CO_2 Sequestration Validation Test in a Deep, Unminable Lignite Seam in Western North Dakota

CO_2 Sequestration and Unminable Coals

Carbon dioxide (CO_2) sequestration is the long-term storage of CO_2 underground in geologic formations or at the earth's surface in vegetation and soils. Sequestration is emerging as a major strategy to reduce anthropogenic CO_2 (CO_2 from human activity) emissions to the atmosphere as a hedge against climate change.

When CO_2 comes in contact with coal, including low-rank coals like lignite, the CO_2 molecules become adsorbed (physically attached) to the coal itself. This adsorption, along with hydrostatic pressure, helps to ensure that the CO_2 will remain stored in the underground coal seam over time. As a result, the many deep, unminable coal seams in the world offer opportunities for the long-term underground storage (geologic sequestration) of anthropogenic CO_2.

Coalbed Methane and CO_2 Sequestration

Natural gas found in coal seams is called coalbed methane (CBM), and many unminable coal seams contain CBM. Injecting CO_2 gas into the coal seam can displace the CBM, and more of the CBM can be brought to the surface. Using anthropogenic CO_2 to help recover additional CBM from unminable coal seams and leaving the CO_2 in long-term storage in the coal seam after the CBM has been produced represent value-added sequestration opportunities that offer both a near-term economic return and a long-term environmental benefit.

What Is "Value-Added"?

The term value-added is used to describe the economic value of an action or product that has been increased through a change in process or practice. Operations that use CO_2 to enhance oil production or natural gas can also add value by using the oil or natural gas reservoir as a storage site for the CO_2. The sale of the additional oil or natural gas can provide the economic return needed to provide incentive for companies to undertake value-added sequestration projects under today's market conditions.

North Dakota Lignite Field Validation Test

The Energy & Environmental Research Center (EERC) Plains CO_2 Reduction (PCOR) Partnership is conducting a multiyear field validation test of CO_2 sequestration in an unminable lignite seam in Burke County in northwestern North Dakota (Figure 1).

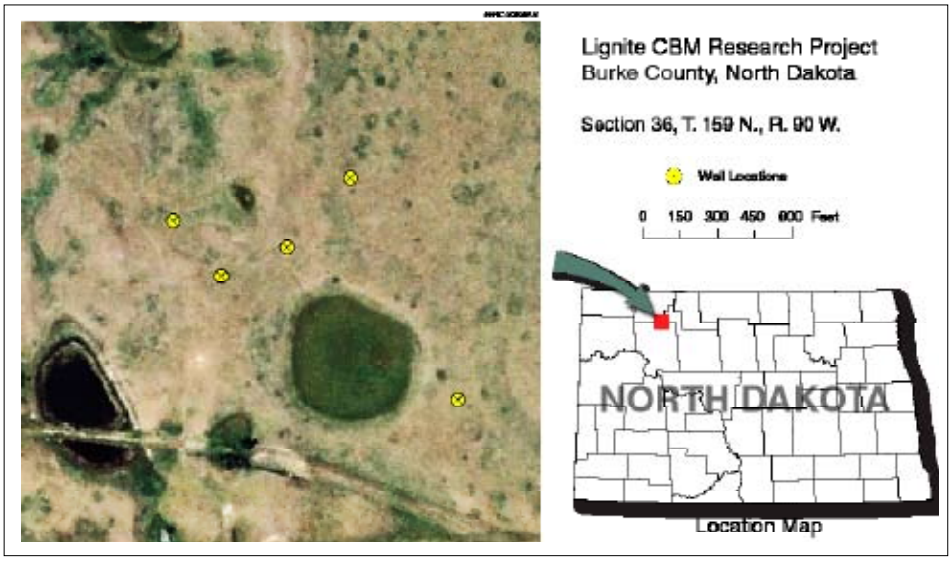

Figure 1. Aerial photograph showing approximate locations of wells for the lignite test.

The PCOR Partnership's Lignite Field Validation Test is designed to develop the protocols needed to define the capacity of lignites to sequester anthropogenic CO_2 as well as to investigate the potential for CBM production from deep, unminable lignite seams that occur in North Dakota and the surrounding PCOR Partnership region. The knowledge gained during this field validation test is expected to have implications for planning and implementing similar value-added CO_2 sequestration operations as well as providing information regarding the potential regional CBM resource base.

Lignite, CO_2, and Coalbed Methane

Lignite is the lowest grade of coal, just above peat in energy content. Lignite's pore structure, a critical element in the adsorption/desorption processes associated with carbon sequestration as well as CBM production,[1,2] differs from that of the higher-grade coals and is not well understood. Lignite occurs in western North Dakota and eastern Montana in the U.S. portion of the PCOR Partnership region and in the southern portion of the province of Saskatchewan in the Canadian area of the region. Lignite seams also occur in the Gulf Coast of the United States, as well as in India, China, eastern Europe, and Russia.[1]

The Lignite Field Validation Test is among the four PCOR Partnership field validation tests currently under way as part of the nearly three dozen field demonstrations under Phase II of the U.S. Department of Energy National Energy Technology Laboratory's Regional Carbon Sequestration Partnership Program. The PCOR Partnership, managed by the EERC, will act as the project operator in collaboration with Eagle Operating, Inc.

Test Goals and Approach

The PCOR Partnership's Lignite Field Validation Test is designed to gather the knowledge needed to predict performance of CO_2 sequestration in lignites and also to gather data useful in understanding the dynamics of simultaneous CO_2 sequestration and CBM production. The goal of the field validation test in Burke County, North Dakota, is to address each of the factors listed below and to create a best practices manual to support the planning and implementation of similar projects. The factors include:

- Methane content, CO_2 storage capacity, and applicability of existing experimental methodologies.
- Features of fluid transport in lignite.
- Stability of CO_2 stored within lignites.
- Factors controlling the success of sequestration/production operations in lignite.
- Economics of the operations.

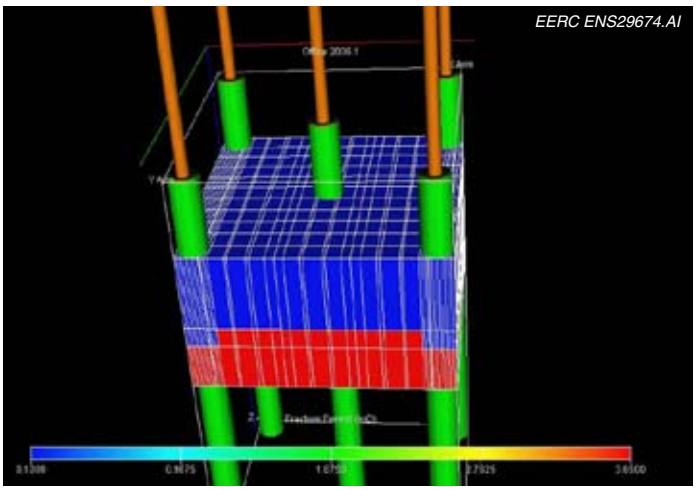

Figure 2. Five-spot model of production from coal seam.

Test Operation

In the summer of 2007, holes for five wells (Figure 2) will be drilled at the test site to provide information on the geology of the coal seam used in the test and the geology of the overlying geologic zones. Once the geological characterization is completed, these holes will then be lined with pipe and cement and completed as CO_2 injection and/or CBM recovery wells. Equipment will also be installed to monitor for CO_2 and other constituents. The 2-year test will be conducted in two phases. Phase I will focus on obtaining baseline data on the lignite seam and on investigating the baseline CBM production potential (potential without CO_2 injection). In Phase II, CO_2 will be injected into the lignite seam to obtain data on the feasibility and reliability of CO_2 storage in lignite as well as to determine CBM production potential with CO_2 injection.

Project Deliverables

Deliverables will include 1) a technical report that summarizes test results and findings, including overall performance, storage capacity, and natural gas content and 2) a best practices manual for use in lignite CO_2 sequestration projects and value-added projects in lignites that combine enhanced production of CBM with the sequestration of CO_2 once the CBM has been produced.

Key North Dakota Partners

- North Dakota State Land Department
- North Dakota Industrial Commission
  - Division of Mineral Resources, Oil and Gas Division
  - Geological Survey
  - Oil and Gas Research Council
  - Lignite Research Council
- North Dakota Department of Commerce
  - Division of Community Services
- North Dakota Department of Health

References and Notes

1. Crosdale, P.J., Beamish, B.B., and Valix, M., 1998, Coalbed methane sorption related to coal composition: Coal Geology, v. 35, p. 147–158.
2. Gan, H., Nandi, S.P., and Walker, P.L., Jr., 1972, Nature of the porosity in American coals: Fuel, v. 51, p. 272–277.

The Plains CO_2 Reduction (PCOR) Partnership is a group of public and private sector stakeholders working together to better understand the technical and economic feasibility of sequestering CO_2 emissions from stationary sources in the central interior of North America. The PCOR Partnership is managed by the Energy & Environmental Research Center (EERC) at the University of North Dakota and is one of seven regional partnerships under the U.S. Department of Energy's National Energy Technology Laboratory Regional Carbon Sequestration Partnership Initiative. To learn more, contact:

Edward N. Steadman, Senior Research Advisor, (701) 777-5279; esteadman@undeerc.org
John A. Harju, Associate Director for Research, (701) 777-5157; jharju@undeerc.org

Visit the PCOR Partnership Web site at www.undeerc.org/PCOR. New members are welcome.

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