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

Award Number: DE-FE0004847

Project Summary:

The main objective of this project was to demonstrate that carbon-14 (^{14}C) could be used as a reactive tracer to monitor geochemical reactions in carbon dioxide (CO_2) injection reservoirs and to evaluate the extent of mineral trapping. Studies were conducted at the CarbFix CO_2 pilot injection site in Iceland. The study evaluated ^{14}C in combination with trifluormethylsulfur pentafluoride (SF_5CF_3) as a conservative tracer to monitor the CO_2 transport in a storage reservoir. In addition, the study helped to verify in-situ mineral carbonation by performing laboratory analyses on retrieved fluid and rock samples. Fluid and rock samples from the CarbFix site were analyzed to study the extent of mineral carbonation in a basaltic storage reservoir.

Prime Performer:
Columbia University, Lamont-Doherty Earth Observatory

Principal Investigator:
Juerg M. Matter

Project Duration:
10/01/2010 – 09/30/2015

Performer Location:
Palisades, New York

Field Site:
CarbFix, Reykjavik, Iceland

Program:
Carbon Transport & Storage

Figure 1: Wireline diamond drilling rig at the CarbFix injection site in October 2014. Photo: M. Stute.

Project Outcomes:

Two injection tests were performed at the CarbFix site: Phase I involved the injection of 200 tons of CO_2, and Phase II involved the injection of 73 tons of a CO_2+H_2S gas mixture. Non-reactive (SF_6, SF_5CF_3) and reactive (^{14}C) tracers were successfully used to monitor CO_2 transport and reactivity in the reservoir. Mass balance calculations of DIC and ^{14}C, corrected for any mixing between the injectate and the ambient groundwater, show that between 95 and 98% of the injected CO_2 has been mineralized through CO_2-fluid-rock reactions between the injection and the monitoring wells between 2012 and 2015. Mineralization of the injected CO_2 was confirmed by retrieving a rock core from the injection reservoir and mineral material from monitoring well. Tracer results of this work demonstrate nearly complete CO_2 mineralization in basaltic rocks within less than two years. The newly developed tracer techniques, using non-reactive and reactive tracers, allowed for quantitative monitoring of dissolved and mineralized CO_2 that is not possible with conventional monitoring technologies.

Presentations, Papers, and Publications

Final Report: **Radiocarbon as a Reactive Tracer for Tracking Permanent CO_2 Storage in Basaltic Rock** (December 2015) – Juerg Matter, Martin Stute, Peter Schlosser, Wallace Broecker