A Probabilistic Assessment of the Geomechanical Response to CO_2 Injections in Large Igneous Provinces

Award Number: DE-FE0023381

Project Summary:

The purpose of this project was to complete a multi-scale investigation of the physical processes governing geologic carbon dioxide (CO_2) storage in basalt reservoirs at the Wallula Basalt Storage Site. This work integrated (i) laboratory measurements of relative permeability in a basalt fracture, (ii) theoretical modeling to understand how relative permeability uncertainty affects geomechanical performance attributes of basalt reservoirs, (iii) outcrop-scale simulation to identify the characteristics of vertical CO_2 flow in a basalt fracture network, and (iv) regional-scale assessment of permeability architecture in the Columbia River Basalt Group. These individual studies were combined into a site-scale stochastic model of geologic CO_2 sequestration in the Columbia River Plateau, which shows how bulk and relative permeability variability affects geomechanical reservoir integrity and storage capacity of flood basalt reservoirs.

Prime Performer:
Virginia Polytechnic Institute and State University

Principal Investigator:
Ryan M. Pollyea

Project Duration:
10/1/2014 – 8/31/2018

Performer Location:
Blacksburg, Virginia

Field Sites:
Wallula Basalt Sequestration Pilot Project

Program:
Carbon Storage

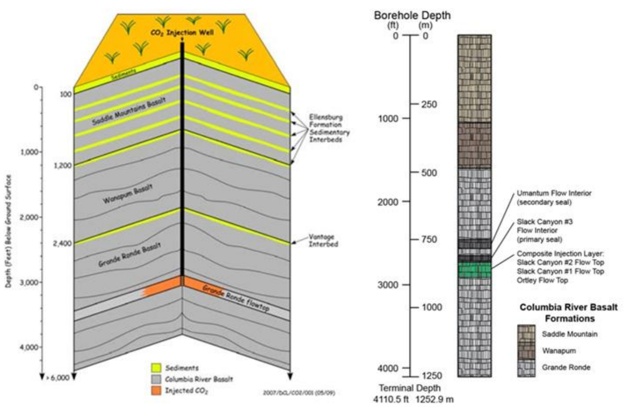

Figure 1: Reservoir characterization at the Wallula test site in Washington.

Project Outcomes:

The project revealed several promising attributes for carbon capture and storage in basalt reservoirs. Both outcrop- and site-scale simulation studies found that basalt fracture networks are capable of trapping free-phase CO_2 over timescales required for widespread mineralization to occur and basalt injectivity is theoretically capable of supporting up to 2 million metric tons per year within a single injection well operating below the fracture pressure. Moreover, this study also found that CO_2 tends to accumulate at fracture intersections, which slows vertical CO_2 mobility and increases fluid residence time, suggesting that mineralization may focus at fracture intersections. As a consequence, there exists a theoretical possibility that basalt fracture networks may be self-sealing systems in the presence of an equilibrium supply of CO_2; however, additional research is needed to more fully understand the dissolution-precipitation processes in natural fractures.

Presentations, Papers, and Publications

Final Report: Assessing the Geomechanical Response of CO_2 Disposal in Flood Basalt Reservoirs (November 2018) – Ryan M. Pollyea, Sally M. Benson