Groundwater Chemistry Changes as a Result of CO_2 Injection at the ZERT Monitoring Field Site, Bozeman, Montana

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The Zero Emissions Research and Technology (ZERT) project is an ongoing field experiment to evaluate near-surface and atmospheric monitoring techniques applicable to the subsurface storage and potential leakage of CO_2. During the 2008 and 2009 injections, approximately 300 and 200 kg/day of food-grade CO_2 were respectively injected into a perforated horizontal well situated 2-2.3 m below ground surface in a shallow, freshwater aquifer at an agricultural field at Montana State University, Bozeman, MT. As part of this multidisciplinary research project, over 100 samples of water were collected from 10 shallow observation wells (1.5 or 3.0 m deep) located 1-6 m from the injection pipe, and from four distant monitoring wells. In addition, two fluorescein tracer tests were conducted in 2009 in the 3 m deep wells to determine the groundwater flow velocity. The sediment cores obtained from three 3 m wells drilled in December 2008, show a well developed clay-rich A horizon and a carbonate-rich B horizon, overlaying a coarse sandy-gravel.

ield determinations show rapid and systematic changes in pH (7.0-5.6), alkalinity (400-1300 mg/L as HCO3) and conductance (600-1800 µS/cm) following CO_2 injection for water samples collected in 2008 from the 1.5 m wells; results obtained in 2009 show the same general trends, but changes are lower, reflecting the 33% lower CO2 injection rate. Laboratory analyses of 2008 samples show major increases in the concentrations of Ca (90-240 mg/L), Mg (25-70 mg/L), Fe (5-1200 ppb) and Mn (5-1400 ppb) following CO_2 injection. Likewise, samples from 2009 show increases in major cations, but the increases are attenuated compared to 2008 levels. Dissolution of observed carbonate minerals and desorption-ion exchange from lowered pH values following CO_2 injection are likely the processes responsible for the observed increases in the concentrations of solutes. The DOC values obtained are 5±2 mg/L, and the variations do not correlate with CO_2 injection. Purge-and-trap analysis of CO_2 samples collected from the source tank showed that the CO_2 was the source of the trace concentrations of detected BTEX (e.g. benzene from 0 to 0.8 ppb in 2008). Results of the tracer tests indicate the lateral groundwater flow is high at ~2 m/day. Upcoming sequential extractions on core sediments will investigate the sources of metals observed in the groundwater as a result of CO_2 injection.