Identifying Sites for CO_2 Geosequestration in the Sydney Basin*

By
Mario Werner[1,2], M. Faiz[1,3], A. Golab[1] and John Kaldi[1,2]

Search and Discovery Article #80028 (2008)
Posted October 10, 2008

*Adapted from oral presentation AAPG Convention, San Antonio, TX, April 20-23, 2008

[1]CRC for Greenhouse Gas Technologies (CO2CRC) (mwerner@asp.adelaide.edu.au)
[2]Australian School of Petroleum, University of Adelaide, Adelaide, SA, Australia
[3]CSIRO Petroleum, North Ryde, NSW, Australia

Abstract

The Sydney Basin region contains the largest concentration of stationary CO_2 emitters in Australia, with the major sources, such as coal-fired power stations, oil refineries and coke ovens, contributing about 34% of the total national stationary emissions. CO_2 emissions from these point sources over the next 20 years are anticipated to be around 1350 Mt. Because of this large emissions profile the CO_2 sequestration potential of the Sydney Basin is being addressed by a systematic basin-scale evaluation to identify, characterise and prioritise potential CO_2 storage areas.

The Sydney Basin contains a number of Permian reservoir-seal pairs in deep saline formations which are potentially suitable for CO_2 storage and containment. However, their distribution in the subsurface is poorly constrained due to the limited number of deep petroleum wells and the paucity of high quality seismic data. As a consequence many potential structural traps are poorly defined. In contrast, Permian coal seams are abundant and have been extensively drilled in the various coal fields. Preliminary work suggests that the major challenge for geosequestration in the Sydney Basin is the low permeabilities of the potential storage rocks. Target sandstones and coals commonly have permeabilities of less than 10 mD. Despite these low permeabilities, considerable amounts of coal seam methane are produced from about 70 wells in the southern part of the basin. Methane flow rates from wells drilled in a high production fairway range up to 900 Mcf/day which suggest possibilities for favourable permeabilities for CO_2 injection. Furthermore, major advances have been made in understanding the behaviour of CO_2 in coal-bearing successions through both natural analogue and laboratory studies. These insights will be applied to improve quantification of CO_2 storage capacities for coal seams in the Sydney Basin.

Identifying Sites for CO_2 Geosequestration in the Sydney Basin

M. Werner[1,2], M. Faiz[1,3], A. Golab[1] & J. Kaldi[1,2]

[1] CRC for Greenhouse Gas Technologies (CO2CRC)

[2] Australian School of Petroleum, University of Adelaide

[3] CSIRO Petroleum, North Ryde

AAPG Annual Convention & Exhibition 20-23rd April 2008

CSIRO

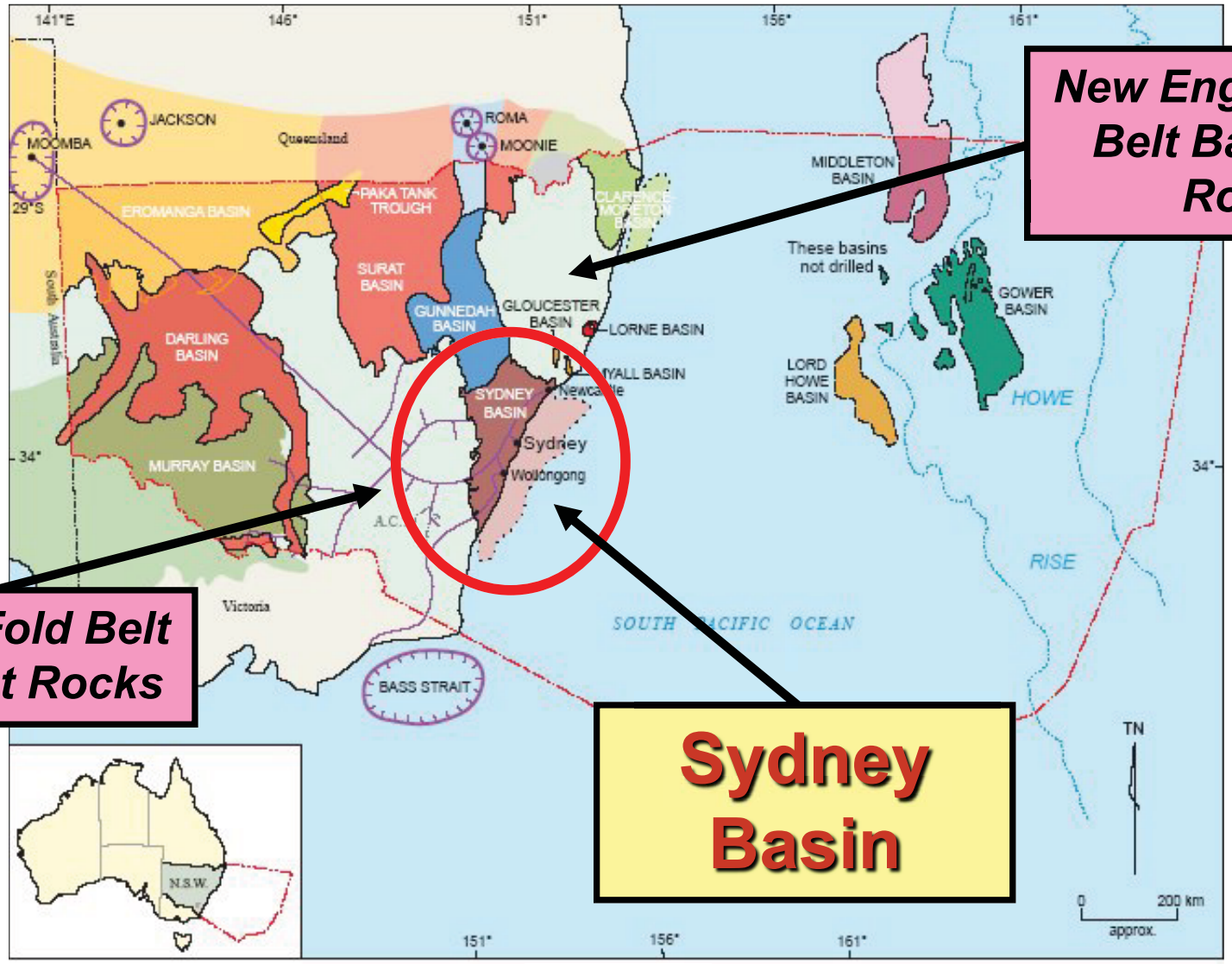
ADELAIDE UNIVERSITY AUSTRALIA

CO2CRC

Presentation Outline

- Location of Study Area
- GHG Emissions Profile of New South Wales, E-Australia
- Key Factors for CO_2 Storage Site Assessments
- Geological Overview of the Sydney Basin
- Geosequestration Potential of Sandstones (Saline Aquifers)
- Geosequestration Potential of Coal Systems (ECBM)
- Conclusions

Location of the Sydney Basin



New England Fold Belt Basement Rocks

Lachlan Fold Belt Basement Rocks

Sydney Basin

http://www.dpi.nsw.gov.au/minerals/resources/petroleum/map

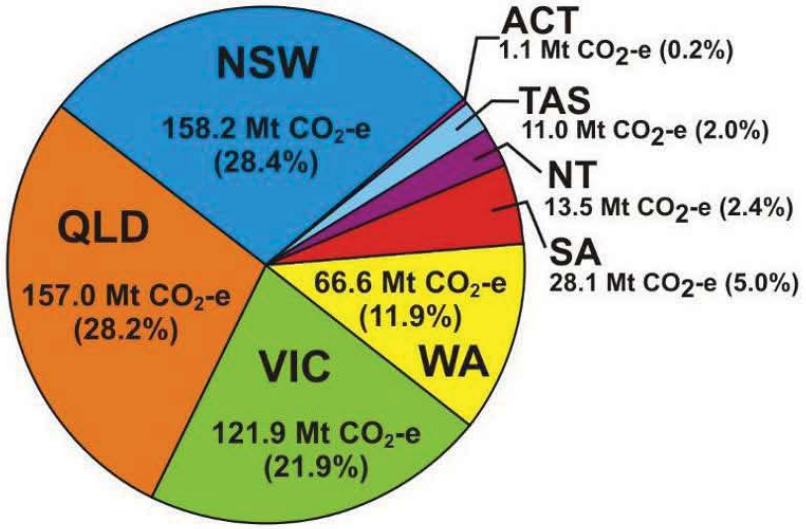
CSIRO

ADELAIDE UNIVERSITY AUSTRALIA

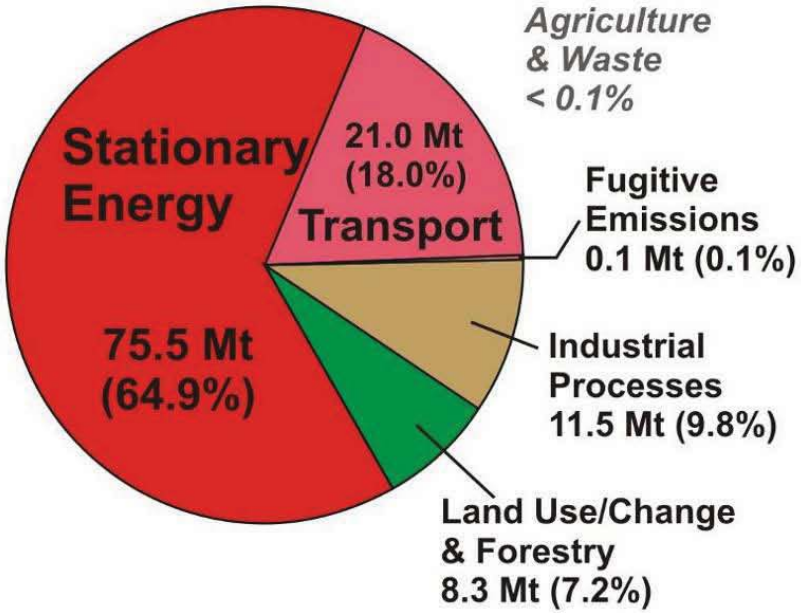
CO2CRC

Emissions Profile of New South Wales

Australian State & Territory Shares of National GHG Emissions, 2005: 559.1 Mt CO_2-e



CO_2 Emissions by Sector, New South Wales, 2005: 116.4 Mt



Potentially sequesterable: CO_2 emissions from the stationary energy sector, from industrial processes and fugitive point sources.

These sectors accounted for ~90 Mt or ~75% of NSW's total CO_2 emissions in 2005

Source: State & Territory Greenhouse Gas Inventories 2005

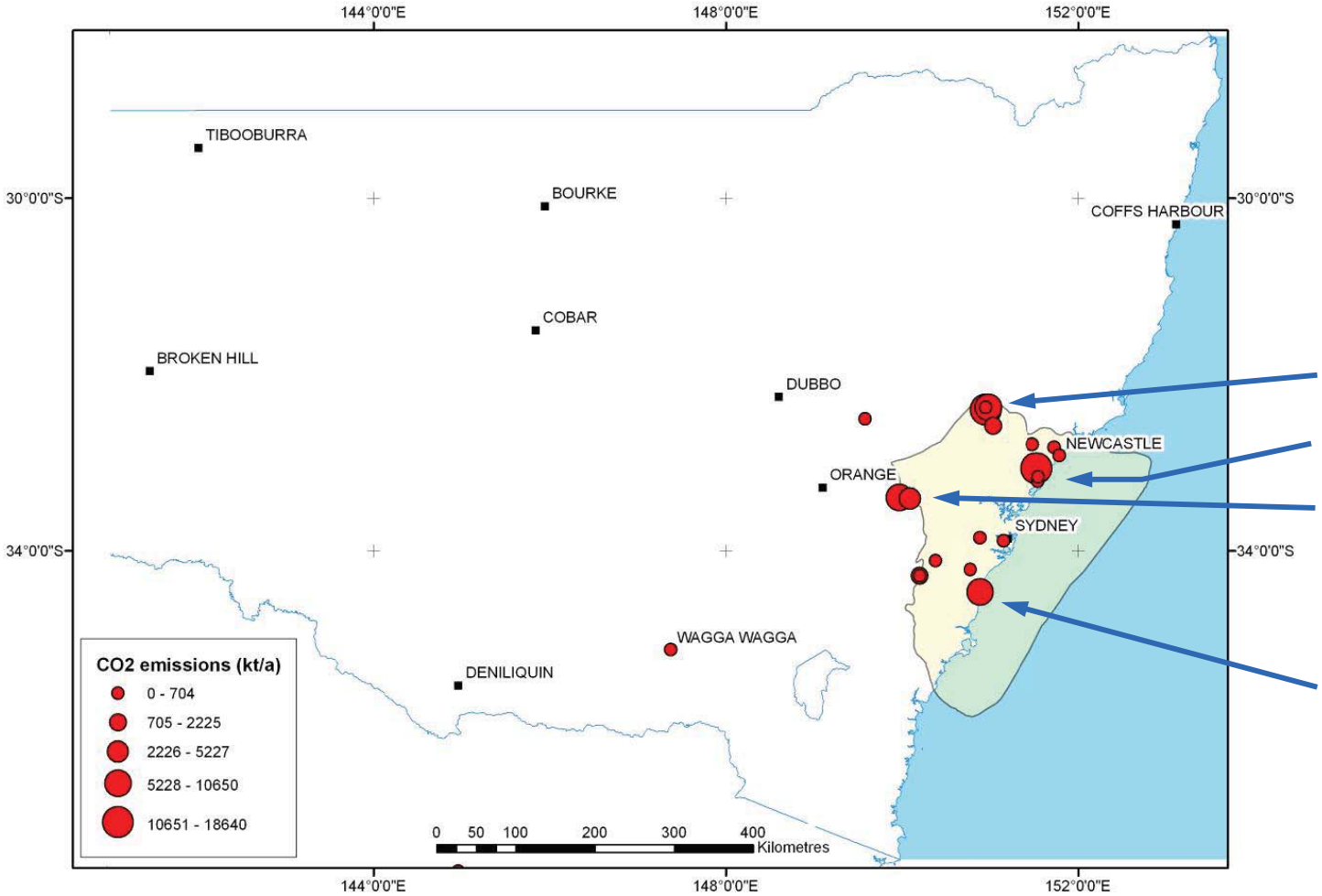
CSIRO

ADELAIDE UNIVERSITY AUSTRALIA

CO2CRC

Stationary emission sources in New South Wales

The majority of NSW's stationary CO_2 emitters lie within the Sydney Basin area, which forms the biggest CO_2 emissions node within Australia (Bradshaw et al. 2002)



<u>Largest stationary CO_2 emitters in NSW:</u>

Major power stations

- ***in the Hunter Valley***
- ***near Lake Macquarie***
- ***in the western Sydney Basin***

Port Kembla Steelworks near Wollongong

The high concentration of CO_2 emitters in the Sydney Basin and the likely increases in emissions in the future demands options for local subsurface storage of CO_2

CSIRO ADELAIDE UNIVERSITY AUSTRALIA CO2CRC

Key Factors for CO_2 Storage Site Assessments

1) **Storage Capacity:** porous rock that can store CO_2

   a: sandstone (storage of supercritical CO_2 in pores within saline aquifers or depleted oil/gas fields, min. porosity ~10%)

   b: coal (adsorption of CO_2 molecules onto micropore surfaces)

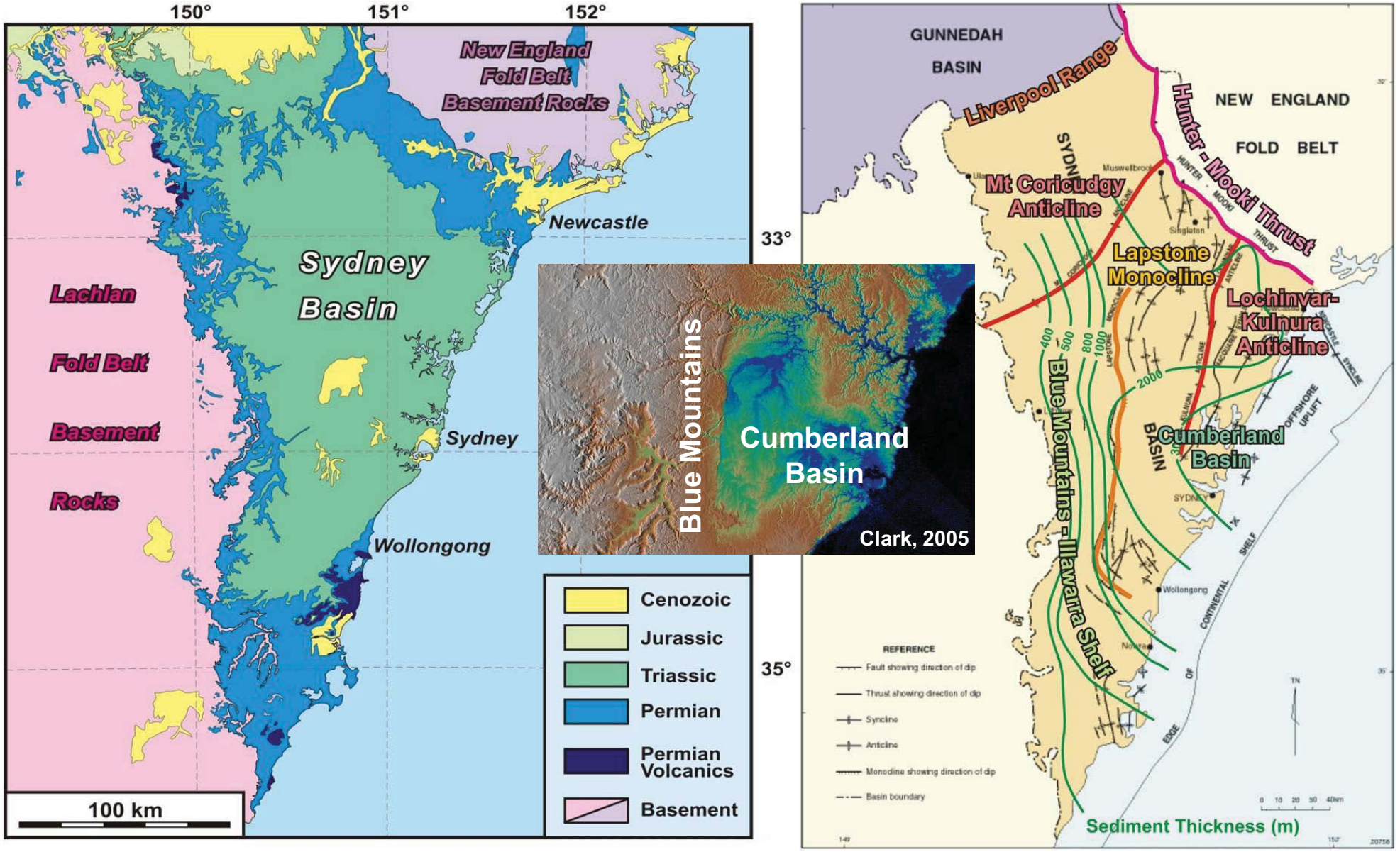
2) **Injectivity:** permeable rock (min. 50 mD for sandstones)

3) **Site Details:** storage rock in suitable depth (sst >800 m, coal >300 m)

4) **Containment:** impermeable seal rock above reservoir & CO_2 trap

5) **Impact on natural resources:** hydrocarbons, groundwater, residential zones, nature reserves

Geological Overview



Brunker & Rose, 1967

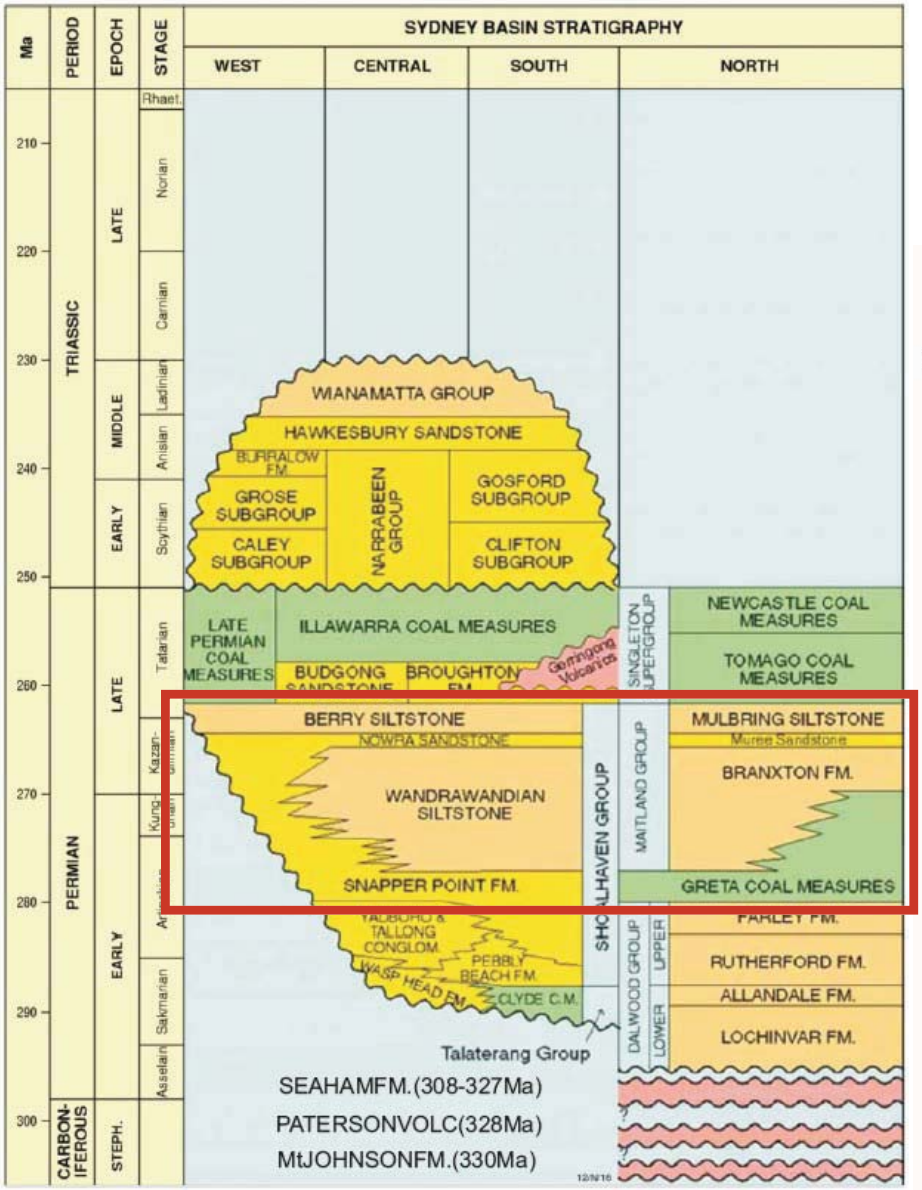
Stewart & Alder, 1995
Bradshaw et al., 2007

CSIRO

ADELAIDE UNIVERSITY AUSTRALIA

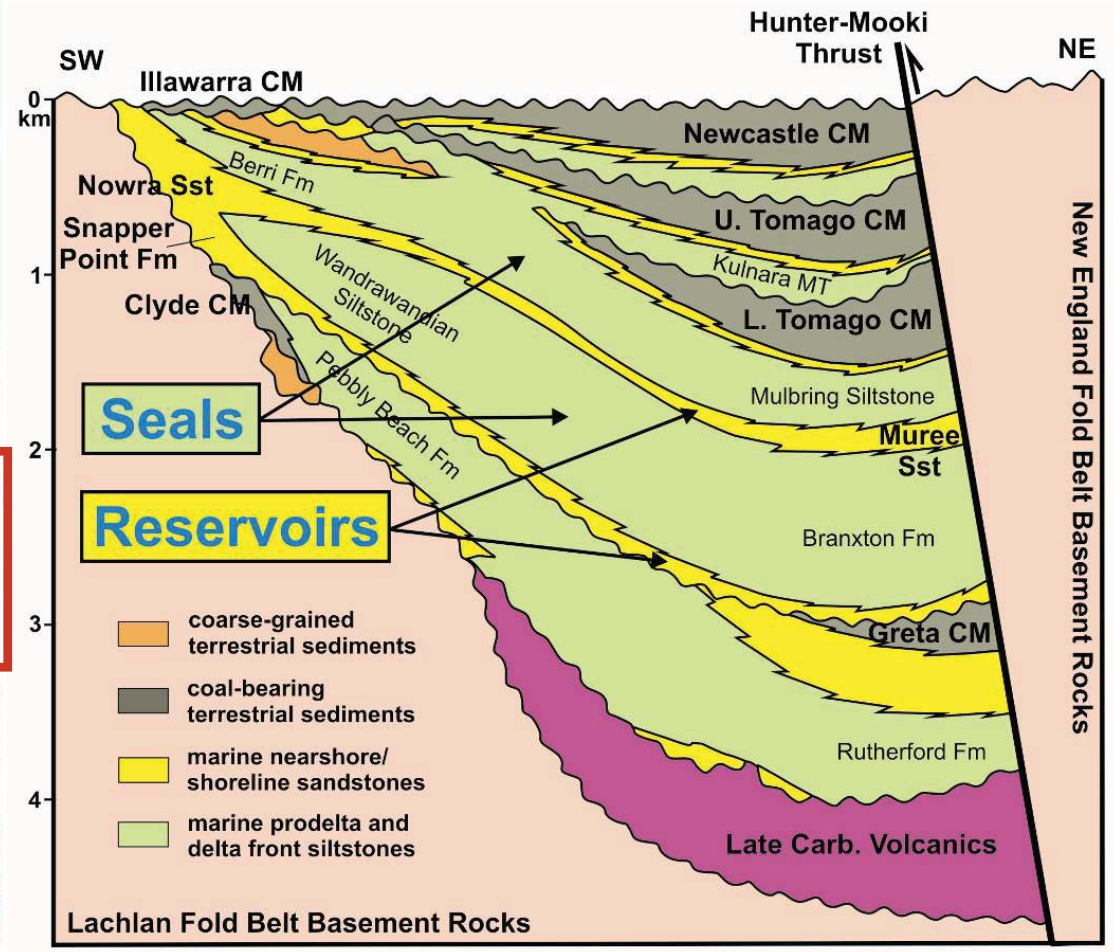
CO2CRC

Stratigraphy & Saline Aquifer Plays



Main target saline aquifers:

- Snapper Point Fm and equivalents
- Nowra – Muree Sst



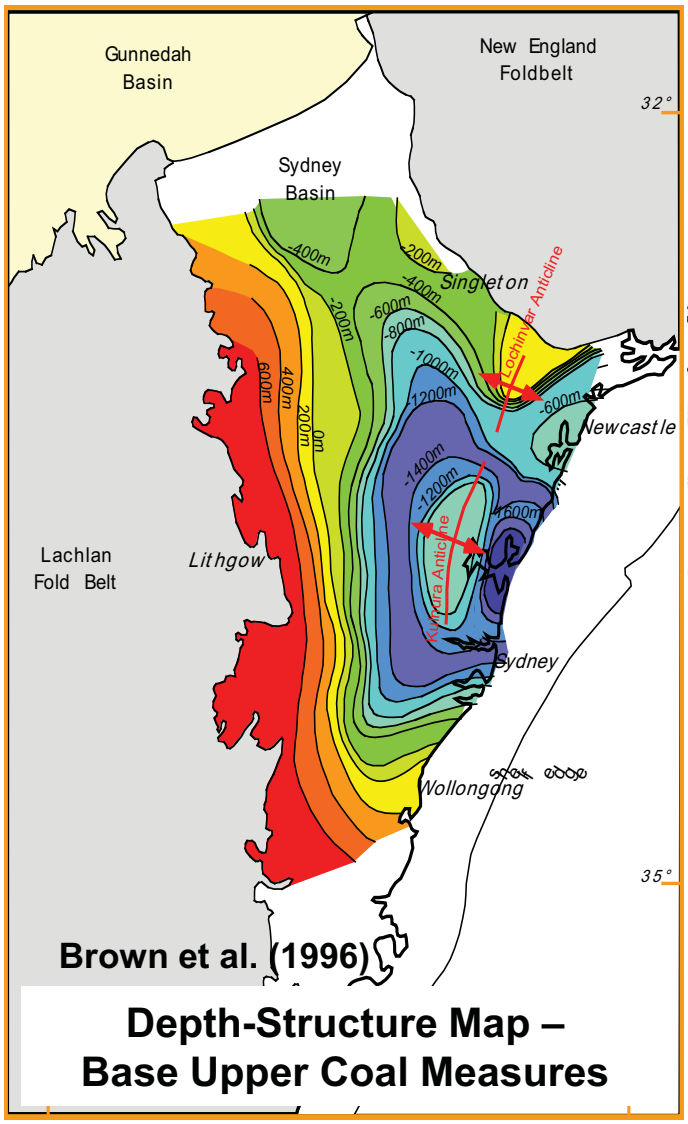
Herbert, 1980; Maung et al., 1997; Alder et al., 1998

CSIRO

ADELAIDE UNIVERSITY AUSTRALIA

CO2CRC

Potential Saline Aquifer CO_2 Storage Site

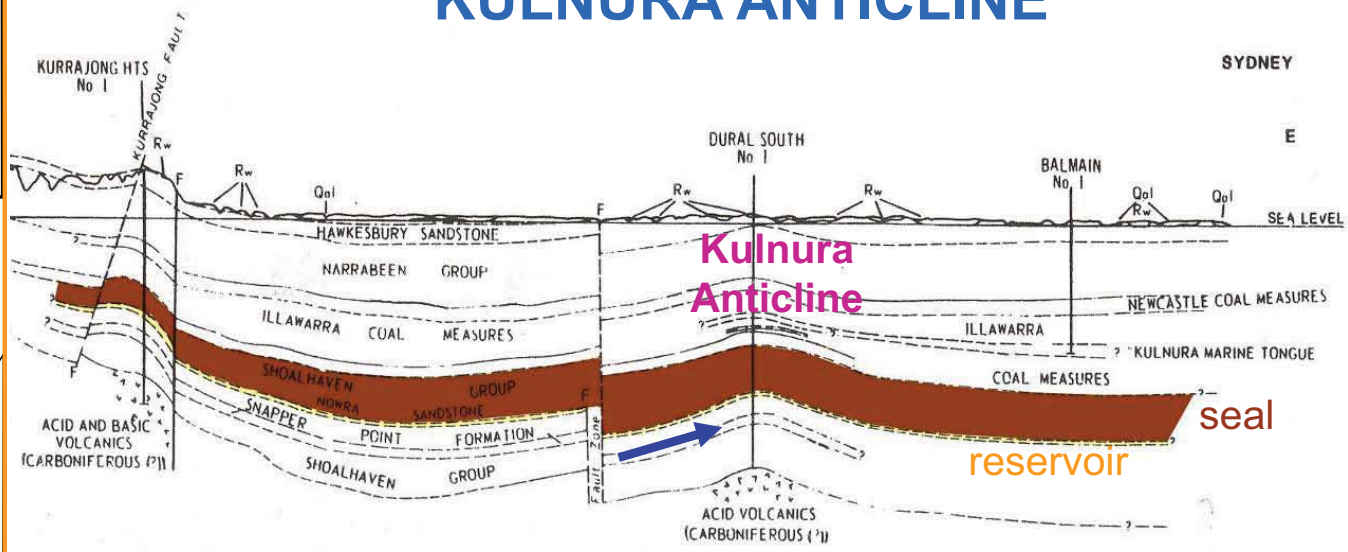


Brown et al. (1996)

Depth-Structure Map – Base Upper Coal Measures

GEODISC:

KULNURA ANTICLINE



Cross-section through Sydney Basin showing structural trap around Dural South-1 (from Bradley et al., 1985).

Reservoir: Nowra & Muree Sst.

(Seal: Berri – Mulbring Siltstone)

Average porosity: 6.5%

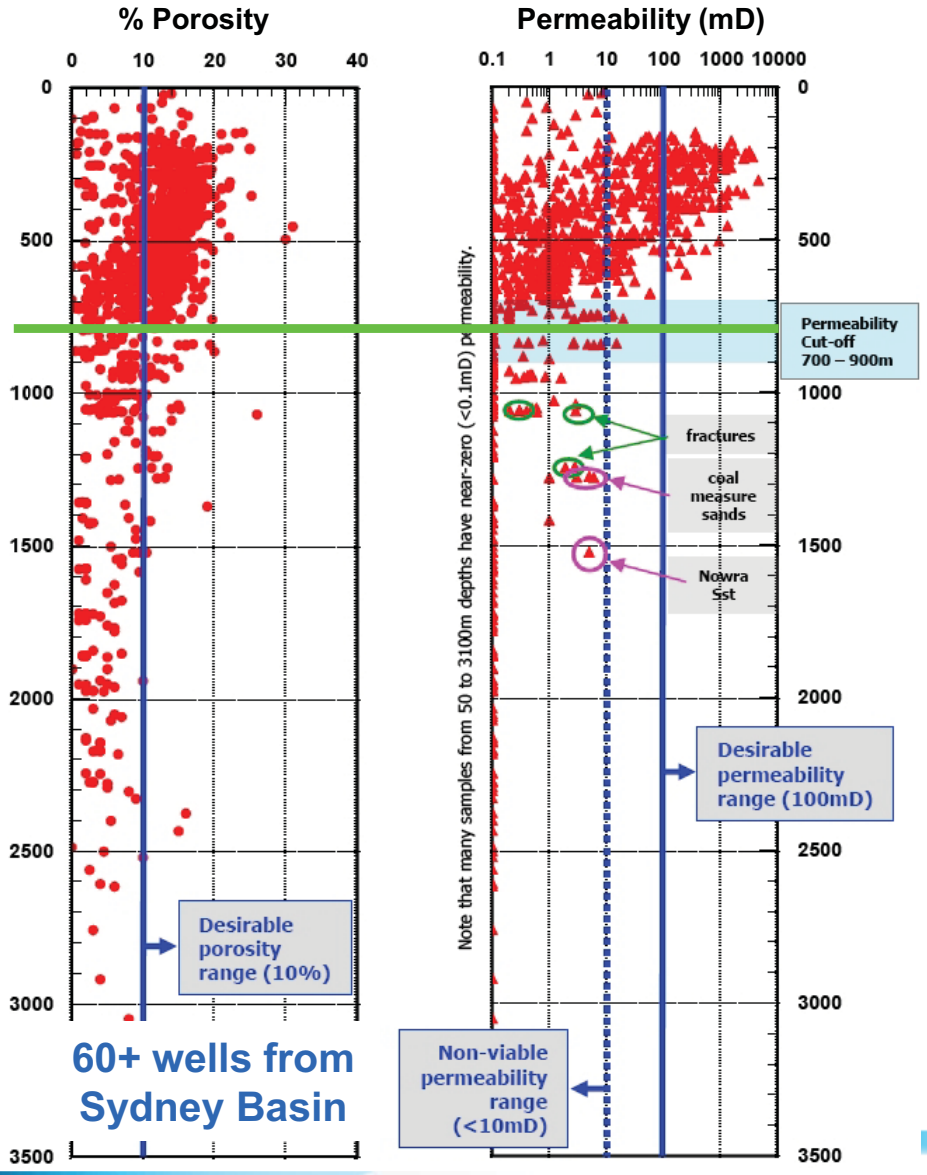
Average permeability: 6.7 mD

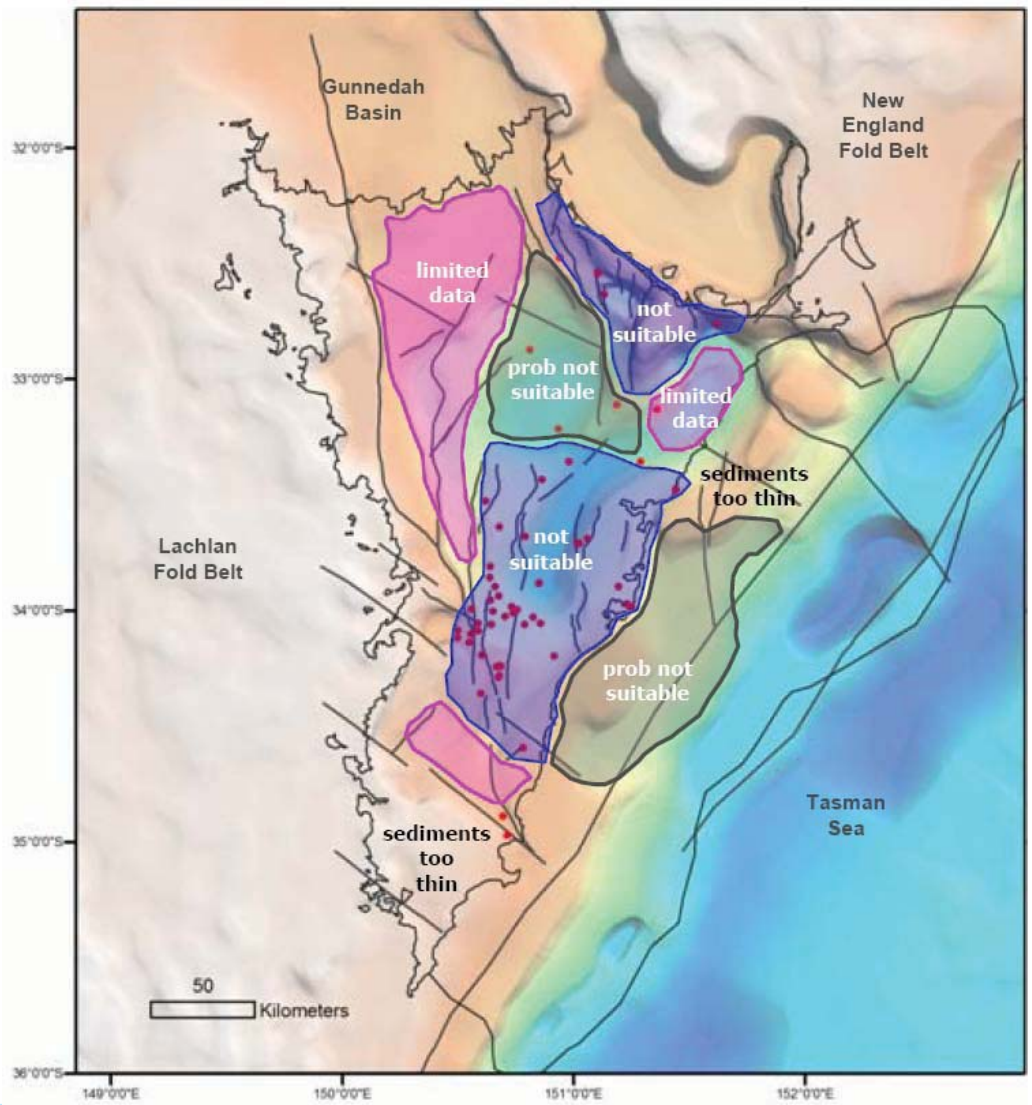
CSIRO

ADELAIDE UNIVERSITY AUSTRALIA

CO2CRC

CO_2 Geosequestration Potential of Saline Aquifers in the Sydney Basin





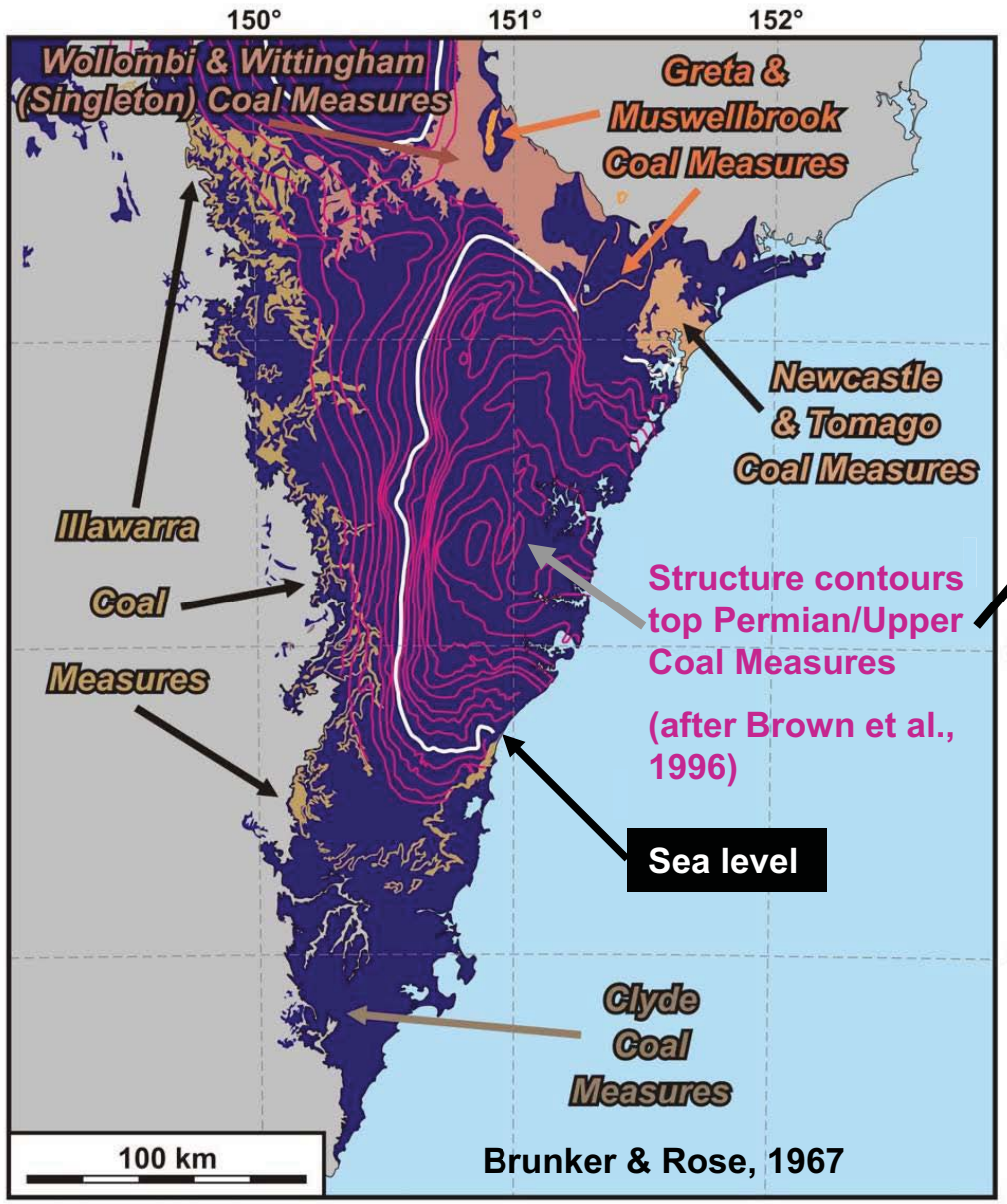
from Blevin et al., 2007 (FrOG Tech)

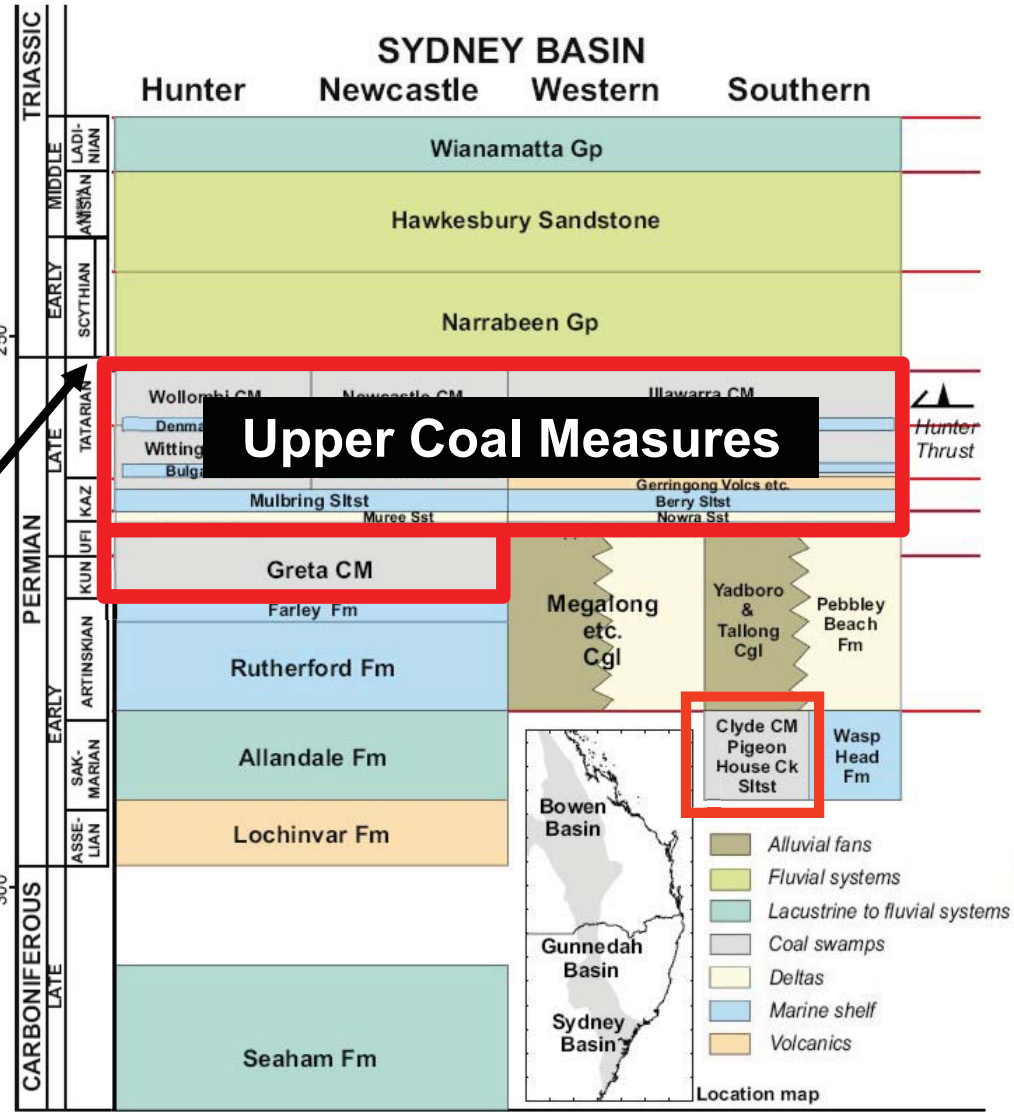
CSIRO

ADELAIDE UNIVERSITY AUSTRALIA

CO2CRC

ECBM Potential in the Sydney Basin





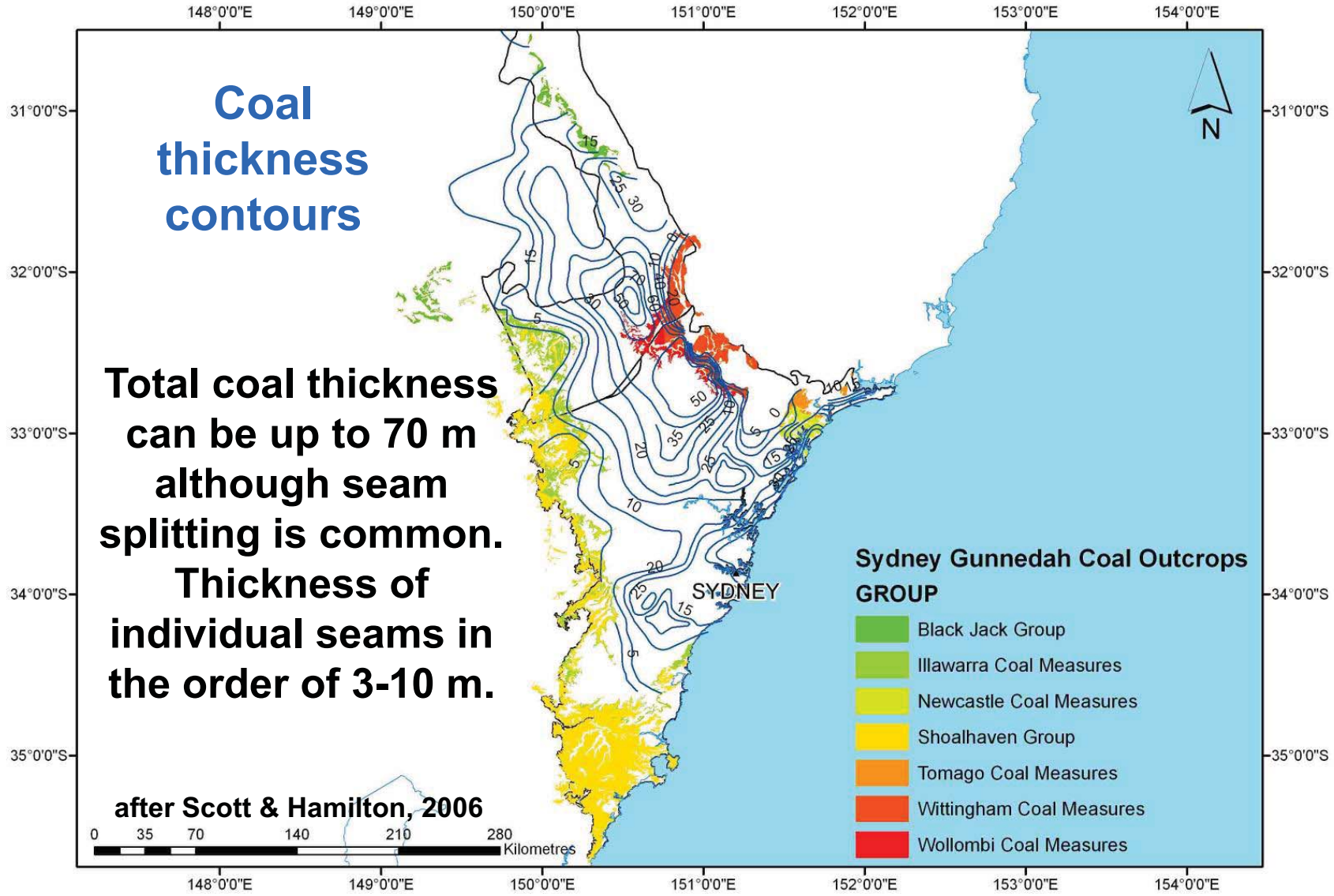
Fielding et al., 2001

CSIRO

ADELAIDE UNIVERSITY AUSTRALIA

CO2CRC

ECBM Potential in the Sydney Basin

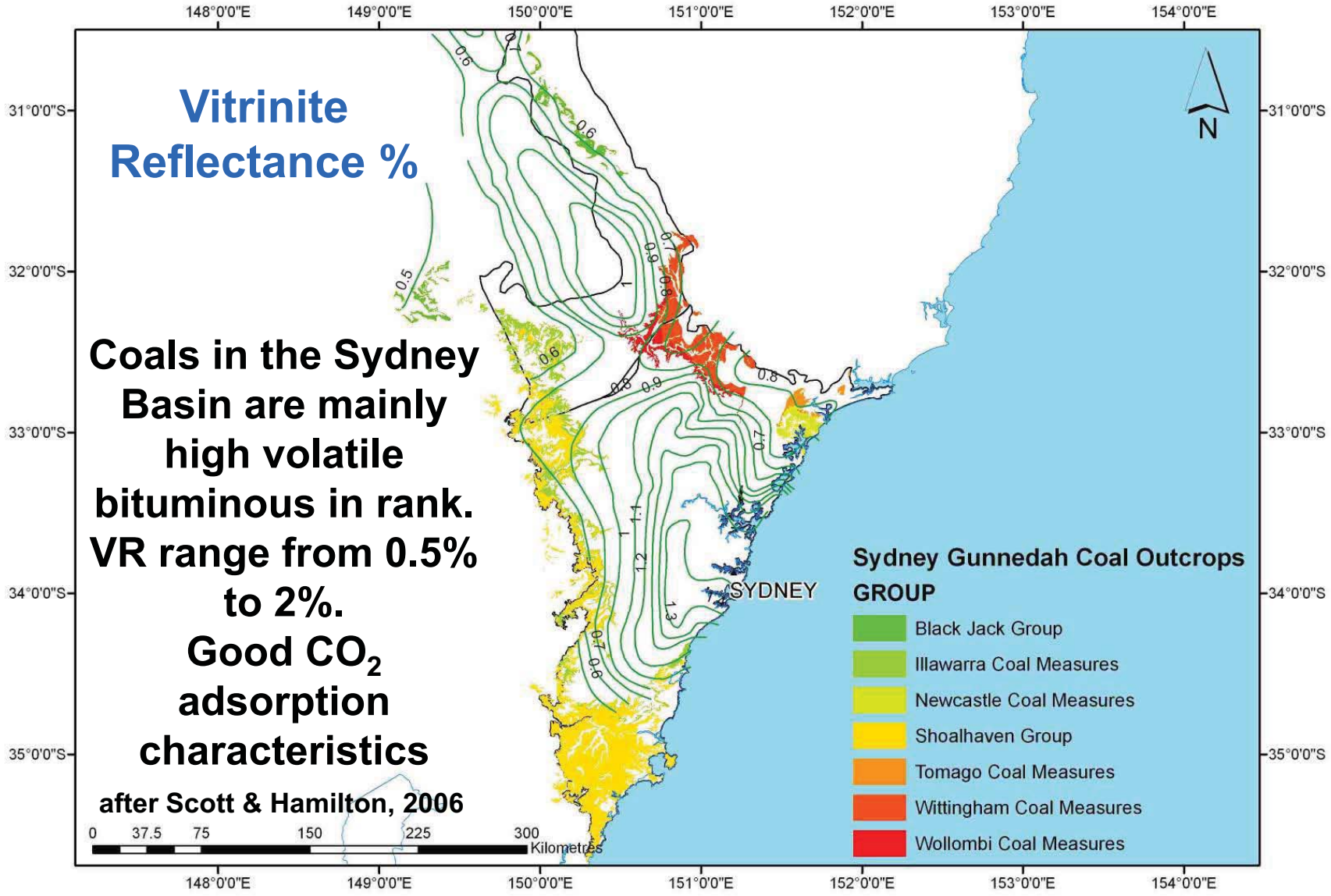


CSIRO

ADELAIDE UNIVERSITY AUSTRALIA

CO2CRC

ECBM Potential in the Sydney Basin

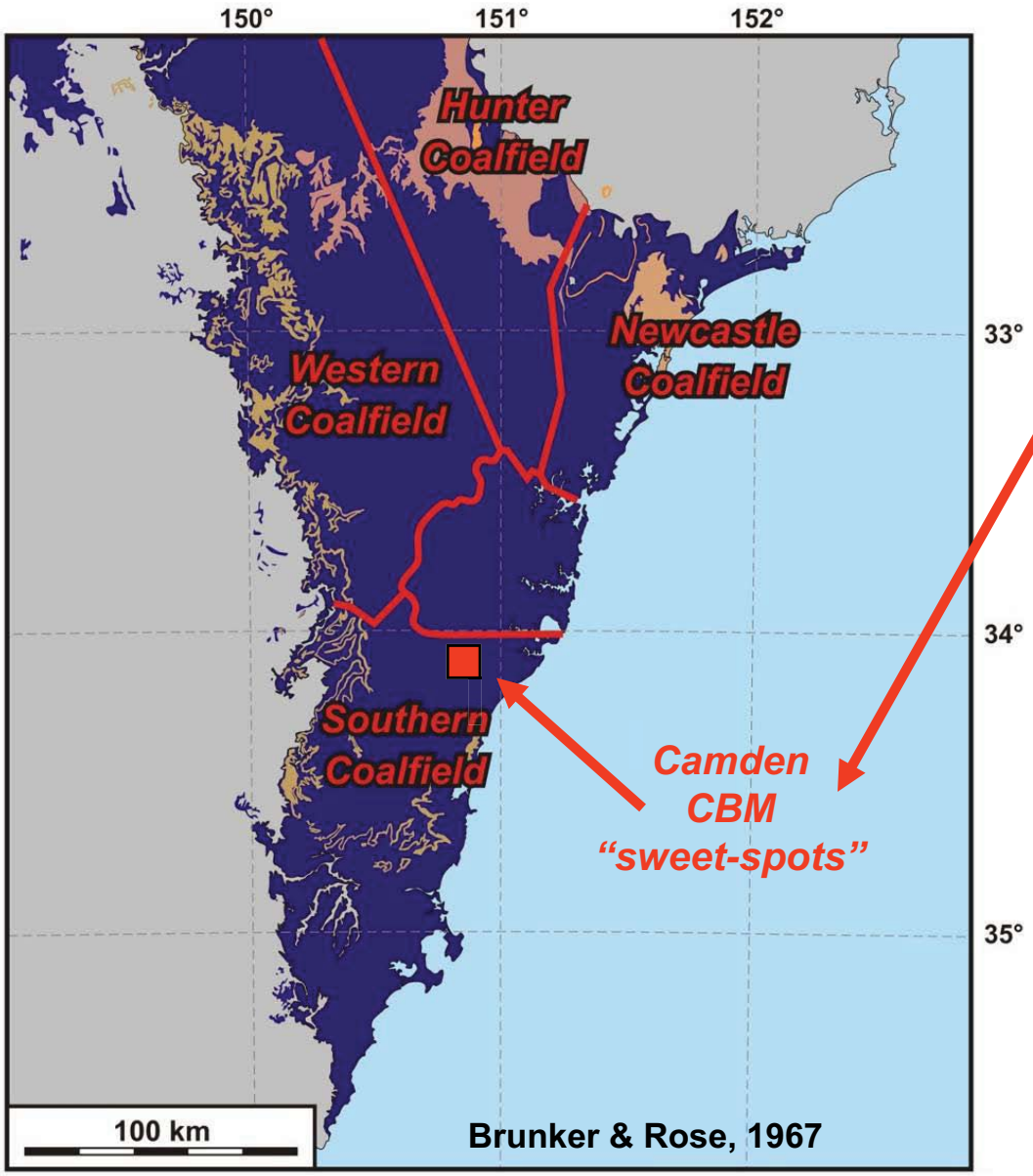


CSIRO

ADELAIDE UNIVERSITY AUSTRALIA

CO2CRC

ECBM Potential in the Sydney Basin



CBM production up to 900Mcf/day in 'high production fairway" indicates possibility of coal seams with favourable permeability for CO_2 injection.

Detailed studies are being currently conducted in both the Southern and Hunter Coalfields to identify locations for CO_2 sequestration in coal.

CSIRO

ADELAIDE UNIVERSITY AUSTRALIA

CO2CRC

Conclusions

- **The high concentration of large CO_2 emitters in the Sydney Basin area demands options for local subsurface storage of CO_2;**
- **The basin fill and structure of the Sydney Basin is in principle favourable for CO_2 sequestration:**
  - **Presence of potential reservoir–seal pairs in the stratigraphy**
  - **Presence of structural traps and moderate faulting intensity**
- **Major challenge for geosequestration in the Sydney Basin is the low permeabilities of potential reservoir rocks *(can reservoir stimulation (fracturing) or horizontal/multilateral drilling be a viable solution?)*;**
- **With the expansion of CBM production in the Sydney Basin niche opportunities will exist for CO_2-ECBM.**

References

Alder, J.D., S. Hawley, T. Maung, J. Scott, R.D. Shaw, A. Sinelnikov, and G. Kouzmina, 1998, Prospectivity of the offshore Sydney Basin, a new perspective: APPEA Journal, v. 38/1, p. 68-92.

Blevin, J., L. Hall, J. Chapman, and L. Pryer, 2007, Sydney Basin reservoir prediction study, MR 705: 136 p., Web. http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0006/191814/Sydney_Basin_Reservoir_Study.pdf.

Bradley, G.M., E.K. Yoo, and P. West, 1985, Geological mapping at Rylstone to assist coal mine planning: Proceedings of the Symposium Advances in the Study of the Sydney Basin, no. 19, p. 64-67.

Bradshaw, J., and R. Causebrook, 2007, The geological storage of carbon dioxide; the hows and whys: Waves Moorooka, v. 13/1, 22 p.

Bradshaw, J., B.E. Bradshaw, G. Allinson, A.J. Rigg, V. Nguyen, and L. Spencer, 2002, The potential for geological sequestration of CO_2 in Australia; preliminary findings and implications for new gas field development: APPEA Journal, v. 42/1, p. 25-46.

Brunker, R.L., and G. Rose (compilers), 1967, Geological map of Sydney Basin: Geological Survey of New South Wales and New South Wales Department of Mines, 1 map.

Fielding, C.R., R. Sliwa, R.J. Holcombe, and A.T. Jones, 2001, A new palaeogeographic synthesis for the Bowen, Gunnedah and Sydney basins of Eastern Australia, *in* K.C. Hill and T. Bernecke (eds) Eastern Australasian Basins Symposium, A Refocused energy perspective for the future: Petroleum Exploration Society of Australia Special Publications, p. 269-278.

Herbert, C., 1980, Wianamatta group and Mittagong formation, *in* C. Herbert and R. Helby (eds), A Guide to the Sydney Basin: Geological Survey of New South Wales Bulletin, v. 26, p. 254-271.

Stewart, J.R., and J.D. Alder, 1995, New South Wales petroleum potential: New South Wales Department of Mineral Resources Petroleum Bulletin, no. 1, 188 p.