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

Catherine M. Gibson-Poole

B.Sc. (Hons.) Geology – Royal Holloway University of London, UK

M.Sc. Micropalaeontology – University of Southampton, UK

Australian School of Petroleum

The University of Adelaide

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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 (CO_2). The subsurface behaviour of CO_2 is influenced by many variables; therefore, accurate appraisal of a potential CO_2 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 CO_2, 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 CO_2 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 CO_2 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 CO_2 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 CO_2. Geological storage of CO_2 is technically feasible in a variety of different geological settings, as demonstrated by studies like these and CO_2 storage projects already in operation. Key to the success of a CO_2 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 CO_2.

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.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

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Catherine M. Gibson-Poole Date

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DEDICATION

Dedicated to my late husband

Marc Andrew Pollett

13/10/1971 – 14/09/2002

"To the world you were but one

To me you were my world"