TOTAL

Memo

**Exploration & Production** **CONFIDENTIAL**

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| **Date :** | June 1st, 2016 |
| **Subject :** | **Denmark - L1/10 License Relinquishment Recommendation** |

Ref: TEP DK 15-088-2

## Executive Summary and Recommendation

The frontier exploration well Vendssysel-1 (VDS-1) drilled in 2015 confirmed an unconventional Alum Shale gas play (Mid Cambrian to Mid Ordovician) in Northern Denmark license L1/10 (2972 km², Figure 1). VDS-1 is plugged and abandoned; it is classified as not successful (no economical value forecasted).

Post-well studies conducted by Total on cores, cuttings and logs lead to the following key conclusions:

- The encountered organic-rich type II dark black shale interval totalizes 39m of hot shales (TOC~6-9%) overlaid by 35m of lean shales (TOC~2%) - which is in accordance with some US analogs,
- Despite high clay content ([redacted] geomechanics model predicts a good fracability/high brittlness,
- Nevertheless, porosity is very low ([redacted], due to lack of organic porosity) as well as gas content (30 scf/t) leading to a low GIP and low potential EUR/well (P90=1.9 Bcf/Well; P50=3.1 and P10=4.8).

Pre-tax technical cost estimates (1Q-2016) are [redacted] above gas price forecast and realized in Europe, at least for wells with EUR up to P10 distribution (~5 Bcf/well). **Therefore, no economically viable development project is foreseen for the Alum Shale play on L1/10.**

**To date all L1/10 license work commitments are fulfilled. Base on above integrated evaluation results, Total recommends relinquishing License 1/10 on its end date of June 5th, 2016.** At OCM level on May 9th 2016, DSNF partner confirmed their alignment to the operator relinquishment recommendation.

## Table of Content



## List of Figures



## List of Tables

## 1. License history key milestones

The location map of the Danish License L1/10 is provided in Figure 1.

Table 1 summarizes License L1/10 work commitments and key milestones. To date, with the completion of VDS-1 in Q3 2015, all L1/10 commitments are fulfilled.

| | |
|---|---|
| 29th April 2010 | Devon 40% Total 40 % DNSF 20% nominated for the award of L1/10 |
| 5th June 2010 | After Devon withdrawal, L1/10 awarded for 6 years to Total as operator (80%) and DNSF as partner (20%) and the below work commitments to be implemented into 3 phases:<br>- Phase 1 (2 years): Geosciences & Environmental evaluation<br>- Phase 2 (2 years): Phase-1 contingent, 2D seismic & Dvp evaluation<br>- Phase 3 (2 years): Phase 2 contingent, 1 exploration well |
| April 2012 | Renegotiation of Phase 2 granted by DEA resulting in the replacement of Phases 2 & 3 by one firm commitment exploration well. |
| July 2014 | Well Environmental Impact Assessment (EIA) granted. |
| 12th Nov. 2014 | Well design approval decision (Total internal) |
| Q2-Q3 2015 | Vendsyssel-1 (VDS-1) drilling operations. |
| 5th June 2016 | End of license date. |

Table 1 : Work commitments and key milestones of License L1/10.

## 2. Vendsyssel-1 Exploration Well

### 1.1 Well Objectives

VDS-1 was the first well dedicated to shale gas in Denmark (frontier exploration). Its main objective was the Alum Shale formation (Mid Cambrian to Mid Ordovician) which had only been encountered in Denmark by two wells, Terne-1 and Slagelse-1, respectively located 130 and 450 km from VDS-1.

Pre-drill stakes were of 0.15/0.4/0.9 Tcf (deterministic mini-mode-maxi case, un-risked prospective resources associated to an area of 42km²* centered on VDS-1).

Pre-drill identified key risks were high clay content and low gas saturation.

**42 km² = surface considered as de-risked by VDS-1 exploration results.*

### 1.2 Key Well Results

VDS-1 was plugged and abandoned without acquiring any dynamic data (as per pre-drill decision tree); it was classified as not successful.

In brief, VDS-1 did encounter the Alum shale formation, which is likely to be a shale play i.e an organic rich formation which could be produced through hydraulic fracturing stimulation. Unfortunately the formation is evaluated with a low productivity potential – due to low Gas-In-Place.

No dynamic data has been acquired, according to pre-drill operational decision tree, hence there is no answer regarding potential (unlikely) over-pressure. Nevertheless, the maxi case take into account some overpressure (1.2 EMW) and the impact on well productivity is low, as related to a low Gas-In-Place.

Key VDS-1 well results are summarized below.

- Depth prognosis proved to be accurate,
- 39m of organic rich shale (6-9%TOC), overlaid by another 35m of organically lean shale (~2% TOC) where encountered (Figure 2), which is in accordance with US analogs (Figure 3)
- Shale of dry gas maturity with a Roeq of ~1.8% (dry gas window).
- Detailed core measurement and subsequent multimineral log interpretation showed low porosity (Figure 2) all over the Alum shale interval (rich & lean).
- Core gas content evaluation exhibit low to very low gas content of ~30 scf/t (Figure 4), on the low side of producing unconventional fields. This low gas content is in line with the low gas filled porosity measured on core samples.
- Core 3D imaging (QUEMSCAN) shows very little organic porosity development (Figure 5), this result is in line with here above observations. In producing shale play, organic porosity is created as maturity increase, reaching its maximum at dry gas stage. It's likely initial source rock geochemistry and/or burial history precludes organic porosity to develop/subsists today, leading to an overall low porosity.
- Mineralogical analysis shows high clay content (as expected) but geomechanical studies shows the rock is nonetheless likely to have good fraccability.

### 1.3 Final post drill evaluation - well area

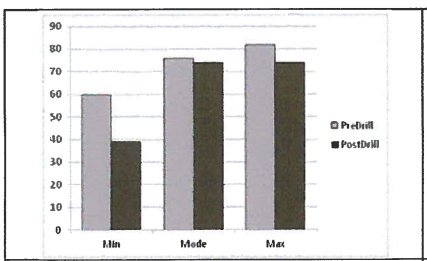
At well location, multimineral log evaluation results have been used as an input to determine Mini-Mode-Maxi GIP and associated potential EUR/well, first deterministically (in this case, with 2 stacked layers, the maxi tends to be overoptimistic, as corresponding to an all-positive scenario in both hot shale and lean shale) and then probabilistically - representative of a P90/P50/P10 distribution.

Using producing US shale as analog (Figure 3), it was considered that both hot and lean shale could contribute to production, should the Alum shale be fracced by a horizontal well. Each interval has been characterized using wireline log interpretation (Table 2 & Figure 7), allowing computing associated Gas In Place.

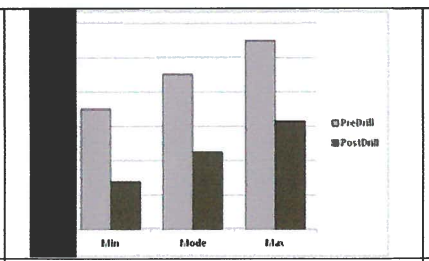
| *Log derived avg. values* | Thickness (m) | Porosity (PhiT, %) | Clay (%) | TOC (%) | Pyrite (%) |
|---|---|---|---|---|---|
| **Hot Shale** | 39 | [redacted] | [redacted] | 6.8 | 7.6 |
| **Lean Shale** | 35 | [redacted] | [redacted] | 1.8 | 4.1 |

Table 2 : Pre & Post drill key assumptions & average parameters for hot shale & lean shale interval

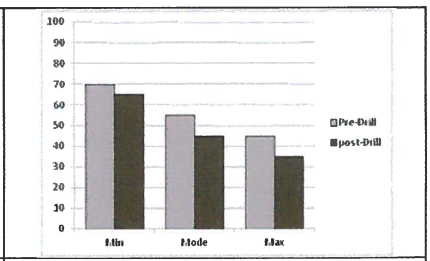
Pre and post-drill key evaluation parameters for the knowledge area are compared below.



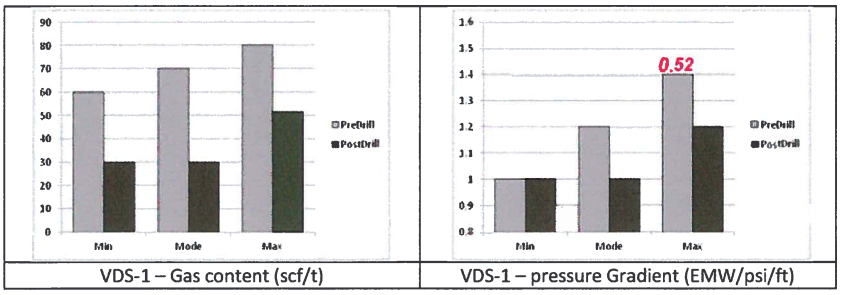

VDS-1 – flow unit thickness (m) postdrill case includes hot & lean shales




VDS-1 – Porosity (PhiT, %)




VDS-1 – Water Stauration (%)




VDS-1 – Gas content (scf/t) | VDS-1 – pressure Gradient (EMW/psi/ft)

The well recovery factor for dry gas is derived from US shale play, so is well spacing (148 acres). The post-well stochastic monte-carlo estimation of the EUR/well has been performed (Table 3). Deterministic post-well evaluation has been discarded as both the hot shale & the lean shale have to be on the high side of the parameter distributions in order to reach the maximum deterministic value which is almost a P01. For reference, deterministic mode case is about 3.3 Bcf/well, close and consistent with the stochastic results (3.1 Bcf/well).

| *Estimated EUR/Well (Bcf)* | LOW CASE | BASE CASE | HIGH CASE |
|---|---|---|---|
| **Pre-Drill Deterministic (mini/mode/maxi)** | 1.6 | 4.1 | 9.4 |
| **Post-Drill Probabilistic (P90/P50/P90)** | 1.9 | 3.1 | 4.8 |

Table 3 : Well Estimated Ultimate Recovery (Bcf)

## 3. L1/10 License Remaining Exploration Potential

The actual depth of the top Hot Alum Shale at VDS-1 is in line with pre drill prognosis. This gives confidence on the pre-drill structural model defining a prospective area "Zone B" of 1110 km² (Alum Shale likely presence at a "reasonable" depth) subdivided into four subzones as per Figure 6**Erreur ! Source du renvoi introuvable.**. The zones A and C representing 1862 km² of L1/10 license (2972km²) are considered as non-prospective.

The undiscovered exploration potential of the Alum Shale play within the prospective area "Zone B" is evaluated post-drill and captured in Table 4. It totalizes about 1.2 Tcf of risked mode resources and 5 Tcf of unrisked resources at the "Zone B"perimeter.

| | PROSPECTIVE RESOURCES | | | | P.S. Play | P.S. Seg | P.S Total | PROJECT DEFINITION |
|---|---|---|---|---|---|---|---|---|
| | Mini (P95) | Mode | Maxi (P05) | | | | | |
| UNDISCOVERED EXPLORATION POTENTIAL | 0,063 | 0,23 | 0,584 | | | | | 42 km² almost knowledge area around VDS-01, productivity still to assess |
| | 0,465 | 1,695 | 4,299 | | | | | Residual Zone 1 + Zone 2 North & South = "vision area" = area of near-homogeneous geologic properties where de-risking from VDS-01 applied, even if less constrained. 383 km² gross, 306 km² developable (80% factor) |
| | 0,108 | 0,394 | 0,999 | | | | | Area 4, Deep Shales, 89km² gross (4000-4500m depth), PS 40%. |
| | 0,712 | 2,593 | 6,578 | | | | | Area 3, 586 km² gross potential Alum Shales, zone affected by erosion, PS 20% (Alum presence). |
| Risked prospective resources | | 1,177 | | | | | | |

Table 4 : Prospective resources over L1/10 prospective Zone B (1110 km²)

Subsenquently and based on the determined EUR/Well, a quick estimation of the associated technical costs has been performed. Those technical costs include Drilling and Completion, well pad, gathering system and CPF, as well as opex and abandonment costs. They are pre-tax figures.

- Mode EUR/well of 3.1 Bcf is associated with [redacted] technical cost [redacted].
- [redacted]P10 EUR/Well of 4.8 Bcf is associated with a technical cost [redacted]

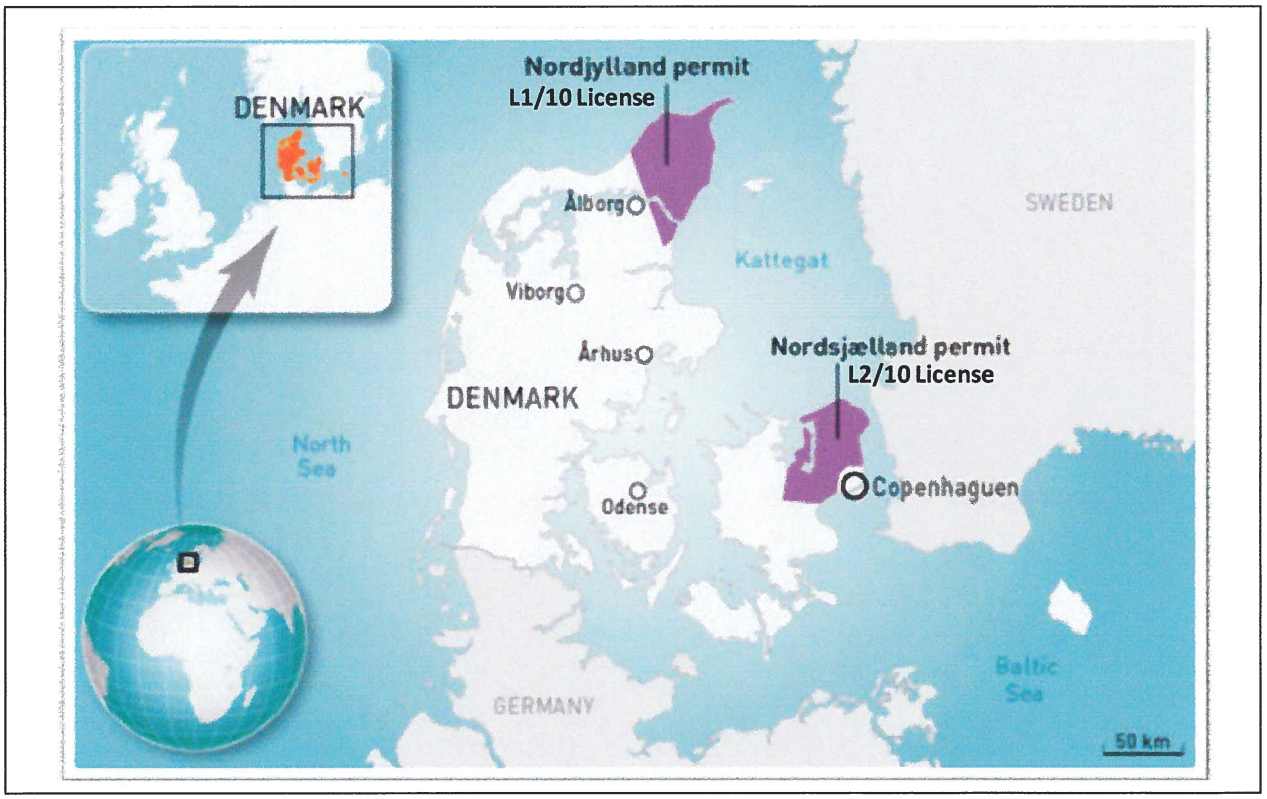



Figure 1 : L1/10 License (Denmark) location map.

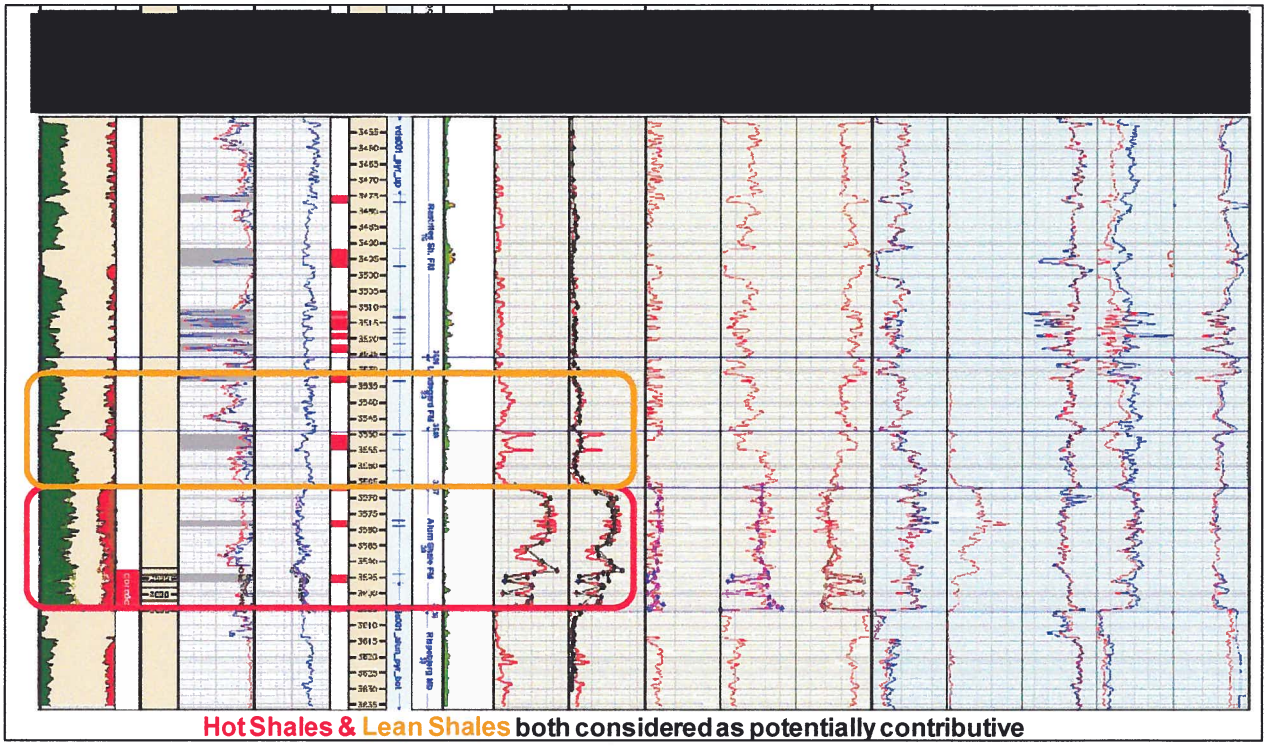



Figure 2 : VDS-1 quantitative log interpretation – Core Driven Model Results.

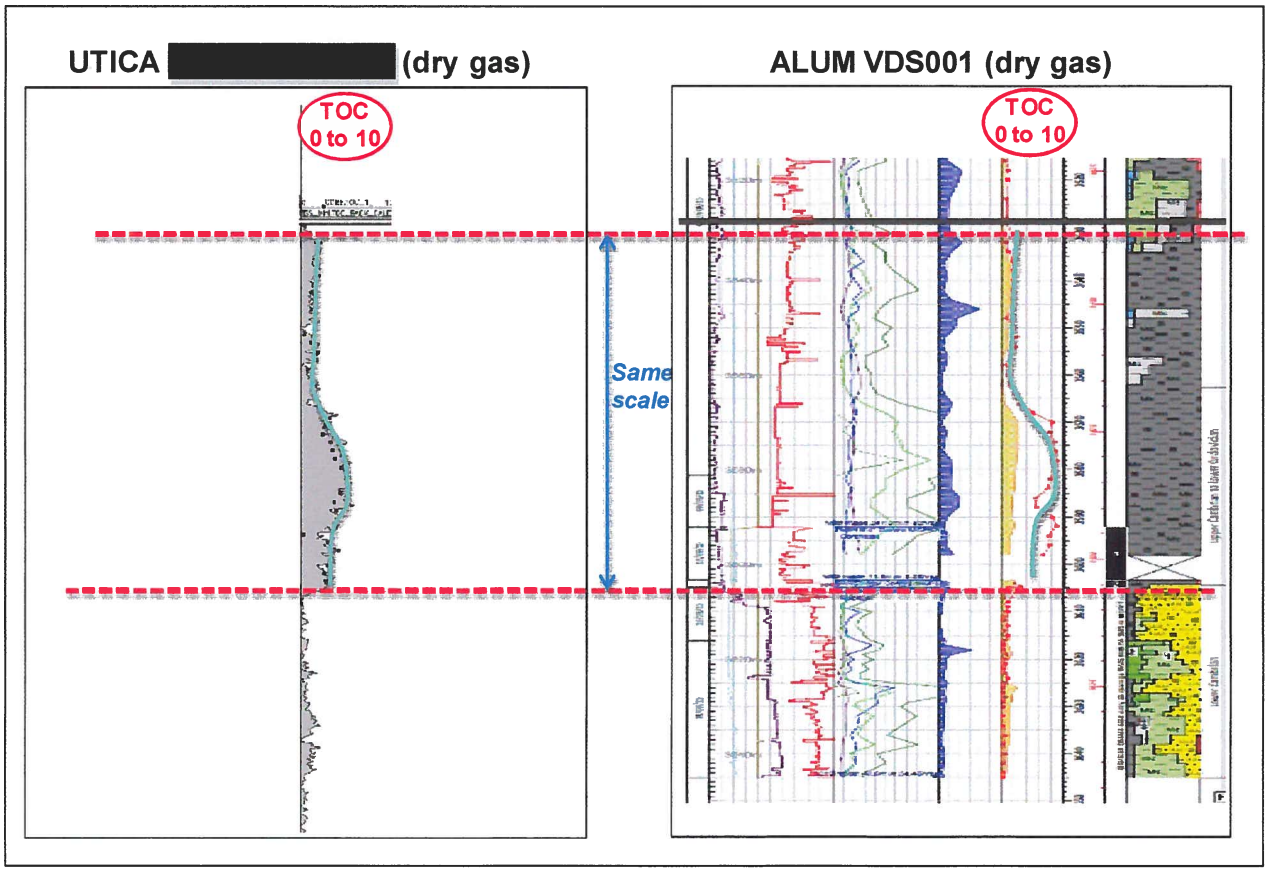



Figure 3 : Thickness and TOC profile comparison of organic rich shale in a typical UTICA well and in VDS-1 well.

**VDS-1 Gas desorption**

Gas desorption tests were leads onsite, and in a lab by GEOKRAK. The c1 content is to 96%.

| Top depth | Base depth | Desorbeb gas content (m3/t) | Residual gas content(m3/t) | Lost gas content(m3/t) | Total Gas content(m3/t) |
|---|---|---|---|---|---|
| 3596.38m | 3596.68m | 0.37 | 0.13 | 0.33 | 0.83 |
| 3602.45m | 3602.75m | 0.35 | 0.21 | 0.26 | 0.82 |
| 3603.30m | 3603.6m | 0.32 | 0.18 | 0.28 | 0.78 |

Figure 4 : Gas content comparison of US producing plays and VDS-1 Alum Shale.

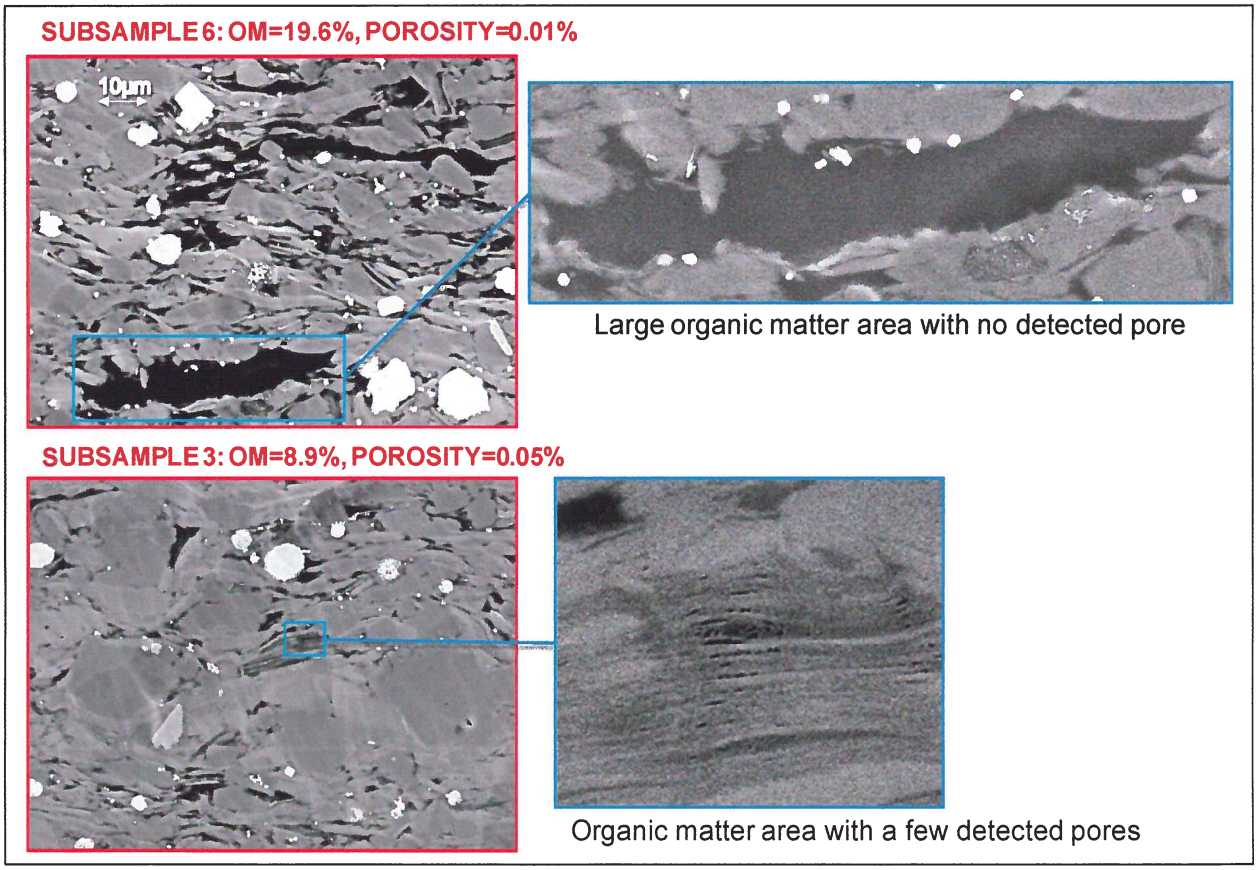



Figure 5 : VSD-1 - core 3D imaging (QUEMSCAN) showing very little organic porosity.

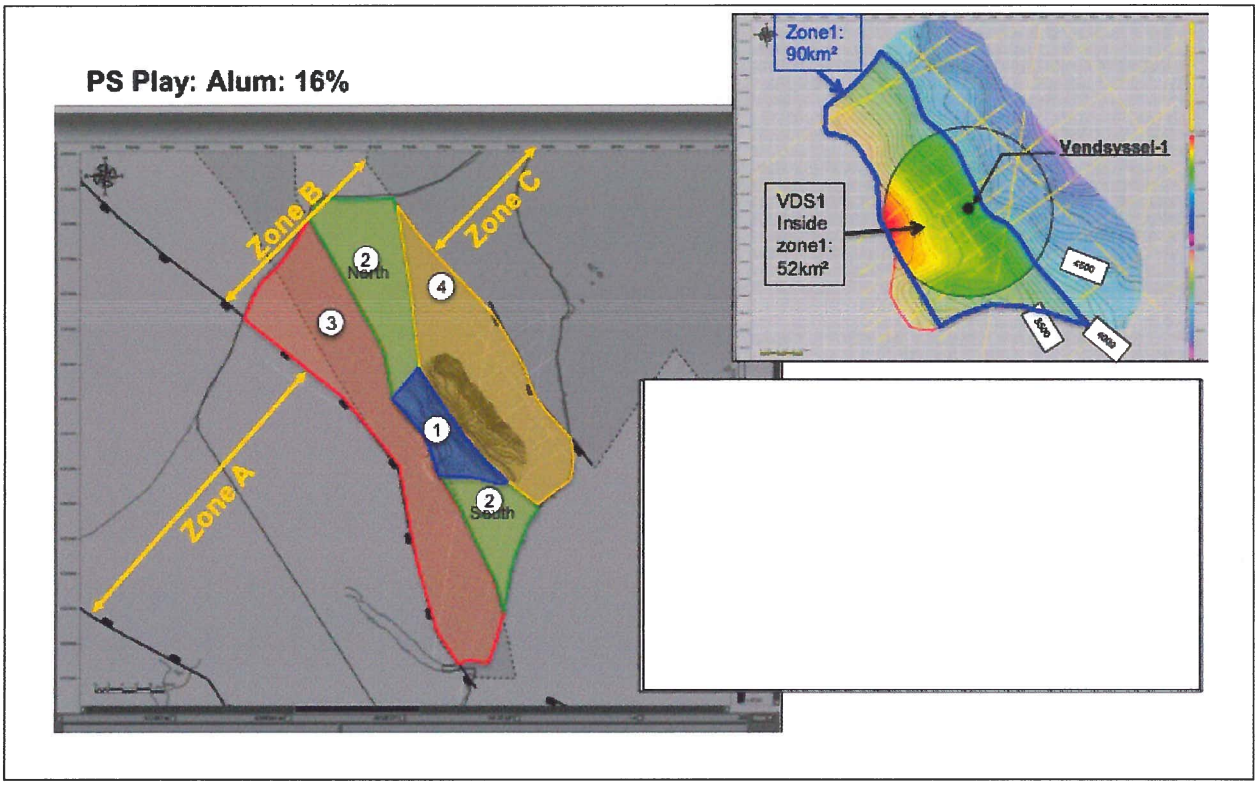
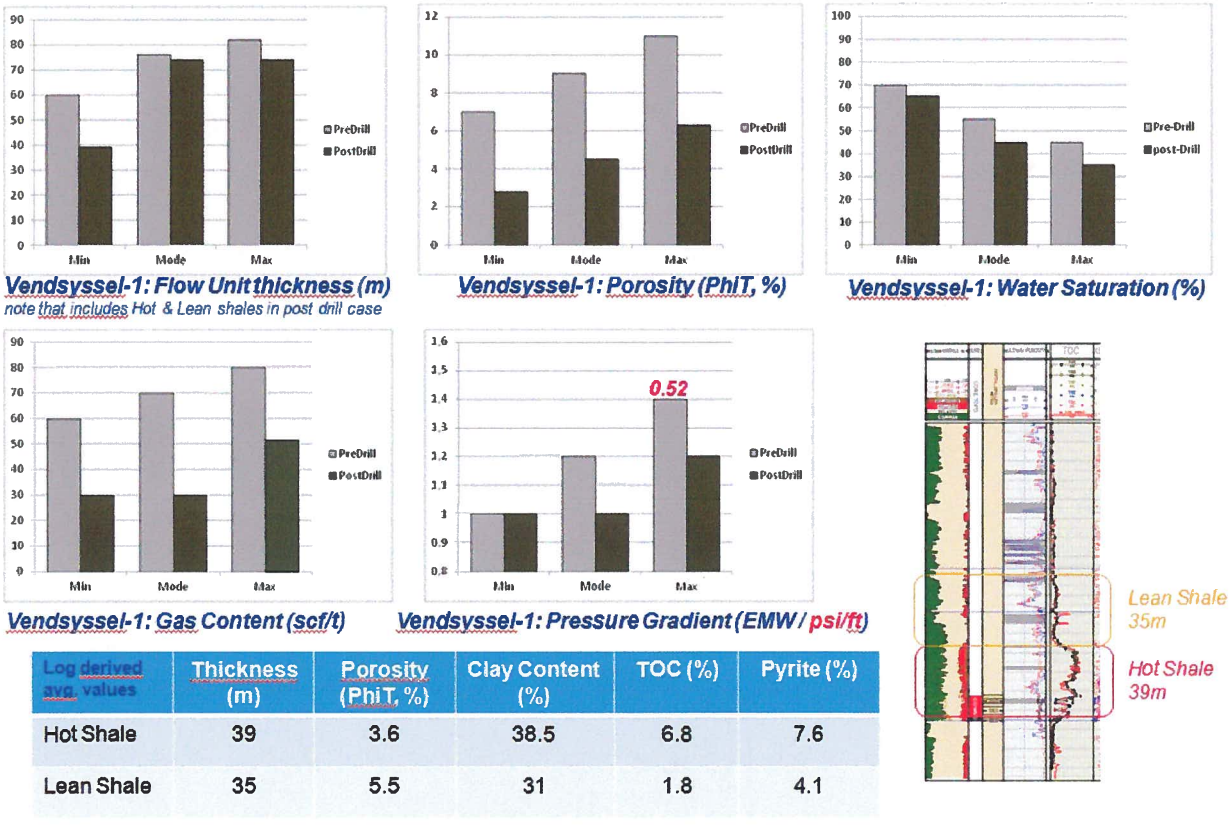



Figure 6 : L1/10 prospective area Zone B (1110 km²) and its subdivision into 4 zones




| Log derived avg. values | Thickness (m) | Porosity (PhiT, %) | Clay Content (%) | TOC (%) | Pyrite (%) |
|---|---|---|---|---|---|
| Hot Shale | 39 | 3.6 | 38.5 | 6.8 | 7.6 |
| Lean Shale | 35 | 5.5 | 31 | 1.8 | 4.1 |

Figure 7 : Key parameters for GIP computations