

Geochemical Monitoring of Fluid-rock Interaction and CO₂ Storage at the Weyburn CO₂-injection Enhanced Oil Recovery Site, Saskatchewan, Canada

S. Emberley*, I. Hutcheon, M. Shevalier, and K. Durocher
University of Calgary, 2500 University Drive, Calgary, AB, T2N 1N4
Emberley@geo.ucalgary.ca

and

W.D. Gunter and E.H. Perkins
Alberta Research Council, Edmonton, AB, T6N 1E4

The Weyburn Field, Saskatchewan, in the Mississippian Midale Formation, is the site of a large CO₂ 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 CO₂ in October 2000. This presented an opportunity to study the potential for geological storage of CO₂ as established by the multidisciplinary IEA Weyburn CO₂ 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, NH₃, $\delta^{13}\text{CH}_4$ and $\delta^{13}\text{CO}_2$ increase from northwest to southeast, and alkalinity, resistivity, H₂S and $\delta^{34}\text{SO}_4$ decrease. After injection of CO₂, 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 CO₂. Isotope data support this interpretation. Baseline samples varied from -22 to -12‰ $\delta^{13}\text{C}$ (V-PDB) for CO₂ gas. The injected CO₂ has an isotope ratio of -34.5 ‰. The monitor samples range from -18 to -13‰, requiring a heavy source of carbon for CO₂, most easily attributed to dissolution of carbonate minerals.

Addition of CO₂ causes dissolution of carbonates and production of CO₂. Geological storage of CO₂ relies on silicate minerals to buffer pH, causing CO₂ 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 CO₂ to be stored for geological time as carbonate minerals.