PETROLEUM AND GEOTHERMAL EXPLORATION AND DEVELOPMENT IN SOUTH AUSTRALIA

ELINOR ALEXANDER, PETROLEUM AND GEOTHERMAL GROUP, PIRSA

PACE

www.petroleum.pir.sa.gov.au
A very brief history..

1836 – SA founded
1859 – Colonel Drake drills 1st successful oil well, Pennsylvania
1866 - First oil well in Australia drilled near Salt Creek SA
1883 - Geological Survey formed
1941 - SA petroleum legislation
1963 – Cooper gas discovered
1967 – First commercial gas discovered in SA - Caroline 1 CO₂
2000 – Modern legislation, Petroleum Act 2000
2003 – First geothermal well, Habanero 1
2009 – Petroleum and Geothermal Act 2000

Since 1970 (2009 dollars):
Hydrocarbon sales A$31.7b
Royalty $1.8b
(avg 6.8% sales value)
Shows in SA basins

Santos Wilkatana 1 (1955):
Cambrian oil shows focused interest on SA

Late Palaeozoic
Mesozoic
Neoproterozoic to middle Palaeozoic

Oil shows at Santos

Santos Ltd., has secured fresh oil showings from the No. 13 hole at Wilkatana.

This was announced by the company today.

The company’s petroleum engineer reports that the abundance of oil shows and globules referred to drilling mud cores taken from the No. 1 discovery bore, which is being bored by the rotary drill, has increased the interest in the area. The shows occurred in heavy consolidated terrane sands between 543 and 568 ft. of the oil reservoirs.

The No. 13 bore is 12,800 ft. east of the No. 1 discovery bore, and is the most easterly of a line of bores being extended towards the base of the Flinders Ranges.

Oil! * Oil!
PUBLIC LECTURE SANTOS
Operations at Wilkatana and Throughout Australia
Port Augusta Town Hall
Thursday, 6th December,
SPEAKERS:
M. S. Grey, B. J. Berryman, and R. C. Sprigg
COLOR MOVIE FILMS

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Then.... and now

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Wells in SA:

2,239 oil and gas wells
1,942 in the SA Cooper Basin
60 geothermal wells
SA’s PETROLEUM AND GEOTHERMAL PORTFOLIO

- Conventional oil and gas
- Gas storage
- Shale gas
- Tight gas
- Coal seam gas
- CO₂ sequestration
- Stratigraphic plays
- Old basins
- Coal gasification plays
- Gas to liquids
- Hot Sedimentary Aquifers
- Hot Rock EGS
New SA Cooper Basin licences and acreage release

- CO2009 bids closed 15 October 2009
- 11 companies applied
- Winning bids: 37 guaranteed exploration wells, ~1000km 2D seismic and 700km² 3D seismic

CO2010 Acreage Release

- 4 northern blocks are proposed for work program bidding
- Bids close 10th March 2011

UPSIDE

- More 4 way dip closed anticlines in data-poor areas?
- 3D seismic reveals new stratigraphic traps
- Coal Seam Gas, Shale Gas, In Situ Gasification of coals?
- Underlying frontier Warburton Basin?

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• No current onshore acreage release
• President Petroleum (Meridian) to drill Northumberland 2 soon
• Industry feedback sought on future onshore releases

Offshore Humpback Lead (Boult, 2005)
Officer Basin

“The last onshore Australian frontier”

- Two explorers active in the basin: Officer Basin Energy (Rodinia), Standard-Dawnpark (Ahava)
- Massive 2D seismic surveys since 2008 (in red)
- 4 known petroleum systems – 2 Cambrian and 2 Neoproterozoic
- Linc Maglia 1 oil show
- High risk, high reward – large structures
Linc Energy’s Maglia 1 oil show
Coal CSG, ISG, CTL

Permian, Triassic, Jurassic and Tertiary coal measures

CSG and ISG being actively explored with seismic and drilling:

- Winton Fm (AGL)
- Southern Cooper (Strike, drilled Forge 1 in 2010)
- Arckaringa & Walloway (Linc)
**SHALE GAS**

**Estimated world shale gas potential**

>16,000 TSCF, compared to 9,000 TSCF for CSG. *(Jenkins and Boyce, 2008)*

**Beach Energy**

First mover in Nappamerri Trough. Roseneath-Epsilon-Murteree (REM) play. **Encounter 1** drilling now to start evaluation, **Holdfast 1** to follow. Beach estimate potential gas in place >200 TCF in Nappamerri Trough (SA, Qld). Recent MOU with Itochu for SA LNG plant.

**Stuart Petroleum**

Significant shale gas potential in PEL 516. Estimate 38 - 60 TCF gas in place in the Allunga Trough-Mettika Embayment.

**Santos Ltd**

Reserves and resources, both conventional and unconventional, suggest at least 3Xs as much gas remains in the Cooper Basin than has already been produced.
COMPARISON BARNETT AND REM SHALE GAS PLAYS

Moomba 77 – Nappamerri Trough
Cooper Basin

Barnett Shale*
Siliceous mudstone
Type II source rock
Thickness: 250-500'
TOC Ave: 5%

REM*
Siliceous mudstone
Type II source rock
Thickness: 400-500'
TOC Ave: 5%

*From Beach Energy presentation “Cooper Basin Shale Gas”, Gordon Moseby, 30 March 2010

Wireline log through Barnett Shale from Kinley et al, 2008
“Hydrocarbon Potential of the Barnett Shale (Mississippian), Delaware Basin, west Texas and southeastern New Mexico” AAPG v92, No 8
### Thick Permian Coal Seams in the Cooper Basin: Future Energy Resource?

<table>
<thead>
<tr>
<th>Location</th>
<th>Details</th>
</tr>
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<tbody>
<tr>
<td>Battunga 1</td>
<td>- 23m coal seam&lt;br&gt;Woofawarra Formation (PP2.2)</td>
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<tr>
<td>Wimma 1</td>
<td>- Thick coals in the Toolachee Formation (PP5)</td>
</tr>
<tr>
<td>Blair Athol Coal Mine</td>
<td>- Western margin Bowen Basin, Qld&lt;br&gt;“Big Seam” (PP3.2) average thickness 29m</td>
</tr>
</tbody>
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From Mallett et al., 1995, “Bowen Basin” in *Geology of Australian Coal Basins*

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**Source:** J. Esterle

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ENORMOUS VOLUMES OF GAS TRAPPED IN DEEP COALS

Wimma 1 – Patchawarra Formation

- Total Gas
- 14m coal seam at ~3400m
- 2800 units Total Gas

Moomba 77 – Patchawarra Formation

- Total Gas
- 10m coal seam at ~2900m
- ~900 units Total Gas

Moomba 77 – Coal Frac, 100,000 scf/d, 9000 ft


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GEOTHERMAL PLAY INGREDIENTS:
1. Non-magmatic heat source,
2. insulating cover, and
3. reservoir combine to provide adequate heat flow rates to economically meet markets

‘HOT SEDIMENTARY AQUIFERS’ natural permeability in sedimentary reservoirs is sufficient to support economic flow rates.

‘HOT ROCK ENGINEERED GEOTHERMAL SYSTEMS’ (EGS) reservoir quality needs be enhanced with either physical or chemical stimulation methods to support economic flow rates.

http://www.panaxgeothermal.com.au
SA geothermal licenses

- 27 companies in 269 licences
- SA has 97% of work program investment and 70% of geothermal licences in Australia

TARGETS:

2012/13
- several successful exploration and proof of concept projects (i.e. heat energy flowed)
- Several power generation demo projects

2030
- 7% base load is geothermal power

2050
- >10% base load is geothermal power
SA BASIN DATA

PEPS online – free download
Petroleum and geothermal, includes production data

Well Completion Reports
Available for free download

WCRs include scanned mudlogs and composite logs (PDFs, TIFs etc.)

Well logs + Images
Core & thin section photos (free)

Seismic

Upholes (‘dot painting’)

Seismic shotpoints, stacks

SEGY, seismic sections

Mapped seismic horizons

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SA oil and gas production

Q. How to address falling production?