the ENERGY lab

PROJECT FACTS

Carbon Storage – GSRA

Assessing Reservoir Depositional Environments to Develop and Quantify Improvements in CO_2 Storage Efficiency: A Reservoir Simulation Approach

Background

The overall goal of the Department of Energy's (DOE) Carbon Storage Program is to develop and advance technologies that will significantly improve the effectiveness of geologic carbon storage, reduce the cost of implementation, and prepare for widespread commercial deployment between 2020 and 2030. Research conducted to develop these technologies will ensure safe and permanent storage of carbon dioxide (CO_2) to reduce greenhouse gas (GHG) emissions without adversely affecting energy use or hindering economic growth.

Geologic carbon storage involves the injection of CO_2 into underground formations that have the ability to securely contain the CO_2 permanently. Technologies being developed for geologic carbon storage are focused on five storage types: oil and gas reservoirs, saline formations, unmineable coal seams, basalts, and organic-rich shales. Technologies being developed will work towards meeting carbon storage programmatic goals of (1) estimating CO_2 storage capacity +/- 30 percent in geologic formations; (2) ensuring 99 percent storage permanence; (3) improving efficiency of storage operations; and (4) developing Best Practices Manuals. These technologies will lead to future CO_2 management for coal-based electric power generating facilities and other industrial CO_2 emitters by enabling the storage and utilization of CO_2 in all storage types.

The DOE Carbon Storage Program encompasses five Technology Areas: (1) Geologic Storage and Simulation and Risk Assessment (GSRA), (2) Monitoring, Verification, Accounting (MVA) and Assessment, (3) CO_2 Use and Re-Use, (4) Regional Carbon Sequestration Partnerships (RCSP), and (5) Focus Area for Sequestration Science. The first three Technology Areas comprise the Core Research and Development (R&D) that includes studies ranging from applied laboratory to pilot-scale research focused on developing new technologies and systems for GHG mitigation through carbon storage. This project is part of the Core R&D GSRA Technology Area and works to develop technologies and simulation tools to ensure secure geologic storage of CO_2. It is critical that these technologies are available to aid in characterizing geologic formations before CO_2-injection takes place in order to predict the CO_2 storage resource and develop CO_2 injection techniques that achieve optimal use of the pore space in the reservoir and avoid fracturing the confining zone (caprock). The program's R&D strategy includes adapting and applying existing technologies that can be utilized in the next five years, while concurrently developing innovative and advanced technologies that will be deployed in the decade beyond. For this project, researchers are improving and advancing reservoir

CONTACTS

Traci Rodosta
Carbon Storage Technology Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507
304-285-1345
traci.rodosta@netl.doe.gov

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

Roland Okwen
Principal Investigator
Illinois State Geological Survey
615 E. Peabody Drive
Champaign, IL 61820-6964
217-244-2869
rokwen@illinois.edu

PARTNERS

Schlumberger Carbon Services

PROJECT DURATION

Start Date	End Date
10/01/2012	09/30/2014

COST

Total Project Value
$1,040,410

DOE/Non-DOE Share
$809,412 / $230,998

AWARD NUMBER

DE-FE0009612

simulation tools to improve storage efficiency estimation and plume distribution for varying degrees of heterogeneity in geologic reservoirs of different depositional systems. Improved understanding in this area can enhance the performance and efficiency of carbon storage operations.

Project Description

Saline reservoirs and oil and gas reservoirs have been identified as potential reservoirs for storage of large volumes of anthropogenic CO_2. These reservoirs have been organized by the DOE into geologic formation classes based on environment of deposition and qualitative CO_2 storage potential. The ability to store large volumes of CO_2 is strongly dependent on reservoir storage efficiency, which is dependent on depositional environment. This is because the depositional environment of a formation defines reservoir architecture which influences fluid containment and fluid flow direction. DOE conducted a review of depositional environments and ranked the following as high or medium with regards to CO_2 storage potential: deltaic, shelf clastic, shelf carbonate, strandplain, reef, fluvial deltaic, eolian, fluvial and alluvial, and turbidite.

Figure 1. Pre-selected project location study sites

This project researches strategies for improving CO_2 storage efficiency in the presence of geologic heterogeneity and architecture common to potential storage formations within specific geologic depositional environments. This will be achieved through rigorously developed geologic and reservoir models representing the different potential formation classes identified by DOE. The models will also be generalized for use in other sedimentary basins in North America. The study will make use of existing geocellular models previously developed by the Midwest Geologic Sequestration Consortium (MGSC) and Illinois State Geological Survey (ISGS), and additional geocellular models will be built as needed from existing ISGS reservoir characterization studies. Available geologic data (log and core data) from at least six existing reservoir characterization studies will be collected and reviewed to develop these additional geologic models. Using geostatistics and geologic models, geocellular models will be developed for use in reservoir simulation. Various field-deployable operations will be simulated to investigate methods of improving storage efficiency in the presence of geologic heterogeneity specific to a depositional system. These operations include modeling:

- Horizontal wells (length, orientation, and inclination)
- Selective and dynamic perforations
- Plume management (well development) strategies

Objectives

The goal of this research is to identify means of improving CO_2 storage efficiency and plume distribution for varying degrees of heterogeneity in geologic storage formations with a variety of depositional environments. The key research objectives are to:

- Identify the Illinois Basin (ILB) (Figure 1) geologic formations that represent a broad and diverse portfolio of promising geologic depositional environments for CO_2 storage
- Develop geocellular geologic models of ILB geologic formations that are suitable for representing the desired depositional environments and geologic formation classes
- Estimate a baseline storage efficiency for each of the formation classes from CO_2 plume distribution (Figure 2)
- Estimate potential incremental improvements in storage efficiency that could be realized for each of the formation classes by applying various field methods or operational techniques

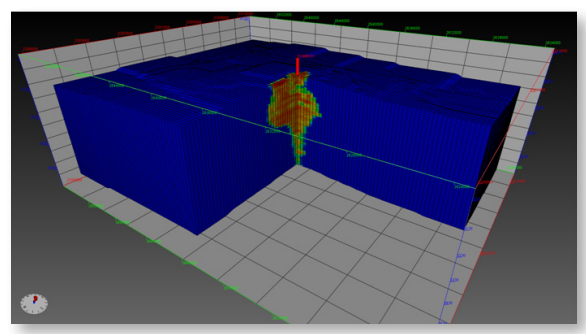

Figure 2. Geocellular model estimating CO_2 plume distribution in a strandplain

Benefits

The project will make a vital contribution to the technical and institutional knowledge base needed to establish frameworks for the development of carbon capture and storage (CCS). Improving our understanding of CO_2 storage efficiency in various depositional settings, and identifying the techniques with the potential to enhance storage efficiency, will provide better regional assessment estimates and site screening criteria. These benefits contribute toward achieving the Carbon Storage Program's goal to support estimating CO_2 storage capacity +/- 30 percent in geologic formations and improve understanding of storage efficiency.