the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Microbial and Chemical Enhancement of In Situ Carbon Mineralization in Geological Formation

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

NETL is partnering with Columbia University (Columbia) to develop a microbial and chemical enhancement scheme for in situ carbon mineralization in geologic formations to achieve long-term stability of injected CO_2. In situ carbon mineralization is one of the best storage pathways for geologic sequestration for long-term stability. Once CO_2 is captured from a point source, it is typically compressed to supercritical phase (31.1 °F and 72.9 atm) to reduce overall volume, and transported to the injection site. In situ carbon mineralization accomplished through chemical interactions with CO_2 and surrounding rock formations can result in solid carbonates that, as a result, remain permanently stored. Little is known about the fundamental characteristics of CO_2-mineral reactions that produce viable in situ carbon mineralization for permanent and safe storage of geologically-injected CO_2. Columbia is performing a systematic thermodynamic and kinetic study of CO_2-mineral-brine systems to determine organic acids that best enhance the rate of mineralization in serpentine rock. A microbial system that produces weak organic acids will also be developed in order to chemically enhance the in-situ mineral dissolution and, in turn, to achieve faster carbon mineralization kinetics.

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PARTNERS

None

PROJECT DURATION

Start Date

12/01/2009

End Date

11/30/2012

COST

Total Project Value

$365,922

DOE/Non-DOE Share

$299,614/$66,308

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

To date, studies of the carbonation of non-carbonate minerals, including Mg-bearing minerals such as serpentine have been contradictory. Particularly, the fate of the dissolving species (i.e., magnesium (Mg), silicon (Si), and iron (Fe)) and the process of magnesium carbonate precipitation in the presence of complex ions have been widely disputed. Columbia's project aims to create a knowledge base for in situ CO_2-mineral-brine interaction for geologic sequestration. Furthermore, a microbial system that produces weak acids will be developed in order to chemically enhance the in situ mineral dissolution and, in turn, achieve faster carbon mineralization kinetics. Each batch of organic acids produced shall be evaluated in a high-pressure reactor that mimics in situ geochemical conditions. The reaction kinetics of mineral dissolution and carbonation shall be investigated and mineral samples will be physically and chemically analyzed before and after the reactions. An economic and environmental analysis will be performed based on the final design of the in situ carbon mineralization process.

Goals/Objectives

Columbia University is utilizing faculty members as well as undergraduate and graduate students to perform all project tasks. This provides individuals with the opportunity to learn key concepts related to CCS and gain the experience necessary to contribute to a future CCS workforce. Specific technical project goals and objectives include:

- Developing a microbial and chemical enhancement scheme for in situ carbon mineralization in geologic formations.
- Thermodynamic and kinetic studies of CO_2-mineral-brine systems.
- Investigating the influence of organic acids produced by a microbial reactor on in situ carbonation.

Benefits

By combining microbial and chemical aspects of geologic sequestration, this novel, fundamental research will advance the United States in its position as the leader in CCS technology, while providing interdisciplinary training opportunities for graduate and undergraduate students. The research findings from this study will provide key information regarding the long term stability of injected CO_2 and an important path forward to reducing risks related to CO_2 injection.

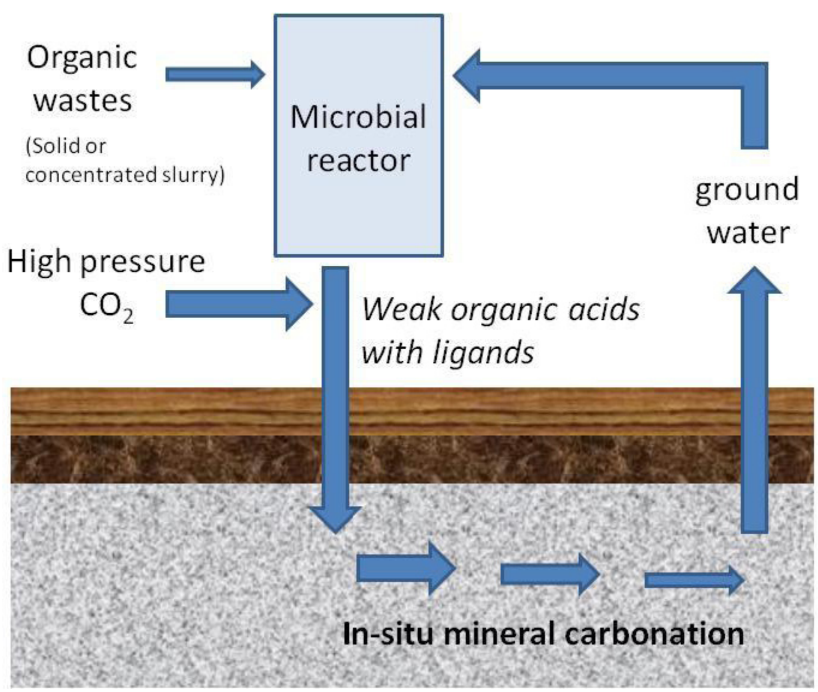

Figure 1. Proposed scheme of Microbial and Chemical Enhancement of In-Situ Carbon Mineralization in Geologic Formations.