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An experimental and numerical study on the sequestration of CO_2 in basaltic aquifers in New Mexico, USA

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Basaltic rocks are a potential repository for reducing atmospheric CO_2 concentration by sequestration into carbonate minerals [1-3] through the dissolution of mafic minerals and/or basaltic glasses by CO_2-bearing waters, which releases divalent cations (Ca^{2+}, Mg^{2+}, Fe^{2+}). The state of New Mexico provides a natural laboratory for exploring CO_2 mineralization into shallow basaltic aquifers due to its geological setting and the presences of large-scale basalt flows generated around the Rio Grande Rift [4]. Here we use a combination of numerical simulations and batch-type experiments to evaluate the CO_2 sequestration potential of selected sites including basaltic rocks from the Raton-Clayton volcanic field and the Carrizozo Lava Flow. Batch-type experiments are conducted at 40-70°C with relatively low P_{CO2} for a range of powdered basalt grain sizes (45-125 μm, 250-500 μm, and 1-2 mm) to evaluate the kinetics and fluid-rock reaction paths. Experiments were conducted for 180 days, and fluid was sampled *in situ* at regular intervals to characterize the water chemistry, derive information on dissolution kinetics and provide monitoring guidelines for water quality protocols for later upscaling and injection projects. Aqueous solutions are measured using ICP-OES/MS and CO_2 contents are determined using titration. Numerical simulations are performed using the GEM-Selektor code package [5] and the MINES thermodynamic database [6]. Numerical simulations are used to determine the CO_2 mineralization potential of different basaltic rock formations and indicate the formation of Fe-hydroxides and zeolites in simulations with 0.1 m CO_2 and precipitation of calcite at low fluid-rock ratios and siderite and dolomite at high fluid-rock ratios in simulations with 1 m CO_2. The results of this study will be used to assess state-wide resources for storage of CO_2. This material is based upon work supported by the Department of Energy under Award Number DE-FE0032257.

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