through the acquisition and interpretation of the PGS 16902VIK PSDM reprocessed survey that covers 89.2% of the PL912 license area and all of the identified prospectivity (Fig. 1.2).

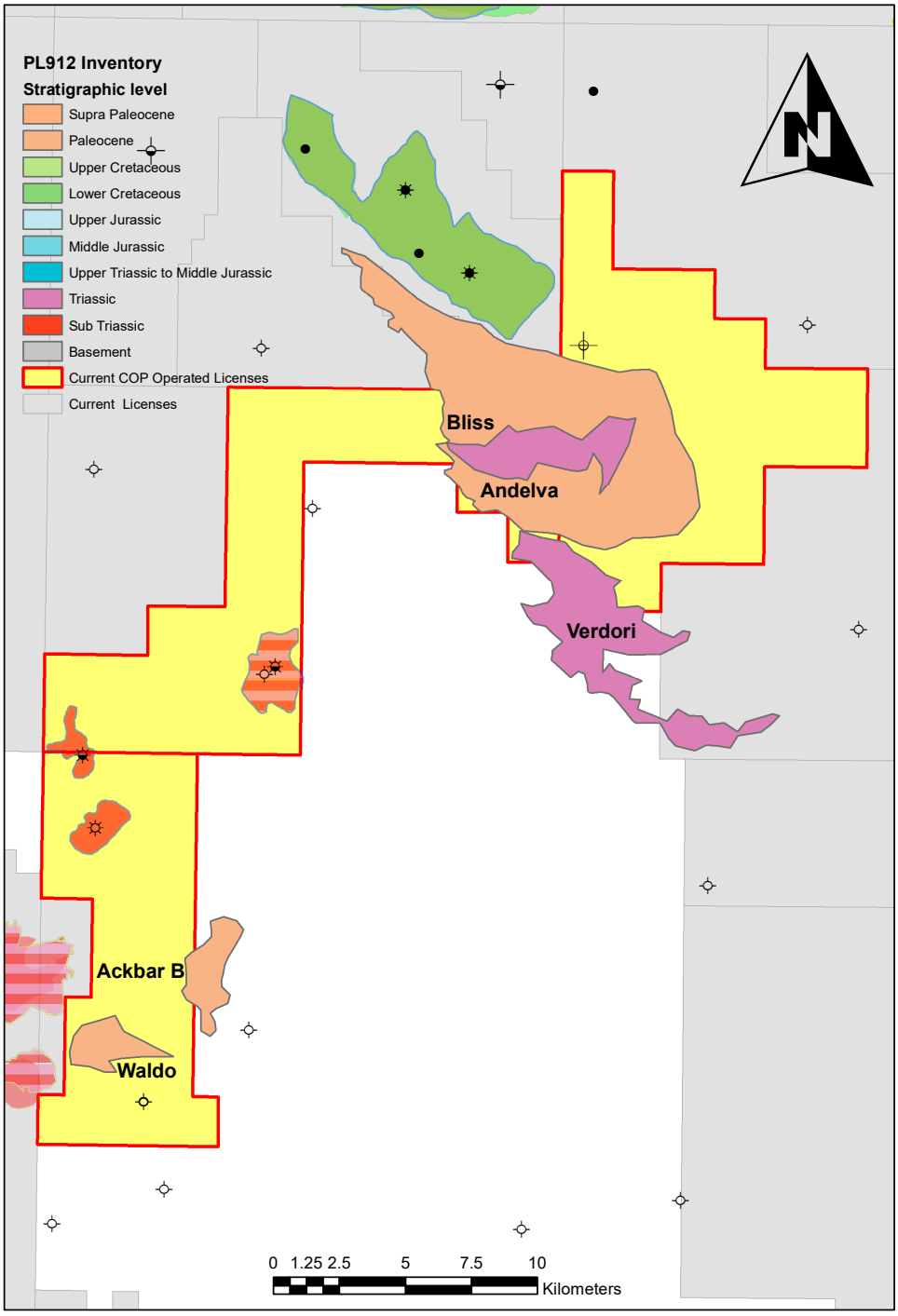


Fig. 1.2 PL912 License inventory map

The work obligations are stated below:

- Reprocess or acquire 3D seismic
- By 2nd March 2020 decide whether to drill an exploration well or relinquish the license

The partnership decided to drop the license at the drill or drop deadline 2nd March 2020 based on the conclusion that the Paleocene play does not extend further east than the traditionally mapped pinch out. Therefore, the identified Bliss prospect is no longer viable. Bliss was seen as a potential play extension to the 2019 relinquished Tertiary inventory in PL775 where the Jackpot prospect was the key prospect. The remaining exploration potential in the traditional Paleocene closures (Ackbar and Waldo) and the newly identified Middle-Lower Triassic pinch-out traps (Andelva and Verdori) are currently deemed to be too high risk or non-economic.

1.1 License Meetings

In total three combined EC/MC meetings were conducted in this license.

- April 2018 - Startup EC/MC meeting
- December 2018 Year End EC/MC meeting
- May 2019 -Mid Year EC/MC meeting
- Novermber 2019 Year End EC/MC meeting

2 Database

2.1 Seismic Database

Seismic Database

A common license database was established at the beginning of the PL912 license. It consists chiefly of the regional dataset (PGS16M01-PGS16902VIK). A reprocessed PSDM volume that covers 89.2% of the license area and was supplemented to the TUN15M01 survey that all partners have access to. Fig. 2.1 shows the coverage of the PGS16M01-PGS16902VIK dataset. Dataset abbreviated as PGS16902VIK.

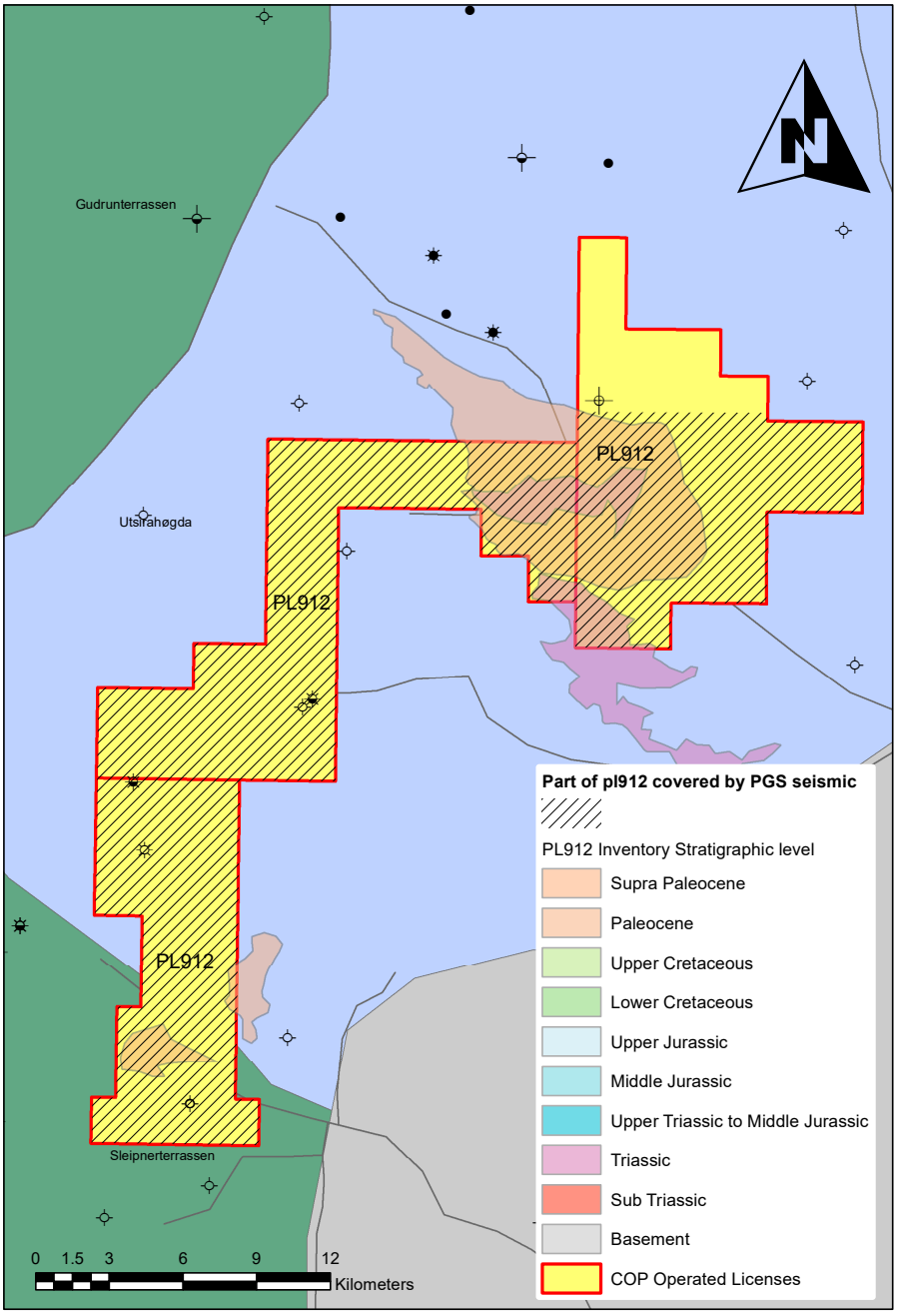


Fig. 2.1 Seismic Database Coverage by the PG16902 PSDM dataset is outlined by the hatched area.

2.2 Well database

Well database

The released wells in and surrounding the license constituted the common well database and are shown in table below.

Table 2.1 Wells used in the study with NPD ID

Well Name	NDPID
15/6-4	319
15/6-7	2084
16/4-1	229
16/4-2	1560
16/4-4	5441
16/4-6 S	7098
16/4-7	7208
16/4-10	7731
16/5-1	189
16/5-5	7285
16/5-6	7962
16/7-1	146
16/7-2	40
16/7-3	75
16/7-5	134
16/7-10	6607
16/8-1	335
16/8-2	234
16/8-3 S	7115

2.3 Special Studies

Special Studies:

- With ConocoPhillips as the operator a very large and detailed regional basin model was constructed and calibrated to all relevant offset wells. In contrast to the publicly available basin models special care was taken to correctly map and incorporate many of the shallow horizons post Balder Formation deposition. This was done to be able to model the intricacies of long distance migration in a basin that underwent very late stage changes with regional tilts and late glacial adjustments. The spatial extent and the horizons utilized by the basin model are shown in Fig. 2.2. The migration and generation was modelled on a 200x200m grid size.
- *Rock Physics:* Rock physics analyses were done to assess amplitude expectations on modern broadband 3D seismic data and its potential to help differentiating lithologies and fluid content.
- *CPI Well Reports*: To better constrain expected reservoir properties for the prospect, CPI analyses were conducted on nearby key wells
- Extensive seismic forward modelling of potential Tertiary reservoirs sands has been undertaken to

determine the minimum unresolved sandstone thickness of a Tertiary sandstone on the PGS16902VIK seismic that is part of the common license database. The modelling showed that is very unlikely that a sandstone body with a net of greater than 15 meters of sand would be unresolved on the high quality available seismic. The modelled response was compared to real seismic and it was concluded that no sandstone body of such a thickness is present east of the currently mapped pinch out line for Tertiary sands. A sandstone body with less than 15 meters net sand combined with the areal extent of the Jackpot stratigraphic closure is not deemed to be an economically viable development scenario in 2019.

- The *uniform shale model*, originally derived in the Balder area, stipulates that the combined shale thickness for large parts of the Tertiary fairway is regionally constant and hence the thickness change in the Top Chalk to Sele seismic interval can be attributed solely to the change in Tertiary sandstone thickness. The shale hence was deposited as a time constant background rain sedimentation. This model was cross validated in the area to the west and around the Jackpot (PL775) and Bliss prospects and it was found that there are semi regional (>10km) significant changes in shale thickness that needed to be incorporated into the model. Taking regional trends into account the model predicts the Tertiary sand thickness to the west of the Jackpot prospect rather well.
- *Traditional high resolution sequence stratigraphic mapping* of the Tertiary section was performed in an area spanning from the UK/ Norway border to the east of well 16/9-1 was performed to determine the spatio/temporal development of the accommodation space and depositional patterns in the area. Eight high resolution reflectors were mapped in the interval from top Chalk to Balder. This lead to the conclusion that the excess accommodation space that is apparent over the Jackpot /Bliss using the uniform shale model was infilled post the deposition on the youngest Heimdal sands. Hence the excess top Chalk to Sele thickness that initially defined the Jackpot /Bliss prospect using the uniform shale model was infilled after the deposition of the Heimdal sands.
- *Neural Network Lithology Prediction:* In collaboration with a summer student from the NTNU a machine learning, artificial intelligence trial using 3D seismic data to classify seismic facies was carried out. Application of this technology showed that computers are able to generate precise and unbiased 3D seismic facies classifications. The automated and unbiased seismic facies mapping calibrated to 35 exploration wellbores did not predict any sand prone seismic facies indicators east of the currently proven pinch-out line of the Tertiary sandstones.
- *Stochastic Basin modelling to determine fill and spill routes:* The subtlety of the Tertiary Ackbar B and Waldo structures in addition to long distance migration required to fill the Jackpot prospect required a non-traditional approach to the mapping of potential hydrocarbon fills and the determination of the fill spill routes. We developed and in-house workflow where the standard deviation derived from the Seissquare depth uncertainty modelling workflow is randomly sampled and used to produce a set of 300 to 500 valid depth surfaces that represent the depth uncertainty ranges. Migration runs are then performed on all of these surfaces and the modelled hydrocarbon fills and spill routes are converted to probability density maps such that an interpreter can read of the chance of migration and or hydrocarbon fill at any given depth along a certain structure or fill route. This allowed a very deep assessment of the charge likelihood in the face of seismic and well tie uncertainty.

Fig. 2.2 Extend and content of the 2018 regional basin model.

3 Review of Geological and Geophysical studies

Of the many studies that were carried out in this license and that are listed in (2 Database, in PL775 – Relinquishment Report, in PL775 – Relinquishment Report) only two will be highlighted in this section in detail since they were instrumental in polarizing the assessed prospect risks and lead to the drop decision of the license:

The uniform shale concept was initially derived in the Balder Field area after it was discovered that the combined total net shale thickness in the interval between top Chalk and the Top Sele Formations do not change significantly over semi regional areas (Fig. 3.1). Applying the same concept in the PL775 / PL912 area and calibrating it to the local wells clearly outlines a Tertiary thickness anomaly that was used to define the Jackpot prospect initially Fig. 3.2. The uniform shale model however only highlights that there is a thickness anomaly but it does not reveal at which time this thickness anomaly was filled in. In order to unravel the spatio-temporal distribution of the Paleocene deposition a high-resolution sequence stratigraphic mapping of the interval was undertaken. Eight detailed surfaces where mapped between the Sele and Top Chalk pick and were been tied to the wells wherever possible (Fig. 3.3). The stratigraphic dip line shows clearly that the majority of the of the accommodation space in the eastern part of the section was filled in post the deposition of the Ty Formation which is characterized by the strong hard reflections (pink reflector). The light green reflectors in the eastern part of the section are not correlatable in the western part of the section due to thinning of the interval. It is however likely that these reflectors are younger than the top Heimdal marker in the west. It therefore looks like that the entire surplus thickness, that is evident from the application of the uniform shale model, was infilled post the deposition of the Tertiary sands. The origin of the excess shales that fill in the accommodation space to the east can only be speculated about. One possible explanation is that these shales where shed in the form of

Assumptions

- Shales are pelagic rain only. The amount varies little areally
- Sandstones are transported laterally into the system
- Siltstones are neglected in the model

- Sele + Lista + Vale Fm thickness = turbiditic sandstones plus pelagic shales
- Turbiditic sandstone = (Sele + Lista + Vale Fm thickness) – shale Thickness

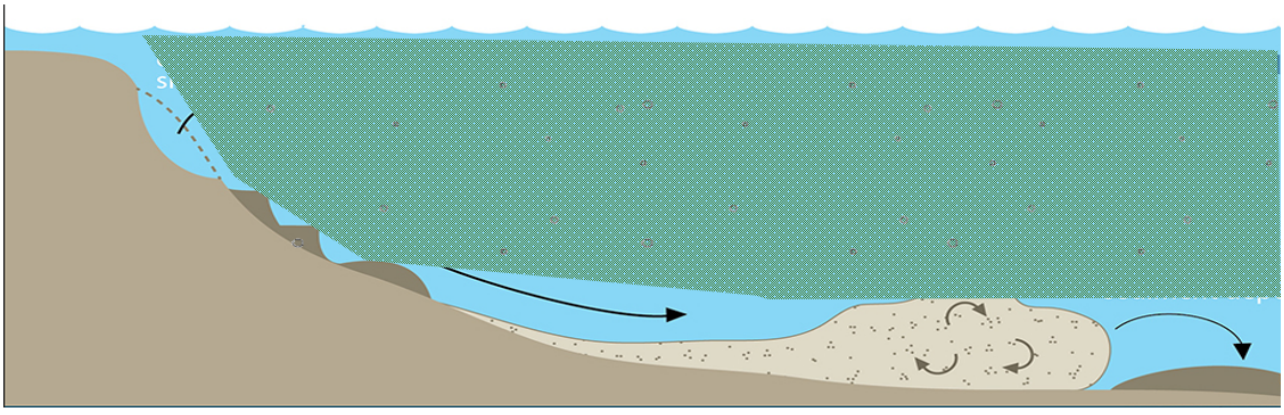


Fig. 3.1 Uniform shale model concept

ultra low density mass flows from the surrounding salt domes that were emerging at the time. Interestingly none of the areas where the uniform shale model has shown to be valid contain any salt domes. The current thinking of the tectonic sedimentary history at the Jackpot / Bliss prospect area is summarized in Fig. 3.4. The incipient uplift of the Utsira High created a hydraulic ramp for the Tertiary sandstones arriving from the west. This hydraulic ramp lead to the rapid drop of sands from the turbiditic flow such that they were deposited mostly to the west and directly on top of the ramp. The later Heimdal sands never reached as far east as the initial Ty sands. In the Balder times most of the accommodation space was created and infilled to the east of the Ty/ Heimdal pinchout line.

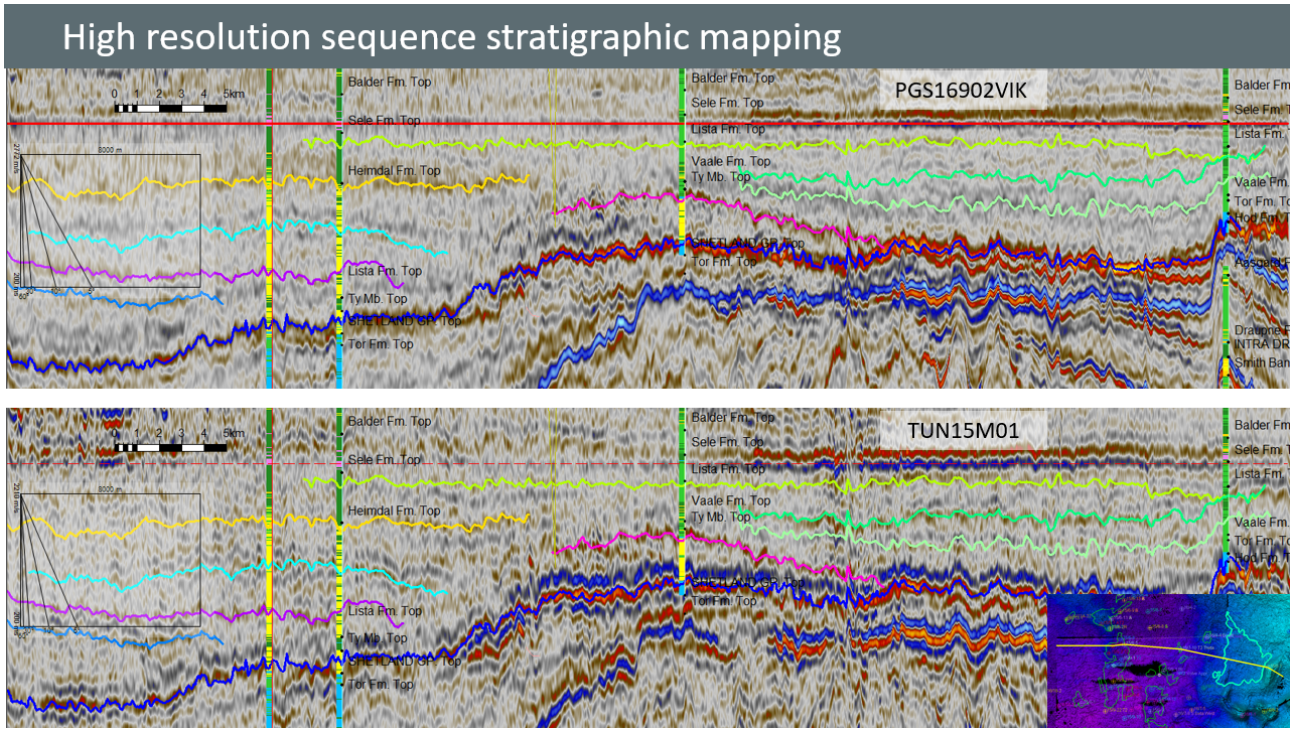


Fig. 3.3 Sequence stratigraphic subdivision of the Paleocene.

The wedge modelling of the Tertiary amplitude response increased our confidence in the conclusion that there are no significant Paleocene sandstone packages east of the currently mapped pinchout lines. In

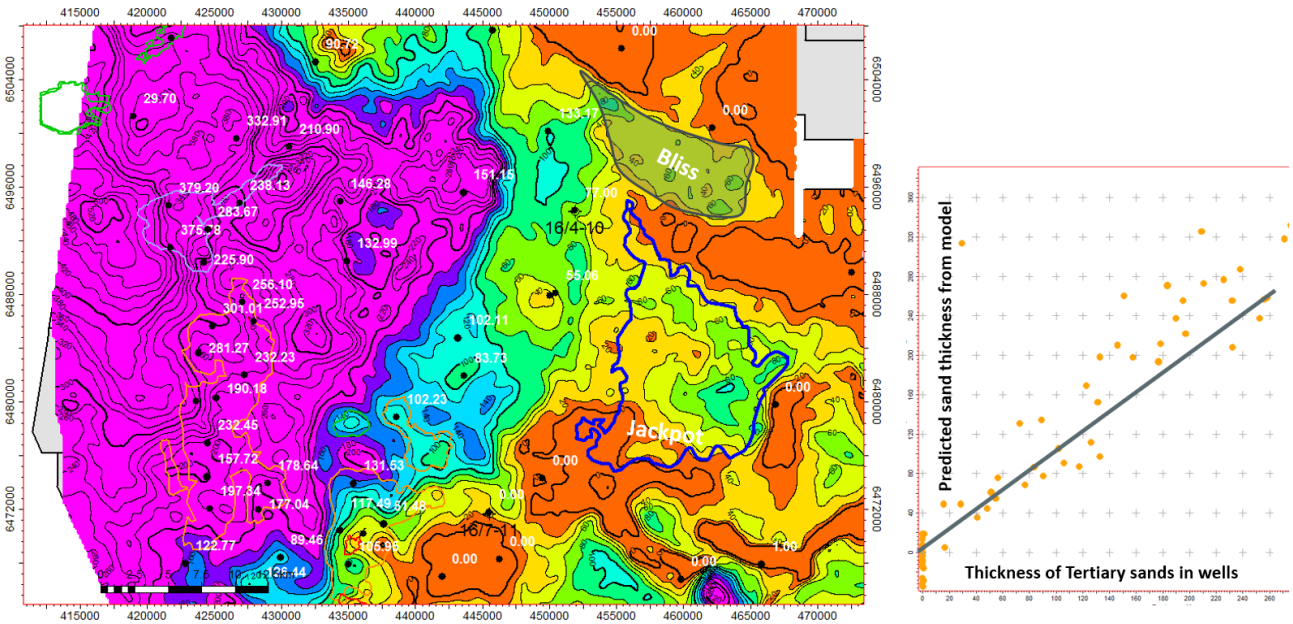


Fig. 3.2 Predicted net Tertiary sand thickness applying a modified uniform shale model

order to test the full potential solution space several sand distribution scenarios were modelled (Fig. 3.5, Fig. 3.6) to determine the minimum detectable sandstone thickness. The sand and shale rock physical models were calibrated to the offset well data. The values used for the formations are tabulated in Table 3.1

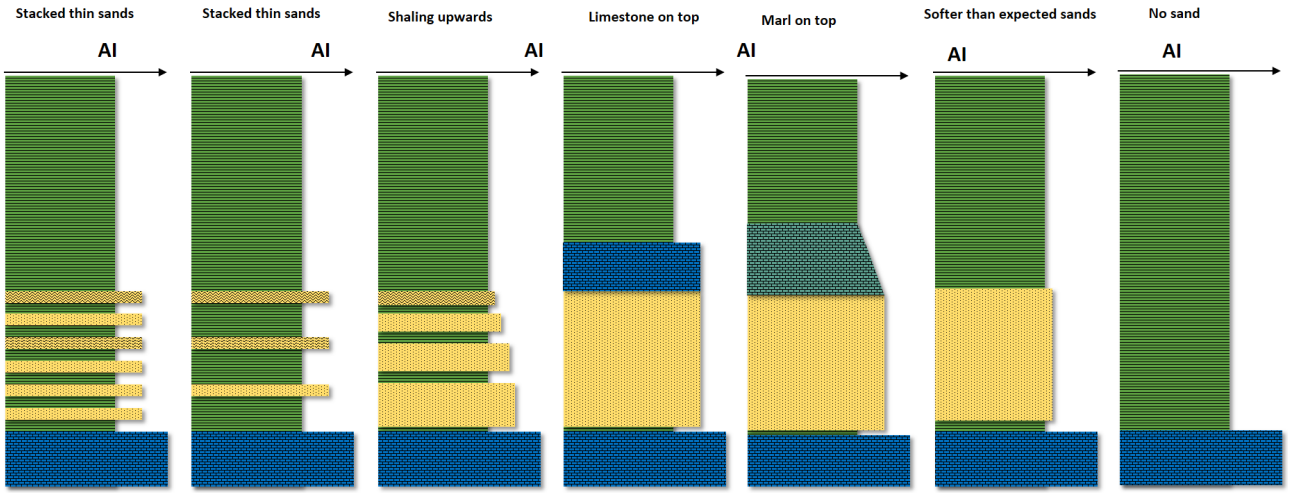


Fig. 3.5 Different lithology distribution models used in the wedge modelling to determine the minimum detectable sandstone thickness

Table 3.1 Rock properties used for wedge modelling

	RHOB	Vp	Vs
Lista / Vaale	2.3 g/cc	2600 m/s	1250 m/s **(Vp/Vs = 2.1
Ty/ Heimdal	2.18 g/cc	3300 m/s	1850 m/s **(Vp/Vs = 1.8)

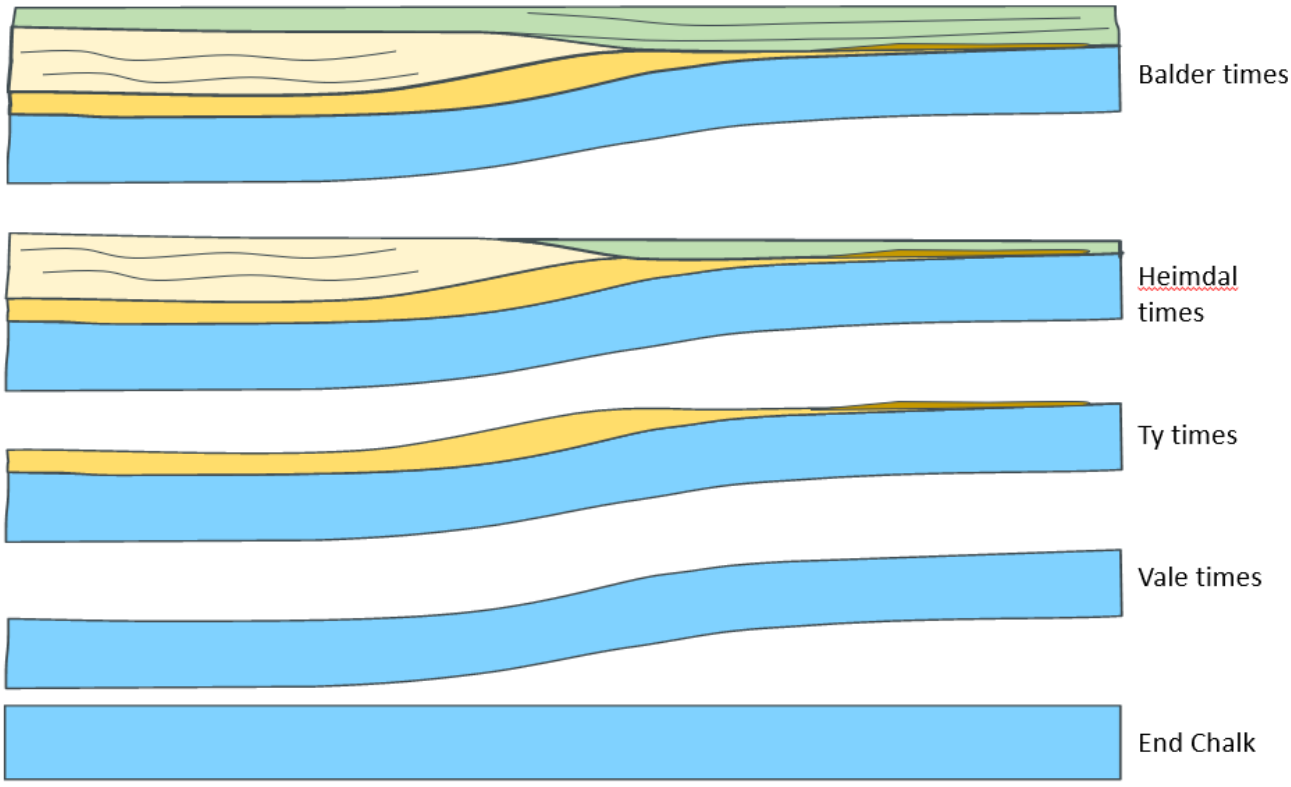


Fig. 3.4 Tectono- sedimentary model over the Jackpot area

The wedge modelling indicated very clearly that a Ty /Heimdal sandstone with a combined net thickness of greater than 15 meters should be resolvable on the high quality seismic. This is quantitatively confirmed by the 15/9-23 well that encountered a 10 m thick sandstone in the Ty Formation which is surprisingly well defined on the seismic. The only geological possible rock physics model that could explain not resolving a smaller than 25 m net Paleocene sandstone on the current seismic would be one where a thick and marly Vale Formation is gradually blended with the sandstones such that no clear impedance contrast is created. Looking at offset wells this scenario is however deemed unlikely and would also negatively impact producibility and therefore the economics of a hydrocarbon trap in such a reservoir. The result of the extensive studies on the Bliss project led to a downgrading of the prospect risk and resources which in turn drives the current decision to relinquish the license.

In order to assess the Early Middle Triassic prospectivity in the northern part of the license a post stack-full offset merged seismic cubed was generated by amplitude balancing in Petrel. (Fig. 3.7). This seismic volume was then used to carry out regional mapping in the pre- Zechstein interval and at the Triassic level. The top Smith Bank marker, the Base Zechstein and some intra Carboniferous markers could be mapped with confidence and helped to establish the structural sedimentological evolution of the area

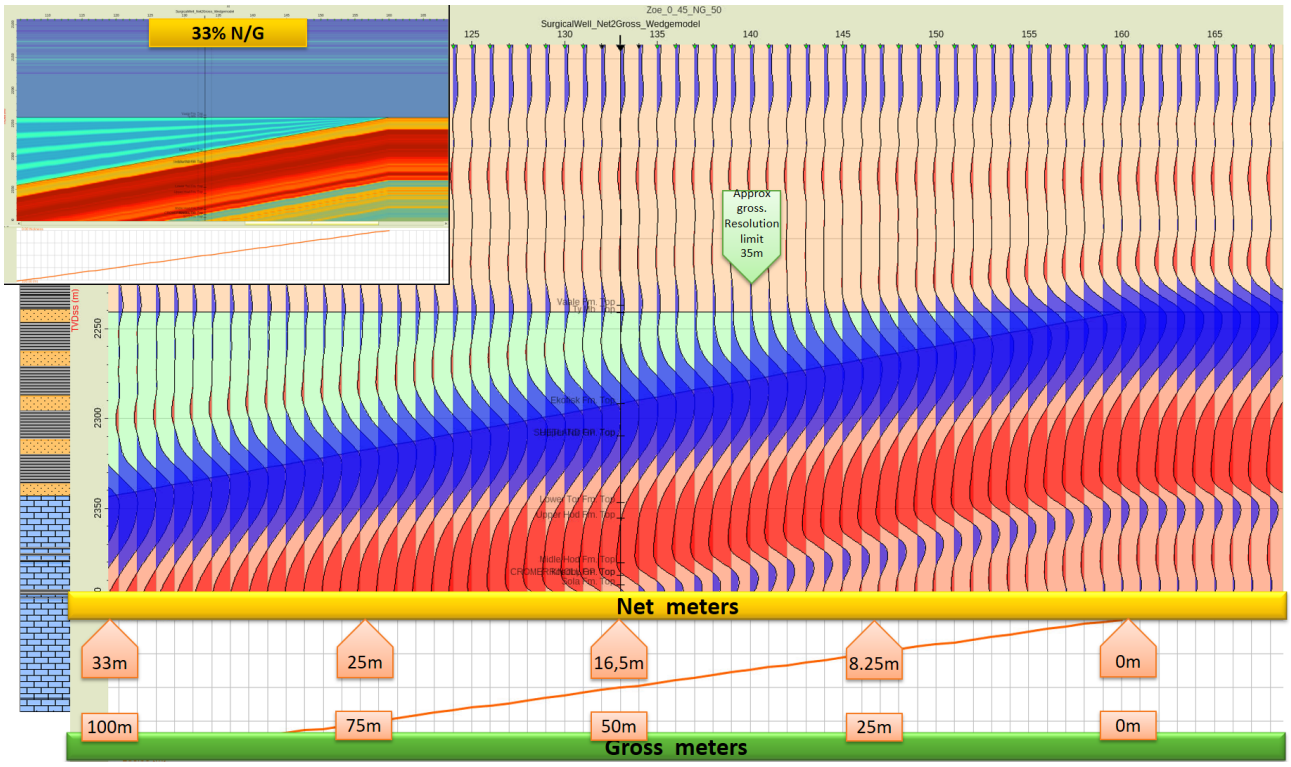


Fig. 3.6 Example of a wedge model with 33% N/G

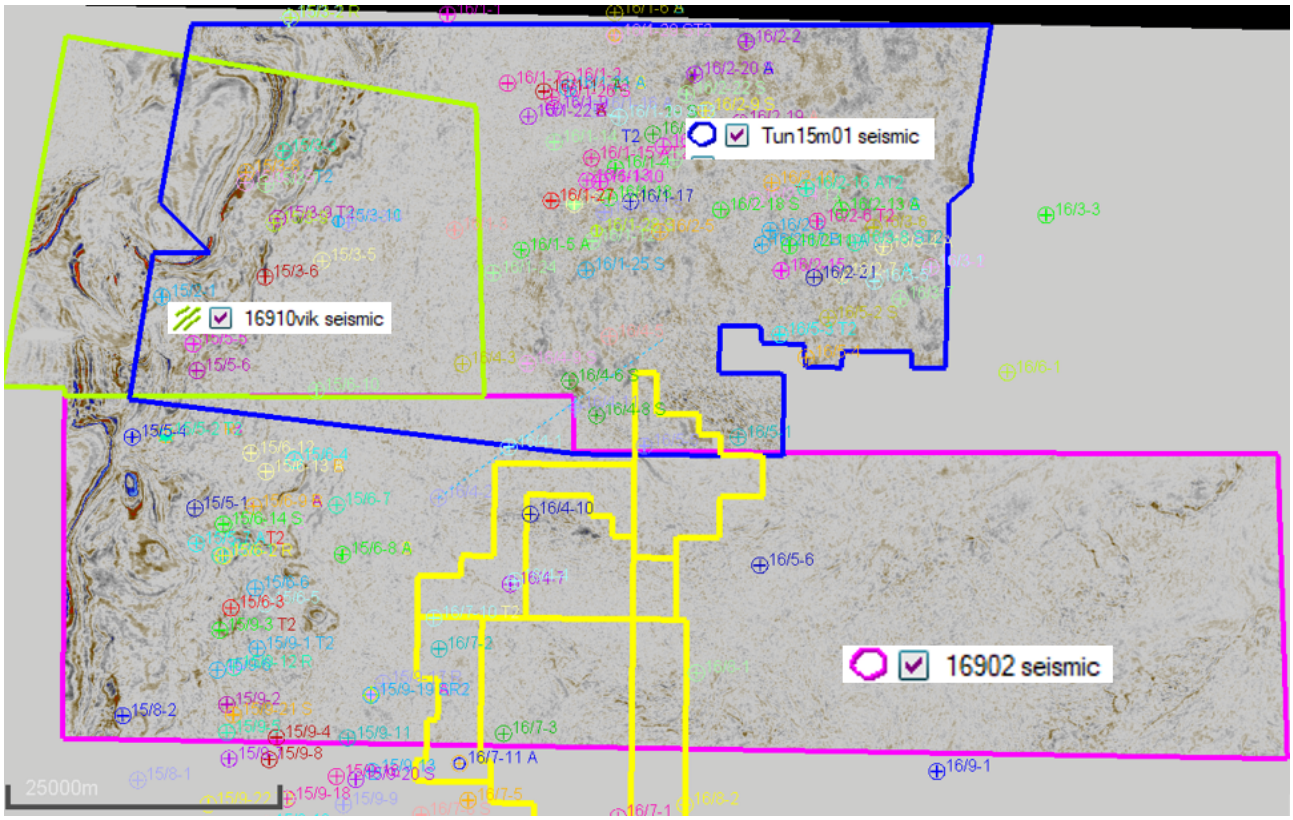


Fig. 3.7 Input seismic volumes to the full offset post stack merge dataset.

4 Prospect Updates

Bliss Prospect

As described in the section 3 Review of Geological and Geophysical studies the Bliss prospect has been downgraded by the performed geological and geophysical work. The previous volume range of 13-164-114mmboe (P10-Mean-P90) has not been reassessed in detail after the negative risk adjustment for the prospect due likely absence of a reservoir. The existing volume and reservoir thickness assessment was based on the application of the uniform shale model and locally exceeded 50 meters. Performed studies since license award indicate that the net sandstone thickness must be below 15 meters to not be seismically detectable on the high quality PSDM seismic that is now available in the PL912. Seismic forward modelling did not indicate that Tertiary sandstones are present at the Bliss location. A sub-seismic sandstone thickness below 15 meters would significantly reduce the to be expected volumes and render the prospect uneconomic.

Ackbar B and Waldo

In the southern part of the license (Fig. 1.2) the leads Ackbar B and Waldo were identified at the time of the application. Subsequent license work upgraded these leads to prospect status based on the clear mapability of these structures on the PGS16902VIK PSDM seismic. Detailed stochastic migration modelling has been used to assess the charge-likelihood of the combined stratigraphic - structural traps east of the Sleipner East Field. Volumetric assessment of the structures indicates that Waldo could hold 9-16 mmboe in a gas condensate case and 8-30mmboe in the more unlikely oil case. Only 4% of Ackbar B is located within the PL912 license and is estimated to have a volumetric range between 4-7mmboe in a gas condensate case and 5-15mmboe in the more unlikely oil case. Both prospects are robust structures but suffer volumetrically from the thinning and pinching out of the reservoir close to the crest of the structures. The detailed stochastic charge modelling did not reveal any straight forward charge routes into Ackbar B and Waldo. In >90% of all charge scenario realisations no charge was predicted in the small Tertiary prospects. The proven fill spill route from Sleipner East - Volve -16/7-2 - 16/4-4 (Biotit) was however favoured in the charge models. Deterministic charge models indicated that the current spill from Sleipner East would have to be 40 meters deeper than present day to allow a viable charge route into Waldo and from there onwards to Ackbar B. The high risk of charging these structures combined with the relatively small volumetric potential led the license group to conclude that Ackbar B and/or Waldo are unfit for an exploration well. The identified prospectivity could potentially be tested by the license group operating the Sleipner East Field.

Newly identified Lower Triassic prospectivity (Verdori and Andelva)

The high quality PGS16902VIK PSDM seismic allowed for detailed mapping of the intra-Triassic stratigraphy and the top Zechstein marker. Two prospects are identified where the Triassic strata is in a trapping configuration between the overlying Cretaceous shales and the underlying Zechstein salt and carbonate base seal. The prospects have been called Andelva and Verdori (Fig. 1.2). The reservoir for these traps consists of the sub and intra Smith Bank sandstones and were for example proven in well 16/4-1 (Fig. 4.1), where a 56m net sandstone body with an average porosity of 22% was encountered. The regional distribution of the Smith Bank sandstones is shown in (Fig. 4.2). It demonstrates a widespread occurrence of the intra Smith Bank reservoirs in the vicinity of the PL912 License. Fig. 4.3 and Fig. 4.4 show the trapping configuration of the Andelva and Verdori prospects. The combined structural and stratigraphic traps require a pinchout of the Triassic reservoir to the north and east respectively. The top seal is represented by a combination of Upper Jurassic shales and where these are absent by Lower Cretaceous strata. The base seal is the Zechstein formation where the dolomites, salts, carbonates and Kupferschiefer Formation are the primarily sealing lithology. A regional analysis of the base seal lithologies is shown in Fig. 4.5. Despite the Zechstein base seal being unproven in the area, the lithological framework of the formation should be able to retard a significant hydrocarbon column. Migration (Fig. 4.6) to the Verdori and Andelva prospects is modelled at the top most porous and continuous reservoir layer below

the BCU and or below the Upper Jurassic Heather and Draupne shales. Modeling indicates that for Verdori the mostly likely charge route from the active kitchen in the eastern South Viking Graben is via Sleipner East. Well 16/7-3 has very good oil shows and extractable hydrocarbons in the Hugin Formation core. This indicates that Upper Jurassic charge at least reached that far. A secondary less likely charge route is from the South Viking Graben kitchen to the 16/7-2 well and onwards to Verdori. For the Andelva prospect charge from local source kitchens around the 15/6-7 well is envisaged (Fig. 4.6).

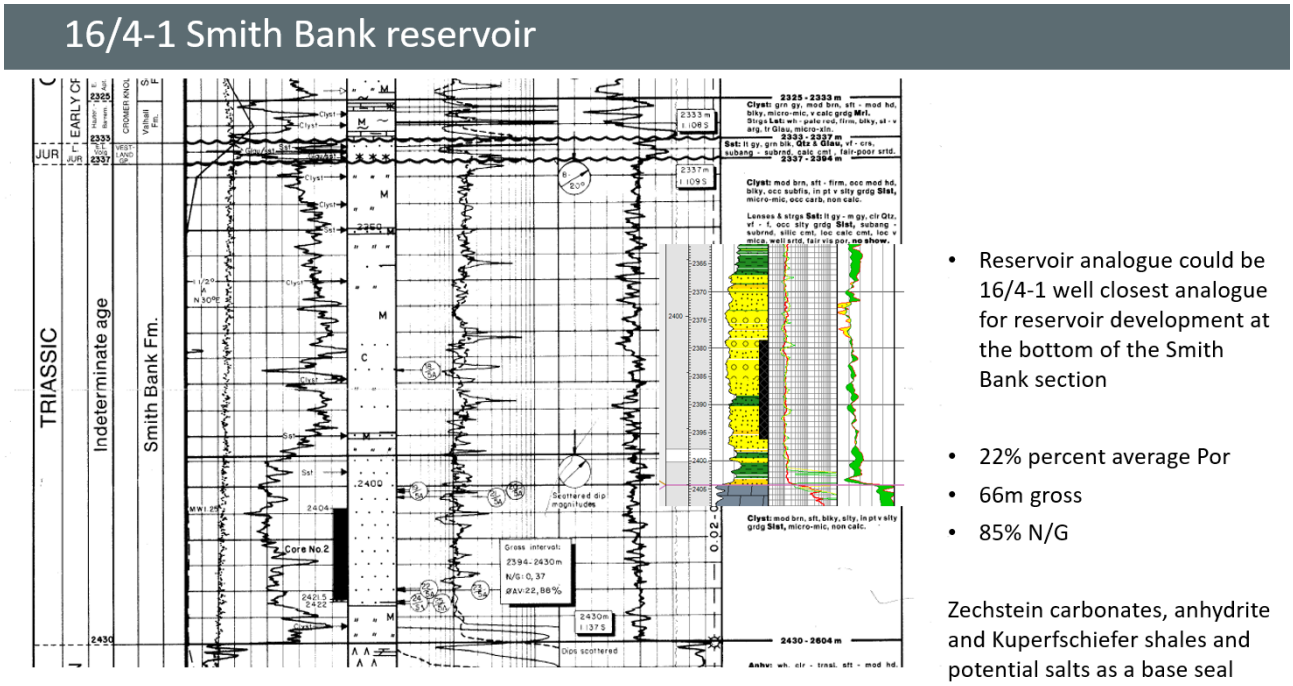


Fig. 4.1 Smith Bank reservoir in well 16/4-1

Fig. 4.2 Regional distribution of the Smith Bank Formation thickness and respective lithological components

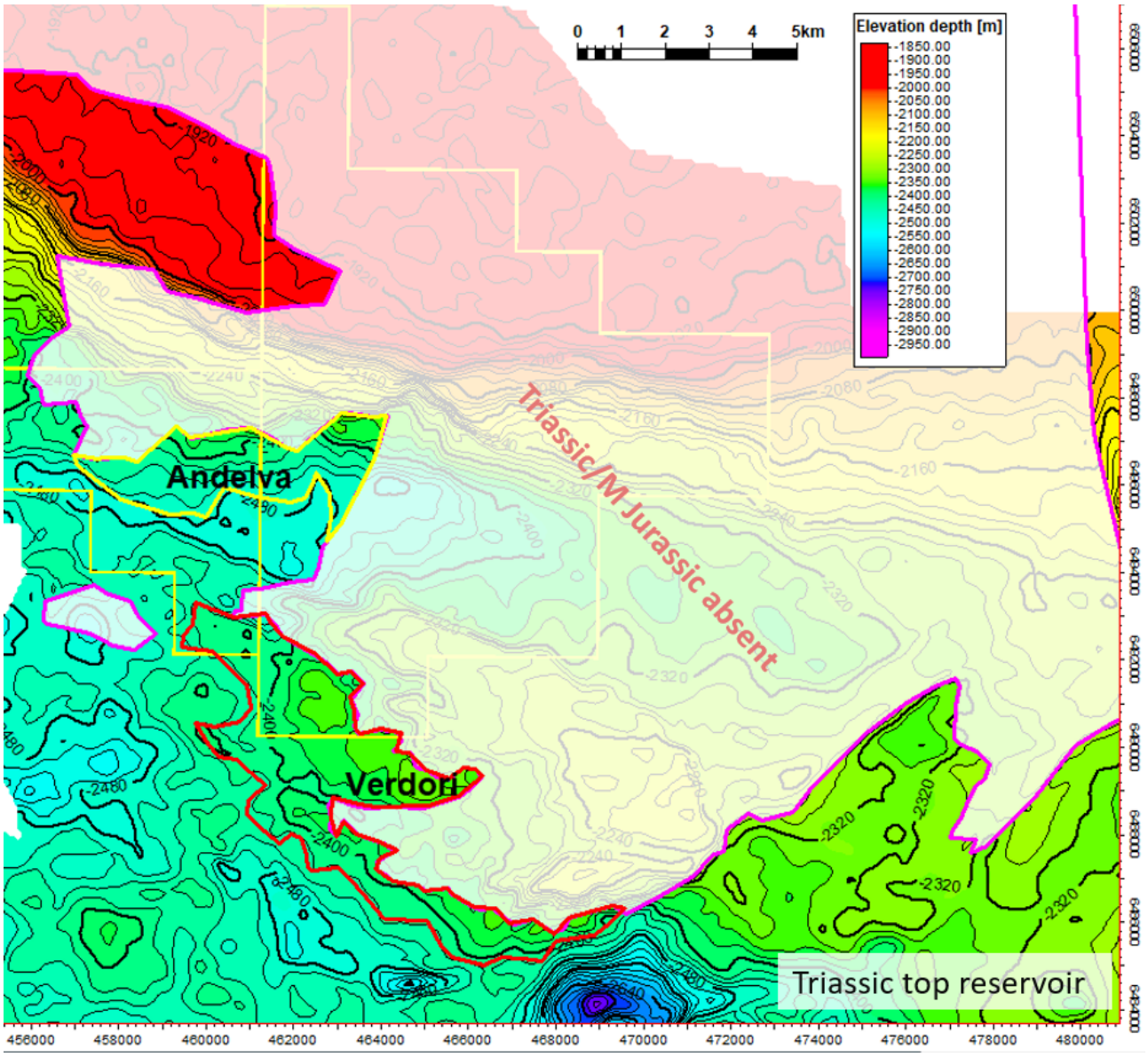


Fig. 4.3 Top Triassic reservoir depth map

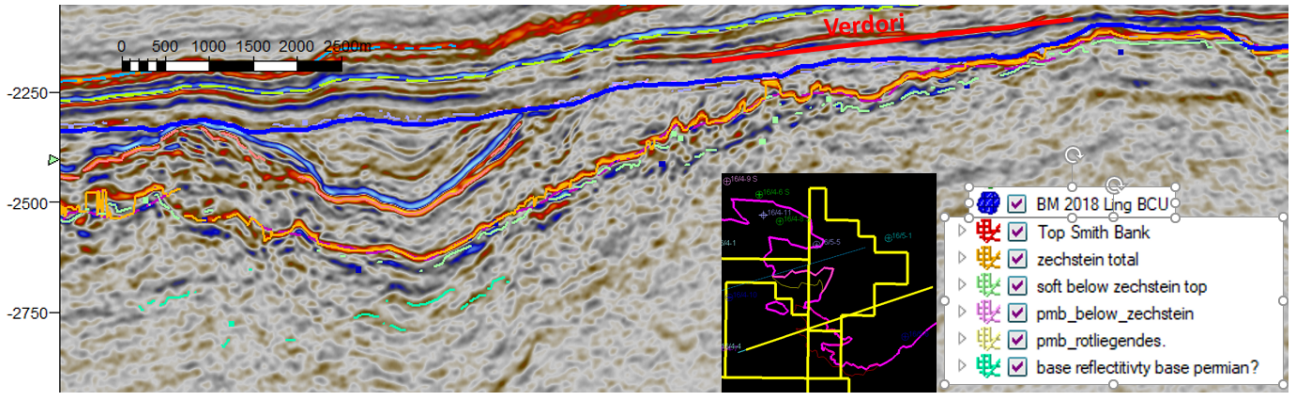


Fig. 4.4 Seismic line over Verdori showing the overall trapping configuration

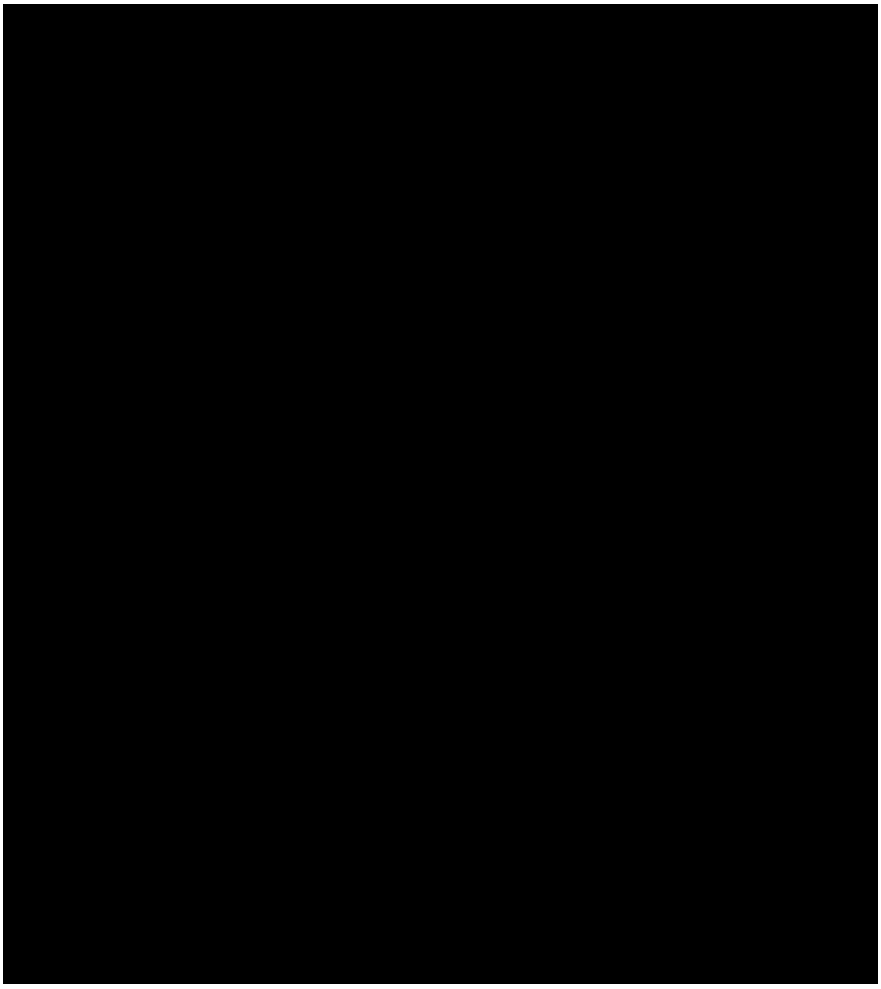


Fig. 4.5 Thickness and lithology of the Zechstein Formation

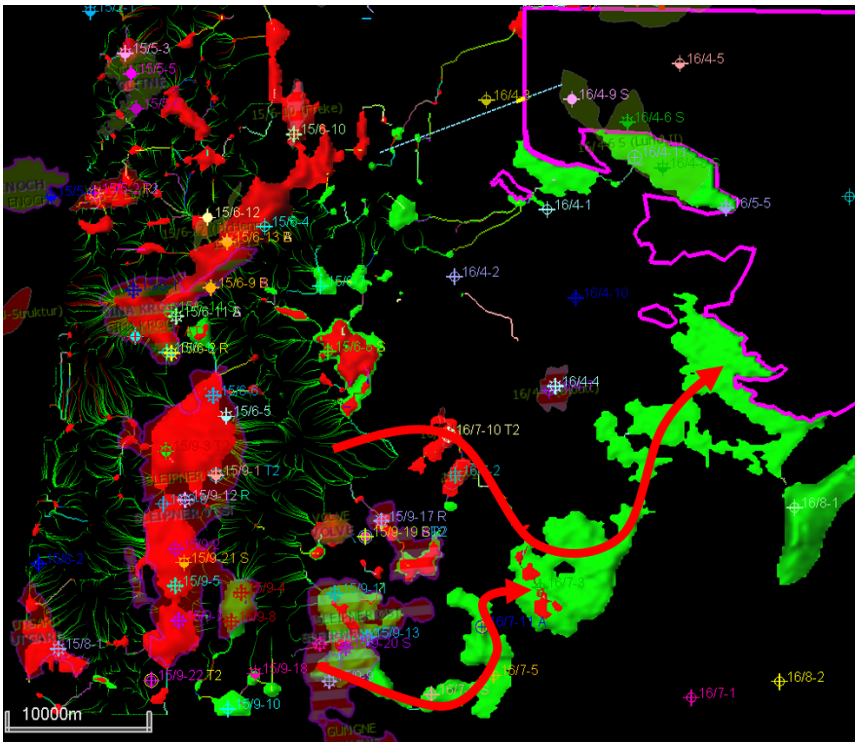
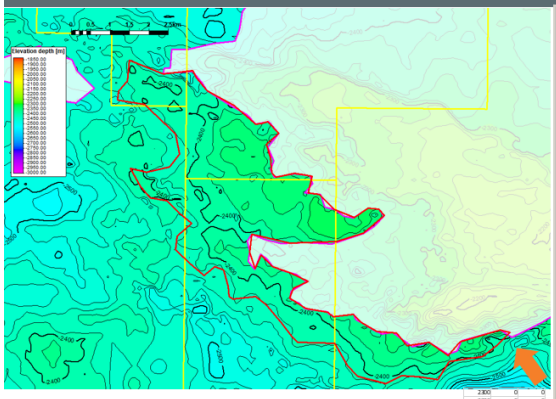
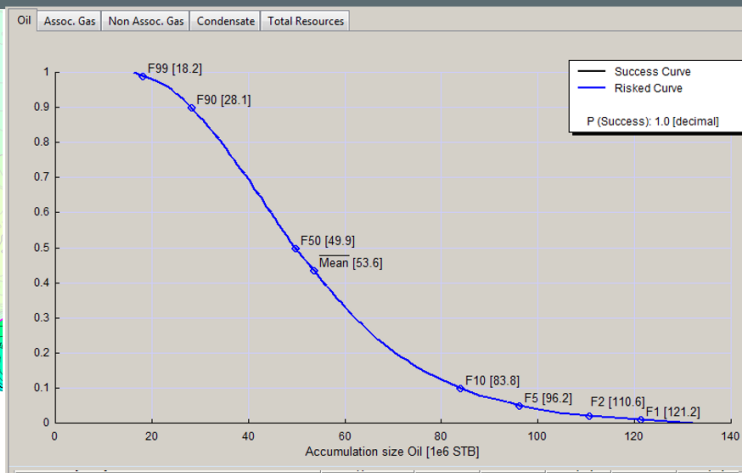


Fig. 4.6 Migration modelling

The volumetric assessment of Verdori and Andelva is shown in Fig. 4.7 and Fig. 4.8 respectively. Verdori is clearly the volumetrically more attractive prospect with a P10-P50-P90 range of 28-50-84 mmboe (oil). 80% of the prospect volumes are however outside the current PL912 license boundaries. Andelva has a better defined spill point than Verdori and but is volumetrically rather small with a P10-P50-P90 range of 16-24-41 mmboe (oil). Preliminary risking indicates that the combined play and prospect risk for these two prospects is below 14% and given the medium to small volumes relatively distant to the nearest infrastructure hub it is concluded that they do not represent interesting drill opportunities for the current license group.

Verdori oil case volumes



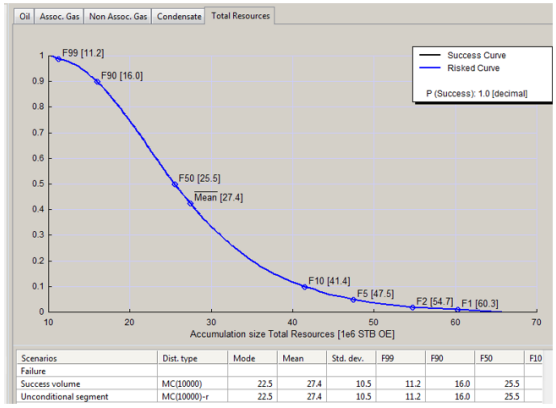


Formation volume factor oil (Bo) [bbl/STB]		Unif	1.55	0.144	1.3	1.8
Gas oil ratio [scf/STB]		CoPdef	324.0	64.8	224.6	280.7	561.5
Recovery factor Oil [decimal]		CoPdef	0.35	0.0389	0.25	0.35	0.45
Recovery factor Assoc. Gas [decimal]		Const	0.4	0.0		0.4	
Parameter [Units]	Dist. type	Mean	Std. dev.	Min (Lo)	Central	Max (Hi)
Net/gross ratio [decimal]	CoPdef	0.319	0.0587	0.2	0.3	0.5
Porosity [decimal]	CoPdef	0.234	0.0157	0.2	0.23	0.28
Oil saturation [decimal]	CoPdef	0.7	0.0389	0.6	0.7	0.8

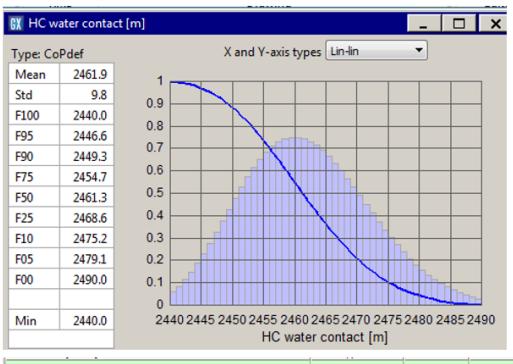
- Conservative N/G (20-30-50%)
- column height 100 -150m fill to spill
- Verdori is located to 80% in the now relinquished PL775
- SE spill point has high uncertainty

Fig. 4.7 Verdori Prospect volumes and input parameters

Andelva Volumes



Scenarios	Dist. type	Mode	Mean	Std. dev.	F99	F90	F50	F10
Failure								
Success volume	MC(10000)	22.5	27.4	10.5	11.2	16.0	25.5	
Unconditional segment	MC(10000)-r	22.5	27.4	10.5	11.2	16.0	25.5	



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Recovery factor Assoc. Gas [decimal]		Const	0.4	0.0		0.4	
Parameter [Units]	Dist. type	Mean	Std. dev.	Min (Lo)	Central	Max (Hi)
Net/gross ratio [decimal]	CoPdef	0.319	0.0587	0.2	0.3	0.5
Porosity [decimal]	CoPdef	0.234	0.0157	0.2	0.23	0.28
Oil saturation [decimal]	CoPdef	0.7	0.0389	0.6	0.7	0.8

- Conservative N/G (20-30-50%)
- column height 100 -150m fill to spill
- Andelva is located to 100% in PL911

Fig. 4.8 Andelva Prospect volumes and input parameters

5 Technical Evaluations

The development concept for the Bliss prospect have not been evaluated in detail. The Jackpot prospect in the now relinquished PL775 envisaged a development with three- 4-slot templates and a tie back to the Sleipner Øst Field (Fig. 5.1) in the P50 oil discovery case. The economic modelling indicated that given a mean sandstone thickness of 50 meters a break even commodity price of below 30USD/boe could reasonably be achieved. Initial screening of the Bliss economics indicated that this prospect would only be economic as a tie back to the PL775 Jackpot opportunity.

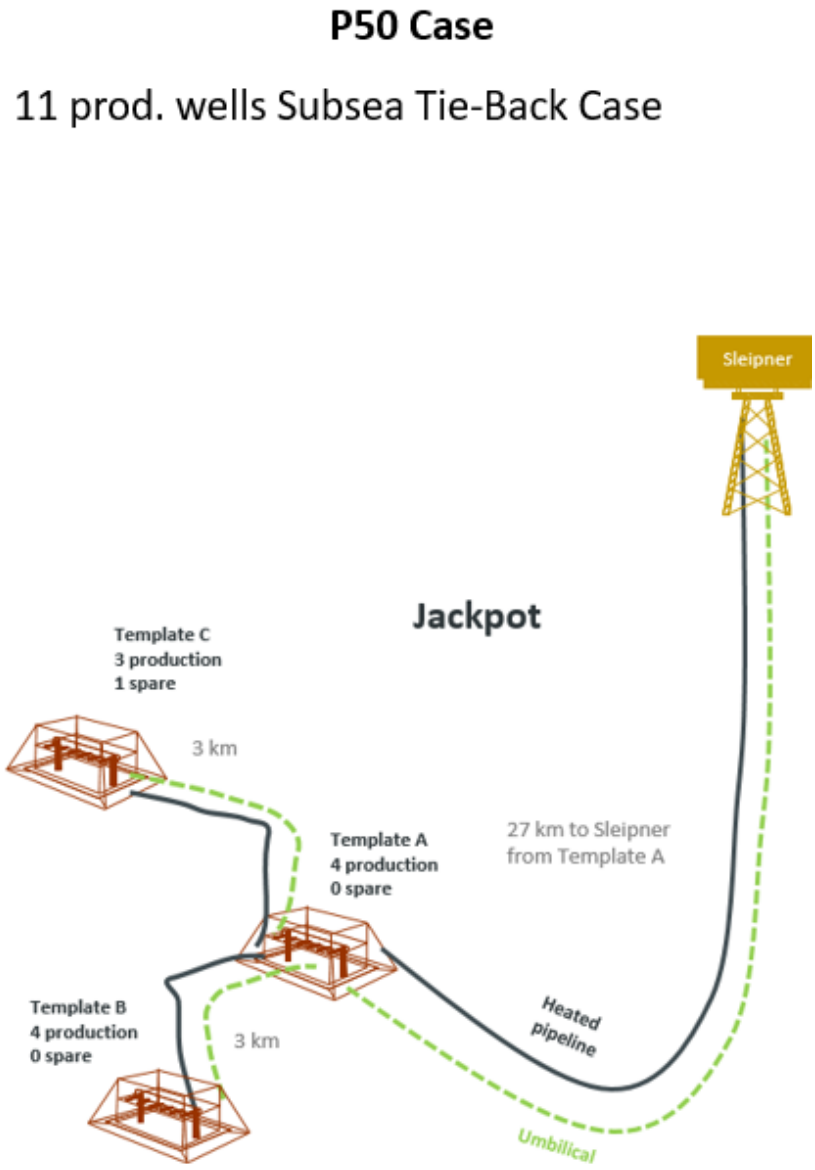

Fig. 5.1 P50 development scenario for a Jackpot discovery

6 Conclusions

PL912 was applied for in the APA 2017 primarily as protection acreage to PL775 where the genetically similar but volumetrically much larger Tertiary Jackpot prospect was envisaged. The detailed analysis carried in PL775 lead to the conclusion that the Tertiary sands are most likely absent over the Jackpot prospect and a similar conclusion can be drawn with a high degree of certainty for the PL912 Bliss prospect.

During the detailed mapping of PL912 and the regional surrounding on the high quality PGS16902VIK PSDM dataset additional prospectivity in lower Triassic combined stratigraphic structural traps was identified. The previously not assessed prospects were thoroughly evaluated as part of the license work and it was concluded that the risk /reward profile of these opportunities does not warrant the drilling of a well at the moment.