ANNUAL PROJECT REPORT
AS OF DECEMBER 2001

1. PROJECT SPONSOR:
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3. OCDO GRANT NO: OCRC3-00-2, C2.1

4. PROJECT UPDATE

5. PROJECT TITLE: Carbon Dioxide Sequestration in the Rose Run Formation

6. PROJECT TERM: FROM: December 1, 2001 TO: January 18., 2002

7. BUDGET:

NAME	COST SHARE
OCDO	$ 79,798
Case Western Reserve University	$ 28,152
TOTAL PROJECT COST:	$ 107,940

I. ABSTRACT

8. OVERVIEW OF PROJECT AND OBJECTIVES:

Capturing and sequestering CO_2 emissions from coal-fired power plants holds great promise for limiting the accumulation of greenhouse gases in the atmosphere. Widespread, deep, saline aquifers could provide high-volume, long-term storage, in close proximity to Ohio's power plants. The capacity and integrity of aquifer storage depends on chemical reactions between the CO_2 and the formation minerals and brines. These reactions can have both negative and positive consequences. For example, they can compromise the impermeable stratigraphic seal, and consequently allow vertical escape of CO_2. Alternatively, mineral-fluid reactions can convert CO_2 into carbonate, and thereby trap the carbon permanently in the subsurface as a stable, immobile, and harmless solid.

This study aims to evaluate the potential of the Rose Run sandstone beneath eastern Ohio to sequester CO_2. The project consists of three integrated parts: 1) aquifer characterization to establish the subsurface spatial variability of rock composition, porosity, and permeability; 2) laboratory experiments to determine reactions and reaction rates between typical Rose Run rock samples and CO_2- saturated brines; and 3) geochemical modeling of experimental and geologic data to simulate CO_2–storage capacity.

9. WORK DONE AND CONCLUSIONS:

Work progressed in tandem on aquifer characterization, laboratory experiments, and numerical modeling producing the following results:

Aquifer Characterization: Rocks equivalent to the Rose Run sandstone and surrounding strata are exposed at the surface in central and southern Pennsylvania and Maryland. These exposures, and 5 cores from the subsurface of Ohio, were measured and described to document the different rock types and their vertical stacking patterns. The cores were compared to their corresponding wireline geophysical logs and additional geophysical logs were correlated to investigate lateral continuity of rock types in the subsurface. Samples of representative rock types were selected for further characterization and reaction experiments.

Laboratory Experiments: A simple, inexpensive batch reactor was designed, tested, and an additional 2 reactors were built so that multiple geochemical experiments can be run simultaneously. The reactors can be pressurized to mimic subsurface conditions of between 750 and 1200 psi, and maintain temperatures of 50 to 100° C. During experiments the reactors are placed on a rocking stand to maintain uniform mixing of liquid, solid, and gas phases. Double sets of valves allow separate sampling of CO_2 and brine through the course of an experiment. Initial reaction experiments were conducted to investigate the dissolution kinetics of Calcite and Amelia Albite in KCl solutions with added CO_2 pressurized to 1000 psi.

Geochemical Modeling: Five computer programs capable of calculating multiphase gas-aqueous-mineral equilibria were identified (WATEQ4F, PHREEQC, MINTEQA2, SOLMINEQ88, Geochemist's Workbench) and evaluated for their suitability for the project requirements. Geochemist's Workbench was selected for numerical experiments to investigate expected reactions and reaction times for typical Rose Run mineral assemblages, brine compositions, and varying partial pressures of added CO_2. Reactions for typical carbonate and siliciclastic mineral assemblages were studied.

10. <u>PLANS FOR COMING YEAR</u>:

During the next year work on aquifer characterization, laboratory experiments, and numerical modeling will continue. Petrographic studies of thin sections of representative rock types will identify the dominant mineral phases present and document the paragenetic history of mineral dissolution, precipitation, and replacement. The geochemical reactors will be further tested by comparison of reaction data for single-mineral-artificial-seawater mixtures with results from the literature and with results from an off-the-shelf stirred batch reactor purchased from Parr. A series of experiments will constrain the effect of pressure and temperature in dissolution rates for Calcite and Amelia Albite in KCl-CO_2 mixtures. Additonal series of experiments will investigate reaction kinetics for common Rose Run minerals such as K-feldspar and glauconite and for reactions with representative Rose Run samples. Methods for measuring carbonate and silicate dissolution rates in mixtures CO_2 with complex brines will be developed. Geochemist's Workbench will be used to develop equilibrium and kinetic simulations of experimental results.

11. <u>HIGHLIGHTS/ACCOMPLISHMENTS</u>

Literature review and preliminary petrographic analysis indicates that the Rose Run sandstone, like other mature sandstone formations in Ohio and the midwest, lacks the Ca-feldspar needed to provide Ca ions for trapping carbon as a solid carbonate phase. However, locally abundant glauconite and clay minerals could provide an alternative sources of Ca for carbon trapping reactions, making the ongoing field, experimental, and numerical studies, all the more necessary in order to quantify and predict the complex series of reactions and reactions rates. Inexpensive batch reactors that have been designed, built and tested will make it possible to run several experiments simultaneously and will significantly enhance our ability to investigate these complex reactions.