Coal Seam Gas in Australia: Resource Potential and Production Issues*

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Abstract

In 2009, Australia's estimated proven and probable coal seam gas (CSG) reserves were 21,180 petajoules (EnergyQuest, 2009); current total resource estimates, however, range up to 250,000 PJ. Last fiscal year, CSG production was 143 PJ to supply Australia's domestic market. Eight separate CSG to LNG projects have recently been proposed and "The Blueprint for Queensland's LNG Industry" estimates that collectively these would process more than 50 Mt/y (~2700 PJ/y) for export. This expansion, however, leads to challenges in developing sufficient production capacity, handling systems and water management. In 2007-08, >13 gigalitres of formation water were produced during CSG production and disposed of mainly in evaporation ponds, a practice which is about to be terminated. Government regulators estimate 126 and 280 GL/yr water production for a 10 and 40 Mt/yr LNG industry respectively. As most of the CSG reserves are located within the Great Artesian Basin, concerns exist on the effects of the major increase in production on water resources in adjacent aquifer systems.

The anticipated expanded production requires improved definitions of resource distributions, reservoir properties and compartmentalisation. A 'coal systems analysis' approach assists in accurately predicting reservoir quality and gas content. Fracture stimulation techniques lead to improving producibility of low permeability CSG reservoirs and numerical modelling techniques have been developed to improve predictions of dynamic reservoir response and aid in the design of production strategies. With adequate legislation in place and integrated reservoir management tools, Australia has the potential to develop a substantial CSG to LNG export industry.

Selected References

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Coal Seam Gas Resource Estimates for Australia

Estimated proven and probable CSG reserves

- 21,180 petajoules (EnergyQuest, 2009);
- Current total resource estimates - up to 250,000 PJ.
- Last fiscal year, CSG production was ~143 PJ to supply Australia's domestic market.

Eight separate CSG to LNG projects have recently been proposed and "The Blueprint for Queensland's LNG Industry" estimates that collectively these would process more than 50 Mt/y (~2700 PJ/y) for export

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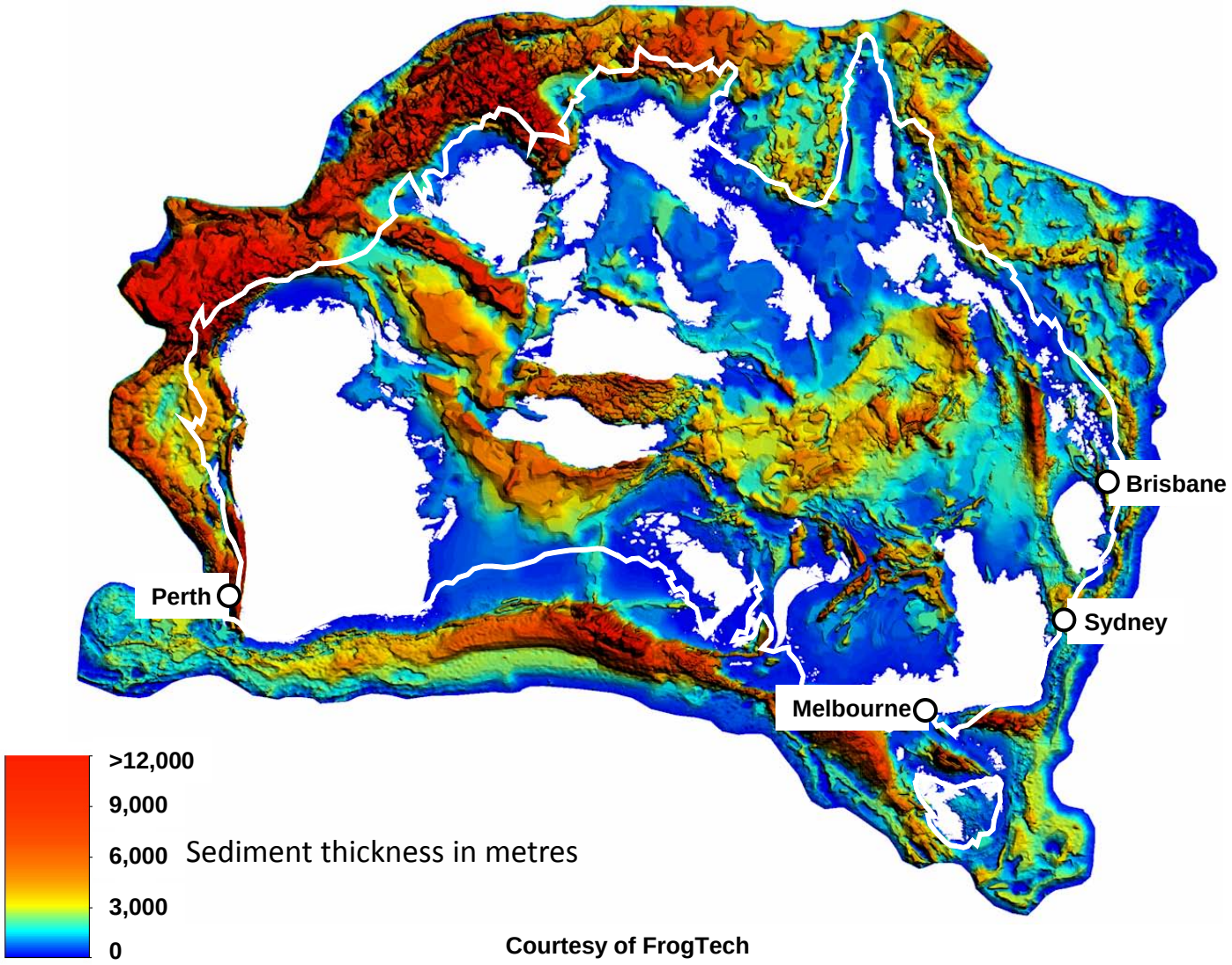
Australia – Onshore and Offshore



Courtesy of FrogTech

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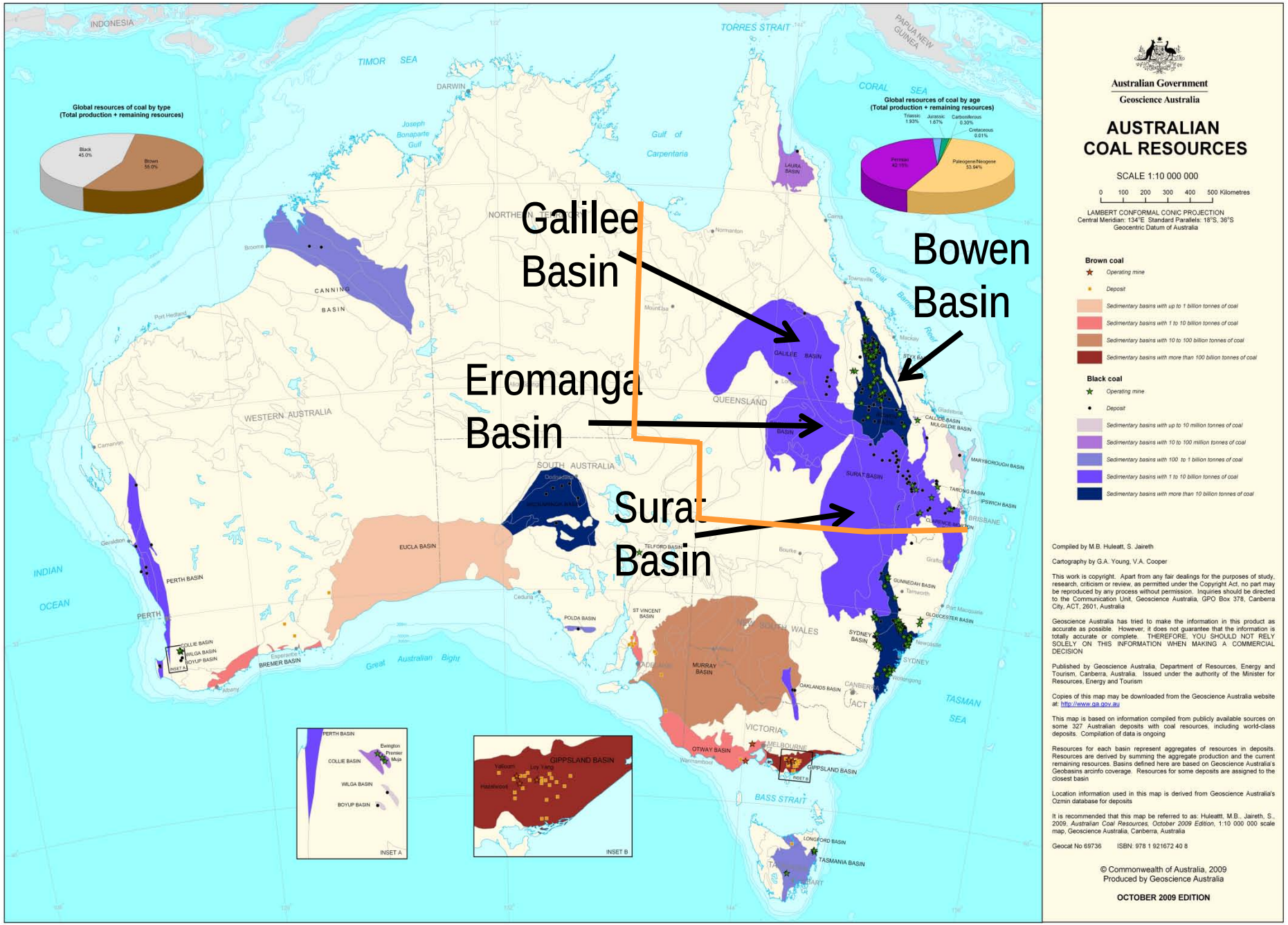

Australian Government
Geoscience Australia

AUSTRALIAN COAL RESOURCES

SCALE 1:10 000 000

0 100 200 300 400 500 Kilometres

LAMBERT CONFORMAL CONIC PROJECTION
Central Meridian: 134°E Standard Parallels: 18°S, 36°S
Geocentric Datum of Australia

Brown coal

- Operating mine
- Deposit
- Sedimentary basins with up to 1 billion tonnes of coal
- Sedimentary basins with 1 to 10 billion tonnes of coal
- Sedimentary basins with 10 to 100 billion tonnes of coal
- Sedimentary basins with more than 100 billion tonnes of coal

Black coal

- Operating mine
- Deposit
- Sedimentary basins with up to 10 million tonnes of coal
- Sedimentary basins with 10 to 100 million tonnes of coal
- Sedimentary basins with 100 to 1 billion tonnes of coal
- Sedimentary basins with 1 to 10 billion tonnes of coal
- Sedimentary basins with more than 10 billion tonnes of coal

Compiled by M.B. Huleatt, S. Jaireth

Cartography by G.A. Young, V.A. Cooper

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Copies of this map may be downloaded from the Geoscience Australia website at: http://www.ga.gov.au

This map is based on information compiled from publicly available sources on some 327 Australian deposits with coal resources, including world-class deposits. Compilation of data is ongoing

Resources for each basin represent aggregates of resources in deposits. Resources are derived by summing the aggregate production and the current remaining resources. Basins defined here are based on Geoscience Australia's Geobasins arcinfo coverage. Resources for some deposits are assigned to the closest basin

Location information used in this map is derived from Geoscience Australia's Ozmin database for deposits

It is recommended that this map be referred to as: Huleattt, M.B., Jaireth, S., 2009, *Australian Coal Resources, October 2009 Edition*, 1:10 000 000 scale map, Geoscience Australia, Canberra, Australia

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OCTOBER 2009 EDITION

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Challenges - Water

2007-08:

- >13 gigalitres of formation water were produced
- disposed of mainly in evaporation ponds

Government regulators estimate:

- for 10 Mt/yr LNG – 126 GL/yr water production
- for 40 Mt/yr LNG – 280 GL/yr water production

Most CSG reserves are located within the Great Artesian Basin

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CSG IS NOT
LOW IMPACT

Other Challenges in Australia

- Resource Characterisation
- Production Performance
- Reservoir Stimulation
- Fugitive Emissions
- Ramp Gas Utilisation

Events Timeline

BusinessDay

LNG project clears major hurdle

Paul Osborne
April 8, 2009

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The $35-billion Australia Pacific LNG (APLNG) project to pipe coal seam gas from Callide to Gladstone, where it would be converted to liquefied natural gas (LNG), is a big step closer.

Queensland's coordinator-general on Wednesday declared it a "significant project", effectively streamlining environmental and other approvals.

"The Bligh government will do everything in its power to encourage an LNG industry and create jobs across Queensland, from our ports to the gas fields out west," Infrastructure Minister Stirling Hinchliffe said.

April 2009

APLNG
(Origin – ConocoPhillips)

QLD Govnt declares it a "special project"

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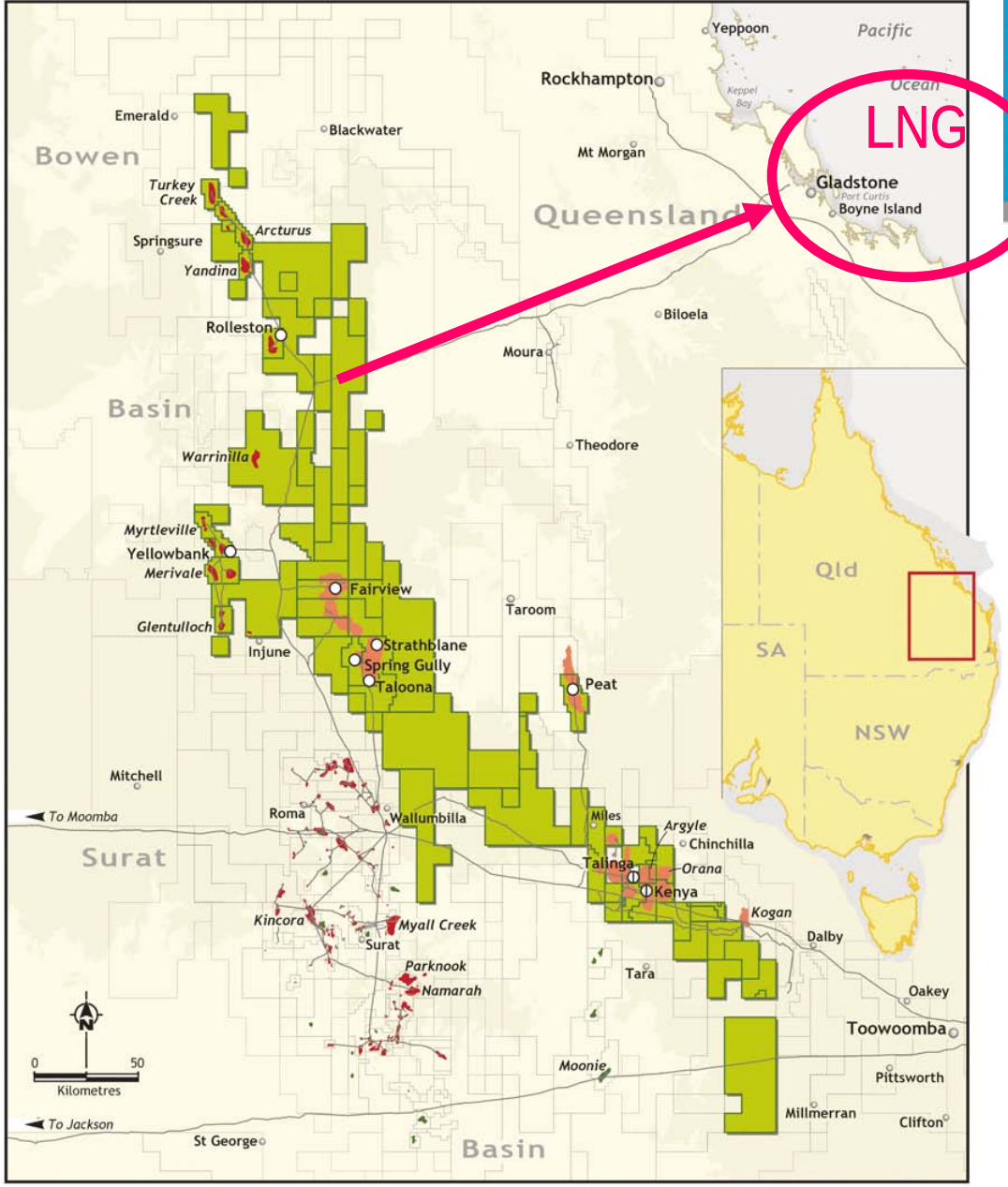

April 2009

APLNG
(Origin – ConocoPhillips

QLD Govnt declares it a "special project" worth $35 billion AUS

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Events Timeline

March 2010:

- Queensland CSG to LNG contract
- Up to 8,500 Queensland jobs and ~$60 billion in export

Premier Anna Bligh announced:

"the BG Group..... China National Offshore Oil Corporation (CNOOC) .....72 Mt of LNG from Queensland over 20 years"

March 2010:

Shell and a subsidiary of PetroChina (CS CSG (Australia) Pty Ltd) offer to purchase Arrow Energy Ltd. (acquisition complete in August 2010).

Events Timeline

April 2010:

Premier Anna Bligh announced:

"$490 m for Gladstone as plans underway to handle Surat Basin LNG boom" to include:

- Port Facilities
- Housing
- Health
- Land acquisition for pipeline
- Training

Events Timeline

May 2010:

QLD Department of Infrastructure and Planning produce a, "Management of Water Produced from Coal Seam Gas Production Discussion Paper".

The policy deals with:

- use of CSG water
- evaporation dams
- design standards for CSG water aggregation and brine dams
- transitional arrangements for existing dams
- management of saline effluent and solid salt wastes from water treatment and evaporation processes.

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The Chronicle

Farmers protest at Cecil Plains

Doug Parrington | 20th May 2010

May 2010

FARMERS turned out in force at Cecil Plains yesterday to demand an immediate Queensland Government moratorium on coal seam gas exploration and production in the area.

About 400 people and the massing of 54 cotton and grain harvesters and tractors created a strong show of farm power to protest against the intrusion of mining companies on prime agricultural land.

The farmers cheered when rally organiser Dave Armstrong called for a moratorium on mining activities so that major environment issues, such as the mining companies' proposed use of large quantities of underground water, could be

Ana Armstrong, left, and Kay and Greg Cook sum up their feelings with signs at the Cecil Plains rally

Doug Parrington

Today
Drizzle clear
10°C/16°C
Toowoomba forecast

Events Timeline

May 2010:

QLD State Government grants conditional approval to the $7.7 billion Santos/PETRONAS Gladstone Liquefied Natural Gas.

Premier Anna Bligh said:

“independent Coordinator-General (CG) Colin Jensen had completed a review of the Environmental Impact Statement (EIS) and approved it with strict conditions”.

June 2010

Premier Anna Bligh Announces:”The State has granted conditional approval to QGC Pty Limited's multi-billion-dollar Queensland Curtis Liquefied Natural Gas project (QCLNG)”.

Events Timeline

July 2010: *The Bligh Government announced extra compliance staff to continue* to closely monitor the coal seam gas industry

July 2010: Health concerns shut down Kingaroy UCG plant Queensland after water quality tests detected benzene and toluene in groundwater monitoring bores close to the plant.

July 2010: $1.5 million for Namoi Water Study

Senator the Hon Penny Wong, *said* "The Federal Government understands local community concerns about the potential impacts of coal mining and coal seam gas extraction on local communities and water resources"

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July 2010

“DUST-UP: Cancer causing chemicals have been found in water near a coal seam gas project at Kingaroy. Gordon Gay has been told he can't use his bores”.

Source: The Sunday Mail (Qld)

Events Timeline

July 2010:

Federal Environment Minister Peter Garrett delays an environmental assessment on two LNG projects, owned separately by Santos Ltd and Britain's BG Group, by three months until Oct. 11 to consider the long-term environmental impact of these developments.

Australian Federal Election

Aug 23 - With no clear winner in Australia's election – hung parliament

nts Timeline

10:

Yes...of Midnight Oil

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Australian Federal Election

Aug 23 - With no clear winner in Australia's election – hung parliament

News Flash: Labour coalition with independents

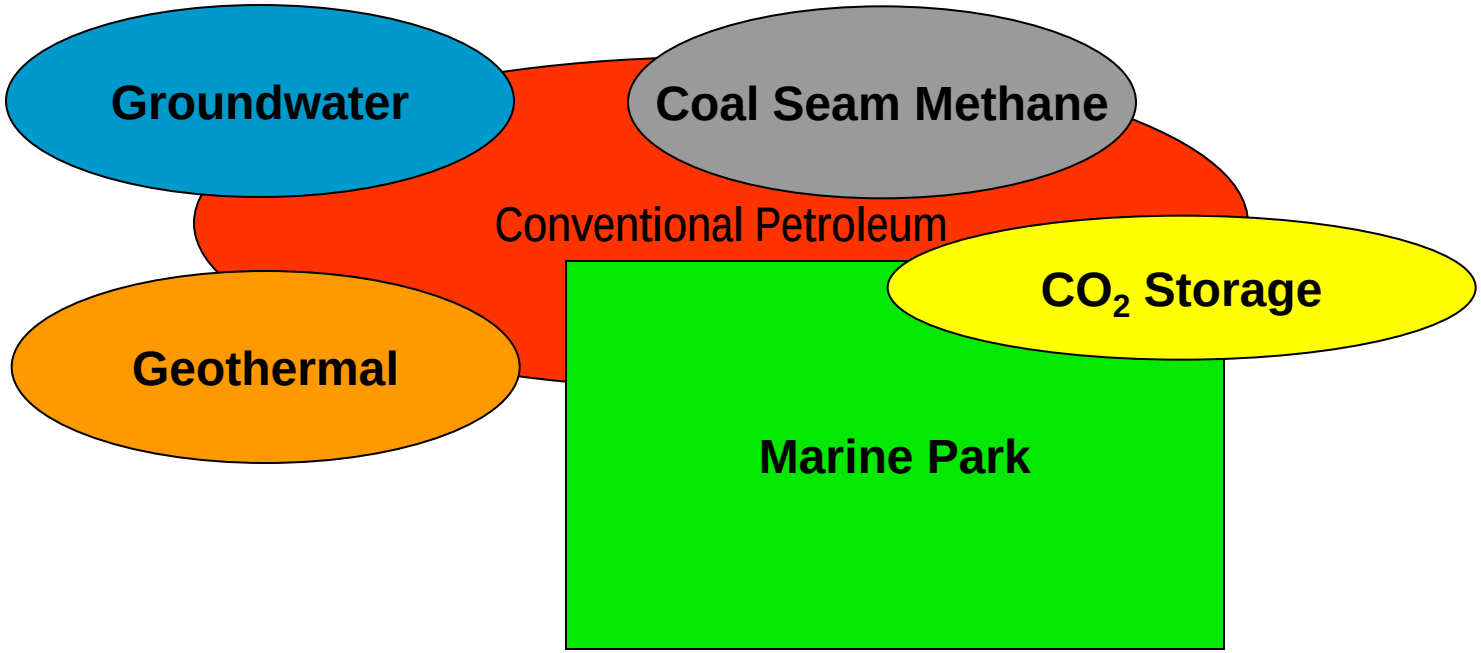
Events Timeline

Targeted Production to start in 2014:

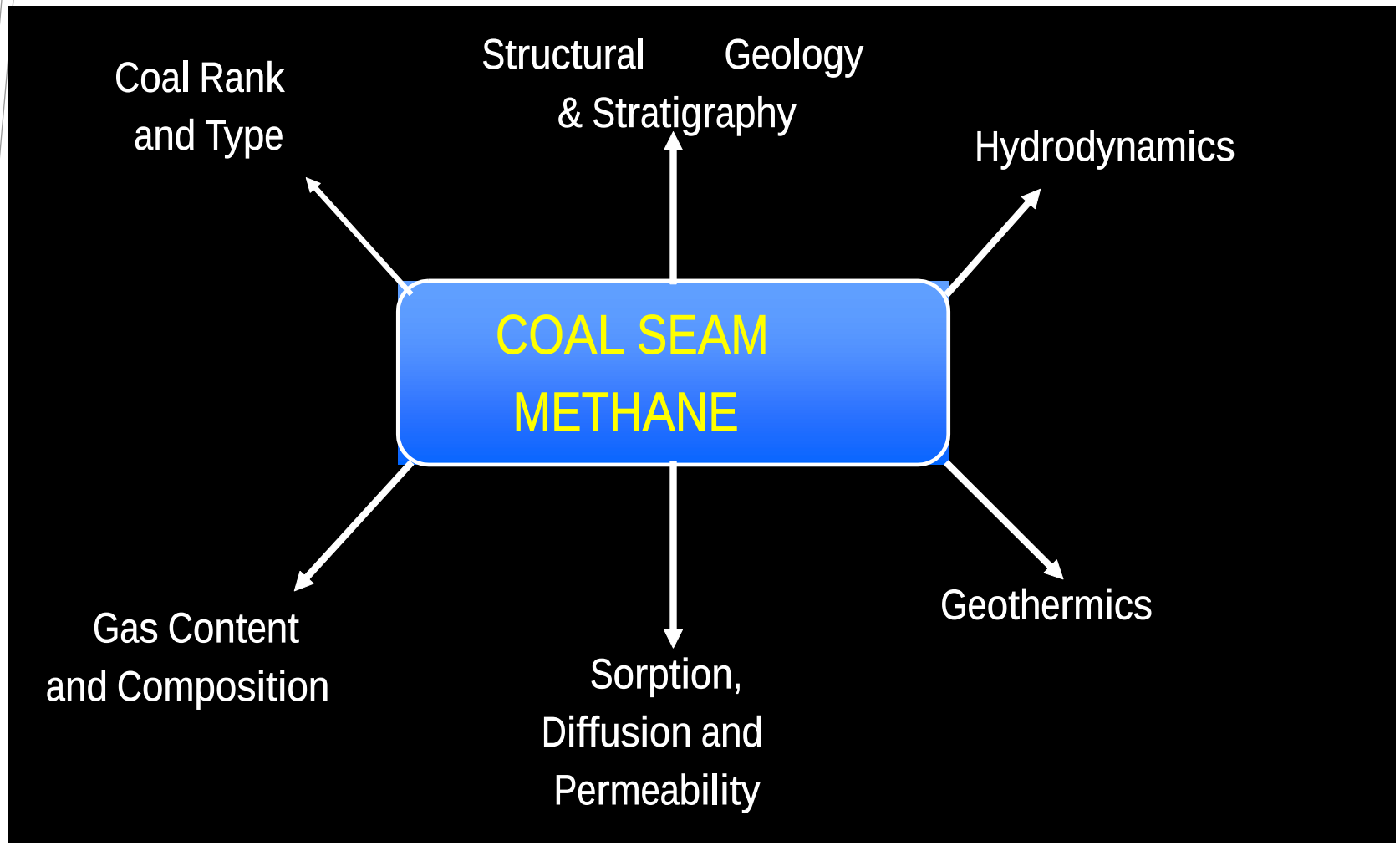
- BG (is planning to approve its project by year-end)
- Santos and Petronas
- Origin Energy and ConocoPhillip's
- Shell and CS CSG (Australia) Pty Ltd (not yet submitted an environmental impact statement).

Challenge: Subsurface Management

Competing use of pore space

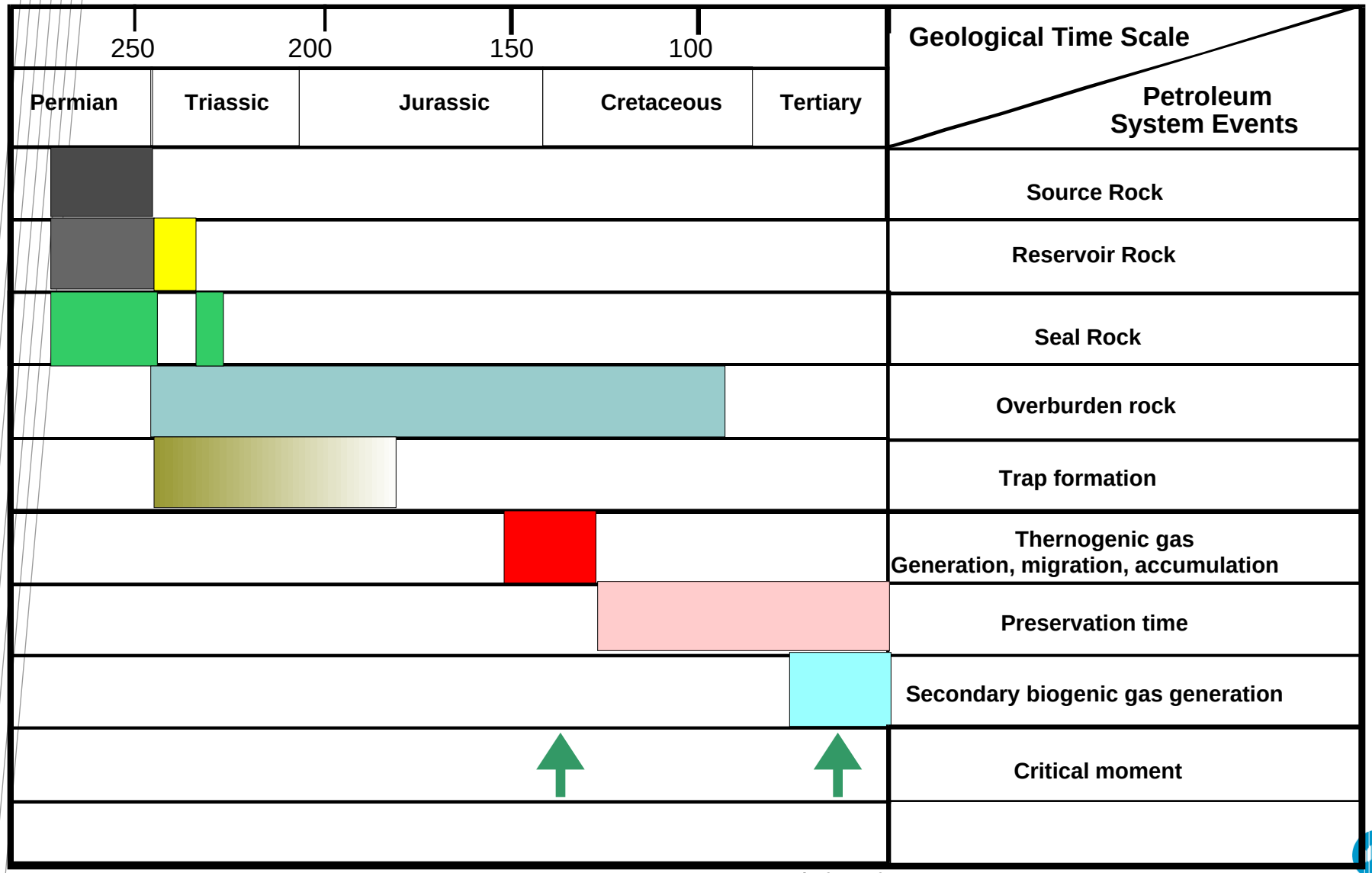


Integrated Coal Systems Analyses (CSA)



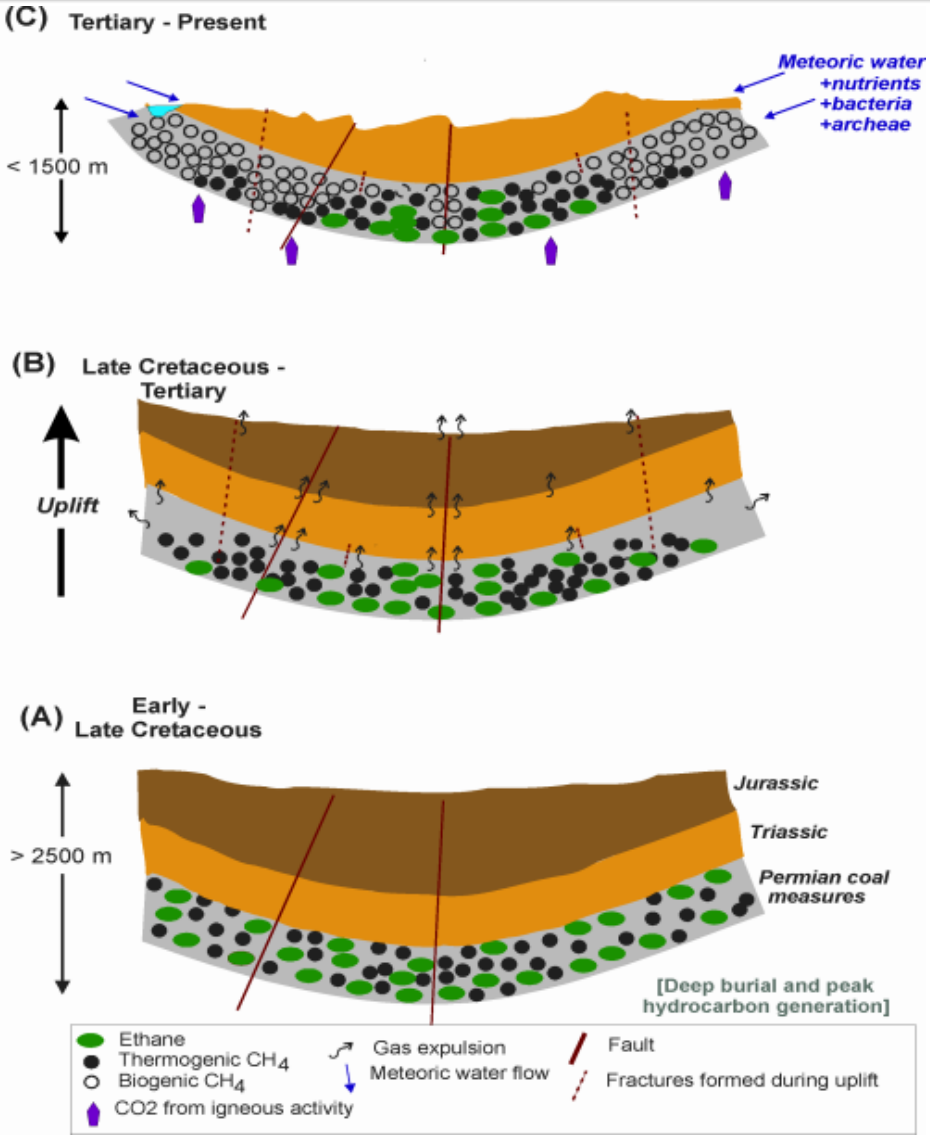
From Faiz (2005)

CSA events chart, S. Sydney Basin



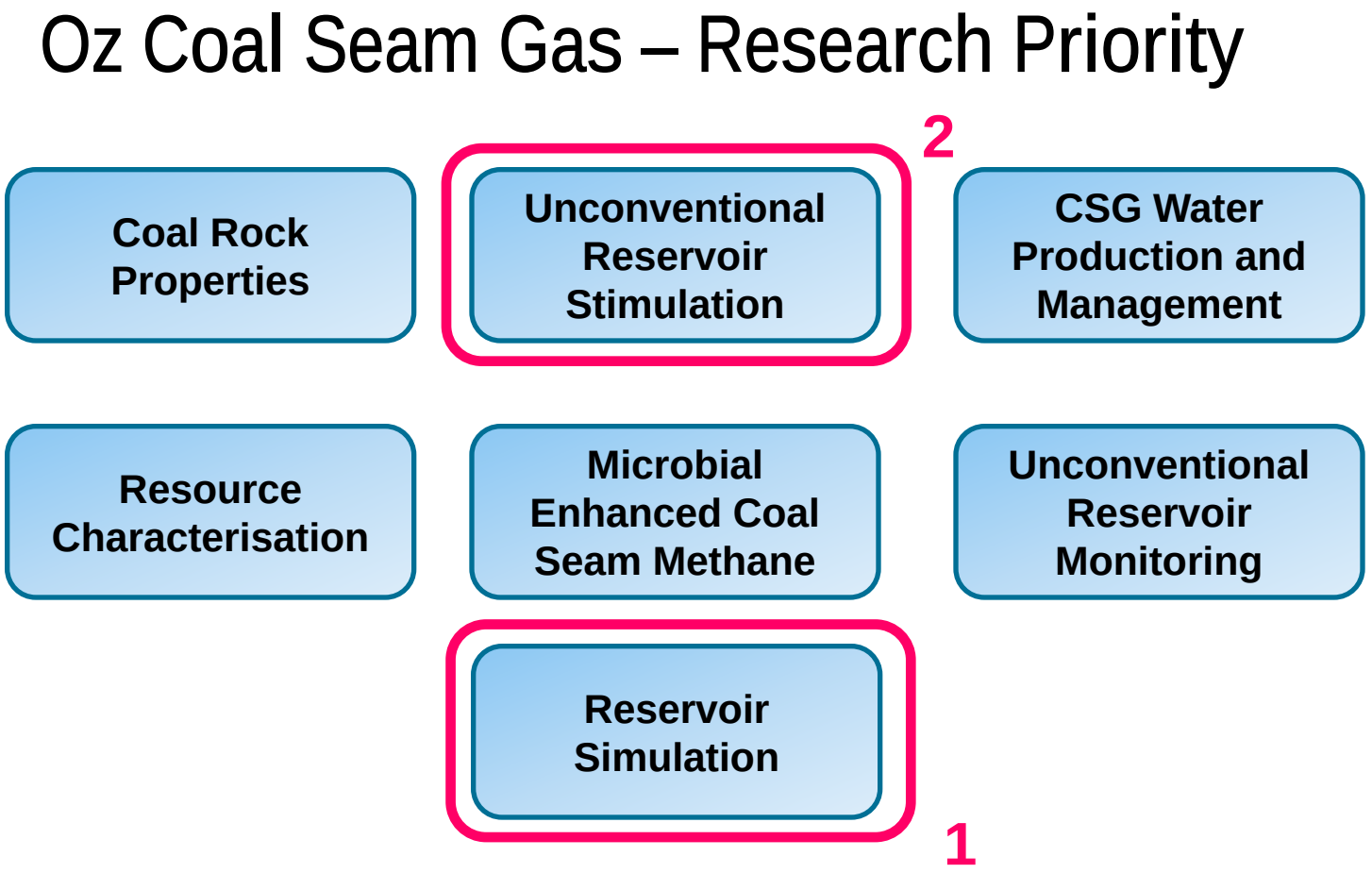
Source: Faiz (2008)

CSA model, Sydney Basin



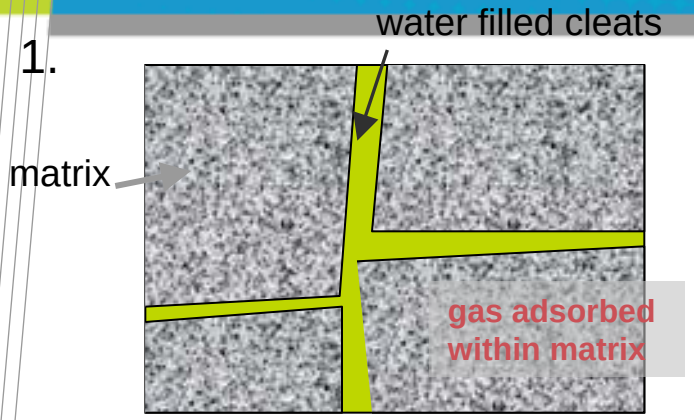
Source: Faiz & Hendry (2007)

Integrated Coal Systems approach



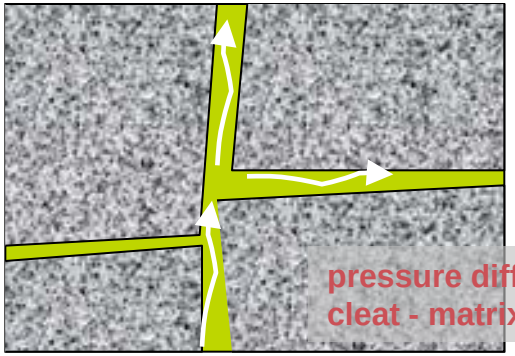
Coal seam gas recovery process

1.



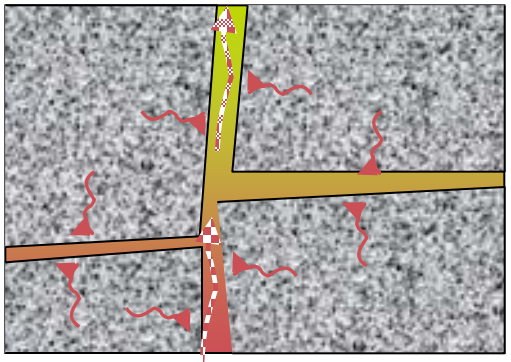
Initial state – pore fluid pressure maintains gas adsorbed within matrix

2.



Fluid pressure lowered in cleat/ fracture system – pressure difference between cleat and matrix

3.



Pressure lowered, gas desorbs and diffuses through matrix to cleat – water and gas flow within cleats

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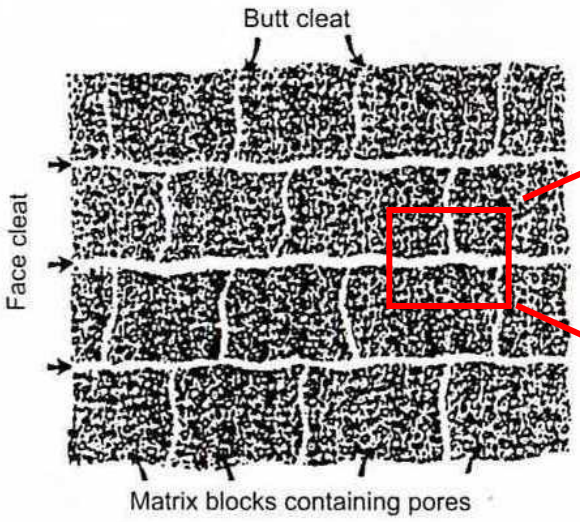
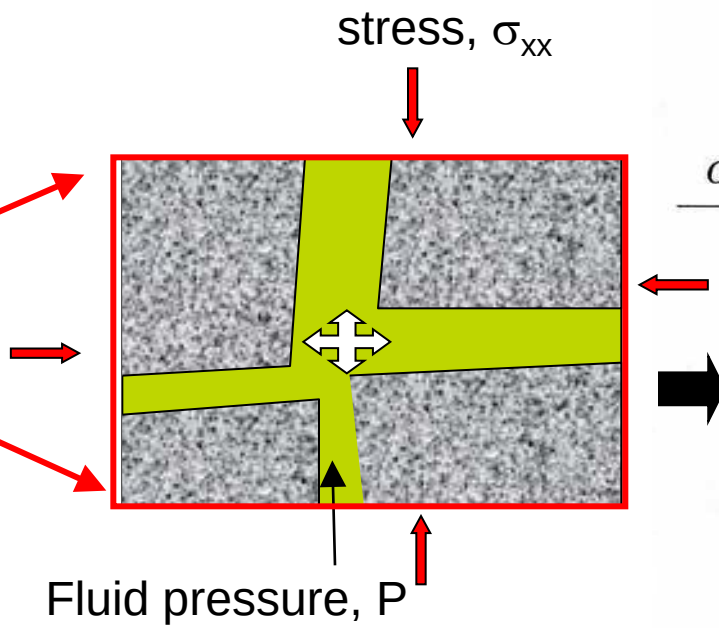
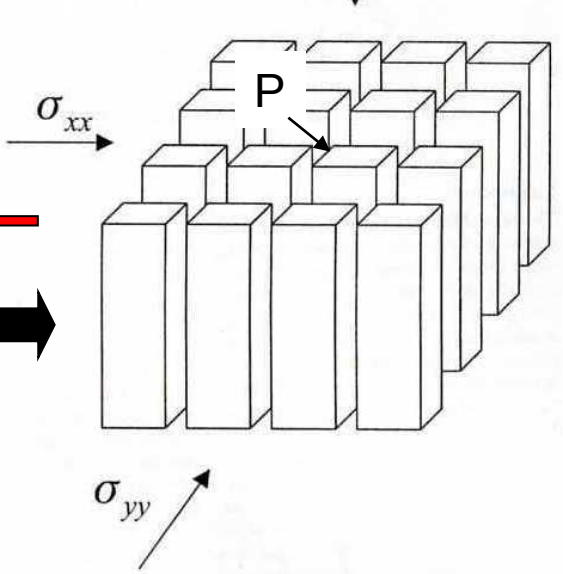
Flow process in coal



Coal structure

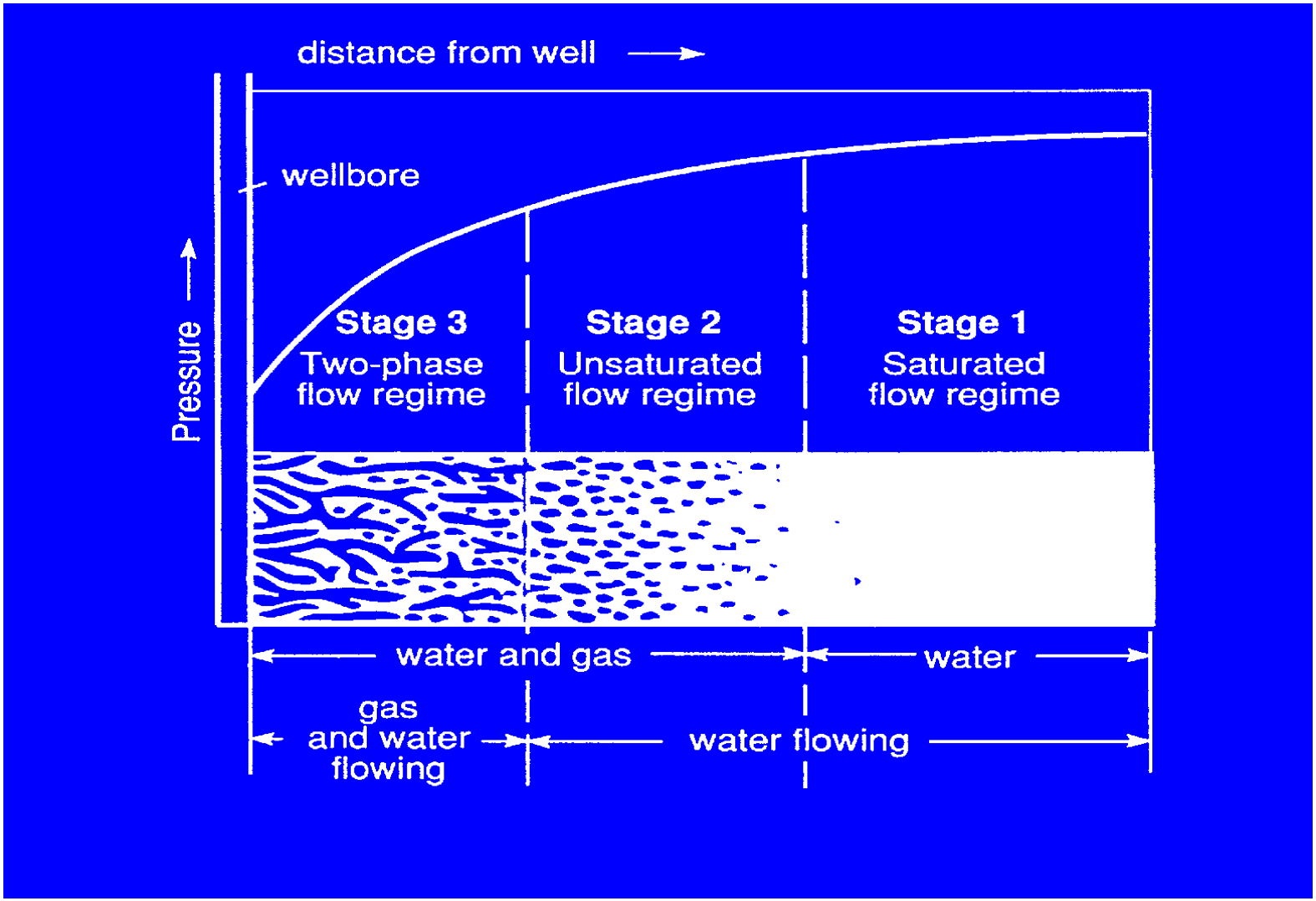


Conceptual model for the cleat-matrix system

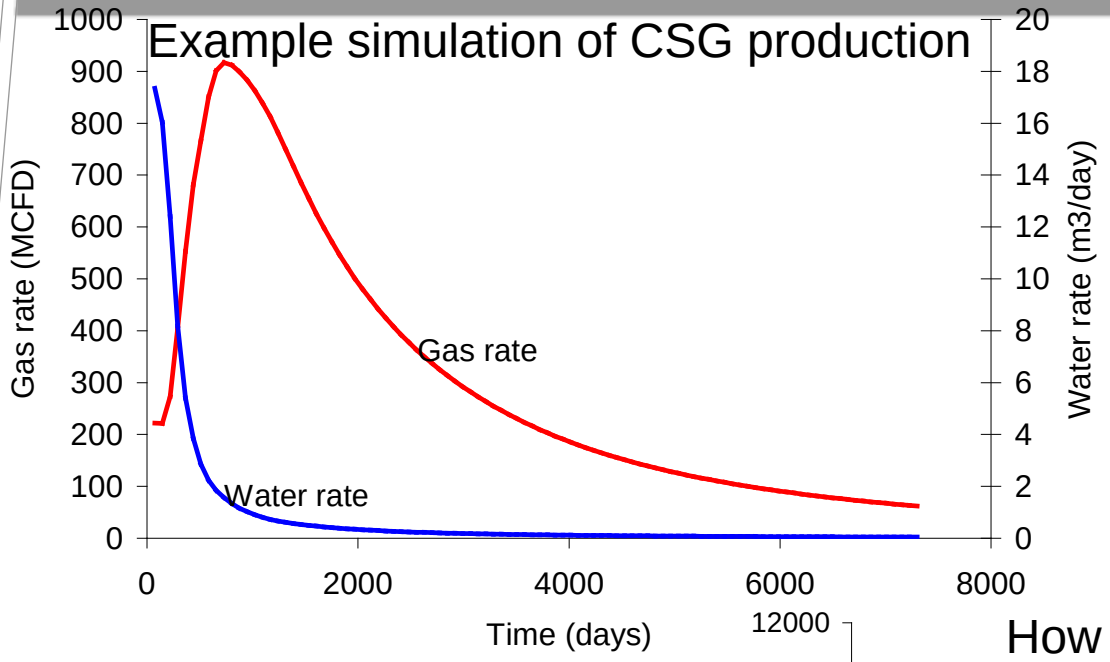


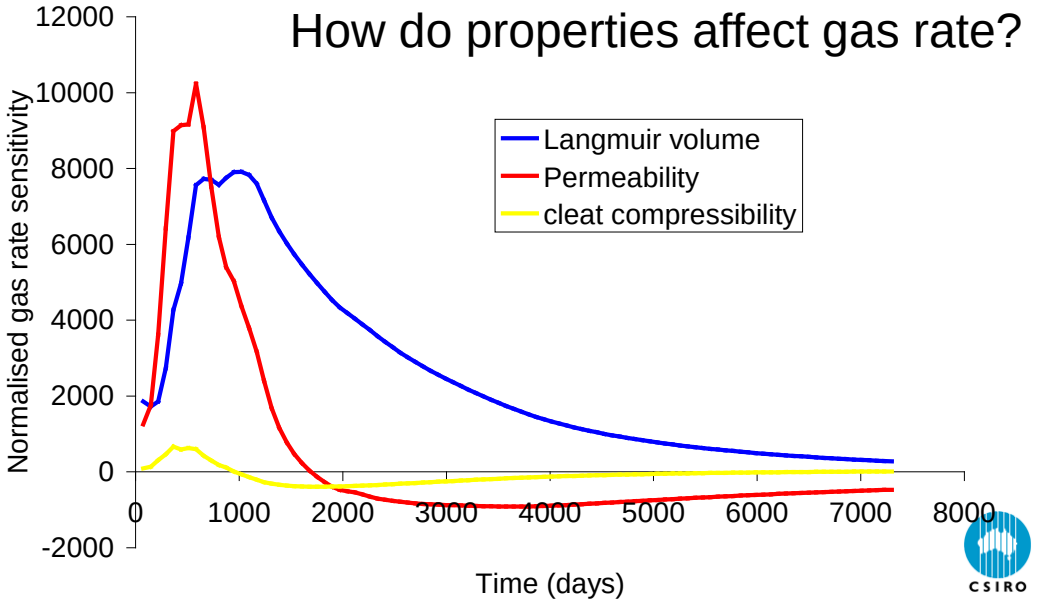
From Shi & Durucan 2005

How does gas de-sorb and flow to the well?



Gas production and reservoir properties





Gas production and reservoir properties

- Numerical Simulation
- Laboratory experiments
- Field Pilots
- Calibration

Hydraulic fracturing of coal

Coal is a naturally fractured reservoir rock.

- Permeability is directional
- Permeability is stress sensitive
- Hydraulic fractures interact with natural fractures and roof and floor rock
  - Non-linear (pressure dependent) leakoff
  - T-shaped, branching and multiple fractures occur
  - Offsets develop along the fracture path
- Fracture treatments in coal can result in higher pressures, complex geometries and shorter than designed propped extent.

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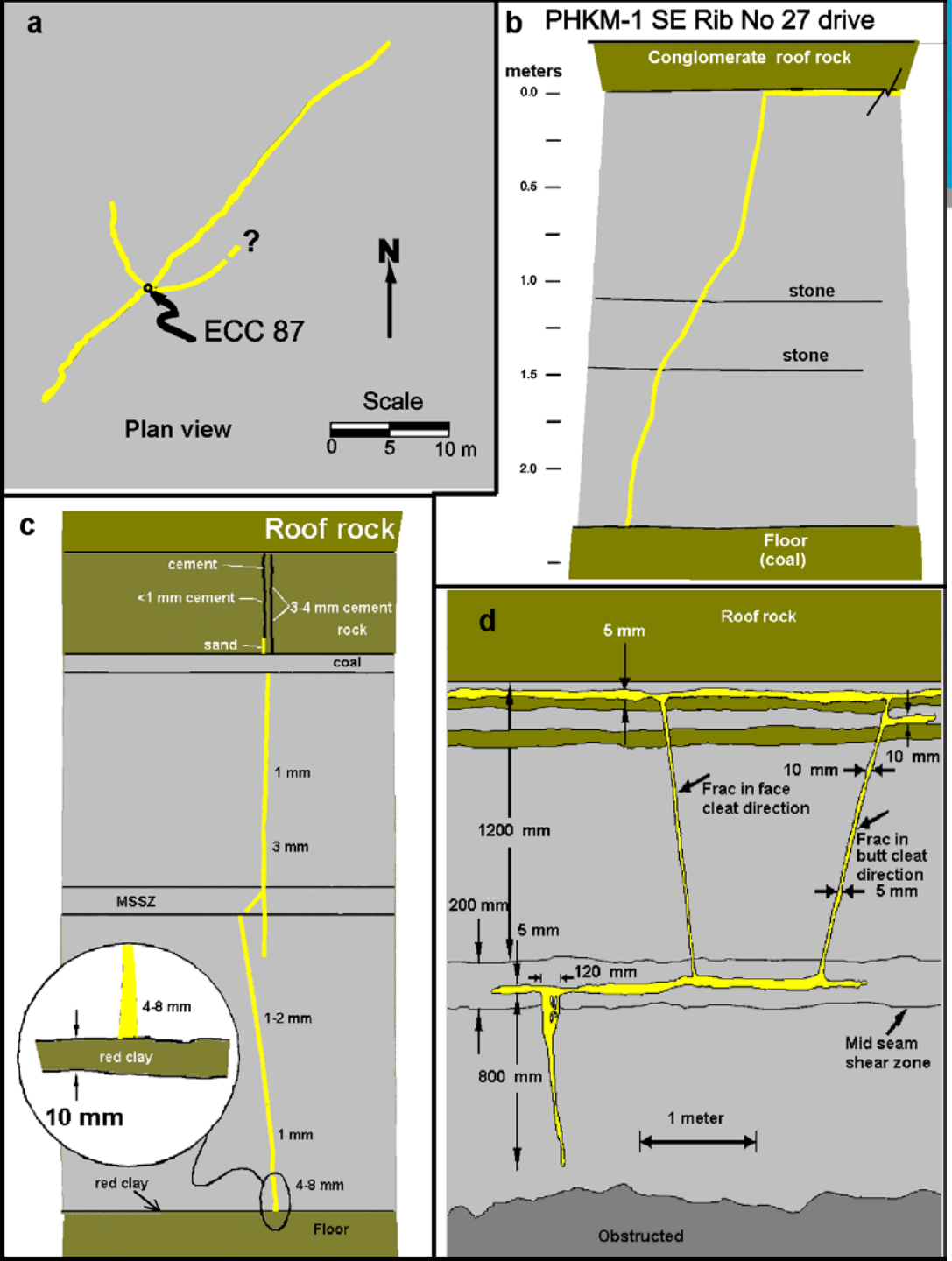
(Jeffrey and Zhang, 2008)

Fractures exposed by mining



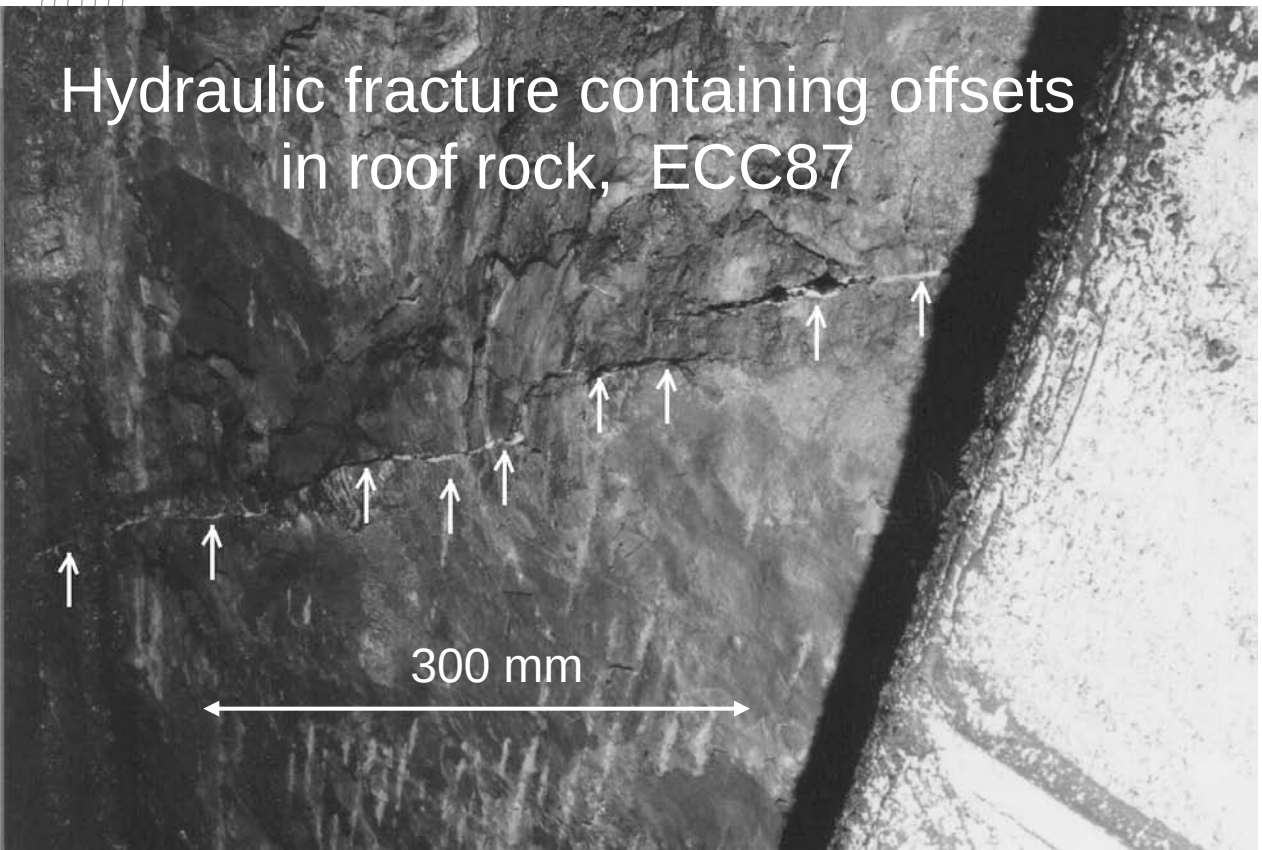
a) Plan view of fracture with growth in face and butt cleat directions.

b) Vertical section of a gamma-shaped fracture.

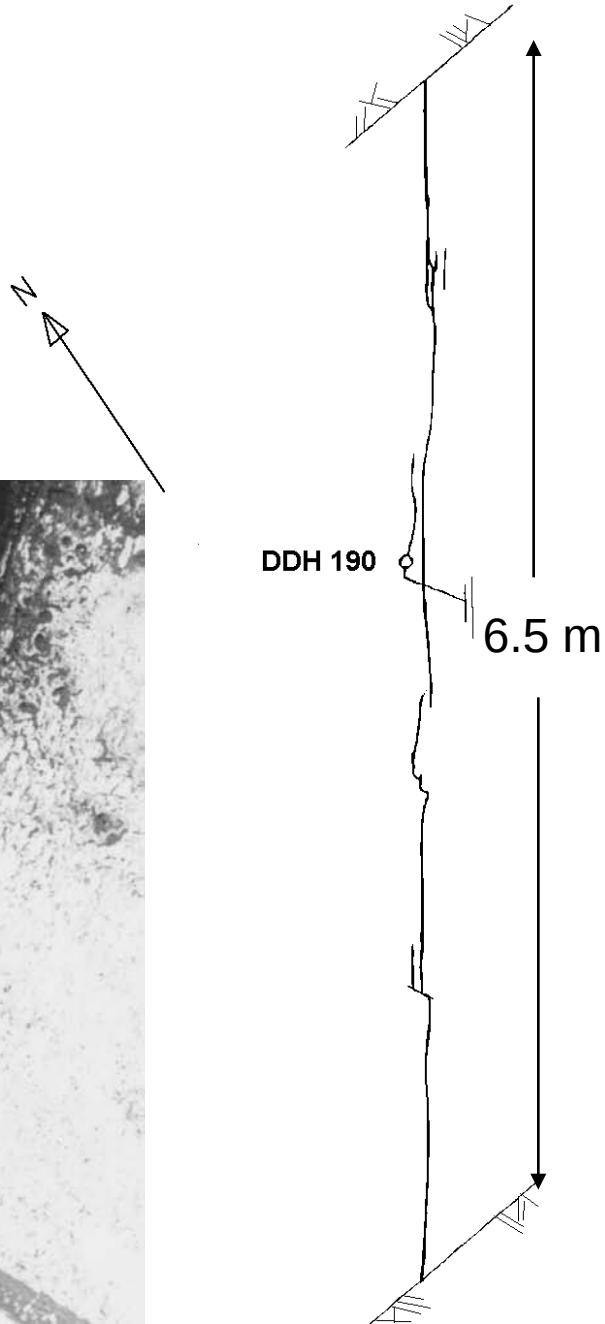
c) Vertical section of fracture offset at MSSZ and blunted at lower point.

d) Vertical section of fracture with both horizontal and vertical branches.

From SPE 119351



Offset fracture in roof rock near DDH 190



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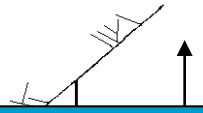

- **Numerical Simulation**
- **Laboratory experiments**
- **Field Pilots**
- **Calibration**

Conclusions

- Coal Seam Methane to LNG is an exciting new export industry for Australia

- Reserves estimates are substantial

- Some technical challenges exist (water production and disposal, simulation, stimulation, etc.)

- We are building R&D capability (people, equipment and techniques) to address industry and regulatory needs

Thank You

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Helping Australia to achieve a secure, clean, wealth-creating energy economy, tailored for a carbon-constrained world

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