Geochemical Monitoring of Fluid-rock Interaction and CO_2 Storage at the Weyburn CO_2-injection Enhanced Oil Recovery Site, Saskatchewan, Canada

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The Weyburn Field, Saskatchewan, in the Mississippian Midale Formation, is the site of a large CO_2 injection project. Primary and secondary recovery is thought to have depleted the Midale vuggy zone, leaving the marly with higher oil saturations. PanCanadian Resources began tertiary recovery by injection of CO_2 in October 2000. This presented an opportunity to study the potential for geological storage of CO_2 as established by the multidisciplinary IEA Weyburn CO_2 program of which geochemical modeling plays an important role.

Comparing pre (baseline) and post injection (monitor) samples has recognized changes in the fluid chemistry and isotope composition. The distribution of Cl, Ca, NH_3, $\delta^{13}CH_4$ and $\delta^{13}CO_2$ increase from northwest to southeast, and alkalinity, resistivity, H_2S and $\delta^{34}SO_4$ decrease. After injection of CO_2, the general patterns are similar, but pH has dropped by 0.5 units and alkalinity has doubled, consistent with calcite dissolution due to reaction with injected CO_2. Isotope data support this interpretation. Baseline samples varied from -22 to -12‰ $\delta^{13}C$ (V-PDB) for CO_2 gas. The injected CO_2 has an isotope ratio of -34.5 ‰. The monitor samples range from -18 to -13‰, requiring a heavy source of carbon for CO_2, most easily attributed to dissolution of carbonate minerals.

Addition of CO_2 causes dissolution of carbonates and production of CO_2. Geological storage of CO_2 relies on silicate minerals to buffer pH, causing CO_2 to be precipitated as calcite. Modeling of water-rock reactions suggests that clay minerals may be present and capable of acting as pH buffers, allowing injected CO_2 to be stored for geological time as carbonate minerals.