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Natural Analogs for Geologic Storage of CO_2: An Integrated Global Research Program

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ABSTRACT

Coordinated research efforts are underway on three continents (North America, Europe, Australia) to study naturally occurring carbon dioxide deposits, in order to address fundamental questions and concerns about the long-term storage of CO_2 in geologic formations. Natural accumulations of carbon dioxide exist in many geologic basins. Some deposits are stored in secure and impermeable traps, whereas others are unstable and leaking. These deposits provide unique "natural analogs" for the various options of storing CO_2 in geologic formations, including injection of CO_2 into depleted oil and gas fields and saline formations. Our research programs comprise an integrated analysis of the geologic, engineering, safety, and economic aspects of natural analogs. How long can CO_2 be stored underground? What are the long-term effects of CO_2 on reservoir and cap rock systems, and in particular what evidence exists for mineralogical changes indicating formation of stable minerals? If the CO_2 leaks similarly to many hydrocarbon accumulations, where does it go, how fast and what are the effects both in the subsurface and at the surface? What reservoir screening methods can be developed to high-grade geologic sequestration candidate sites? What are the low-cost and safe engineering techniques already developed by the CO_2 production industry that could be adapted for geologic storage? These and other fundamental issues will be evaluated to address scientific and public interest about the safety and efficacy of the geologic storage of CO_2.

INTRODUCTION

Geologic storage has been proposed as one of the most attractive methods for controlling emissions of CO_2. But is geologic sequestration of CO_2 a safe and long-term option? As important, will the public accept it? Naturally occurring geologic CO_2 deposits provide unique analogs that can help address these and other important technical and policy questions confronting geologic sequestration. Natural analogs provide an insight into future geologic CO_2 storage sites and will provide crucial information into the safety and security of geologic sequestration, the long-term impact of CO_2 on reservoirs, and field operating and monitoring technologies that could be adapted for geologic sequestration. However, they are inconsistently documented and have not yet been studied in the context of geologic CO_2 storage.

Carbon dioxide occurs naturally as a result of geologic processes in large, often high-purity (>90%) deposits in many sedimentary basins. Several CO_2 fields in the United States, Hungary, and Turkey have been exploited to provide injectant for enhanced oil recovery projects (**Table 1**). In 1998, an estimated 40 Mt (equivalent to a rate of 2 Bcfd) of naturally sourced CO_2 was injected, mainly in the Permian basin of Texas and New Mexico, southwestern USA. Prices vary with oil prices (around 3.5% of WTI), averaging around $11/t ($0.65/Mcf) for pure, high-pressure CO_2 delivered to the Permian basin during much of the 1990's. Over 2,000 km of dedicated CO_2 pipelines are in operation (**Table 2**). Gross annual revenues from commercial sales of CO_2 exceed US$350 million. Other commercial uses for CO_2 include bottling, horticulture, and chemical manufacturing. Surprising to some, CO_2 can be viewed as a valuable commodity rather than just a waste product.

The scientific study of natural CO_2 deposits is still at an early phase. Previous work has included documentation of worldwide occurrences of natural CO_2 deposits (Chernichowski-Lauriol et al., 1996 and Pearce et al., 1996), experimental mineral reactions of CO_2 with reservoir rock analogues (Pearce and Rochelle, 1999), and preliminary assessment of commercial CO_2 fields in the USA (Stevens et al., 2000).

This paper discusses the objectives, methodology, and data of three major research programs that have recently initiated coordinated studies of natural analogs:

NASCENT. The Natural Analogues for the Storage of CO_2 in the Geological Environment (NASCENT), co-ordinated by the British Geological Survey with industry, academic and European national geological survey participants, is focusing on evaluating European natural CO_2 deposits. Some of these deposits are leaking, providing insight into the effects of CO_2 streams on the geologic and surface environment and on human activity in densely populated regions. Fields have been identified in France, Germany, Greece, Hungary and Italy (**Figure 1**). Most of these fields are currently, or have been previously, exploited and current operators are providing access to production data, operating processes and geologic data as well as access to core material and field sites for soil gas and groundwater sampling. These fields will provide information on the effects of CO_2 storage on reservoirs and caprocks, as well as on migration mechanisms in the near surface and their effects on groundwaters and soil environment.

NACS. The Natural Analogs for Geologic CO_2 Sequestration (NACS) effort, headed by Advanced Resources International, Inc. (ARI), is evaluating large commercial CO_2 fields in the USA (**Figure 2**). Industry partners Kinder Morgan, Ridgeway, and Denbury Resources are providing proprietary geologic and engineering data from their large McElmo Dome, St. Johns-Springerville, and Jackson Dome CO_2 fields, respectively. These fields – located in sparsely populated areas -- are expected to provide insights into the timing of CO_2 migration and storage, geochemical and mineralogical effects of CO_2, as well as the operations, safety, and costs of CO_2 handling and distribution.

GEODISC. The Australian Petroleum Cooperative Research Centre (APCRC) is evaluating the technological, environmental and commercial feasibility off geological sequestration of CO_2 in Australia in the GEODISC research program (**Figure 3**). One of the 10 projects within this program is the study of several high-CO_2 natural gas fields to better understand CO_2 generation, migration and entrapment.

U.S. ANALOGS

At present, five large natural CO_2 fields provide a total 25 Mt (1.5 Bcfd) of carbon dioxide injectant to EOR projects in the United States (**Table 1**). These include McElmo Dome, Sheep Mountain, and Bravo Dome in the southwestern U.S., Jackson Dome in Mississippi, and Labarge field in Wyoming (**Figure 2**). A sixth field, the St. Johns-Springerville deposit in Arizona and New Mexico, is undergoing initial development. Most field data are considered proprietary.

McElmo Dome. Located in southwestern Colorado, McElmo Dome is the best documented natural analog site as well as the world's largest supply of commercially traded carbon dioxide. Commercial production commenced in 1984 with completion of an 808-km CO_2 pipeline, which supplies injectant for enhanced oil recovery projects in the Permian basin. The field is delineated by a large data set of geophysical logs from over 50 wells, seismic data, core and fluid data, reservoir simulation studies, and other information. Kinder Morgan CO_2 Co., the current operator, is providing proprietary geologic and engineering data from the field. Because of its large size, extensive data control, and long operating history, McElmo Dome will be a key site for evaluating natural CO_2 fields as analogs for long-term geologic storage of CO_2.

Carbon dioxide at McElmo Dome is trapped in a supercritical state within the Mississippian Leadville Formation, a dolomitic carbonate unit averaging 100 m thick and 1,800 to 2,600 m deep. The domal structure provides 815 km^2 of areal closure. At the time of discovery in 1948, McElmo Dome field contained an estimated 1.6 billion t (30 Tcf) of carbon dioxide, consisting of 98 to 99% CO_2 with minor amounts of nitrogen and methane. Initial carbon isotope data suggest that the CO_2 is of inorganic origin, derived from the thermal decomposition of the Leadville Limestone (Cappa and Rice, 1995). More detailed isotope and geologic analysis are planned to elucidate the timing of CO_2 migration and trapping at McElmo Dome.

A total of 59 CO_2 production wells have been drilled at McElmo Dome since 1976. Most wells can deliver 1,100 t/day (20 MMscfd). A two-phase liquid/gaseous CO_2 mixture is produced. The produced CO_2/water mixture is transported to twelve cluster facilities, where free water is separated and then re-injected into the Leadville Fm. At the central processing facilities, the two-phase CO_2 is further dehydrated, compressed, and delivered to the Cortez pipeline. A field-wide SCADA system provides control for the surface facilities. An alarm system alerts the community if a CO_2 leakage occurs. However, no leakage affecting the community has occurred in 15 years of operation at McElmo Dome. As of January 1, 2001, the field is producing about 14.6 million t/year (750 MMcfd) of CO_2 from 41 wells. Cumulative production has totaled 190 million t (3.6 Tcf), or about 12% of original gas-in-place.

St. Johns-Springerville Dome. Discovered in 1994 by Ridgeway Petroleum Corp., an independent oil and gas producer, the St. Johns-Springerville field is still largely undeveloped. It extends over an area of 1,800 km^2 along the Arizona/New Mexico border. Conditions at St. Johns Dome are geologically and operationally distinctly different from those at McElmo Dome, providing useful contrast as a sequestration analog. The St. Johns field is much shallower and contains CO_2 in a free gas state within a clastic sandstone reservoir. There is no gas pipeline infrastructure at St. Johns and commercial production has not yet been initiated.

The St. Johns field contains CO_2 in the Permian Supai Formation, primarily fine-grained non-marine sandstone, with intercalated siltstone, anhydrite, and dolomite. Well depths are relatively shallow (200 to 700 m). Multiple impermeable anhydrite cap rocks are present, vertically segregating the carbon dioxide within multiple zones. A major reverse fault and smaller related splays may have influenced sourcing and trapping the carbon dioxide at St. Johns. Gas in place is estimated to be 830 million t (15.8 Tcf). Gas composition averages 95% CO_2, along with nitrogen, helium, methane, and argon. The origin of CO_2 at St. Johns is unknown. Overall, geologic data control on the St. Johns field is not as complete as for McElmo Dome. Remote imagery analysis is planned for identifying direct indications of current or past CO_2 emissions from this reservoir.

Ridgeway has delineated the extent of the St. Johns field, drilling a total of 15 wells in Arizona and 6 wells in New Mexico. These wells are capable of producing in excess of 110 t/day (2 MMscfd) of CO_2, but are currently shut in pending pipeline construction. The relative lack of development at St. Johns field is advantageous for our analysis. The reservoir at St. Johns is undeveloped and may be more reflective of original geomechanical conditions. This contrast allows comparison of two fields with very different operational history and reservoir conditions, making the proposed study more applicable to the larger universe of potential depleted oil and natural gas fields.

Bravo Dome. CO_2 has been produced at Bravo Dome since the 1930's, but most development occurred during the 1980's. Currently, 250 wells produce about 21,000 t/day (375 MMcfd) that is supplied via pipeline to Permian basin EOR projects. The main reservoir is the Tubb Sand, at relatively shallow depths of 600 to 700 m. Most wells require hydraulic stimulation to produce gas at economic rates. Original reserves were estimated at about 225 million t (4 Tcf), of which about half had been produced through 2000. Recent soil surveys suggest that the reservoir is a dynamically filling structure (Baines and Worden, 2000)

Sheep Mountain. Discovered in 1971, the Sheep Mountain field in southern Colorado was developed by Arco starting in 1975. Currently, 150 MMscfd of CO_2 is produced and transported 650 km via pipeline to the Permian basin EOR projects. Sheep Mountain field is a relatively small deposit (110 million t; 2 Tcf), and may be the first natural CO_2 field to deplete, after which it could become a candidate site for CO_2 re-injection and storage. Surface elevation is rugged, ranging from 2,300 to 3,500 m. Carbon dioxide is produced from the Cretaceous Dakota and Jurassic Entrada sandstones at depths of 1,000 to 1,800 m (Roth, 1983). The geologic structure is complex, with numerous folds and faults. During 1982, a production well blew out of control during drilling. During well control operations, CO_2 was found to be blowing out of surface fractures on the west slope of Little Sheep Mountain, directly above the drill site (Lynch et al., 1985). Understanding these types of operational problems and CO_2 seepage through the cap rock will be crucial to safely developing geologic storage in structurally complex depleted oil and gas fields.

Jackson Dome. Located in central Mississippi in the onshore Gulf Coast province, Jackson Dome is the deepest of the commercial natural analog sites. An estimated 530 million t (10 Tcf) of CO_2 is present in several fields. Current production of about 1.6 Mt/day (30 MMcfd) supplies an EOR project and other industrial demand. CO_2 is trapped in the Jurassic Norphlet, Smackover, and Buckner Formations at depths below 5,000 m. The Norphlet is an eolian sandstone with complex porosity and permeability distribution controlled by authigenic illite clays. Reservoir pressure at Jackson Dome 50% above hydrostatic, perhaps due to thermal CO_2 formation and migration. This overpressuring indicates an effective cap rock seal. H_2S is a common hazard, reaching concentrations as high as 35%. Jackson Dome is expected to provide insights on geologic storage and operations in deep, overpressured geologic formations.

EUROPEAN ANALOGS

France. The French carbogaseous perialpin province (including Perrier, Vichy and Badoit) contains many CO_2-rich mineral springs with gas/liquid ratios of over 4. The Varisk basement of the French "Massif Central" was affected by the Pyrenean and Alpine orogenesis, resulting in faults, graben and volcanism. Basement either crops out at the surface or is covered by sandstone formations (Vichy in the Limagne graben) and carbonate formations (Perrier and Montmiral).

Although having a predominantly mantle origin, CO_2 may be derived from thermal metamorphism of carbonates linked to volcanic activity in some areas. CO_2 migrates towards the surface mainly along Tertiary and Quaternary tectonic faults, but diffuse migration also exists. Where the basement crops out at surface, mantle-derived CO_2 is released to the surface through faults. Where the basement is overlain by sedimentary formations, the CO_2 is either released to the atmosphere through faults, springs or diffuse emanations. Claystones cap free CO_2 accumulations, discovered during geothermal, mineral water or oil exploration, in Vichy, St-Parize and Montmiral. The CARBO 2 production company currently exploits these accumulations for industrial use. However, in the Vichy area, the seals are not 100% efficient as several CO_2-rich springs occur. Typically, CO_2 represents up to 99% of the non-condensible gases. The waters are either sodium bicarbonate (and some chloride) or calcium bicarbonate groundwaters, depending on sedimentary context.

Italy. The Latera caldera, located in central Italy about 100 km NW of Rome, is an active geothermal resource which has been studied and exploited since the mid 1970’s. In addition to the elevated temperatures and high water flow rates in the area, many of the wells drilled in the carbonate host rock encountered intervals containing large volumes of a separate gas phase, consisting of 80% CO_2 and 20% H_2S, CH_4 and N_2. Probably generated by water-rock interactions (acidic gases, elevated temperatures etc.), the CO_2 has been trapped for thousands of years in Mesozoic carbonates by overlying volcanic units of lower permeability and faults sealed by secondary mineral precipitation. Locally the host unit occurs between 200 and 2,000 m below ground surface, with surface expression of the structure given by a slight surface depression, warm-water springs and gas vents.

Greece. The Florina CO_2 gas deposit is close to the border with FYROM. This field is located in Miocene fluvial sandstones with clay and marl cap rocks. The host sediments fill a NNE-SSW intramontane graben surrounded by metamorphic rocks (mainly marbles) to the east and plutonic and metamorphic rocks to the west border. Commercial exploitation as an industrial gas by Air Liquide Hellas started in 1980 but was increased during the last decade, with an average annual production of 20,000 t of CO_2.

Hungary. The Mihályi CO_2 field, discovered in 1933, is located in the Kisalfold sub-basin of the Pannonian Basin. The gas-bearing structure is a NE-SW striking, uplifted Palaeozoic basement high lying under 1,100 to 1,300 m of Neogene sedimentary cover. The CO_2 reservoir has ten levels. The lowest is in fractured Early Palaeozoic phyllites, schists and slates. Two productive layers occur in overlying syn-rift Middle Miocene calcareous sandstone sequences but the best gas reservoirs are the post-rift Late Miocene delta slope and front sandstones on the flanks of the basement ridge. The Neogene layers above the basement ridge form a gentle anticlinal structure that, together with lateral changes in lithology, forms the trap for gas accumulation. The overlying and laterally extensive delta plain and lacustrine claymarls and silty clays provide the seal. In spite of subsequent regional Quaternary erosion, no traces of gas migration have been detected at surface. The total reserve of the Mihályi CO_2 occurrence was 10.766 million m^3 as of January 1, 2000. Annual production is about 58,000 m^3. In some areas, combustible gases occur together with carbon dioxide.

Mátraderecske is a small village in Northern Hungary in the foreland of the Mátra Mountains (Eocene andesite), where natural CO_2, and CH_4 gas vents occur. The Eocene andesite, andesite tuff and andesite agglomerates form the basement, which subsides to 600-800 m depth as step-faulted blocks. The andesite is overlain by Eocene limestone and middle Oligocene silty sand and sandstone layers. In those areas where the andesite is uplifted, the soil cover is only a few m thick. The deep-origin gases migrate upwards along the tectonic fractures of the andesite (NNE-SSW strike faults are the most important), but the overlying layers might modify migration routes and lead the gases in lateral directions along bedding planes. The groundwater also impedes gas escape to the surface, as CO_2 is easily dissolving in the groundwater, shown by the many CO_2-rich mineral waters in the area.

Germany. A small gas field occurs at Vorderrhöhn, Central Germany, c. 120 km NE of Frankfurt. The almost pure CO_2 is trapped in a fractured reservoir of Middle Permian Base Zechstein evaporites and Top Rotliegend clastic sediments with a large anticlinal structure. Sediment effective porosities are low and permeabilities are very low: 10^{-3} to 10^{-1} mD, with the gas confined to N-S striking fracture zones. Groundwaters are highly mineralised and of

Permian origin. Anhydrite and calcite mineralisation in fractures confines CO_2 to several discrete layers. Zechstein salts form the caprock. The CO_2 ranges from 94-97% with minor amounts of other gases (1% N_2, < 0.7% CH_4, traces of C_2H_6, C_3H_8, H_2 and He). Depending on pressure and temperature, CO_2 occurs as either liquid, gas or in a supercritical phase. CO_2 is genetically and chronologically connected to Late Tertiary volcanism with no CO_2 "invasion" after that event. The field was produced for industrial gases from 4 isolated deposits using more than 30 wells of varying production capacities. However, since German reunification, production has ceased.

AUSTRALIAN ANALOGS

Elevated levels of CO_2 are known from many petroleum exploration wells in Australia. These include wells intersecting the Permian succession within the Cooper, Bowen, Sydney, and Gunnedah Basins, the Triassic of the Carnarvon Basin, and the Cretaceous of the Otway Basin (**Figure 3**). Only the occurrences listed below will be included in the natural analog study.

Otway Basin. The Mesozoic to Tertiary Otway Basin in southeastern Australia contains a number of gas accumulations with varying concentrations of CO_2, from 0% to 100%. Methane in the accumulations is from conventional maturation of organic-rich shales (Morton, 1995) but the majority of the CO_2 is from the degassing of Pleistocene to Recent basic volcanics. The 100% CO_2 in Caroline-1 well has a strong juvenile or primitive gas signature indicated by the carbon isotopes, and the isotopic ratios of helium and the traces of neon and xenon. The source volcanics fall into an older group (1Ma-20,000 years BP) and a younger group around 5,000 years BP.

Exploration for oil and gas in the Penola Trough at the NW end of the Otway Basin in South Australia, has shown a very patchy distribution of CO_2. In particular, the Katnook and Ladbroke Grove gas fields, which are just two kilometers apart, contain 0% and 54% CO_2 respectively. This proximity, and the fact that the gas is reservoired in the same formation at the same depth, makes this area an excellent site for the study of the influence of CO_2 on reservoir rocks. The host sandstone in both cases is the Early Cretaceous (Neocomian) sublithic Pretty Hill Sandstone. Work to date on the influence of CO_2 on the Pretty Hill Sandstone by detailed petrology and analysis of formation waters shows that sodic plagioclase is dissolved with the release of sodium ions accompanied by the formation of kaolin and silica. The Na cations are balanced by mainly bicarbonate anions and held in solution. The calcium zeolite, laumontite, is present in the non-CO_2 areas but is dissolved in contact with CO_2. Calcite and dolomite replace some feldspars but it is unclear whether these reactions are controlled in part by CO_2. Future work in the Penola Trough will include documentation of the changes to reservoir rock chemistry induced by elevated CO_2, studies on changes in the overlying sealing lithologies and soil gas sampling to see if there is any leakage of CO_2 from the trap. Knowledge of the timing of input of CO_2 to the system should provide information on the rates of the reactions involving CO_2.

South of the Tartwaup Hingeline, the Early Cretaceous succession is deeply buried by the Late Cretaceous and the main petroleum target is the Cenomanian, quartz-rich, Waarre Sandstone. Carbon dioxide has found its way into reservoirs of the Waarre Sandstone, displacing methane in some places and filling previously uncharged traps in others. Caroline-1 currently produces near pure liquid CO_2, mainly for the carbonated drinks market. The gas from this well gives the most primitive neon and xenon isotope signatures so far recorded worldwide (Sheard, 1995). Future work over the Caroline area will involve soil gas sampling.

A number of petroleum exploration and development wells in the Port Campbell area of the Otway Basin contain elevated levels of CO_2. The CO_2 concentrations are highly variable, ranging from pure methane to pure CO_2 over short distances. Water analyses have been collected from many of the petroleum exploration wells and these have been collated. Many wells show high concentrations of sodium and bicarbonate, the characteristic CO_2 signature of the region. The sodium aluminium carbonate mineral, dawsonite, has been reported from one well in the Port Campbell area. This mineral has been tied to magmatic CO_2 in the Permian basins of eastern Australia (Baker et al., 1995)

Bowen Basin. Hydrocarbon exploration in the Denison Trough of the Bowen Basin has uncovered evidence of dawsonite as a cement phase in some reservoir sands. (Baker and de Caritat, 1992). The prospective units are quartzose and volcanolithic sandstones within Permian coal measures. The occurrence of dawsonite has been linked to CO_2 leakage from a magmatic source. We plan to study these occurrences to elucidate the controls on dawsonite precipitation relative to the feldspar dissolution and associated kaolin and silica precipitation observed in the Penola Trough.

Carnarvon Basin. Within the Barrow Sub-Basin, the Gorgon gas discovery contains around 16% CO_2. Detailed core petrology will be undertaken within the gas column and compared with many surrounding wells without CO_2, to determine evidence of mineralogical changes resulting from CO_2.

R&D PROGRAM

Although extensive data has been collected on natural analogs, their origin, evolution, and current physical state are surprisingly poorly understood. Neither have these deposits been thoroughly evaluated in the context of long-term geologic storage of CO_2. The authors plan a comprehensive and multi-disciplinary assessment of geologic, engineering, and safety aspects of natural analogs. Potential insights include the long-term effects of CO_2 on reservoir geology, the suitability of different types of reservoir settings for sequestration, and the field operation practices that best optimize, reduce the costs, and ensure the safety of CO_2 sequestration. Research plans include:

1) **Geology.** Geochemical, isotope, and petrologic study of soil gas, rock core and fluids to determine CO_2 origin, migration, and residence time within the reservoir; geomechanical research to determine the impact of faulting and fracturing on CO_2 distribution and potential leakage; the geochemical impacts of CO_2 on reservoir rock, matrix, and fluids; and both remote imagery and soil geochemical analysis to assess direct and indirect evidence of CO_2 leakage.

2) **Engineering.** Analysis of existing CO_2 production well drilling, completion, testing, and operation technologies. Field operations analysis will examine drilling, completion and

operation history; surface facilities design and operation; reservoir monitoring techniques; and mitigation of adverse impacts of CO_2 exposure on well and facilities integrity. We would also evaluate the capital and operating costs of CO_2 handling.

3) **Safety.** Evaluate the effects of slow or rapid CO_2 leakage on the environment during initial operations or subsequent storage period. Evaluate techniques for monitoring field integrity and security. Warning and public alert systems. Remediation of the field, should that become necessary. Operational licensing and local health & safety regulations.

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Table 1: Major developed natural CO_2 production fields

Field	Location	Operator	Original CO_2 in Place		1998 CO_2 Production		Reservoir Lithology	Depth (m)
			10^6 t	Tcf	10^6 t/yr	MMcfd		
McElmo Dome	CO	Kinder Morgan	1,600	30	15.9	820	Carbonate	2,300
Bravo Dome	NM	Occidental	1,600	30	7.2	375	Sandstone	700
Sheep Mountain	CO	Arco	780	15	2.9	150	Sandstone	1,500
Dodan	Turkey	Turkish Pet.	27	0.5	1.2	60	Carbonate	1,500
NE Jackson Dome Fields	MS	Denbury	320	6	0.4	20	Sandstone	4,700
St. Johns	AZ, NM	Ridgeway	830	16	0	0	Sandstone	500
Total			5,157	97.5	27.8	1,425		

Table 2: Major long-distance CO_2 pipelines

Pipeline	Location	Operator	CO_2 Capacity		Length (km)	Year Finished	Origin
			Mt/year	Bcfd			
Cortez	CO, NM, TX	Kinder Morgan	20	1.00	808	1984	McElmo Dome
Sheep Mountain	CO, NM, TX	BP	9	0.48	660	1984	Sheep Mountain
Bravo	NM, TX	Occidental	7	0.37	350	1984	Bravo Dome
Choctaw	MS	Denbury	4	0.20	295	1985	Jackson Dome
Canyon Reef	TX	Kinder Morgan	3	0.13	130	1998	VV Gas Plants
Bati Raman	Turkey	Turkish Pet.	1	0.06	90	1983	Dodan Field
Total			44	2.24	2,333		

Figure 1. NASCENT sites

Figure 2. Location of natural CO_2 study sites in USA, as well as CO_2-EOR infrastructure.

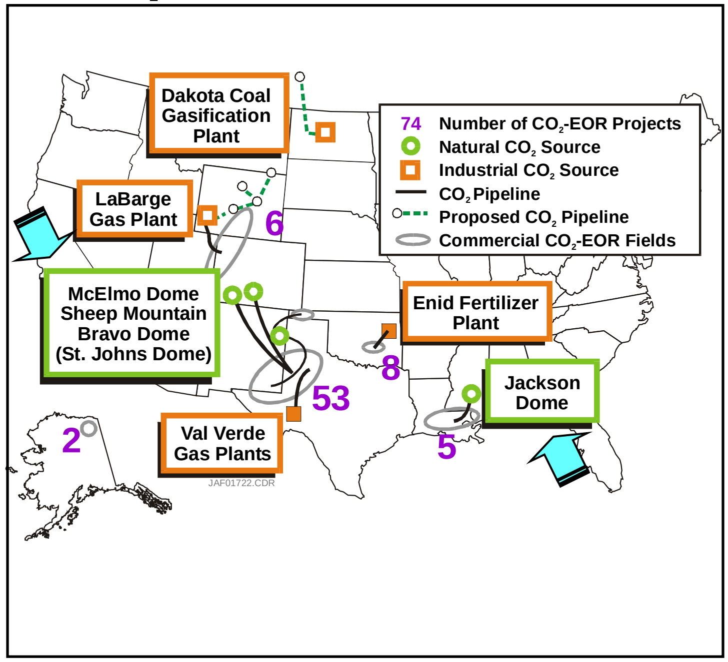
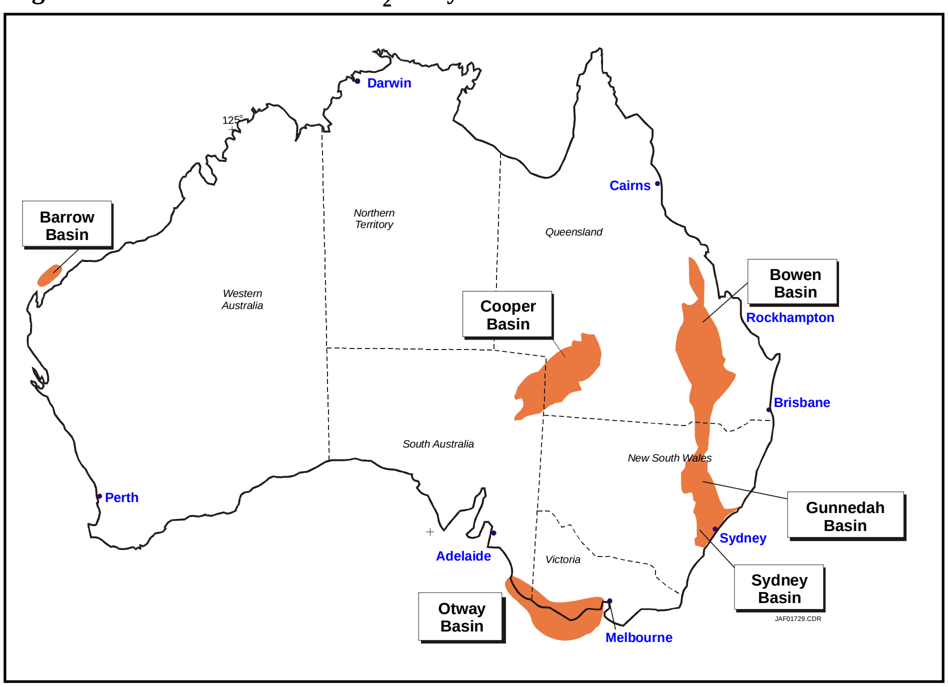


Figure 3. Location of natural CO_2 study sites in Australia.



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