Mineral Sequestration of CO_2 mixed with H_2S and SO_2 in Sandstone-Shale Formation

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Abstract. Carbon dioxide (CO_2) injection into deep geologic formations can potentially reduce atmospheric emissions of greenhouse gases. Sequestering less-pure CO_2 waste streams (containing of H_2S and/or SO_2) is less expensive or requires less energy than separating CO_2 from flue gas or a coal gasification process. The long-term interaction of these injected acid gases with shale-confining layers of sandstone formations has not been well investigated. We therefore have developed a conceptual model of injection of CO_2 with H_2S and/or SO_2 into a sandstone-shale sequence, using hydrogeologic properties and mineral compositions commonly encountered in Gulf Coast sediments. We have performed numerical simulations using a 1-D radial well region considering sandstone alone and a 2-D model using a sandstone-shale sequence under acid-gas injection conditions. Results indicate that shale plays a limited role in mineral alteration and sequestration of gases within a sandstone horizon for a short time period (10,000 years in present simulations). Unlike H_2S, the co-injection of SO_2 results in different pH distribution, mineral alteration patterns, and CO_2 mineral sequestration. Simulations generate a zonal distribution of mineral alteration and formation of CO_2 and SO_2 trapping minerals that depends the pH distribution. Co-injection of SO_2 results in a larger and stronger acidic zone close to the well. Precipitation of CO_2 trapping minerals occurs in the higher pH ranges beyond the acidic zones. In contrast, SO_2 trapping minerals are stable at low pH ranges (below 5) in the front of the acidic zone. Corrosion and well abandonment caused by co-injection of SO_2 is a very significant issue. Significant CO_2 is sequestered in ankerite and dawsonite, and some in siderite. CO_2 mineral-trapping

capability can reach 76 kg per cubic meter of medium. Most of SO_2 is trapped by alunite precipitation, while some of the SO_2 is trapped by anhydrite and pyrite precipitation. Addition of the acid gases and induced mineral alteration result in changes in porosity. The limited information currently available on the mineralogy of natural high-pressure acid-gas reservoirs is generally consistent with our simulations.

Key words. CO_2 sequestration, acid gas injection, mineral trapping, numerical simulation, Sandstone-shale sequence.