the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Radiocarbon as a Reactive Tracer for Tracking Permanent CO_2 Storage in Basaltic Rocks

Background

The U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) is currently funding research aimed to advance 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. This study is exploring ways to predict the fate of CO_2 after it has been injected into a formation.

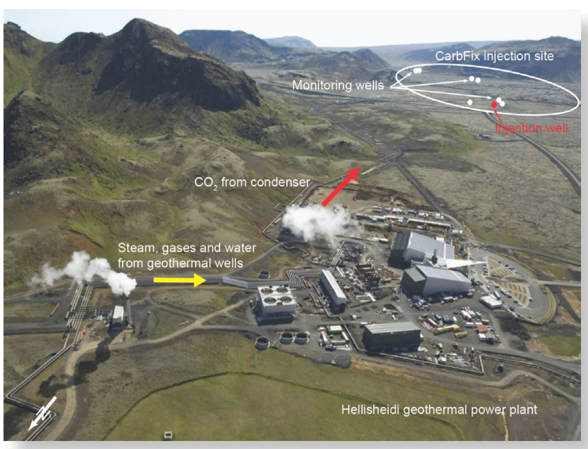

Figure 1 - Aerial photograph of the Hellisheidi geothermal power plant and the CarbFix CO_2 geologic storage site, which includes one injection and several monitoring wells. The geothermal power plant, which is approximately 3 km to the north of the injection site is the source of the CO_2.

CONTACTS

John Litynski
Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
Phone: 412-386-4922
john.litynski@netl.doe.gov

Karen Kluger
Project Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
Phone: 412-386-6667
karen.kluger@netl.doe.gov

Juerg Matter
Principal Investigator
Columbia University
Earth Institute/Lamont-Doherty Earth Observatory
61 Route 9W
Palisades, NY 10964
Phone: 845-365-8543
jmatter@ldeo.columbia.edu

PARTNERS

Reykjavik Energy

PROJECT DURATION

Start Date
10/1/2010

End Date
9/30/2013

COST

Total Project Value
$1,364,699

DOE/Non-DOE Share
$1,019,030 / $345,669

Project Description

Columbia University researchers are performing field studies at the CarbFix CO_2 geologic storage site in Iceland. This site is home to a pilot study where CO_2 is being injected into a storage formation of basaltic rock. A field study is being used to test and evaluate the efficacy of using carbon-14 (14C) as a reactive tracer (a substance that is used to monitor chemical reaction) to monitor the CO_2 transport and characterize CO_2 geochemical reactions in the basalt formation. To date, water injection tests verified the injectivity of the formation and small quantities of CO_2 (on the order of kilograms) have been injected. To prepare for the use of tracers, small scale nitrogen injection was also performed. Once the system is operational at the pilot scale level, CO_2 dissolved in water will be used as the injection stream at a rate of 2,200 tonnes of CO_2 per year.

Researchers are obtaining fluid and rock samples from the CarbFix site where the injected CO_2 is labeled with the 14C tracer. These samples will be analyzed to determine the extent of mineral carbonation (the process by which CO_2 reacts with minerals in the reservoir to form solid carbonates) that occurs when CO_2 is injected into a basaltic storage reservoir. To predict the CO_2 movement in the target injection reservoir, Columbia University will monitor the trifluormethylsulphur pentafluoride (SF_5CF_3) tracer concentration in the storage reservoir by collecting fluid samples in the injection and monitoring wells. Fluid samples will be analyzed and the results will be used to characterize the CO_2 dispersion in the basalt. Results will be integrated to assess the use of the tracers for determining reservoir flow and geochemical reactivity, and to assess in situ mineral carbonation in basalt storage formations.

Mineral carbonation is the most permanent storage mechanism as it locks CO_2 into the solid structure of a mineral. Basalts are a promising reservoir rock because they have the potential for permanent storage through carbonation. However, mineral carbonation can affect the permeability of reservoir rock, reducing the amount of CO_2 that can be injected and stored. It is therefore vital to characterize the relevant geochemical reactions that occur in a reservoir after the injection of CO_2 and to improve our understanding of the rate at which these reactions occur. Little is known about geochemical reactions caused by CO_2 injection and in situ mineral carbonation rates in basaltic storage reservoirs. The results of this research should increase our understanding of migration and carbonation processes in these potential reservoirs.

Goals/Objectives

The goal of this project is to demonstrate that 14C can be used as a reactive tracer to monitor geochemical reactions in a CO_2 reservoir and to evaluate the extent of mineral trapping in basaltic rocks. 14C will be used in combination with SF_5CF_3 as a conservative tracer to predict the CO_2 transport in a storage reservoir and to verify in situ mineral carbonation using retrieved fluid and rock samples. This research will increase confidence in geologic sequestration by providing actual validation that mineral carbonation is occurring in these types of reservoirs and by providing real world rate estimates for this process.

Benefits

None of the currently suggested approaches to monitor and verify geologic storage reservoirs provide a set of direct measurements that can characterize geochemical reactions and determine the amount of carbon stored in mineral form. This research will test and evaluate 14C as a reactive tracer to predict the CO_2 transport in the storage reservoir and to verify in situ mineral carbonation using retrieved fluid and rock samples. This increases confidence in geologic sequestration by allowing fluid and rock samples to provide verification of mineral trapping under actual reservoir conditions.

NETL