

# Technology review of the Northern Bowen and Galilee basins

Michael P. Scott, Raymond Johnson Jr, Janny Spilsbury-Schakel  
and Andrew Garnett

# Acknowledgement of Country

The University of Queensland (UQ) acknowledges the Traditional Owners and their custodianship of the lands on which we meet.

We pay our respects to their Ancestors and their descendants, who continue cultural and spiritual connections to Country.

We recognise their valuable contributions to Australian and global society.

*The Brisbane River pattern from A Guidance Through Time  
by Casey Coolwell and Kyra Mancktelow.*



# Premise of the work

- The owners of the gas resource (governments) wish to better understand the experience to date and the technical challenges to commercial flow in the Northern Bowen and Galilee basins.
- This paper, and a more detailed technology review report (Scott et al. 2023, *in prep.*), provide insight into current activities and uncertainties around past activities to support and evaluate proposals towards these.
- Evaluation is based on publicly available work.

# Overview

- Review of techniques used for drilling, completing and testing wells
- Large array of techniques trialled – what worked or didn't work and the associated analyses are poorly reported
- Horizontal drilling has been a key technology in commercial development

# Literature Review

- Significant information on the Bowen and Galilee basins
- Most has focused on geological aspects and resource potential of these basins (coal and petroleum)
- Minimal information regarding drilling and completion techniques
- GSQ Open Data Portal (identified as having gaps)
  - Well completion reports
  - Hydraulic fracturing activities completion reports
  - Production reports
- Poor reporting of lessons learned from trials

# Study Areas – this project

Index map

- Technology review divided into 6 main study areas
- 2 x Galilee basin A and B
- 4 x Northern Bowen basin A to D

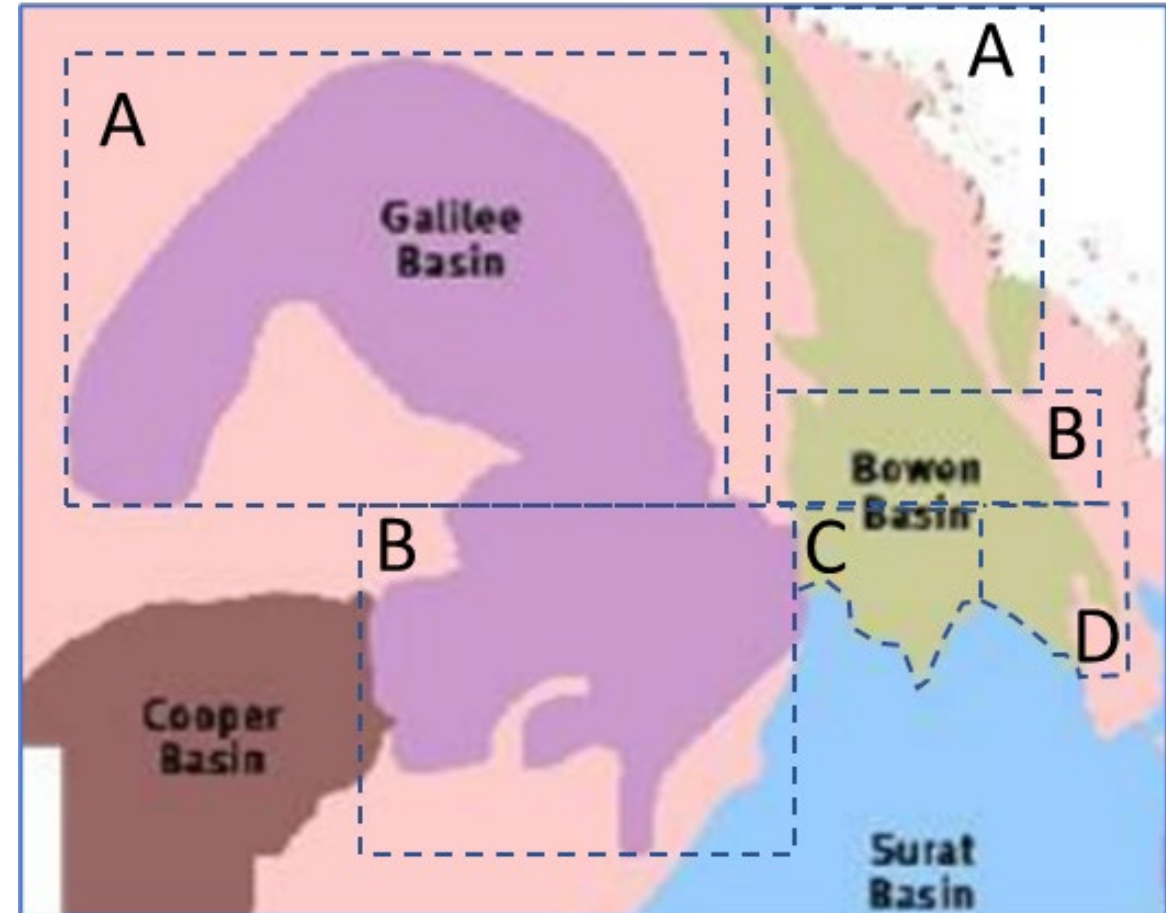
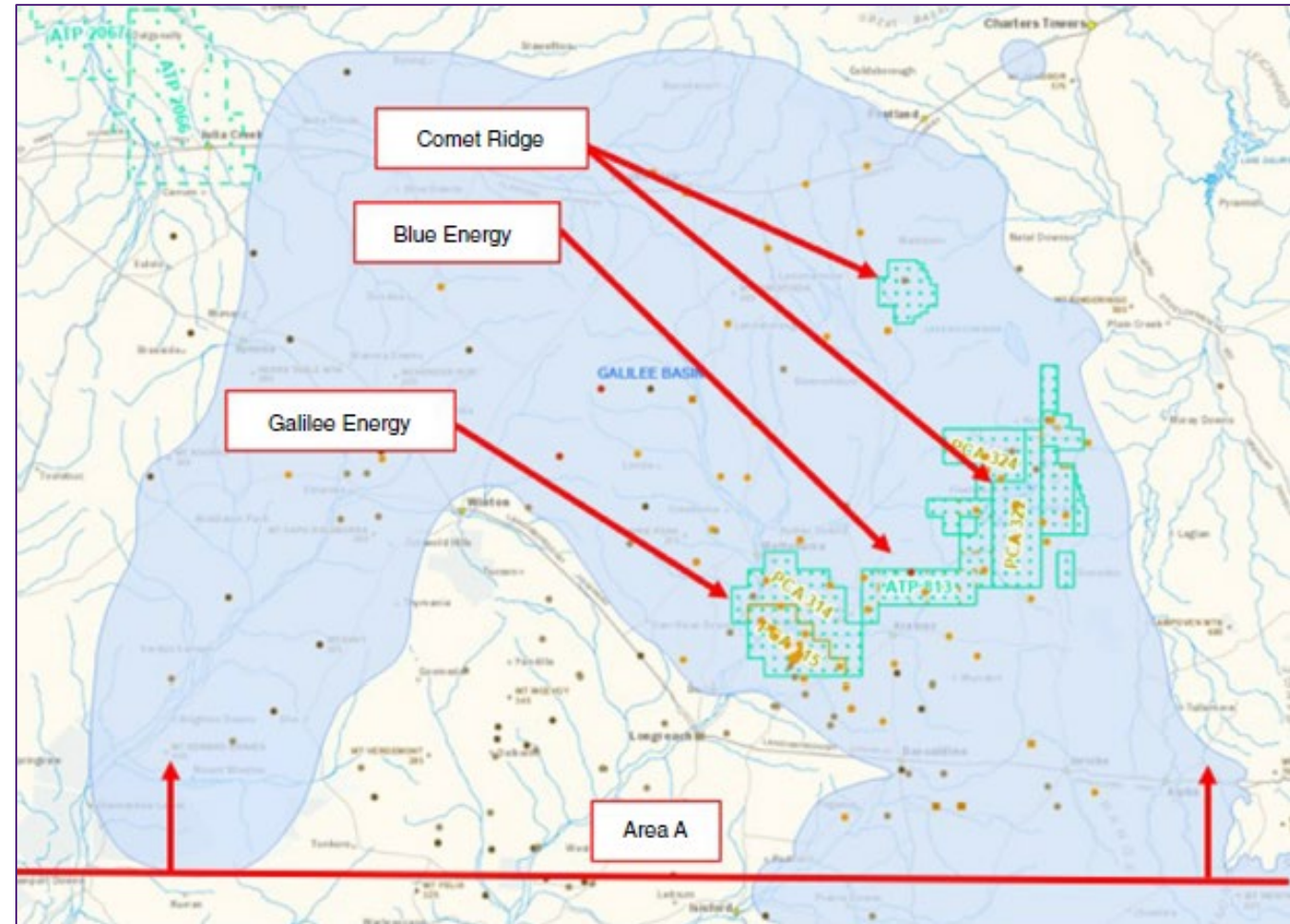


Figure 1: Index map for areas studied in this report (modified after L'Anson et al., 2016).

# Galilee Basin Area A

No commercial production yet

- Blue Energy
  - 6 CSG wells (2008 to 2013) targeting the Betts Creek Beds and Aramac Coal Measures
- Comet Ridge
  - Prior to Comet Ridge 4 other wells drilled (abandoned) and 3 CSG wells (2012 to 2014) that were cored and abandoned
  - 6 CSG wells with core and formation tests
  - Three other wells on the Albany structure (previous Carmichael 1) targeting Lake Galilee Sandstone
  - Albany 1 fracture stimulated ~230 mscf/day



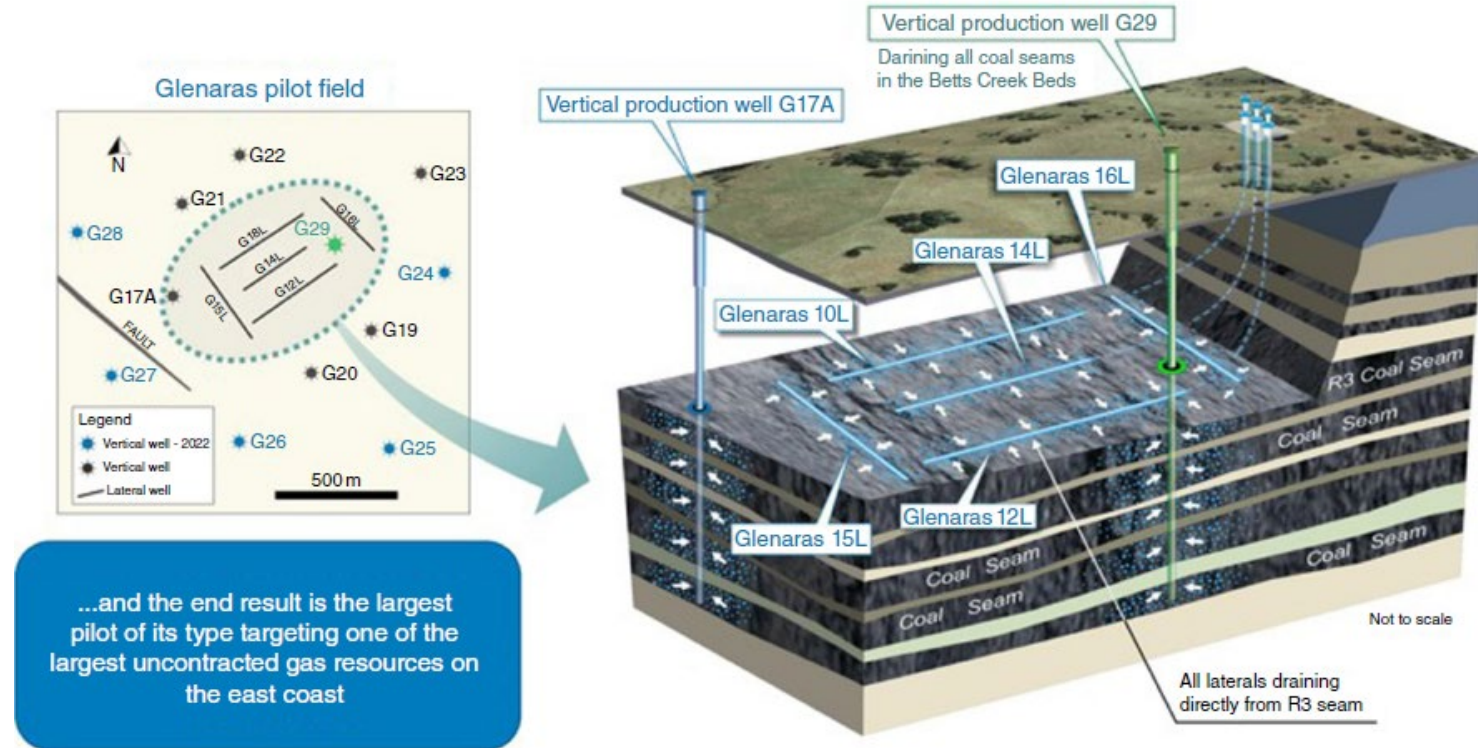
Source <https://georesglobe.information.qld.gov.au>

# Galilee Basin Area A

Galilee Energy Energy

No commercial production yet

- Mid 1990s Enron Energy drilled the initial Rodney Creek and Crossmore wells – Cased cemented and fracture stimulated
- **Betts Creek Beds and Aramac Coal Measures**
- 2000 – Galilee Energy – Rodney Creek 4 to Rodney Creek 7 – 7” fracture stimulated
- 2008 – AGL – 5 well pilot – mixture of cased, cemented and fracture stimulated and open hole, underreamed with 7” liner
- 2009 to 2011 – AGL – 7 well exploration program
- 2018 – Galilee Energy – 3 laterals from one pad
- 2019 – Galilee Energy – additional 3 laterals
- 2020 – Galilee Energy – 6 vertical wells



...and the end result is the largest pilot of its type targeting one of the largest uncontracted gas resources on the east coast

Source Galilee Energy Limited 2022

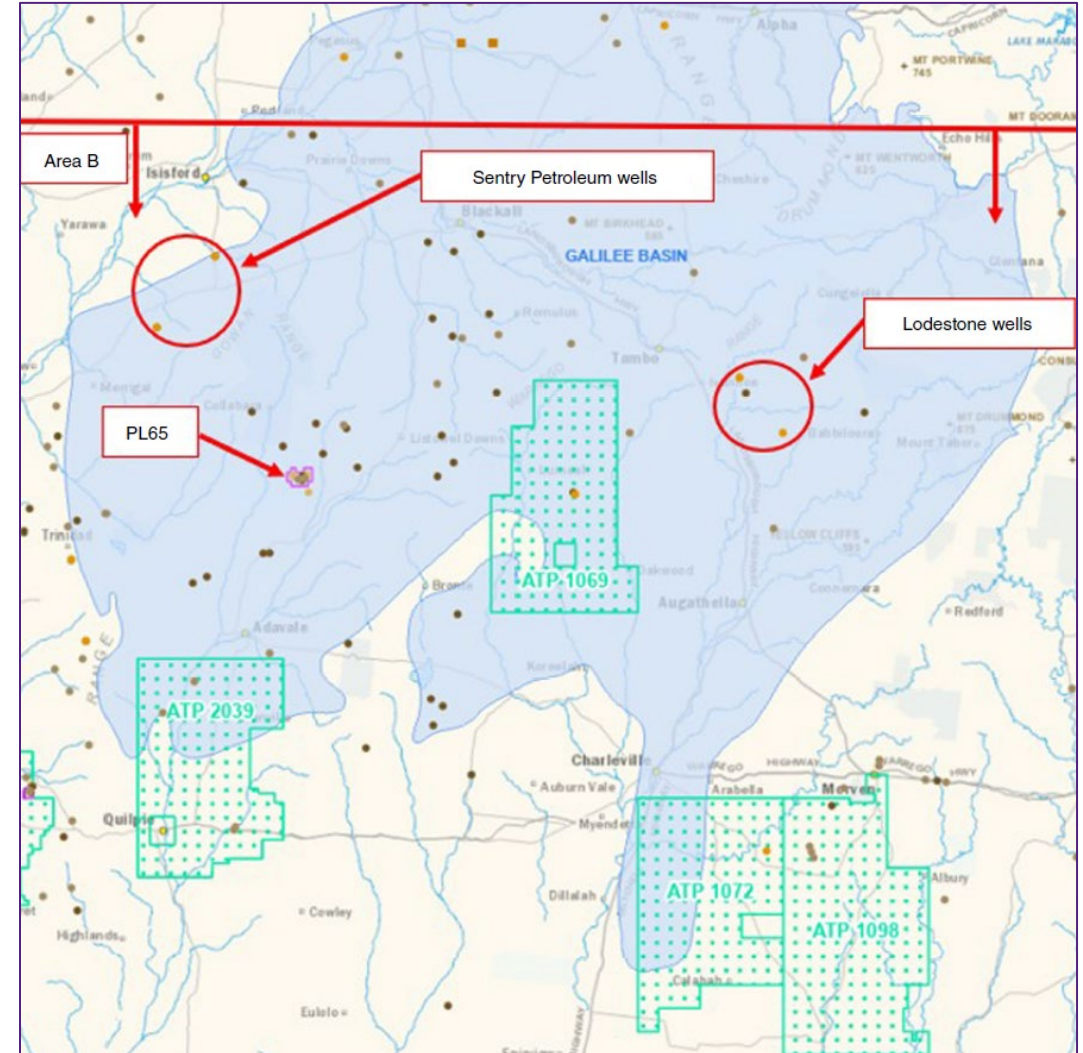
Pilot ~90 mscf/day (October 2022)



# Galilee Basin Area B

No Galilee basin commercial production rates have been achieved / reported

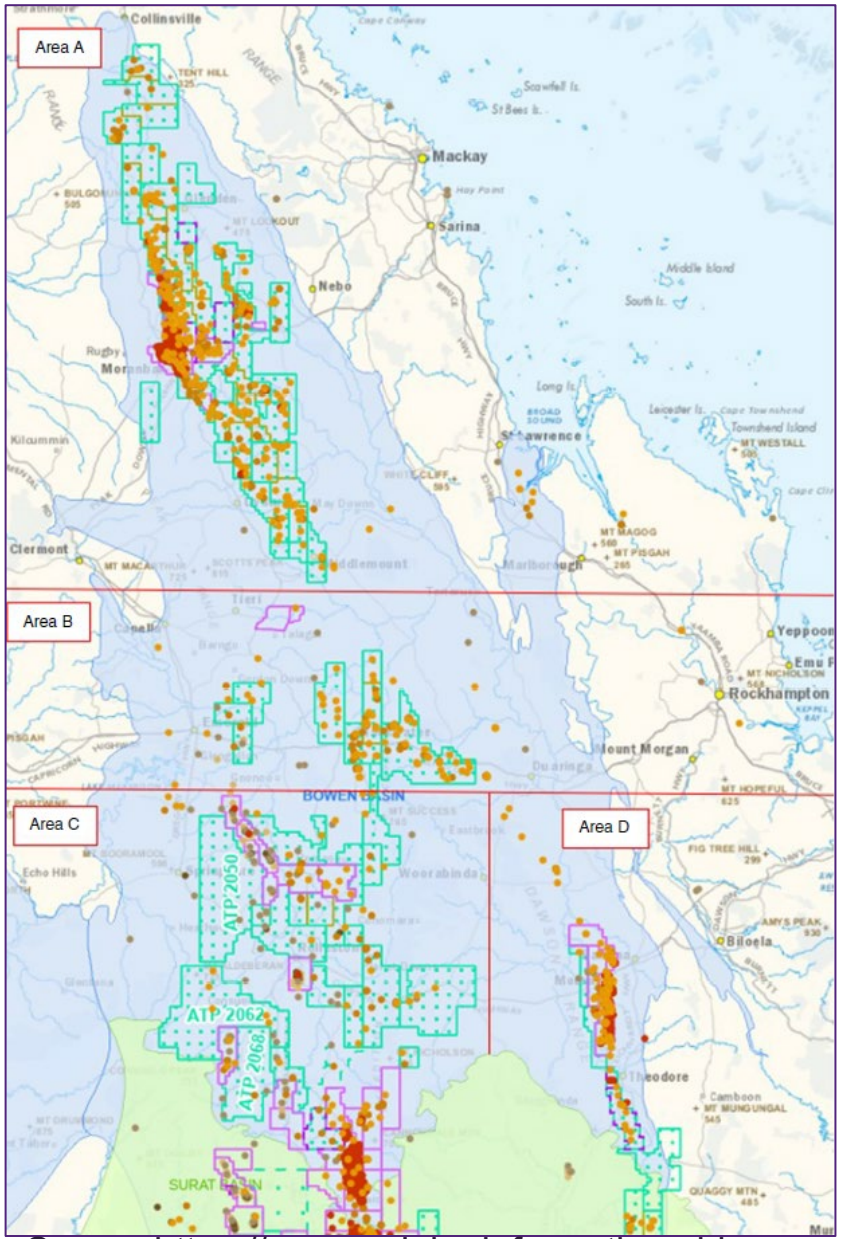
- Gilmore Gas Field in the underlying Adavale Basin (PL65)
- Outside current tenements 46 other wells (1920s to 1996) and 5 CSG wells (2009 to 2011) all abandoned
- Activities have not generally progressed past exploration work



Source <https://georesglobe.information.qld.gov.au>

# Northern Bowen Basin Area A

- Airlie Energy
  - Recently acquired ATP688 from Westside
  - Tilbrook and Mount Saint Martin wells
  - Exploration focus (cores and DSTs) though completed wells with SIS and vertical intercepts
- Blue Energy
  - ATP814 (3 PCAs and 3 PLs)
  - Monslatt and Sapphire wells targeting Moranbah Coal Measures, Rangal Coal Measures and Fort Cooper Coal Measures
  - Mainly exploration though recent pilots with vertical well with two horizontal intercepts with four laterals – “modified chevron intercept” design
- QGC
  - Foxleigh area
  - Rangal Coal Measures, Burngrove Formation and the Fairhill Formation
  - Three wells cased, cemented and fracture stimulated in 2013 with a coiled tubing straddle assembly. Short production test with low reported volumes.
- South32 and Peabody Pty Ltd – PLs overlaying mines

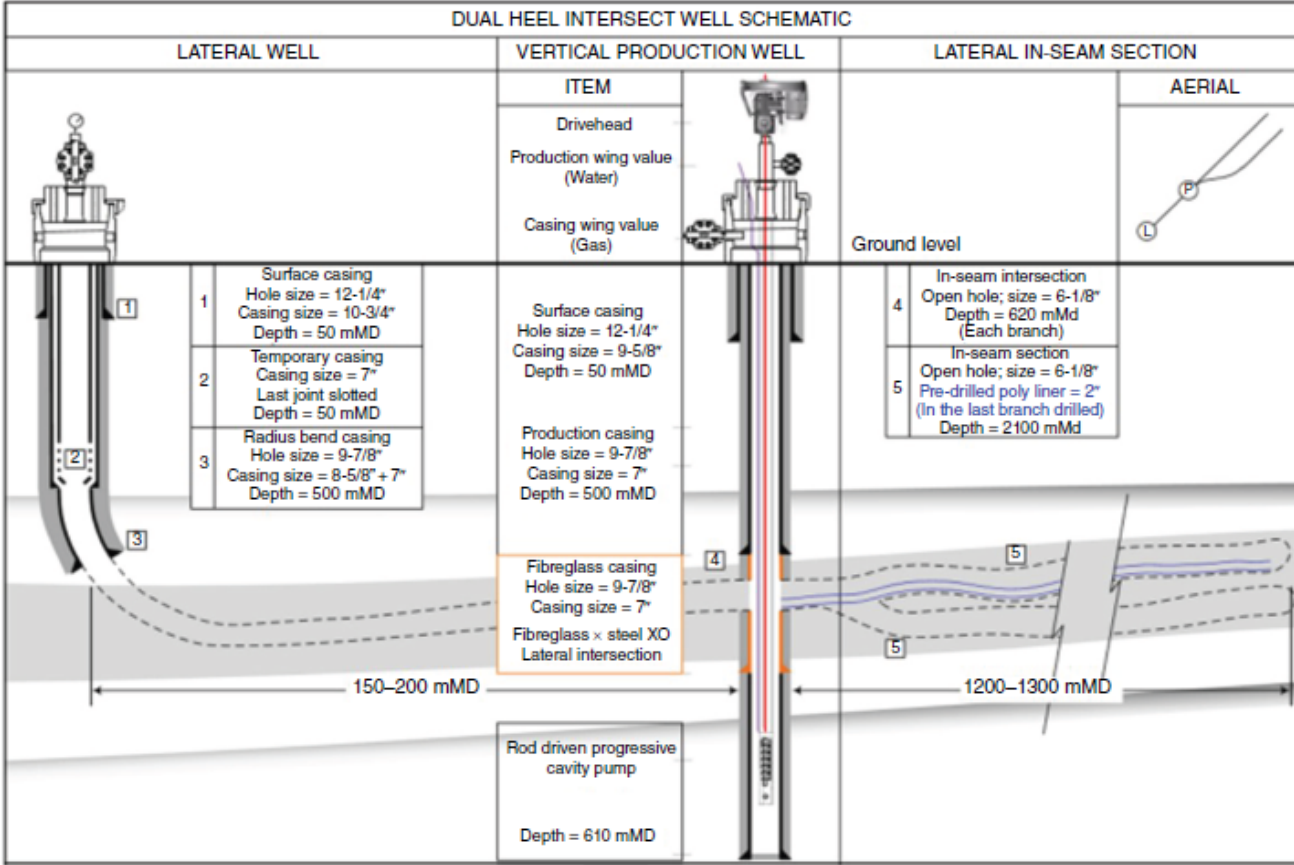
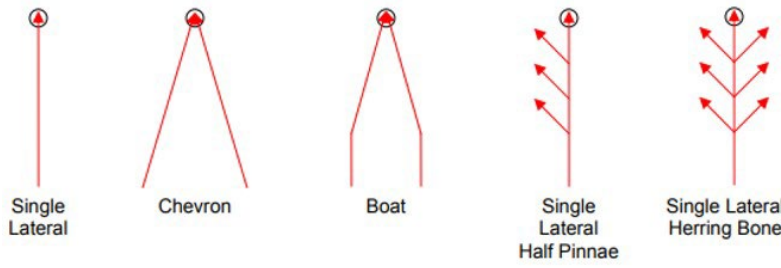


Source <https://georesglobe.information.qld.gov.au>

# Northern Bowen Basin Area A

- First CSG well, Broadmeadow 1 drilled in 1987
- Initial wells completed barefoot in single seams (Moranbah Coal Measures)
- Mud and air drilling, treated water and linear gel fracture stimulations, clean-out with air, acidisation, slug tests and injection/fall-off tests
- 1991 to 1994 – MGC Resources Australia Pty Ltd – nitrogen coal fracture stimulation
- 2000 – CH4 Pty Ltd took over operatorship of ATP364 and drilled their first wells
- 2001 – CH4 drilled their first SIS well GR6 (intersecting GR3) – 40mm slotted PVC liner run in lateral – first trialled in Moranbah North Mine
- Arrow Energy has continued SIS drilling techniques
- Vertical intercept wells – cased and cemented, slotted liner and gravel packed – drilled first and intercepted at the toe
- Branched laterals

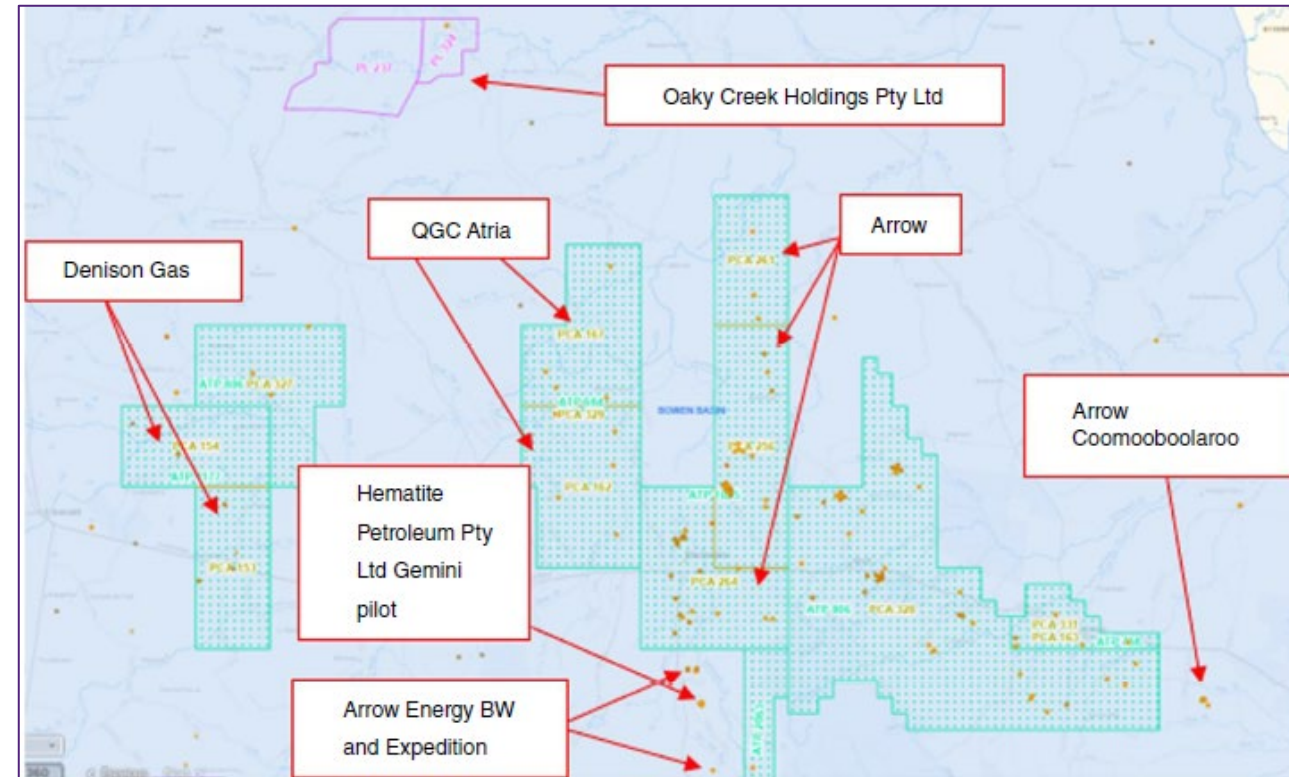
Source Arrow Energy Limited 2008



Source Lu et al. 2022

# Northern Bowen Basin Area B

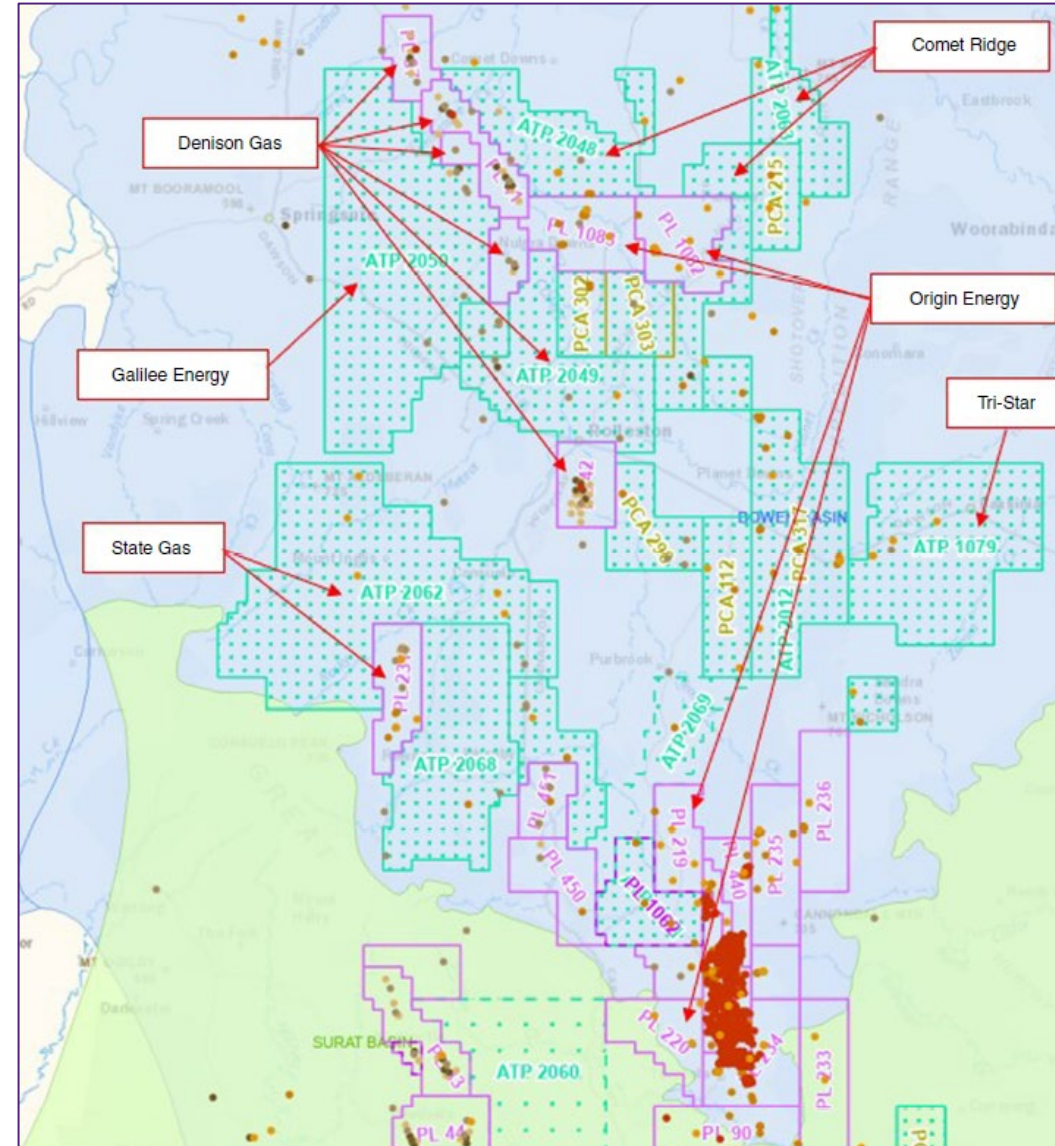
- 1980 – First CSG wells drilled in QLD – Gemini pilot
- Arrow Energy tenements
  - 1992 MIM Holdings
  - 2009 to 2013 Bow and Arrow Energy
  - Typically vertical exploration wells, some wells fracture stimulated and some SIS with vertical intercepts
  - Short production testing with low rates
- Denison Gas
  - 3 conventional wells drilled with air
  - 3 CSG wells targeting Rangal Coal Measures and Burngrove Formation
- QGC
  - Dingnonose, Duckworth and Liberty
  - Air drilling and hydraulic fracturing including diagnostics
  - No onsite activities since 2014
- Glencore PLs overlapping German Creek and Aquila coal mines
- **Appears no commercial rates to date and minimal activity in recent years**



Source <https://georesglobe.information.qld.gov.au>

# Northern Bowen Basin Area C

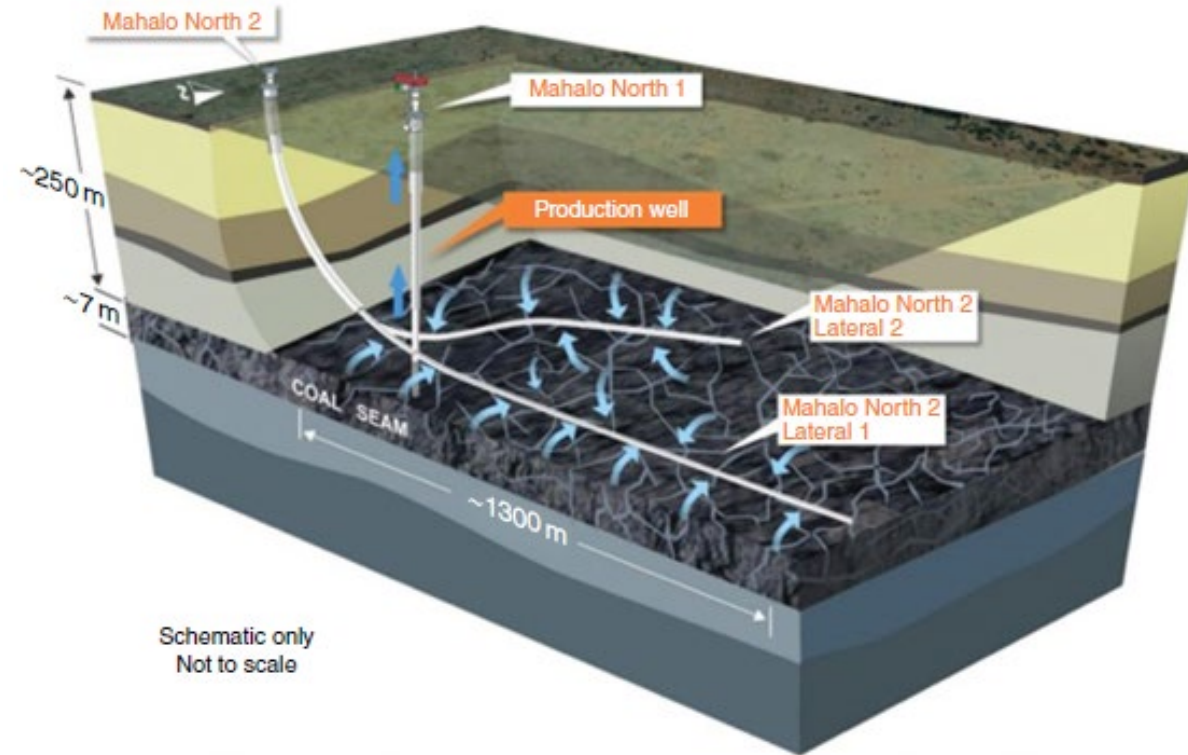
- Santos
  - Numerous techniques trialed
  - First CSG well drilled by Santos in 1993 (Comet Ridge 1 in Origin tenement)
  - 2000 to 2005 – Tri-Star and Tipperary drilled including cavitation, fracture stimulation and horizontal wells
- ✓ Arcadia gas project
  - Development drilling started in late 2017, typically cased and fracture stimulated with some deviated/horizontal wells
- State Gas
  - Multiple iterations to appraise and the develop the Reids Dome structure in PL231 back to 1954
  - Most recently State Gas has drilled 5 CSG wells including underreamed open hole wells with a liner
  - Conoco drilled 3 CSG wells in 1995 targeting Reids Dome Beds
  - Rougemont horizontal and vertical intercept targeting Bandanna Coal Measures
- Tri-Star Group
  - 4 CSG wells and one tight gas sand well that was fracture stimulated
- Origin Energy
  - 8 scattered CSG wells



Source <https://georesglobe.information.qld.gov.au>

# Northern Bowen Basin Area C

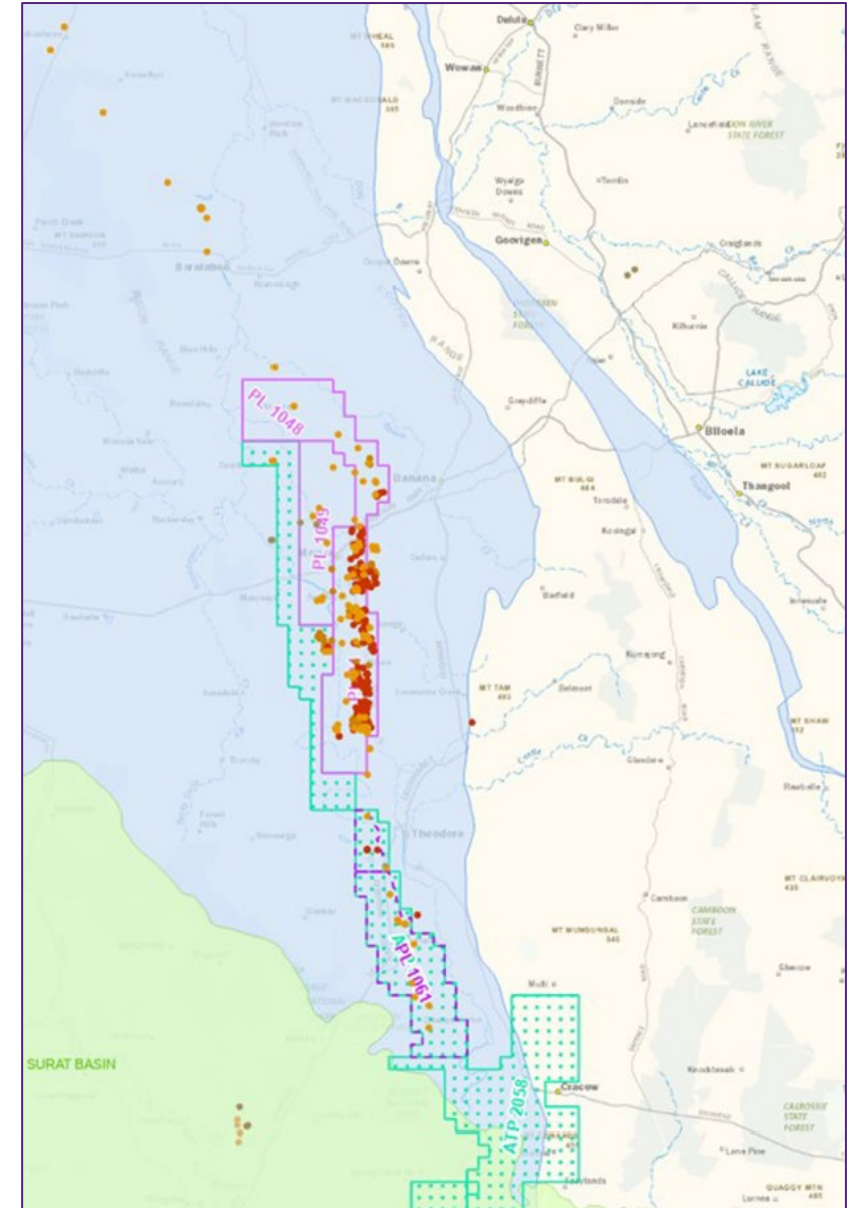
- Comet Ridge/Origin/Santos – PL1082 and PL1083
  - 2006 to 2008 – 4 Zerogen wells looking at carbon dioxide sequestration
  - Most recent wells (Mahalo North 1 and Mahalo North 2) drilled by Comet Ridge in late 2021.
    - Other activities including Humboldt South, Mira, Mahalo and Straun
  - 3-1/2" GRE run in the lateral
  - Open hole underreamed and horizontal wells
  - ✓ Mahalo North 1 shut in August 2022 >1.7mmscf/d
- Denison Gas
  - 5 PLs with 3 CSG and 47 other wells
  - Conventional fields (Rolleston, Springton, Arcturus, Turkey Creek and Yandina) – underbalanced drilling since 1997
  - ✓ Cased and open hole wells including dual completion strings
- Galilee Energy
  - Recently granted ATP2050
  - 7 historical wells, predominately exploration with air drilling on some wells



Source Comet Ridge Limited 2022c

# Northern Bowen Basin Area D

- Westside Corporation
  - Prior to 1998 multiple operators trialed cavitation and hydraulic fracturing
  - Mid-2000s Anglo drilled in-seam lateral wells
  - 2010 – Westside drilled down-dip SIS wells, then vertical fracture stimulated wells
  - 2011 – Drilled first up-dip, single seam lateral
  - 2017 – Drilled first up-dip, dual lateral
  - 2019 – Drilled first up-dip, tri lateral
  - ✓ Gorton and Martin 2022 – Meridian SeamGas project
- Senex Energy
  - No reported activity



Source <https://georesglobe.information.qld.gov.au>

# Northern Bowen – Test & Production Records

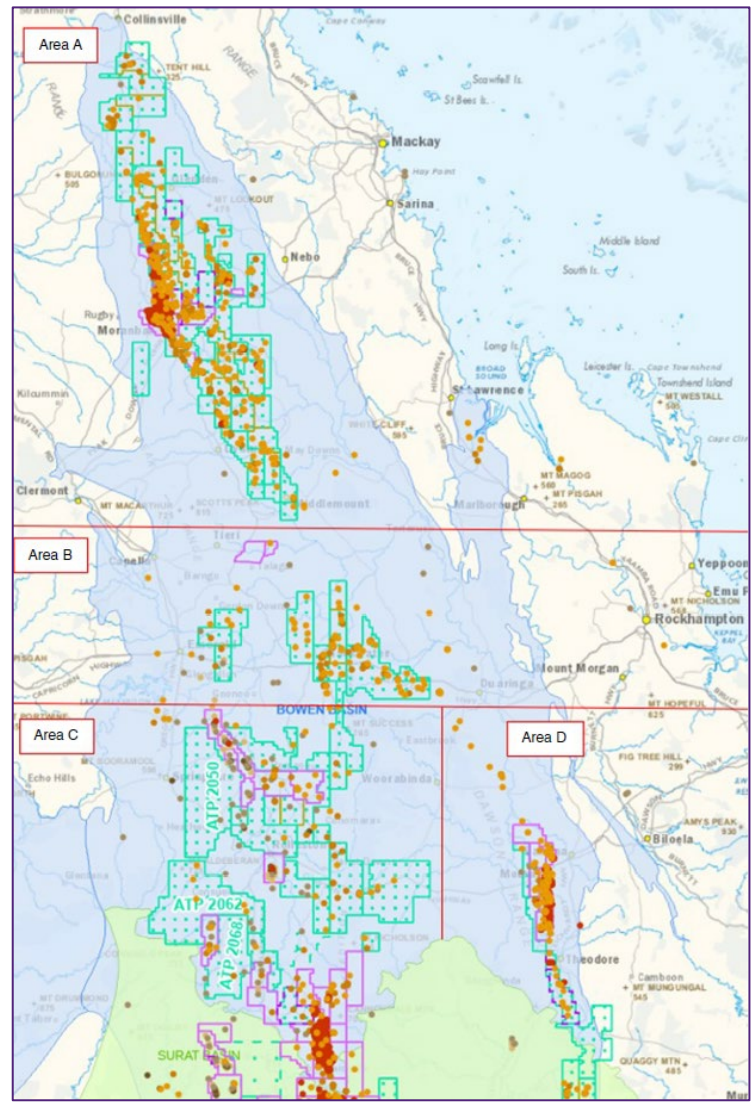
Assessment negatively impacted by quality/completeness of reported analyses

Table 1: Well Test Data

Northern Bowen Area	No of records of well tests	No. which record zero average rate (Mscf/d)	% of well test records which record zero flow
Area A - Moranbah	224	112	50%
Area B – Blackwater Emerald	40	21	54%
Area C – Rolleston Arcadia	125	27	21%
Area D - Moura	10	2	20%

Table 2: Production Test & Production Data

		Mscf/day/well		
		No. of records	Avg. gas rate (incl. zeros)	Max avg. rate
Area A - Moranbah	Prod. Test Data	224	34	1196
Area A - Moranbah	Production Data	1314	166	792
Area B – Blackwater Emerald	Prod. Test Data	40	11	120
Area B – Blackwater Emerald	Production Data	-	-	-
Area C – Rolleston Arcadia	Prod. Test Data	125	336	20466
Area C – Rolleston Arcadia	Production Data	164	290	1264
Area D - Moura	Prod. Test Data	10	14	56
Area D - Moura	Production Data	91	142	406





# Summary of techniques

- Open hole (including underreaming) and cased hole wells
- Hydraulic fracturing including the use of acid, nitrogen foam and indirect fracturing
- Cavitation
- Underbalanced drilling
- Horizontal wells and surface to in-seam well pairs as well as multi-laterals with numerous configurations such as chevron and boat well designs
- Shield wells to assist dewatering
- Fines mitigation techniques such as Foam-X
- Appraisal of carbon dioxide sequestration
- Dual completion strings

Horizontal drilling has been a key technology in commercial development in almost all areas

# Conclusions

- Significant private “at risk” funds have been invested (\$100s of millions) – many ‘zeros’ or ‘failed’ trials – enough lessons learned?
- Poor / no records of data and post-implementation analyses impacts negatively on area evaluation
- The good news:
  - Difficult plays can be opened (e.g. Moura) but this always requires multiple, often sophisticated technology trials.
  - Need to incentivise risk taking (resource and market policy settings).
    - This means incentivise private companies to take risk ultimately for the public good (aligned incentives).
  - To make it a ‘public good’ over time we need real learning in the public domain (licence obligations)
  - Industry and government need improvement in two main areas:
    - complete reporting
    - proper post-trial analyses (success and failure analyses)

# End

Professor Andrew Garnett

Director, UQ Centre for Natural Gas

[a.garnett@uq.edu.au](mailto:a.garnett@uq.edu.au)



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