Enhanced Simulation Tools to Improve Predictions and Performance of Geologic Storage Coupled Modeling of Fault Poromechanics and High-Resolution Simulation of CO_2 Migration and Trappings

Award Number: DE-FE0009738

Project Summary:

The objective of this project was to develop tools for better understanding, modeling, and risk assessment of carbon dioxide (CO_2) permanence in geologic formations. The specific objectives were: (1) to develop computational models that will enable the assessment of the potential for fault slip, leakage, and induced seismicity; (2) to develop computational methods for better predictions of capillary and solubility trapping at large scales and in the presence of aquifer heterogeneity; and (3) to apply the models of fault poromechanics and CO_2 migration and trapping to synthetic and actual deep saline aquifers.

Prime Performer:
Massachusetts Institute of Technology

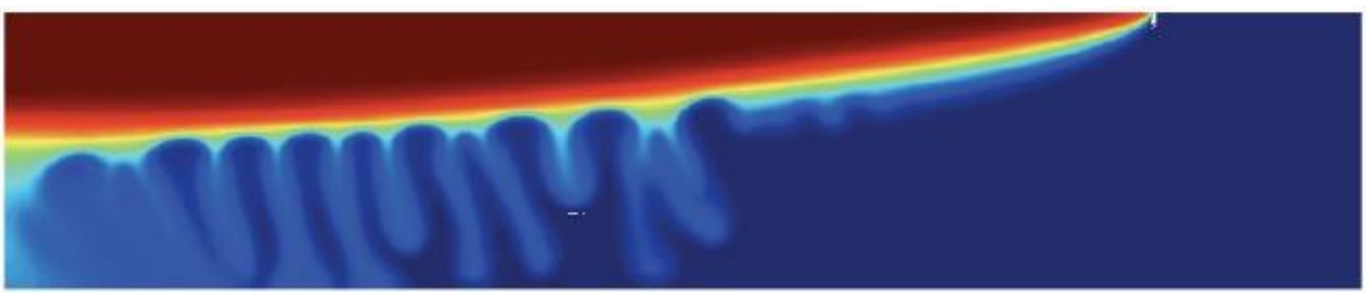
Principal Investigator:
Ruben Juanes

Project Duration:
10/01/2012 – 09/30/2016

Performer Location:
Cambridge, Massachusetts

Program:
Carbon Transport & Storage

Figure 1: A preliminary high-resolution simulation of plume migration in a homogeneous, horizontal aquifer under the effect of convective dissolution trapping. The simulation employs the fluid properties of the analogue fluid system (water and propylene-glycol) and a very low value of the Rayleigh number (Ra=1,000)



Project Outcomes:

This project developed a coupled model of flow and geomechanics of CO_2 injection in deep geologic formations that is capable of simulating the poromechanics of faults, to assess the potential for fault slip and fault activation upon CO_2 injection. The fixed-stress sequential split of the coupled flow-geomechanics problem was used to develop an accurate, stable, and efficient computational tool for simulating fault poromechanics by coupling a multiphase/compositional flow code with a geomechanics code capable of simulating static and dynamic geo-deformation problems with localized deformation along faults. Alternative descriptions of the dependence of the coefficient of friction on slip rate and state were implemented, and the code was applied to synthetic and actual reservoirs to evaluate the risk of induced seismicity from CO_2 storage. Finally, high-resolution simulation tools were developed to investigate the interplay between CO_2-plume migration and CO_2 trapping. The multidimensional models captured a wide range of scales from those associated with the convective dissolution instability (meters) to those related to the large-scale (tens of kilometers), to elucidate the impact of aquifer heterogeneity on CO_2 migration and trapping.

Presentations, Papers, and Publications

Final Report: **Enhanced Simulation Tools to Improve Predictions and Performance of Geologic Storage: Coupled Modeling of Fault Poromechanics, and High-Resolution Simulation of CO_2 Migration and Trapping** (December 2016) – Ruben Juanes