PL711 RELINQUISHMENT REPORT

Repsol Exploration Norge AS

August 2015

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1. Key licence history & Summary

The PL711 licence was awarded the 21st of June 2013 in the 22th bidding round. The initial period was valid until the 21st of June 2015. Partnership has been the same through all the license history.

The licensees were:

Repsol Exploration Norge AS	40% (operator)
OMV Norge AS	20%
PGNIG Upstream International AS	20%
Idemitsu Petroleum Norge AS	20%

The licence work obligations had been fulfilled or exemption has been granted by authorities as described below by the end of the first exploration period:

- Purchase of 3D seismic in all assigned areas that already have 3D seismic coverage: The SWB11 3D survey from CGG covering the PL711 licence was purchased by all licensees. An exemption was granted by the authorities on the commitment to purchase 18.25 Km2 from the WG1001 3D (West Loppa Phase 3) survey.
- Asses acquisition of EM data: The license ran a feasibility study for the acquisition of EM data but no agreement was reached among the licensees to go ahead with it so it was discarded.

G&G evaluation was performed as per work program during the two years of the first exploration period after which, a Drill or Drop decision was expected. Due to the negative outcome of the G&G evaluation stressed by two dry holes (Darwin and Byrkje) in the nearby area, a unanimous consensus to drop PL711 was reached among licenses.

2. Database

2.1 Seismic Database

The 2D and 3D seismic coverage of the licence are listed in and shown in Figs. 2.1 & 2.2.

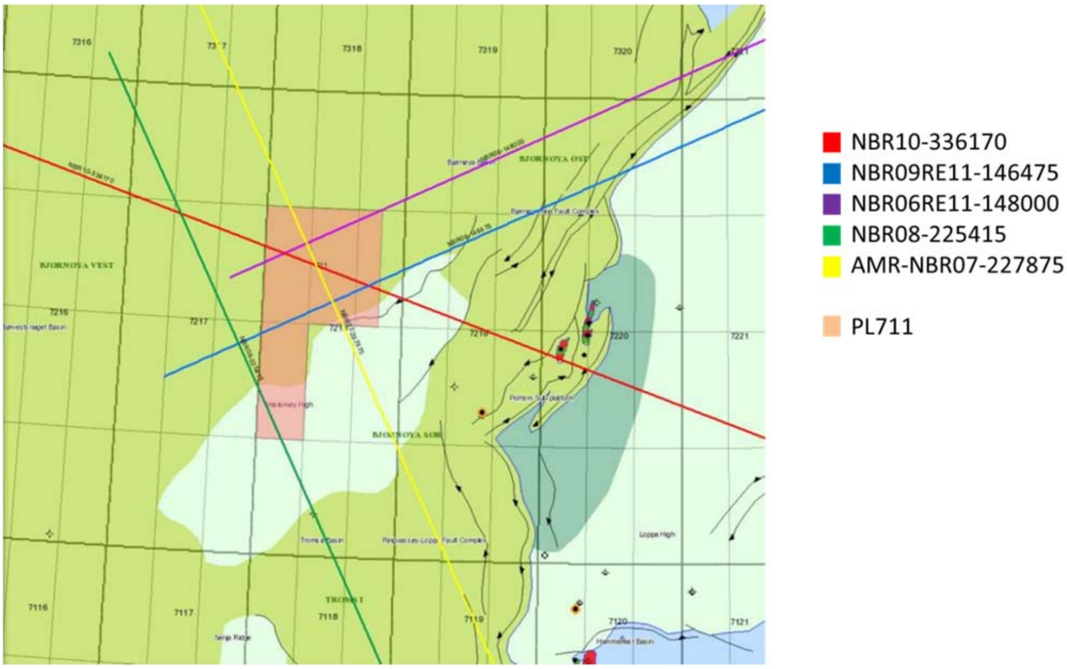


Figure 2.1 PL711 2D Seismic Common database

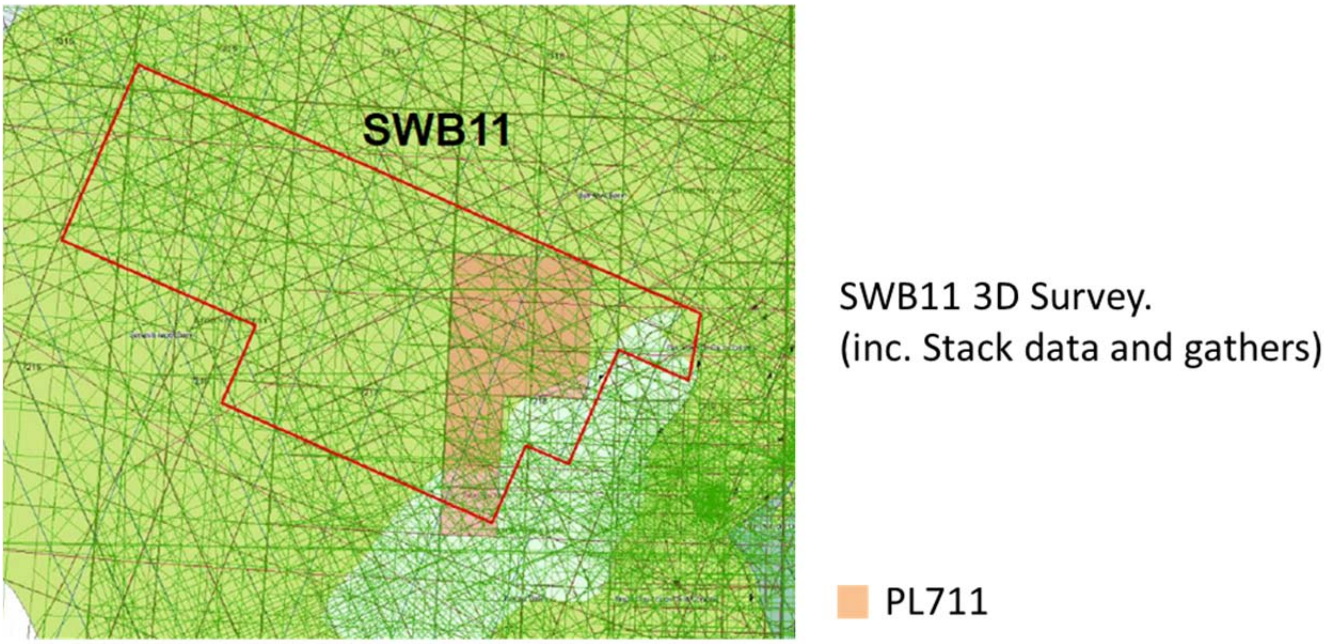


Figure 2.2 PL711 3D Seismic Common database.

Purchasing of the 3D data was commitment of the License. This 3D data included the stack data and also the gathers necessary to perform EEI & AVO analyses included in the work program.

2.2 Well database

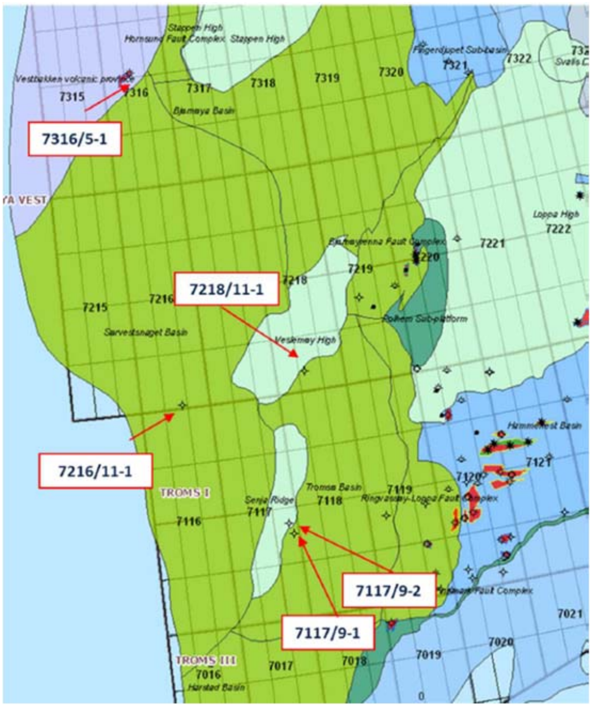


Figure 2.3 and Table 2.1 show the wells specifically included in the database for licence PL711 although all public wells were considered when gathering data for the studies performed.

Table 2.2 includes a brief summary on the results of the well.

Fig 2.3 Wells included in common database

Wells	Year drilled	Status	HC shows	Reservoir
7216/11-1S	2000	Dry	No shows	Eocene Torsk
7117/09-01	1982	Dry	Poor Fluorescence	Eocene Torsk
7117/09-02	1983	Dry	No shows	No reservoir
7316/05-1	1992	Discovery	Gas	Mid Eocene Torsk
7218/11-1	2013	Dry	Gas	No reservoir

Table 2.1 Wells included in common database

3 Review of geological framework

Licence PL711 is located mostly in the Sorvestsnaget basin and partly over the Veslemøy High (Fig. 3.1)

Overall, the Sorvestsnaget basin and generally all the Western Barents Sea (WBS) structural configuration and sedimentation is currently interpreted as the result of a progressive collapse and extensional rejuvenation of the original framework developed by the Caledonian orogeny by mid Paleozoic times.

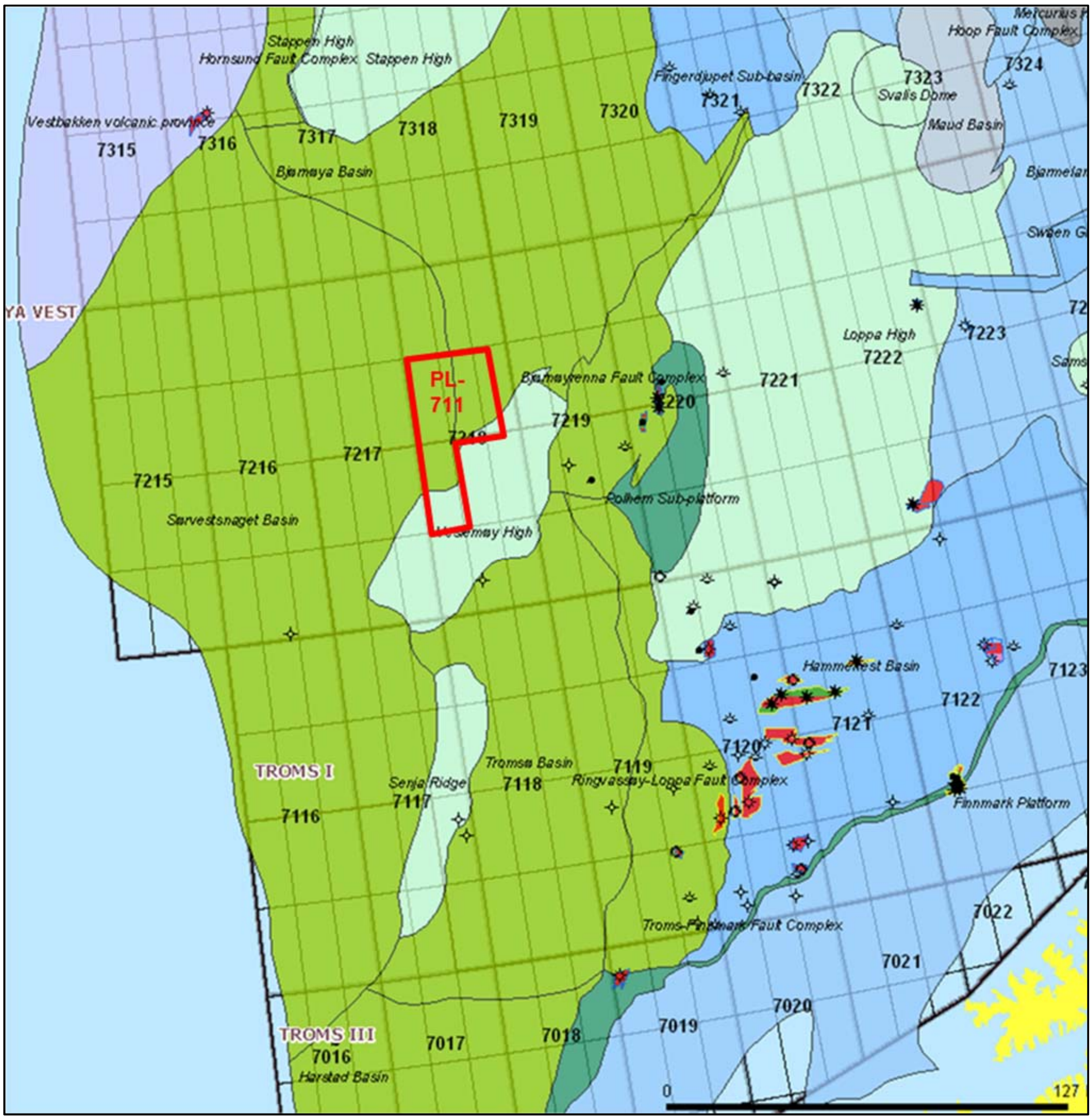


Figure 3.1 PL711 Location map

After the breakup of Scandinavia and Greenland, the westernmost Barents Sea became a passive margin characterised by prograding sedimentation during Cretaceous, Tertiary and Quaternary times. The Cretaceous and Tertiary megasequences are separated by a major unconformity, the Base Tertiary Unconformity (BTU). (Fig 3.2)

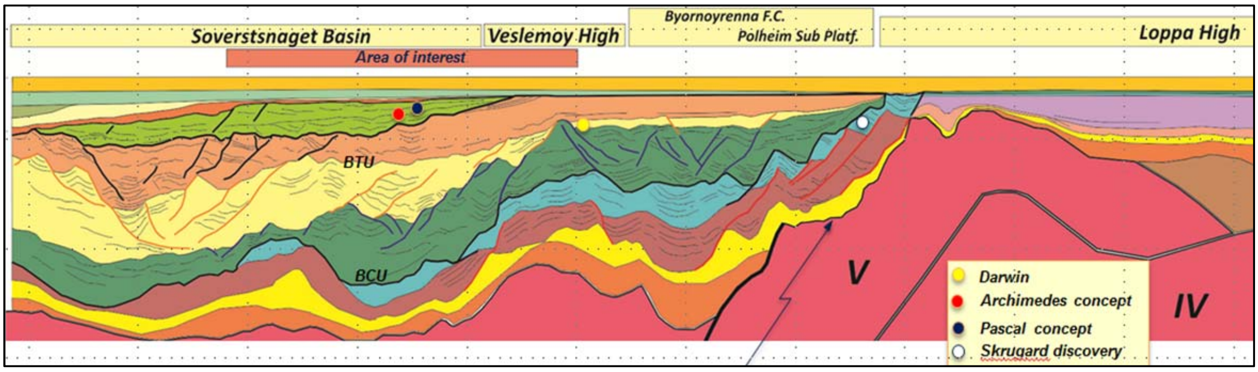


Fig 3.2 Main Stratigraphic Units at time of bid round application.

3.1-Regional Seismic and Structural interpretation:

A regional seismic interpretation of the Western Barents Sea was done and the following horizons: Top Plio-Pleistocene, Top Pliocene, Top Miocene, Base Oligocene Unconformity, Top Eocene, Top Mid Eocene, Intra Mid Eocene, Top Paleocene, Base Tertiary Unconformity, Base Turonian, Mid Cretaceous Unconformity, Base Cretaceous Unconformity, Base Triassic, and Top Caledonian (associated to Basement) (Figs 3.1.1 & 3.1.2).These regional horizons depth converted were used for several other studies performed in the area such as the 3D stratigraphic forward modelling and the 3D Petroleum system modelling (both mentioned elsewhere) and the Structural Interpretation.

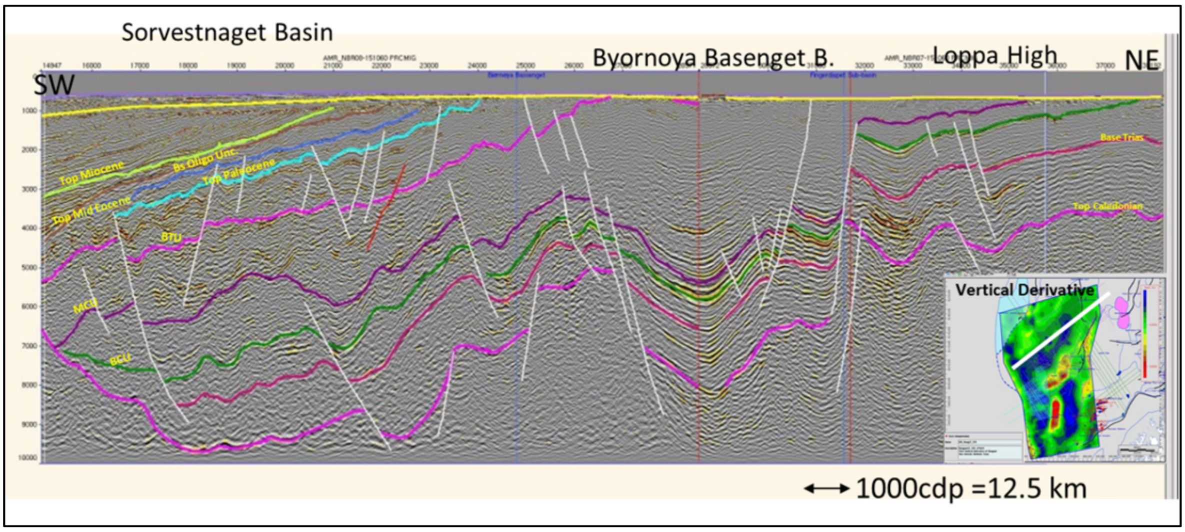


Fig. 3.1.1 Regional seismic interpretation.

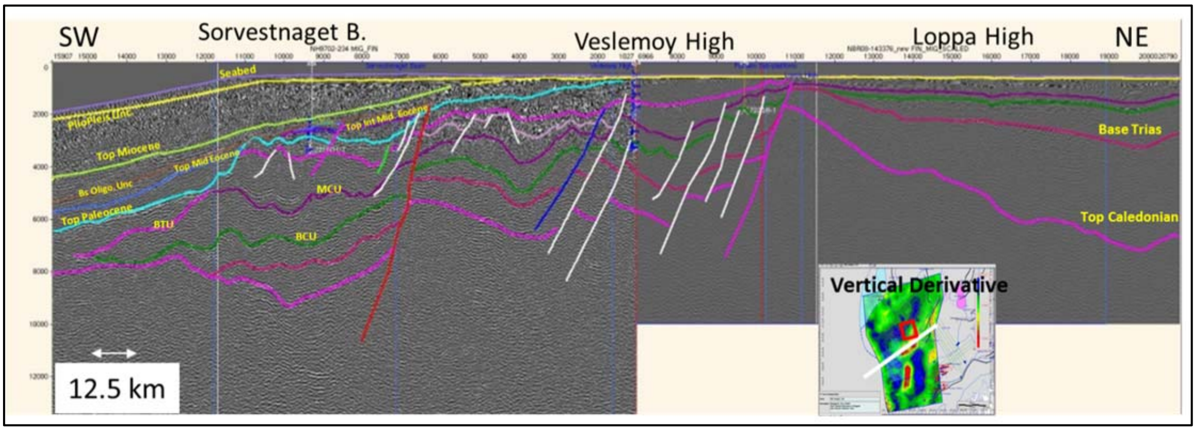


Fig 3.1.2 Regional seismic interpretation

This structural interpretation assumed a hyperextended margin for the WBS as the different domains corresponding to hyperextended margins theory could be interpreted in the area of interest (Fig. 3.1.3)

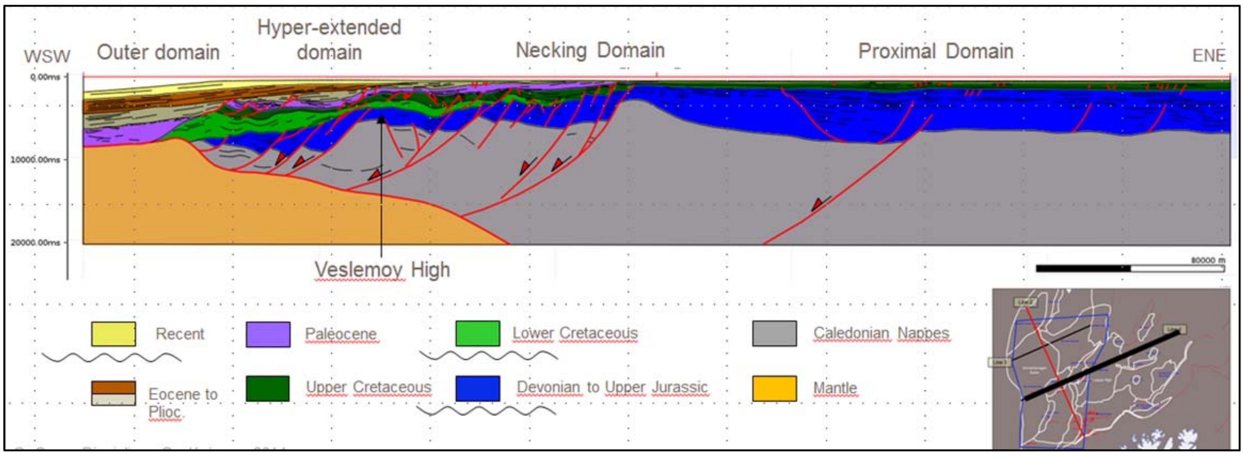


Fig. 3.1.3 Hyperextended domains in WBS.

This model is still in agreement with the previous understanding of the area in terms of westward progradation and progressive collapse on a succession of faulting, sliding and progradation (Fig.3.1.4)

In order to understand evolution through time in the area, 3 regional lines reconstructions were performed based on de-compaction and flexural isostasy. This again shows the progradation, progressive gliding and collapse of the Mesozoic and Cenozoic sections with an extension ranging approximately between 20% to 40%. (Fig. 3.1.5. For a deep review and details on the structural analysis, please see documents posted in License2Share server)

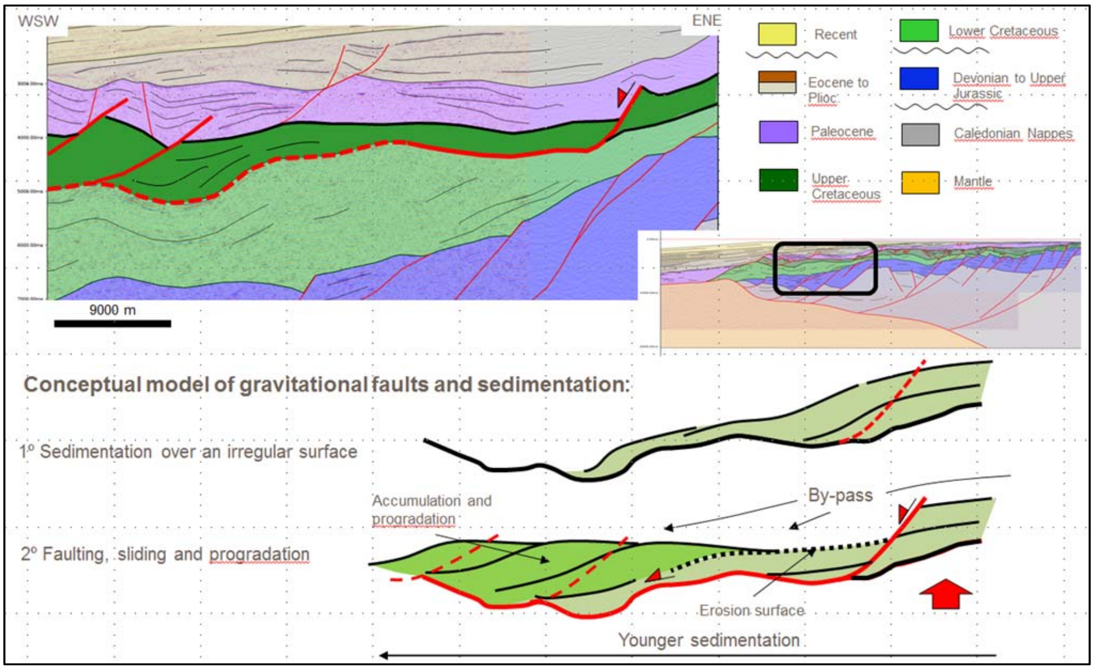


Fig. 3.1.4 Faulting, sliding and progradation

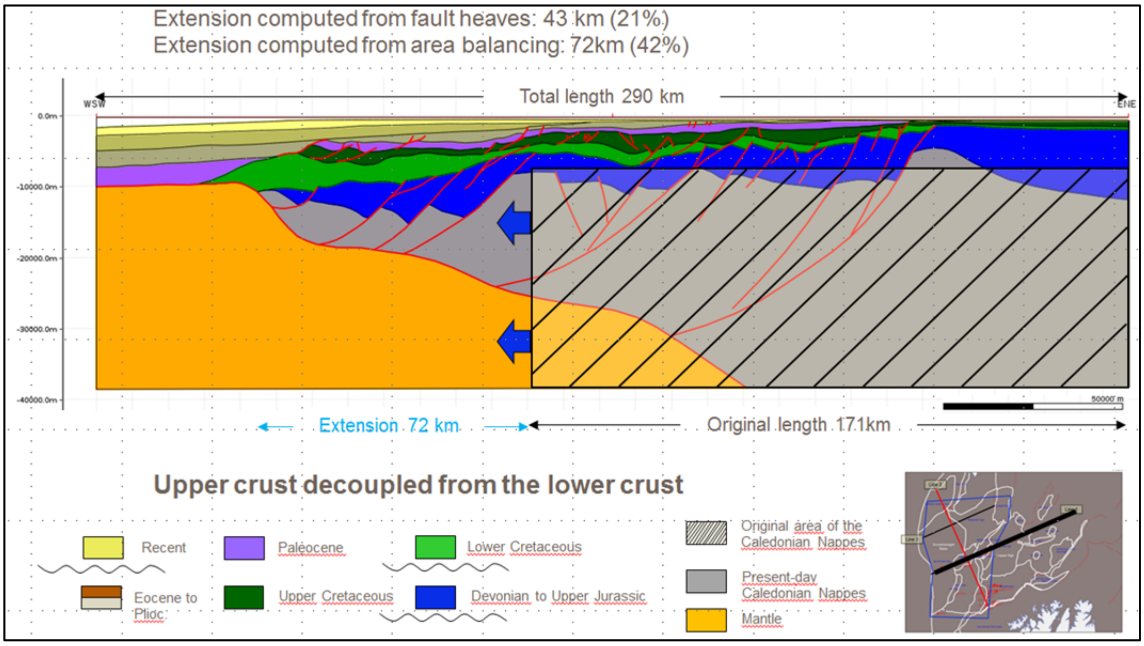


Fig. 3.1.5 De-compaction and flexural isostasy

3.2- Petroleum System modelling.

In order to improve the understanding of hydrocarbon potential in PL711, a regional Thermal, Maturity & Expulsion 3D basin modelling for the WBS and a 1D modelling for Pascal prospect were run. Regionally interpreted sources were used in these models: Hekkingen Fm, Barremian source and Turonian (detected in 7218/11-1 Darwin well). Furthermore, three different heat flow scenarios were modelled combined with two different Erosion models.

The result of this modelling shows that Hekkingen and Barremian are likely overmature in the area of interest but the Turonian level, if present as in Darwin well, is most likely Oil Mature at present day (Fig 3.2.1) . Onset of expulsion would have taken place by Eocene times (Fig 3.2.1) and would have generated modest amounts of Oil that would migrate vertically.

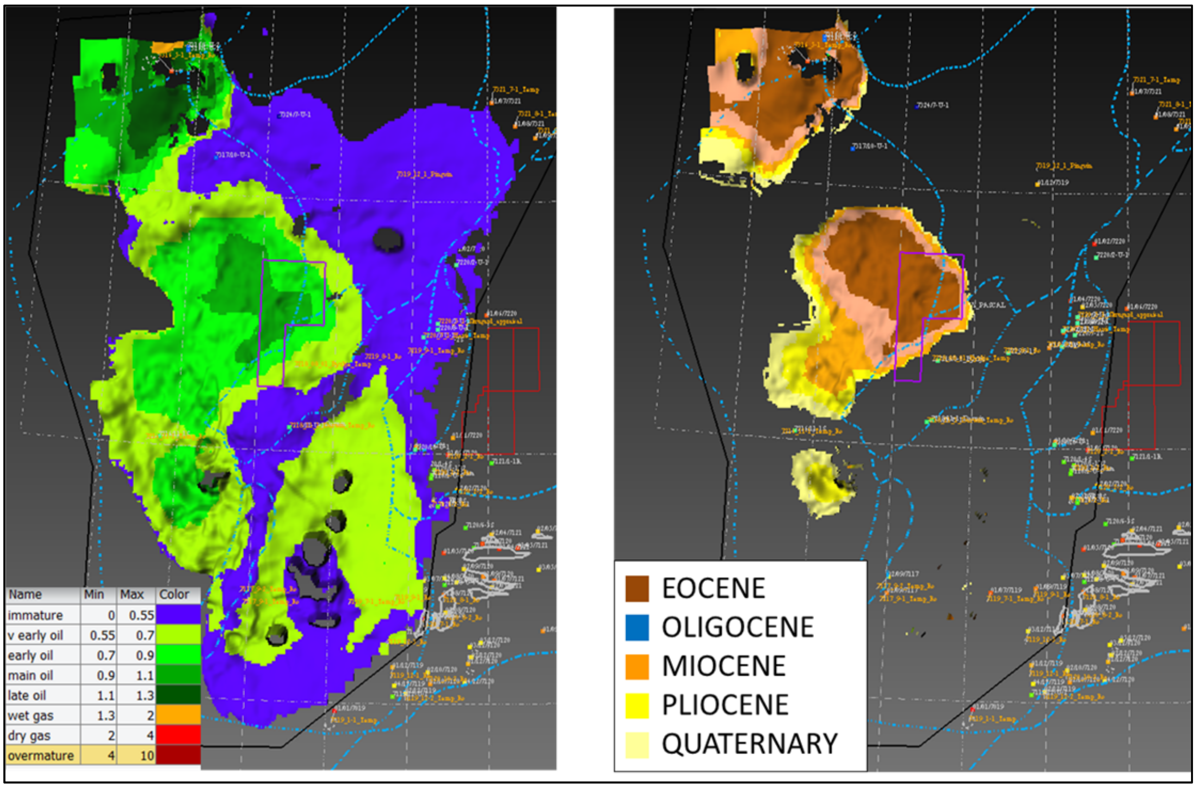


Fig. 3.2.1 Thermal maturity as per Vro (left) and Onset of Expulsion (right)

3.3- Stratigraphic forward modelling:

Reservoir presence was one of the main risks identified for the potential Eocene reservoir proposed for Pascal prospect. This risk was associated to the presence of Biosiliceous Oozes in the Tertiary section of the Western Barents Sea. To analyse the reservoir presence, a 3D stratigraphic forward modelling, including water flow and sediment fairway (Fig 3.3.1,) was run in order to understand deposition through time in the AOI.

The 3D Stratigraphic forward numerical model was run using Dionisios software from IFP. These kind of models are run by definition of the basin deformation and accommodation space, definition of the sediment supply (fluvial input or in-situ marine carbonate production) and simulation of the sediment transport using deterministic laws and the mass balance principle. The model was run on 500 K. years time steps, from 65.5 Million years to 38 My. The results from the model were used as input to generate gross depositional environment maps for different tertiary levels (Fig. 3.3.2)

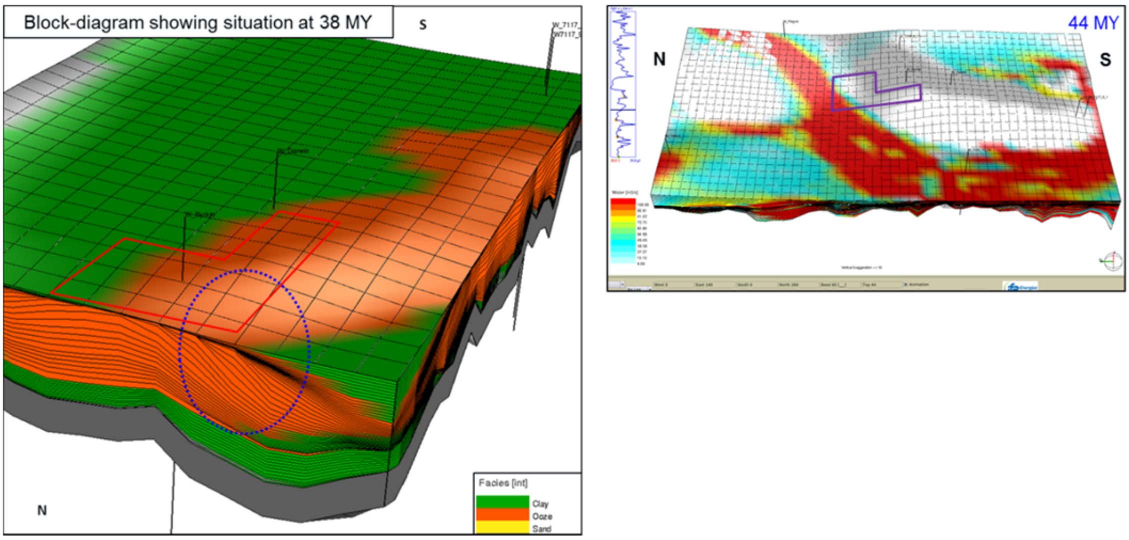


Fig. 3.3.1 Facies model at the end of simulation (Left) and sediment fairways (Right)

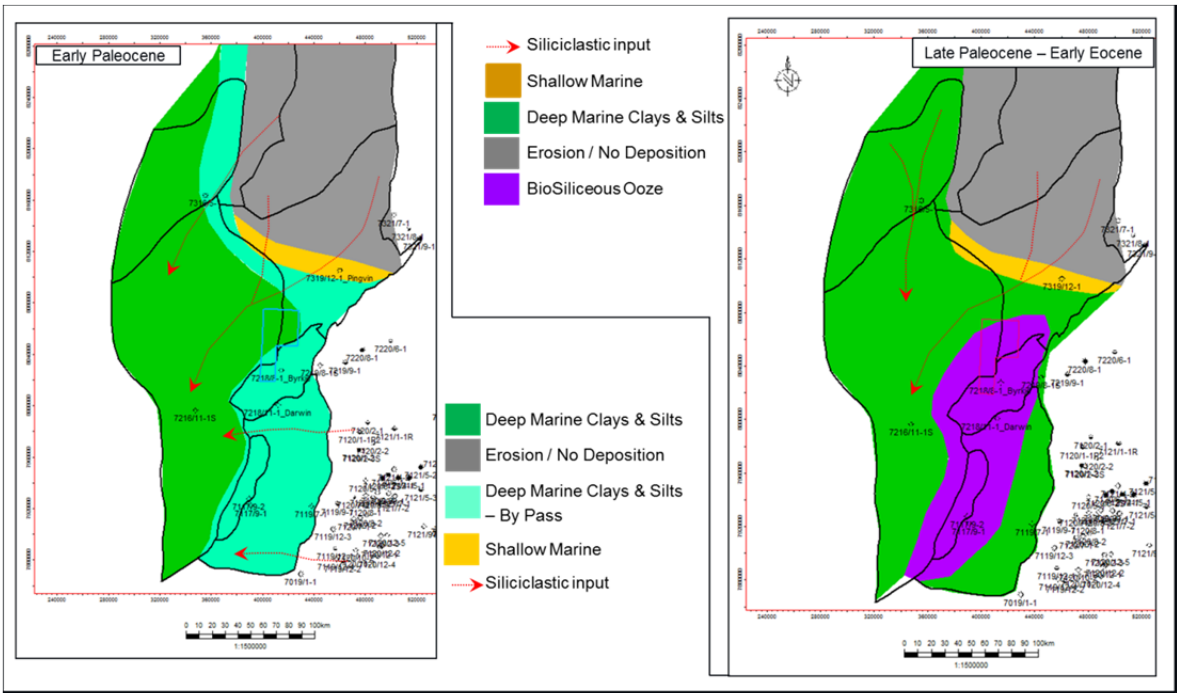


Fig. 3.3.2 Examples of GDE maps for Tertiary section.

This stratigraphic modelling reproduced the observed clinoforms prograding from East to west as well as the bypass areas for lower Paleocene observed in Senja ridge and Veslemoy high. It also reproduced reasonably the water/sediment fairways that would eventually generate the sandstones observed in 7216/11-1S and 7316/5-1 wells and therefore the model is considered valid.

Overall and as main conclusion for the prospectivity of PL711, this regional model stresses the poor prospectivity of Late Paleocene & Early Eocene section due to the presence of Oozes (Fig. 3.3.1)

3.4- EM acquisition feasibility study

In order to investigate the sensitivity to the reservoir resistivity, a 1D feasibility modelling was run using a 1D model. The feasibility study was performed by Petromarker. The 1D model was based in the thicknesses calculated from the seismic and the resistivities of the nearby wells. The model also included four different reservoir thicknesses and two different reservoir resistivties (see figure 3.4.1). Results are show in figure 3.4.2. The conclusion was that the combination of a shallow reservoir (ca 700 m of overburden) and relatively thick resistor (134 m) provides favourable conditions for vertical EM measurements. Although the results of the study were positive, there was no agreement among the partnership to go ahead with the acquisition.

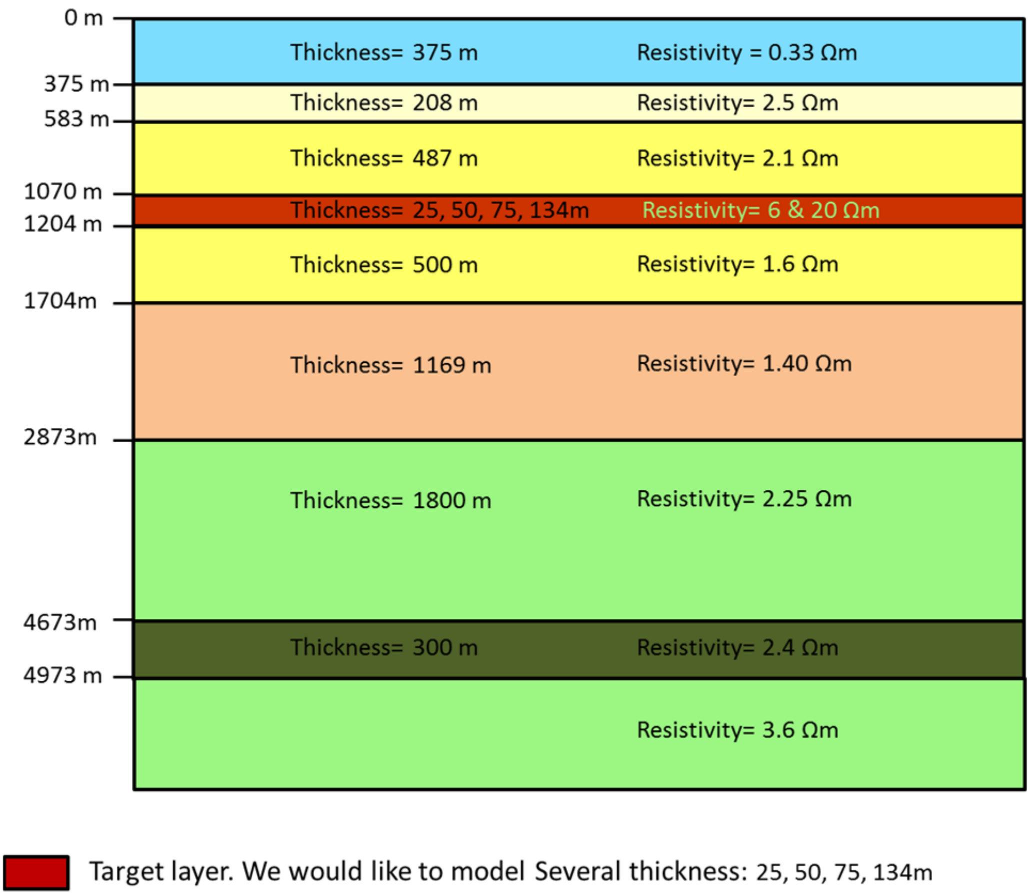


Figure 3.4.1: 1D input model

MODELING RESULTS QUANTIFIED

	t_m [s]	$Contrast_m$ [%]	$Anomaly_m$ [nV]
Reservoir resistivity 6 Ωm , thickness 25 m	1	6.8	216
Reservoir resistivity 6 Ωm , thickness 50 m	1	12.6	400
Reservoir resistivity 6 Ωm , thickness 75 m	1	17.6	558
Reservoir resistivity 6 Ωm , thickness 100 m	1	22	695
Reservoir resistivity 20 Ωm , thickness 25 m	1.25	22.3	455
Reservoir resistivity 20Ωm , thickness 50 m	1.25	36.5	745
Reservoir resistivity 20Ωm , thickness 75 m	1.25	46.4	948
Reservoir resistivity 20Ωm , thickness 100 m	1.25	53.6	1095

High probability for successful resolution
Fair probability for successful resolution
Cannot resolve

- t_n – time for maximum observable contrast before noise level is reached
- $Contrast_n$– contrast before noise floor is reached
- $Anomaly_n$ – anomaly at t_n

Figure 3.4.2: 1D feasibility study results

3.5- 3D reprocessing feasibility study

The seismic quality in the SWB11 survey was variable becoming very poor especially where Pascal prospect was located. The licence ran a 3D feasibility study in order to quantify the uplift that might bring the reprocessing of the SWB11 3D survey. Five different companies (CGG, Geofizika Torum, Geokinetic, Geotrace and Teec) reprocessed 1 sail line (test line) of the SWB11 survey. The results were relatively different (see figures 3.5.1 to 3.5.6). For more information please refer to the relevant documents in L2S.

As there was not a considerable uplift in the reprocessed test line and no agreement was reached within the partnership, it was decided not to proceed with the full reprocessing.

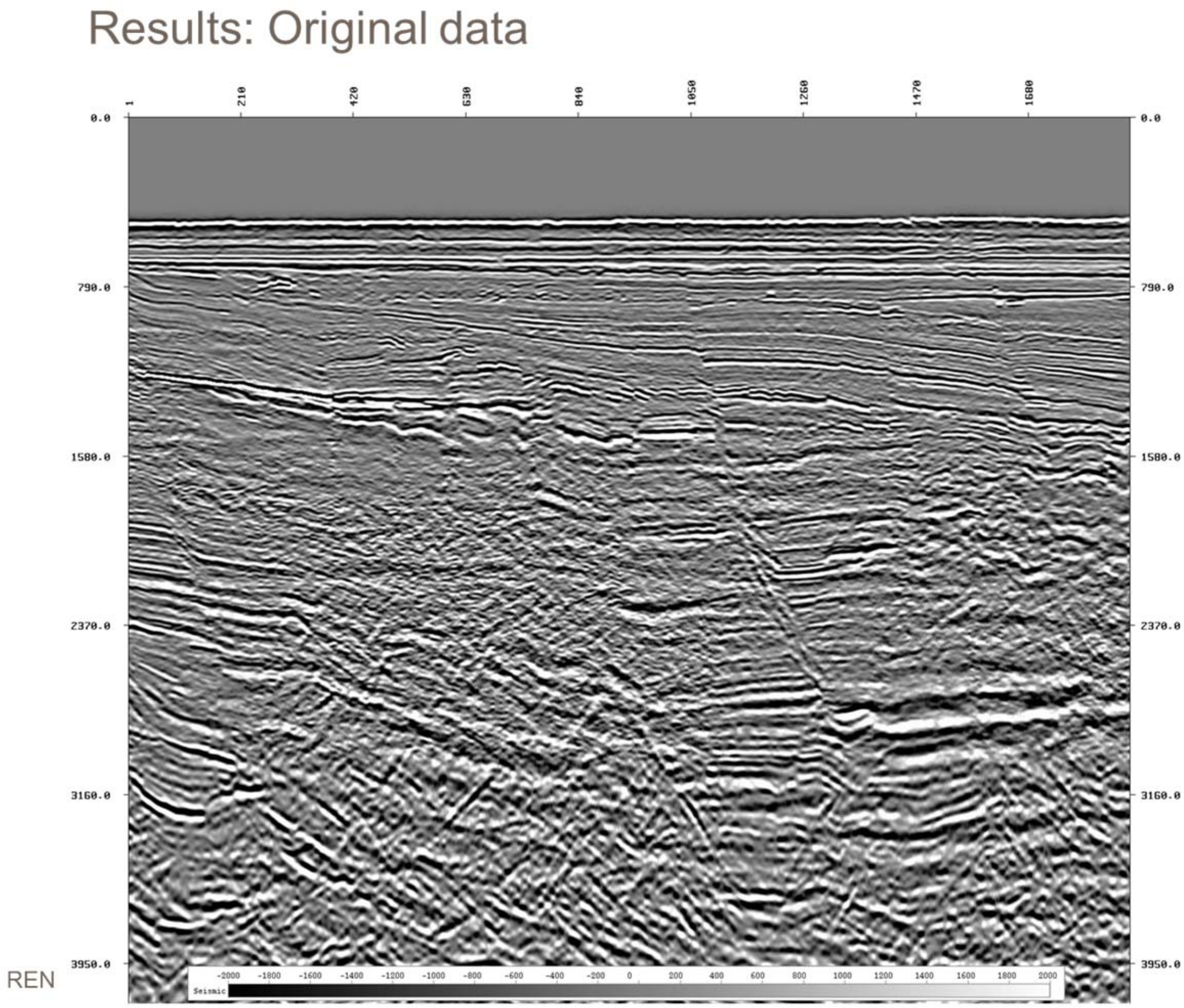


Figure 3.5.1. Original line

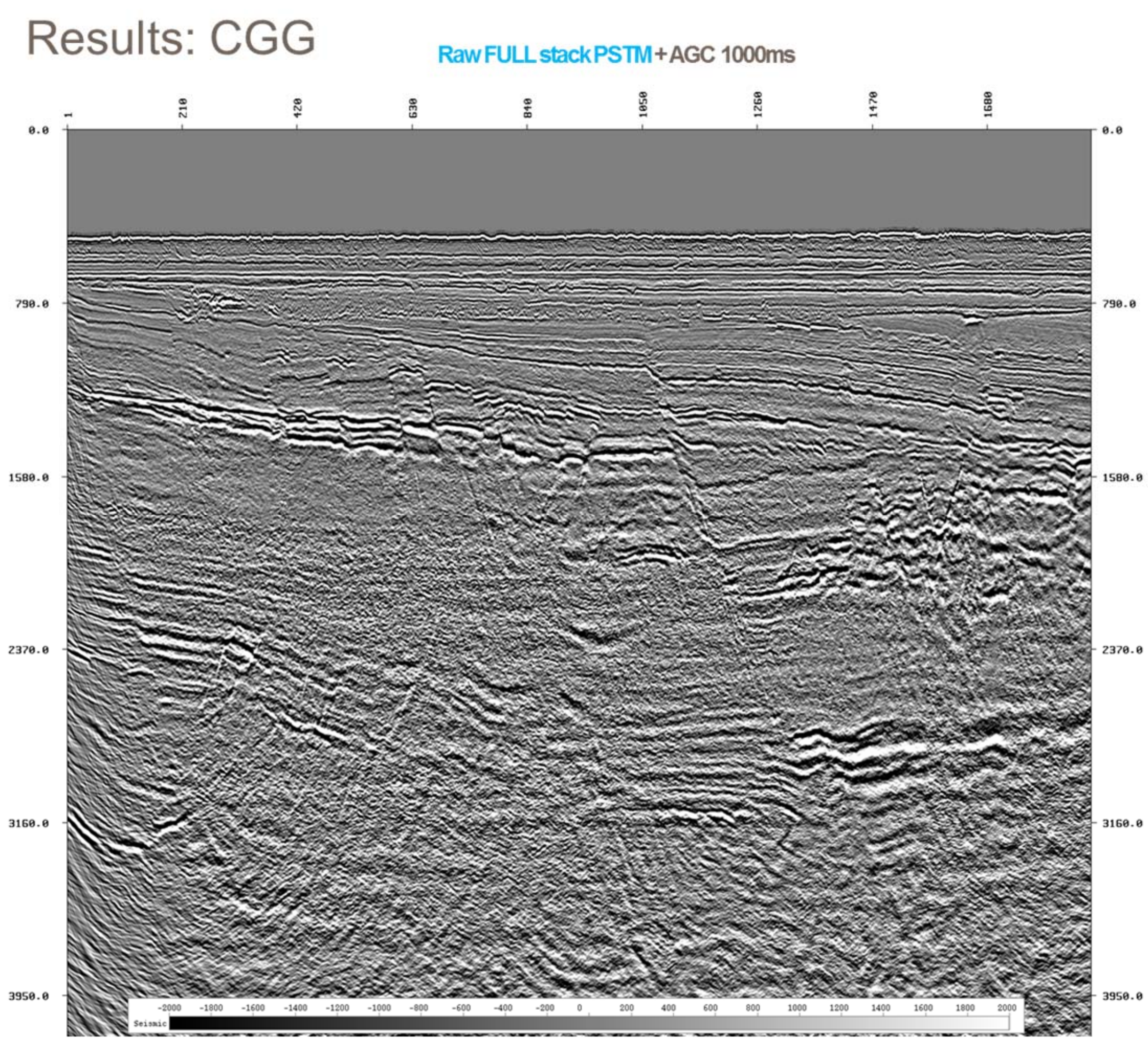


Figure 3.5.2. Results from CGG reprocessing

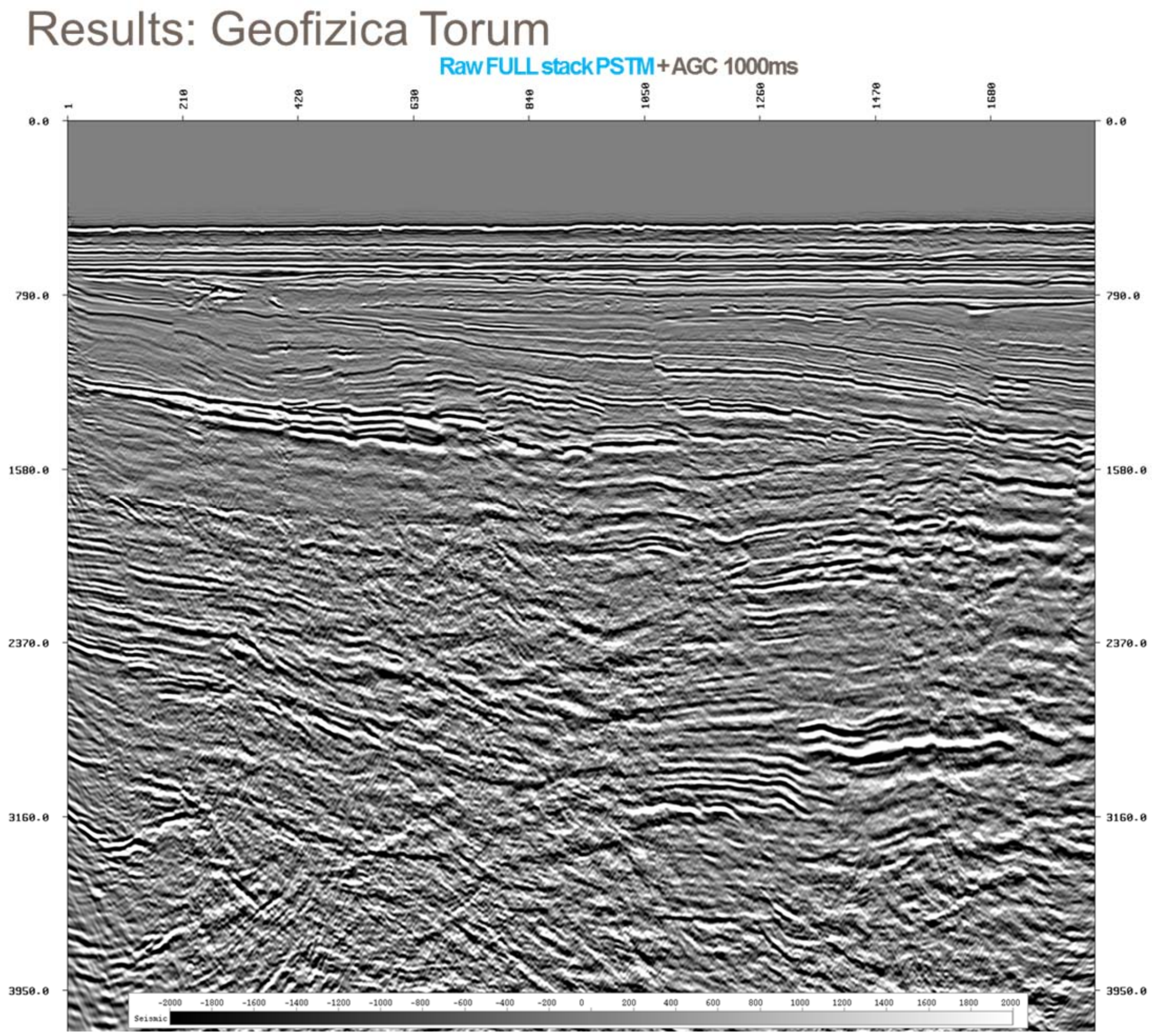


Figure 3.5.3. Results from Geofizica Torum reprocessing

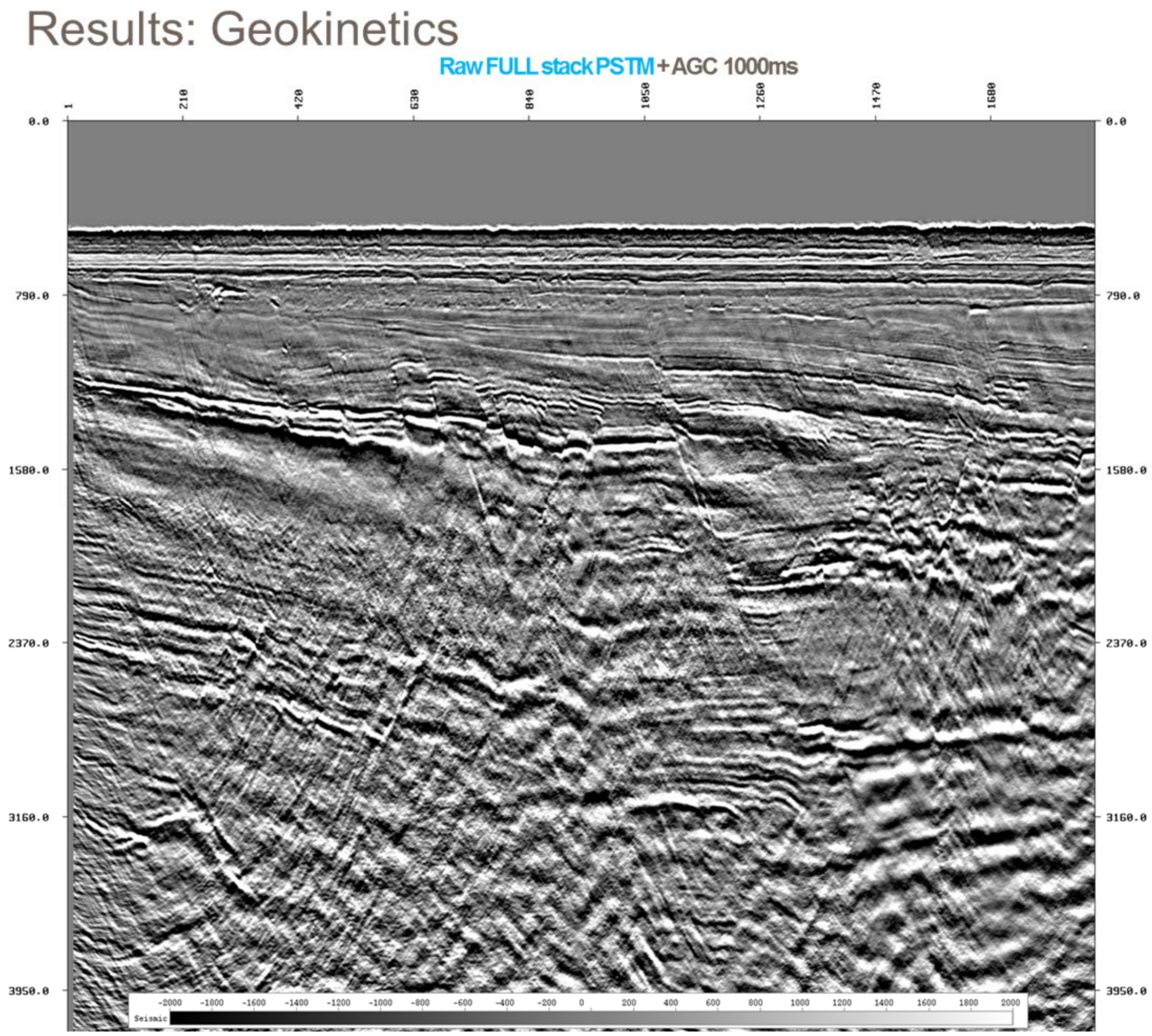


Figure 3.5.4. Results from Geokinetics reprocessing

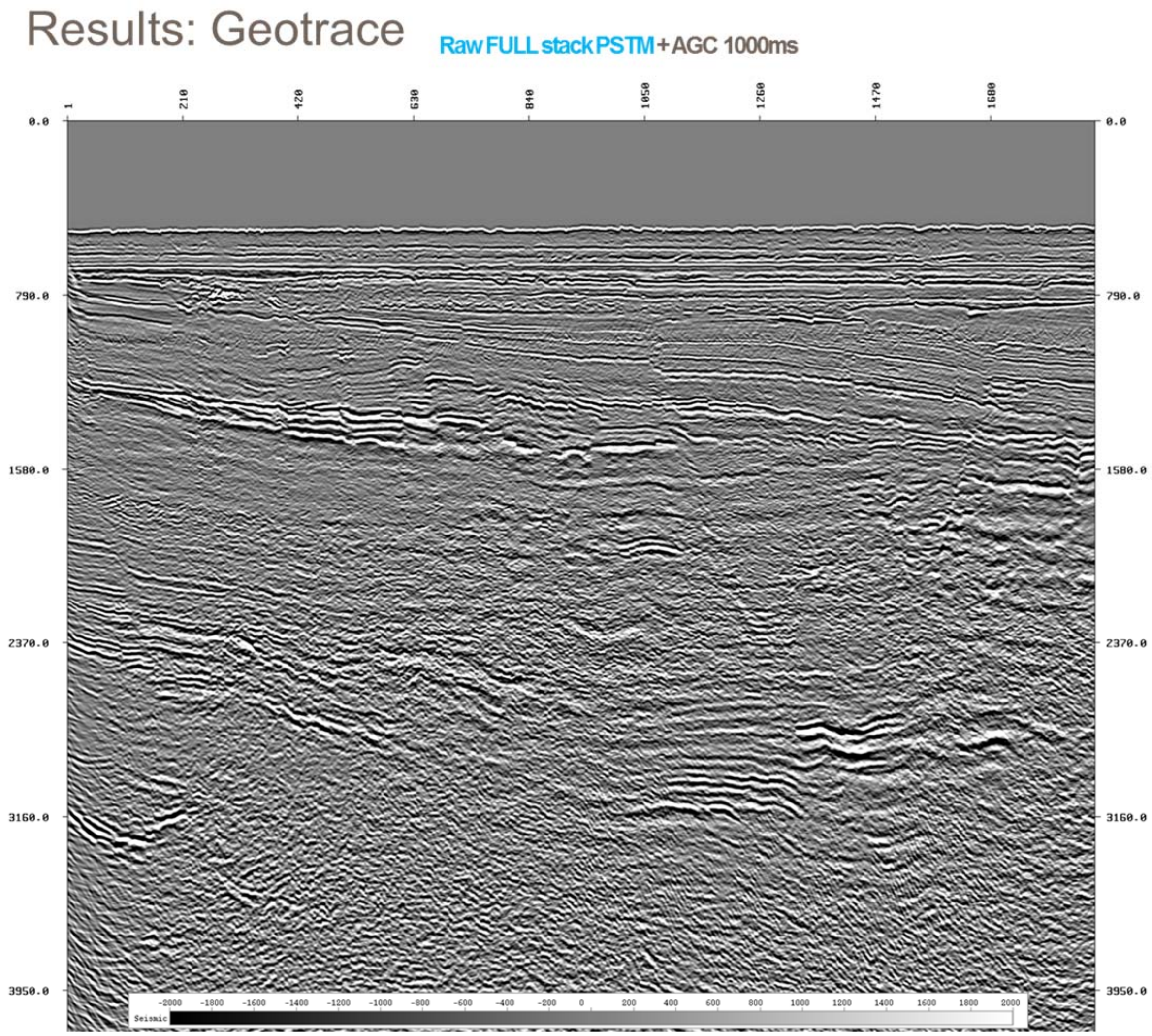


Figure 3.5.5. Results from Geotrace reprocessing

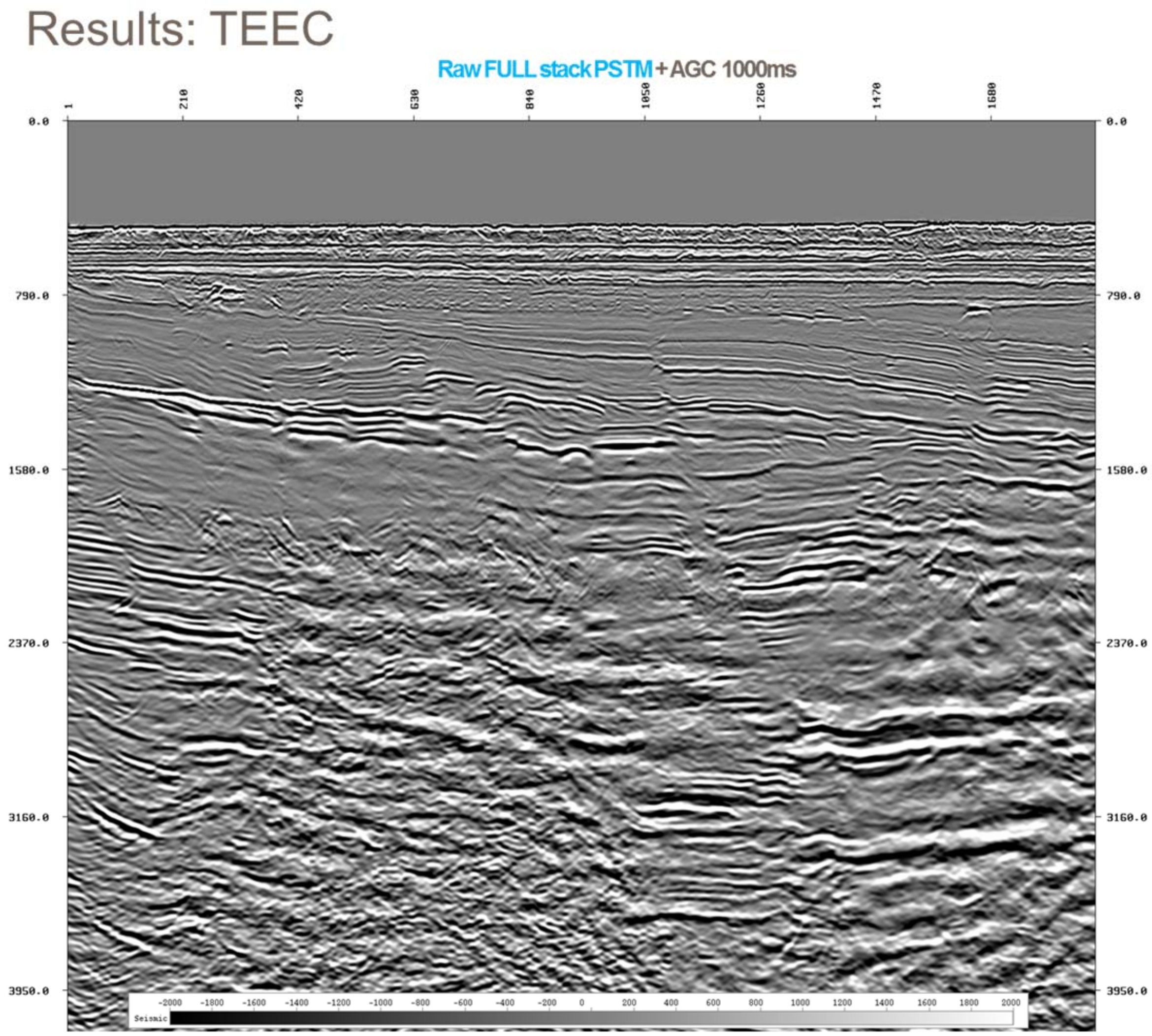


Figure 3.5.6. Results from Geotrace reprocessing

3.6 Rock physics study, AVO Analysis and Extended Elastic Impedance (referred in section 4.1)

The study included a rock physics study of the relevant wells in order to define the seismic response and calculate the Chi-angles used for the EEI. It also included a prestack data conditioning for AVO inversion, a two terms AVO inversion for Intercept and Gradient, a relative inversion of the AVO volumes and a EEI volume calculation/generation.

3.7- Petrophysical analysis of key wells

In additional to the conventional petrophysical evaluation, a multimineral interpretation was carried out with special focus on Quartz mineralogy. The following wells were evaluated: 7216/11-1S, 7316/05-1, 7117/09-02, 7117/09/01, 7216/11-1S.

4 Prospect Update

4.1- Pascal and Arquimedes:

At the time of the application, one main prospect, Pascal, and one lead, Arquimedes, were identified. Pascal was defined by an Eocene amplitude anomaly and interpreted to be a combination of prograding shoreface and low stand deposits sealed by highstands slope shales (Fig. 4.1.1). This concept would be associated to NPD beo-1 Eocene play.

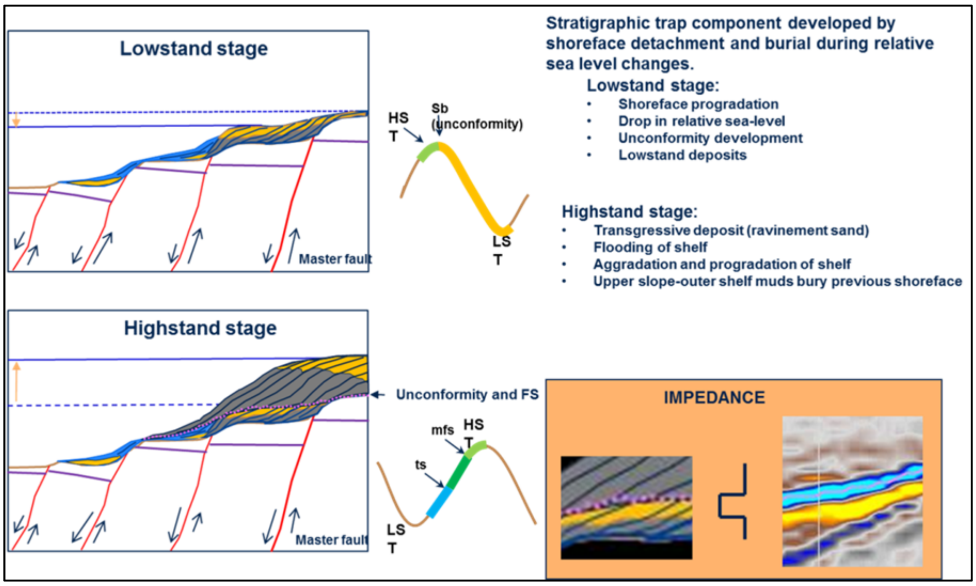


Fig. 4.1.1. Reservoir model initially proposed

A detailed seismic interpretation (Fig. 4.1.2) was done on the 3D seismic covering the AOI and the Pascal prospect, including specifically top and base of it (Fig 4.1.3.)

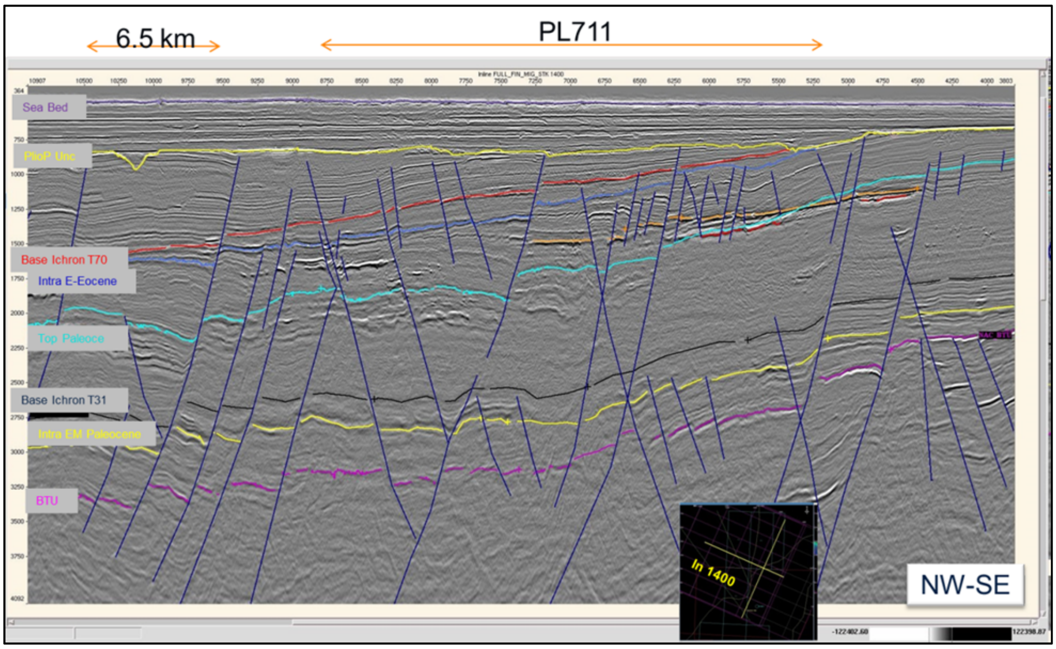


Fig. 4.1.2

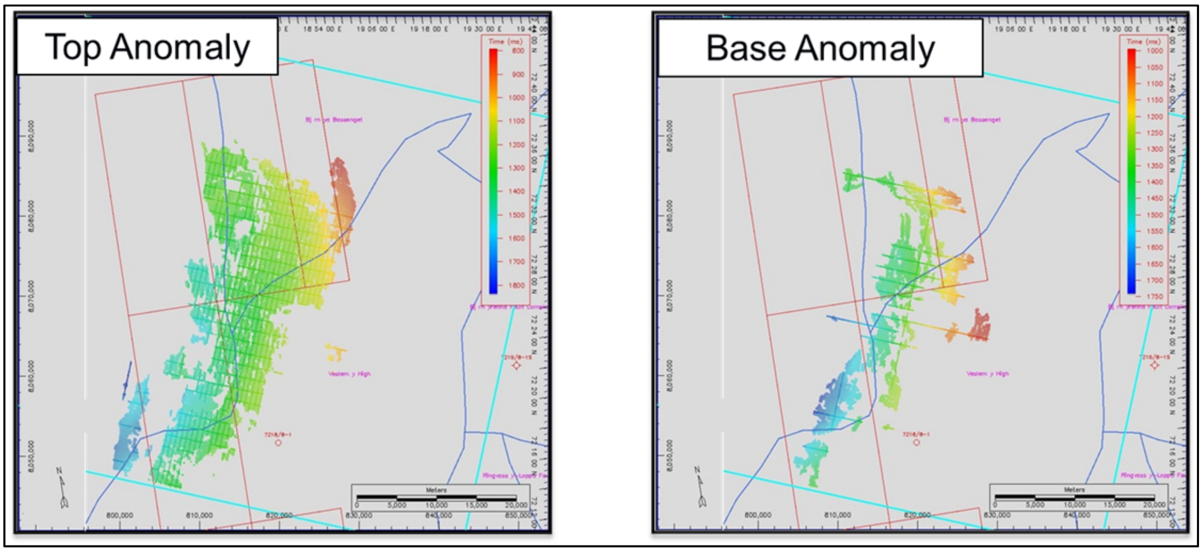


Fig. 4.1.3. Top and Base of Anomaly.

The anomaly seems to be a superimposed feature that is cross-cutting the stratigraphy and is discontinuous (Fig. 4.1.4).

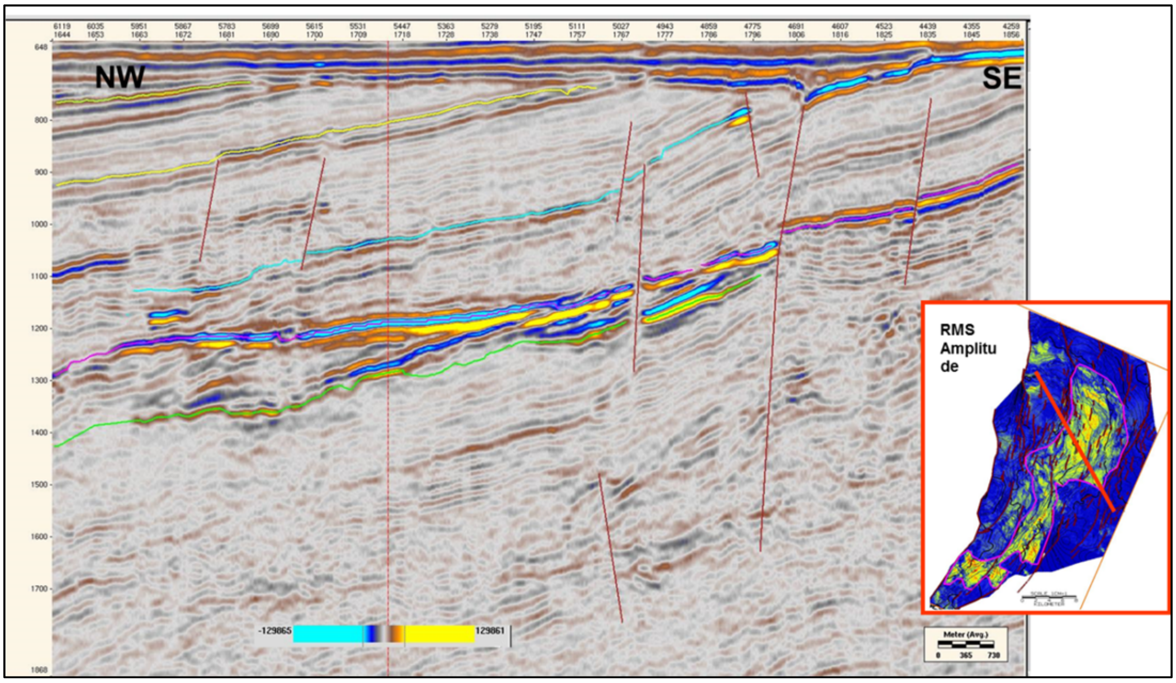


Fig. 4.1.5. Anomaly and Stratigrahpy relationship.

Several wells in the Barents Sea penetrated biosiliceous sediments in the Tertiary section. The Biosiliceous sediments (diatoms, silicoflagelates, radiolarians, etc.) are deposited under acid conditions in a slope to upper slope environment with upwelling currents. They are deposited in clean waters with little siliciclastic input. The sedimentation is by suspension, traction (they prograde with the slope) and is characterized by high productivities. Its high productivity could generate instabilities in the upper slope, triggering gravity flows that could transport the biosiliceous sediments deeper into the basin. Once buried, temperature and pressure increase and silica precipitates transforming the Ooze (Opal A) into to Opal CT and then into Quartz. The depth at which the transformation takes place depends on the temperature but also in the purity of the bisosiliceous sediments, in such a way that, the less pure they are the deeper they transform into the Opal CT and the quicker they transforms into Quartz (see figure4.1.6).

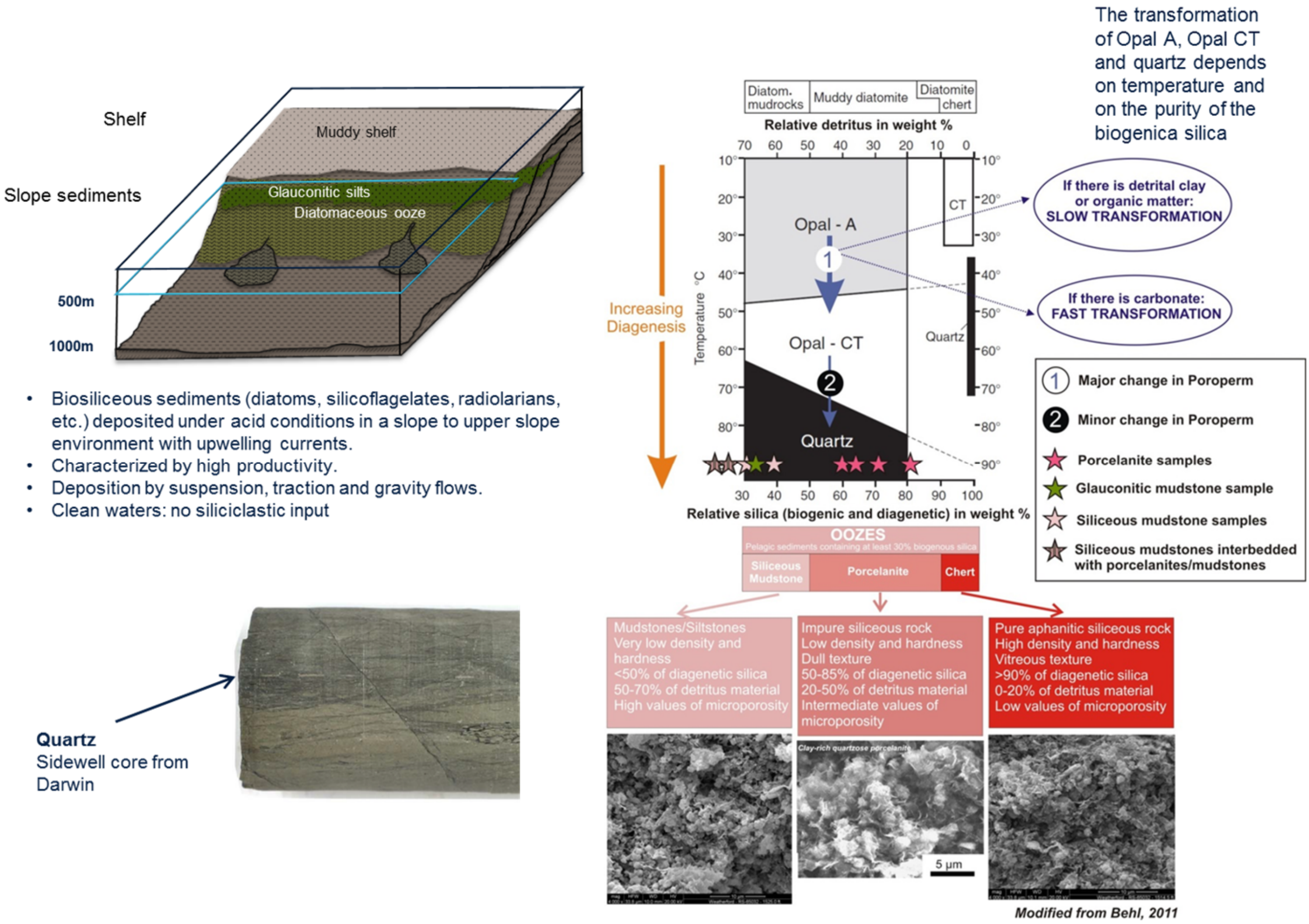


Fig. 4.1.6 Biosiliceous sediments: characteristics.

An abrupt reduction in porosity and an increase on bulk density is associated with each of the two silica phase transformations, particularly in the Opal CT transition.

Based on the biostratigraphy of the wells (revised by Ichron), the deposition of the Ooze took place from the Upper Selandian until the Upper Yppressian (between T31 and T70 as per Ichron stratigraphy). Figure 4.1.7 shows a correlation between 7117/9-1 (Senje ridge), 7218/11-1 (Veslemøy High) and 7218/8-1(Veslemøy High). The 7218/8-1 well was not included in the licence database; however, RENAS (operator of licence 711) traded the well and was able to interpret the cross section. Most of the Tertiary section is dominated by Biosiliceous sediments. The Opal A, Opal CT and Quartz section in well 7117/9-1 had been proven by X ray analysis. Same applies to the Quartz interval in well 7218/11-1 (Darwin). The interpretation of the different zones (Opal A, CT and Quartz) in well 7218/8-1 and 7218/8-1 was based in log data as the different intervals have a characteristic response in the density Neutron logs (see figure 4.1.8).

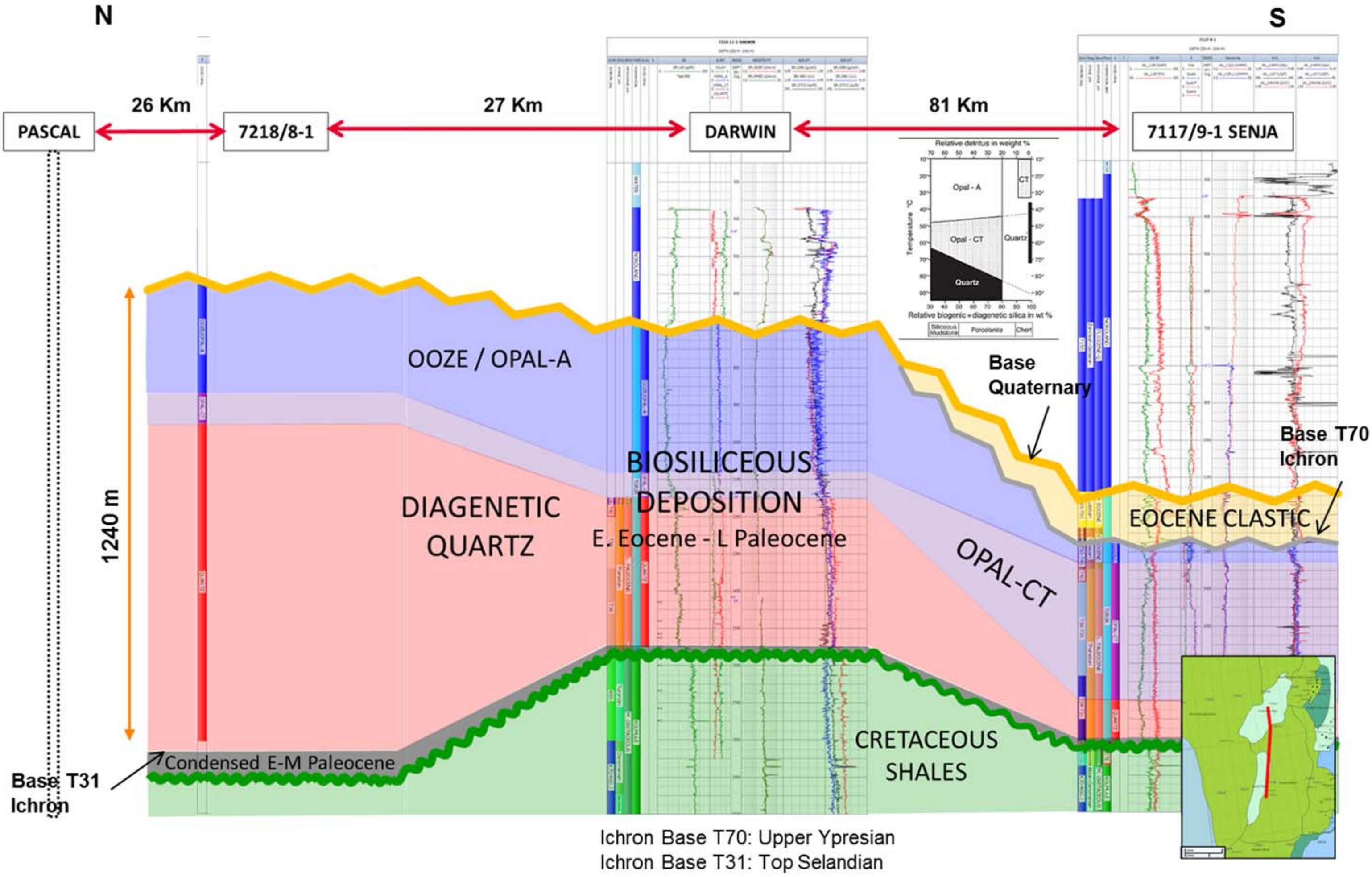


Figure 4.1.7 Cross section trough Senja Ridge and Veslemøy high wells. Note that the Tertiary section is dominated by biosiliceous sediments.

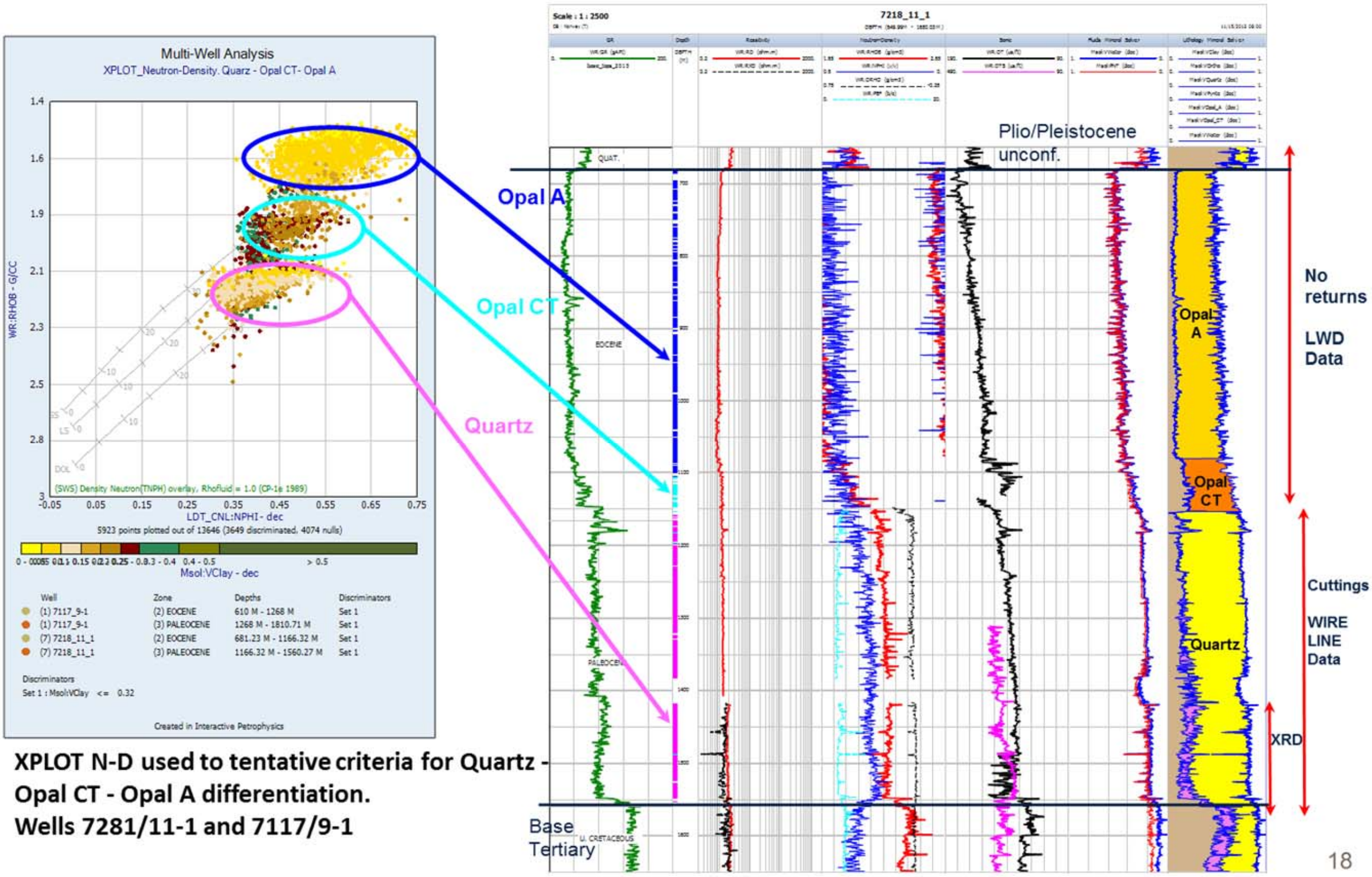


Figure 4.1.8 Opal A-CT-Quartz intervals defined by logs

Pascal prospect was located 26 Km away from well 7218/8-1. The biosiliceous sediments extend along several kilometres covering the Senja ridge and the Veslemøy High (see figure 4.1.7). Is therefore difficult to image how the 1240 m of those sediments found in well 7218/8-1 could suddenly disappear in 26 Km.

On the other hand, the Opal A is characterized by considerably low velocities (due to its high porosity and low density). Figure 4.1.9 shows an abrupt drop in the velocity at the Opal A interval in 7218/11-1 well. This inversion in the velocity trend was also detected in the PreSDM velocities prior to the drilling of the well. As exposed in previous sections, the licence carried out a detailed velocity analysis in the SWB11 3D survey. The study showed and abrupt velocity inversion above the Pascal amplitude anomaly (see figure 4.1.10). Based on well 7218/11-1 results, this low velocity layer is interpreted to be Opal A. The top of the low velocity layer coincides with a clear seismic unconformity that is interpreted to correspond to the unconformity observed at the top of the Opal A section in well 7117/9-1 (Senja ridge), that is, the base of T70 time as per Ichron stratigraphy (Upper Ypresian).

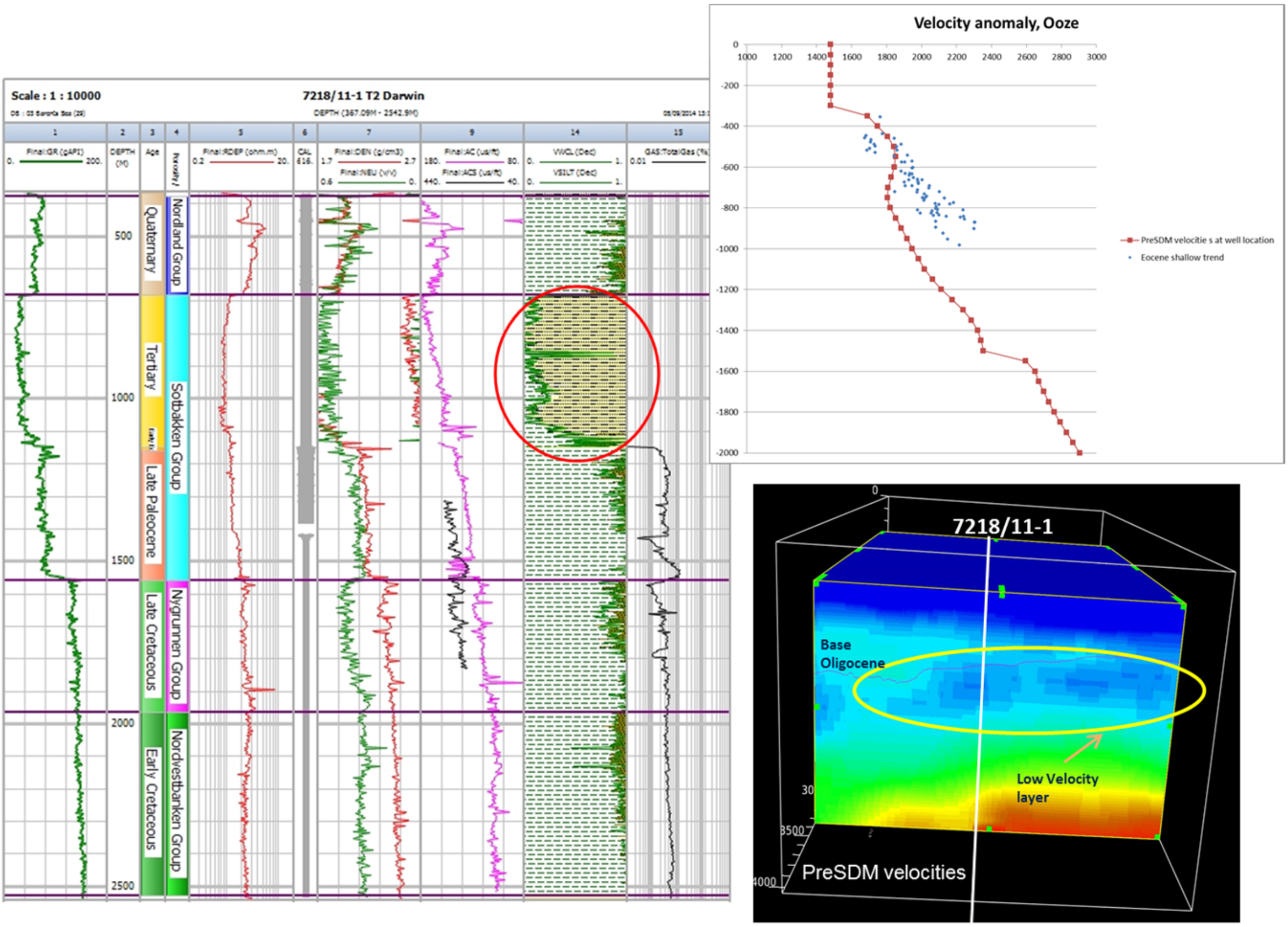


Figure 4.1.9. Velocity drop along the Opal A interval in 7218/11-1 well

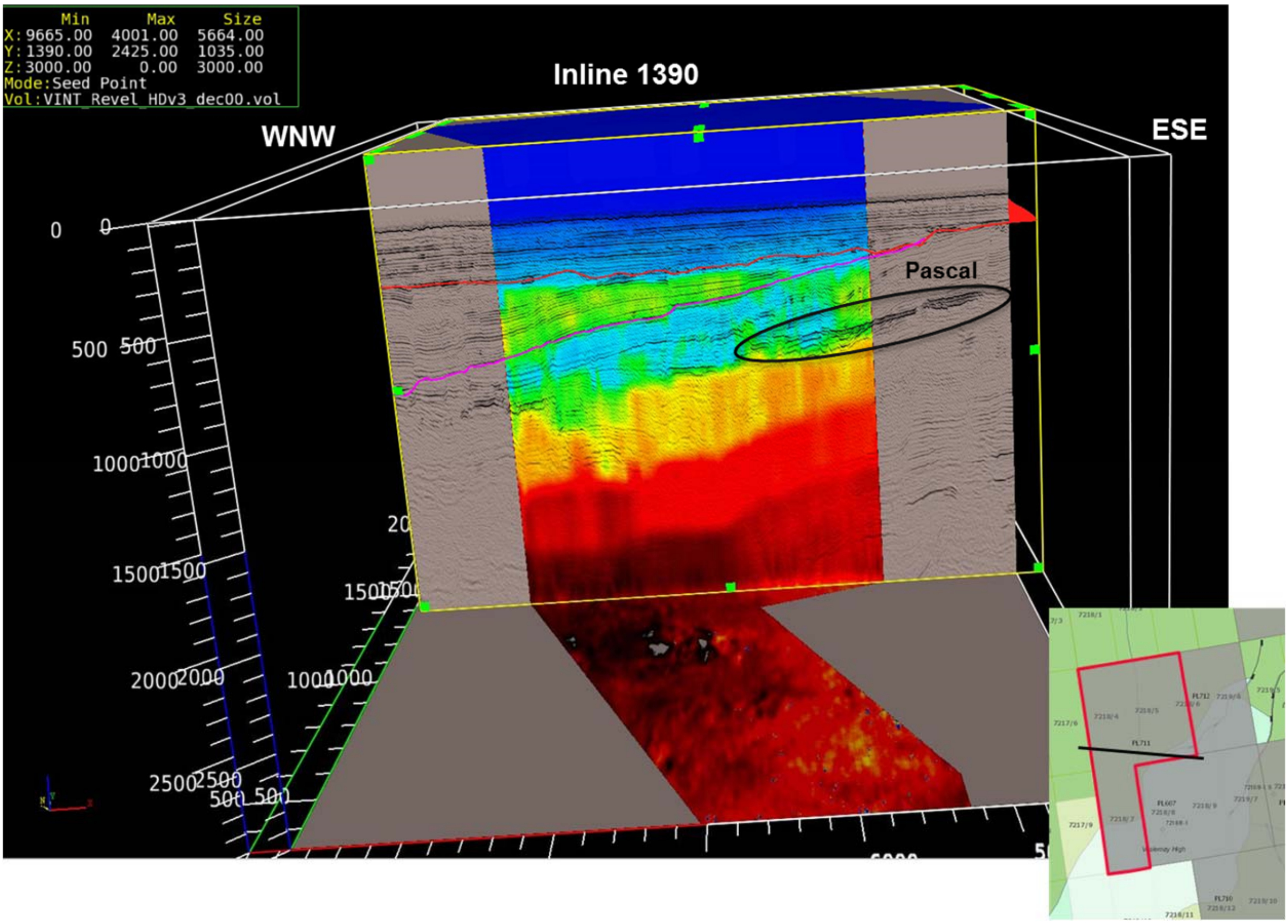


Figure 4.1.10. Velocities in colours juxtaposed with the seismic in grey scale. Note the velocity drop above Pascal amplitude anomaly

In order to evaluate the seismic response of the biosiliceous sediments, a rock physics study (including rock physics model analysis, AVO modelling and fluid substitution) was performed over the wells 7118/11-1 and 7117/9-1. Figure 4.1.11 shows the main results for well 7218/11-1. For a dry case the interface between the Opal A and the Opal CT generates a class 1 AVO seismic response (peak). If we saturate the Opal CT with gas, the seismic changes to a class 3 AVO seismic response with high intercept values, that is, a relatively high amplitude trough. The effect is the same even with saturations below 5%.

Based in the previous observations, the Licensees heavily downgrade the Pascal prospect and other potential anomalies associated to this play (i.e. Arquimedes lead) due to the extremely high geological risk in terms of reservoir presence: All the analyses and studies pointed to interpret the anomaly as a digenetic effect, as the result of Opal phases transitions with minor gas saturation rendering the Mid Eocene non-prospective in the AOI (Fig. 4.1.6)

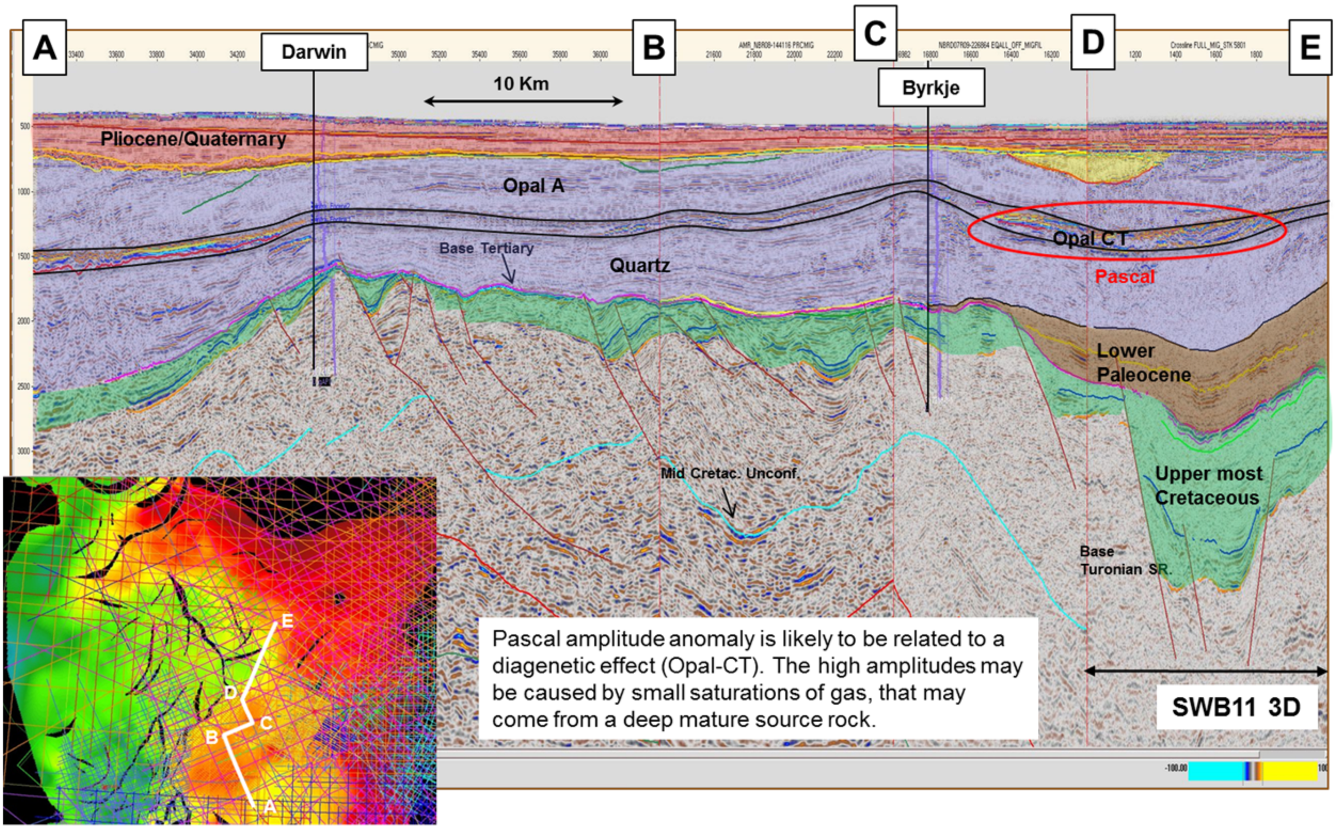


Fig. 4.1.6 Geoseismic section.

4.2- Remaining Prospectivity.

Having discarded the mid Eocene play, Operator focused on evaluating prospectivity at other intervals, particularly on the Mid-Upper Cretaceous and the Lower Paleocene.

The Upper Cretaceous in the AOI could be analogue to the Skalle or Juksa discoveries found in Hammerfest basin. A detailed 3D seismic interpretation of the interval was performed together with a well review focusing on the Cretaceous plus literature review on paleoenvironments.

A lead consisting of a series of stacked amplitude anomalies (Fig. 4.2.1) could be identified at Upper Cretaceous level, right below BTU. Also, possible channelized features could be seen on seismic attributes. Analysis of these amplitudes showed that most of them are Class 1 AVO anomalies although they are weak and do not stand far out of the background (Fig. 4.2.2). In addition there is no structural closure as the anomalies are climbing towards the Stappen high and the anomalies extend outside the 3D seismic and the PL711 licence.

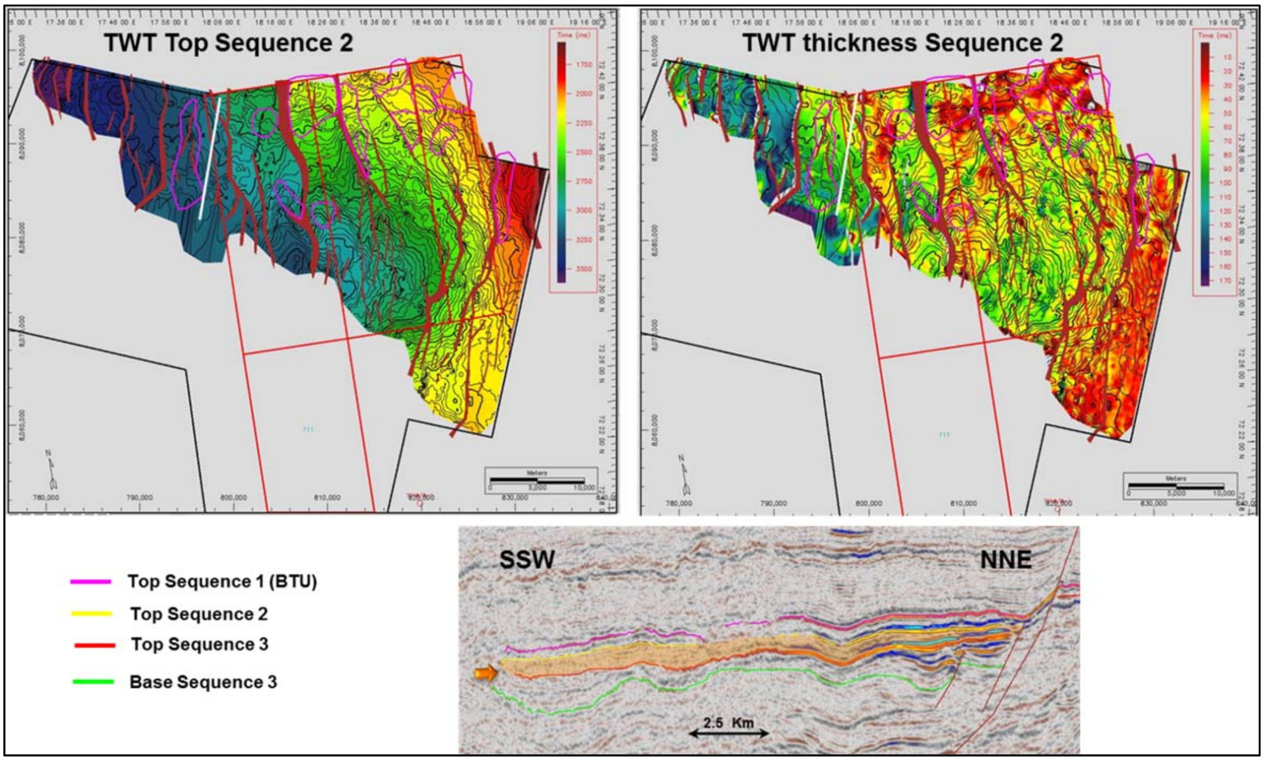
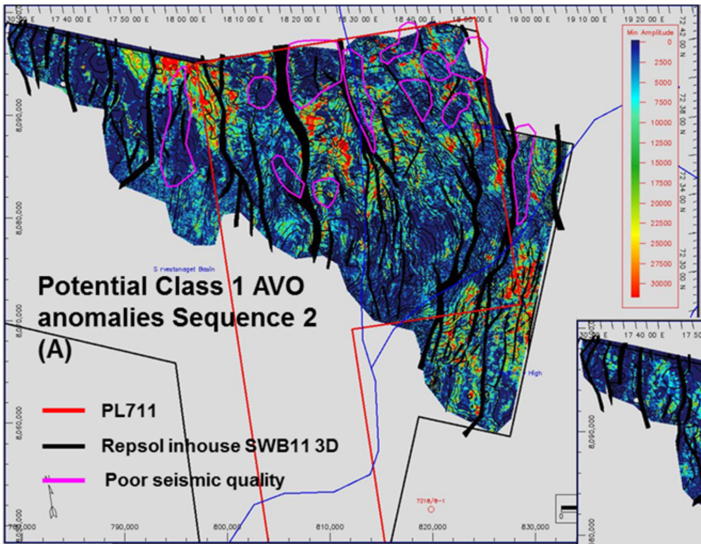


Fig. 4.2.1.Interpreted sequences and example of Sequence 2.



Window: Top Sequence 2 - Top sequence 3

Seismic data: Min amplitude

$$A = \frac{(NEAR - FAR) * NEAR}{RMS\ AMPL}$$

$$B = \frac{(FAR - NEAR) * FAR}{RMS\ AMPL}$$

The anomalies observed in Sequence 1, apart from the one in the north (see left hand side image), are most likely AVO Class 1. However, the anomalies do not stand very far out of the background (they are weak; colour bars had to be compressed to improve the visibility). The Class 3 anomalous area coincides with the one in sequence 1.

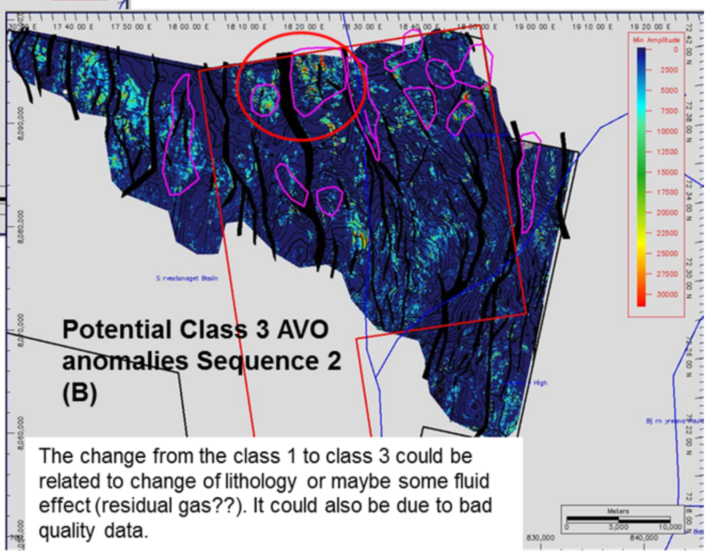


Fig. 4.2.2 Intercept x Gradient Horizon slice.

Regarding the depositional environment were those anomalies could have been deposited, it is not very clear from the seismic data. However, the presence of possible channelized features together with the basin configuration at the time of the deposition, led the operator to interpret it as a lower slope to deeper marine environment with possible turbiditic currents. Sediments transport seems to be parallel to the faults in a NNW-SSE direction. The possible sources of sediments are:

- Veslemøy High: The source could possibly be the Cretaceous shales (based on the the 72218/11-1 and 7218/8-1 wells) that were eroded at the crest of the Veslemøy High and then transported to the Sørvestnaget Basin by turbiditic currents.
- Stappen High: There are uncertainties associated to the sediments that were being eroded at the Upper Cretaceous/ Lower Paleocene times (Lower Cretaceous? Jurassic?) as well as the amount of sandstones available.

Based on the above observations/interpretations, the Upper Cretaceous lead is considered of high risk due to the lack of a structural closure and the high risk of reservoir.

Alternative interpretations were considered for these anomalies. As the picking of Base Tertiary Unconformity was not straightforward in the area, it was considered the possibility that these anomalies could be above BTU and therefore of Paleocene age. However, this interpretation does not greatly modify the reservoir risk and there will still be a lack of closure.

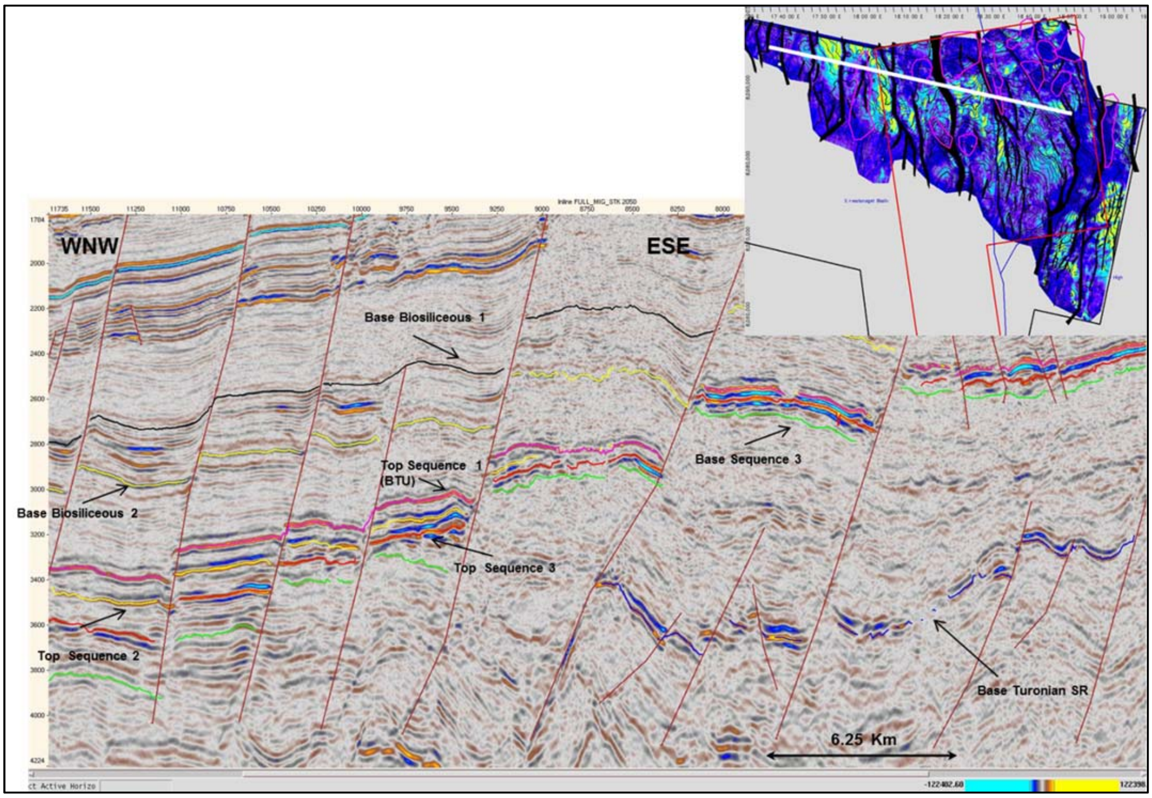


Fig. 4.2.3 Paleocene interpretation for anomalies.

5 Technical evaluations

In the 23rd bid round application the operator presented a standalone development scenario for the Pascal prospect consisting on a FPSO and a mean case of 11 horizontal producers, 5 slanted water injectors and 3 gas injectors. It was considered that Oil would be produced, stored and transferred while gas and water would be re-injected.

Productions profiles were generated and an economic exercise was run in accordance with the guidelines provided by the NPD.

Given the fact that Pascal prospect was discarded for G&G reasons and no other prospects have been identified, no new development scenarios or economic exercises have been run.

6 Conclusions

All the geological and geophysical studies performed by the license during the first exploration period have led the partnership to the conclusion that the main prospect in the license, Pascal, is most likely the result of a diagenetic change in Opal phases. This issue has been tackled from different fronts and all of them seem to lead to the same conclusion. Therefore, it is the license opinion that Pascal prospect has been analysed to a level of reasonably irreducible risk.

The assessment of the license prospectivity shows that geological risk are at levels that prevent the partnership from committing to exploration drilling in PL711 and partners have therefore decided to relinquish PL711 in full, in accordance with the timeline originally proposed as of June 2015.