GEOCHEMICAL INTERACTIONS OF CO_2 WITH RESERVOIR FLUID AND ROCKS OF POWDER RIVER BASIN

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ABSTRACT

A series of laboratory experiments and numerical modeling of geochemical reactions have been conducted to determine potential mineral dissolution and/or precipitation reactions caused by the injection of CO_2 into one of the sandstone formations of the Powder River Basin in Montana and Wyoming. Kinetic experiments were conducted using outcrop samples from Madison, Newcastle, Goose-Egg, Tensleep, Amsden, and Skull Creek formations of the Powder River Basin. Prior to exposure, samples were analyzed using x-ray diffraction (XRD) and QEMSCAN® techniques. Sixteen samples were "soaked" for a period of 4 weeks at 3000 psi (206.8 bar) and 140°F (60°C) in synthetically generated brine conditions. Over that time period, this set of mineral core plugs was exposed to pure carbon dioxide. The initial XRD mineralogical analysis of selected samples indicates the presence of the following minerals: anhydrite, calcite, dolomite, forsterite, halite, illite, magnetite, and quartz. XRD analysis of obtained reaction products indicated that most samples displayed some degree of reactivity with CO_2, for instance, the water analysis with inductively coupled plasma–mass spectrometry technique revealed the elevated concentrations of Ca, Mg, Si, and, for some cases, Al and K. Refined QEMSCAN technique revealed spatial redistribution of iron and indicated phase changes for iron-rich samples. Effective porosity measurements were conducted, where both gains and losses of porosity were observed for different samples. Results of the laboratory experiments were compared with the numerical modeling performed using the Geochemist's Workbench simulator and PHREEQC. This work was performed by the Energy & Environmental Research Center through the Plains CO_2 Reduction Partnership, one of the U.S. Department of Energy's National Energy Technology Laboratory Regional Carbon Sequestration Partnerships.