An Assessment of Queensland's CO_2 Geological Storage Prospectivity — The Queensland CO_2 Geological Storage Atlas

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Abstract

Thirty six onshore basins in Queensland, Australia, have been assessed for their CO_2 geological storage prospectivity through injection into either: regional reservoir-seal intervals ('saline reservoirs' and aquifers); depleted oil and gas fields; or deep unmineable coal seams. This comprehensive state wide regional assessment is based on the technical (geological) suitability for geological storage, and does not consider factors such as potential interference with other resources, distance from emissions nodes or absolute storage volumes. Basins were assessed by evaluating the potential reservoir-seal intervals for their effectiveness for injection, storage and containment of CO_2. Methodologies have been developed that allow the estimation of storage capacity volumes within highly prospective reservoir-seal fairways at a regional scale. These estimates reflect conservative values that are more reliable than previous theoretical estimates, which relied upon access to pore space at the physical limit of the pore rock volume to accept fluids. Results show that the greatest potential to store the large quantities of CO_2 required to make deep cuts in Queensland's stationary emissions is to use deep, regional reservoir-seal intervals using structural traps or migration assisted storage (MAS) mechanisms. The Bowen, Cooper, Eromanga, Galilee and Surat basins contain Paleozoic–Mesozoic age fluvial reservoirs that have either produced hydrocarbons, and/or are major aquifers, and are evaluated as having the highest prospectivity for CO_2 geological storage in Queensland. Other basins have either low prospectivity or are unsuitable for geological storage. Depleted oil and gas fields and deep unmineable coal seams provide only limited opportunities for geological storage of CO_2 in Queensland.

1. Introduction

A major capacity to geologically store CO_2 is required to underpin future commercial deployment of large-scale clean coal technology projects to capture existing and future stationary CO_2 emissions in Queensland, Australia. Stationary emissions are currently concentrated in eleven major nodes representing ~95% of the operating fossil fuel power station capacity, as well as major cement, aluminum and petroleum refineries and processing plants (Figure 1). In 2008, the Queensland Government launched its Carbon Geostorage Initiative to assess Queensland's geological storage potential by identifying, characterising and evaluating geological sites with the potential for long-term, safe and secure storage of CO_2 from current and future stationary emissions. As the first phase of this initiative, a CO_2 geological storage atlas for Queensland was completed in 2009 [1], which provides an assessment of 36 onshore basins for their CO_2 geological storage prospectivity through injection into either: regional reservoir-seal intervals ('saline reservoirs' and aquifers); depleted oil and gas fields; or deep unmineable coal seams.

This comprehensive regional assessment is based on the technical (geological) suitability for geological storage, and does not consider factors such as potential interference with other resources, distance from emissions nodes or absolute storage volumes. Each of the 36 basins is assessed by identifying potential reservoir-seal intervals, and ranking these intervals based on their effectiveness for injection, storage and long-term containment of CO_2. Reservoir ranking results are used to classify basins as having either 'high prospectivity', 'low prospectivity' or 'unsuitable' conditions for CO_2 geological storage. Highly prospective basins contain at least one reservoir-seal interval with demonstrated effectiveness for injection, storage and containment of CO_2 (i.e. a reservoir-seal interval with a total ranking score ≥ 13; see [1 & 2] for ranking scheme methodology). Low prospectivity basins contain reservoir-seal interval/s with uncertain effectiveness (i.e. a total ranking score of 8–12). Unsuitable basins are known to be unprospective as their reservoirs and/or seals are all below the minimum criteria for CO_2 geological storage.

For each highly prospective basin, a storage fairway is defined using the maximum extent of high prospectivity reservoir-seal intervals (Figure 2). A maximum theoretical CO_2 storage volume is then calculated for these storage fairways using regional pressure, temperature, porosity and net reservoir thickness data. These storage estimates reflect conservative values that are more reliable than previous theoretical estimates, which relied upon access to pore space that was at the physical limit of the pore rock volume to accept fluids.

2. High Prospectivity Basins

The greatest potential to store the large quantities of CO_2 required to make major cuts in Queensland's stationary emissions is within deep regional reservoir-seal intervals using residual gas saturation (RGS) trapping through migration assisted storage ('MAS' — new term). The Bowen, Cooper, Eromanga, Galilee and Surat basins contain extensive, quartzose fluvial reservoirs sealed by fluvial-lacustrine or marine strata that have either produced hydrocarbons, and/or are major aquifers, and are evaluated as high prospectivity areas for geological storage (Figure 2; Table 1).

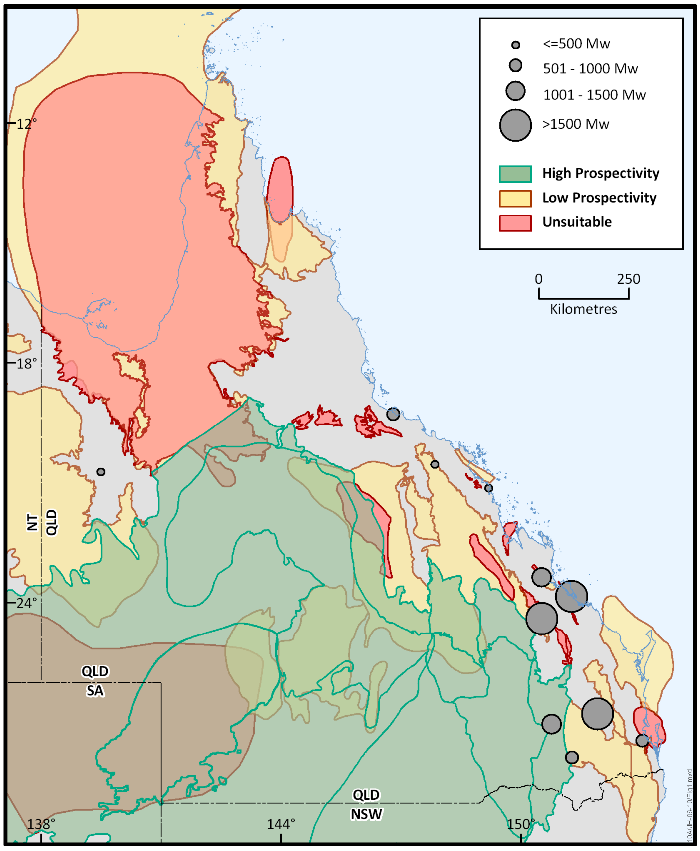

Figure 1: Geological storage prospectivity of onshore Queensland basins. Also shown are locations of major stationary CO_2 emission nodes scaled by total installed power station capacity (Mw).

2.1 Eromanga Basin

The Eromanga Basin is a vast intracratonic basin in central Australia (extent in Queensland = 600,000 km^2) that contains up to 3,000 m of Jurassic–Cretaceous fluvial, lacustrine and marine deposits. Oil has been produced from ~80 fields in Queensland. Groundwater is utilised from shallow aquifers around the basin margins where salinities are typically <1,000 ppm TDS, but increases to 3,000–20,000 ppm TDS in deeper aquifers within the centre of the basin [3]. The Eromanga Basin has the following geological characteristics that are potentially highly prospective for geological storage of CO_2: regionally extensive, thick, vertically stacked braided-fluvial and coastal sandstones with moderate to excellent reservoir quality; a thick regional seal comprising marine mudstones and several intraformational seals comprising siltstone-dominated fluvial-lacustrine deposits; the presence of large anticlinal structures as well as flat-dipping synclines and monoclines that provide opportunities for both free-phase gas trapping in dry structures and RGS trapping using MAS. A very large maximum potential storage area is mapped over the Eromanga Basin, which has an estimated maximum theoretical storage capacity of >46 Gt of CO_2. The Eromanga Basin is located >600 km from existing major stationary CO_2 emission nodes and is currently of limited interest for storage of these emissions.

2.2 Surat Basin

The Surat Basin is a large intracratonic basin that extends over an area of 327,000 km^2 in central southern Queensland, and contains up to 2,500 m of Jurassic and Cretaceous continental and marine clastics. Oil and gas have been produced from some 65 fields, most now nearing depletion. Recently, exploration has focused on coal-seam gas (CSG) resources within the Middle Jurassic Walloon Sub-group, with 19 fields currently producing or under development. The basin contains important domestic groundwater resources within a number of aquifers [4]. Regionally extensive fluvial sandstones occur in Early–Middle Jurassic strata, which form moderate to excellent quality reservoirs across the basin. Regional seals are provided by thick, shallow marine–lacustrine shales and siltstones from the upper Evergreen Formation, and fluvio-lacustrine siltstones, mudstones and argillaceous sandstones from the lower Walloon Sub-group. The basin forms a broad structural depression, which favours long-range migration of CO_2 along the gently dipping basin flanks. A relatively large maximum potential storage area is mapped over the Surat Basin, which has an estimated maximum theoretical storage capacity of ~3 Gt. This is a potentially attractive basin for geological storage, with most of the major stationary CO_2 emission nodes located within 0–300 km of the mapped storage area.

2.3 Galilee Basin

The Galilee Basin extends over an area of 247,000 km^2 in central Queensland, and contains up to 3,000 m of Late Carboniferous–Triassic rocks of dominantly continental origins. No commercial hydrocarbons have been discovered in the Galilee Basin despite drilling of most structures. Consequently, seismic and well data coverage is relatively sparse, and does not allow detailed mapping of reservoir fairways. Good quality groundwater resources (salinities 82–2,832 ppm TDS) occur within Late Permian and Triassic aquifers [5]. Regionally extensive, thick, Late Permian–Triassic fluvial sandstones form good quality reservoirs across much of the basin. Potential regional seals include conventional marine-deltaic and lacustrine-delatic shales and siltstones from the Black Alley Shale and Moolayember Formation, and unconventional thinly interbedded fluvial–lacustrine mudstones, siltstones and sandstones from the Early Triassic Rewan Formation. The effectiveness of these seals requires testing with a dedicated coring and analysis program. Trapping mechanisms are predominantly MAS through migrating CO_2 over relatively flat strata in the northern Galilee Basin, and both MAS and structural trapping over extensively folded strata in the southern Galilee Basin. Maximum potential storage areas have been mapped for both Triassic and Late Permian plays in the northern and southern parts of the Galilee Basin, which have a total estimated maximum theoretical storage capacity of 3.4 Gt. In comparison to other high prospectivity basins, these storage areas and volumes are poorly constrained. Although the Galilee Basin storage areas are located 350–450 km from major emission nodes, there is interest in using the basin to store CO_2 for future power stations under consideration in central Queensland. However, a better understanding of the effectiveness and regional extent of reservoirs and seals is required by drilling and analysing fully-cored stratigraphic holes and acquiring new regional seismic data before the area can be used for geological storage.

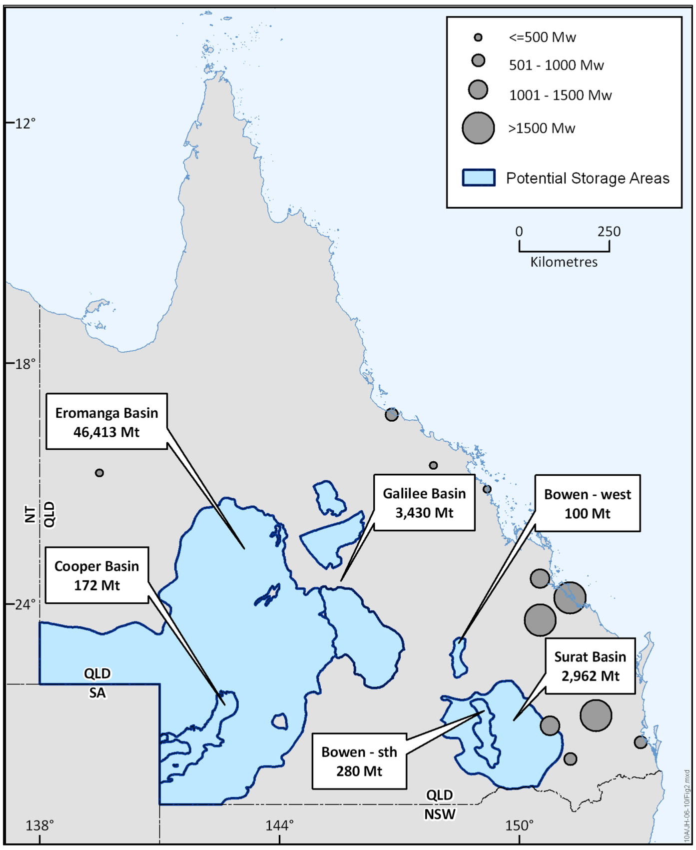

Figure 2: Maximum potential storage areas and estimated storage capacities for high prospectivity basins in Queensland.

2.4 Southern Bowen Basin

The southern Bowen Basin is an asymmetrical foredeep that extends over an area of 84,500 km^2 and contains up to 9,000 m of Permian–Middle Triassic age volcanic, volcano-clastics, coals, and continental–marine clastics. Oil and gas have been produced from some 76 fields, most now nearing depletion. Recently, exploration has focused on CSG resources within Late Permian coal measures, with 6 fields currently producing. Triassic age aquifers contain good quality groundwater resources (salinities 500–1,000 mg/l TDS), while older strata are considered hydrogeological basement [6]. Regional seals are provided by Late Permian marine and Middle Triassic lacustrine mudstones, which provide effective seals for hydrocarbons. Reservoirs of suitable quality for CO_2 injection and storage are limited to Late Permian and Triassic fluvial sandstones that extend over shallow basement areas from the southwest basin margin. However, these reservoirs have highly variable permeability, and are concentrated in thin channel

Table 1: Ranking results and maximum theoretical storage capacity estimates for high prospectivity reservoirs in Queensland. C = conventional seal; U = unconventional seal. [1]Low median permeability in these units reflects sampling from both the reservoir and seal intervals.

Basin Name	Reservoir Unit	Average Net Thickness (m)	Average Porosity (%)	Median Kh (mD); Max Kh (mD)	Seal Unit	Seal Thickness (m)	Geothermal Gradient (C/km)	Storage Area (km2)	Seal Ranking			Res. Ranking			Total Score	CO_2 Storage Capacity (Mt)
									Seal Type	Bulk Seal Effectiveness	Faults through Seal	Porosity	Permeability	Depth at Base Seal Adequate		
Eromanga	Wyandra Sandstone (coastal)	10	21.8 (n=42)	[1]0.4 (n=222); 12,000	Wallumbilla Fm/Allaru Mudstone (marine mudstones)	400-700	38.8	314,383	C	3	2	3	3	3	14	20159
Eromanga	Adori Sandstone (fluvial-lacustrine)	18	19.8 (n=82)	403 (n=78); 8,091	Westbourne Formation (fluvial-lacustrine shale, siltstone, sst)	<160	38.8	314,383	C	2	2	3	3	3	13	6474
Eromanga	Hooray Sandstone (fluvial)	59	17 (n=1,984)	[1]4.5 (n=1834); 7,520	Cadna-owie Formation (shoreface mudstone to siltstone)	<130	38.8	314,383	C	2	2	3	3	3	13	5473
Eromanga	Hutton Sandstone (fluvial)	99	17 (n=1,984)	91 (n=2,321); 2,321	Birkhead Formation (fluvial-lacustrine siltstone and sandstone)	<110	38.8	314,383	C	2	2	3	3	3	13	12226
Eromanga	lower Poolowanna Formation (fluvial)	55	12 (n=525)	[1]6.4 (n=489); 2,700	upper Poolowanna Fm (fluvial-lacustrine siltstone & mudstone)	<100	38.8	314,383	C	2	2	3	3	3	13	2081
Surat	Precipice Sandstone (fluvial)	4 (n=9)	16.8 (n=1,654)	13 (n=1519); 7,908	Evergreen Formation (marine-lacustrine shale & siltstone)	50-100	28.0	39,491	C	3	3	3	3	3	15	1298
Surat	Basal Evergreen Unit (fluvial)	1.5 (n=2)	14.9 (n=32)	5.4 (n=32); 3,320	Evergreen Formation (marine-lacustrine shale & siltstone)	50-100	28.0	2,091	C	3	3	3	2	3	14	21
Surat	Boxvale Member (fluvial)	8.4 (n=4)	15.7 (n=475)	7.1 (n=426); 7,380	Evergreen Formation (marine-lacustrine shale & siltstone)	50-100	28.0	7,300	C	3	3	3	2	3	14	454
Surat	Hutton Sandstone (fluvial)	32.7 (n=3)	17.6 (n=2,649)	98 (n=2451); 13,600	Walloon Sub-group (fluvio-lacustrine siltstone & mudstone)	50-420	28.0	12,748	C	2	3	3	3	3	14	1198
Galilee - north	Betts Creek beds (fluvial)	54 (n=15)	14.8 (n=37)	29 (n=60); 5,852	Rewan Formation (fluvial-lacustrine siltstone & sst)	100-340	40.2	12,344	U	2	2	3	3	3	13	594
Galilee - north	Clematis Sst/Rewan Fm (fluvial)	247 (n=2)	19.4 (n=10)	no data	Moolayember Fm (fluvio-lacustrine)	50-717	40.2	4,616	C	2	3	3	3	2	13	534
Galilee - south	Clematis Sst/Rewan Fm (fluvial)	129.5 (n=6)	20.7 (n=29)	144 (n=46); 4,770	Moolayember Fm (fluvio-lacustrine)	50-411	40.2	22,106	C	2	2	3	3	3	13	982
Galilee - south	Colinlea Sandstone (fluvial)	21 (n=12)	20.4 (n=11)	245 (n=23); 5,738	Black Alley Shale (marine-deltaic shale & siltstone)	<55	40.2	25,191	C	2	2	3	3	3	13	1320
Bowen - Southern	Showgrounds Sandstone (fluvial)	5.1 (n = 21)	12.4 (n=1,634)	14 (n=1410); 9,577	Snake Creek Mudstone (lacustrine mudstone)	<25	34.9	5,347	C	3	2	3	2	3	13	191
Bowen - Southern	Tinowon Formation (fluvial)	13.1 (n=8)	12.3 (n=684)	1.6 (n=512); 9,440	Black Alley Shale (marine-lacustrine shale & siltstone)	<50	34.9	1,239	C	3	2	3	2	3	13	89
Bowen - Western	Aldebaran Sandstone (coastal-fluvial)	15.6 (n=8)	13.1 (n=432)	2.1 (n=302); 1,390	Intraformational & Ingelara Fm (marine shales)	>200	43.6	2,769	C	3	2	3	2	3	13	100
Cooper	Toolachee Formation (fluvial)	22	10.2 (n=1,163)	2.5 (n=1163); 7,100	Callamurra Member (fluvio-lacustrine mudstone/siltstone)	<180	38.8	15,188	C	3	2	2	3	3	13	172

sandstones with average pay zone thicknesses in gas fields of 5–17 m. The main option for CO_2 storage is injecting downdip into the channel sandstones, and using MAS to trap CO_2 as it migrates up-dip along relatively long (25–35 km) and tortuous migration pathways towards structural highs. A relatively small maximum potential storage area is mapped based on the known reservoir fairways. Although this area has a relatively low maximum theoretical storage capacity of 280 Mt, there is interest in using it for CO_2 storage due to its proximity (150–350 km) to stationary emission nodes.

2.5 *Western Bowen Basin*

The western Bowen Basin is characterised by a N–NW trending depocentre, the Denison Trough, and adjoining basement highs to the east and west. The basin extends over an area of 44,600 km^2 and contains up to 6,500 m of Permian–Triassic age volcanics, coals, and continental–marine clastics. Gas is produced from 13 conventional fields, most with significant remaining reserves, and from 2 world-class CSG fields over the Comet Ridge. There are no significant groundwater resources. Only the Denison Trough contains reservoirs and seals at suitable depth for CO_2 storage. Thick regional seals are provided by a series of Late Permian marine shales. Reservoirs of suitable quality for CO_2 injection and storage include Early and Late Permian coastal and fluvial-deltaic sandstones. However, these reservoirs have highly variable permeability, and are relatively thin with average pay zone thicknesses in gas fields of 4.4–17.4 m. The trough is characterised by a series of large fault-propagation anticlines with 4-way dip closure. These structures have all been drilled and either contain hydrocarbon fields often with high CO_2 contents (up to 30.7%), or are located outside of the reservoir fairway. The main option for CO_2 storage is to inject downdip of the anticlines and use MAS as the CO_2 migrates 15–30 km up-dip towards the anticline crests. A relatively small maximum potential storage area is mapped based on the main reservoir fairway. Although this area has a relatively small maximum theoretical storage capacity of 100 Mt, there is interest in using the basin for CO_2 storage, with Zerogen Pty Ltd actively exploring the northern Denison Trough for storage sites to capture future coal-fired power station emissions [7].

2.6 Cooper Basin

The Cooper Basin is a large (93,000 km^2) intra-cratonic basin that contains up to 1,500 m of Late Carboniferous–Middle Triassic fluvial-lacustrine clastics and coals. Within the basin there are numerous four-way dip closed structures of various sizes. The Cooper Basin is a mature hydrocarbon province where most of the highly productive fields are nearing depletion. Groundwater in the Cooper Basin is saline, except around the basin margins where freshwater from the overlying Eromanga Basin has either flushed or diluted saline waters from the Cooper Basin. Reservoirs in the Cooper Basin are characterised by tight to moderate, rarely excellent reservoir quality. Sheet-like fluvial sandstones from the Late Permian Toolachee Formation tend to retain better reservoir quality. Reservoir quality reduces with depth due to diagenetic quartz cementation, with poor reservoir quality at depths >2,400 mSS. The main regional seal is provided by thick fluvio-lacustrine mudstones and siltstones from the Late Permian Callamurra Member. Potential storage mechanisms include both structural and MAS traps. The Cooper Basin defines a large synclinorium with strata dipping up towards the flanks, which could be suitable for MAS trapping along structural ramps. A relatively small maximum potential storage area is mapped in the Cooper Basin, with a maximum theoretical storage capacity of 172 Mt. Although there may be additional capacity in dry structures, there are regional fault/seal issues that need to be resolved before these could be considered for storage. The Cooper Basin storage area is located 600 km from any of the major emission nodes in Queensland, but may be of interest for emissions from gas processing plants within the basin.

3. Low Prospectivity & Unsuitable Basins

Thirteen Queensland basins, including the northern sub-division of the Bowen Basin, are ranked as having low prospectivity for CO_2 geological storage (Figure 1). Most low prospectivity basins appear to have unfavorable geological settings for large-scale CO_2 storage, but cannot be ranked as unsuitable due to insufficient knowledge of reservoir and seal effectiveness. In some cases, the low prospectivity ranking is due to highly variable reservoir quality and uncertain containment potential due to extensive faulting. Several low prospectivity basins are located near major emissions nodes in eastern Queensland, and may warrant the acquisition of new well and seismic data to address some of the uncertainties in reservoir and seal effectiveness.

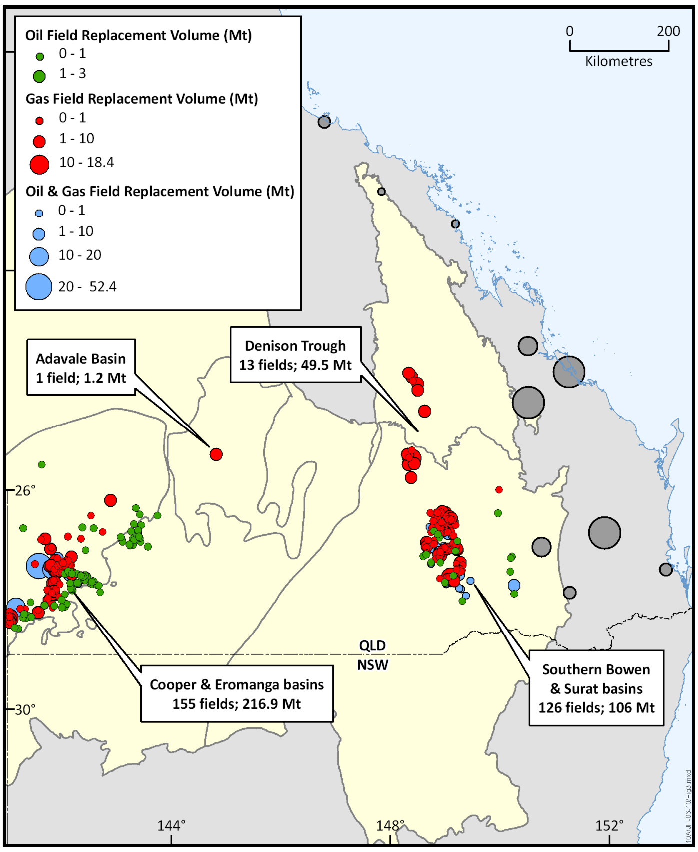

Figure 3: Location of hydrocarbon fields in Queensland scaled by their CO_2 MTRV.

Nineteen Queensland basins have reservoir-seal intervals that all fall below the minimum criteria for geological storage, and are therefore ranked as unsuitable for CO_2 geological storage (Figure 1). Most of these basins are located in close proximity to major CO_2 emissions nodes. Although there is usually limited sub-surface data, the geological knowledge of these basins is sufficient to confidently assess them as unsuitable geological storage areas. Most of these basins fail because their regional geology is unfavorable for containment of CO_2 due to either highly deformed basin fills that lack regional seals above steeply dipping beds, or because they have a shallow basin fill that lacks a regional seal. Reservoir quality is generally uncertain in unsuitable basins due to limited well data, though some do fail due to poor reservoir quality.

4. Depleted Oil and Gas Fields

The potential for geological storage in depleted oil and gas fields was evaluated by estimating the maximum theoretical CO_2 replacement volume (MTRV) for all hydrocarbon fields in Queensland using June 2008 reserves and production data. Results show that depleted fields provide very limited geological storage opportunities. The total MTRV for 295 fields in the Bowen, Surat, Cooper, Eromanga and Adavale basins is estimated at 374 Mt CO_2 (Figure 3). Most of this theoretical capacity (360.4 Mt CO_2) is in gas accumulations, while oil accumulations provide very limited potential (13.4 Mt CO_2). About 65 % (243 Mt CO_2) of the MTRV comes from just 25 fields in the Bowen, Surat, Cooper and Eromanga , Bowen and Surat basins, with 14 % (52 Mt CO_2) from the Challum field in the Cooper and Eromanga basins.

However, most large fields are still producing and are unlikely to be available for CO_2 storage in the near-future. Only 99 fields are either depleted or near-depleted (<5 % original 2P reserves remaining), which have a combined MTRV of 64.6 Mt CO_2. The Brumby gas field in the Cooper Basin is the largest depleted field (4.3 Mt CO_2), while the Silver Springs-Renlim gas field in the Bowen Basin is the largest near-depleted field (13.5 Mt CO_2). However, there is significant competition for the use of depleted and near-depleted fields for gas storage, particularly for CSG fields feeding into LNG plants. There are also questions regarding the integrity of reservoirs and seals in many fields once production has ceased, and the ability of well casing cements to resist attack from carbonic acid that forms when CO_2 dissolves in formation waters. It is therefore unlikely that depleted oil and gas fields will provide viable CO_2 geological storage options for large scale injection from major emissions nodes in Queensland. CO_2-EOR may increase the recovery of oil from some fields, but would not produce a significant net reduction in CO_2 emissions in Queensland.

5. Deep Unmineable Coal Seams

Queensland contains several sedimentary basins with major coal deposits and CSG resources. Based on the current state of knowledge and technology, storing CO_2 into deep unmineable coal seams in Queensland is only likely to be feasible at depths >400 m where it is less likely to sterilise future coal resources, and <1,000 m where suitable permeabilities may be preserved in areas of low geological stresses. However, injection rates into coal seams using current technologies are very low (e.g. maximum rate of 0.75 MMcf/d in the Allison Unit Study [8]), which would require hundreds to thousands of injection wells to store emissions from major nodes. Consequently, storage of CO_2 into coal seams is only likely to be economically feasible when undertaken to enhance the production of existing CSG resources. A qualitative assessment of Queensland's main CSG exploration areas in the Bowen, Surat and Galilee basins was undertaken by using regional depth-structure and isopach maps of the main

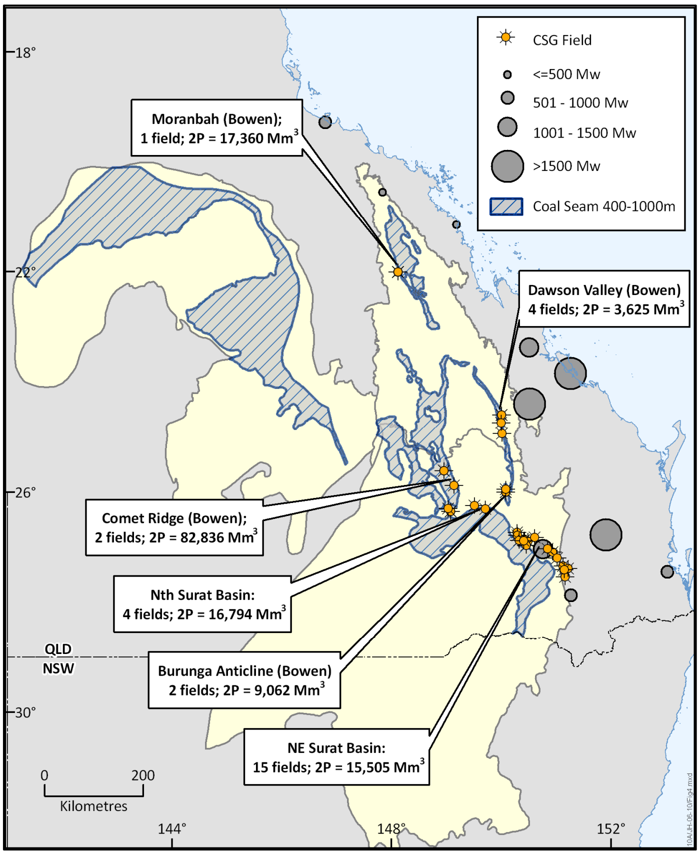

Figure 4: Location of producing CSG fields and areas where coal measures occur at depths >400 m and <1000 m. Also shown are 2008 2P CSG reserves. The only potentially suitable existing fields for enhanced CSG production are on the Comet Ridge and Burunga Anticline.

coal measures to highlight where thick coal seams are present at suitable depths for CO_2 injection and storage (Figure 4). Potential storage volumes were not calculated, as previous studies [9] have shown that these are unrealistically large and should only be calculated on a case-by-case basis for fields where an economic benefit of enhanced CSG production can be demonstrated.

Results show that the Comet Ridge in the western Bowen Basin and Burunga Anticline in the southern Bowen Basin are the only areas that currently have theoretical potential for CO_2-enhanced CSG production and storage. Other CSG production areas in the Bowen Basin and Surat Basin currently produce from coal seams that are too shallow for CO_2 storage. The Galilee Basin currently has no proven CSG resources, and thus unknown enhanced CSG potential.

6. Conclusions

Around the world, regional assessments have been undertaken at a country or regional level to evaluate the storage potential of sedimentary basins. These have been made using various levels of quality, coverage, and public availability of data as well as using different standards. Our regional assessment of CO_2 geological storage in Queensland basins shows that sustainable, large-scale storage of CO_2 requires using MAS within regionally extensive reservoir-seal fairways. Although there are many good opportunities for geological storage in Queensland, there is still a paucity of data in many areas to fully document the quality of the storage prospectivity. The Queensland CO_2 Geological Storage Atlas is one of the first steps in documenting where future work should occur, and to understand the nature of the work that is required. This study also highlights the importance of a prospectivity-based approach to regional assessments that uses reservoir-seal pairs as the primary evaluation unit in combination with mapping of migration pathways (where possible). In determining the CO_2 storage capacity volumes of basins with high geological storage prospectivity, our approach uses site-specific data for each assessment criterion rather than approximate values, and has constrained the potential storage area by identifying storage fairways that correspond to areas with high integrity seal, and good potential reservoir and trapping characteristics [1]. Maximum theoretical storage capacities have been calculated for each high prospectivity reservoir-seal interval, which are constrained by specific reservoir properties within the storage area, and are discounted for the percentage of the total rock pore volume that would be affected by the CO_2 plume, depending on whether the reservoir is very thick or thin [2]. Thus in this assessment, not all of a formation (areally and thickness) is considered in the volumetric calculations. Mapping of maximum potential storage areas based on the extent of highly prospective reservoir-seal intervals, and calculation of conservative maximum theoretical storage volumes based on site-specific data highlights to explorers and policy makers areas with the best theoretical potential for storage, thus enabling future exploration to be focussed and more cost effective.

7. Acknowledgements

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8. References

[1] Bradshaw BE, Spencer LK, Lahtinen AC, Khider K, Ryan DJ, Colwell JB, Chirinos A, Bradshaw J, 2009. Queensland carbon dioxide geological storage atlas. Compiled by Greenhouse Gas Storage Solutions on behalf of Queensland Department of Employment, Economic Development and Innovation.

[2] Spencer LK, Bradshaw J, Bradshaw BE, Lahtinen AC, Chrinos A, 2010. Regional CO_2 storage capacity estimates: prospectivity not statistics. The 10th International Conference on Greenhouse Gas Control Technologies (GHGT-10), Sept 2010.

[3] Radke BM, Ferguson J, Creswell RG, Habermehl MA, 2000. Hydrochemistry and implied hydrodynamic of the Cadna-owie-Hooray aquifer, Great Artesian Basin, Australia. Bureau of Rural Science.

[4] Draper J, 2007. Studying the Surat Basin resources. Queensland Government Mining Journal, 2007:27–28.

[5] Hawkins PJ, Gray ARG, Brain TJ, Scott SG, 1992. Geology and resource potential of the northern Galilee Basin. Geological Survey of Queensland.

[6] Reyenga PJ, Habermehl MA, Howden SM, 1998. The Great Artesian Basin – bore rehabilitation, rangelands and groundwater management. Bureau of Resource Sciences, Canberra.

[7] Morrison H, Schwander M, Bradshaw J, 2008. A vision of CCS business – the ZeroGen experience. The 9th International Conference on Greenhouse Gas Control Technologies (GHGT-9), Nov 2008.

[8] Stevens SH, Kuuskraa VA, Spector D, 1999. CO_2 sequestration in deep coal seams: pilot results and world-wide potential. Proceedings of the 4th International Conference on Greenhouse Gas Control Technologies (GHGT-4), 345–355.

[9] Bradshaw BE, Bradshaw J, Simon G, Mackie V, 2001. GEODISC research: carbon dixoide sequestration potential of Australia's coal basins. Proceedings of the 18th Pittsburgh Coal Conference, Newcastle, NSW, Australia.