The Nappamerri Trough, Cooper Basin unconventional plays: proving a hypothesis

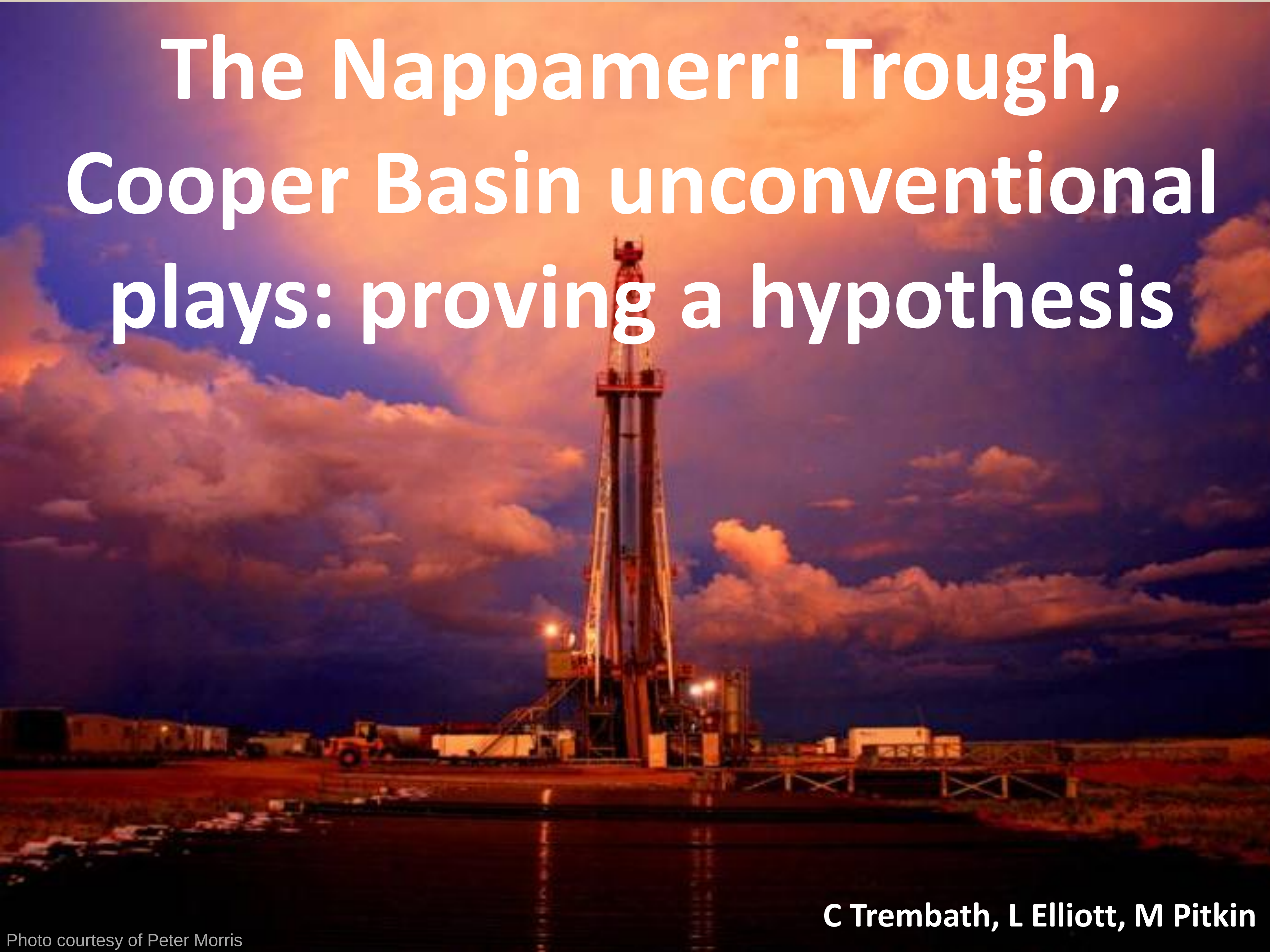

Photo courtesy of Peter Morris

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Outline

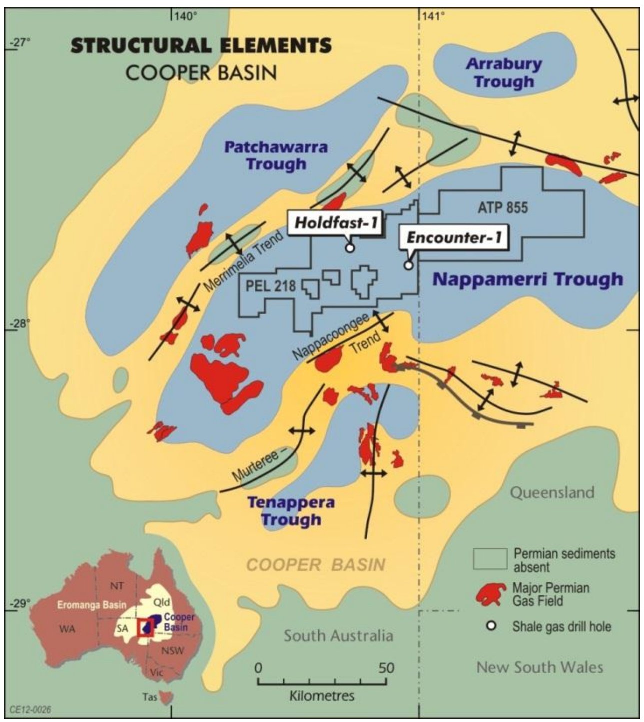
- Background
- Nappamerri Trough Geological setting
- Parameters for shale gas in place
- Parameters for shale deliverability
- Results of recent drilling campaign
- Forward program
- Summary

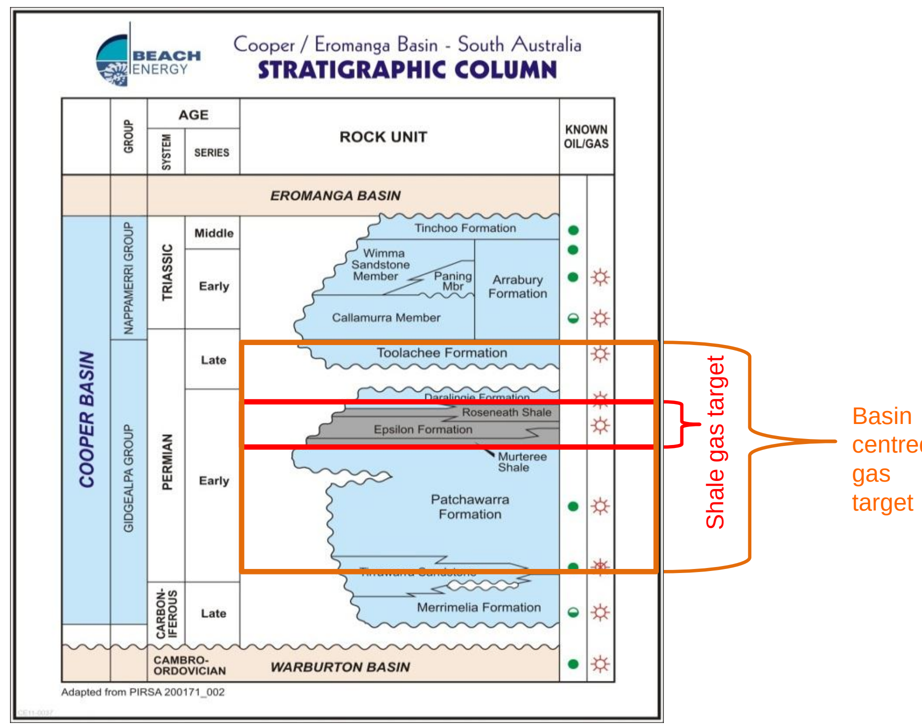
Background

- In 2007, Beach understanding the success of US shale gas developments, reviewed Australian basins for opportunities
- Beach identified technical key contributors to success
  - Shale thickness
  - Organic content
  - Mineralogy
  - Maturity
  - Over-pressure
- Nappamerri Trough came to the top of the list and was further high graded due to potential of low permeability sands being part of a basin centred gas play
- Beach farmed into two large permits in the trough in 2008 and 2009 and commenced exploration activities in 2010

Nappamerri Trough- geological setting

- The deepest and largest of the northeast-southwest trending troughs in the Cooper Basin
- Thick Permian section of coals, siltstones, sandstones and shales
- Roseneath Shale, Epsilon Formation and Murteree Shale (REM) were the initial focus for shale gas





Parameters for gas in place

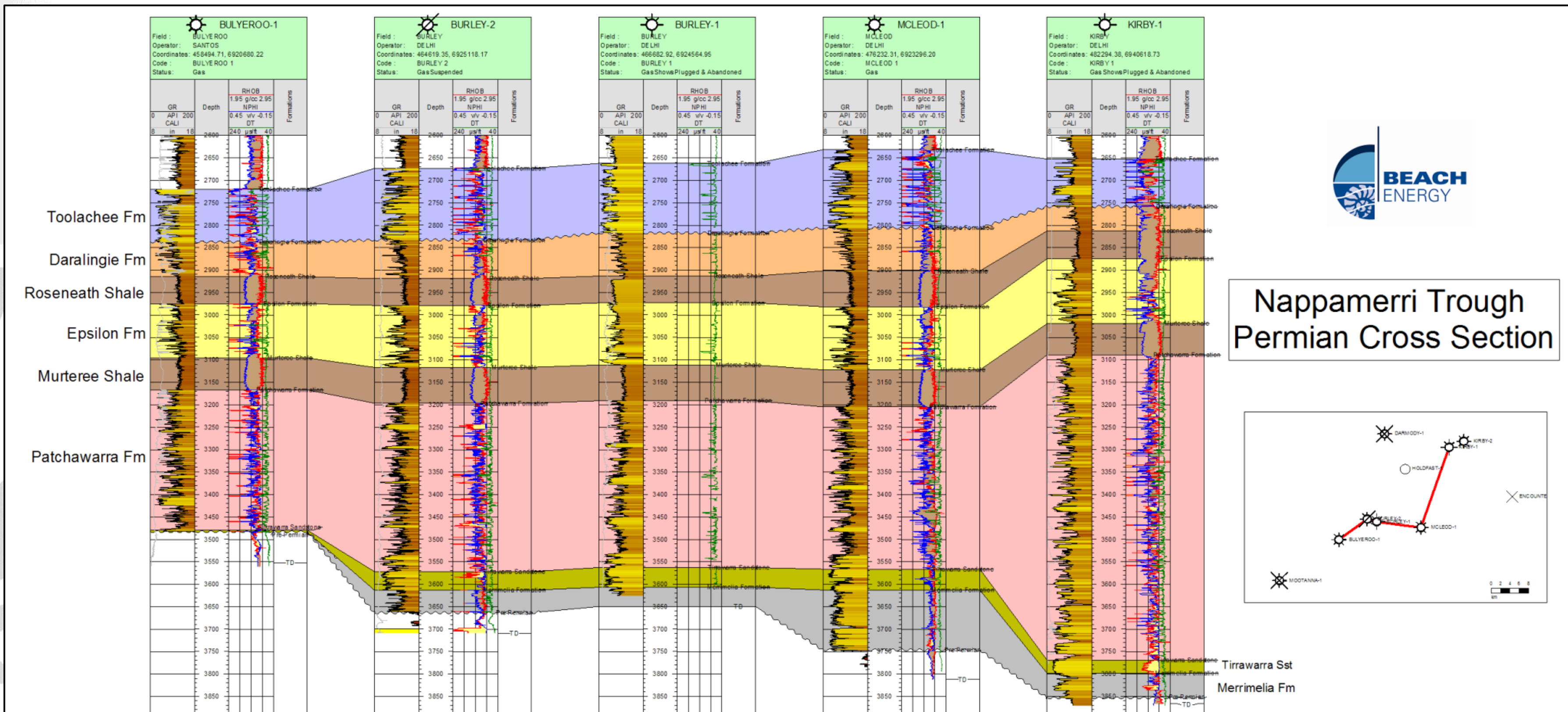
- Shale thickness
- Lateral continuity
- Organic content
- Maturity

$$GIP = A * h * \rho * GC_t$$

- Gas in place (GIP)
- Drainage area (A)
- Reservoir thickness (h)
- Bulk density (ρ)
- Total gas content (GC_t)

Shale thickness and continuity

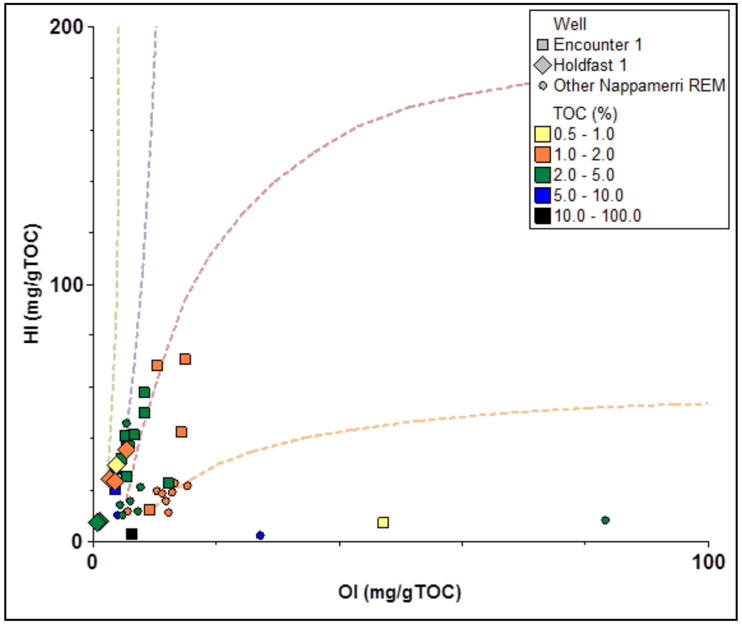
- Individual shale units of about 70-190m thick present across all of the permit area (PEL 218 ~1,600km^2)
- Moonta-1ST1 recently intersected 269m of shale in the REM
- Average Epsilon Formation thickness of 130m



Organic content and maturity

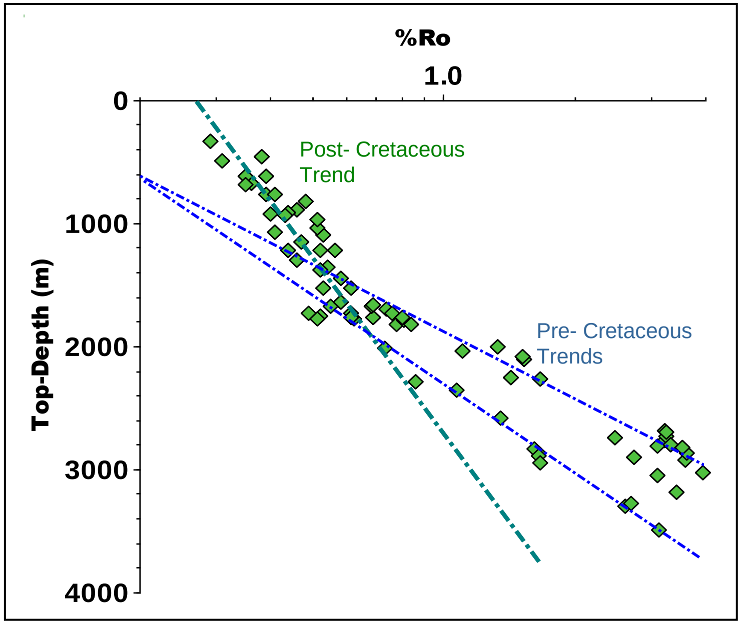
Organic Content

- TOC range typically 2-4% in shales, can get up to 9%
- TOC considered very good given the maturity
- Type II/III kerogens dominate



Maturity

- Variable maturity gradients in Permian section
- Prospective REM section 2-4% Ro
- Dry gas window



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Parameters for gas in place

- Shale thickness
- Lateral continuity
- Organic content
- Maturity

$$GIP = A * h * \rho * GC_t$$

- Gas in place: GIP
- Drainage area: A
- Reservoir thickness: h
- Bulk density: ρ
- Total gas content: GC_t

Shale parameters

Parameters for gas in place

- Shale thickness
- Lateral continuity
- Organic content
- Maturity

Parameters for deliverability

- Maturity
- Overpressure
- Mineralogy

Gas in place
Drainage area
Bulk density

$$GIP = A * h * \rho * GC_t$$

Reservoir thickness
Total gas content

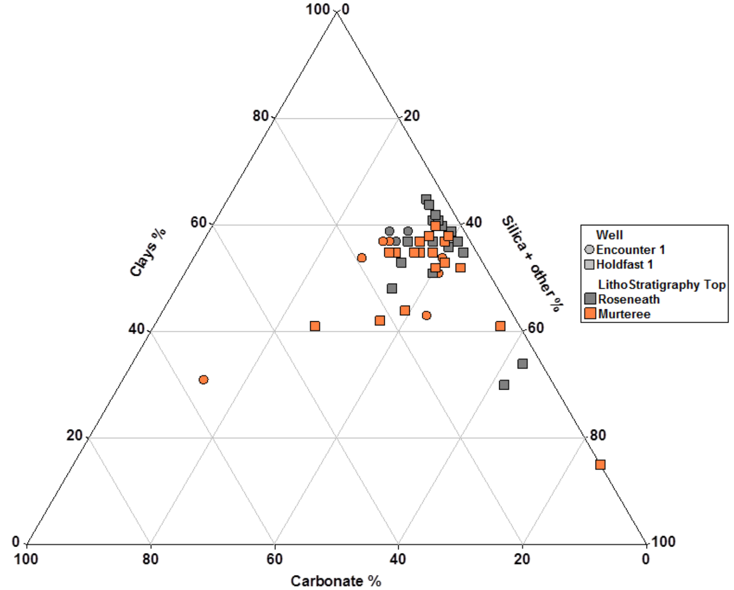
Permeability
Cross-sectional area

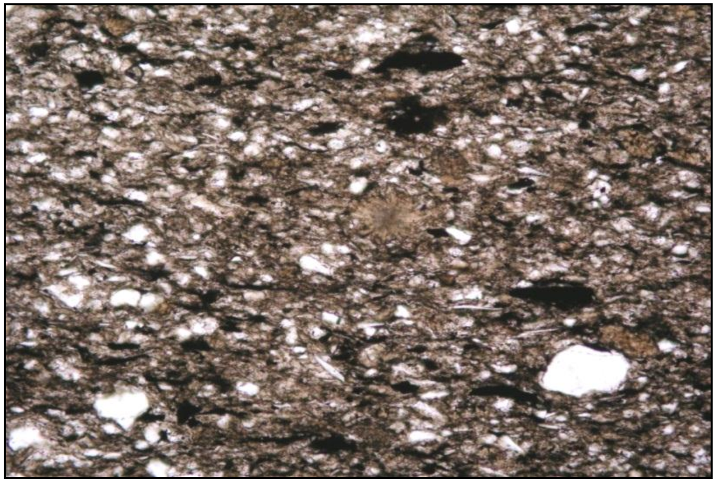
$$Q = \frac{k * A * \Delta P}{\mu}$$

Pressure Gradient
Volumetric flow rate
Viscosity of flowing fluid

Mineralogy

- High silica and siderite content is beneficial for successful fracture stimulation
- Absence of swelling clays beneficial for drilling, stimulation and production
- Very little variation in composition between shales and between wells
- Illite 40-50%, Quartz 30-40%, Kaolinite 10-15%, Siderite 5-10%

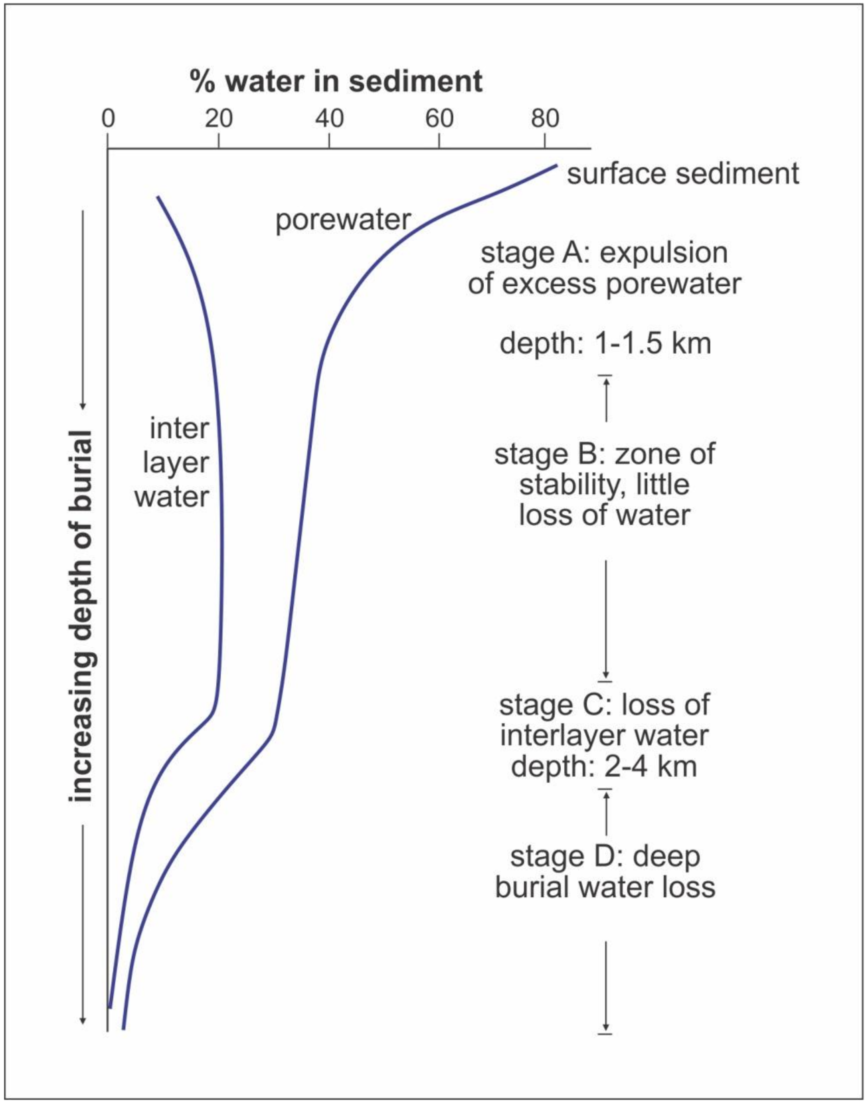




Encounter-1. Clays and siderite (brown), silt size grains (white) and organic matter (opaque)

Maturity for deliverability

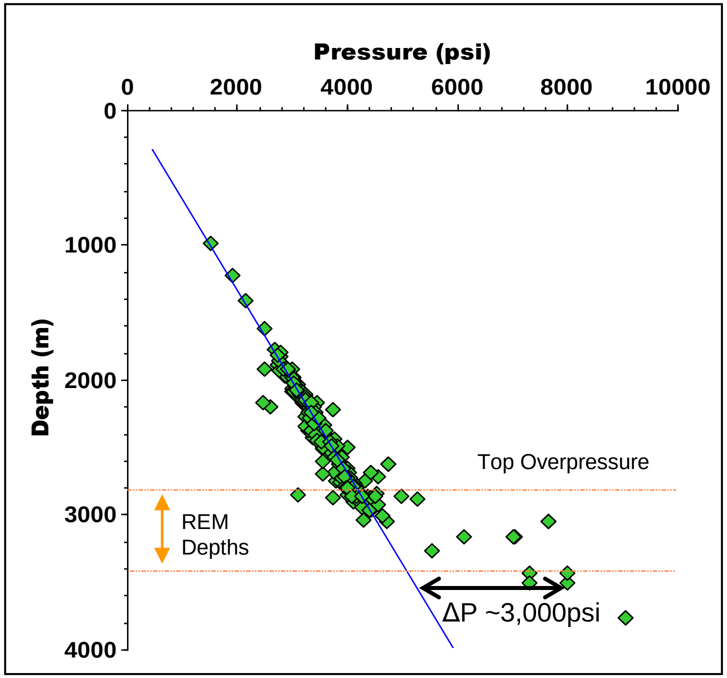
- With increasing maturity expect enhanced dewatering and dehydration of clays
- Loss of capillary water enhancing permeability
- Fluid viscosity is a function of maturity
- Methane is less viscous than wet gas and all things being equal, methane will flow better
- High level of maturity enables abundant gas generation creating over-pressure

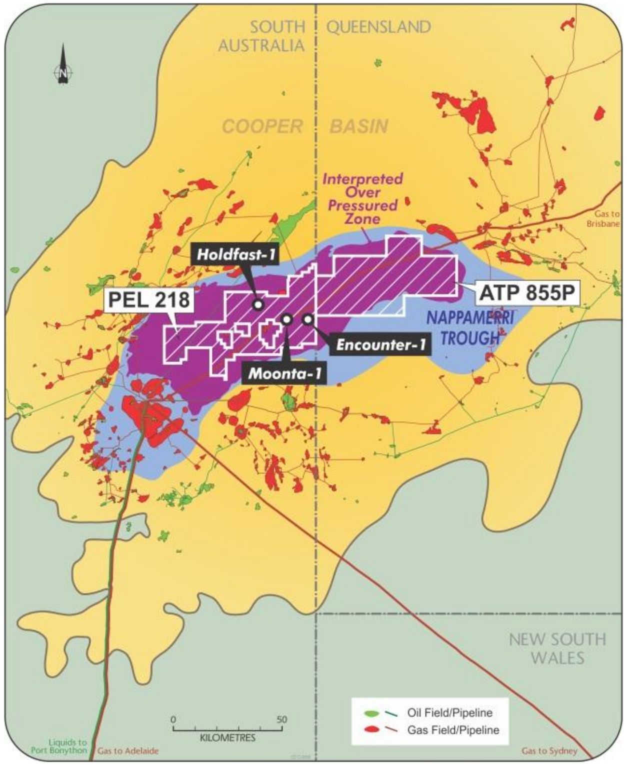


Source: Tucker.M, Sedimentary Petrology, 1998

Over-pressure

- Over-pressure created by hydrocarbon generation
- The pressure gradient in the Nappamerri Trough is ~0.72 psi/ft
- Over-pressure necessary for gas drive
- Preservation of pore throats during compaction enhancing permeability



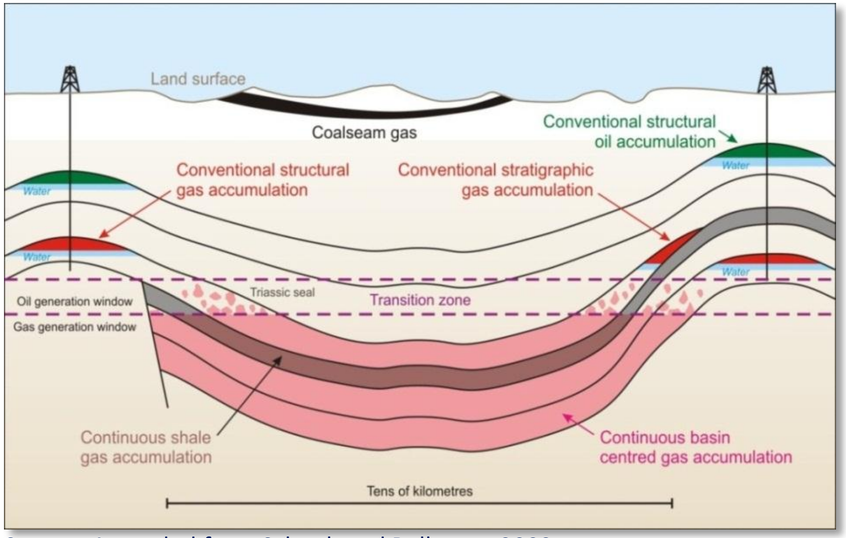


2010-2012 drilling results

- Encounter-1 (2010), Holdfast-1 (2011) and Moonta-1ST1 (2012)
- Permian target section gas saturated and over-pressured
- Holdfast-1 fracture stimulated and flowed gas to surface at up to 2 MMcfd
- Encounter-1 Patchawarra Formation fracture stimulated and flowed up to 0.75 MMcfd
- Moonta-1ST1 preliminary results indicate gas saturated Patchawarra Formation

Basin centred gas confirmed

- Conventional exploration wells drilled in the Nappamerri Trough intersected gas saturated, low permeability sands in the Epsilon and Patchawarra Formations



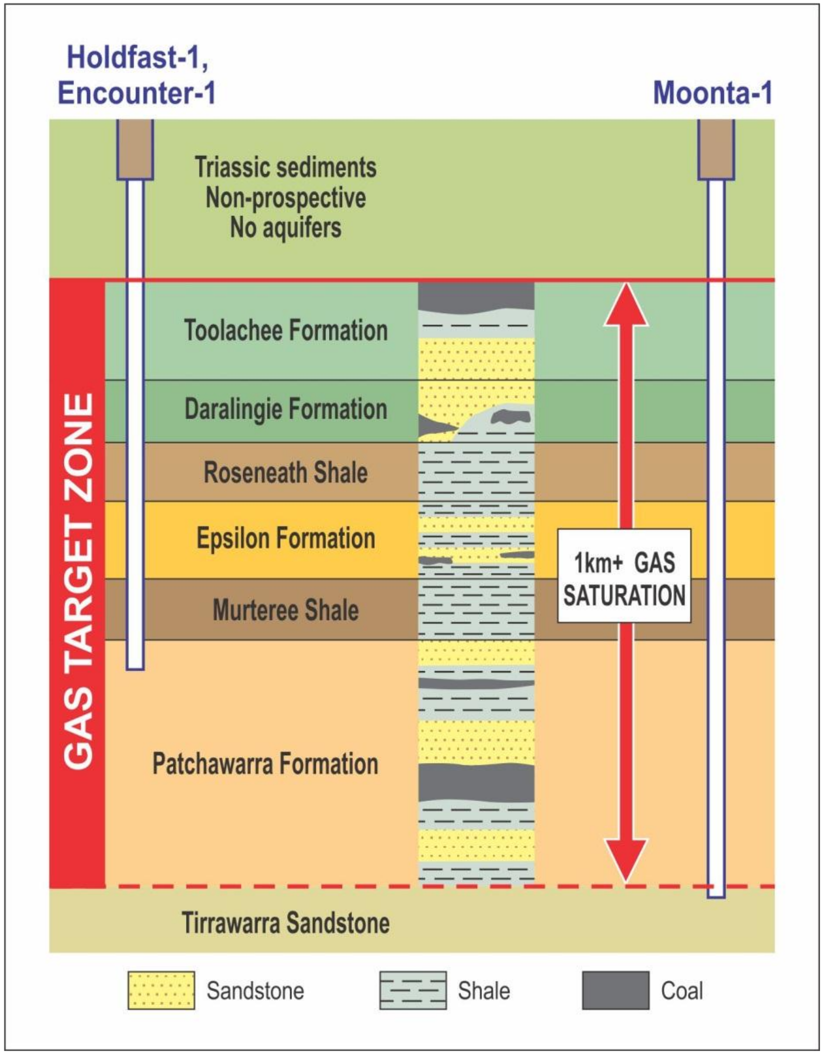
Source: Amended from Schenk and Pollastro, 2002

- Lack of recovered formation water plus over-pressure indicated the Nappamerri Trough had the potential to be a large basin centred gas play[1]
- Encounter-1, Holdfast-1 and Moonta-1ST1 intentionally drilled outside of structural closure to test the concept and intersected gas saturated sands in the Epsilon and Patchawarra Formations

1. HILLIS, R.R, et al, 2001 - Deep basin gas: a new exploration paradigm in the Nappamerri Trough, Cooper Basin, South Australia, APPEA Journal 41 (1), 185-200.

2012 exploration/appraisal

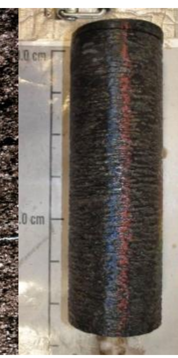
- A minimum of five vertical wells to assess the full extent of the gas saturation in the Patchawarra Formation
- Expand understanding of shale properties across large permit area
- Two horizontal wells to be drilled and fracture stimulated in PEL 218 in 2012 (one each next to Encounter-1 and Holdfast-1)
- Vertical wells to be sequentially fracture stimulated for individual zone assessment



Summary

- Decisive and aggressive exploration
- Confirmed shale gas and basin centred gas objectives
- Unique shales
- Substantial multi-level resource play
- Fast paced and comprehensive forward exploration program

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