Asia-Pacific Unconventional Opportunities at $60 Oil
Comparisons between North American and Asia-Pacific Unconventional Opportunities

June 2018
Ian Cockerill
RISC’s Global reach and experience

2000+ completed assignments in more than 90 countries for over 500 clients worldwide
There are no hard lines between conventional and unconventional resources. Unconventional reservoirs share a lot of similar characteristics to conventional reservoirs:

- Zones of higher Porosity / Permeability
- Zones of higher Resistivity
- Zones of higher Pressure
- Regional structures or structural highs

It's not just a game of finding a shale and fracking the bejeezus out of it.
Unconventional potential resources correlation to conventional resources

Estimated Ultimate Recoverable Unconventional Resources

Estimated Ultimate Recoverable Conventional Resources

PERMIAN
GULF COAST
APPALACHIAN
ANADARKO
WILLISTON
ARKOMA
Unconventional potential resources correlation to conventional resources

Estimated Ultimate Recoverable Unconventional Resources

Estimated Ultimate Recoverable Conventional Resources

CONVENTIONAL RESOURCES IN ASIA-PACIFIC BASINS

US
CHINA
INDONESIA
PNG
AUSTRALIA
Oil price versus North American unconventional development

Weekly Average Oil Price (US$/bbl)

WTI
Oil price versus North American unconventional development
Oil price versus North American unconventional development
Global unconventional ‘interest’

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Technically Recoverable Shale Gas Resource (Tcf)

OIL PRICE

RELATIVE COMMERCIAL INTEREST
Leading North American unconventional plays

OIL PLAYS:
- BAKKEN
- MANSO
- NIOBRARA
- TMS
- PERMIAN
- EAGLE FORD
- SCOOPSTACK

GAS PLAYS:
- ANTRIM
- HAYNESVILLE
- EAGLE FORD
- COLORADO
- MONTNEY
- LIARD
- HORN RIVER
- POWDER RIVER
- GREEN RIVER
- BARNETT
- FAYETTEVILLE
- NEW ALBANY
- UTICA
- MARCELLUS
- MONTEREY
- MONTEREY
- DUVERNAY
- MONTNEY
- MONTNEY
- PIMIENTA
- PIMIENTA

1000km
Leading North American unconventional plays

Source: Consensus view from public domain information
Leading North American unconventional plays – Year of first production

Source: Consensus view from public domain information
Major North American unconventional plays

Some things to keep in mind

- Discrete zones of higher porosity /higher resistivity
- Plays are laterally heterogeneous
- Over-pressure. Rate more important than in-place
- Finding the balance in GOR. Rate versus product
- Areas of very mature conventional production – data / infrastructure / tolerant community stakeholders

*Logs presented at same scale. Source PXD*
Play heterogeneity

Source: Consensus view from public domain information
Break-even oil prices for new wells in North American plays

**KEY PLAYS**

- MONTNEY (CANADA)
- WOLFCAMP MIDLAND
- WOLFCAMP DELAWARE
- EAGLE FORD
- CRETACEOUS (CANADA)
- BAKKEN
- BONE SPRING
- NIOBRARA
- SCOOP/STACK
- DUVERNAY (CANADA)
- THREE FORKS

**RANGE OF BREAK-EVEN IN THE NORTH AMERICAN UNCONVENTIONAL PLAYS ($/BBL)**

- SWEET-SPOTS
- FRINGE

Source: Consensus view from public domain information
Breaking point in the Eagle Ford

100% of Eagle Ford break-even at $70> Oil

Source: Consensus view from public domain information
Breaking point in the Eagle Ford

58% of Eagle Ford break-even at <$70 Oil (4,634,000 acres)

Source: Consensus view from public domain information
Breaking point in the Eagle Ford

**OIL PRICE SLIDER BAR**

$30 $40 $50 $60 $70 $80

46% of Eagle Ford break-even at <$60 Oil (3,653,000 acres)

Source: Consensus view from public domain information
Breaking point in the Eagle Ford

31% of Eagle Ford break-even at <$50 Oil (2,508,000 acres)

Source: Consensus view from public domain information
18% of Eagle Ford break-even at <$40 Oil (1,482,000 acres)
Breaking point in the Eagle Ford

31% of Eagle Ford break-even at <$50 Oil (2,508,000 acres)

Source: Consensus view from public domain information
Breaking point in the Eagle Ford

46% of Eagle Ford break-even at <$60 Oil (3,653,000 acres)

Source: Consensus view from public domain information
Growth of the Eagle Ford

Eagle Ford 2007

Eagle Ford 2017

[Map of Eagle Ford 2007 with OIL WELL and GAS WELL markers]

[Image of Eagle Ford 2017 with lights indicating well locations]
Unconventional challenges outside of North America

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<tr>
<th>REGION</th>
<th>HIGHER COSTS</th>
<th>SERVICE SECTOR</th>
<th>REGULATORY FRAMEWORK</th>
<th>OPPOSITION</th>
<th>INFRA-STRUCTURE</th>
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<th>WATER SCARCITY</th>
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- Higher costs / Smaller service industry
- Poor regulatory framework
- Lack of infrastructure
- Lack of security
- Water shortages
- Low prices – Mexican gas prices are linked to those in the US. 4.5 BCF/D US Gas exported to Mexico*
- Contract sanctity (July 2018 presidential election, where energy nationalist Andrés Manuel López Obrador has been leading in early polls)

*US gas prices would be around $2 without Mexico exports
### Unconventional challenges outside of North America

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Asia-Pacific unconventional opportunities

**CHINA** – STATE DRIVEN EFFORT WITH MIXED RESULTS

**SE ASIA** – CHALLENGES IN INFRASTRUCTURE/LOGISTICS

**AUSTRALIA** – SIGNIFICANT EFFORT WITH POOR RESULTS (OUTSIDE OF CBM) AND CHALLENGING SOCIAL ISSUES
China – Sichuan Basin

**FULING (2012)**
- 13.4 TCF ESTIMATED RESOURCE
- 3.4 TCF ESTIMATED RECOVERABLE (8.8 BCF / KM²)

**WEIYUAN (2010)**
- 970 BCF ESTIMATED RESOURCE
- 240 BCF ESTIMATED RECOVERABLE (5 BCF / KM²)

**CHANGNING (2011)**
- 4.8 TCF ESTIMATED RESOURCE
- 1.2 TCF ESTIMATED RECOVERABLE (7.5 BCF / KM²)

Wells in the Wufeng-Longmaxi Formation yielding up to 19 MMSCF/D (98% Methane)
US equity bids $530M bid for SinoGas

US EQUITY firm Lone Star Capital has made a takeover bid for Sino Gas & Energy for 25 cents per share, valuing the company at close to $530 million — an offer the board unanimously recommended to shareholders this morning.

Helen Clark | 31 May 2018 | 11:58 | News

Sino's Lining development

Sino calls it "an attractive premium over recent trading prices" in the absence of a superior offer given it offers a 19% premium over Wednesday's closing price and 32% over the volume weighted average price of the last 30 days and a 47% premium over the past six months.

At the time of writing Sino's price had shot up over 15% and was hovering at just over 24¢, indicating the market had more confidence than some of the private investors in a phone conference this morning, who said they would not be accepting it.

Related Content
- US equity bids $530M bid for SinoGas
- US equity farms into Key's Marengo project
- Chinese bid for AVE

Topics (Select for more information):
Australian unconventional potential

2000km

EIA/ARI World Shale Gas and Shale Oil Resource Assessment

Technically Recoverable Shale Gas and Shale Oil Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States

INFRASTRUCTURE CHALLENGES
Historic Australian unconventional investment

2010 - $300MM
Conoco/ New Standard, Buru/Mitsubishi Hess, Fortsecue

2011 - $430M
Hess, Total, Statoil

2011 - $50MM
CNOOC/Exoma

2011 - $200MM
Alcoa, AWE, Norwest, Waarego

2012 - $340MM
Total/Central Santos

Over $2.3 Billion spent on Australian unconventional

Regional ‘Sweet-Spots’

Regional Infrastructure and Remoteness

Supporting Jurisdiction

Potential

Good

Fair

Challenging
Ongoing Australian unconventional interest

- **BURU AND MITSUBISHI**
  - LOWER LAUREL CLASTICS
  - TIGHT GAS PLAY

- **ORIGIN ENERGY**
  - BEETALOO VELKERRI
  - SHALE GAS PLAY

- **FINDER**
  - GOLDYWER SHALE
  - TIGHT OIL PLAY

- **KEY**
  - PERMIAN
  - TIGHT GAS PLAY

**Regional ‘Sweet-Spots’**

- **Potential**
- **Supporting Jurisdiction**
- **Infrastructure and Remote**
- **Challenging Fair Good**

**Location:**
- **Perth**
- **2000km**

**Jurisdiction:**
- **NT**
- **WA**
- **SA**
- **NSW**
- **VIC**
- **TAS**
- **QD**
- **COOPER**
- **CANNING**
- **GEORGINA**
- **OFFICER**
- **AMADEUS**
- **BOWEN-SURAT**
- **SYDNEY**
- **GALILEE**
- **PERTH**
Origin sitting on shale gas bonanza

MATT CHAMBERS
ENERGY
Off the outback Stuart Highway in the frack-free Northern Territory, it is looking increasingly likely that Origin Energy has discovered a world-class shale gas resource, comparable to those in the US just east of Daly Waters.

And while it would take at least five years to develop, even if an NT fracking moratorium is eased, it could be a play big part in balancing east coast gas supplies that are expected to struggle to meet demand over the next 20 years after the construction of export plants at Gladstone.

Known as the Beetaloo joint venture, Origin Energy estimates it has 6.6 trillion cubic feet (tcf) of contingent gas resources over 2000 square kilometres of ground. This follows the hydraulic fracturing, or fracking, and testing of Australia’s most successful shale well to date — the Amungee horizontal well. It was fracked just before the NT’s Labor government took power in September and, at least temporarily, banned the practice.

That is a lot of gas in itself, but the shale play that was tested, known as the Velkerri formation and holding the world’s oldest gas source rocks, extends over 17,000 sq km on Origin’s ground.

This means the resources could be expanded to eight times its current size, or about 50 trillion cubic feet of gas.

And it gets better. Slightly shallower than the 2.4km deep, 1.4 billion year-old Velkerri, sits another younger play, known as the Kyalla formation, at just 1.2 billion years old. It has not been horizontally drilled — the technique that made fracking viable in the US commercially viable — but recent testing of samples have given the surprise indication the liquids-shale has properties that can be fracked.

So Beetaloo could have some valuable liquids and “stacked” plays, which is the property that has made the Permian basin in West Texas the hottest ticket in US onshore oil of late, to the extent that extra expected production is weighing down oil prices.

The Australian
20 July, p17

Proterozoic shale gas plays in the Beetaloo Basin and the Amungee NW-1H discovery

Dave Flaws, Alexander J Clai, Elizabeth M Barsch, Carl M Ataun, Katt M Mahindar, Bronnie Richards and Rachael Ziv}. 

{ images: 
(a) 
(b)
Beetaloo Basin - Proterozoic Middle Velkerri tight gas prospect

Tier 1 (RQ&CQ) B Shale
- Thickness (m): 29.5
- TOC (%): 4.1
- Phi gas (%): 4.4-4.5
- Poisson’s ratio: 0.2
- Young modulus (GPa): 32.8

15 day test
Canning Basin - Carboniferous Lower Laurel tight gas prospect

YULLERRO TIGHT GAS DISCOVERY

VALHALLA – ASGARD TESTING

• Two vertical wells, 11 zones stimulated
• Commingled tests over limited period with gas flows between 0.5 – 3mmcf (unstabilised rates, wells still cleaning up)
• Indications of liquids component (25-38 bbls/mmcf commingled)
Canning Basin - Carboniferous Lower Laurel tight gas prospect

BURU YULLEROO TIGHT GAS PLAY AREA

YULLEROO 4  YULLEROO 3  YULLEROO 1  YULLEROO 2

TOP LOWER LAUREL CLASTICS

FRACKED AND FLOWED GAS FROM TIGHT SAND ON YULLEROO STRUCTURE

190km

MITSUBISHI VALHALLA TIGHT GAS PLAY AREA

VALHALLA NORTH  VALHALLA 1  ASGARD 1

FRACKED AND FLOWED FROM MULTIPLE SHALE ZONES APPARENTLY OFF STRUCTURE
Theia-1 acquired excellent data for analysis (now open file). A follow-up horizontal well (Helios-1) is planned to fracture stimulate and attempt to flow test the Goldwyer zone of interest (subject to WA WA fracking moratorium).
Immediate focus is on conventional Permian gas opportunities that are nearby to Barrolka, Marengo and other fields within ‘basin centred gas fairway’.
South East Asian onshore proven petroleum systems

North American Observations
- Proven hydrocarbon systems
- Big Unconventional resources will follow big Conventional resources
- Existing infrastructure
- Supportive industry framework and stakeholders
Indonesian unconventional potential

North American Observations

- Proven hydrocarbon systems
- Big Unconventional resources will follow big Conventional resources
- Existing infrastructure
- Supportive industry framework and stakeholders

Areas with proven petroleum significant discoveries (>200 MMBOE) and existing infrastructure
Areas with proven petroleum systems and existing pipelines
Areas with proven petroleum systems
Areas with no existing discoveries
Indonesian gas flaring

- Unconventional Gas development in areas of ongoing Gas Flaring
- Shorter term opportunity would be in finding a market for flared Gas
North Sumatra Basin – Potential unconventional resource targets

North Sumatra Basin Stratigraphy

CHRONOSTRATIGRAPHY

LITHOSTRATIGRAPHY

after Morrison, 2014
North Sumatra Basin – Quantifying unconventional resource potential

COMMON RECOVERY SEGMENT MAPPING

<table>
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<th>Control EUR Development Plan</th>
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<td>40.63 BCF</td>
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‘STACKING’ OF PARAMETERS INFLUENCING UNCONVENTIONAL RECOVERY

EUR potential per 2500m x 2500m cell

Melucut-1
Pertamina

BAONG EUR POTENTIAL
North Sumatra Basin – Quantifying unconventional resource potential

COMMON RECOVERY SEGMENT MAPPING

EUR potential per 2500m x 2500m cell

Melucut-1
Pertamina

BAONG EUR POTENTIAL

BCF/cell
- 0 - 2.5
- 2.5 - 5
- 5 - 7.5
- 7.5 - 10
- 10 - 12.5
- 12.5 - 15
- 15 - 17.5
- 17.5 - 20
- 20 - 22.5
- 22.5 - 25
- 25 - 27.5
- 27.5 - 30
- 30 - 32.5
- 32.5 - 35
- 35 - 37.5
- 37.5 - 40
- 40 - 42.5
North Sumatra Basin – Quantifying unconventional resource potential

Assumes –
- 2500m laterals at 400m spacing with a type curve distributions of 2BCF (low) – 6.5 BCF (mid) – 13BCF (high)
- Common Recovery Segment Mapping using multiple regional input factors
- Probabilistic resource estimate of between 1 and 2 working zones in the Peutu/Belumai
- Probabilistic resource estimate of between 1 and 3 working zones in the Baong
- Development efficiency of 40-80%

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Technically Feasible Estimated Ultimate Recoverable Resource
Some closing thoughts

- BIG unconventional hydrocarbon plays will **follow** BIG conventional hydrocarbon plays. North American unconventional systems are typically extensions of conventional petroleum systems

- **Low-cost business environments** for conventional plays will be the lower-cost areas for unconventional plays. Unconventional plays are about cost efficiencies

- **Heterogeneity** in unconventional opportunities can be seen at a global scale through to a play scale. Heterogeneity sets up opportunities. There are winners and losers

- Indonesia has good geological potential but infrastructure and cost challenges

- Australia has challenging geology, limited infrastructure, cost and above-ground stakeholder challenges

- China has good geology, a hungry market, industry support, but access to opportunities are limited

Oppportunities are created by those who see things differently