the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Analysis of Microbial Activity Under a Supercritical CO_2 Atmosphere

Background

Increased attention is being placed on research into technologies that capture and store carbon dioxide (CO_2). Carbon capture and storage (CCS) technologies offer great potential for reducing CO_2 emissions and, in turn, mitigating global climate change without adversely influencing energy use or hindering economic growth.

Deploying these technologies in commercial-scale applications requires a significantly expanded workforce trained in various CCS specialties that are currently under-represented in the United States. Education and training activities are needed to develop a future generation of geologists, scientists, and engineers who possess the skills required for implementing and deploying CCS technologies.

The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) has selected 43 projects to receive more than $12.7 million in funding, the majority of which is provided by the American Recovery and Reinvestment Act (ARRA) of 2009, to conduct geologic sequestration training and support fundamental research projects for graduate and undergraduate students throughout the United States. These projects will include such critical topics as simulation and risk assessment; monitoring, verification, and accounting (MVA); geological related analytical tools; methods to interpret geophysical models; well completion and integrity for long-term CO_2 storage; and CO_2 capture.

Project Description

DOE is partnering with the Massachusetts Institute of Technology (MIT) to study how microorganisms acclimate and adapt to high partial pressures of CO_2 associated with geological sequestration of supercritical CO_2. In its supercritical state, CO_2 has the high-density characteristics of a liquid yet behaves like a gas by filling all the available volume. An enabling technology for geological carbon sequestration is the development of reservoir sealing mechanisms and leak remediation strategies, should they be needed. Biofilm barriers—an aggregate of microorganisms in which cells adhere to each other or a substrate—hold promise as a geologic carbon sequestration leak mitigation tool. However, establishing such barriers in situ (e.g., following hydrocarbon reservoir decommissioning) requires that biofilm producing strains remain active under high-pressure CO_2 conditions (Figure 1).

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PARTNERS

None

PROJECT DURATION

Start Date
12/01/2009

End Date
11/30/2012

COST

Total Project Value
$299,984

DOE/Non-DOE Share
$299,984/$0

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

This project will identify and develop microbial strains capable of activity in supercritical CO_2 environments. If successful, the results would support the DOE's objective to develop technologies to form seal mechanisms that can be deployed in the event of potential CO_2 leakage or that can proactively mitigate leakage in abandoned wellbores attributable to remediation/plugging activities. MIT will characterize the diversity of bacteria capable of surviving in a supercritical CO_2 atmosphere and will investigate the molecular mechanism of microbial survivability and stress response in supercritical-CO_2-tolerant bacteria through physiological, genomic, and transcriptomic (ribonucleic acid) profiling.

Goals/Objectives

The objectives of this project are to:

- Characterize the growth requirements and optima of a biofilm-producing supercritical-CO_2 tolerant microbial consortium (labeled MIT0212) isolated from hydrocarbons recovered from the Frio Ridge, Texas carbon sequestration site.
- Evaluate the ability of this microbe to grow and subsequently reduce permeability of sandstone cores under simulated reservoir conditions associated with supercritical CO_2 injection.
- Isolate and characterize individual microbial strains from this group of microbes.
- Investigate the mechanisms of supercritical CO_2 tolerance in isolated strains and the consortium through (meta)genome-enabled studies.

Benefits

Overall the project will make a vital contribution to the scientific, technical, and institutional knowledge base necessary to establish frameworks for the development of commercial-scale CCS. Project research will advance knowledge of microbial populations that can persist in reservoirs following CO_2 sequestration and help to better understand the activities they mediate. These microorganisms hold potential as agents for biofilm barrier engineering due to their tolerance and growth under high-pressure CO_2 conditions.

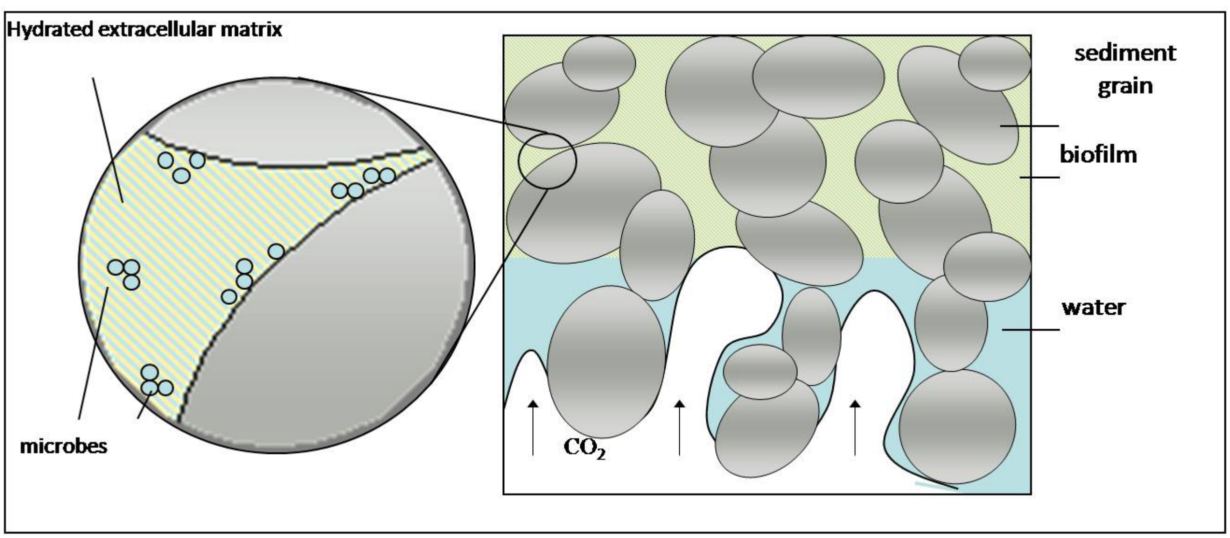

Figure 1. Conceptual model of microbial growth (biofilm) in residual pore spaces filled with high pressure CO_2 brine/water. Microbial biofilms may impede buoyant or capillary migration of CO_2 plume during geologic carbon sequestration.