Field Demonstration of CO_2 Injection Monitoring Using Krauklis and Other Guided Waves

Award Number: DE-FE0028659

Project Summary:

The goal of this project was to conduct a feasibility study of a new, low-impact geophysics monitoring method designed to incrementally track the saturation front of carbon dioxide (CO_2) injected into a geologic reservoir. The method employs a newly utilized subsurface signal called the Krauklis wave (K-wave) and other guided waves for seismic monitoring that may be applicable in carbon capture, utilization, and storage (CCUS) applications. The objectives of the feasibility study were to demonstrate, validate, and evaluate the K-wave method's ability to monitor the morphology of the injected CO_2 and estimate the saturation distribution over a study area incorporating up to 30 wells. The system was field-tested at Denbury's Bell Creek oil field, currently undergoing CO_2-enhanced oil recovery (EOR) in southeastern Montana, the site of the EERC's Plains CO_2 Reduction (PCOR) Partnership Program large-scale CO_2 storage demonstration project.

Prime Performer:
University of North Dakota Energy and Environmental Research Center (EERC)

Key Performers:
Seismos, Inc.
Denbury Onshore, LLC

Principal Investigator:
Shaughn Burnison

Project Duration:
10/01/2016 – 12/31/2018

Performer Location:
Grand Forks, North Dakota

Field Sites:
Bell Creek Oil Field, Montana

Program:
Carbon Transport & Storage

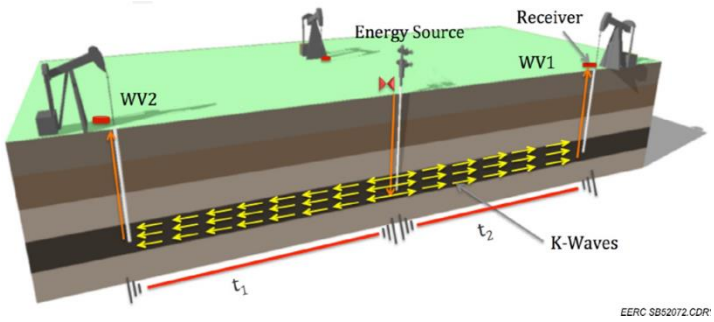

Figure 1: Simplified K-wave system illustration showing two well pairs (one "source" well and two "receiver" wells). (Image courtesy of Seismos, Inc.)

Project Outcomes:

The new source failed to produce a detectable signal, which indicated that the Bell Creek Field is not an ideal site for the K-wave test. Researchers concluded that a source with sufficient strength and bandwidth could not be built to overcome the limiting factors discovered by the modeling within a reasonable amount of time. Several other CO_2-EOR sites were evaluated; however, none of these sites was amenable because of geology, limitations in the source and receiver hardware, or the advanced state of the CO_2 flood, which would preclude the acquisition of baseline measurements. In addition, two other configurations of the source and receiver layout were considered; however, these design modifications either changed the scope of the project or did not meet the goals of the Carbon Storage Program. A decision was made to terminate the project, thereby avoiding additional expenditures that would not meet the current project objectives. Project activities have moved the K-wave technology forward by developing modeling equations that can be applied elsewhere, advancing the state of wellhead sensors and sources, and spurring improvements to field operations. The 3D seismic survey in the project area and the dynamic reservoir simulations done as part of this study have provided value for ongoing and future synergistic activities at Bell Creek related to U.S. Department of Energy carbon storage goals.

Presentations, Papers, and Publications

Final Report: Field Demonstration of the Krauklis Seismic Wave in a Novel MVA Method for Geologic CO_2 Storage (December 2018) Shaughn Burnison, Amanda Livers-Douglas, Lu Jin, Neil W. Dotzenrod, John A. Hamling, Charlie D. Gorecki