Structure, Stratigraphy and Petroleum Potential of the Central Officer Basin, South Australia*

Peter Boul1, Paul J. Bennett2, and Annelise Freeman2

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Abstract

Recent wildcat exploration drilling (2 wells) by Rodinia Oil has found the thickest section of Neoproterozoic aged rocks of any wells in the central and eastern parts of the Officer Basin. Thick sections of Neoproterozoic aged rocks are seen in Officer Basin wells in Western Australia, but these do not appear to have as complete a section as the two most recent wells in South Australia.

The Officer Basin was formed as part of the early Neoproterozoic Centralian Super Basin. An initial basin fill of coarse clastics and evaporates was followed by the deposition of finer mixed clastics and carbonates, glacial sediments and finally carbonates during the Cryogenian period. Latest Neoproterozoic sediments of finer clastics, incised canyon fill and mudstones are overlain in the recent wells by Cambrian clastics and Quaternary aeolian deposits.

The central Officer Basin was deformed by several major tectonic events since the early Neoproterozoic. The oldest of these events is manifested by the major Sturtian angular unconformity at the top of the Burra Group and may be equivalent in age to the Areyonga Movement as reported in Western Australia by Apak and Moors (2001). The second major structure forming event in the Central Officer Basin relates to the latest Neoproterozoic Petermann Orogeny that involved canyon formation and decollement on a thick salt layer near the base of the section. This major tectonic event was later amplified by similarly oriented movement during a third major event, the Devonian/Carboniferous aged Alice Springs Orogeny. Evidence of these tectonic events can be seen in the recent wells and seismic gathered by Rodinia Oil.
The two recent wells have added considerable knowledge to the understanding of the petroleum potential of the Officer Basin. In the Mulyawara-1 well continuous gas and oil shows were recorded throughout the middle and lower parts of the Neoproteozoic section, particularly in the Burra Group. In the Kutjara-1 well, gas shows with "heavies" were recorded throughout the entire mid Neoproteozoic in similar setting to the Mulyawara-1 well. Although commercial deposits were not encountered in the two recent wells, the presence of an active Neoproteozoic petroleum system has been convincingly demonstrated. Excellent reservoir properties were also established for the Murnaroo, the informally named Mulyawarra and the Pindyin sandstones, and the predicted continuous thick salt seal within the Callana Group was confirmed.

Reference

Structure, Stratigraphy & Petroleum Potential of the Central Officer Basin, South Australia.

By

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Rodinia’s Exploration Program

- 4045 km new seismic (2007-2011)
- 1363 km reprocessing (2011)
- 6153 km seismic interpreted
- 2 wells

Mulyawarra-1 – TD 2691.3 m
P & A with oil and gas shows

Kutjara-1 – TD 2453.7 m
P & A with oil and gas shows
Location – Rodinia’s permits - over Bouger Gravity

Neoproterozoic to Early Palaeozoic depocentre

Mulyawara
Kutjara

PEL 253
PEL 81

New & repro seismic

WA
SA

100 km
Western Officer Basin (SA)
Stratigraphic Column

**KEY**
- Limestone
- Sandstone
- Shale
- Glacial fill
- Dolomites
- Evaporite
- Canyon fill
- Halite
- Magnesite
- Potential Source Rocks
- Down-lap
- On-lap
- Oil Shows
- Gas Shows
- Wet Gas Shows

<table>
<thead>
<tr>
<th>Age</th>
<th>Seismic Horizon</th>
<th>Ma</th>
<th>Formation</th>
<th>Group</th>
<th>Simplified Lithology</th>
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**Isochrons**
Location – over Bouger Gravity
Western Officer Basin (SA) Stratigraphy & Strike Section (OBE-07-01)
West – East strike section highlighting the Sturtian Unconformity
Drilling results 2011
Drilling results 2011

Kutjara-1

Gas GR

OBE-07-01 OBE-10-56 OBE-10-32

EAST NORTH

Base Alinya Salt.

Top Mesoproterozoic.

34 km

Mulyawarra
Mulyawara-1 gas ratio logs

Drilled with Air / then air and water / then mud

Air drill to 1589m
Gas to 8.8%

Air and water to 1727 m
Western Officer Basin (SA)
Stratigraphic Column

**KEY**
- Limestone
- Sandstone
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- Evaporite
- Canyon fill
- Halite
- Magnesite
- Potential Source Rocks
- Down-lap
- On-lap
- Oil Shows.
- Gas Shows.
- Wet Gas Shows.

**Age**
- Cambrian
- Marinoan
- Sturtian
- Toronian
- Willoilian
- Mesoproterozoic

**Seismic Horizon**
- Formation
- Group
- Simplified Lithology

**Targets**
- Conventional
- Unconventional

**Isochrons**

**Bold horizons** = Key modelled / mapped horizon
**Minor horizons** = partially picked

**Targets**
- Oil Shows.
- Gas Shows.
- Wet Gas Shows.
Kutjara-1 – highlighted reservoirs

- **Meramangye Fm.**
  - Por = 13.3%
  - 950 m

- **Base Mulyawara Sst.**
  - Por = 21.5%
  - Por = 23.2%
  - 1850 m

- **Mundallio Fm.**
  - Por = 16.1%
  - 1450 m

- **Mundallio SGp.**
  - 1850 m

- **Pindyin Sst**
  - Por = 4.9%
  - 2225 m
  - Por = 10.8%
  - Por = 15.1%
Seismic mapping

- 16+ horizons (7 modelled)
- 9 Isochores (TWT)
- Surface attributes
  - Dip
  - Azimuth
  - Maximum curvature
- Faults
  - Predominantly thrust
  - Common strike-slip releasing (keystone)
  - Minor strike-slip restricting (pop-up)
  - Minor normal – mainly basement graben
### Western Officer Basin (SA) Stratigraphic Column

**Targets**
- Conventional
- Unconventional

**KEY**
- Limestone
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**Age**
- Camb
- Marinoan
- Sturtian
- Toronian
- Willouran
- Mesoproterozoic

**Seismic Horizon**

**Formation**
- Trainor Hill / Ouldburra
- Mena Mdst / Narana Fm.
- Dey Dey Mdst.
- Muranoo Sst. / Meramangyte Fm
- Tapley Hill Eq / Marinoan Reefs / Sturt Tillite Belair SubGp
- Myrtle Springs Fm.
- Mundallio SubGp.
- Emeroo Sub Gp.
- Alinya Fm.
- Pindyin Fm.
- Granite / Gneiss

**Group**
- MARLA
- UPLIFT
- Ungoolya Gp.
- Lake Maurice Gp.
- Glacial UPLIFT
- Burra Gp.
- Callanna Gp.

**Simplified Lithology**

**Isochrons**

- Bold horizons = Key modelled / mapped horizon
- Minor horizons = partially picked

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**Targets**
- Conventional
- Unconventional
Seven horizons gridded in detail

- Cambrian Unc
- Base Narana
- Murnaroo Mkr
- Sturtian Unc
- Top Emeroo Salt
- Base Alinya salt
- Top Mesoproterozoic
Sturtian Unc. – Mesoproterozoic

General thickening to west – unconformity cuts down to east

Salt tectonics

Glacial valley

North

15:1 20ms contours ~ 45m
### General thickening to north

#### Base Cambrian – Sturtian Unc.

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#### 15:1 20ms contours ~ 45m

- TWT (ms)
  - 300
  - 800

- North
20ms contours ~ 45m

Base Narana
Base Narana

10ms contours ~ 22m

Maggi Canyon. Correlates to Wonaka Fm. canyons in the Flinders Ranges
Base Narana

10ms contours ~ 22m
Base Narana

10ms contours ~ 22m
Base Narana

10ms contours ~ 22m

OBE-07-08 10:1
10ms contours ~ 22m
Base Narana

10ms contours ~ 22m
Base Narana

10ms contours ~ 22m

North
Base Narana

10ms contours ~ 22m
Base Alinya Salt
Base Alinya Salt - TWT

10ms contours ~ 22m
Base Alinya Salt - dip attribute

10ms contours ~ 22m
Base Alinya Salt - azimuth attribute

10ms contours ~ 22m
Base Alinya Salt - curvature attribute

Curve magnitude
Top Mesoproterozoic

10ms contours ~ 22m
Top Mesoproterozoic

10ms contours ~ 22m

Thrust faults
Top Mesoproterozoic

Thrust faults
Normal faults

10ms contours ~ 22m
Top Mesoproterozoic

Thrust faults
Normal faults
Keystone faults

10ms contours ~ 22m
Top Mesoproterozoic + Bouger Gravity
Top Mesoproterozoic + RTP TMI 1VD
Top Mesoproterozoic + RTP 1VD TMI
Top Mesoproterozoic + RTP 1VD TMI
Top Mesoproterozoic + overlying structural interpretation

Strike-slip lineaments  Keystone features  Pop-ups
Conclusions (1)

• A working petroleum system exists in the Callana / Burra Gps of the central Officer Basin.
  – Good reservoirs & excellent seals
  – Shows

• Main risk is charge & trap integrity
  – Understanding timing & structure
Conclusions (2)

- Charge
  - Marinoan – Early Palaeozoic

- Structure
  - Early extension (Willouran grabens)
    - Willouran aggredation
    - Torrensian progradations (two directions)
    - Sturtian uplift & glaciation
  - Early Marinoan SAG
  - Late Marinoan uplift and canyoning
  - Peterman uplift & thrusting > Cambrian unconformity
  - Cambrian extension – main depocentre to north
  - Alice springs orogeny – strike slip keystones and pop-ups
Where to now?

• Coventional
  – Many more structures to drill
• Unconventional?
Depth SS: Base Alinya Salt horizon

Available as A0 pdf
Depth SS: Top Murnaroo Sandstone

Detailed Depth SS Top Murnaroo Sandstone Map – Enclosure 11

Available as A0 pdf
Thankyou.

from

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