

Relinquishment Report

Licence P2024

Blocks 214/23, 214/24a, 214/28a,
214/29b

November 2016

JX Nippon Exploration and Production (U.K.) Limited

Idemitsu Petroleum UK Ltd.

ENGIE E&P UK Ltd

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1. Licence Information

Licence Number:	P2024
Licence Round:	27th Round
Licence Type:	Traditional seaward production licence
Licence award:	1st January 2013
Block Number:	214/23, 214/24a, 214/28a, 214/29b
Operator:	JX Nippon Exploration and Production (U.K.) Limited (40%)
Partner:	Idemitsu Petroleum UK Ltd. (30%) ENGIE E&P UK Ltd. (30%)

Block coordinates:

Block 214/23

61° 20'00.000''N 2°36'00.000''W
61° 20'00.000''N 2°24'00.000''W
61° 10'00.000''N 2°24'00.000''W
61° 10'00.000''N 2°36'00.000''W
61° 20'00.000''N 2°36'00.000''W

Block 214/24a

61° 20'00.000''N 2°24'00.000''W
61° 20'00.000''N 2°12'00.000''W
61° 15'00.000''N 2°12'00.000''W
61° 15'00.000''N 2°21'00.000''W
61° 10'00.000''N 2°21'00.000''W
61° 10'00.000''N 2°24'00.000''W
61° 20'00.000''N 2°24'00.000''W

Block 214/28a

61° 10'00.000''N 2°36'00.000''W
61° 10'00.000''N 2°24'00.000''W
61° 05'00.000''N 2°24'00.000''W
61° 05'00.000''N 2°30'00.000''W
61° 02'00.000''N 2°30'00.000''W
61° 02'00.000''N 2°36'00.000''W
61° 10'00.000''N 2°36'00.000''W

Block 214/28a

61° 10'00.000''N 2°24'00.000''W
61° 10'00.000''N 2°21'00.000''W
61° 05'00.000''N 2°21'00.000''W
61° 05'00.000''N 2°24'00.000''W
61° 10'00.000''N 2°24'00.000''W

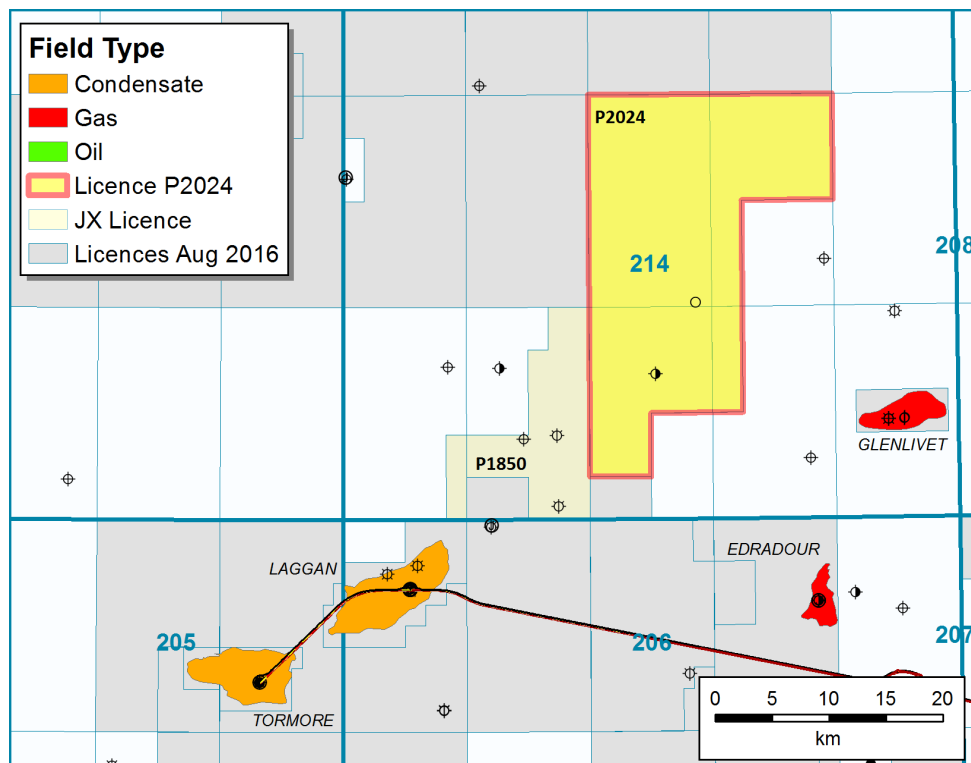


Figure 1 P2024 license location map

2. Licence Synopsis

Licence P2024 is located 75 km northwest of the Shetland Islands in water depths of c.a. 800m. The licence lies 20km northeast of the Total operated Laggan field and is adjacent to JX Nippon's operated P1850 licence (Figure 1). The P2024 licence was awarded to JX Nippon, Idemitsu and ENGIE (formerly GDF Suez) on the 1st January 2013 as a Traditional Licence and expires on the 31st December 2016.

The evaluation of the P2024 licence at the time of application identified multiple Vaila Formation prospects in T35-T34 aged sequences. The prospects are mainly stratigraphically trapped and identified on the basis of seismic anomalies, although the Loanan prospect is a structural trap with good amplitude/impedance conformance with depth structure.

The licence group elected to drill a well on the Loanan prospect (well 214/23-1) in May 2016. The well was drilled on a broad NE-SW elongated structural closure and encountered a gas bearing, 35ft gross T35.4 reservoir sand with good net:gross (0.70) and porosity (20%). Mobilities, however, were extremely poor (c. 1mD/cP). Post well analysis on cutting samples identifies diagenetic pore bridging/filling chlorite and illite as the culprits for the poor mobilities.

A volumetric re-evaluation of the resource potential of the Loanan discovery suggest it is significantly below MEFS (Minimum Economic Field Size) and remaining prospectivity on the licence has also been considerably downgraded following re-evaluation on the basis of the reprocessed PSDM seismic data. As a result, the licencees have elected not to continue the Licence into the second term.

3. Work Programme

The licence commitments consists of the following firm work programme,

- Shoot 360 sq. km of 3D Long Offset seismic data.
- Drill a well on the Loanan prospect to 4200m or 50m into the T20 sequence, whichever is the shallower.

In addition to completing the firm work programme, the licensees carried out the following studies:

- Biostratigraphy and sedimentology on offset wells to constrain reservoir stratigraphy, facies models and predictive reservoir quality models for the T35 sequence.
- Rock physics modelling to calibrate seismic attributes from the JX proprietary 3D seismic data to well control and derive predictive models for reservoir quality and fluid content.
- 1D fault seal study of the Loanan prospect to de-risk the seal element.

3.1 3D Long offset seismic

The licence group has acquired a proprietary 3D survey (JX123D0001) over the identified prospectivity in the P2024 and P1850 licences, covering an area of 660 sq km. The data has been processed to PSTM and used for final prospect interpretation. The JX123D0001 survey has also been reprocessed to PSDM and merged with 650 sq km of PGS MegaSurveyPlus data.

3.2 Drill or Drop Well

The licence group elected to drill a well on the Loanan prospect to test the Vaila sandstone play in May 2016. Due to operational and HSE reasons, the licence group were unable to test the deeper, secondary reservoir target and the well was prematurely P&A'd short of the commitment TD.

3.3 Inversion and Rock Physics Studies

In addition to the proprietary 3D survey (JX123D0001), PGS MegSurveyPlus data over most of the Flett sub-basin has been purchased to provide regional context. The JX123D0001 3D survey has been used for Pre-stack AVO inversion and covers the licence prospectivity along with the Laggan field wells, which is the geophysical analogue. Nine wells over the survey area were used for calibration and rock physics modelling.

3.4 Core Study

A sedimentological study on the cored Palaeocene Vaila sandstone in blocks 206/1, 214/27, 28, 29 has helped our understanding of the depositional, paragenetic and diagenetic aspects of T35-T20 sequences.

Following the drilling of the Loanan well in July 2016, a diagenetic and paragenetic study of all T35.4 sandstones was undertaken.

4. Database

The JX123D0001 3D survey has been used for detailed seismic interpretation and pre-stack AVO inversion. The PGS MegSurveyPlus data has been used to widen the interpretation and gain a regional understanding of the main sequences. The merged and reprocessed Q214 survey 3D PSDM has verified the structural interpretation and has been used to confirm depth prognosis during drilling operations. All the wells in blocks 206/1, 214/27, 214/28, 214/29 and 214/30 have been used for seismostratigraphic correlation, biostratigraphic and petrophysics analysis and integrated into an allostratigraphic framework. The seismic and well database is shown in Figure 2.

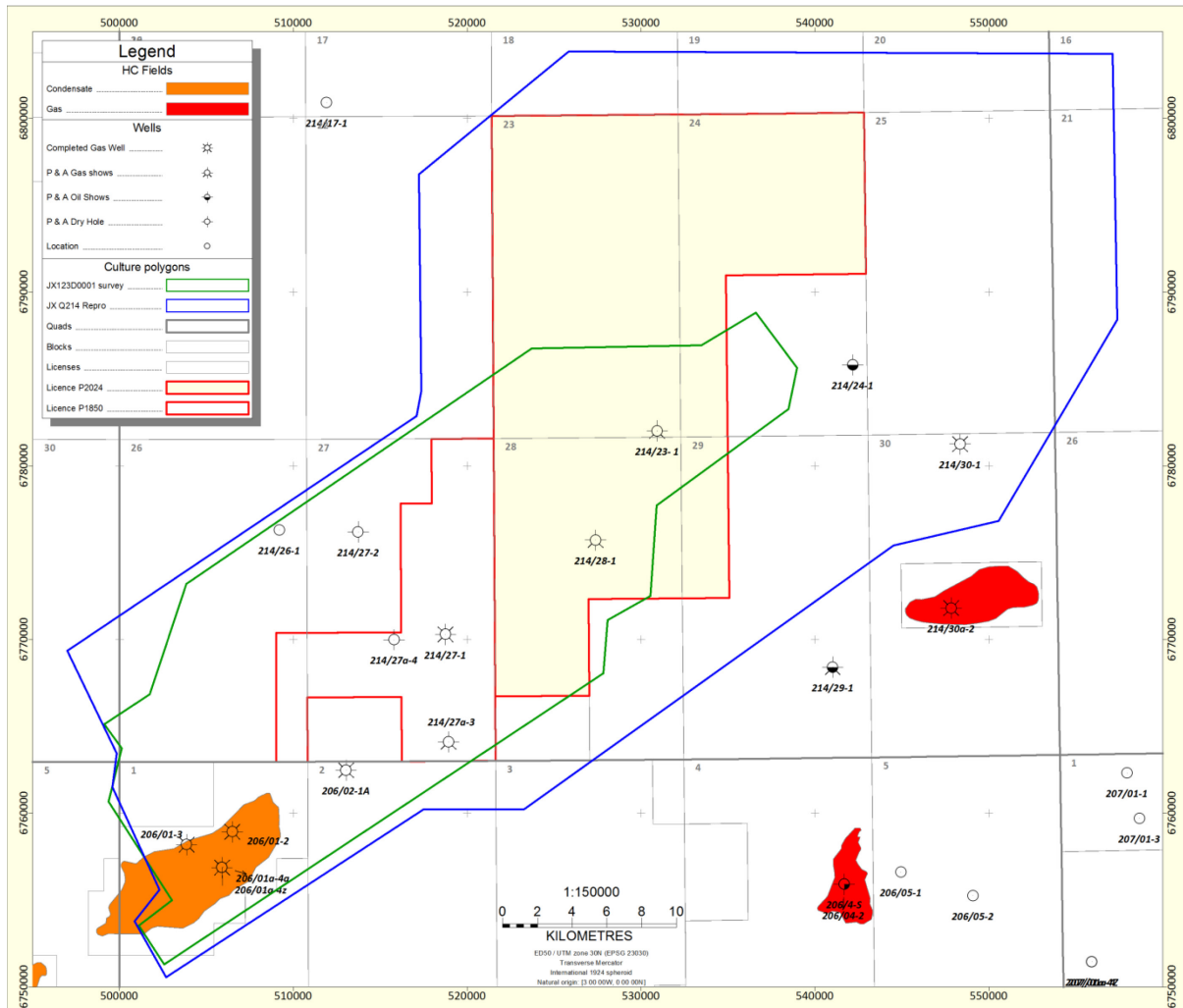


Figure 2 P2024 license location and database map

5. Prospectivity

A number of T35-T34 aged sandstone prospects have been identified in the P2024 licence and are shown in Figure 3. The work programme has assessed the validity of the T35-T34 prospects and high graded the T35.4 sequence in the basin on the basis of seismic and geological analogues with nearby discoveries, notably the Laggan–Tormore fields.

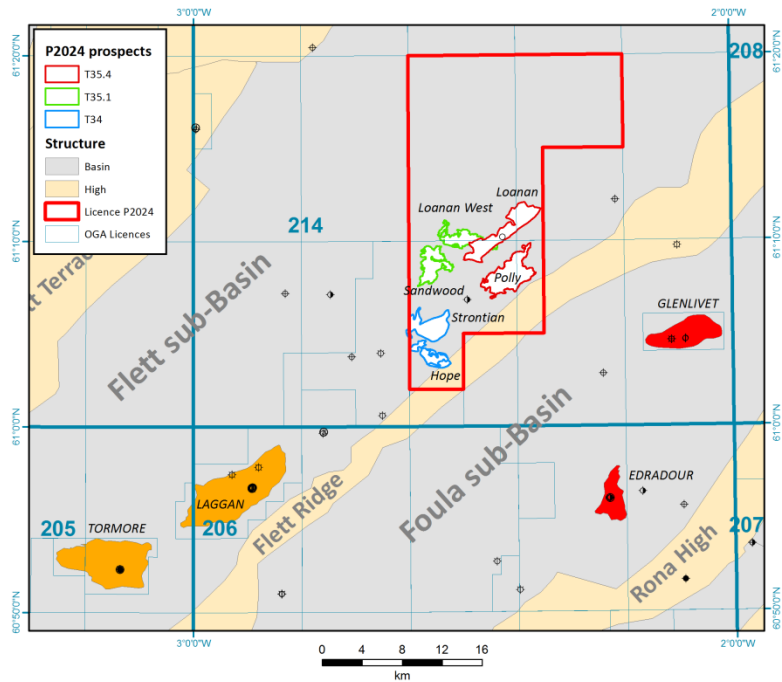


Figure 3 Palaeocene Vaila sandstone prospects in licence P2024 colour coded by T sequence

The Loanan prospect was high-graded to drillable status based on a robust petroleum system analysis and a high amplitude/low impedance seismic event which showed good conformance with mapped depth structure (Figure 4). The primary reservoir target (T35.4) is located in a robust four way dip closure (Figure 5) and positioned in a T35.4 sequence isochore thick. Importantly, the primary reservoir horizon target could be correlated to thin T35.4 sands in the two nearest offset wells (Figure 6) which had been poorly positioned on the edge of the sand fairway to test the play.

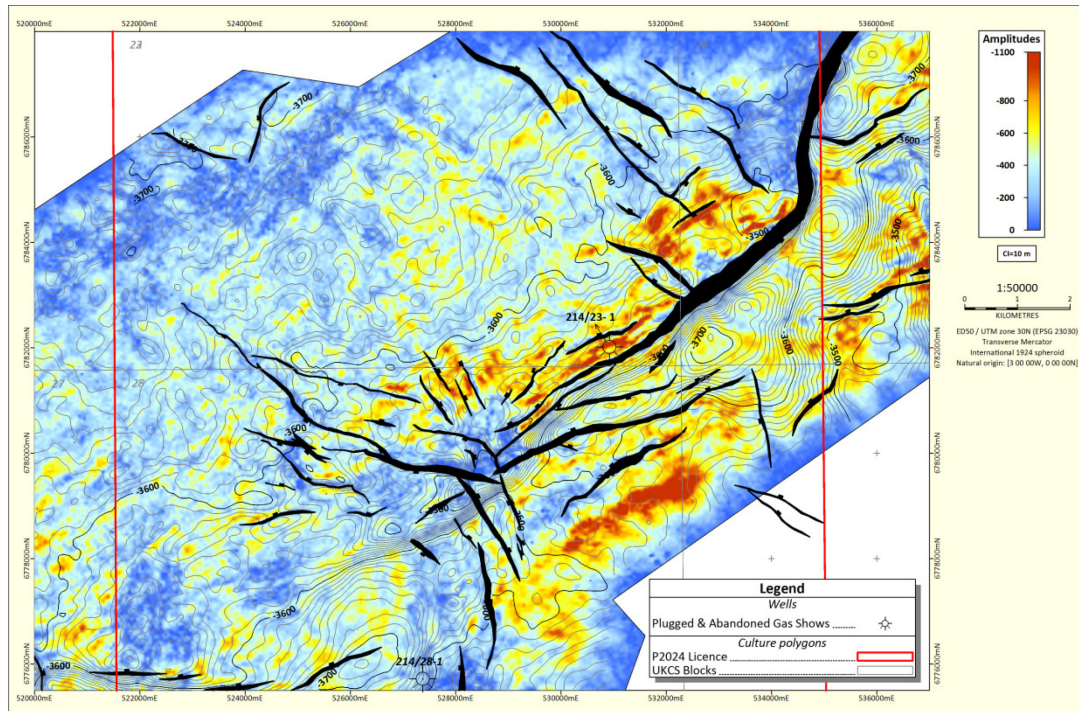


Figure 4 Full stack amplitude map extracted on the T35.4 horizon over the Loanan prospect with depth structure contours. Data: JX123D0001 seismic survey

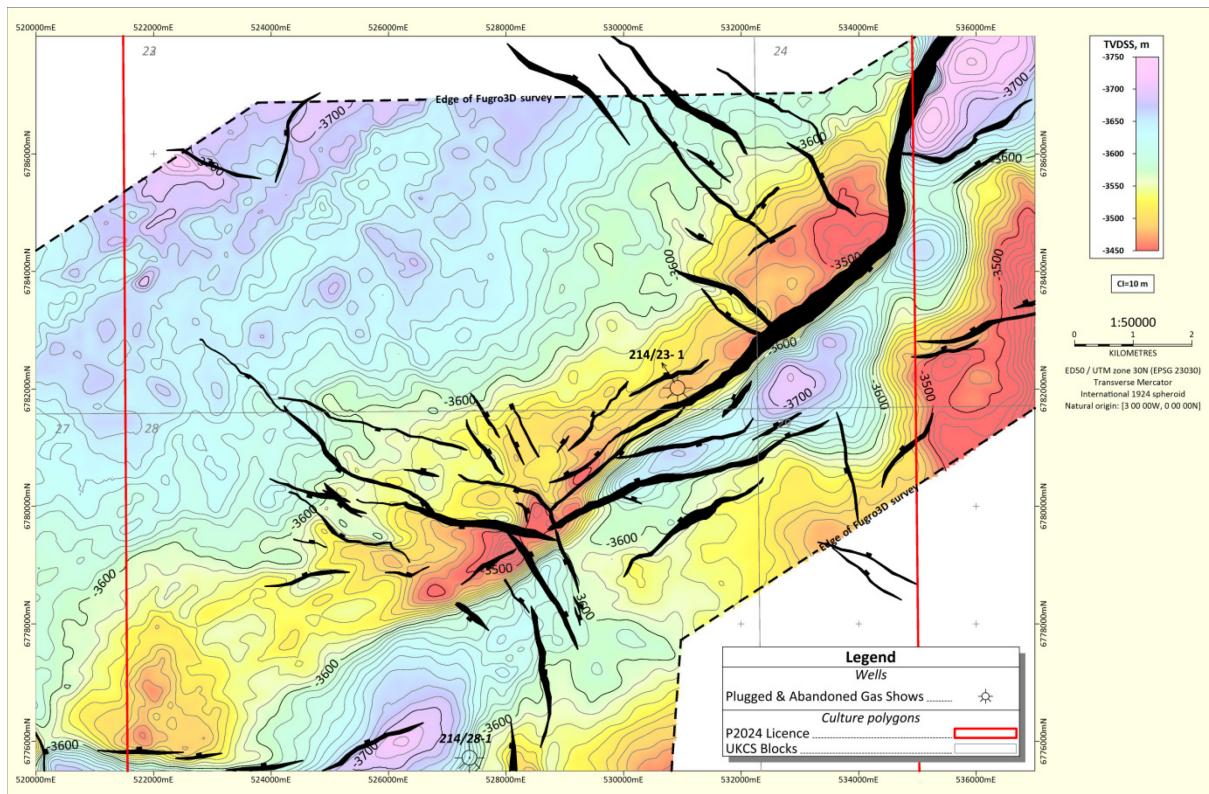


Figure 5 Top T35.4 reservoir depth structure map. Data: JX123D0001 seismic survey

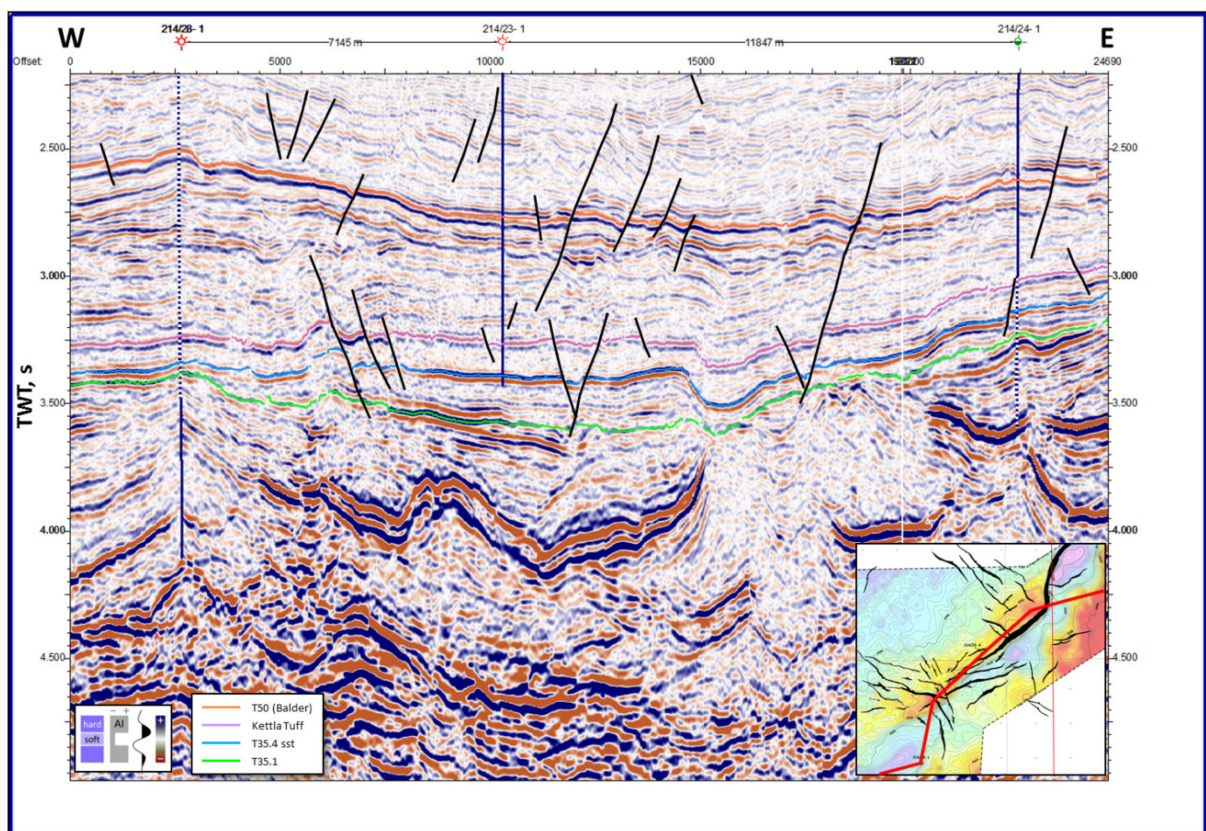


Figure 6 Arbitrary seismic line across the Loanan prospect and two nearest offset wells. Data: Reprocessed JX123D0001

The pre-drill volumes for the T35.4 sand were moderate ($P_{\text{mean}} = 61 \text{ MMboe}$) but the prospect was evaluated as being low risk (0.38 GCOS) and importantly, would de-risk nearby prospectivity.

The T35.1-T34 Vaila sequence sandstones formed a secondary, stacked objective although the Loanan well was not positioned to optimally test this deeper prospectivity. Unfortunately, the well did not reach the deeper reservoirs as the LOT taken below the base of the primary reservoir was insufficient to provide adequate kick tolerance should an overpressured dolerite sill be encountered near TD (the pre-drill risk was assessed as low but not negligible).

Additional T35.4 prospectivity is located updip of the Loanan prospect. The Polly prospect is a stratigraphic pinchout trap formed by the updip thinning and ultimate pinchout of the T35 sequence, shown to be absent in updip wells (e.g. 214/29-1). The prospect is located in a topographic low to the west of the 214/28-1 well, which encountered a thin T35.4 sand. In common with Loanan, the prospect has been mapped on the basis of low impedance response but shows poor conformance with mapped depth structure.

The remaining T35 (Sandwood) and T34 (Hope, Strontian) prospectivity is stratigraphic and again defined on the basis of high amplitude, low impedance events. However, the Sandwood prospect is difficult to separate from the water wet T35 sand in 214/28-1, whilst the T34 prospects are shown to be connected to ponded slope deposits updip via inferred siliciclastic channels on the reprocessed PSDM dataset.

6. Petroleum System

6.1 Source Rock

The most significant and widespread source rock within the Flett sub-basin is the Kimmeridge Clay Formation (KCF), which typically has moderate-high TOC and is predominantly of type II/III marine kerogen. HC generation is modelled as beginning in the Late Cretaceous with main gas generation in the early Tertiary. Maturity models calibrated to well-derived maturity indicators indicate that the KCF is over-mature below much of the Faroe-Shetland Basin at the present day and that the P2024 prospects will be gas charged.

6.2 Migration

All Palaeocene aged discoveries in the Flett sub-basin are concentrated along the eastern edge as a result of regional uplift of the Shetland Platform during the Neogene. In some cases, there is seismic evidence that deep seated faults have acted as hydrocarbon conduits (e.g. Torridon, Glenlivet discoveries).

In certain areas of the Flett sub-basin, there is evidence from gas peaks in mud log data that the edges of fractured dolerite intrusions may act as hydrocarbon migration pathways (e.g. 214/28-1; Rateau et al., 2013). This observation focussed the licence group's attention during the 27th licence round to prospects lying along the eastern edge of the basin which were directly overlying the edges of saucer shaped intrusions and is one of the reasons that the Loanan prospect was high graded in the prospect portfolio.

6.3 Reservoir

T35

The proven Palaeocene reservoirs in the Flett sub-basin are the Vaila Formation T20-T35 sequences. The T35.1-T35.3 age sandstones in the Laggan and Tormore fields form clean, blocky fine grained sandstones deposited as discrete fan lobes by amalgamated high density turbidite flows. Reservoir quality in these sands is good with average core porosities of 22% and average core permeabilities of 65 mD. Reservoir quality is linked to the presence of pore lining chlorite, which prevents widespread quartz cementation (Sullivan et al., 1999).

Seismic mapping has identified a series of structural lows with pinchout of younger T35 fan lobes against intra-basinal highs. These fan lobes belong to the T35.4 sequence, defined as the claystone dominated section between the top of the Laggan sand and the base of the Kettla Tuff Member, and are the basis of identified prospectivity. Although thick, T35.4 basin floor sandstones with good reservoir quality have been penetrated in well 205/9-1, wells have been poorly positioned to test the sequence and only thin sands have been logged e.g. 205/5a-1 ("Z" sand), 214/27-2, 214/27a-4, 214/24-1, 214/28-1 (Figure 7). Despite these wells penetrating the edge of the T35.4 sand fairway, log porosities are good (20%).

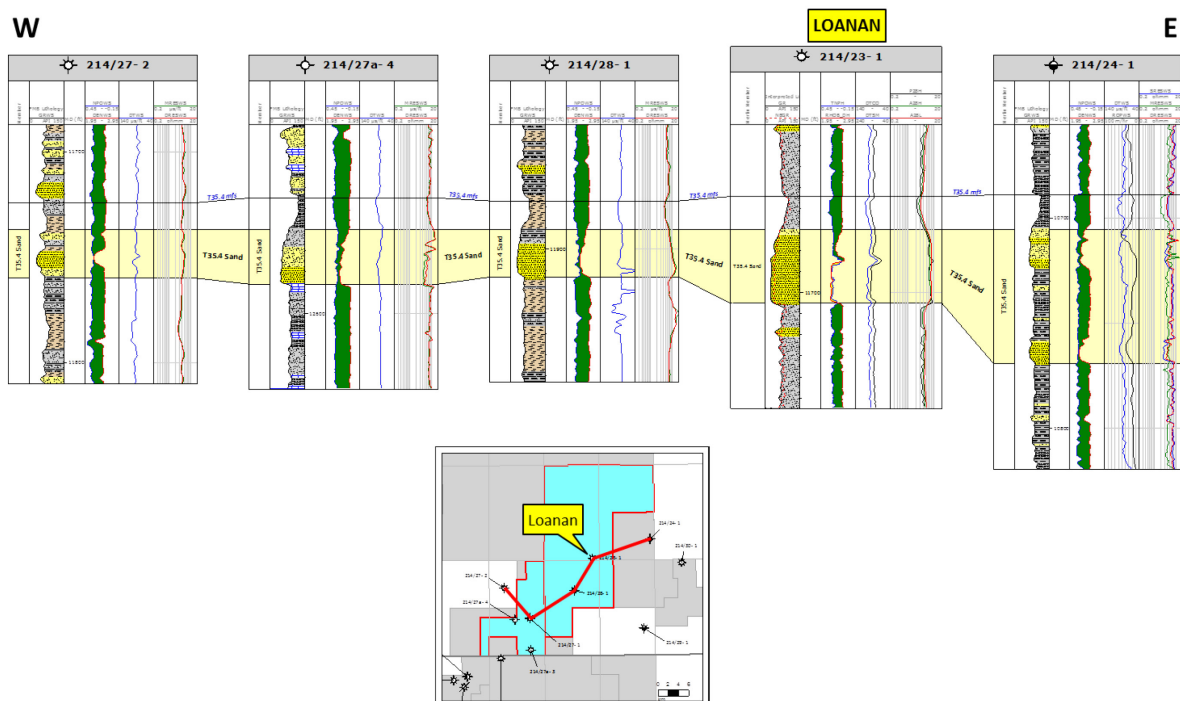


Figure 7 T35.4 sequence sand offset well correlation. Section flattened on Top T35.4 sand

The Loanan well (214/23-1) has been positioned to test the T35.4 play in an isochore thick along the central part of the sand fairway, where thicker and better reservoir quality would be expected. The well penetrated a 35ft section of blocky, very fine grained sandstone with good NTG (0.70), good porosity (average 20%), moderate hydrocarbon saturation ($S_w \sim 0.40$) but very low mobilities averaging around 1 mD/cP (). Although the pressure and sampling programmes were unable to confirm hydrocarbon type, the optical fluid analyser suggested a dry (lean) gas was flowing during the attempted fluid sampling run.

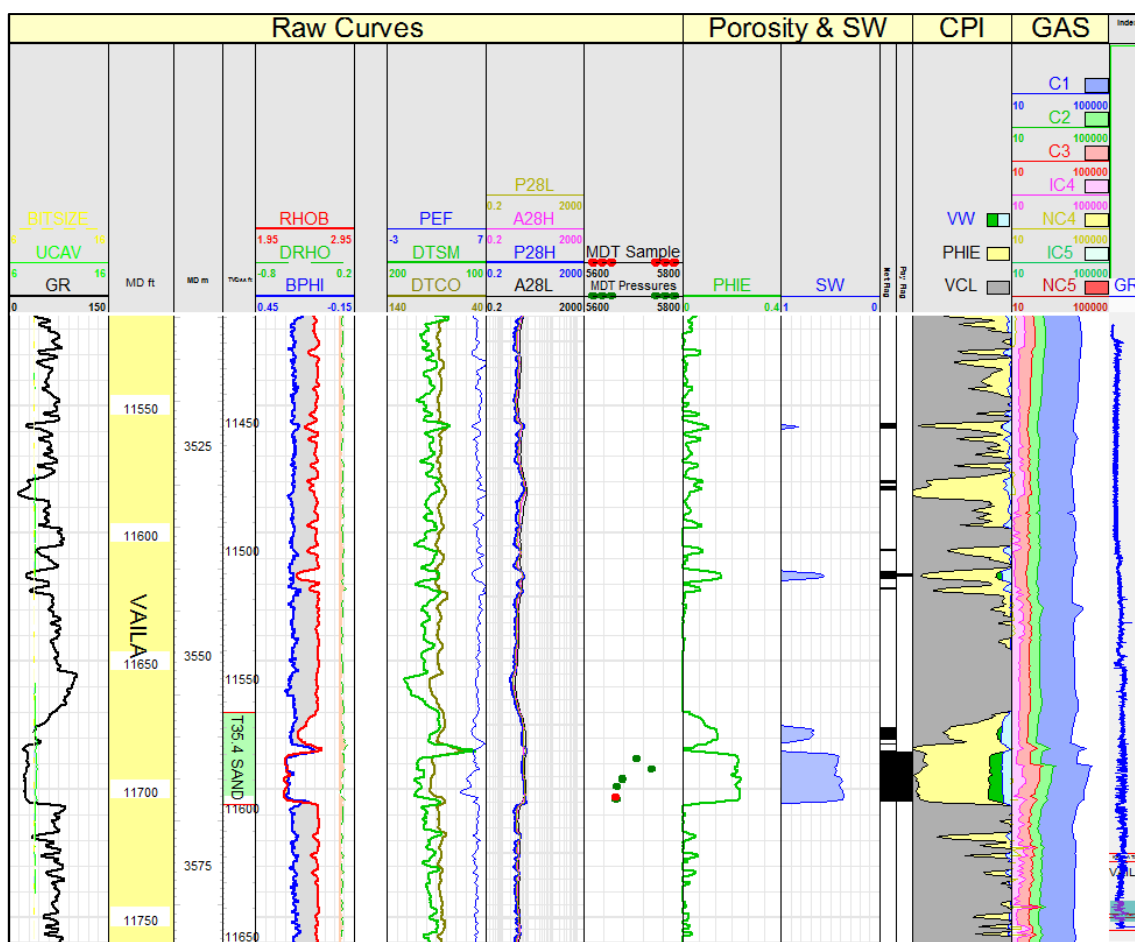


Figure 8 Petrophysical CPI over the T35.4 reservoir section

Post well studies show that although pore lining chlorite is present throughout the T35.4 reservoir limiting quartz overgrowths, pore bridging/filling chlorite and minor fibrous illite form significant antigenic cements reducing permeability.

T34

The older T34 fairway is locally developed in blocks 214/24, 27, 28, 29 as a series of deep-water fans systems deposited in basin floor and complex slope settings. Cored sections reveal the T34 fan sequence to be made up of amalgamated, fine-medium grained, massive sandstones deposited by high density turbidity currents.

With the exception of the T34 sands at shallow burial depths (214/29-1, 214/30-1), reservoir quality is generally poor due to lack of pore lining chlorite and has resulted in compaction and the formation of quartz cements.

6.4 Trap

The quality of seismic data is good and depth conversion uncertainty is considered small due to nearby well control and relatively straightforward layer-cake stratigraphy.

The Loanan prospect is a robust, NE-SW orientated, four way dip anticline in both time and depth at the T35.4 reservoir, with an areal closure of c. 40 sq km.

The remaining T35 and T34 prospects are stratigraphic and rely on pinchout of the sands inferred from amplitude/impedance decay or demonstrable thinning and onlap of sequences.

6.5 Seal

The T35 basin floor fan sandstones, which form the primary reservoir objective in the Flett Sub-basin, are overlain by a regionally extensive highstand system mudstone sequence (T35.4 mudstone or V4 Upper Vaila Fm. mudstone) which forms an effective regional pressure seal separating normally pressured Lamba Formation from over-pressured Vaila sandstones below.

The top seal to the T34 basin floor sandstones is indicated by the development of a thin (30-100ft) but laterally continuous highstand shale.

Base seal in both sequences is provided by intraformational mudstones within individual fan sequences.

7. Additional Technical Work

In addition to the petroleum system evaluation, the licence group has undertaken rock physics, core studies, biostratigraphic and fault seal analysis studies, which have reduced fluid type uncertainty and charge risk and also resulted in greater confidence in fault seal efficiency.

7.1 Rock Physics and Inversion

Rock physics has been carried out on ten wells surrounding the P2024 licence and overall log data quality is good, with four wells containing sonic shear data. Seismic well ties show that the top of the T35.4 reservoir is an acoustically soft seismic event, in common with good quality T35 reservoirs elsewhere in the basin. Fluid substitution and AVO (amplitude variation with offset) modelling also shows that the majority of wells containing T35 sands have a class IV response and that the introduction of hydrocarbons causes a general brightening across the entire offset range. Wedge modelling using the Laggan and Tormore discovery wells suggests that the maximum tuning thickness for the T35 reservoir is c. 40m. In both fluid substituted models using gas, the fluid effect is stronger than the tuning effect.

The Loanan well encountered a gross reservoir thickness of 11m suggesting that it is within tuning but at the lower end of the tuning curve. Even at these thicknesses the change in amplitude with gas supports the hypothesis that amplitudes at the T35.4 reservoir level should brighten by a factor of two in the presence of a gas bearing reservoir versus a brine bearing sand (Figure 9).

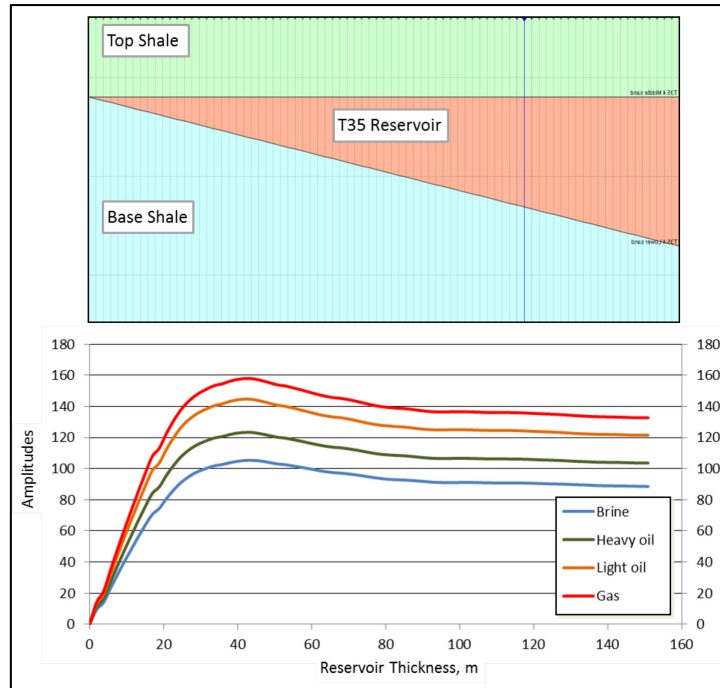


Figure 9 Wedge modelling of T35 sands based on a blocky model

The Lambda Rho attribute separates gas and brine sands more successfully than Vp/Vs. In combination with the far stack amplitudes, a Lambda Rho cube has highlighted sweet spots within the T35.4 sequence (Figure 10).

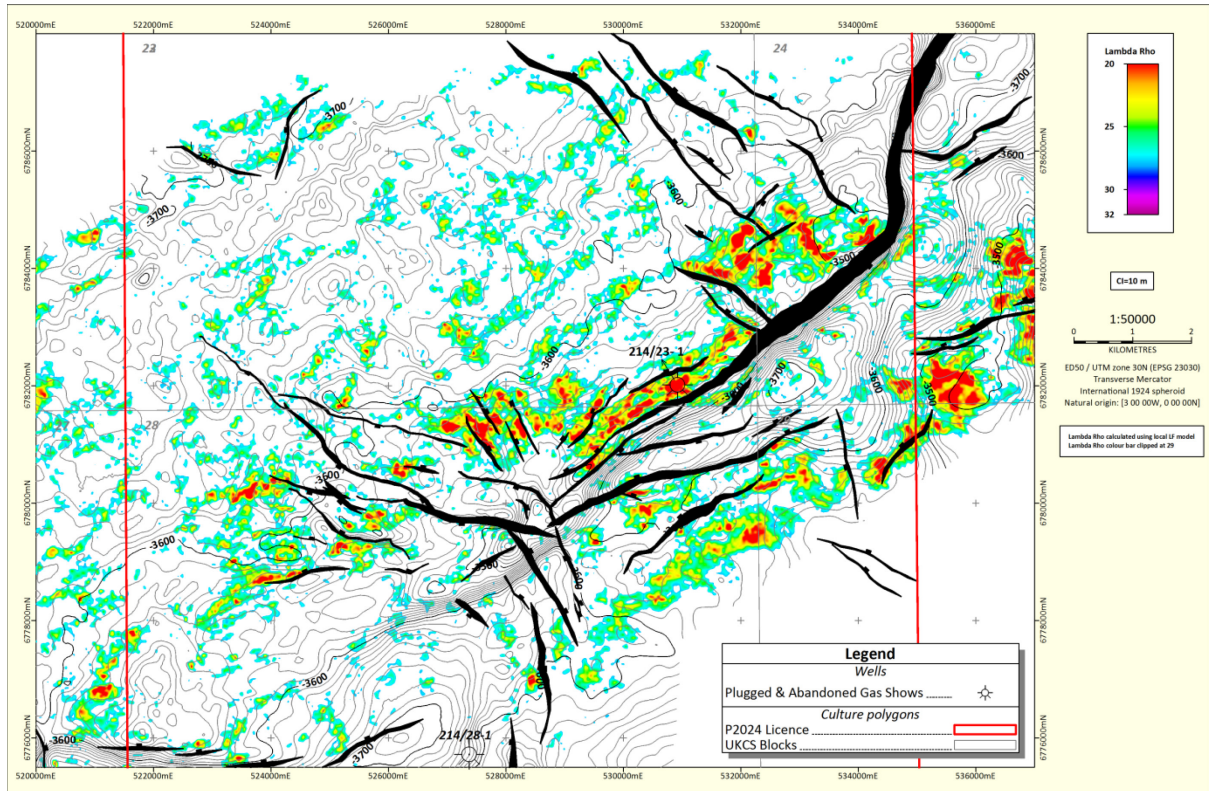


Figure 10 Lambda Rho fluid volume (RMS ± 25 ms window) for the T35.4 horizon with depth structure contour (CI=10m).

8. Resource and Risk Summary

Based on the prospect evaluation and results of the Loanan well, GIIP and risk are summarized below (Table 1).

	Total Pmean GIIP, Bcf	GPOS
Loanan	97	1.00
Loanan West	300	0.24
Polly	94	0.25
Sandwood	317	0.10
Strontian (T34)	274	0.09

Table 1 Summary table of prospect GIIP based on a gas case scenario

9. Conclusions

The work programme has evaluated the prospects identified in the 27th Round Application and highgraded the Loanan prospect to drill ready status. The Loanan well was drilled in May 2016 and tested the T35.4 sandstone play, encountering 35ft of gross reservoir section, with moderate gas saturation. Unfortunately, the reservoir thickness and quality were below pre-drill expectations and significantly below MEFS. A re-evaluation of the remaining T35.4 prospectivity suggests that similar aged prospects will also be below MEFS.

The remaining T35-T34 prospects are stratigraphic and have been downgraded on the basis of the reprocessed seismic data. The prospects are either difficult to separate from offset wells known to contain water wet reservoir sands, have no amplitude conformance with structure or can be shown to be connected to high density turbidites in ponded, complex slope settings.

Both reserves and GPOS have been downgraded compared to the pre-award evaluation. As a result, with current economic assumptions, the prospects are considered commercially unattractive. The licence group have therefore decided to relinquish the P2024 licence.

10. Clearance

This report has been approved for publishing by JX Nippon Exploration and Production (U.K.) Limited, Idemitsu Petroleum UK Ltd and ENGIE E&P (UK) Ltd.

11. Data Release

Digital well data, along with sedimentological and geochemical post well studies have been released through the CDA portal.

12. References

Rémi, R., Schofield, N. & Smith, M. 2013. The potential role of igneous intrusions on hydrocarbon migration, West of Shetland. *Petroleum Geoscience*, **19**, 259–272.