An overview of the petroleum systems of South Australian basins

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SA is situated between the Archaean Shield and eastern orogenic belts. As a result, the State's geological record has preserved a unique history of sedimentation from Proterozoic - Ordovician and from Early Devonian - Cenozoic. Viable Petroleum Systems have: Source, reservoir and seal. Trap formation, then generation & migration, and Preservation.

Petroleum Systems – GA’s Australian scheme (Bradshaw 1993).

>2/3 world's known conventional petroleum resources are generated from Jurassic-Cretaceous source rocks.
SA’s petroleum portfolio

Proven plays:
• Cooper-Eromanga basins oil & gas
• Otway Basin gas

Prospective plays:
• On and offshore frontier basins, conventional plays yet to be explored in producing basins
• Deep coal/source rocks – Cooper Basin
• Tight gas/Basin Centred Gas/composite plays - Cooper Basin
• Shale gas - Cooper and other basins
• Oil shale – Arckaringa? Eromanga?
• Coal extraction for syngas and synfuel projects, in situ gasification (Telford Basin)
Santos Wilkatana 1 (1955): Cambrian oil shows focussed interest on SA

Bona fide oil shows discovered in many frontier basins which remain only lightly explored.

‘Alf Flat 1’ drilled to 7.6 m depth in 1866-68. First oil well in Australia.
Petroleum wells and seismic survey coverage
Proterozoic basins

**MESOPROTEROZOIC**

**URAPUNGAN PETROLEUM SYSTEM**
No evidence of viable petroleum systems in SA, unlike the NT’s McArthur Basin.

**NEOPROTEROZOIC**

**CENTRALIAN PETROLEUM SYSTEM**
Widespread marine to non-marine deposition, in a rift setting, minor igneous activity.  
*Officer Basin* – widespread oil shows, oil bleeds indicate viable source rocks, reservoirs, seals (salt) and traps – timing, preservation?
**CENTRALIAN PETROLEUM SYSTEM**

*Shows* – oil shows across basin and stratigraphy (bleeds, staining, fluorescence).

At least 2 Neoproterozoic petroleum systems identified (McKirdy & Tingate, 2003).

*Source* – black pyritic shales

*Reservoir* – sandstone and carbonate

*Seal* – marine shale and salt

*Traps* – variety of structural styles, salt diapirs

*Migration* – shows

*Preservation* risk in some areas due to Peterman Ranges Orogeny, Delamerian Orogeny and Alice Springs Orogeny.

**Pindyin Sandstone**

Porosity = 22.6% Permeability = 1.5 Darcies
Cambrian – Ordovician

LARAPINTINE PETROLEUM SYSTEM
Low latitudes, marine shale and carbonates, volcanism, intrusions, orogeny.

Officer Basin – 2 Cambrian petroleum systems identified by McKirdy and Tingate (2003).


Arrowie Basin – oil shows at Wilkatana and gas shows in Moorowie 1, potential marine shale and carbonate source rocks. Trap preservation? Lightly explored.

Stansbury Basin – traces of oil recorded. Trap preservation? Lightly explored for oil and gas as well as gas storage.
Late Carboniferous to Triassic basins

GONDWANAN - Late Palaeozoic
Most productive onshore Petroleum System

- High latitudes, mountain building, glaciation followed by extensive and thick coal deposition. Coals important source of Cooper Basin oil and gas.
- Coal measures in Pedirka and Arckaringa basins – CSG, conventional potential.
- Evidence of active petroleum system: Cooper Basin production, Pedirka - shows, Arckaringa – Stuart Range Fm shale oil play.
- Triassic coal in Poolowanna Trough, Cooper Basin and in small intramontaine basins (e.g. Telford, Springfield and Boolcunda basins).
### Cooper Basin

#### Conventional

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#### Resource Plays

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![Dr Lisa Hall, Geoscience Australia, 2016](image)
Hydrocarbon Generation Potential

- Total hydrocarbons generated by formation and lithology: the best source rocks are the Patchawarra coals and coaly shales, followed by those of the Toolachee Formation.

- Total Hydrocarbons generated from the Permian Gidgealpa Group > 2000 billion bbls oil equiv.

From Dr. Lisa Hall (GA) 2016
**Jurassic to Cretaceous basins**


**AUSTRAL PETROLEUM SYSTEM**
Southern rifted margin, Gondwana break up *Otway Basin* – massive thickness of sediment, oil shows & economic gas onshore, offshore asphaltite strandings and shows, fault seal risk. Bight Basin – oil shows in Greenly 1, gas anomalies offshore, GA’s Jurassic oil shale grab sample.
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<tr>
<th>AGE</th>
<th>ROCK UNIT</th>
<th>LITHOLOGY</th>
<th>DEPOSITIONAL ENVIRONMENT</th>
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Cenozoic

Trap formation, migration. Reactivations, uplift – traps breached in some basins/places. Neotectonics.
Summary

URAPUNGAN – no evidence yet of viable petroleum system in SA.
CENTRALIAN – at least 2 potential petroleum systems identified in Officer Basin.
LARAPINTINE – at least 2 potential Cambrian petroleum systems identified in Officer Basin, elsewhere no evidence yet for viable Cambro-Ordovician petroleum systems.
GONDWANAN – Cooper Basin production, unconventional reservoir plays. Potential in Pedirka and Arckaringa basins?
AUSTRAL AND MURTA – production from Eromanga (Cooper region) and Otway basins. Potential for Eromanga oil beyond Cooper Basin margin - Poolowanna Fm? E. Cretaceous Toolebuc Fm oil shale potential in SA? Potential for oil and unconventional gas plays in Otway Basin? Potential for conventional oil and gas plays in Bight Basin?
What can we do to address gas production trend and sustain oil trend?

Develop new play concepts in mature basins - Cooper, Eromanga, Otway.
Foster exploration in frontier onshore basins – Officer, Pedirka, Arckaringa.
New Data, Technologies, ideas
Energy Resource Division is:

• Undertaking pre-competitive prospectivity research to better understand the State’s prospectivity and address critical uncertainties for priority basins - in collaboration with ASP, SACGER, GA, international (e.g. USGS) and interstate.
• Generating new datasets, reports and products – e.g. Cooper Basin Atlas. Otway Basin next for review and modelling.
• Collating data to build new models for key SA basins. Review overlooked basins and plays.
• Developing new data products – e.g. PEPS-SA online, downloadable well logs, more data in SARIG.
• Developing the 2nd Edition of the Roadmap for Oil and Gas in SA – late 2017.

Please say G’day to the ERD reps at the DSD stand to discuss further.
South Australia’s door is open.

- Rated most attractive petroleum jurisdiction in Australia by Fraser Institute
- Bight Basin attracting billions in exploration investment
- Cooper Basin remains Australia’s largest onshore oil and gas province
- Oil and gas roundtable with hundreds of members working to address priorities
- Australia’s first roadmap for unconventional gas projects

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