the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Injection and Reservoir Hazard Management: Mechanical Deformation and Geochemical Alteration at the In Salah CO_2 Storage Project

Background

Safe and permanent storage of carbon dioxide (CO_2) in geologic reservoirs is critical to geologic sequestration. The In Salah Project (joint venture of British Petroleum (BP), Sonatrach, and StatoilHydro) has two fundamental goals: (1) 25–30 years of 9 billion cubic feet per year (bcfy) natural gas production from 8 fields in the Algerian Central Sahara, and (2) successful minimization of the associated environmental footprint by capture and subsurface isolation of the excess CO_2 extracted from production streams, with isolation in the Krechba sandstone reservoir.

Description

The In Salah project provides an opportunity to study key physical and chemical processes in operation deployment of geological carbon sequestration. This research will study two components relevant to storage effectiveness and operational success at In Salah: reactive chemistry of the brine-CO_2-reservoir-caprock-wellbore system, and the geomechanical effects of large-scale injection on crustal deformation and fault leakage hazards. Results from this work will enhance predictive capability of field performance, provide a new basis for interpretation of geophysical monitoring at In Salah, and provide additional information for the development of geological sequestration standards. The Joint Industry Project (A consortium consisting of BP, StatoilHydro and Sonatrach, hereafter referred to as the JIP) is cost-sharing 50 percent of the total

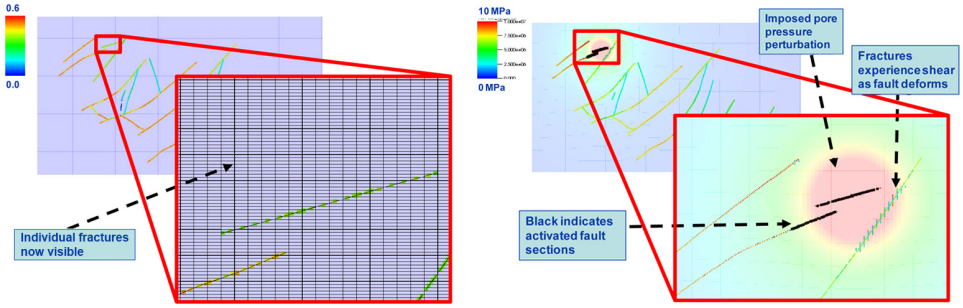

Figure 1. Work performed to date has included predicting the detailed response of combinations of faults and fractures at the field scale. In this instance, the response of the faulted-fractured Krechba reservoir is observed to deform on both the faults and fractures. This has consequences for predicting the mobility of the sequestered CO_2.

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COST

Total Project Value
$2,135,000

DOE/Non-DOE Share
$1,135,000 / $1,000,000

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project cost ($500,000/year for each of three years). The JIP and Lawrence Livermore National Laboratory (LLNL) are sharing data and results to achieve the objectives of this work.

The LLNL project involves several phases. The initial phase is focused upon interpretation of field data supplied by the JIP and information exchange with the JIP and other participating research teams. Subsequently, the field data is integrated into a combined geological model that provides input for the LLNL computational and experimental efforts. These studies include geochemical reactive transport experimental studies and supporting simulations. The field data is also being used for geomechanical modeling of the reservoir including predictions of fracture network and fault response. Finally, the geochemical and geomechanical study results will be integrated to develop models for storage mechanisms, storage performance, reservoir integrity, and injection operational hazards for the In Salah project. The results of this effort will also be applicable to future U.S. brine storage operations.

Primary Project Goal

This study is composed of a comprehensive multi-disciplinary effort with objectives that address two challenges to successful geologic CO_2 isolation at In Salah that are relevant to a broad range of CO_2 storage scenarios:

1. Quantify CO_2 plume migration and sequestration partitioning among distinct trapping mechanisms within dynamic, complex permeability fields characterized by multi-scale heterogeneity, with assessment of coupled processes that may lead to early CO_2 breakthrough at production wells.

2. Evaluate geomechanical response and potential supra-reservoir leakage, through faults, fractures, and wellbores, which may ultimately reach the surface.

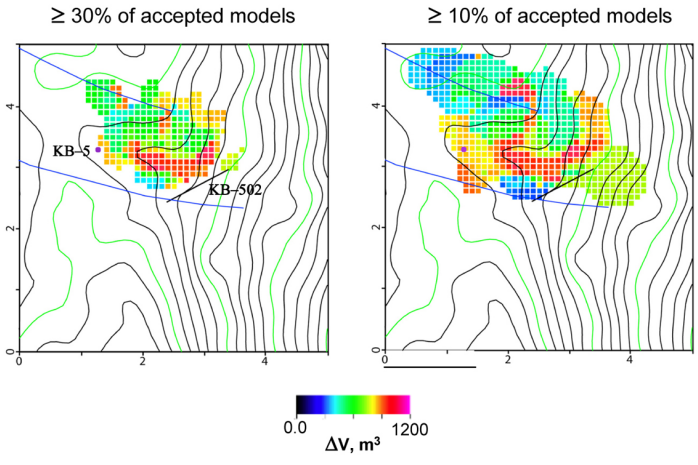

Figure 2. Through stochastic inversion of surface deformation data the uncertainty in plume location was quantified.

Objectives

The objectives of the study will be accomplished by completing the following activities:

- Construction of reactive transport and geomechanical models
- Batch/mixed flow and plug flow reactor experiments and modeling
- Field-scale reactive transport modeling
- Fault failure forecasting
- Discrete fracture modeling
- Simulation of microseismicity

Accomplishments

- Collaborated with the In Salah Joint Industry Project to establish partnership to share data, provide support, and cost share.
- Simulations performed at LLNL indicate significant permeability enhancement of the fracture network within the reservoir during the injection phase, within the vicinity of the injectors.
- A preliminary stochastic inversion of satellite data provided an initial quantification of the uncertainty in plume position about one of the injectors.
- Initial reactive transport calculations for CO_2-rich fluids flowing through fractures were performed, and demonstrated that minor porosity and permeability changes will be expected in response to CO_2 injection.
- Preliminary reactor experiments including the cement formulation used in the Krechba field indicate that the composition of the cured cement is sensitive to reservoir water composition.
- Participated in a BP hosted geomechanics workshop in London in 2008 and presented FY08 research highlights.

Benefits

The project has immediate benefit to DOE by supporting U.S. involvement in a full scale CO_2 sequestration project in anticipation of such projects being deployed in the United States. Additionally, this project is providing benefit to the JIP in their management of the In Salah Project, by providing an independent study of the storage site performance and assessment of CO_2 plume mobility.