P608 Relinquishment Report

May 2016

Work by: Martin Stephenson
Hervey Breese
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Contents</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIGURES AND TABLES</td>
<td>2</td>
</tr>
<tr>
<td>1. LICENCE INFORMATION</td>
<td>3</td>
</tr>
<tr>
<td>2. LICENCE SYNOPSIS</td>
<td>3</td>
</tr>
<tr>
<td>3. WORK PROGRAMME SUMMARY</td>
<td>4</td>
</tr>
<tr>
<td>4. DATABASE</td>
<td>4</td>
</tr>
<tr>
<td>5. PROSPECTIVITY UPDATE</td>
<td>4</td>
</tr>
<tr>
<td>5.1 Kepler Gas Discovery – Well 43/20b-2</td>
<td>4</td>
</tr>
<tr>
<td>5.2 Cavendish East and Far East</td>
<td>5</td>
</tr>
<tr>
<td>6. FURTHER TECHNICAL WORK</td>
<td>5</td>
</tr>
<tr>
<td>7. RESOURCES SUMMARY</td>
<td>6</td>
</tr>
<tr>
<td>8. CONCLUSIONS</td>
<td>6</td>
</tr>
<tr>
<td>9. CLEARENCE</td>
<td>7</td>
</tr>
<tr>
<td>10. MAPS AND FIGURES</td>
<td>7</td>
</tr>
</tbody>
</table>
FIGURES AND TABLES

List of Figures

1. Map of licence P608 as at award and following various partial relinquishments
2. Map showing licence P607, P608 and the Cavendish Field Determination outline
3. Map of 3D seismic Database held by Ineos over licence P608 and the immediately adjacent area at time of surrender
4. Well logs over the gas bearing interval in well 43/20b-2 (Kepler)
5. Well correlation between Cavendish field and Kepler discovery
6. One realisation of Top Carboniferous reservoir depth map over Kepler
7. Depth and TWT maps on Near Top Crawshaw Sandstone over part block 43/20b, showing the Cavendish East and Far East structures
8. Summary of the stratigraphy of the reservoir interval in the Cavendish field
9. Allan Diagram – Cavendish East Structure F1 fault seal analysis

List of Tables

1. Kepler Discovery: Historical best technical case GIIP estimates
2. GIIP estimates for the structural leads in block 43/20b
1. LICENCE INFORMATION

Licence Number: P608
Licence Round: 10th Round
Licence Type: Traditional
Block Number: 43/20b & 43/20e

All permissions to publish have been obtained (see Section 9)

2. LICENCE SYNOPSIS

Licence P608, comprising block 43/20b, was awarded to Premier Oil Exploration Limited (50%) and Chevron Petroleum Company Limited (50%) on the 04/06/1987 (Figure 1). On 31/12/1994 Premier acquired Chevron’s interest in the licence, becoming the sole licensee. Amoco (UK) Petroleum Limited acquired the licence from Premier as of 15/11/1996. In turn, RWE Dea UK Development Limited acquired the licence with effect from 30/10/2000. RWE Dea UK was subsequently acquired by Letter One Holdings (12/03/2015), becoming DEA UK SNS Limited before being sold on to Ineos in December 2015, with Ineos UK SNS Limited as the Operator.

Over time various parts of the licence have been relinquished:
- 04/06/1993 - licence area reduced from 160.7 to 80.4 km²
- 04/06/2001 - licence area reduced from 80.4 to 56.2 km²
- 30/11/2007 - licence area reduced from 56.2 to 28 km²
  - 43/20b identified as potentially fallow and scheduled for listing in January 2008.
    Following discussions with the BERR a partial relinquishment was agreed, resulting in the formation of 2 part blocks; 43/20b and 43/20e
- 30/10/2015 – part block 43/20e (Kepler) was relinquished

Figure 1 shows the extent of the licence at various stages and illustrates the eventual fragmentation of the licence area into two separated part blocks (43/20b and 43/20e). Block 43/20e, which contained the 'Kepler' gas discovery, was relinquished in 2015.

The last remaining part block (43/20b) of the licence is located adjacent to the Cavendish field. The Cavendish field determination extends over a large part of block 43/20b, however, it is not party to the field development, which was granted through the adjoining P607 licence (Figure 2). Two structures have been identified down-dip of the Cavendish field. However, they rely on fault seals, have small mean GIIP values of ~25bcf each and therefore lack economic support for drilling (see Section 5 for details).

Notification of the surrender of licence P608 was submitted 29/04/2016 with an suggested effective date of 31/05/2016.

Initial Term Work Obligations:
- Acquire at least 400 km of 2D seismic
- Firm well into the Carboniferous
- Contingent second well.

Well 43/20b-2 was drilled in 1988 by Premier and penetrated 900m of Namurian – Westphalian section beneath the Base Permian Unconformity (BPU) with gas shows
throughout. The well was tested, confirming a gas discovery (Kepler) – see Section 5 for details.

3. WORK PROGRAMME SUMMARY

Initial Term Work Obligations:
- Acquire at least 400 km of 2D seismic
- Firm well to 14,000 feet or 2000 ft into the Carboniferous, whichever is the lesser.
- Contingent second well.

The Initial Term commitments were fulfilled before RWE Dea UK (now INEOS) entered the licence. The commitment well was drilled by Premier Oil in 1988 – see Section 5 for the results.

4. DATABASE

Figure 3 shows the seismic database currently available to INEOS over the subject area.

5. PROSPECTIVITY UPDATE

5.1 Kepler Gas Discovery – Well 43/20b-2

The firm obligation well, 43/20b-2, was drilled by Premier Oil in 1988. The well penetrated 900 m of Namurian – Westphalian aged section beneath the BPU with gas shows throughout. Four intervals were tested but only one (also the only interval calculated to have >50% gas saturation) yielded significant gas. This interval tested at 48 mmscfd with 9 mol% CO₂ (Figure 4).

Pressure tests accurately define the Free Water Level at 4156 m TVDss, which implies a 17 m gas column at the well. However, by analogy with the neighbouring Cavendish field, we can only be sure of productivity from the high quality, Upper Sand (labelled ‘Q’ in Figure 4). With a single penetration and a short test there is no control over the thickness or extent of sandstones away from the well and therefore low confidence in the potential connected volume of gas.

A multi-well biostrat study was undertaken in 2006 (MB Stratigraphy Ltd). Results demonstrated a revised interpretation of the original Westphalian – Namurian interval and provided a high level of confidence in correlation across a number of offset wells.

The successful well test interval (Test #4) has been identified as Marsdenian in age and is the equivalent of the Guiseley Sand in the Cavendish field. This interval has contributed to production on Cavendish (with a lower CO₂ content than Kepler) although overall recovery has been poor at around 37%. The main reservoir interval on Cavendish, the highly prolific early Westphalian Crawshaw Sandstone is however absent. The slightly younger Alton and Loxley sands (Langsettian) are present above the G.subcrenatum marine band. These sands have proved to be poor reservoir intervals and have only contributed minor quantities gas. A well correlation with the nearby Cavendish field is provided in Figure 5.
The area is covered by a 2004 Pre-Stack Depth Migrated seismic data set (Figure 3). The Carboniferous interval contains few laterally continuous reflectors so it is necessary to utilise horizons typically over 100m above or below top reservoir and infer structural shape by isochore. The structure is flat-topped with a structural relief of only 80-120m (Figure 6). Depending upon which intra-Carboniferous horizon is mapped and the depth conversion methodology used, the structural culmination in depth can move significantly, with some interpretations placing a significant portion of the gas volume off block. GIIP lies in the range of 60 – 90 Bscf. However, only around 20 Bscf of this is robust, being attributed to the Upper, high quality, sandstone (Figure 4).

5.2 Cavendish East and Far East

Two undrilled structures have been identified in part block 43/20b:
- Cavendish East
- Cavendish Far East
Both lie down-dip of the Cavendish field (43/19a) and rely on cross-fault seals and are therefore considered high risk (Figure 7). The stratigraphy of the reservoir interval in the Cavendish field is shown in Figure 8.

Cavendish East - is defined by two major cross-faults identified as ‘F1’ and ‘F2’ that cut across the main Cavendish-Murdoch ridge (Figure 7). The F1 fault, shared with the eastern boundary of the Cavendish field, is down-thrown to the east and has increasing throw running north along the fault plane. The structure dips to the east before intersecting the F2 fault. It is likely that Westphalian A (Langsettian) sediments are preserved below the BPU and reflect the broad anticline structure that is the core to the Cavendish field and mirrored on the western flank (Figure 9).

Analysis of the F1 fault at Crawshaw and Guiseley reservoir intervals suggests that there is more than one point where sand-on-sand juxtaposition will occur (Figure 10). Without fault plane seal the gas column is likely to be common with the main body of the Cavendish structure and the primary objective, the Crawshaw Sandstone, will lie mostly below the GWC (Figure 8). Equivalent Loxley and Alton sandstones are likely to be preserved below the BPU on this structure, however, these intervals have proved to be of poor reservoir quality where penetrated on the western flank of Cavendish (Figure 9). The mean GIIP is estimated at 25 Bscf. Drilling of this structure from the Cavendish platform was considered feasible but could not be justified commercially due to the high cost and low potential reward.

Cavendish Far East - is a rotated fault block with significant throw along the F2 fault, which separates it from Cavendish East (Figure 10). The rhombic shaped structure is fault bounded on all four sides and is offset from the Kepler structure further to the east. The mean GIIP is estimated at 24 Bscf.

6. FURTHER TECHNICAL WORK

A re-evaluation of the Kepler gas discovery was undertaken by RWE Dea UK in 2012 as part of the 27th Licence Round effort. The work undertaken included petrophysical analysis, remapping, depth conversion, Petrel modelling and commercial evaluation.

The gas export route evaluated was the Cavendish-Murdoch line (RWE 50%) which was deliberately deviated to cross Kepler and provided with a T-piece on installation (Figure...
2). However, entry to this line requires <3.5 mol% CO₂. The high quality upper sand in Kepler has a CO₂ content of 9 mol%. Consequently, the development concept evaluated was to share CO₂ handling facilities across Kepler and Copernicus, another small CO₂- rich stranded asset in open acreage some 10km SE of Kepler in block 44/16b (Figure 2). A number of commercially proven gas treatment options were studied, the preferred option being an amine-based process. However, all options required a manned offshore installation, the high operating costs of which precluded commercial development.

43/20b has been fully evaluated as part of the active Cavendish field opportunities register and more recently in preparation of the Cavendish CoP. The block has adequate 3D seismic cover and a full mapping exercise has been completed on the Cavendish PSTM data set.

7. RESOURCES SUMMARY

Table 1 summarises the main Gas-In-Place (GIIP) exercises conducted for the Kepler gas discovery since RWE Dea UK acquired the licence.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Constant Upper Sand</td>
<td>Thickened Upper Sand</td>
<td>Map 1</td>
<td>Map 2</td>
</tr>
<tr>
<td>Upper Sand</td>
<td>16</td>
<td>25</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Lower Sand</td>
<td>77</td>
<td>67</td>
<td>68</td>
<td>69</td>
</tr>
<tr>
<td>Total</td>
<td>63</td>
<td>69</td>
<td>93</td>
<td>86</td>
</tr>
</tbody>
</table>

Table 1. Kepler Discovery - historical best technical case GIIP Estimates.

Table 2 contains the latest GIIP estimates for the untested leads in part block 43/20b, which lies adjacent to the Cavendish Field.

<table>
<thead>
<tr>
<th>GIIP (bcf)</th>
<th>P90</th>
<th>P50</th>
<th>P10</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cavendish East</td>
<td>13</td>
<td>23</td>
<td>40</td>
<td>25</td>
</tr>
<tr>
<td>Cavendish Far East</td>
<td>15</td>
<td>23</td>
<td>35</td>
<td>24</td>
</tr>
</tbody>
</table>

Table 2. GIIP estimates for the structural leads in block 43/20b

8. CONCLUSIONS

- The Kepler gas discovery (43/20b-2) comprises a poorly-defined intra-Carboniferous closure which is likely to contain 60-90 Bcf of gas in place with a CO₂ content of ~9 mol%.
- However, only 20 bcf of this gas is considered to lie within sandstones of adequate reservoir quality, capable of sustained production.
- Attempts to commercialise Kepler have failed due to a combination of small, poorly defined, resource volumes and the additional cost of dealing with the high CO₂ content.
- Given its fallow status and lack of a firm activity plan, part block 43/20e (Kepler) was relinquished effective 30/10/2015.
Part block 43/20b lies adjacent to the Cavendish field (43/19a) and contains two undrilled structural leads. However, both are small (mean GIIP ~25 Bscf), rely on cross-fault seals and lack economic support for drilling.

9. **CLEARENCE**

Ineos UK SNS Limited confirms that the OGA has clearance to publish this report and that all third party ownership rights (on any contained data and/or interpretations) have been considered and appropriately cleared for publication purposes.

10. **MAPS AND FIGURES**

Please see Following Pages
Figure 1. Map of licence P608 as at award and following various partial relinquishments (culture data - present day in all cases)

a) As at licence award 04/06/1987    b) As at 04/06/2001
   c) As at 30/11/2007    d) As at 30/10/2015
Figure 2. Map showing licences P607, P608 and the Cavendish Field Determination outline.
Figure 3. Map of 3D seismic database held by Ineos over licence P608 and the immediately surrounding area at time of licence surrender.
Figure 4. Well logs over the gas bearing interval in well 43/20b-2 (Kepler). Four intervals were drill stem tested but only the “Q” Sand (Test #4) yielded significant gas, flowing at 48 mmscf/d but with 9 mol% CO₂.
Figure 5. Well correlation between Cavendish field and Kepler discovery
Figure 6. One realisation of Top Carboniferous reservoir depth map over Kepler (C.I. = 50m)
Figure 7. Depth and TWT maps on Near Top Crawshaw Sandstone over part block 43/20b, showing the Cavendish East and Far East structures.

Figure 8. Summary of the stratigraphy of the reservoir interval in the Cavendish field.
Figure 9. NW – SE geological cross section through the Cavendish field (43/19a) and Cavendish East structure (43/20b).

Figure 10. Allan diagram – Cavendish East structure F1 fault seal analysis