Identifying Sites for CO₂ Geosequestration in the Sydney Basin*

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Abstract

The Sydney Basin region contains the largest concentration of stationary CO₂ 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. CO₂ emissions from these point sources over the next 20 years are anticipated to be around 1350 Mt. Because of this large emissions profile the CO₂ sequestration potential of the Sydney Basin is being addressed by a systematic basin-scale evaluation to identify, characterise and prioritise potential CO₂ storage areas.

The Sydney Basin contains a number of Permian reservoir-seal pairs in deep saline formations which are potentially suitable for CO₂ 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 CO₂ injection. Furthermore, major advances have been made in understanding the behaviour of CO₂ in coal-bearing successions through both natural analogue and laboratory studies. These insights will be applied to improve quantification of CO₂ storage capacities for coal seams in the Sydney Basin.
Identifying Sites for CO$_2$ Geosequestration in the Sydney Basin

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Presentation Outline

• Location of Study Area

• GHG Emissions Profile of New South Wales, E-Australia

• Key Factors for CO₂ 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

Emissions Profile of New South Wales

Potentially sequesterable: CO₂ 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 CO₂ emissions in 2005.
Stationary emission sources in New South Wales

The majority of NSW’s stationary CO₂ emitters lie within the Sydney Basin area, which forms the biggest CO₂ emissions node within Australia (Bradshaw et al. 2002)

The high concentration of CO₂ emitters in the Sydney Basin and the likely increases in emissions in the future demands options for local subsurface storage of CO₂.
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 $\sim$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

Blue Mountains
Cumberland Basin

Clark, 2005

100 km

Cenozoic
Jurassic
Triassic
Permian
Permian Volcanics
Basement

Sediment Thickness (m)
Main target saline aquifers:
- Snapper Point Fm and equivalents
- Nowra – Muree Sst

Herbert, 1980; Maung et al., 1997; Alder et al., 1998
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
CO$_2$ Geosequestration Potential of Saline Aquifers in the Sydney Basin

from Blevin et al., 2007 (FrOG Tech)
ECBM Potential in the Sydney Basin

Coal thickness contours

Total coal thickness can be up to 70 m although seam splitting is common. Thickness of individual seams in the order of 3-10 m.

after Scott & Hamilton, 2006
ECBM Potential in the Sydney Basin

Vitrinite Reflectance %

Coals in the Sydney Basin are mainly high volatile bituminous in rank. VR range from 0.5% to 2%.

Good CO₂ adsorption characteristics

after Scott & Hamilton, 2006
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 CO₂ injection.

Detailed studies are being currently conducted in both the Southern and Hunter Coalfields to identify locations for CO₂ sequestration in coal.

Brunker & Rose, 1967

Camden CBM “sweet-spots”
Conclusions

• The high concentration of large CO\textsubscript{2} emitters in the Sydney Basin area demands options for local subsurface storage of CO\textsubscript{2};

• The basin fill and structure of the Sydney Basin is in principle favourable for CO\textsubscript{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 (\textit{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\textsubscript{2}-ECBM.
References


