Assessing the unconventional hydrocarbon resource potential of central Australian basins

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Acknowledgements: USGS, State and NT geological surveys
In Australia, unconventional hydrocarbon resources of current interest are CSG, shale gas/oil and tight gas/oil.

Unconventional hydrocarbon resources are characterised by:
- the low permeability of hosting reservoir rocks
- laterally extensive accumulations
- a requirement for capital-, energy- and technology-intensive extraction methods
History in Australia

• Unconventional hydrocarbons are not “new” in Australia:
  – oil shale (1860s~)
  – CSG (1942~)
  – tight gas (1960s~)

• Unprecedented recent growth


• Shale and tight gas/oil exploration has boomed since late 2000s – first shale gas flow and contingent resource booking in Cooper Basin (2011)

• Major question: will shale and tight gas/oil follow the CSG/US shale pathway in Australia?
Exploration in Central Australia

- **Central Australia** has a history of conventional petroleum exploration since 1960s – production and infrastructure since 1980s

- Now a **major exploration focus** for unconventionals...
  - **Beetaloo Sub-basin** (McArthur Basin): sustained gas flow and liquids during Shenandoah-1 re-entry (2011)
  - **Galilee-Eromanga Basin**: CSG resource bookings in Permian Betts Creek beds and Aramac Coal Measures (2010), excellent shale gas/oil potential confirmed in Toolebuc Formation (2011)
Potential in Australia

Total CSG, shale and tight gas resources for Australia uncertain, but potentially very large compared to conventional gas resources

<table>
<thead>
<tr>
<th>Resource category</th>
<th>Conventional Gas</th>
<th>Coal Seam Gas</th>
<th>Tight Gas</th>
<th>Shale Gas</th>
<th>Total Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PJ</td>
<td>tcf</td>
<td>PJ</td>
<td>tcf</td>
<td>PJ</td>
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<tr>
<td>EDR</td>
<td>113,400</td>
<td>103</td>
<td>35,905</td>
<td>33</td>
<td>-</td>
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<tr>
<td>SDR</td>
<td>59,600</td>
<td>54</td>
<td>65,529</td>
<td>60</td>
<td>-</td>
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<tr>
<td>Inferred resources</td>
<td>~11,000</td>
<td>~10</td>
<td>122,020</td>
<td>111</td>
<td>22,052</td>
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<tr>
<td>Identified resources</td>
<td>184,000</td>
<td>167</td>
<td>223,454</td>
<td>203</td>
<td>22,052</td>
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<tr>
<td>Total resources</td>
<td>184,000</td>
<td>167</td>
<td>258,888</td>
<td>235</td>
<td>22,052</td>
</tr>
</tbody>
</table>

Source: Geoscience Australia and BREE (2012), Australian Gas Resource Assessment 2012
TOTAL RESOURCE >258,000 PJ or >235 tcf
Source: Geoscience Australia and BREE (2012)

PERMIAN TO JURASSIC BASINS

- Current production from bituminous coals <1000 m
  - Shallow sub-bituminous coals e.g. Arckaringa, Pedirka
- Deep CSG potential e.g. Cooper, Bowen
- CSG-shale exploration in Galilee Basin
- Biogenic CSG e.g. Gippsland, Murray, Eromanga
TOTAL RESOURCE ~435,600 PJ or 396 tcf
Source: US EIA (2011)

Potential across a wide range of Australian basins

Assessment based on selected basins
The map is intended as a schematic depiction of the location of sedimentary basins with predicted potential for tight oil or gas based on their gross geological characteristics. Many basins highlighted do not have proven potential for tight oil or gas, and not all of the highlighted areas are necessarily prospective. Tight oil or gas may also occur outside of the highlighted areas.
TOTAL IN-PLACE RESOURCE ~22,000 PJ or 20 tcf
Source: Geoscience Australia and BREE (2012)

Largest known resources in Cooper, Perth and Gippsland
Source: Campbell (2009)

Potential across a wide range of Australian basins
Issues with the current resource estimates

- Use of volumetric methods in ‘in-place’ and ‘total’ resource assessments – **is it really recoverable?**
- Reliance on publicly available material – no confidential or unpublished data
- Variable quality, methodology and coverage
- Evolving industry experience and technology
Geoscience Australia national unconventional resource assessment

• Current lack of an unified or consistent national approach in unconventional hydrocarbon resource assessment

• Onshore Hydrocarbons Section at Geoscience Australia (GA) has commenced a three-year project to assess the unconventional hydrocarbon potential of Australia’s onshore basins

• The principal objective – to produce resource assessments for prospective basins using a nationally consistent methodology
Collaborations

- Assessments completed in collaboration with State/Northern Territory government authorities, United States Geological Survey (USGS), and industry

- **USGS**: assessment methodology and international experience in unconventional hydrocarbon assessments

- **GA, States and Northern Territory**: wealth of geologic data and local knowledge

- **Industry collaborative agreements**: gas, water and source rock sample analyses using GA’s extensive analytical laboratory facilities – build up geologic data base
USGS Resource Assessment Methodology

- **Standardised methodology** based on actual and predicted well productivity (as derived from production decline curves)

- …cf. volumetric methods

**Barnett Shale production decline curve**

Source: Gautier, USGS (2012) after Charpentier and Cook (2011)
USGS Resource Assessment Workflow

**Data-rich basins**
- Define assessment unit (AU)
- Estimated ultimate recovery (EUR) & geologic uncertainties
- MONTE CARLO simulation
- Aggregation & economic analysis

**Frontier basins**
- Develop analogue models from geologic & production data
- Identify & apply suitable analogue models

After Gautier, USGS (2012)
Statistical approach: accounting for uncertainty

• Estimated ultimate recovery (EUR) expressed as a probability distribution – i.e. a likely range of values, rather than a single number
Advantages

• **Quantifies the uncertainty** around predicted resource volumes – potentially avoids overestimation associated with volumetric methods

• **Standardised and reproducible method** – uses simple form-based user interface for inputs

• **Benchmarked** against ‘real-world’ production data – mitigates uncertainties in geological and engineering controls on ultimate recovery

• **Method tested in over 100 plays in US and applied globally**… including the GA programme

Source: Klett et al., USGS (2011)  
Source: Schenk et al., USGS (2011)
Limitations

- Assessments do not consider future advances in production technology
- Large data and labour requirements
- North American production data may not always be the best analogues in Australia

Source: WestSide Corporation (2011)
Australian shale and tight gas/oil resources may be different…

- **Proterozoic to Cretaceous age**
  - cf. dominantly Devonian, Carboniferous and Cretaceous in North America, Silurian in eastern Europe

- **Wide range of depositional environments** including fluvio-lacustrine
  - cf. marine in North America

- Many Australian shale and tight gas/oil basins developed as **intracratonic rifts and sags**
  - cf. foreland basins in North America

Source: Gautier, USGS (2012)
Geoscience Australia assessment priorities

- Frontier shale and tight gas/oil basins (e.g. Georgina Basin) – test assessment methodology on data-poor basins
- High potential shale and tight gas/oil basins (e.g. Cooper Basin) – high level of exploration interest, basin-wide synthesis of available data
- Eastern Australian CSG basins (e.g. Sydney-Gunnedah basins) – high level of public interest

- Further assessments likely to cover central Australian basins: Beetaloo, Amadeus, Galilee-Eromanga, Arckaringa, Officer, Pedirka???
Outcomes

• Inform government, industry and other key stakeholders on the location and volumes of unconventional hydrocarbon resources in Australia

• Provide precompetitive geologic information to exploration industry from a single distribution point

• Provide a benchmarked baseline for resources/reserves reporting

• Provide background information for assessment of potential impacts of unconventional hydrocarbon production
Further information

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