

Site Characterisation for Geological Storage of Carbon Dioxide: Examples of Potential Sites from the North West Shelf, Australia

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This thesis is submitted in fulfilment of the requirements of Doctor of
Philosophy in the Faculty of Science, The University of Adelaide

August 2009



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ABSTRACT

Release of anthropogenic greenhouse gas emissions to the atmosphere is a concern for global warming. Thus, practical and economic solutions are being sought to combat this problem. One possible methodology for reducing emissions is the geological storage of carbon dioxide (CO₂). The subsurface behaviour of CO₂ is influenced by many variables; therefore, accurate appraisal of a potential CO₂ storage site requires detailed site characterisation. In particular, potential sites need to be evaluated geologically in terms of their injectivity, containment and capacity. Detailed site characterisation was undertaken for two possible sites for geological storage of CO₂, located offshore northwest Australia in the Petrel and Barrow sub-basins.

The injection targets in the Petrel Sub-basin are the Jurassic Plover and Elang formations, locally sealed by the Frigate Formation, and the overlying Cretaceous Sandpiper Sandstone, regionally sealed by the Bathurst Island Group. The Plover/Elang formations are laterally extensive, fluvio–deltaic sandstones of fair to good reservoir quality, with likely excellent lateral and vertical connectivity. The Frigate Formation may not be an effective seal up-dip, but the overlying secondary reservoir (Sandpiper Sandstone) and thick regional seal (Bathurst Island Group) will ensure continued CO₂ containment. The Jurassic–Cretaceous post-rift sediments are structurally simple and dip gently up towards the basin margins with no defined structural closures. Therefore, hydrodynamic, residual and solubility trapping beneath the regional seal will be the dominant storage mechanisms. The potential storage capacity is vast (> 10,000 Mt), highlighting why deep saline formations may provide a realistic solution to large-scale greenhouse gas emissions reduction.

In the Barrow Sub-basin, the Cretaceous Flag Sandstone is the injection target, sealed by the Muderong Shale. The reservoir units are laterally extensive, amalgamated, basin floor fan sandstones with excellent reservoir quality. Hemipelagic shale drapes may locally restrict the vertical connectivity. The Muderong Shale has excellent seal capacity, with the potential to withhold a CO₂ column height of 565–790 m. The structural geometry is a large anticline and the trapping mechanisms are likely to a combination of stratigraphic, residual and solubility trapping along the axis of the anticline, as well as structural trapping within the anticlinal closure. A few large faults exist which could potentially be reactivated if injection pressures are not appropriately managed. The hydrodynamic flow has been altered by production-

induced pressure decline; however, the impact on the CO₂ migration pathway is likely to be insignificant due to the stronger buoyancy drive.

The detailed geological characterisation process identified that both sites are suitable candidates for geological storage of CO₂. Geological storage of CO₂ is technically feasible in a variety of different geological settings, as demonstrated by studies like these and CO₂ storage projects already in operation. Key to the success of a CO₂ storage project is an understanding of the stratigraphic architecture and reservoir heterogeneity. This will allow an optimal injection strategy to be devised to utilise the inherent geological characteristics of the site and maximise the benefits of injectivity, capacity and containment for efficient geological storage of CO₂.

STATEMENT

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Catherine M. Gibson-Poole

Date

ACKNOWLEDGEMENTS

There are several people I would like to thank for their assistance, for which without their help this thesis would not have been completed. I would therefore like to thank the following people for their help, advice, encouragement and support.

First and foremost, I would like to thank my primary supervisor, Dr. Simon Lang, who has been an inspiration throughout this study. I would also like to thank my co-supervisors, Dr. Tobi Payenberg and Dr. Bruce Ainsworth, for taking me on late in the process and helping me through the final stages. Peter Cook (Director, APCRC) and Andy Rigg (GEODISC™ Program Manager, APCRC) are thanked for their substantial leadership and guidance throughout the research program. The GEODISC™ sponsoring companies (Australian Greenhouse Office, BHP Billiton, BP, Chevron, Gorgon LNG, Shell, Total and Woodside) are thanked for their financial support. Many thanks to all the other researchers in the GEODISC™ Program, for their insights and technical discussions: in particular, John Bradshaw, Barry Bradshaw and Lynton Spencer (Geoscience Australia); Jonathan Ennis-King, Lincoln Paterson, Claus Otto and Allison Hennig (CSIRO); Robert Root, Adam Hill, Janet Skinner, Jürgen Streit, Richard Hillis, Ghazi Kraishan, Max Watson and Nick Lemon (NCPGG/ASP).

I would also like to acknowledge the technical and administrative support provided by the following people: Andy Mitchell, Tony Hayball, Lester Davies, Ian West, Mark Reilly, Nathan Ceglar, Paul Grech, Ric Daniel and Maureen Sutton (NCGPP/ASP). Thanks also go to David Quinn and Schlumberger GeoQuest for GeoFrame™ software and support, Mike Wiltshire (Wiltshire Geological Services) for donation of wireline log data, Steve Tyson (GeoVisual) for provision of GEOCard 3D modelling software and support, and Jochen Kassin (Whistler Research) for advice on 3D modelling and assistance with GEOCard software.

Additional thanks are extended to all the CO2CRC researchers for their continuing technical discussions and development of research ideas. John Kantorowicz (BP Alternative Energy) is thanked for his timely critique, which significantly improved this thesis. Finally, I would like to thank all my friends and family for their never-ending patience, encouragement, love and support.



DEDICATION

Dedicated to my late husband

Marc Andrew Pollett

13/10/1971 – 14/09/2002

NOTE:

This image is included on page xxv of the print copy of the thesis held in the University of Adelaide Library.

“To the world you were but one

To me you were my world”
