PROJECT **facts**

Carbon Sequestration

4/2008

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

THE COAL-SEQ CONSORTIUM: ADVANCING THE SCIENCE OF CARBON DIOXIDE SEQUESTRATION IN DEEP, UNMINEABLE COAL SEAMS

CONTACTS

Sean Plasynski
Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4867
sean.plasynski@netl.doe.gov

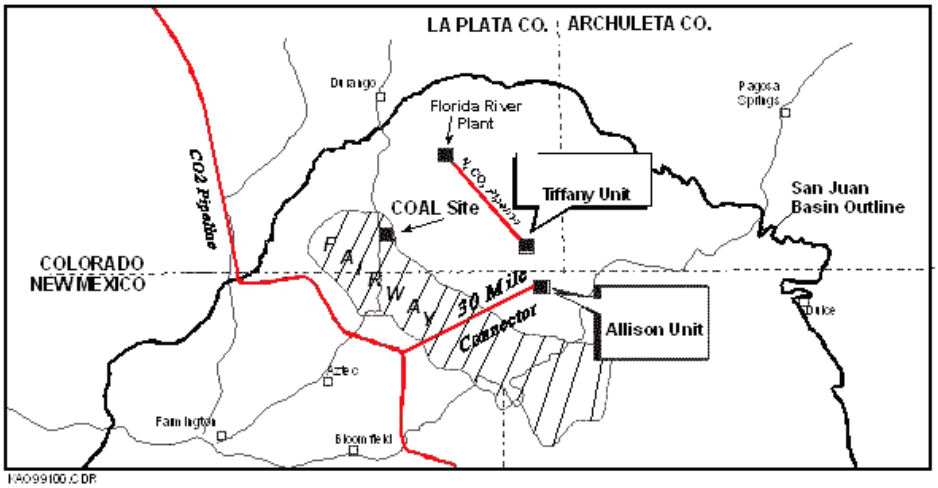
Darin Damiani
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4398
darin.damiani@netl.doe.gov

Scott R. Reeves
Principal Investigator
Executive Vice President
Advanced Resources International
11490 Westheimer Rd.,
Suite 520
Houston, TX 77077-6841
281-558-9200 (extension 1)
sreeves@adv-res-hou.com

Background

One of the few value-adding approaches to sequestering carbon dioxide (CO_2) is to inject it into deep, unmineable coal seams. The advantage of coal seam sequestration is that CO_2 more readily adsorbs to coal than methane, thus resulting in a greater volume of CO_2 adsorbed. In addition, methane is displaced and can be recovered and sold to help offset costs. This process is known as enhanced coalbed methane recovery, or ECBM.

During Phase I of the Coal-Seq project, Advanced Resources International and its partners teamed with the industry operators of the only long-term, multi-well ECBM projects that have been performed in the world (the Allison and Tiffany Units in the San Juan basin) to evaluate the viability of storing CO_2 in deep, unmineable coal seams. The knowledge gained from studying those projects was coupled with laboratory research to verify and validate gas storage mechanisms in coal seams, and a screening model was developed in order to assess CO_2 sequestration potential in other promising coal basins of the United States.



PARTNERS

Advanced Resources International (performer)

Oklahoma State University (performer)

Southern Illinois University (performer)

Electrochemical Systems (performer)

Higgs-Palmer Technologies, LLC (performer)

BP (sponsor)

CO_2-CRC (sponsor)

Illinois Clean Coal Institute (sponsor)

Japan Coal Energy Center (sponsor)

Shell International Exploration & Production (sponsor)

Schlumberger Limited (sponsor)

Repsol YPF (sponsor)

ConocoPhillips (sponsor)

The potential CO_2 sequestration capacity of deep, unmineable coal seams was also assessed (~90 billion tons), as was the concomitant ECBM recovery (~150 trillion cubic feet [Tcf]). Importantly, the project identified numerous important sub-surface reservoir mechanisms that were not clearly understood, and that have an important impact on industry's ability to predict the performance of integrated ECBM/ sequestration projects. Specifically, it was discovered that multi-component sorption, diffusion, and fluid behavior in coal seams was much more complex than previously thought. In response, the Coal-Seq Consortium was formed with the objective of establishing a better predictive capability of such projects to promote investment in them.

Primary Project Goal

The primary goal of the Coal-Seq Consortium is to develop a technical understanding of the CO_2-sequestration / ECBM process by performing experimental and theoretical research and development on coal reservoir behavior, and validating the findings against the results from the field projects studied in Phase I.

Objectives

Below are the specific objectives of the Coal-Seq Consortium:

- Develop new, advanced predictive models for multi-component sorption, bi-directional diffusion, and CO_2-mixture PVT (pressure/volume/temperature) behavior.
- Couple with permeability model, incorporate into dynamic flow simulator, and validate against laboratory flow experiments and field data.
- Perform sensitivity analysis to better understand best geologic/reservoir environments and development strategies.
- Provide a knowledge base on global activities regarding CO_2 sequestration in deep, unmineable coals to consortium membership.

Accomplishments

- Initial field studies have demonstrated that ECBM via carbon dioxide-nitrogen (CO_2/N_2) injection and CO_2 sequestration in coal seams is technically feasible.
- Developed an understanding of the technical and economic performance of gas injection into coal via detailed studies of two multi-well, multi-year ECBM field pilots in the San Juan basin – the Allison Unit CO_2-ECBM pilot and the Tiffany N_2-ECBM pilot.

- Analysis of field and laboratory data showed the tendency for coal to "swell" when it comes into contact with CO_2, reducing injectivity.
- Developed new, more accurate multi-component gas sorption and diffusion models.
- Uncovered new evidence of coal-weakening behavior with CO_2 injection.
- Performed comparative analysis of coal permeability models.
- Performed sensitivity studies to identify best coal reservoir environments for CO_2-sequestration/ECBM.
- Began development of an internet-accessible knowledge base.
- Developed a model for screening potential CO_2-ECBM/sequestration projects.
- Assessed CO_2 sequestration and concomitant ECBM recovery potential of coal basins in the United States.
- Created a field "best practices" manual based on the experience gained from the ECBM pilots.
- Evaluated the applicability of commonly used (i.e., Langmuir) isotherm models when applied to multi-component gaseous systems.

The detailed results from the work sponsored by the COAL-SEQ consortium are proprietary. Selected accomplishments from this phase included:

- A significantly expanded CBM adsorption database, which includes valuable data for pure-gas adsorption on six wet coal matrices and activated carbon.
- An improved model and the attendant computational algorithms to estimate sorption capacity for coalbed gases based solely on readily accessible coal characterization.
- Development of a new multi-component counter diffusion model (yet to be tested).
- A theory-based adsorption modeling capability, including further development of the simplified local–density framework for describing CBM adsorption equilibrium of pure fluids and mixtures.

Plans for future activities include the following:

- Completion of equation-of-state work undertaken in the current project, and extension to full methane-carbon dioxide-nitrogen ternary gaseous systems with moisture.
- Selected laboratory experiments to understand the conditions and nature of coal weakening and/or mechanical failure, and/or plasticization, with CO_2 injection.
- Development of a robust algorithm to account rigorously for water as a separate adsorbed component.
- Incorporation of each of these theoretical advancements into a reservoir simulator such that predictive modeling can be performed with the benefit of the most advanced knowledge of reservoir process.

The final report of the project effort will be completed in the fall of 2008.

PERFORMANCE PERIOD

9/30/2000 to 9/30/2008

COST

Total Project Value
$7,395,575

DOE/Non-DOE Share
$ 2,636,323 / $4,609,252

ADDRESS

National Energy Technology Laboratory
1450 Queen Avenue SW
Albany, OR 97321-2198
541-967-5892

2175 University Avenue South
Suite 201
Fairbanks, AK 99709
907-452-2559

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4764

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4687

One West Third Street,
Suite 1400
Tulsa, OK 74103-3519
918-699-2000

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

Benefits

The technical knowledge base gained from this project effort will benefit the energy and environmental industries by providing verifiable and valid CO_2 storage mechanisms in coal reservoirs, as well as a new source of clean natural gas supply. The ability to take advantage of these opportunities will be facilitated by the development of a screening model to assess CO_2 sequestration and ECBM potential.