

Potential Impacts of Carbon Sequestration on Freshwater Aquifers: Adding Pieces to the Puzzle

Assaf Wunsch¹, Alexis K. Navarre-Sitchler, John E. McCray
Hydrological Science and Engineering Program, Colorado School of Mines, Golden, CO

Abstract. Injection of large amounts of carbon dioxide into deep saline formations – often referred to as geological carbon capture and storage (GCCS) - has been proposed as a climate change mitigation option (a “wedge” contributing to reduction of atmospheric CO₂ concentrations; Pacala and Socolow, 2004). Injection of large amounts of CO₂ into the subsurface will result in pressure increases, which may result in displacement and leakage of native brine and leakage of carbon dioxide from the intended repository. Where leaking fluids migrate and interact with shallow freshwater aquifers, the water quality of the aquifers may be degraded. The effects of brine leakage and CO₂ leakage on water quality are quite different. Risk assessment of water quality impact is comprised of many aspects, including probability of leakage (Lindeberg 1997), probability of exposure (Siirila et al., 2010), intrinsic aquifer properties (Wang and Jaffe, 2004), etc. Two missing water-quality pieces of the risk-assessment puzzle are addressed in this work: expected brine composition (analysis of the NETL brine database) and effect of CO₂ leakage on carbonate aquifers (laboratory experiments of natural rocks exposed to various partial-pressures of CO₂). The expected brine composition and the overall concentration distribution of brine constituents are compared to EPA drinking water standards, as well as salt tolerances of different crops. It is found that at a brine/freshwater ratio of 0.004 the EPA secondary standard for total dissolved solids in drinking water is surpassed, whereas at a brine/freshwater ratio of 0.006 the most salt-sensitive crops exhibit some yield reduction. The laboratory experiments show that the acidity-buffering capacity of carbonate aquifers does not prevent the release of minor and trace metals from aquifer material into water. The temporal release trend of these metals is discussed in context of solid-solution theory, desorption and pure-phase equilibrium controls.

¹ Environmental Science and Engineering Division
1500 Illinois St.
Golden, Colorado 80401
P: 720-290-5133, F: 303-273-3413
Email: awunsch@mines.edu