Mesoproterozoic Unconventional Plays in the Beetaloo Basin, Australia: The World’s Oldest Petroleum Systems*

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Abstract

Unconventional oil and gas shale plays have been mapped and confirmed by recent drilling by the Shenandoah well in the depocenter of thick Precambrian rocks in the Beetaloo Basin, Northern Territory, Australia. Only 12 wells have been drilled in the entire basin. Total depths rarely exceeded 2000 m, though at least 3000 m of potentially prospective section is present. Structural traps and conventional sandstone reservoirs have also been identified, as has a pervasive tight-sand gas play near the basin center.

Reinterpretation of the basin’s burial history based on new and existing 2-D seismic data has revealed substantial exploration potential from plays and leads that were not evaluated by earlier drilling. Highly encouraging shows were noted in several of these wells. Any production to be established would be among the oldest in the world.

Organic-rich shales and quartzose sandstones in the upper portion of the Mesoproterozoic Roper Group (~1.4 Ga) are the key objectives. Work on the burial history of these strata suggests that peak hydrocarbon generation may have occurred in the Jurassic, much later than previously thought, greatly increasing the potential for preserved traps.

The Shenandoah-1 was drilled by PetroHunter Energy in 2007 to a total depth of 1550 m. The well noted hydrocarbon shows in the Hayfield Sandstone at a depth of 780 m. This zone and significant oil pay zones in the upper Kyalla Shale at depths of 943 to 1020 m are regarded as highly prospective, with about 40 m considered to be an oil pay upon subsequent stimulation. The top of a Basin Centered Gas Accumulation (BCGA) was penetrated at the mid- Kyalla Sandstone at 1464 m with numerous gas shows.

Falcon Oil & Gas deepened this well as the Shenandoah-1A in 2009 to 2714M. Multiple gas zones in the lower Kyalla Shale, Moroak Sandstone and Velkerri Shale were noted. These include:
• Gas shows in the lower Kyalla from 1500-1718 m,
• A Moroak conventional gas play from 1717 to 2060m, with the upper 88 meters indicating high permeability,
• intermittent gas shows in Moroak sandstones to 2200 m,
• A Mid-Velkerri gas shale play from 2400 to 2558 m.
Results of the planned 2010 completion of this well are discussed.

References


Mesoproterozoic Unconventional Plays, Beetaloo Basin, Australia: The World’s Oldest Petroleum Systems

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If you have to leave early

The Beetaloo Basin has significant potential for both unconventional resources (oil and gas) and conventional structures

- 8.8+ million acres, the size of the Williston Basin
- 193 BBO In Place; 19 BBO Recoverable Resource*
- 385 TCF Gas In Place; 64 TCF Recoverable Resource*
- Three Total Petroleum Systems (Kyalla - 800M and Velkerri - 800M, Hayfield - 450M)—thermally mature for oil and gas
- World Class Source Rocks in Kyalla and Velkerri with Abundant Oil and Gas Shows
- Six Potential Sandstone Reservoir Units with Shows and Light Oil Recoveries

*Ryder Scott
Beetaloo Exploration Permits

Darwin LNG Facility

Natural Gas Pipelines

600 KM TO DARWIN

Northern Australia
Comparative Size

Beetaloo Basin
Australia

Williston Basin
USA & Canada
Wide distribution of oil and gas shows and tests throughout Basin.

This is an active hydrocarbon system.
Beetaloo Basin Stratigraphic Column & Petroleum Plays

- More than 3,000 Meters of Sediment in Basin Center
- Over 1,400 Million Years Old
- Peak Oil Generation is Less Than 200 Million Years Ago
- Early Rift Basin with Later Compressional (Transpressional) Structures
Two Thick Organic Rich Shales – Thick Self-Sourcing Reservoirs

Kyalla Shale
• Up to 800 Meters Thick
• TOC 2-3%, Thin Intervals to 9%
• Oil-Prone & Currently in Oil Window
• Highly Fractured

Velkerri Shale
• Up to 800 Meters Thick
• TOC Up to 12%
• Mature for Oil & Gas
• Gas Shale in BCGA
Source Rock – Shale Play Cores

Kyalla Oil Shales-Bed C
Jamison-1
1025.05 to 1028.93m

Mid Velkerri Oil Shales
Altree-2
993.96m to 938.2m
Jamison-1 is near basin center.

Kyalla oil/gas mature, Velkerri gas mature

after Thomasson, 2005
Beetaloo-- T_max vs. Depth

Law, 2010
Six Sandstone Reservoirs

- Bukalara Sandstone – ≤ 50M
- Hayfield Sandstone – 10M AVG.
- Jamison Sandstone – 75-160M
- Kyalla Sandstone – 15M AVG.
- Moroak Sandstone – <300M
- Bessie Creek Sandstone – 300M+
Jamison Sandstone Reservoir
Jamison - 1 Core

Oil Staining
Jamison Porosity
(core-derived)

4 wells
n=118
Moroak Sandstone Reservoir
Jamison - 1 Core

Oil Staining
Moroak Permeability (core-derived)

Permeability (md)

Depth (m)
The World’s Oldest Petroleum Systems (1.4Ga)

Mesoproterozoic oceans, continents, organic matter, sedimentary sequences different (the present is not the key to the past)

- Pre-vitrinite
- Interesting sulfate minerals related to high sulfur and low oxygen oceans
- Weird fossils and sedimentary structures
- Significant hydrocarbon potential, high TOC, high HI’s, good preservation of kerogen, kinetics different?

Exploring in a basin where virtually everything is a new discovery;
- aborted rift basin, not an intracratonic sag
- Unknown 175-km long thrust belt
Beetaloo Basin Paleography Compared to Major Neoproterozoic Producing Basins

Neoproterozoic~750 Mya

USGS Bull. 2201-C,F, 2167; PIRSA, 1998
Beetaloo Basin Rift Model
Burial History: AFTA

"Triassic-Jurassic event"
"Cretaceous event"
"Tertiary event"

Cessation of maturation in Precambrian source rocks at some time between 240 and 200 Ma:
Triassic - E. Jurassic

Duddy et al., 2003
Beetaloo Basin
Thrust Belt
(Daly Waters Arch)
Kalala Structure

Daly Waters Arch
Kalala
Shenandoah 1
Source Rock Kitchens

GA Bouguer Gravity
N-S Line 103

200 Km

Elliott #1  Jamison #1  Altree #1

Rift Margin

Jamison
Moroak
Bessie Creek

Rift Margin

South  North
Middle W-E Line

180 Km

Kalala
Shenandoah #1

Jamison
Moroak
Bessie Creek

Thrust Belt
Rift Margin

West
East
Upper Kyalla Shale Oil
Upper Kyalla Oil Zone

4.4 million net acres are in the oil window of the Upper Kyalla shale

Prospective area in basin (based on seismic mapping: Depth Structure Map on Upper Kyalla)

Additional prospectivity (based on gravity map)
Upper Kyalla Shale Oil Core

Kyalla Oil Shales-Bed C
Jamison-1
1025.05 to 1028.93m
Lower Kyalla Shale Oil
Lower Kyalla Oil and Gas Zones

3.7 million net acres are in the oil window of the Lower Kyalla shale
Shenandoah #1A
Mud Log Shows
Lower Kyalla Shale Gas

Core 1585-1594M

Good Gas Shows
1475-1711 M (236M or 719’)

Excellent Gas Shows
(Up to 1000 Units or 11% Gas
1575-1675M (100M or 305’)

1600M

1700M
L. Kyalla Shale Open Fractures
Shenandoah - 1A Core-1592M
Velkerri Shale Oil & Gas
Mid-Velkerri Oil and Gas Zones

Prospective area in basin (based on seismic mapping
Depth Structure Map on Mid-Velkerri)

3.1 million net acres are in the oil window of the Velkerri shale

Additional prospectivity (based on gravity map)
Mid Velkerri Oil Shales
Altree-2
993.96m to 938.2m
DEPTH vs. TOC –VELKERRI SHALE
Altree 2 Well

Total Organic Carbon (Weight %)

N=156
Mid Velkerri A & B Shale: Shows to 174 units
C1 to C3: 30,000 ppm
Shenandoah #1
Central Beetaloo Basin
Thank You

Falcon Oil & Gas
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