Volumetric resource assessment of the lower Kyalla and middle Velkerri formations of the McArthur Basin
NTGS
greater McArthur Basin shale study

• provide valuable datasets to assist with mineral and hydrocarbon exploration
  – Moving from imprecision to a more robust dataset
• estimate the resources in place in the greater McArthur Basin; P10, P50 and P90 values for Oil In Place (OIP) and Gas In Place (GIP)
• The government can quote this resource to support science-based decision making with repeatable assessment volumes
• Resource unrestrained by tenement boundaries
• Publicly available dataset – Digital Information Package 014
Certainty in estimation

Quantity actually recovered will equal or exceed the calculated value given:

- **P10 (3P)** – 10% probability (proved+probable+possible)
- **P50 (2P)** – 50% probability (proved+probable)
- **P90 (1P)** – 90% probability (proved)

P90 & P10 forecasts change with time, dependent on information well beyond reservoir characterisation, engineering and management.
<table>
<thead>
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<td>CONTINGENT RESOURCES</td>
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<td>Play</td>
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Increasing confidence

AGES2017
sub-basins of the McArthur Basin region

Beetaloo Sub-basin

<table>
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<tr>
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**Diagram: Flow of Resources**

- Play/lead
- Prospect
- Not mature
- Mature for development decision
- Committed for development
- Under development
- Production

**Uncertainty decreasing??**

*Data increasing*
GAS IN PLACE
middle Velkerri Formation

118 – 293 TCF

(P90-P10) TCF = trillion cubic feet

Multiple methods used in the volumetric calculation

<table>
<thead>
<tr>
<th>Formation</th>
<th>P10</th>
<th>P50</th>
<th>P90</th>
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<tr>
<td><strong>Kyalla Formation</strong></td>
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<tr>
<td>Map Based Volumetric</td>
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<td>SRP Based Volumetric</td>
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<td>S1 Based Volumetric</td>
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- Australia consumed 1.3 TCF in 2014-15
- Around 13.5 TCF produced from USA shale reservoirs in 2015.
Volumetric assessment region
Process of the NTGS volumetric resource estimation of the Roper Group

- Desktop study ~ 6300 historical samples
- Sampling program ~ 1600 new samples
- Analyses (TOC, XRD, pyrolysis, element ratios in organics, GCMS, biomarkers, organic reflectance, porosity, permeability, fluid saturations)
- Interpretation and calculation
- Integration of the data into the depth and volume of the formation
Interpretation of results

- Interpretation available now as NTGS Record 2017-002
Modelling thickness

- Kyalla Formation
- more data so more constrained than the Velkerri Fm
- Thickest in the central part of the basin
- lower Kyalla shale 50% of volume
Modelling thickness

- Middle Velkerri Formation
- less data so less constrained
- Additional drilling data will change the model
- A, B & C shales make up about 33% total volume
Modelling depth

Kyalla Formation

- Shallow – early to late oil window (600 - 1500 m)
- Depth is greatest in the central region of the basin
Modelling depth

middle Velkerri Formation

• Deep – dry-gas window (1700 m+)
• Surface will change with additional data
• Need to be in gas window for overpressure
thermal maturity fluid saturations

Original hydrocarbons in place

porosity

fluid saturations

adsorbed gas content

Original hydrocarbons in place
middle Velkerri Formation: A, B and C shale

- three distinct facies within middle Velkerri
- unique geophysical responses and geochemical composition

- continuous across the region
- each facies an individual shale gas play
- B shale most consistent across the basin
Shale plays of the middle Velkerri Formation

Gamma-ray spikes

A, B and C shales – basic indicators

High total organic carbon
Shale plays of the middle Velkerri Formation
Open-file data

• only open-file data could be used

• **significant impact** on volumetric assessment when recent drilling included

• this assessment has significant volumes already, 100’s TCF defined
risks

- old drill core – compositional change over time
- frontier basin, large region with a paucity of data
- homogeneity assumed for heterogeneous rocks
- individual facies grouped into one volume
Where to next?

• Determine the RESERVES:

- **recoverable oil reserves (STB):**
  \[ \text{STB} = \text{OIP} \times \text{RF} \]

- **recoverable gas reserves (SCF):**
  \[ \text{SCF} = \text{GIP} \times \text{RF} \]

**Recovery Factor (RF)**

USA RF’s:  
- shale oil ≈ 4-5%
- shale gas ≈ 15-25%

**Amungee NW-1H announced as RF= 16%**

based on one well, multiple wells needed to increase confidence
summary

• The Beetaloo Sub-basin has an enormous shale gas resource, 50% of Australia’s shale gas potential.

• Resource estimation work has produced estimates in the 100’s of TCF of gas

• This resource is still in appraisal, the estimates will change with increases in knowledge