Active Seismic Monitoring of CO_2 Leakage Through a Hydromechanically Reactivated Fault: Caprock Integrity Monitoring for a Geological Carbon Sequestration Site Analog: Validating a CASSM Monitoring System

Award Number: DE-FWP-FP00007630

Project Summary:

The purpose of this project was the field validation of a cross-well continuous active-source seismic monitoring (CASSM) method for time-lapse imaging of carbon dioxide (CO_2) leakage during and after activation of a fault zone affecting a reservoir caprock. The key idea was to distinguish changes in seismic velocities related to changes in fault permeability, fault compliance, CO_2 saturation, and effective stress from those related to stress perturbations induced by fault rupture.

Prime Performer:
Lawrence Berkeley National Laboratory

Principal Investigator:
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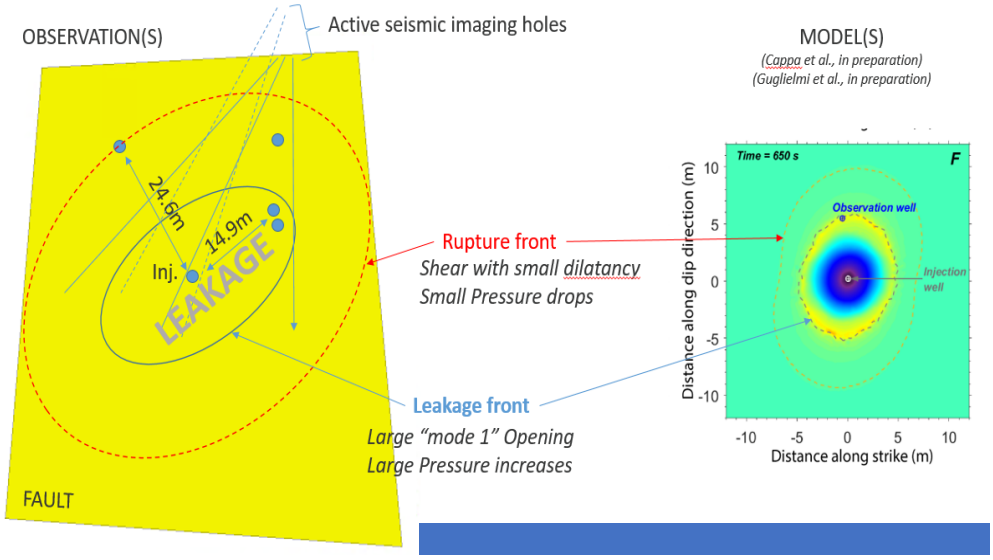
Project Duration:
07/01/2018 – 12/31/2021

Performer Location:
Berkeley, California

Field Sites:
Mont Terri, Switzerland

Program:
Carbon Transport & Storage

Figure 1: Conceptual model of fault leakage. Active seismic is mainly seeing the leakage front.



Project Outcomes:

The CASSM system was deployed and tested at the Mont Terri site during a controlled fault activation in shales. Researchers used a total of five monitoring wells for fault imaging. Twenty-four sources were placed in three boreholes and 44 receivers were placed in two boreholes. The CASSM active seismic imaging system functioned well over the course of 6 months with high repeatability. The study found that when using six injection cycles at a constant flowrate of 2 to 10 liters/minute, the fault started leaking at about 5.5 millipascals (mPa). Conceptualized modeling found that leakage is more localized than fault shear due to a combination of micro-crack dilation in the leakage fault patch and long-term damage response, possibly related to shear. This project improved and tested technology to assess and mitigate potential risk of induced seismicity affecting caprock integrity as a result of injection operations.