LABORATORY AND NUMERICAL MODELING OF CO_2–H_2S–WATER–ROCK INTERACTIONS AT WILLISTON BASIN RESERVOIR CONDITIONS

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ABSTRACT

A series of laboratory experiments, field observations from a small-scale CO_2 enhanced oil recovery project, and numerical modeling of geochemical reactions have been conducted to determine the chemical kinetics of potential mineral dissolution and/or precipitation caused by the injection of CO_2 and of sour gas. Kinetic experiments were conducted using core samples from potential Williston Basin storage formations and pure mineral samples (e.g., calcite, dolomite, siderite, etc.) obtained from vendors. Samples were analyzed using x-ray diffraction (XRD) and QEMSCAN® techniques. Two sample sets consisting of 16 samples each, under the same experimental conditions, were "soaked" for a period of 4 weeks at 2500 psi (172 bar) and 176°F (80°C) in synthetically generated brine conditions. Over that time period, one set was exposed to pure carbon dioxide and the other to a mixture of carbon dioxide (88 mol%) and hydrogen sulfide (12 mol%). 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 high reactivity with acid gas. Meanwhile, most samples showed lower reactivity when pure CO_2 was utilized. 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.