THE NORTHERN AUSTRALIA CO₂ STORE PETREL SUB-BASIN

REFINING THE GEOLOGICAL EVALUATION FOR CCS

Rosie Johnstone and Jose Torres  - Presented by Owain Tucker
Shell Australia
DEFINITIONS & CAUTIONARY NOTE

The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate legal entities. In this release “Shell”, “Shell group” and “Royal Dutch Shell” are sometimes used for convenience where references are made to Royal Dutch Shell plc and its subsidiaries in general. Likewise, the words “we”, “us” and “our” are also used to refer to subsidiaries in general or to those who work for them. These expressions are also used where no useful purpose is served by identifying the particular company or companies. “Subsidiaries”, “Shell subsidiaries” and “Shell companies” as used in this release refer to companies over which Royal Dutch Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as “joint ventures” and “joint operations” respectively. Entities over which Shell has significant influence but neither control nor joint control are referred to as “associates”. The term “Shell interest” is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in a venture, partnership or company, after exclusion of all third-party interest.

This release contains forward-looking statements concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management’s current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management’s expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by the use of terms and phrases such as “anticipate”, “believe”, “could”, “estimate”, “expect”, “goals”, “intend”, “may”, “objectives”, “outlook”, “plan”, “probably”, “project”, “risks”, “schedule”, “seek”, “should”, “target”, “will” and similar terms and phrases. There are a number of factors that could affect the future operations of Royal Dutch Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this release, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell’s products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; and (m) changes in trading conditions. There can be no assurance that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this release are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Royal Dutch Shell’s 20-F for the year ended December 31, 2015 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward looking statements contained in this release and should be considered by the reader. Each forward-looking statement speaks only as of the date of this release, 19 June 2016. Neither Royal Dutch Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this release.

With respect to operating costs synergies indicated, such savings and efficiencies in procurement spend include economies of scale, specification standardisation and operating efficiencies across operating, capital and raw material cost areas.

We may have used certain terms, such as resources, in this release that United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. U.S. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov.
Shell Australia Team

Jose Torres, Senior Sequence Stratigrapher, Sedimentologist

Now in Shell UK, formerly of Shell Australia and Shell Brunei, PBE and Regional Teams. Regional interpretation and depositional model

Rosie Johnstone, Senior Exploration Geologist

Shell Australia Asset Team, Chevron Operated Acreage (Greater Gorgon) Seismic Interpretation and ongoing focal point

Paul Martin, Discipline Lead Petrophysics Development IG Australia

Project Lead
Regional assessment of the CO₂ storage potential of the Mesozoic succession in the Petrel Sub-basin, Northern Territory, Australia

Summary report

Christopher Consoli, Karen Higgins, Diane Jongaen, Kamal Khider, David Leclair, Robbie Morris and Victor Nguyen

Review of the central Petrel Sub-Basin for CO₂ sequestration potential

by

L. R. Seldon (GSUK-PTU/D/E)
D. D. Long (SUKEP-U10/W/N)
A. C. Evans (GSUK-PTU/O/NN)
A- P. Peyret (SIEP-PTU/D/SS)
How has Shell progressed the assessment of the Petrel SB?

Work done by Geoscience Australia (Consoli et al, 2013) focused on the eastern half of the Petrel Sub-Basin.

Further work carried out by Shell (Seldon et al, 2015) loosely defined two small areas within the eastern part of the basin as potential sites for CO₂ disposal. Recommendations from this report included further detailed work focusing on the structural elements that could compromise the seal integrity, and a better understanding of the lateral extent of the target reservoirs and seals.

Shell’s 2016 geological assessment has concentrated on:

1. Use all available data to re-interpret well tops
2. Updated depositional understanding in Jurassic and Cretaceous sediments using regional stratigraphic framework, based on proprietary 2D seismic
3. Updated depth and thickness maps, using regional velocity models
4. Mapping of major faults, polygonal fault density in Wangarlu, pockmarks
5. Provision of updated surfaces to CSIRO for next stage of project
Starting Area Of Interest – Constrained by seismic, pinchouts and WA/NT boundaries?

Pinchout/Truncations
Reinterpret correlations using chronostratigraphic approach, biostratigraphy, and new seismic
NWS Regional Framework: Petrel Sub Basin – what is connected?

Sandpiper and Plover Formations - are they continuous?
Shell

K - somewhere between 1329 and 1536m. It could be as high as 1314m.

JT - somewhere between 1783 and 1823m. It could be as high as 1768m

JO/JC – somewhere between 1904 and 1965m

JP1 – somewhere between 2028 and 2374m (but more likely below 2125m)

TRL1 – somewhere between 2125 and 2478m

So JP1 and TRL1 could possibly be at the same place... As the S.speciosus sample could be S.quadrifidus

---

**Biostrat: Petrel 1A – look at deposition time not rock type**

<table>
<thead>
<tr>
<th>Horizon picked at base</th>
<th>Simplified Regional Play Level</th>
<th>Approximate Unit Name in Petrel Sub-Basin (as used in this study)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO</td>
<td>T30-T40</td>
<td>Oligocene to Present</td>
</tr>
<tr>
<td>KC</td>
<td>K50-T20</td>
<td>Upper Bathurst Island Formation</td>
</tr>
<tr>
<td>KA</td>
<td>K40</td>
<td>Lower Bathurst Island Fm / Wangaru / Jamieson Fm</td>
</tr>
<tr>
<td>JT</td>
<td>J50-K30</td>
<td>Frigate/Sandpiper Formation</td>
</tr>
<tr>
<td>JO</td>
<td>J40</td>
<td>Elang Formation /</td>
</tr>
<tr>
<td>JP1</td>
<td>J10-J30</td>
<td>Plover Formation</td>
</tr>
<tr>
<td>TRL1</td>
<td>TR20-TR30</td>
<td>Malta Red Beds</td>
</tr>
<tr>
<td>P2</td>
<td>TR10</td>
<td>Goodwyn Formation / Cape Londonderry Formation</td>
</tr>
<tr>
<td></td>
<td>P20</td>
<td>Hyland Bay Carbonates (Top Permian)</td>
</tr>
</tbody>
</table>
Could not use core – lots was cored but with us no longer
DIP LINE CORRELATION WITH CHRONOSTRAT

Shell
Combined latest seismic, and chronostratigraphy.
Two delta systems separated in time

- **K10 Delta**
  - Max. extent offlap break K10
  - Pinchout/truncation K10

- **Late J50 Delta**
  - Max. extent offlap break J50
  - Pinchout/truncation Late J50
Sandpiper not necessarily continuous to the east.
Updated depth and thickness maps, using Estimages velocity models
Data

coverage \( \sim 500,000 \text{ km}^2 \)

3D seismic velocity cubes \( 21 \)

2D seismic velocity data sets \( 54 \)

wells (TZ functions) \( 232 \)

regional interpretation \( 7 \)

source \text{open + Shell}
### GRIDDED DEPTH MAPS – E.G. BASE SEAL (KA)

<table>
<thead>
<tr>
<th>Horizon picked at base</th>
<th>Simplified Regional Play Level</th>
<th>Approximate Unit Name in Petrel Sub-Basin (as used in this study)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO</td>
<td>T30-T40</td>
<td>Oligocene to Present</td>
</tr>
<tr>
<td>KC</td>
<td>K50-T20</td>
<td>Upper Bathurst Island Formation</td>
</tr>
<tr>
<td>KA</td>
<td>K40</td>
<td>Lower Bathurst Island Fm / Wangarlu / Jamieson Fm</td>
</tr>
<tr>
<td>JT</td>
<td>J50-K30</td>
<td>Frigate/Sandpiper Formation</td>
</tr>
<tr>
<td>JO</td>
<td>J40</td>
<td>Elang Formation</td>
</tr>
<tr>
<td>JP1</td>
<td>J10-J30</td>
<td>Plover Formation</td>
</tr>
<tr>
<td>TRL1</td>
<td>TR20-TR30</td>
<td>Malita Red Beds</td>
</tr>
<tr>
<td>PZ</td>
<td>TR10</td>
<td>Goodwyn Formation / Cape Londonderry Formation</td>
</tr>
<tr>
<td></td>
<td>P20</td>
<td>Hyland Bay Carbonates (Top Permian)</td>
</tr>
</tbody>
</table>

Slight deviation in contours is a picking artefact – not a real feature.
THICKNESS MAPS – SANDPIPER, WANGARLU

KA-KC (Jamieson/Bathurst Fm)
3

Mapping of major faults, polygonal fault density in Wangarlu Fm, pockmarks
Seismic 2D Line 336-207: Polygonal faulting

NW to SE 10 Km TWT (~AOI)
4

Recommended AOI for further study
CONSTRaining elements in the final AOI

- Petrel field (inject up dip)
- Early Paleozoic rift faults reactivated in Late Jurassic/Cretaceous?
- Seismic imaging poor (Tertiary multiples)
- Plover and Sandpiper merge, seal thins
- Areas with microfaults at KA
- Pinchout/Truncation of KA (mostly coastal onlap on Eastern side of basin)
- Latest Jurassic/Earliest Cretaceous faults
- Pinchout/Truncation of KC
- Diapirs
Final Area of Interest. Isopach map of the Wangarlu Formation. C.I. 50 m.
SUMMARY

• All existing open file data (seismic 2D and 3D, well data and interpretation legacy data) have been integrated into a regional interpretation project and used in this study
• Fit for purpose seismic interpretation of main horizons and identified faults. Created Grids (time and depth) for all key markers and isopach maps
• Re-evaluated existing well data and proposed a new stratigraphic framework with distribution of main reservoirs and seals
• Identified a potential AOI that fulfills the main requirements:
  • Minimum depth of 800 m at top of reservoir
  • No obvious faults that could leak up to the surface
  • Within area of preserved thickness of main regional seal (Bathurst Gp)
• Recommendation: Assess the storage volume of this AOI and mechanical properties of seal rock, use CRS (Common Risk Segment) maps to further delineate the AOI.
Q & A
Next steps?

- Confirming a robust seismic signal against noise (required to support use of 4D monitoring for plume monitoring) is recommended for the next phase.

- Sand Continuity: The key well log data suggests very high net-to-gross Jurassic sand formations which are unlikely to be internally compartmentalised. Cretaceous Sandpiper Fm now observed as a series of prograding delta facies that are less likely to connect to their deeper water equivalent in Gull. 3D data and more core information would progress this (seismic over data gap).

- Seismic indicators of facies variation were observed in the seal formations, suggesting more variation than wells suggest. 3D data and more core information would progress this.

- Malita Sandstone – assess in more detail as an alternative (deeper) for containment.

- Shell undertaking a well engineering review of well abandonment around selected appraisal area recommended prior to appraisal drilling. Dynamic modelling will be addressed in the later phase of the project.
Following this latest phase of geological assessment of the Eastern Petrel Sub-Basin, the Mesozoic sediments continue to show great potential for CO2 storage with a suggested AOI for selecting an injection site – however more work will be required to close uncertainties including future appraisal activities.

CSIRO will continue next phase with reservoir modelling and rock mechanics.