the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Validation of Models Simulating Capillary and Dissolution Trapping During Injection and Post-Injection of CO_2 in Heterogeneous Geological Formations Using Data from Intermediate Scale Test Systems

Background

The U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) is currently funding research aimed to advance current state-of-the-art technologies that address geologic storage of carbon dioxide (CO_2) in multiple formation types and across all phases of CO_2 geologic storage operations.

Geologic storage involves the injection of CO_2 into underground formations that have the ability to securely contain it over long periods of time. Research efforts are currently focused on several geologic storage formation types: several clastic and carbonate types, coal, organic rich shale, and basalt formations. These formations contain different fluids such as saline water and oil and natural gas. A principal element of DOE's Carbon Sequestration Program is Core Research and Development (R&D), and one of the R&D focus areas—geologic storage—is aimed at addressing the challenges of CO_2 storage in these formations.

Critical challenges identified in the geologic storage focus area include CO_2 well bore integrity, geochemical and mechanical responses, fluid flow and containment, and development of mitigation technologies. Laboratory investigations dealing with CO_2 injections and flow patterns have been conducted on a small-scale in homogeneous

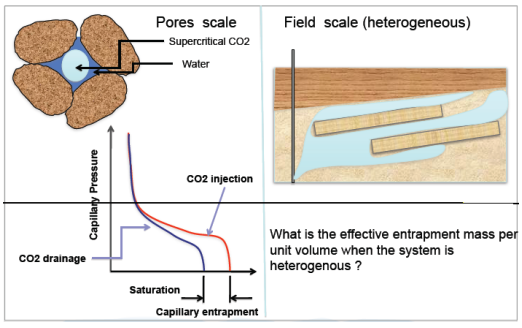

Figure 1: Fundamentals of CO_2 capillary trapping mechanisms

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PROJECT DURATION

Start Date
9/15/2010

End Date
12/31/2013

COST

Total Project Value
$650,277

DOE/Non-DOE Share
$510,752 / $139,525

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reservoirs. More research is needed to further evaluate CO_2 injection and flow modeling in heterogeneous reservoirs, so more accurate containment estimates can be made for the geologic sequestration of CO_2.

Project Description

Researchers at the Colorado School of Mines and the Lawrence Berkley National Laboratory are analyzing CO_2 trapping data sets to verify models that simulate CO_2 trapping mechanisms in heterogeneous porous reservoirs at an intermediate to large scale. The basic processes of CO_2 trapping are not easily understood through field testing, so a set of multi-scale laboratory tests will be conducted to further analyze CO_2 trapping mechanisms. The focus of this research will be to analyze capillary (Figure 1) and dissolution trapping (Figure 2) mechanisms since they are considered to be the most relevant processes facilitating permanent CO_2 storage in the absence of geologic structural traps; the efficiency of capillary and dissolution trapping mechanisms is considered to be strongly affected by the heterogeneity of the storage formation. Capillary trapping involves CO_2 being isolated in pore-space bubbles surrounded by formation water, and dissolution trapping involves CO_2 being dissolved in the formation fluid. This project will supplement previous research with multi-phase injection flow experiments conducted at various scales.Small-scale experiments will identify the fundamental trapping processes in homogeneous systems and provide supplemental data for use in intermediate- and large-scale models to capture the capillary and dissolution trapping processes in storage media with pore-scale heterogeneities.

Goals/Objectives

The objective of this project is to improve the understanding of how CO_2 trapping mechanisms are affected by the heterogeneity of the reservoir formation, with the ultimate goal of improving larger-scale trapping mechanism models. This will be accomplished by conducting laboratory experiments focusing on flow in heterogeneous media to improve the understanding of the fundamental processes of CO_2 trapping mechanisms.

The project will consist of three primary objectives:

- Generation of a comprehensive data set using intermediate-scale test tanks to simulate multi-phase flow to investigate the effect of capillary trapping in heterogeneous reservoirs.
- Generation of a comprehensive data set using intermediate-scale test tanks to simulate the dissolution of partially soluble fluids to analyze the effect of dissolution trapping in heterogeneous reservoirs.
- Evaluation of whether or not existing modeling codes can mimic the processes observed in the test tanks.

The project will be conducted by applying previous expertise in theoretical and applied aspects of multi-phase fluid flow to evaluate the effects of preferential flow and intra-layer mixing in heterogeneous reservoirs. Once the research is completed, a comprehensive data set that can be used to improve predictive tools for CO_2 storage will be generated.

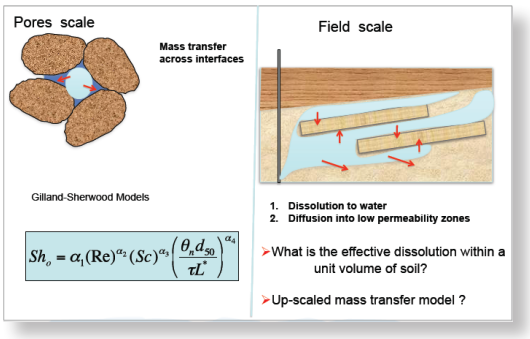

Figure 2: Fundamentals of CO_2 dissolution trapping info formation fluids

Benefits

This project will benefit CO_2 sequestration in geologic reservoirs by providing greater insight into how CO_2 can be trapped by capillary and dissolution mechanisms in heterogeneous formations. The new data set generated by these intermediate-scale simulations could also improve existing trapping mechanism simulation modeling, as current data sets have only evaluated trapping mechanisms in homogeneous micro-scale media.

More precise modeling will improve the understanding and characterization of heterogeneous geologic reservoirs associated with CO_2 injection. This research will demonstrate the ability of heterogeneous reservoirs to capture CO_2 in a more effective manner, which could also reduce the cost of sequestration operations.