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Some Technical Practicalities and Legal Implications of Geological Storage of CO_2: a Geologists Perspective

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Some Technical Practicalities and Legal Implications of Geological Storage of CO_2: a Geologists Perspective.

By Dr John Bradshaw*

SUMMARY
The challenges and developments required for geological storage to play a significant role in CO_2 emission reductions are substantial, as are the volumes that have to be considered, but achieving the required goals are within the abilities of experienced geologists, engineers and companies that operate in the geological subsurface today but that needs to be closely intertwined with regulators and policy to ensure it is technically and legally viable to perform the necessary activities.

From the legal and regulatory viewpoint the challenges of having enormous volumes of a buoyant migratory fluid injected into the deep subsurface could be the 'Achilles heel' of the business if not properly planned for and considered.

Practicalities of Geological Storage of CO_2
Geological storage of carbon dioxide has been rapidly evolving over the last 15 years from a concept with some promise to provide large scale emissions reduction of CO_2, to become something that is considered technically viable. It still faces significant challenges, as do all major projects that deal with movement and assessment of subsurface fluids, but these are not insurmountable and will mostly be site specific issues. The volumes of CO_2 that are being emitted means that a future geological storage industry will be as big as the current world gas industry. Thus one of the challenges this new industry faces is that of meeting the scale of emissions and dealing with flow on effects associated with that scaling up of the effort. By 2050, over 500 power stations may be required with carbon dioxide capture and storage, and they may involve piping and injection of over 5Gt of CO_2 per year, equivalent to 100 TCF of gas processing per year (equivalent to worldwide gas processing of methane by the gas industry).

To deal with such volumes on an annual basis will mean that the rock sequences will need to be thoroughly understood in terms of geological heterogeneity of reservoirs and seals, fluid flow dynamics within the reservoirs, and pressure transmission effects. All of these factors will combine to impact on geomechanical processes in the subsurface. Time lapse seismic may be a valuable tool, but may not always be viable as a measurement and monitoring tool of the injected CO_2 plume, as its suitability depends on the age and depth of the rock sequences. New tools will be required to help meet the expectations of the regulators and the community to be able to verify and monitor that the CO_2 is behaving as predicted from modeling.

Costs associated with the industry will need to be kept under control, due to the lack of a commercial profit from such activities in the current economic regime. It is anticipated that some offsets will come from future emissions trading schemes, and possibly from Clean Development Mechanisms if they decide to include CCS, or if a similar regime is introduced for CCS. One of the important areas to reduce costs will be in reducing well numbers through smart engineering and completion of wells. Individual projects could require many 10s of wells, including injection and pressure relief wells.
Apart from development of technology and knowledge, there will be a required change in mindset for geologists and engineers dealing with geological storage. The processes of assessing geological storage sites and engineering them is not a simple re-design of petroleum geology, petroleum systems analysis and petroleum production. New entrants to this technology will require exposure to training and a different way of thinking to what they may be use to from classical petroleum exploration and production work. However their skills sets are transferable and will provide valuable experience in assessment of storage sites.

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Legal and Regulatory Issues
From the legal and regulatory viewpoint the challenges are not simple and could be the 'Achilles heel' of the business if not properly planned for and considered. Unlike petroleum and groundwater extraction activities, the CO_2 is injected back into the deep subsurface into porous and permeable reservoirs. Whilst the oil and gas industry commonly re-inject fluids to maintain pressure in declining fields, they have never dealt with the volumes that are involved with geological storage of CO_2 and the injection occurs into physical traps in the subsurface. A significant complication is that the CO_2 is buoyant and less dense than water and oil. This means it will flow through the subsurface unless it is physically trapped in structures like occur for oil and gas accumulations. However, the most effective mechanism for large scale trapping of the CO_2 is through a process known as residual gas saturation (RGS). RGS is effective if the CO_2 migrates (slowly) through the porous reservoirs beneath an impermeable seal. This means to achieve large scale trapping of CO_2, then the CO_2 plume will have to be migratory over time, potentially crossing between tenement boundaries of competing licenses for other stakeholders and resources. Additional to the physical nature of the CO_2 plume movement is the pressure wave that emanates relatively instantly. The pressure build up from large scale injection potentially can lead to fracturing of the reservoir if not closely modeled and monitored by regulators. This in turn may lead to pressure build up in neighbouring stakeholders licenses, either affecting their activities or even potentially preventing them injecting fluids themselves due to a regulatory control not to exceed a certain pressure in the regional aquifer system.

Conclusion
The challenges and developments required for geological storage to play a significant role in CO_2 emission reductions are substantial, as are the volumes that have to be considered, but achieving the required goals are within the abilities of experienced geologists, engineers and companies that operate in the geological subsurface today, but that needs to be closely intertwined with regulators and policy to ensure it is technically and legally viable to perform the necessary activities.

Biography
Dr John Bradshaw has a BSc (Honours) and PhD from the University of New South Wales in Applied Geology, which included several years of a combined science/law degree. He is currently Chief Executive Officer of CO_2 Geological Storage Solutions (CGSS). He has worked as a consultant, in industry and government over the last 30 years. He has managed numerous large industry sponsored research programmes examining the petroleum and CO_2 storage potential of Australia and PNG, and has published over 120 papers and reports. Since 1999 he has dedicated all of his time to Geological Storage of CO_2, working with the GEODISC project, the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC) and as Group Leader of the Greenhouse Gas Advice Group and Chief Scientist CCS at Geoscience Australia. He was a Lead Author on the Special Report by the Intergovernmental Panel on Climate Change on Carbon Dioxide Capture and Storage, was an Australian technical delegate on the international Carbon Sequestration Leadership Forum and was the technical architect for the Commonwealth Government Greenhouse Gas Storage Act. He is a member of PESA, AAPG, DEG and GSA.

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