the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Rock Physics of Geologic Carbon Sequestration/Storage

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 underrepresented 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

DOE is partnering with Stanford University in their effort to establish a unified rock physics framework for quantitatively interpreting seismic observables. This research will focus on developing a deterministic workflow that will allow an expert to dial in the host formation properties as well as injection and storage conditions, to generate seismic reflection records of CO_2 in space and time. Seismic reflections depend on the elastic properties and thickness of the reservoir and surrounding formations. The elastic properties of the reservoir depend on the properties of its mineral frame and the fluid distribution and pressure. Seismic imaging is a powerful subsurface imaging tool that can be used in geologic CO_2 storage applications to identify subsurface features and geologic strata over a large area, as well as map CO_2 plumes to confirm confinement in the target storage formations.

The approach of this research is to (1) compile a systematic database of existing laboratory data on CO_2 storage as well as field observation; (2) use these data to create a theoretical rock physics framework for MVA of CO_2 (Figure 1); and (3) use this framework to explain and predict the responses observed in the field by developing a seismic reflection catalogue as a field guide (Figure 2).

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PARTNERS

None

PROJECT DURATION

Start Date
12/01/2009

End Date
11/30/2012

COST

Total Project Value
$385,276

DOE/Non-DOE Share
$295,777/$89,499

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

This work will be conducted by two doctoral students under the supervision of Drs. Gary Mavko and Jack Dvorkin of Stanford. By conducting fundamental research, these graduate students will acquire unique technical skills in quantifying rock properties during injection and storage of CO_2 and, as a result, will advance science in these topics and become experts in predicting and monitoring the quantities of CO2 stored in the host formation as well.

Goals/Objectives

The primary objective of the project is to establish theoretical rock physics relations between CO_2 injection into clastic and carbonate reservoirs and the resulting changes in the reservoir's elastic-wave, electrical, and other properties.

Benefits

Overall the project will make a vital contribution to the scientific, technical, and institutional knowledge base necessary to establish frameworks for the development of commercial-scale CCS. The effort will establish a framework for an industry standard for predictive modeling of the relationship between injected CO_2 and the changes in the reservoir's rock physics properties. This research will also produce experts trained in predicting and monitoring the movement and redistribution of sequestered CO_2.

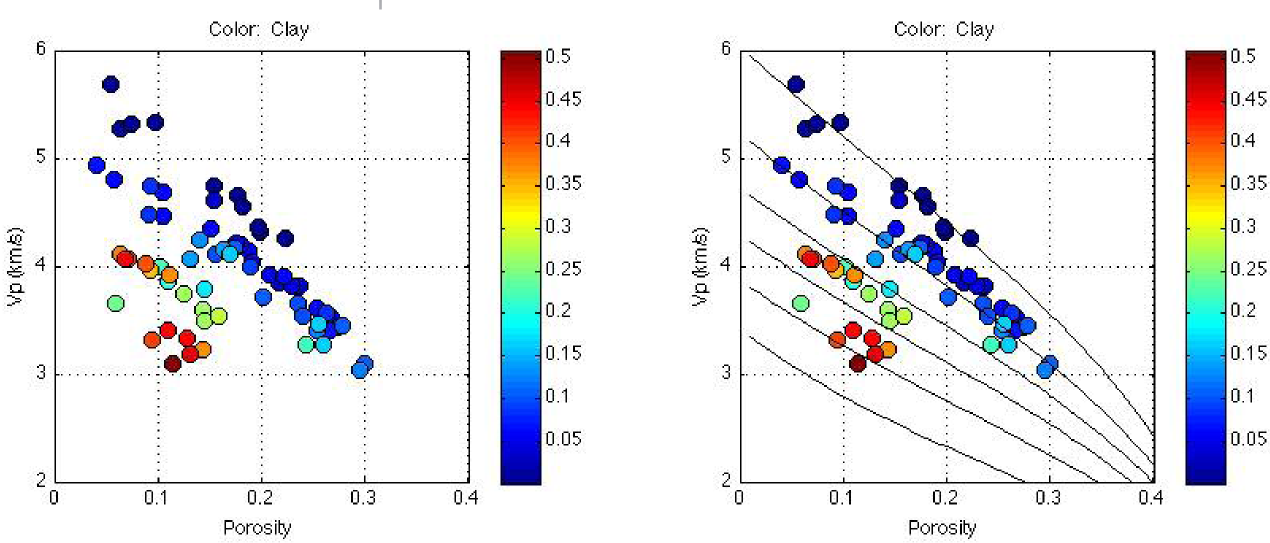

Figure 2. Evolution of P- and S-wave velocity for the five injections of acidic fluid in a carbonate sample. Open samples are for the dry sample, while filled circles are for the fluid-saturated sample.

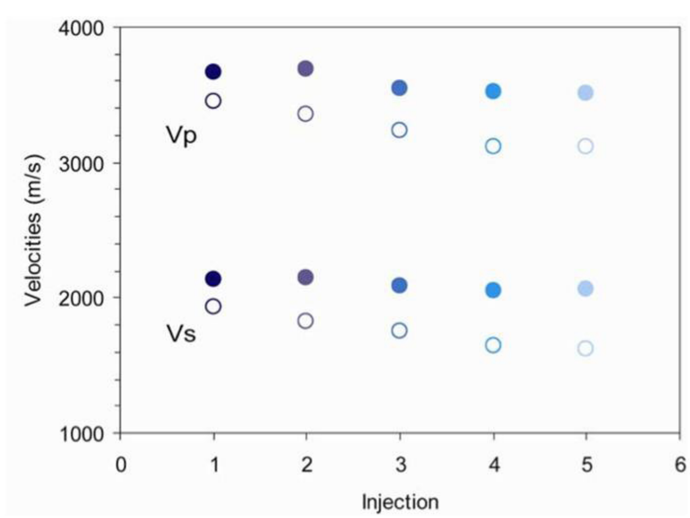

Figure 1. Rock physics models will use relationships such as those between P-wave velocity, porosity, and clay content.