



BASF Group

Report title:

# PL743s Relinquishment Report

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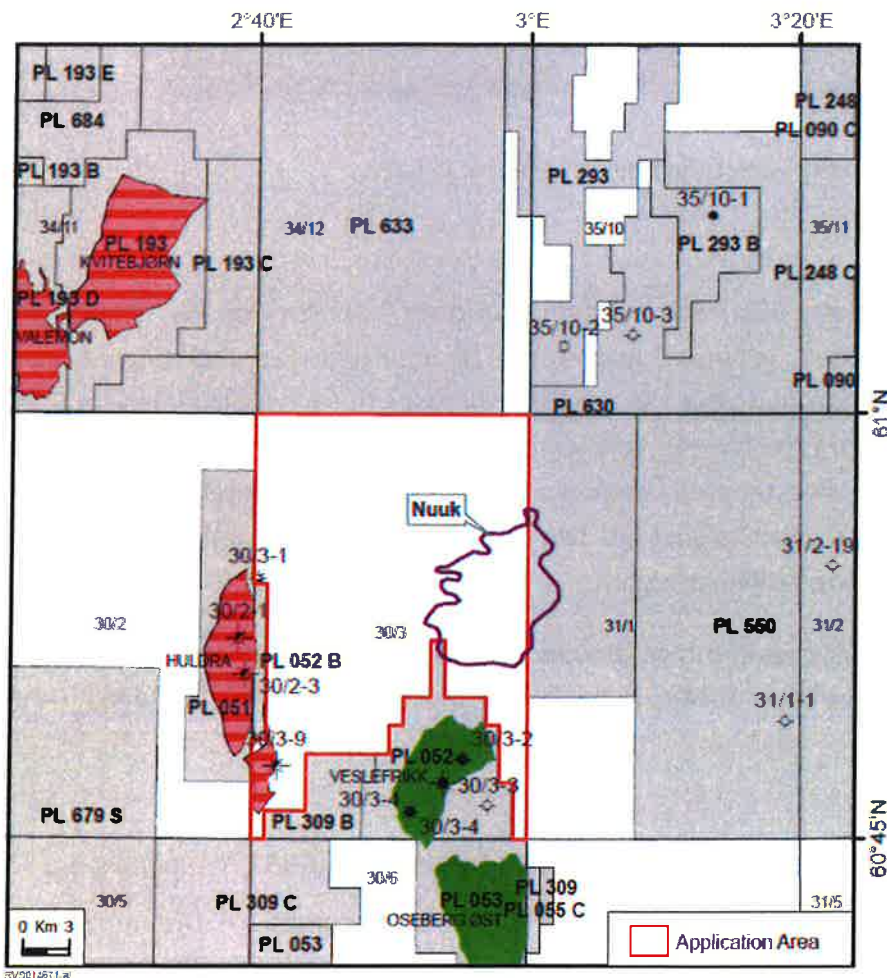
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## 1. License History

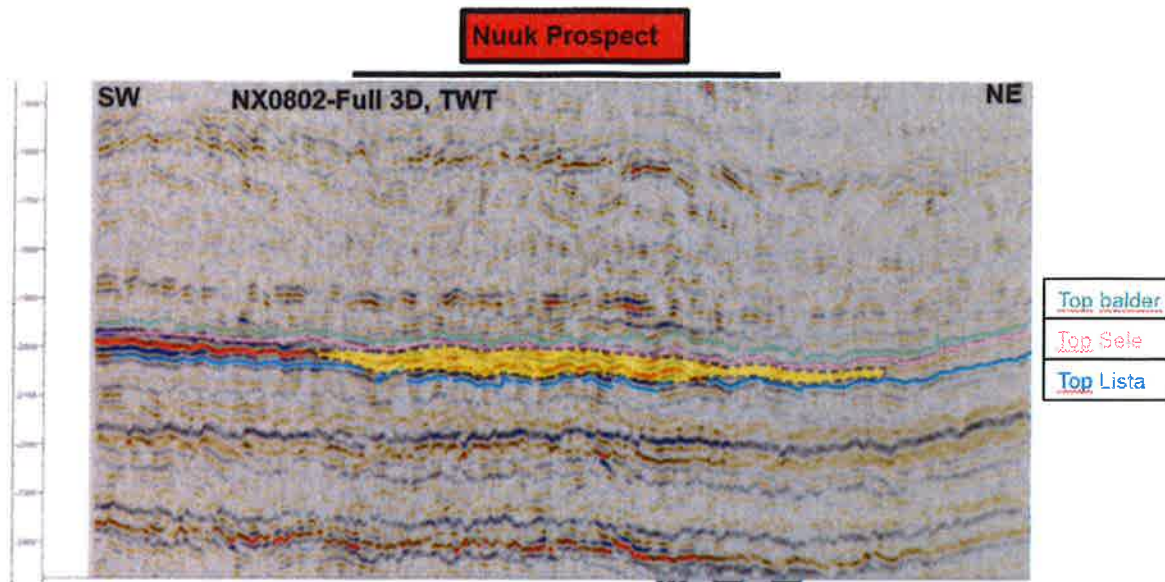
License PL743S, covering parts of block 30/3 (Figure 1) was awarded on February 7<sup>th</sup>, 2014 in the APA 2013 licensing round. The license was awarded to Wintershall Norge AS as operator (50%) with Bayerngas Norge As (50%) as partner.

The initial 7 year period had a drill-or-drop decision after 2 years. The work obligation included reprocessing of 3D seismic data over the license area and G&G work. The PreSDM reprocessing was performed by DUGeo in London from June 2014 to mars 2015. During that time G&G work was started using NX0802 data and then continued or confirmed using the reprocessed WIN13M03 seismic.



**Figure 1.** Location map for the PL743s license with prospectivity at the time of the license application.

PL743s is a stratigraphic license focused on the Lower Paleogene. The main prospectivity is recognized in the Nuuk Prospect, a local thickness anomaly in the Sele or Lista Formations which could indicate the presence of a Hermod or Heimdal equivalent sand body. The Nuuk Prospect was seen as a combined stratigraphic and structural trap. No additional prospectivity had been recognized at the time of the application.



**Figure 2.** Seismic line through the Paleocene Nuuk prospect in PL743s.

All stratigraphic levels above BCU, which define the lower boundary of the stratigraphic license, have been evaluated, including assessment of the Nuuk Prospect (Figure 2) and additional opportunities identified after the award. In all cases these opportunities could not be matured into valid exploration targets. Following completion of the license work program, it is concluded that the small estimated volumes in place and the high level of risk due to a combination of unlikely reservoir presence and lack of effective traps (e.g. top and lateral seal) do not support an explorative drilling program.

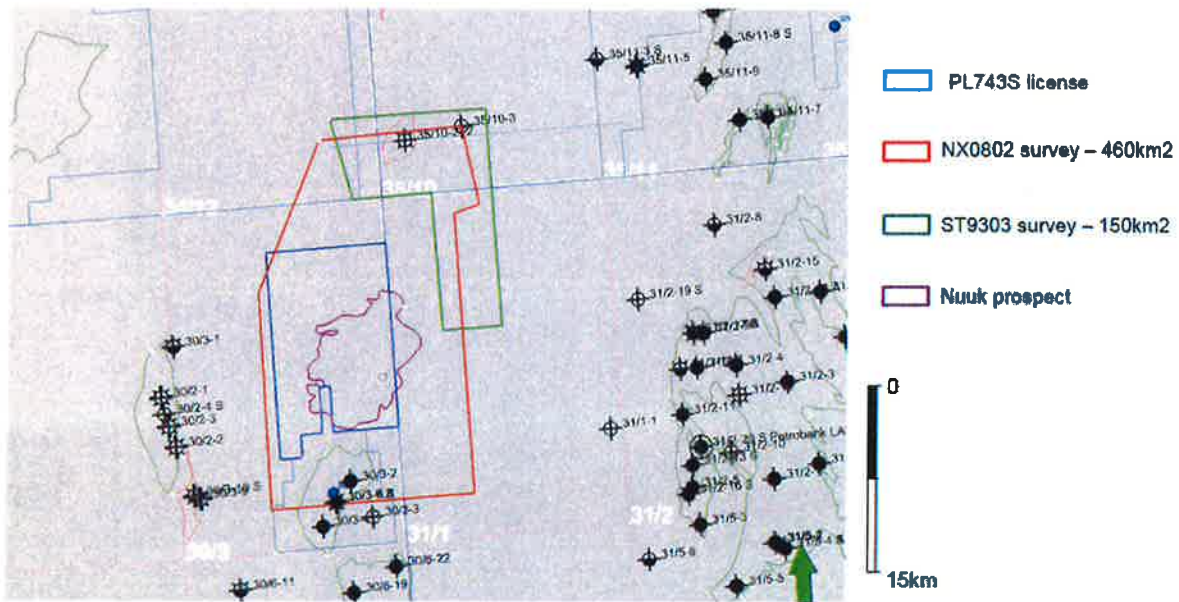
The partnership unanimously agreed that prospectivity is no longer recognized within this license and therefore relinquished PL743s at the Drill or Drop date February 7<sup>th</sup> 2016.

## 2. Database

At the time of the PL743s application the primary seismic dataset used for interpretation was the MC3D Megamerge survey. As part of the license work program, a PSDM merged 3D seismic survey of 550 sqkm, was created by reprocessing ST9303 and NX0802 to provide maximum resolution and 3D coverage of the license prospectivity (Figure 3).

One of the primary objectives of the seismic work program was to allow for effective AVO analysis through the generation of AVO products.

In addition the surrounding wells: 35/10-2, 35/10-3, 30/3-4 were included in the common database as key wells for the Depth reprocessing as well as the interpretation of the WIN13M05 survey and evaluation of the prospectivity of the license.



**Figure 3.** Location map for the seismic and Well database for PL743s.

### 3. Geological Framework

The license is located in the southern end of the deep Magne Sub-basin in the North Viking Graben and more specifically at the Northern edge of the Brage-vesselfrikk Horst. The central part of the North Viking Graben was a depositional center throughout the Paleocene period.

The overall Tertiary sequence is very thick in the Magne Sub-basin and is sourced from both East and West. However the Paleocene is relatively thin in the license and thickens towards the North-East which is believed to be the source area of the sediments at this time. It can be defined by two strong seismic marker: top Shetland group for the top and the Top Balder formation for the base (Fig 4).

The Nuuk Prospect was believed to be located within the southeastern extension of a fan coming from the North-East and penetrated to the North of the License by well 35/10-3 with a minor Paleocene oil discovery in a 35m thick Hermod sandstone reservoir.

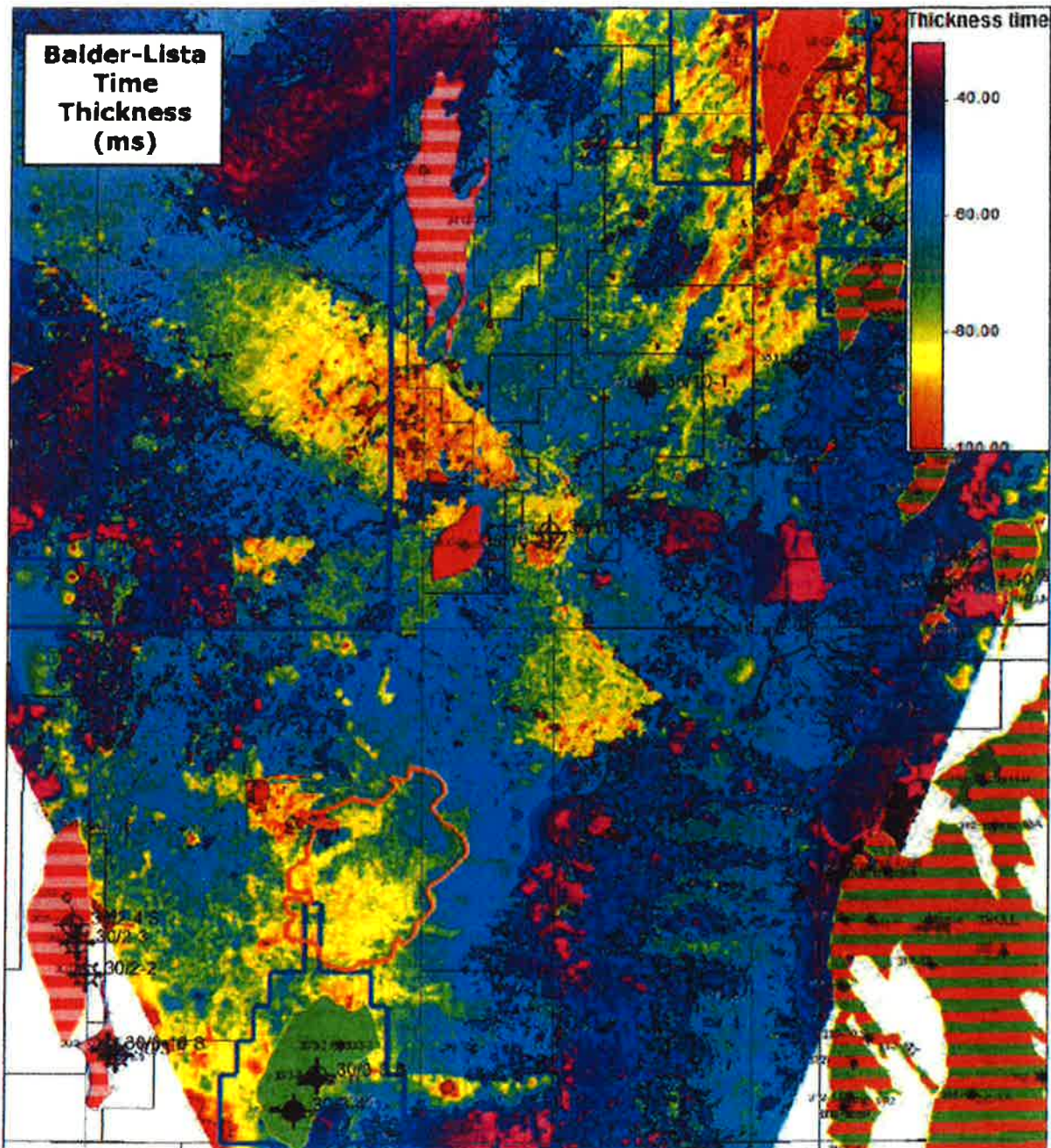


Figure 4. Regional Paleocene time thickness in the vicinity of the PL743s in the Magne Sub-basin.

#### 4. License Evaluation

Based on the new seismic data, all prospective horizons have been evaluated in the PL743s licenses using Wintershall's knowledge and experience from nearby licenses along trend (PL550-PL633).

Due to the general low relief of the strata from top Hordaland to the base of the Paleocene, a strong focus was put on identifying thickness anomalies using a detailed interpretation and

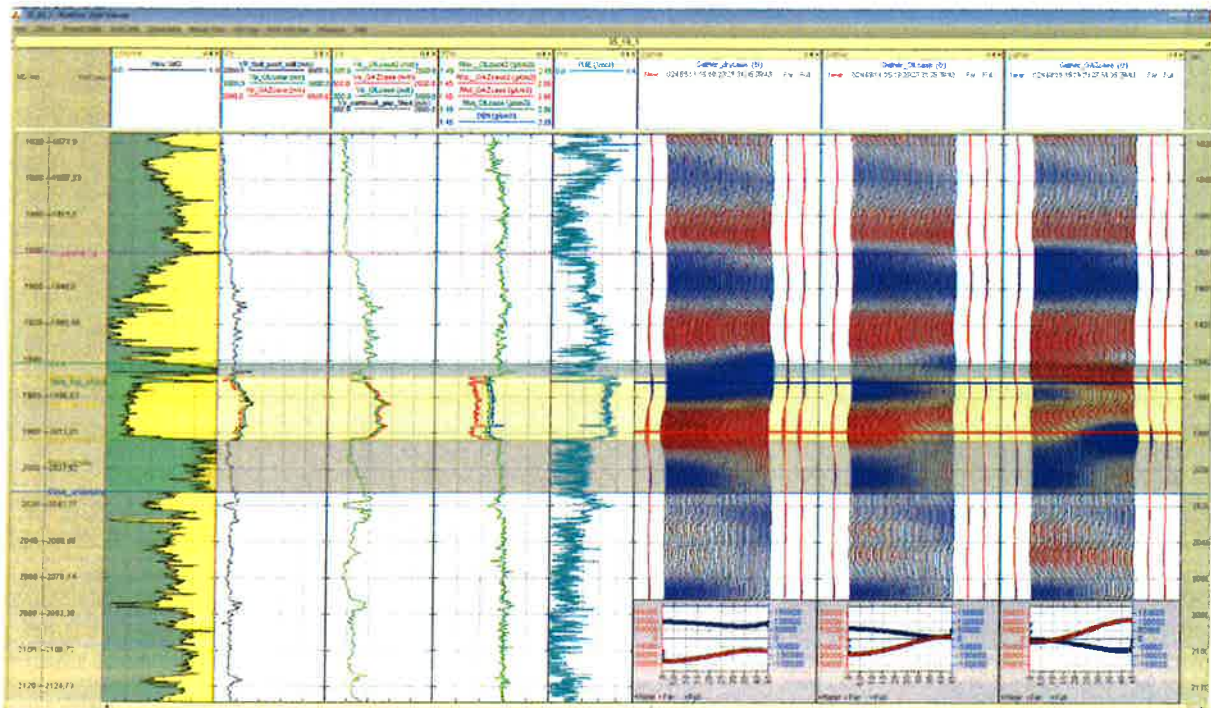
screening for Amplitude and AVO anomalies to detect possible hydrocarbon effect, as predicted by fluid substitutions modelling using nearby wells (Figure 5).

The WIN13M05 seismic dataset proved to be effective to de-risk prospectivity due to the high resolution of the deghosted seismic, but also the more accurate geometries given by the depth imaging ( important in these low relief strata ) and for AVO analysis in order to identify reservoir and/or hydrocarbon presence.

The interpretation of WIN13M05 was tied to the wells 35/10-2, 35/10-3 and 30/3-4 and incorporated in the general regional knowledge of former license PL633 to the North and PL550 in the East which allows a better understanding of the sediment provenance and the geometries of main depositional events.

Other geological studies were conducted to address key risk elements:

- Creation of detailed semi-automated depositional model using Paleoscan to image subtle thickness anomalies and depositional features.
- Additional screening of lateral lithology change using frequency decomposition
- Amplitude anomaly and AVO screening
- Geophysical analysis and modelling of key offset wells



**Figure 5.** Fluid substitution of the Hermod sand penetrated in Well 35/10-3 showing an AVO class 1 for the water case, class 2 for the oil case and class 3 for the gas case.

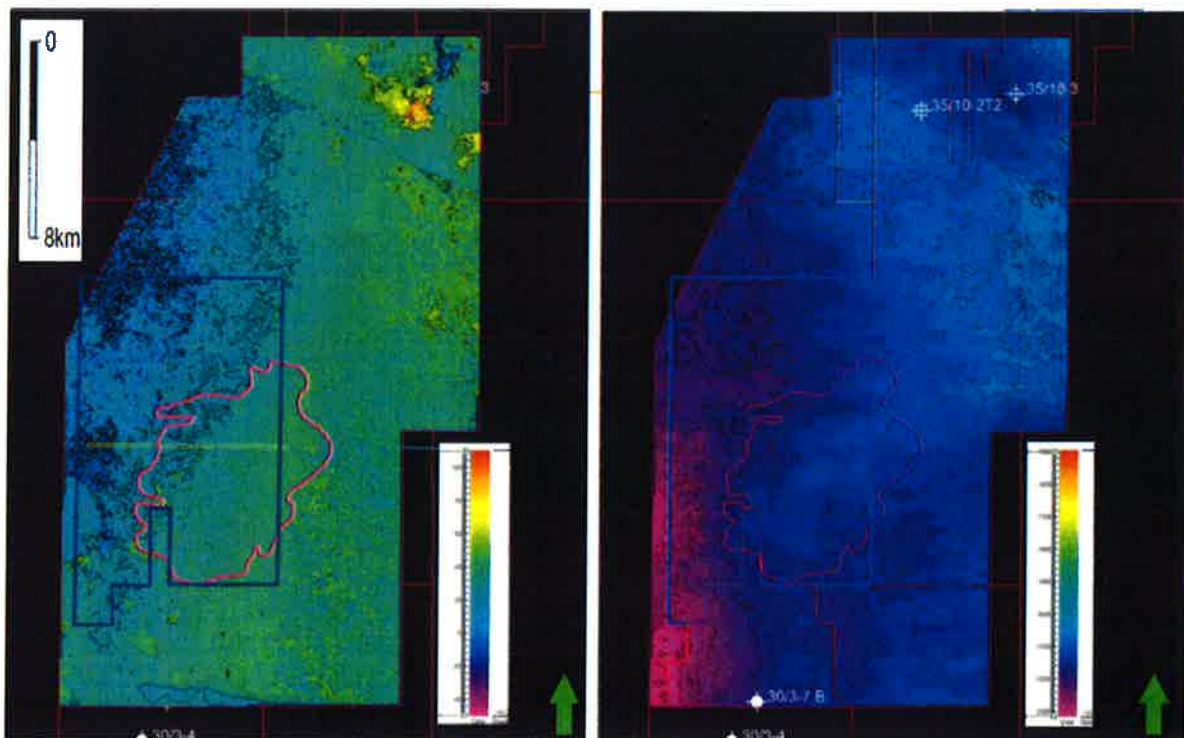
## 5. Prospect Update

The application for PL743s was based only on one identified prospect. After the award, attention was also given to the shallower stratigraphy presenting several thickness and amplitude anomalies. The following is a summary of all opportunities that have been identified, although all have subsequently been downgraded or discarded as viable exploration prospects.

### Nuuk Prospect

The Nuuk Prospect was defined as a stratigraphic/structural trap originally described as a thickness anomaly in the Sele Formation indicating possible reservoir presence equivalent to the Hermod Member as penetrated in wells further to the North like 35/10-3.

After careful remapping on the new higher resolution seismic we could not see any significant thickness anomaly neither in the Sele which is very thin and completely pinching out in the West of the license (Figure 6), nor in the underlying upper Lista. Furthermore the structural closure that was identified on the Mega merge data disappeared on the new seismic only to become a ridge with a subtle relief of about 25m (Figure 6).

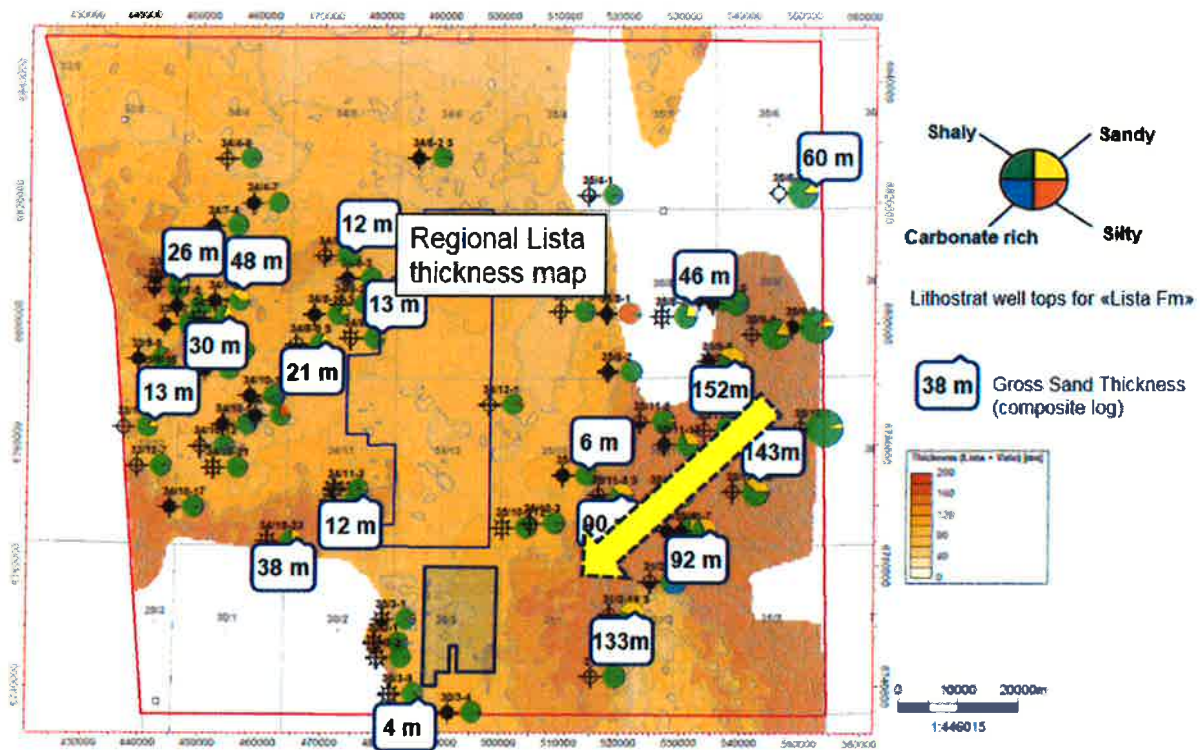


**Figure 6.** On the Left : Thickness map of the The Sele Formation, with 25m contours. On the Right : Depth map of the top Sele horizon, with 50m contours, over the reprocessed area over the reprocessed area with PL743s overlaid in blue lines. There is no clear thickness anomaly in place of the Nuuk prospect delineated by the pink polygon. Note that we can clearly see the end of the 35m thick Hermod fan penetrated by the 35/10-3 well in the North-west corner of the map.



The absence of any visible depositional features on the amplitude extraction and the absence of a thickness anomaly, in the very thin Sele sequence makes the presence of an interesting prospect unlikely. The general slight dip of the strata to the South-West also makes the hydrocarbon retention difficult and force us to conclude on the absence of prospectivity in the Sele Fm.

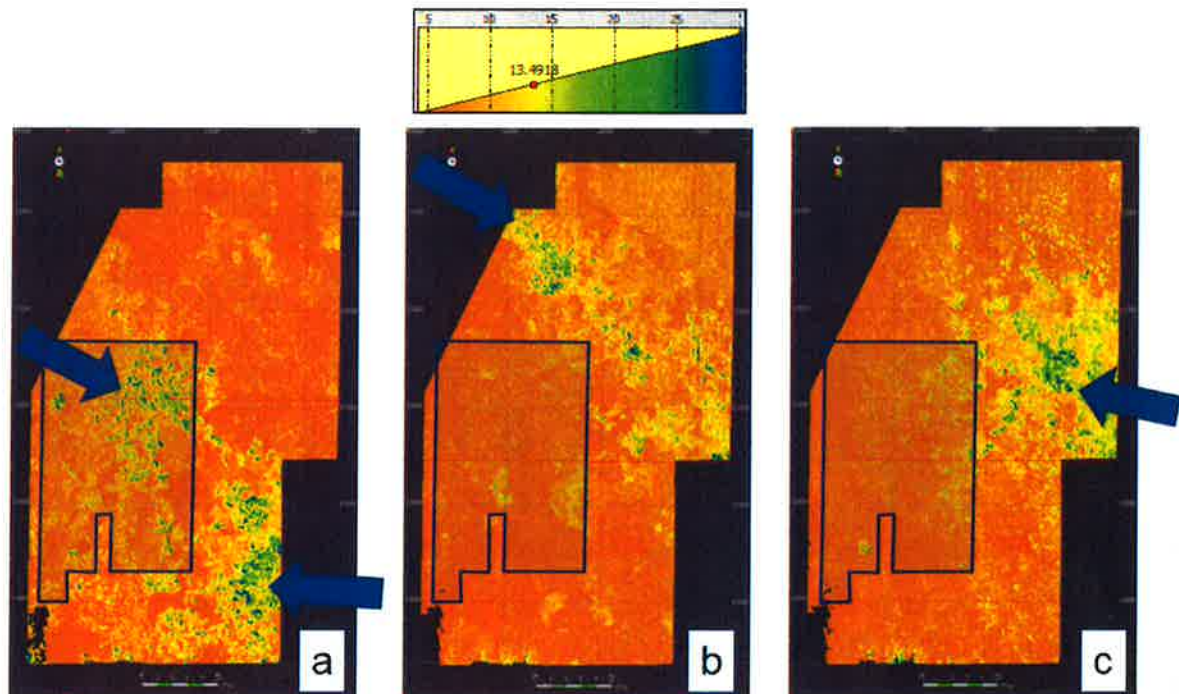
The Lista Formation however is well developed in the area. Furthermore it thickens to the North-East where channels can be mapped north of the Troll high. One of the biggest channels is penetrated by well 31/2-19s which proved 133m of clean sands (Figure 7). The channels are believed to be sourced from the North-East and to run down to the South-West in the direction of the PL743s License. However these features gradually disappear before entering the license, suggesting the possible presence of basin floor fans. Our focus naturally shifted to the detection of possible Heimdal reservoirs in that stratigraphic unit.



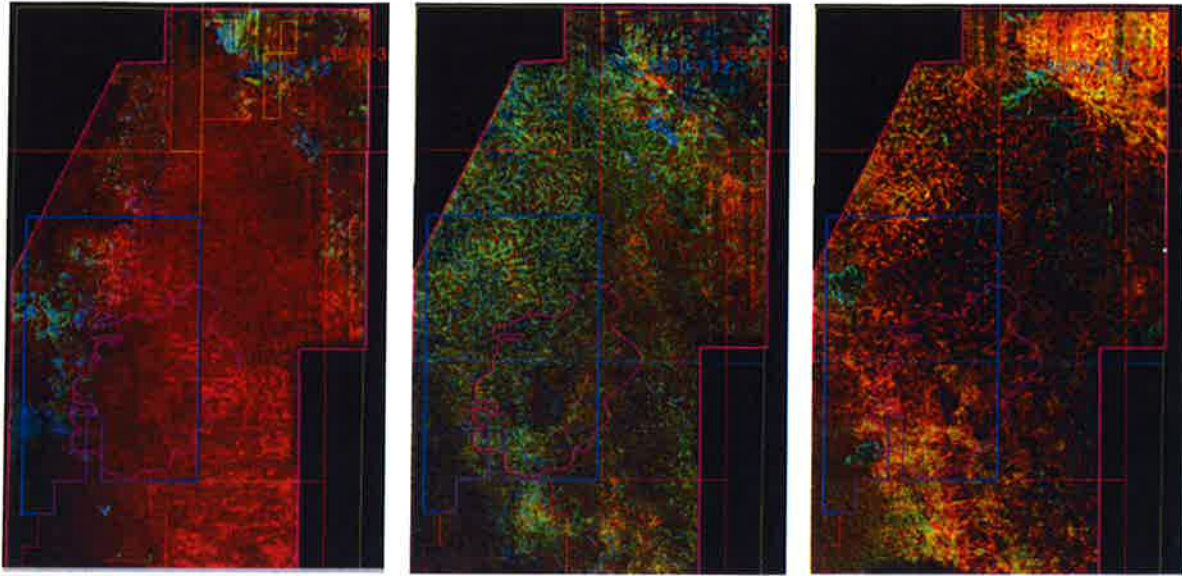
**Figure 7.** Thickness map of the Lista and distribution of sand this interval for the Region of the PL633 and PL743s licenses, showing a thicker Lista in the North-East of PL743s corresponding to the sediment.

To image these fans which does not create visible thickness anomaly, we selected 2 approaches :

1. The first approach was a semi-automated high resolution mapping of the entire Lista section, through the creation of a subsurface depositional model in Paleoscan. The Lista was sliced into 100 surfaces, giving a precise sequence of depositional steps, which highlighted influx of sediment coming from the East but also the North-West with fans shifting laterally to fill the accommodation space (Figure 8 ). These fans are however very thin: on average around 10m with the biggest around 20-25m thick.
2. The second approach was to use a frequency decomposition technique and RGB blending which is known to highlight subtle depositional features as well as lithology variations. However this technique did not allow us to image the thin fans that we could see with the Paleoscan technique. However it highlighted hydrocarbon chimney above Jurassic highs and main faults that suggests vertical migration is working in the area (Figure 9).



**Figure 8.** Paleoscan thickness map in meter of selected intervals of the middle lista (a), lower lista (b), base of the lista (c), showing several sediment influx from the North-West and the East. PL 743s License in Blue.



**Figure 9.** Spectral decomposition example of 3 seismic slices in the Lista (after flattening the cube on a mid-lista horizon) failing to show clear depositional feature but highlighting hydrocarbon migration chimney as green patches on the right hand side image. License boundary in blue lines and Nuuk prospect boundary in pink lines.

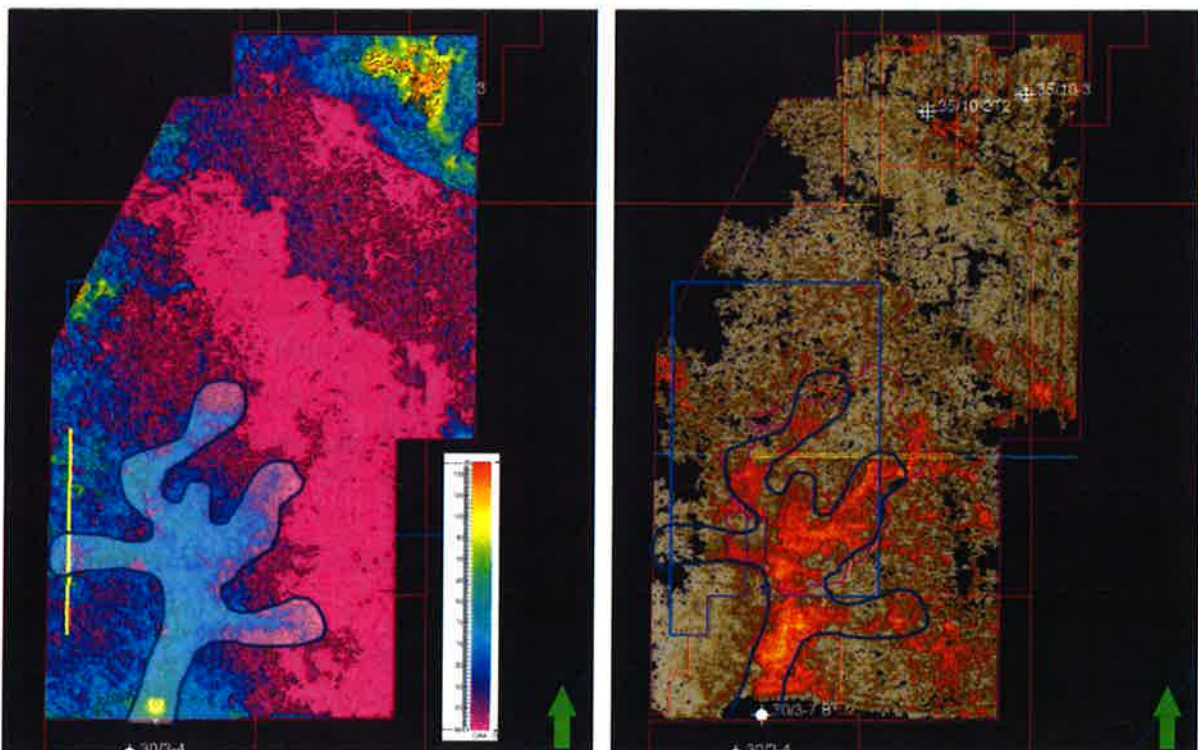
The presence of reservoir in the Lower Lista is likely. PL743s seems to be the distal end of 2 depositional systems coming from the North-West and North-East. The more developed system is the North-East system, with sands proven in several wells, and entering the PL743s license from the East after by-passing a small local graben in the Paleocene time to the north of PL743s ( where well 35/10-2 and 35/10-3 were drilled). This fairway is however risky in several ways that limit its prospectivity:

- The main risks are seal and trapping mechanism. The absence of closure makes it rely on stratigraphic trap only.
- The lateral seal is unlikely to work since the fans migrate and stacks laterally and seem to also interconnect with systems from East to West making stratigraphic trapping difficult (Figure 8)
- The presence of reservoir is likely however the fans observed are thin (10m on average) which makes potential accumulations of volumes limited.
- The charge rely on vertical migration which is considered less risky due to visible migration routes seen on the seismic and spectral decomposition.

## Other Prospectivity & Play Potential

A few additional opportunities have been identified and studied, such as a fan in the Balder Formation and a prograding sedimentary wedge in the Pliocene.

The Balder fan is characterized by a strong amplitude and AVO anomaly as well as a thickness anomaly in a fan like geometry seemingly coming from the south and shedding sediment right over the license ( figure 10 ). However this fan is penetrated by well 30/3-4 who proves the presence of tuffs incased in shales and limestones causing the amplitude anomaly (soft sediments encased in harder lithology). The tuffs are believed to have been remobilized and redeposited as a fan rather than filling a local low, because we see the impact of this fan in the overlaying Frigg layer that is thinner above the fan (than on its sides), thus showing compensational stacking.



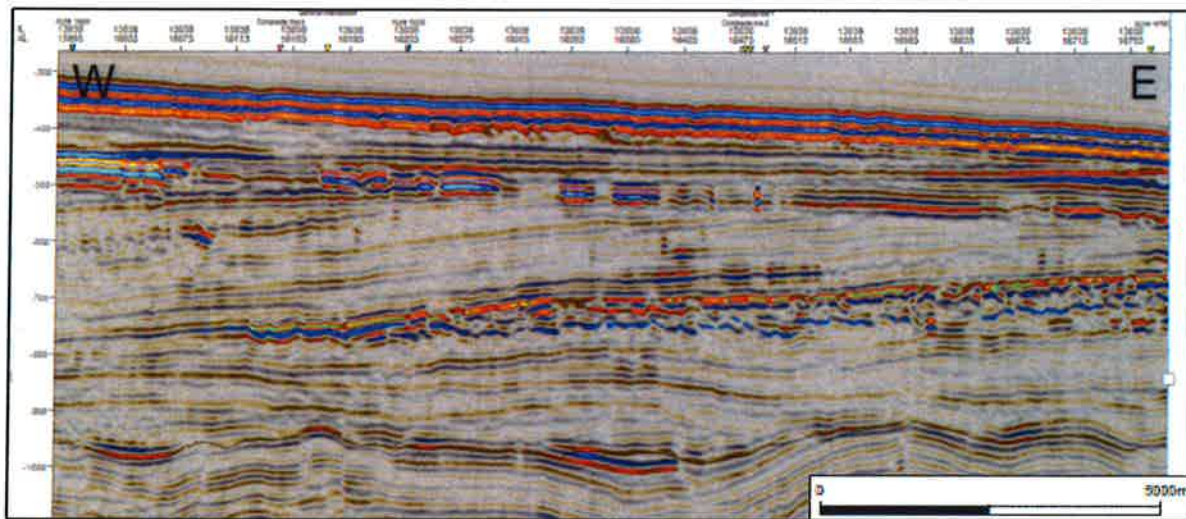
**Figure 10.** Balder formation thickness ( left picture ) and amplitude at the top of the Formation ( right picture) showing a fan shape feature outlined by blue lines.

In the PL743s license, the Pliocene sequence has the form of prograding clinoforms coming from the East, and later truncated by the base Quaternary unconformity. One of the sequences of the clinoforms presents strong anomalies at the top and base and present a discontinuous seismic response probably due to a gravity driven displacement of the sediment after deposition on the slope margin (Figure 11). Unfortunately only the lowest part of this sequence enters the license and the broken up signature of the amplitudes seem to further

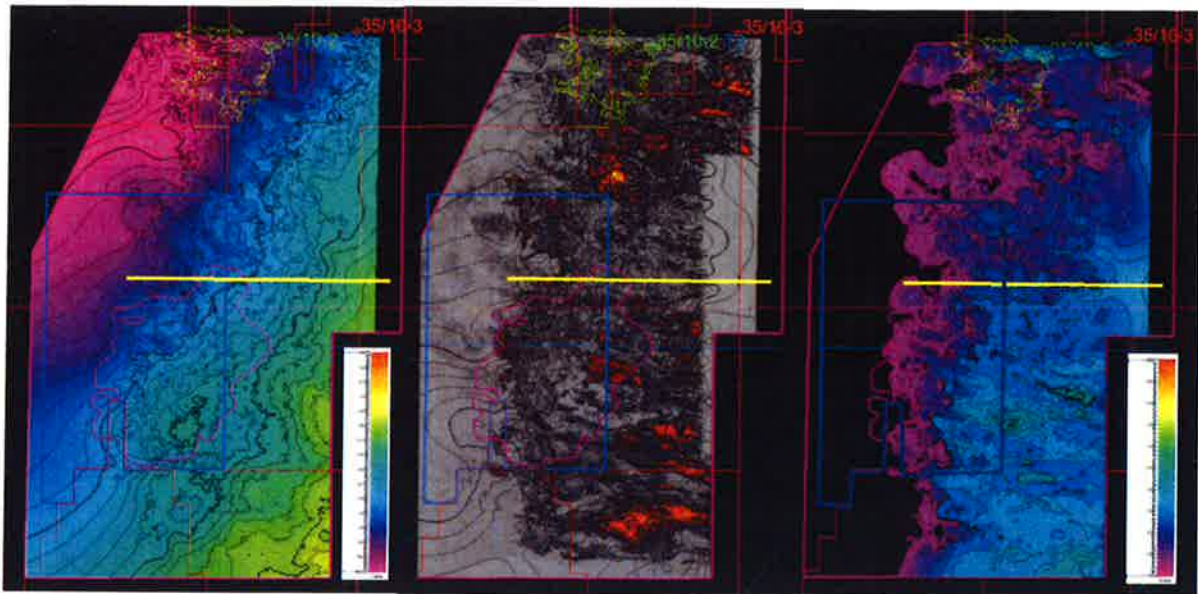
reduce the potential connected hydrocarbon accumulation (Figure 12). Although the amplitude and its polarity ( soft top and hard base ) seems to be in line with hydrocarbon presence, we expect it to be gas at this depth and we cannot rule out its possible low saturation. In addition tis could represent biogenic gas formed and trap in situ.

The Hordaland and Utsira levels were also mapped and screened for amplitude and AVO anomaly which would be expected at this depth. No amplitude or Avo anomly was observed.

As a result of this work we also discarded the prospectivity of this shallow stratigraphy from sea bed to top Sele.



**Figure 11.** Seismic dip section through the Pliocene prograding clinoform which present strong amplitude on the top and base of one of the sequences.



**Figure 12.** From left to right, depth map of the top of the amplitude anomaly in the clinaform, amplitude extraction at the top and thickness map of the sequence. Yeallow line represent the location of the seismic line shown in figure 12.

## 7. Conclusions

The work programme and subsequent technical evaluation has provided conclusive results with regards to the prospectivity in the PL743s license. The earlier identified Nuuk prospect has been discarded as valid and no other viable prospectivity has been recognised. Based upon these results the decision to relinquish PL743s was agreed unanimously by the license partners.