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Santos Community Committee - Narrabri Shire

Exploration & Appraisal

11 September 2012

Introduction

- What is Exploration and Appraisal
- Seismic
- Core holes and Objectives
- Pilots and Objectives
- Managing Water
- NSW Regulation of Coal Seam Gas

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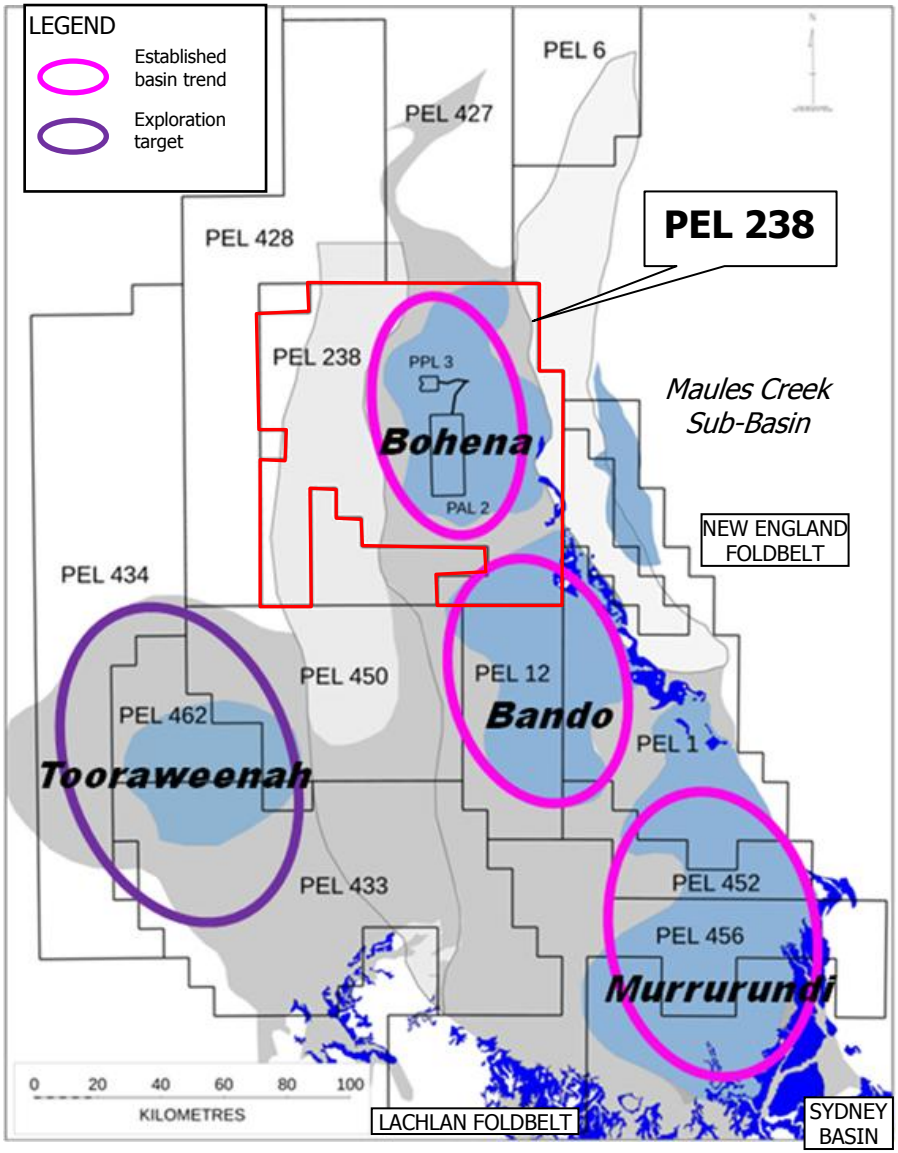
Location and Geological Setting

- Gunnedah Basin is a Permian age N-S trending depositional basin from Queensland (Bowen Basin) to New South Wales (Sydney Basin)
- Bound by New England Fold Belt (East) and the Lachlan Fold Belt (West)
- **Primary Target:** Early Permian Maules Creek Formation



Setting the Scene-Components of Evaluation

Seismic Acquisition

Core Hole Drilling

Pilot Well Drilling

- Regional Basin studies
- Seismic acquisition, processing and interpretation
- Create Geological models
- Drill core holes
- Laboratory analysis
- Pilot testing

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The Seismic Method

- Initial layout is undertaken on the desktop utilising satellite, cadastral, cultural heritage, environmental significance maps and topographic maps to fit lines whilst still obtaining geologic data

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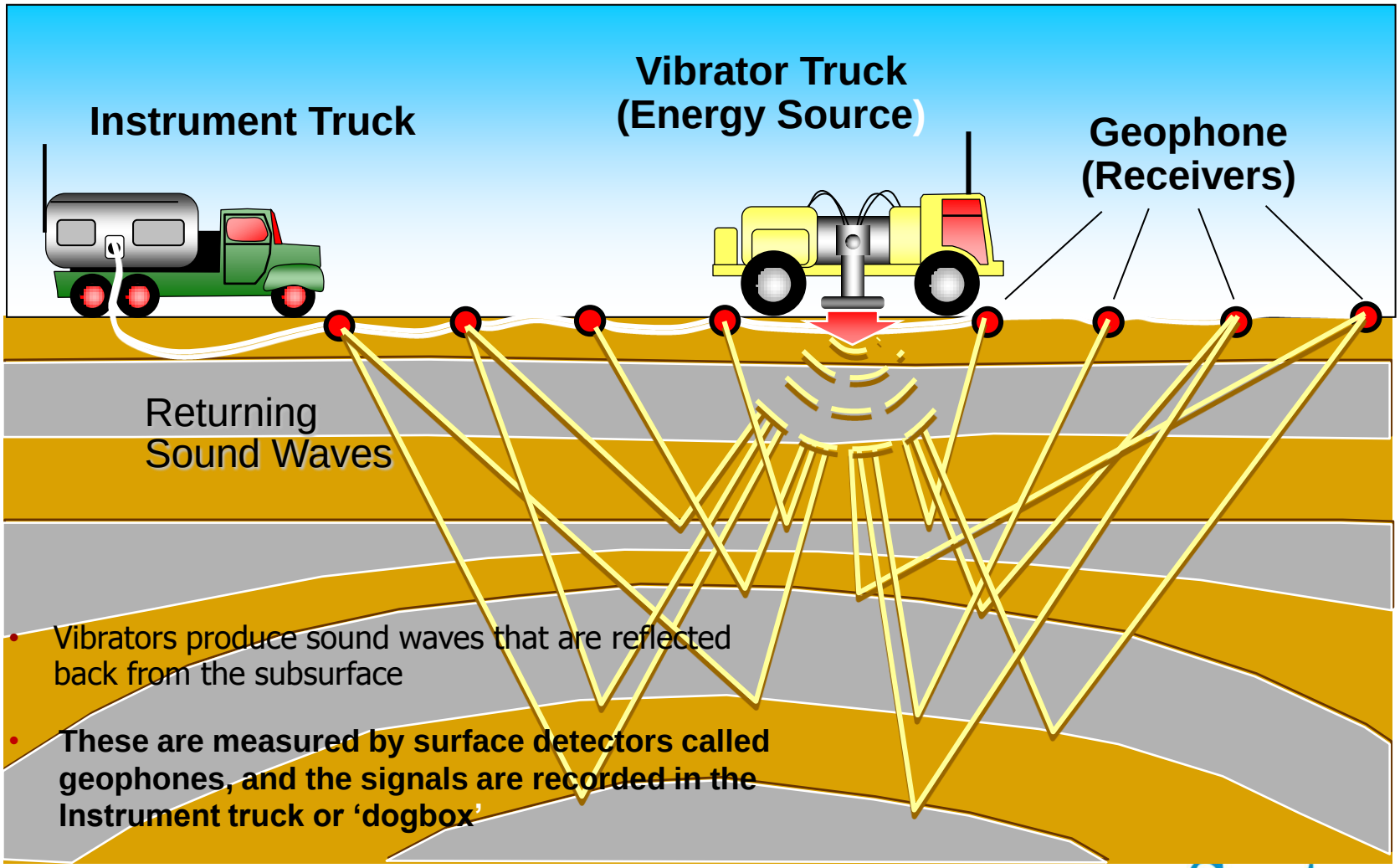
The Seismic Method - Recording



- Vibrators produce sound waves that are reflected back from the subsurface
- **These are measured by surface detectors called geophones, and the signals are recorded in the Instrument truck or 'dogbox'**

American Petroleum Institute, 1986

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The Seismic Method - Recording

- The seismic vibrator trucks move in formation down the line, sending a 2-8 second 'sweep' of vibration signal into the ground.
- Typically the vehicles cover 10 – 12 km/day.

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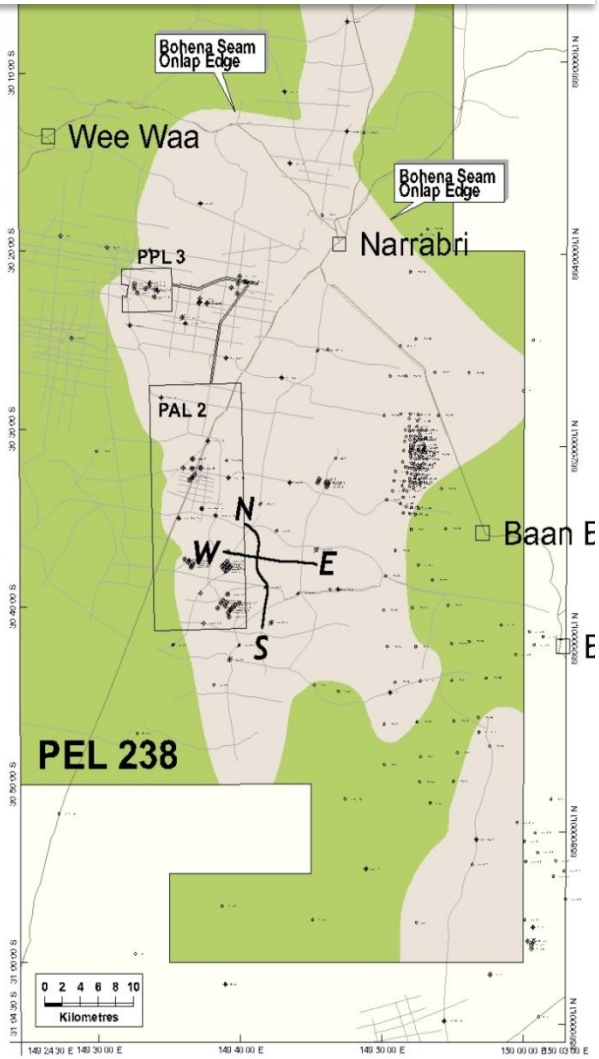
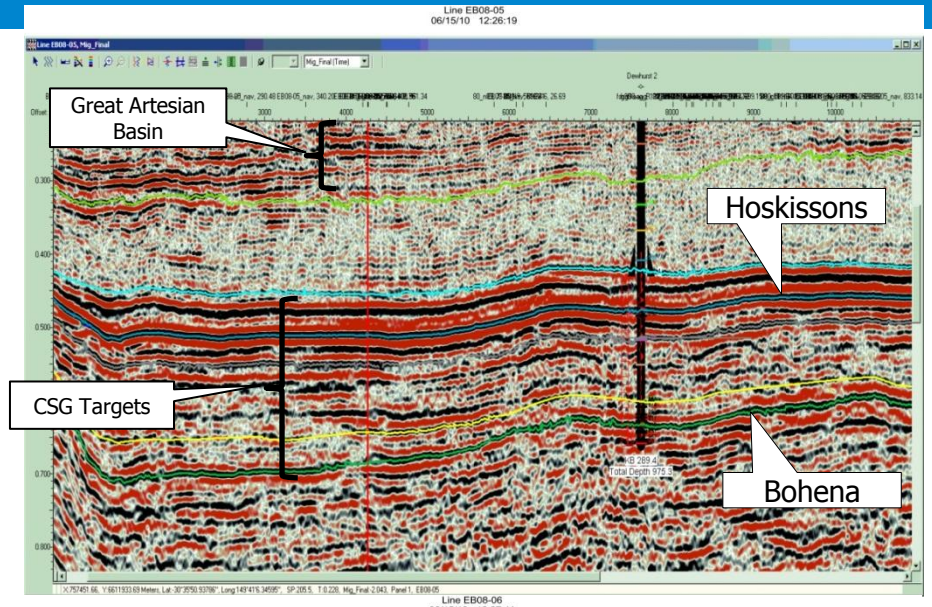
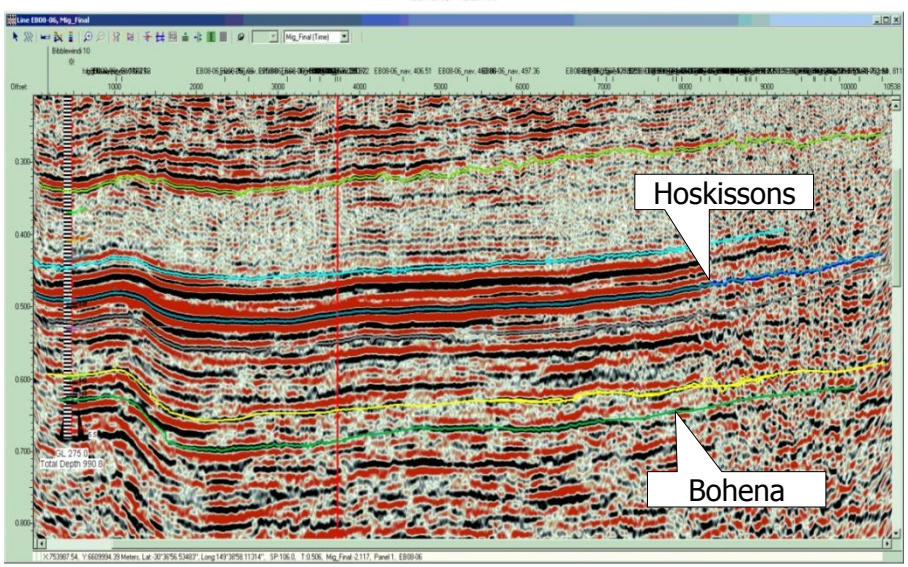
Typical Data, Seismic

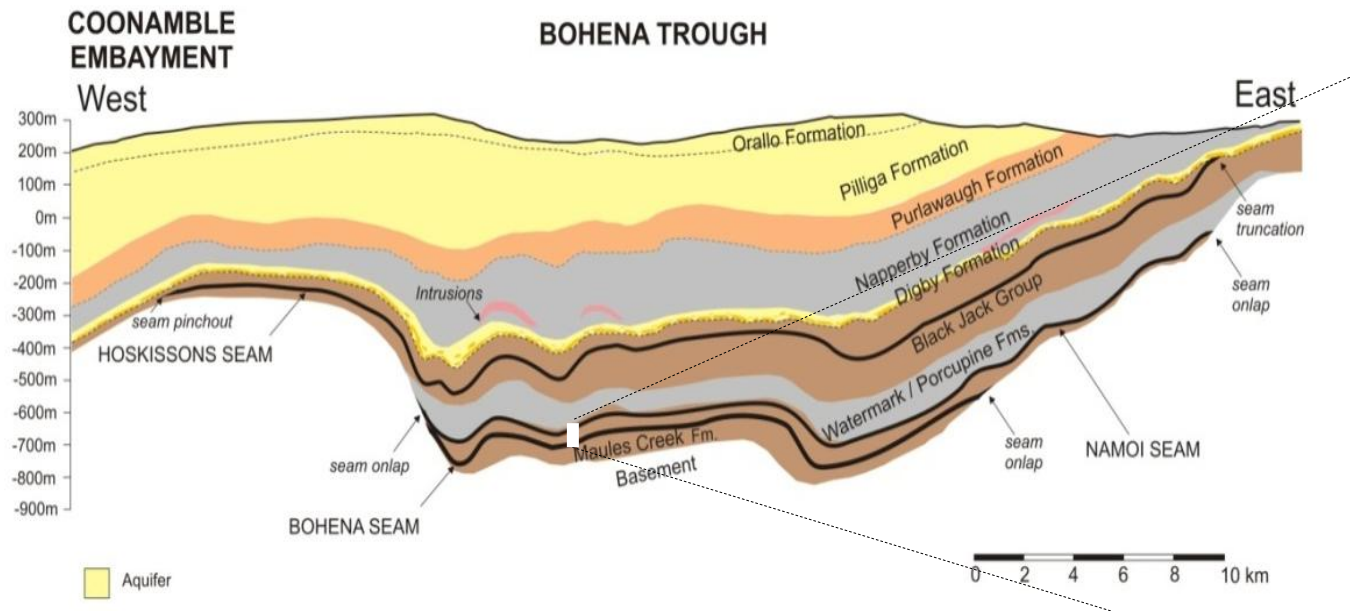
Bohena Seam Areal Extent





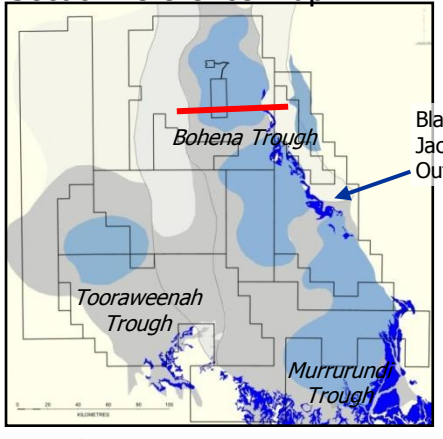


Gunnedah Basin – Early Permian play



Typical PEL 238
Early Permian Section

Section reference map

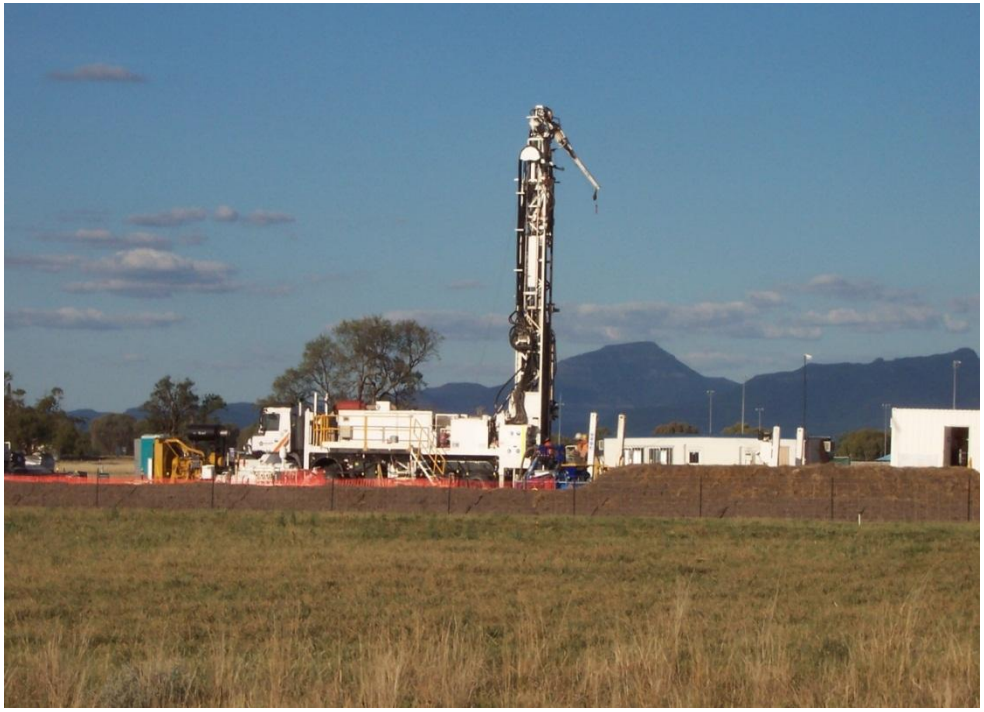


Early Permian play

- Depth: 500 – 1200 m
- Primary target seam - Bohena seam
- High gas content
- Excellent production performance from lateral pilots

Core Holes

- If seismic indicates strong character over a large enough area and at depths which are attractive, drilling will be planned.
- To determine if there is any gas in coal, a core hole will be drilled to determine the characteristics of the coal.
  - Net Coal
  - Gas Content
  - Permeability
  - Saturation
- As drilling can cost >$1 million the decision to drill is not taken lightly.
- Often the results of a seismic survey will lead to a decision that no drilling should take place.



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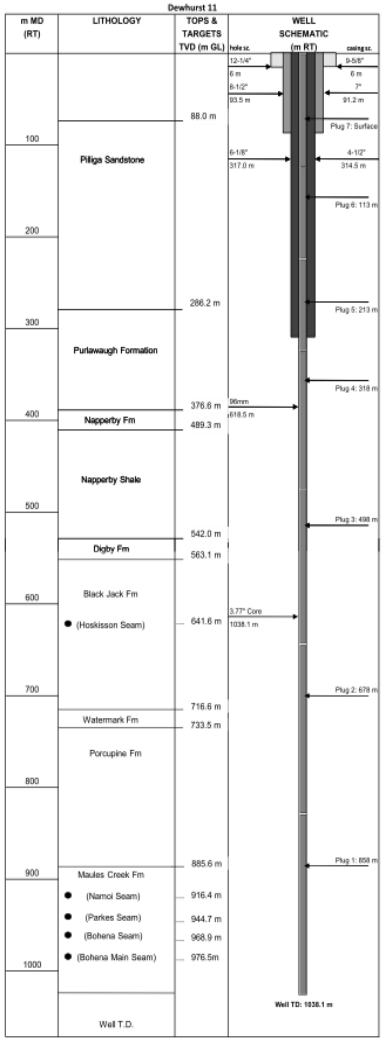
Core Hole Design

Well Schematic



- Surface Conductor (steel) passes through topsoil into solid sandstone. It is drilled first and cemented into place to provide a stable foundation for subsequent drilling
- Surface Casing (steel) passes through the entire Pilliga Sandstone layer. It is cemented into place so that water from the Pilliga Sandstone cannot move between formations, and to ensure water from deeper layers cannot enter the Pilliga Sandstone
- Drill down to target formation-obtain core
- Coal samples are placed in a canister and the gas content is measured
- At total depth wireline logs are run-to measure the properties of the rock
- Permeability tests can be conducted over Hoskissons and Maules Creek coals

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Core Hole

Plug and Abandonment

- Once drilling and testing is completed the core hole is then plugged and abandoned
- The hole is sealed completely from bottom to surface with cement
- The site is then rehabilitated

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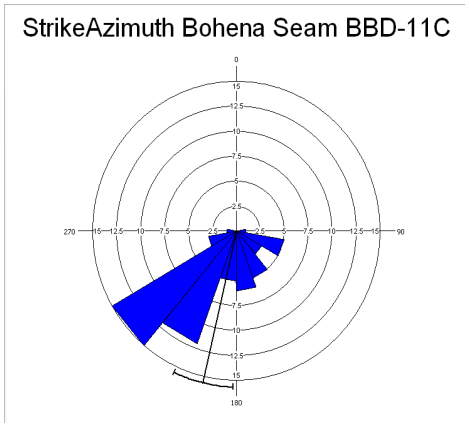
Core Hole - Typical Data, Core

Cores and Acoustic Image logs used to interpret fractures



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Reports and Approvals required

- **Exploration**
- Petroleum Exploration Licence (Division of Resources and Energy-NSW)
- Approved work program (Division of Resources and Energy-NSW)
- Review of Environmental Factors and Environmental Management Plan under Part 5 (Division of Resources and Energy-NSW)
- Local Shire approval for any temporary development (i.e. location of temporary offices)
- Road Traffic Management Plan with relevant authorities (i.e. TRMS (RTA) and local Council

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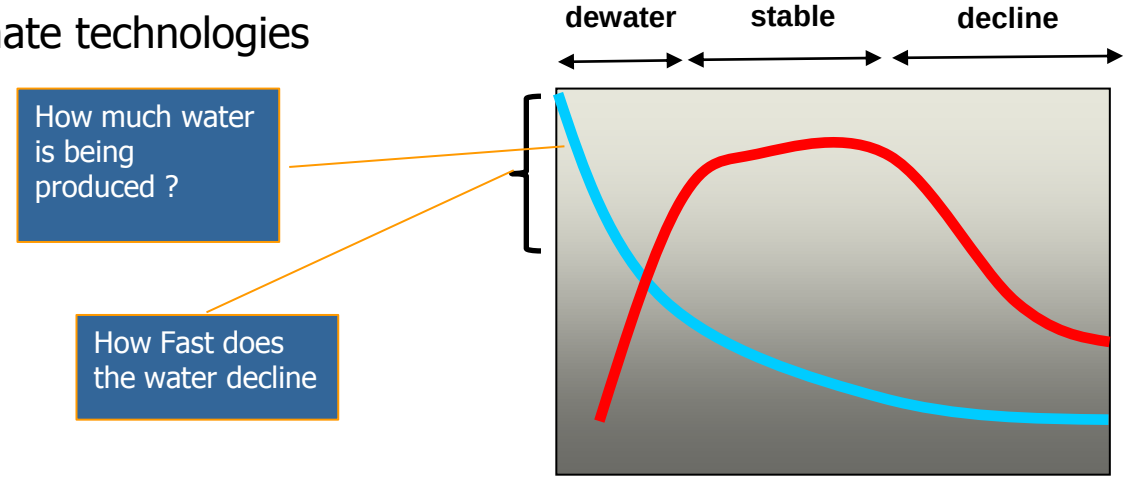
Pilot Testing

- The intention of the pilot testing is to gather information about:
  - Aquifer isolation
  - Water quantity
  - Water quality
  - Gas deliverability
- Provide calibration data for water studies
- Outcomes from pilot testing:
  - More data to make decisions
  - Look at alternate technologies



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Appraisal Pilot Overview

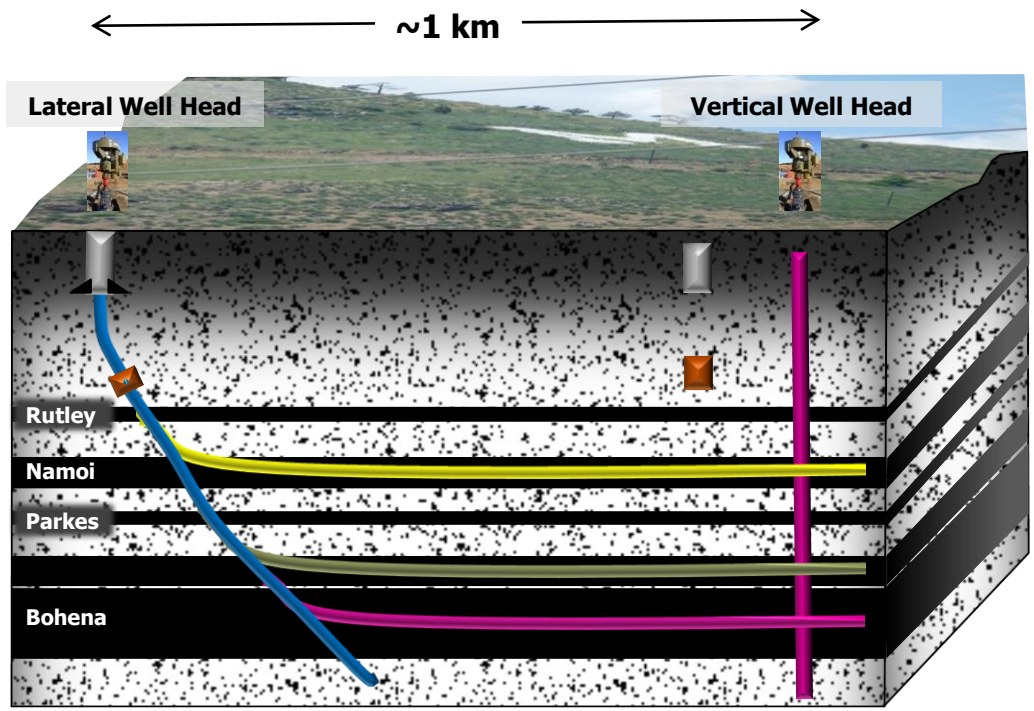
Unique geology:

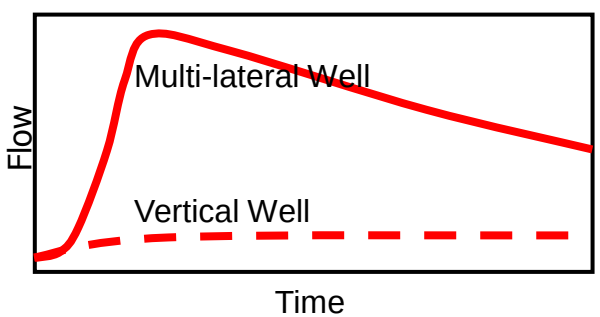
- Isolated from groundwater resource
- Deep coal seams results in high gas content
- Natural fractures have high directional permeability

Completion technology defined:

- In-seam horizontal laterals provide excellent reservoir connectivity
- Lower surface impact-wider spacing
- No fracture stimulation required
- Stacked laterals allow additional coal horizons to be produced.

PEL238 Conceptual Well Design





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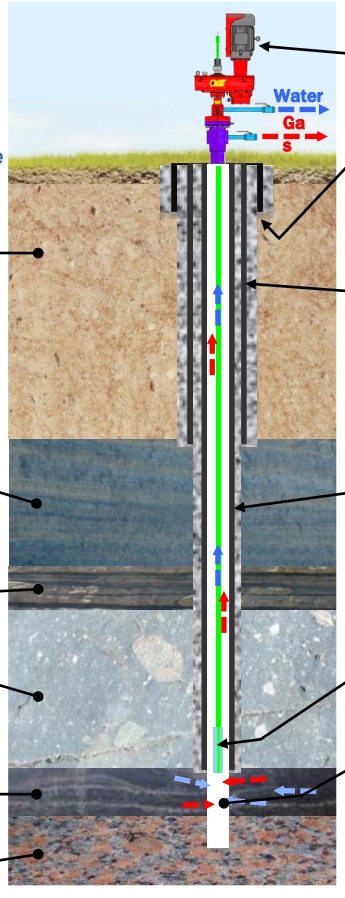
Pilot Well Design



Pilliga Sandstone
contains water resources (aquifers)

Purlawaugh Fm/Napperby Shale
(an 'aquatard' meaning water cannot pass up or down through it)

Black Jack Formation
(coal & shale)

Paraglomerate
(a natural rock resembling concrete, and also an aquatard)

Maules Creek Formation
(includes Bohena coal seam)

Basement ('Bedrock')

- Variable speed electric motor with pump drive assembly is mounted on wellhead
- Surface Conductor (steel) passes through topsoil into solid sandstone. It is drilled first and cemented into place to provide a stable foundation for subsequent drilling
- Surface Casing (steel) passes through the entire Pilliga sandstone layer. It is cemented into place so that good quality water from the Pilliga cannot move between formations, and to ensure water from deeper layers cannot enter the Pilliga Sandstone
- Production Casing (steel) runs all the way from the surface to the top of the targeted coal seam. It is cemented into place and further ensures that water cannot move from one layer to another layer
- Shaft driven pump is used to pump water from the well. Gas flows up through the well to the surface
- The well extends below the production casing through the target coal seam into the rock ('basement') below the coal. Water and gas flow from the target coal into the well. Water from the target coal seam is not suitable for agricultural or other uses, it however can be treated for beneficial reuse

The coal is **not mined**, the water and gas from within the coal is **extracted** and the coal structure remains in place.

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Pilot Water Handling

- A detailed assessment of the management of lifted water is under review
- A pilot appraisal program includes a Water Management plan for lifted water
- As part of the pilot appraisal program, Santos will continue to undertake monitoring of the ground waters surrounding the exploration and appraisal area. This will include both shallow and deep aquifer monitoring

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Reports and Approvals required

- **<u>Assessment Appraisal (Pilot)</u>**
- Petroleum Assessment Lease (Division of Resources and Energy-NSW)
- Review of Environmental Factors (REF) and Environmental Management Plan under Part 5 (Division of Resources and Energy-NSW)
- Licence to lift water (NSW Office of Water)
- Water Management Operations Plan (NSW Office of Water & Division of Resource and Energy)
- Local Shire approval for any temporary development (i.e. location of temporary offices)
- Environmental Licence to dispose of treated water (Department of Environment and Heritage NSW)

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Environmental Approvals

- **All** activities must have approvals in place **before** they are undertaken
- Keeping stakeholders informed of our activities
- Commonwealth referral/approval where required
- Part 5 REF for exploration and appraisal activities
  - Environmental Assessment
  - Integrated assessment with all relevant govt agencies
- Water related activities
  - Access licenses
  - Approval for work

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Questions?

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