UKCS Licence P1968, Blocks 2/10a, 3/6a and 3/11c
Relinquishment Report
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1 Introduction

This report documents the relinquishment of licence P1968, UK Blocks 2/10a, 3/6a and 3/11c, awarded to EnQuest Heather Ltd in the UK 27th licence round. The location and extent of the licence area can be seen in Figure 1; a brief summary of the licence is presented in Table 1.

<table>
<thead>
<tr>
<th>Licence Number</th>
<th>P1968</th>
</tr>
</thead>
<tbody>
<tr>
<td>Licence Round</td>
<td>27th</td>
</tr>
<tr>
<td>Licence Type</td>
<td>Traditional</td>
</tr>
<tr>
<td>Block Number(s)</td>
<td>2/10a, 3/6a and 3/11c</td>
</tr>
<tr>
<td>Operator / Partners (%)</td>
<td>EnQuest Ltd (100%; operator)</td>
</tr>
</tbody>
</table>

Table 1: Licence Summary

![Figure 1: Licence P1968 Location](image-url)
2 Licence Synopsis

The P1968 licence was awarded 100% to EnQuest in the 27th UK offshore licence round with a start date of the 1st of January 2013. At the time of application nine leads were identified within the application area. The Eocene, Palaeocene, Cretaceous and Jurassic within the three blocks were all evaluated.

Post award evaluation continued, on the 11th of November 2014 a partial relinquishment of the licence was carried out with the non-prospective areas to the north relinquished. This focused the evaluation to south of the licence area around the Cheviot Field.

The Cheviot Field (originally called the Emerald Field) was discovered in 1978 by exploration well 2/10a-4 and was subsequently appraised by a further five wells drilled between 1981 and 1985. The field came on stream in 1992 as an 18 well development but was abandoned in 1996 due to high water cut and low oil price, with the acreage subsequently being relinquished. This initial development recovered a cumulative 16 MMstb of oil, only 7% recovery of the 232 MMstb oil in place estimated at the time plus 25 Bcf of gas.

ATP Oil & Gas (UK) Limited subsequently acquired Emerald (renaming the field Cheviot) in the 21st Licensing Round in 2003, with a plan for a standalone 'Octabuoy' facility (with storage/offshore oil loading to tanker). However, after ATP UK’s parent company got into financial difficulties, Alpha Petroleum Resources acquired ATP UK and now hold the Cheviot Field 100%. A development concept study is underway, with planned first oil quoted to be in Q3 2018. The oil is of low gravity (approximately 23° API) with a high TAN number (2.9) it cannot be exported via the regional oil pipeline system to the Sullom Voe Terminal (SVT). Gas evacuation was expected to be via pipeline to tie into Total's Alwyn North to St Fergus pipeline.

EnQuest attempted to farm down the P1968 licence in 2014/2015 with a data-room held for interested parties. Unfortunately, due to the low oil price environment there was no offers made and the licence was determined on the 25th of September 2015.
3 Work Programme Summary

Work programme Firm Commitment

The Licensee shall:

a) Obtain 160km² of 3D seismic data; and  
b) Carry out enhancement and inversion, Rock Physics and AVO work and a Reservoir Diagenesis study

Drill-or-drop

The Licensee shall either:

a) Drill one well to 3050m or to the Pre-Cretaceous, whichever is the shallower, or:
   b) Elect to allow the licence to automatically cease and determine pursuant to Clauses 3 and 6

The firm work programme of enhancement, inversion, rock physics and AVO work are complete. This in conjunction with an evaluation of reservoir quality has led to the decision to relinquish the licence.

Section 6, Further Technical Work Undertaken (page 18) provides more detail on the work carried out.

4 Database

4.1 Well Database

EnQuest had access to an extensive well database in this region as shown in Table 2, which includes well reports, composite logs and wireline log data. All the relevant released well data in the surrounding acreage was acquired from CDA and analysed.
<table>
<thead>
<tr>
<th>Well</th>
<th>Year Drilled</th>
<th>Status</th>
<th>Target</th>
<th>TD Formation</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/10-1A</td>
<td>1974</td>
<td>Suspended oil well</td>
<td>Mid Jurassic Dogger Sands</td>
<td>Mid Jurassic?</td>
<td>HC bearing Jurassic sands were present. Pay horizon is most likely Callovian/Bathonian and could be stratigraphically higher than the main Dogger or Brent sands of adjacent fields.</td>
</tr>
<tr>
<td>2/10a-2</td>
<td>1975</td>
<td>P&amp;A dry hole</td>
<td>Mid Jurassic Sands</td>
<td>Triassic breccia</td>
<td>621ft gross sandstone no significant shows</td>
</tr>
<tr>
<td>2/10-3</td>
<td>1975</td>
<td>P&amp;A with oil shows</td>
<td>Mid Jurassic Sands</td>
<td>Mid Jurassic Bajocian</td>
<td>Bajocian sandstone present with strong oil show. 6 DST's failed to establish oil production, below 11,585 formation water with traces of oil were recovered. Intervals with shows during drilling and coring only produced gas cut mud.</td>
</tr>
<tr>
<td>2/10a-8</td>
<td>1984</td>
<td>P&amp;A</td>
<td>Mid Jurassic Brent Sands</td>
<td>Basement</td>
<td>No significant oil or gas shows were encountered</td>
</tr>
<tr>
<td>2/10b-9</td>
<td>1984</td>
<td>P&amp;A</td>
<td>Primary Mid Jurassic Sands and Secondary Palaeocene</td>
<td>Basement</td>
<td>No significant oil or gas shows were encountered. No Jurassic Sands</td>
</tr>
<tr>
<td>3/6a-1</td>
<td>1896</td>
<td>P&amp;A dry hole</td>
<td>Mid Jurassic Brent Sands</td>
<td>Cormorant</td>
<td>Dry Brent sands</td>
</tr>
<tr>
<td>3/7-3</td>
<td>1977</td>
<td>P&amp;A</td>
<td>Mid Jurassic Brent Sands</td>
<td>Cormorant</td>
<td>36ft oil column in Broom sands</td>
</tr>
<tr>
<td>3/7b-6</td>
<td>1986</td>
<td>P&amp;A</td>
<td>Primary Brent Sands, Secondary Statfjord Sands</td>
<td>Cormorant</td>
<td>Brent sands absent, thin Statfjord</td>
</tr>
<tr>
<td>3/7a-7</td>
<td>1991</td>
<td>P&amp;A dry hole</td>
<td>Middle Jurassic Brent Sands</td>
<td>Cormorant</td>
<td>Primary target Brent sands absent. U Jurassic predominantly argillaceous.</td>
</tr>
<tr>
<td>3/7a-8</td>
<td>2005</td>
<td>P&amp;A</td>
<td>Middle Jurassic Brent Sands</td>
<td>Dunlin Gp</td>
<td>Poorly sorted sands</td>
</tr>
<tr>
<td>3/12-2</td>
<td>1977</td>
<td>P&amp;A oil well</td>
<td>Middle Jurassic Brent Sands</td>
<td>Cormorant</td>
<td>Rec 5.9l of light oil GOR 11200 38.5*API 7326psi</td>
</tr>
<tr>
<td>3/12b-4</td>
<td>1992</td>
<td>P&amp;A</td>
<td>Middle Jurassic Brent Sands</td>
<td>Triassic New Red Group</td>
<td>Original well side-tracked due to stuck BHA. Middle Jurassic Sandstone absent</td>
</tr>
</tbody>
</table>

Table 2: Offset well data summary
Figure 2: Well Database Map
4.2 Seismic Database

The PGS Megamerge, PGS MC3D_NVG2005_Nuggets, reprocessed Heather 3D, and the WesternGeco 1997 Aidan 3D, were all used to define the regional setting. The original TGS-Nopec ESB2000 and its reprocessed 2009 version were used for the block specific detailed mapping.

At the time of application EnQuest had access to a portion of the ESB2000 survey reprocessed in 2009, predominantly over the 3/11 block to the south. As part of the work programme we obtained the 165.7 sq km portion of the 2009 reprocessing over Blocks 2/10a and 3/6.

The 3D seismic database that EnQuest has used over this licence for this evaluation and application is detailed in Table 3.

<table>
<thead>
<tr>
<th>Survey Name</th>
<th>Volume Description</th>
<th>Year</th>
<th>Licence Areas Covered</th>
<th>Overall Coverage (Km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGS MegaMerge</td>
<td>Released full stack data</td>
<td>-</td>
<td>2/10a, 3/6 &amp; 3/11c</td>
<td>167</td>
</tr>
<tr>
<td>WesternGeco 1997 Aidan 3D</td>
<td>Full Stack</td>
<td>1997</td>
<td>3/6 &amp; 3/11c</td>
<td>252</td>
</tr>
</tbody>
</table>

Table 3: Seismic Data Summary
Figure 3: Seismic Database
5 Prospectivity Update

This is a mature and established area of the Northern North Sea and a significant amount of previous work has been performed on the area. As part of the original licence application EnQuest evaluated the prospectivity within blocks 2/10a, 3/6 and 3/11c identifying nine leads.

<table>
<thead>
<tr>
<th>Lead Name</th>
<th>Age</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monarch</td>
<td>Middle – Upper Jurassic</td>
<td>Emerald sandstone prospect within block 3/6.</td>
</tr>
<tr>
<td>Swallowtail</td>
<td>Upper Jurassic</td>
<td>Deep marine turbidite, stratigraphic pinch out trap</td>
</tr>
<tr>
<td>Brimstone</td>
<td>Lower Cretaceous</td>
<td>Stacked Lower Cretaceous wedge containing high amplitudes</td>
</tr>
<tr>
<td>Cardinal</td>
<td>Lower Cretaceous</td>
<td>Channel fan system</td>
</tr>
<tr>
<td>Emperor</td>
<td>Eocene</td>
<td>Dornoch sands stratigraphic trap</td>
</tr>
<tr>
<td>Caterpillar</td>
<td>Eocene</td>
<td>Elongate east-west mounded channel like feature</td>
</tr>
<tr>
<td>Admiral</td>
<td>Eocene</td>
<td>Dornoch sands channel feature, stratigraphic trap</td>
</tr>
<tr>
<td>Peacock</td>
<td>Palaeocene</td>
<td>Small amplitude supported compaction feature within the Balder/Dornoch</td>
</tr>
<tr>
<td>Copper</td>
<td>Upper Jurassic</td>
<td>Deep marine fan system, stratigraphically trapped</td>
</tr>
</tbody>
</table>

Table 4: Previously identified prospectivity

Following award of the licence and subsequent evaluation the key prospectivity was limited to Monarch, Brimstone and Peacock. The following section will discuss these in more detail.
5.1 Monarch

Monarch is a Middle to Upper Jurassic Emerald sandstone prospect located within Block 3/6.

The trap is a downthrown rotated fault block trap immediately to the northeast of the Cheviot Field.

The Cheviot Field, previously known as Emerald, is an elongate dip and fault closed structure where the Middle Jurassic “Emerald Sandstones” provide the reservoir. These are a homogeneous transgressive unit of Callovian to Bathonian in age, which is underlain by tilted Precambrian and Devonian Basement horst blocks.

The Middle Jurassic Emerald Sandstone also provides the reservoir in Monarch. There is some uncertainty over reservoir quality and thickness, which varies across the study area. However, seismic character suggests the reservoir properties are similar to those seen in the Cheviot Field. In Cheviot, the reservoir had excellent reservoir qualities with porosities averaging 28% and permeabilities in the range of 0.1 to 1.3 darcies. Where the sandstone is hydrocarbon bearing the net to gross was close to 100%. The Emerald sandstone thins and pinches out to the west (into the fault) and to the south (onto the platform). The exact limit of the sand is unknown due to data resolution and lithological and seismic character changes further to the southeast. A southern extension into a small graben is mapped, this may be linked to Monarch or it may be a separate accumulation, dependant on the sand pitchout position versus spill point.

The Late Jurassic siltstones and shales of the Heather and Kimmeridge Clay Formations overlie the reservoir and are believed to provide the vertical seal. The major fault on the western side of Monarch is required to seal.

The source for the prospect, like the Cheviot Field, would be primarily from the Kimmeridge Clay formation on the flanks of the Graben area to the east. In the Cheviot field, the oil contains a dominant biodegraded component mixed with smaller amounts of lighter gravity oils and gas.

Due to the size and location of the Monarch lead, drilling it as part of a Cheviot Field development would be the optimal solution. Alpha Petroleum plan to develop the Cheviot field along with the two satellite discoveries Peel and Padon. It is stated that it is their intention to look at using the Cheviot facility as a hub for other nearby discoveries.
Figure 4: Monarch Structure Map (Depth to Top Emerald Sandstone. C.I. 25ft)

Figure 5: Seismic Line through Monarch
5.2 Brimstone
The Brimstone lead is located in the southern part of block 3/6. The lead is a stacked Lower Cretaceous wedge containing high amplitudes interpreted to contain Lower Cretaceous deep marine sandstones sourced from the East Shetland Platform or the Transitional Shelf immediately to the south.

Brimstone is a 3-way dip closed stratigraphic pinch-out trap (Figure 6), seismically defined by mapping the BCU to K30 envelope and then internally mapping the high amplitude K10 peak and K20 trough. It is essentially a stacked sandstone stratigraphic up dip pinch-out trap, the shales of the Kimmeridge Clay Formation and overlying Lower Cretaceous muds and marls provide the base and lateral seal.

The reservoir parameters were defined by using analogue data from the Outer Moray Firth Scapa field. It is predicted that if present, the Lower Cretaceous Brimstone sands would be at a depth of approximately 10,200ft, which may lead to some reservoir quality concerns. The critical factors associated with this lead are reservoir presence and effectiveness. Thick good quality Lower Cretaceous sandstones have not been encountered in this sub-basin and the high amplitude events may simply be tight cemented sands, silts and carbonates.

The main risk is reservoir presence and quality and the secondary risk is trap. The trap has been defined on seismic anomalies, some or all of which may be tuning effects.

![Figure 6: Brimstone Structure Map (Depth to Top Aptian. C.I 50ft)](image-url)
Figure 7: Seismic line through Brimstone
5.3 Peacock

The Peacock lead is a 4-way dip closed anticline with amplitude/AVO support (Figure 8 and Figure 9). The seismic stack amplitude data shows clear conformance of amplitude with structure indicating the likelihood of trapped hydrocarbons. The PSTM gathers also show a clear brightening of amplitude with offset at Balder level (Class III AVO) indicating the presence of gas (Figure 10).

The lead is interpreted to contain deep marine channel sandstones of the Balder/Dornoch Formation, sourced from the transitional shelf immediately to the west.

The mature Kimmeridge Clay provides the source. Oil rims are present in the down-dip nuggets fields and hydrocarbon shows exist in up-dip wells. It is proposed that the oil has migrated up through the Palaeocene sand prone channel system.

The Lista and Balder formation shales provide both lateral and vertical seal.

Figure 8: Peacock Structure Map (Depth to Base Balder Event C.I 25ft)
Figure 9: Peacock Amplitude Map (White outline Peacock P50)

Figure 10: Balder Level PSTM Gather Response

- Seismic stack amplitude data shows clear conformance of amplitude with structure indicating the likelihood of trapped hydrocarbons.
- PSTM gathers show clear brightening of amplitude with offset (Class III AVO) at the Balder level.
Figure 11: Seismic Line through Peacock
6 Further Technical Work Undertaken

EnQuest carried out testing on the newly obtained seismic to evaluate options for further data enhancement. The selected options combined both random (Tdiffusion) and coherent (Structurally Orientated Filtering) noise reduction. These edge-preserving techniques enhanced interpretation quality without compromising geologic structure and faulting.

![Image](image1.jpg)

Figure 13: Data conditioning of original (left) data enhanced signal to noise (right)

Subtle channels and faulting were ambiguous in the original data. Spectral Decomposition generates high-resolution images from blends of discrete frequency slices. The RGB enhanced visualization provided sharper definition of the thin layer spatial variation resulting from faulting and channel development.

![Image](image2.jpg)

Figure 14: Basement RGB Colour Blend used to aid interpretation of structural development

A good match observed between synthetic seismic forward modelling and the seismic traces indicates the data was reliable. Gas is easily discernible in the section as a strong Class III anomaly.

![Image](image3.jpg)

Figure 15: Full Stack section compared to 2D Simulation Model across 2/10a-10, 2/15-1, 2/10a-7 and 3/11b-7
Inversion of the seismic increases resolution and reliability of the data, improving estimation of rock and fluid properties. Coloured inversion of the seismic shapes the mean amplitude spectrum to the mean impedance spectrum from wells, creating a bandlimited impedance dataset (Lancaster and Whitcombe (2002)). Coordinate rotation of the Gradient and Intercept impedance volumes over a range of Chi angles to give Extended Elastic Impedance optimised against the wells for Lithology and Fluid discrimination. Although inversion results were encouraging no shear sonic information was available to QC or control the EEI inversion and lower the risk of the inversion.

Figure 16: EEI Fluid Volume and Attribute RMS Amplitude Mapping over Peacock and Caterpillar

Lithological discrimination is only mildly improved over the original full stack data however there is still overlap of the sands and shale in the P-impedance sections. Fluid discrimination is optimised in the Poisson’s Ratio domain although lack of shear data limits the ability for a more quantitative interpretation. The data was of sufficient quality to address the geology over the prospects.
7 Resource and Risk Summary

Table 5, below shows the predicted hydrocarbons in place and geological chance of success for the three key opportunities within the licence.

<table>
<thead>
<tr>
<th>Prospect Lead Discovery Name</th>
<th>P L D</th>
<th>Stratigraphic Level</th>
<th>Unrisked recoverable resources</th>
<th>Geological Chance of Success (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oil (MMbbls)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
<td>Central</td>
</tr>
<tr>
<td>Monarch</td>
<td>P</td>
<td>Mid Jurassic</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>Brimstone</td>
<td>L</td>
<td>Lower Cretaceous</td>
<td>35</td>
<td>135</td>
</tr>
<tr>
<td>Peacock</td>
<td>L</td>
<td>Palaeocene</td>
<td>12</td>
<td>37</td>
</tr>
</tbody>
</table>

Table 5: Summary Table of recoverable resources

8 Conclusions
Following evaluation of the licence post award, the remaining key prospectivity was limited to Monarch, Brimstone and Peacock as previously discussed. This area is no longer considered to be within the EnQuest hub strategy and as such has been relinquished.

9 Clearance
The OGA is free to publish the Report and that all third party ownership rights (on any contained data and/or interpretations) have been considered and appropriately cleared for publication purposes.