TECHNICAL PROGRESS REPORT
for
JANUARY TO MARCH 2005
NOVEL CONCEPTS RESEARCH IN GEOLOGIC
STORAGE OF CO₂
PHASE III

THE OHIO RIVER VALLEY CO₂ STORAGE PROJECT

Contract No. DE-AC26-98FT40418

Prepared for:

**Charles Byrer
NETL Project Officer
U.S. Department of Energy
National Energy Technology Laboratory
P.O. Box 880
Morgantown, WV 26507-0880**

Prepared by:

**Neeraj Gupta
Battelle Project Manager
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201**

May 26, 2005

This report was prepared by Battelle as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor Battelle makes any warranty, express or implied, or assumes any legal liability of responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by Battelle, the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

ABSTRACT

As part of the Department of Energy's (DOE) initiative on developing new technologies for storage of carbon dioxide in geologic reservoirs, Battelle has been awarded a project to investigate the feasibility of CO₂ sequestration in the deep saline reservoirs in the Ohio River Valley region. This project is the Phase III of Battelle's work under the Novel Concepts in Greenhouse Gas Management grant. In addition to the DOE, the project is being sponsored by American Electric Power (AEP), BP, The Ohio Coal Development Office (OCDO) of the Ohio Department of Development, and Schlumberger. The main objective of the project is to demonstrate that CO₂ sequestration in deep formations is feasible from engineering and economic perspectives, as well as being an inherently safe practice and one that will be acceptable to the public. In addition, the project is designed to evaluate the geology of deep formations in the Ohio River Valley region in general and in the vicinity of AEP's Mountaineer Power Plant in particular, in order to determine their potential use for conducting a long-term test of CO₂ disposal in deep saline formations and potentially in nearby deep coal seams.

The current technical progress report summarizes activities completed for the January through March 2005 period of the project. As discussed in the report, the technical activities focused on development of injection well design, preparing a Class V Underground Injection Control permit, assessment of monitoring technologies, analysis of coal samples for testing the capture system by Mitsubishi Heavy Industry, and presentation of project progress at several venues. In addition, related work has progressed on a collaborative risk assessment project with Japan research institute CREIPI and technical application for the Midwest Regional Carbon Sequestration Partnership.

TABLE OF CONTENTS

ABSTRACT	iii
FIGURES	iv
EXECUTIVE SUMMARY	v
 1.0 INTRODUCTION	 1
 2.0 EXPERIMENTAL	 1
 3.0 RESULTS AND DISCUSSION.....	 1
Task 1 – Geologic Data Assessment	2
Task 2 – Seismic Survey	2
Task 3 – Borehole Drilling and Testing	3
Task 4 – Reservoir Simulations.....	3
Task 5 – Design the Future Injection and Monitoring Facility and Prepare Regulatory Permits.....	3
Task 6 – Risk Assessment and Stakeholder Interactions.....	4
Task 7 – Project Briefings and Meetings.....	4
Task 8 – Building the Regional Geologic Framework.....	5
 4.0 CONCLUSION	 5
4.1 Future Activities	5
 5.0 REFERENCES	 5

FIGURES

Figure 1. Comparison of Seismic Monitoring Suitability for Locations in Midwest U.S.	2
---	---

EXECUTIVE SUMMARY

This is a Quarterly Technical Progress Report for Contract DE-AC26-98FT40418. It has been prepared in accordance with the requirements of the National Energy Technology Laboratory (NETL). The reporting period for the current document is January through February 2005.

The purpose of this project is to evaluate the geology of deep formations in the Ohio River Valley region to determine their potential use for conducting a long-term test of carbon dioxide disposal in deep saline formations and potentially in nearby unmineable coal seams. As discussed in the report, the technical activities focused on development of injection well design, preparing a Class V Underground Injection Control permit, assessment of monitoring technologies, analysis of coal samples for testing the capture system by Mitsubishi Heavy Industry, and presentation of project progress at several venues. In addition, related work has progressed on a collaborative risk assessment project with Japan research institute CREPI and technical application for the Midwest Regional Carbon Sequestration Partnership.

1.0 INTRODUCTION

The main objective of this project is to evaluate the geology of deep formations in the Ohio River Valley region in order to determine their potential use for conducting a long-term test of CO₂ disposal in deep saline formations and in nearby unmineable coal seams. This work supports the overall project objective of demonstrating that CO₂ sequestration in deep formations is feasible from engineering and economic perspectives, as well as being an inherently safe practice and one that will be acceptable to the public. Following is a description of the progress accomplished for January through March 2005.

2.0 EXPERIMENTAL

Activities undertaken during the reporting period include reservoir injection simulations, assessment of methods to increase injectivity, and integration of data into a site characterization report. Major accomplishments were related to the following topics:

- High sulfur coal samples from the Ohio Valley region were tested by Mitsubishi Heavy Industry (MHI) for optimization tests needed to design the capture system.
- A joint three-day meeting was held between Battelle and Schlumberger-Doll Research (SDR) Center scientists in Ridgefield, CT. The objective of the meeting was to resolve remaining issues in interpretation of the field data and discuss the potential design scenarios for injection and monitoring options for the AEP#1 well.
- Preliminary injection well designs were considered, including issues related to injectivity, well construction, and engineering aspects of slipstream capture. Testing data from the wireline logs, cores, and reservoir tests were evaluated to identify the best reservoirs to be considered for well design.
- Preparation of the draft document for Class V Underground Injection Control permit was started. Initial work focused on attaining background information necessary for the permit, mainly based on the site characterization work that has already been completed.
- Project management and stakeholder outreach activities continued. Several project presentations were prepared for meetings and conferences.
- Proposals to DOE for continued funding of the project activities under the current contract and potentially a new contract for development of regional framework were evaluated and processed.

The preliminary findings of these activities are summarized in the sections below.

3.0 RESULTS AND DISCUSSION

The following sections summarize the major activities and their outcomes for the reporting period under each task of the project.

Task 1 – Geologic Data Assessment

Task 1 includes subsurface geologic assessment in the vicinity of the field site based on pre-existing information. All activities under Task 1 of the Statement of Work have been completed, and Battelle has developed a thorough understanding of the geologic framework for the site for deep saline reservoirs, caprock formations, and coal seams. An Interim Topical Report on the findings was submitted to NETL on August 3, 2003.

Task 2 – Seismic Survey

A meeting was held with WesternGeco on the seismic modeling of the data during a trip to Houston. Dr. Xu at WesternGeco has completed the sensitivity analysis to evaluate feasibility of 4D monitoring. In the process, he has also modified the fundamental equation used for this analysis by extending the pressure range and adjusting the equation to show a better match with laboratory data. The final report from WesternGeco is complete and this has been incorporated into the site characterization report.

In addition, a sensitivity analysis for the feasibility of seismic monitoring of CO₂ in the Mt. Simon Sandstone at three additional locations in the Midwest was completed. At these locations, thickness and porosity are greater, seismic velocities are lower, and the Mt. Simon is shallower compared to the Mountaineer Plant area and in much of the Appalachian Basin. Based on the sensitivity analysis, it appears that these other locations are more amenable to seismic monitoring (Figure 1). The results of this analysis will be presented at an oral presentation during the 4th Annual Conference on Carbon Capture and Sequestration. All other seismic assessment has been completed.

Figure 1. Comparison of Seismic Monitoring Suitability for Locations in Midwest U.S. (Geologic Conditions in Western Ohio Would be Most Suitable for 4-D Seismic Monitoring)

Task 3 – Borehole Drilling and Testing

The primary activities remained focused on final interpretation of the field data and preparation of the report as the data and interpretation on individual aspects are completed. During a visit to the Schlumberger-Doll Research Center in January, all of the wireline log data were evaluated to discuss remaining issues and maximize the data mining effort. Previous conclusions from the borehole data were reaffirmed. It was determined that the Rose Run Sandstone and selected zones in the Beekmantown Dolomite and Copper Ridge Dolomite remain the candidates for injection in this well. SDR scientists also reviewed and commented on the relevant sections of the site characterization report.

We were informed by BP that the relative permeability analyses on the Rose Run core samples had been almost completed. However, there were some technical difficulties related to testing with high pressure CO₂. These issues are being addressed by the experts at BP and it is hoped that at least partial results will be available in the near future. Experience gained from these tests will be considered for any future relative permeability tests.

Preparation of the draft site characterization report continues as the chapters on individual activities are finalized. A draft version of the report is currently in internal review.

Task 4 – Reservoir Simulations

An advanced parallel processing version of the STOMP-CO₂ code has been completed at PNNL so that a larger number of more complex simulations can be run. More than 25 scenarios have been prepared that incorporate a range of formation parameters, injection pressures, anisotropy, and injection formations. A final round of simulations with actual injection scenarios to support the field testing, and risk assessment, as well as to evaluate the potential scenarios for full-scale injection is scheduled to be conducted over spring and summer.

Scientists at Princeton and Stanford universities have shown interest in conducting some simulations for the Midwestern U.S. deep saline formations. Battelle sent some papers and general data for Mt. Simon Sandstone and other Midwestern reservoirs to these scientists. Princeton is still deciding on the path forward. However, Stanford University through its GCEP program is planning to conduct modeling of injection data in the Mt. Simon Sandstone to evaluate injection, regional flow, and geomechanical aspects. This effort will complement the site-specific simulations being conducted using STOMP and ECLIPSE and help improve our understanding of regional aspects.

Task 5 – Design the Future Injection and Monitoring Facility and Prepare Regulatory Permits

Activities continue to focus on application of a CO₂ injection system at the Mountaineer site. Battelle continued assessment of various aspects of the design of the capture and injection system in collaboration with AEP and Schlumberger.

- The high sulfur coal samples sent to Mitsubishi Heavy Industry (MHI) were used for optimization tests during mid-February. The testing is conducted in a 1-ton/day capacity system, which is also equipped with NOX and sulfur controls. The results of the testing and an updated basic design for a 30-t/day capture system will be presented by Mr. Ishida of MHI in a meeting at Battelle on April 11.
- During the meeting at SDR, several potential scenarios for injection and monitoring system design were defined. These include sequential testing in multiple zones in the existing well; use of lateral wells in Rose Run Sandstone; and the option of installing a monitoring well for the

injection phase. Battelle continued to compile information of various monitoring technologies being used in projects such as Weyburn, Sleipner, and Frio Formation tests.

- Battelle also started discussion with the regional drilling experts to evaluate the practicality of some of the injection and monitoring system designs being considered for the AEP#1 well. This testing will be useful in developing the design basis for the capture system. Battelle and AEP engineers also met during February to discuss the permitting, design, and waste disposal issues related to the capture system.
- Discussions were held with AEP on engineering aspects of developing a small slipstream from the main emissions stack that could be used for a CO₂ capture demonstration.
- Work on a Class V Underground Injection Control permit for the Mountaineer site was started. Initial work has focused on identifying the requirements of the permit. While most of the permit requirements were addressed in site characterization and well drilling, much of the permit will be completed in conjunction with the final injection well design.

Task 6 – Risk Assessment and Stakeholder Interactions

Major stakeholder interaction-related activities included:

- Stakeholder Interactions – Draft report describing all stakeholder interactions and communications during the last two years has been completed and incorporated into the overall site assessment report. Several media interactions took place during January. An article on the project and its relevance to the WV coal industry was published in the Huntington (West Virginia) Herald-Dispatch on January 19. The project was also mentioned in the Wall Street Journal article on carbon sequestration.
- Risk Assessment –The remaining work on this task will be undertaken when all of the modeling results become available from Task 4.

Task 7 – Project Briefings and Meetings

- Presented the project findings in the opening plenary session of the Groundwater Protection Council's UIC meeting in New Orleans in January.
- Presented project status and options for the future to Gary Kizior of BP during his visit to Columbus.
- Participated in the BP CO₂-FEST in Houston to present the CO₂ sequestration project status and findings to a cross section of BP employees.
- Participated in the Ohio CO₂ Seminar organized by the Ohio Air Quality Development Authority to educate a large number of Ohio stakeholders on the technical, safety, site selection, and economic aspects of geologic sequestration.
- President George W. Bush and Secretary of Energy Samuel Bodman visited Battelle Columbus Operations on March 9 to highlight energy research and give a speech on energy policy. The presentations to President Bush included a discussion on the CO₂ sequestration research, Mt. Simon Sandstone, and the FutureGen project.
- Presented the project status at the Ohio Geologic Society meeting on March 23 in Columbus
- Two abstracts, one on the seismic monitoring and the other on the overall project findings, submitted for the Fourth Annual Conference on Carbon Capture and Sequestration have been accepted, with an oral talk for the seismic presentation and a poster format for the project overview.
- Continued submittal of project administrative reports to project sponsors.