Simulation of Aqueous CO_2 Injections into Eastern Snake River Plain Basalts, Idaho, USA

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Geological carbon sequestration, in which captured carbon dioxide is injected into subsurface reservoirs, is a strategy for the mitigation of greenhouse gas emissions. Deep saline aquifers and depleted hydrocarbon reservoirs within sedimentary basins have received considerable attention as potential targets for CO_2 storage. In these systems, supercritical CO_2 is injected into the reservoir and is physically trapped as a free gas phase which slowly dissolves into the formation fluids and may ultimately reacts with the formation rock to permanently entomb CO_2 as carbonate minerals. An alternative to sedimentary basins for geological carbon sequestration are basalt formations. Pilot/field-scale demonstrations of injected supercritical CO_2 (Wallula Basalt Pilot Project, SE Washington, USA; T = 36 °C) or aqueous CO_2 (CARFIX, Iceland; T = 20-33 °C) have shown that CO_2 rapidly react with base-cation rich basalts to form carbonate minerals over relatively short time frames.

In collaboration with an industrial partner, we are planning to extend our understanding of field-scale mineralization rates by conducting an aqueous CO_2 injection into the ~13 °C basalts of the Eastern Snake River Plain (ESRP), Idaho USA. In preparation for this injection, we are planning laboratory mineralization experiments using ESRP basalt. We have also used The Geochemist's Workbench® to simulate one-year aqueous CO_2 injections into the basalt formation at site groundwater temperature and for groundwater heated to 40 °C. These simulations show that ankerite is the dominant carbonate mineral formed at both temperatures with five-times greater abundance predicted at the higher temperature. For both cases porosity reduction was negligible. In addition, the basalt dissolution rate and the fraction of CO_2 sequestered are predicted to be two- and five-times larger, respectively at the higher temperature. Finally, a factor of two change in results in only a 7-9% change in the amount of basalt reacted during a one-year injection. The results of these and similar simulations will be used to design the experimental program, the results of which will be used to update our simulations in support of the design of a field-scale aqueous CO_2 injection pilot project.