Sensitivity of groundwater systems to CO_2: Application of a site-specific analysis of carbonate monitoring parameters at the SACROC CO_2-enhanced oil field

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Abstract

A field study and geochemical modeling of a shallow aquifer, situated above a long-running (>35 years), large-scale (~250 km2) CO_2-enhanced oil recovery site (SACROC oil field), were conducted to determine how the aquifer might react to input of injectate CO_2. Because calcite dissolution is widely accepted as the process that will result from CO_2 input into an aquifer, our assessment focused on carbonate-specific geochemical parameters (e.g., DIC, pH, Ca^{2+}, and HCO^{3-}). After a careful characterization of the geochemical system of the Dockum aquifer above SACROC, a hypothetical leak of CO_2 was modeled into the system. Our analysis indicates that dedolomitization (dolomite dissolution with concurrent calcite precipitation) is the dominant native geochemical process and calcite dissolution cannot be assumed to result from CO_2 input. Dedolomitization, which is widely documented and common in many hydrologic systems, is driven in the Dockum above SACROC by both natural hydrologic and human-induced mechanisms. A sensitivity analysis under simulated CO_2 input for systems undergoing dedolomitization or calcite dissolution shows that both systems are relatively sensitive to CO_2. Whereas the magnitude and direction of geochemical shift in pH, Ca^{2+}, and HCO^{3-} depend on site-specific environmental factors, the shift in DIC is relatively similar in any of the modeled environments. The implication for monitoring geologic sequestration sites is that use of current monitoring parameters may require characterization of fundamental site-specific conditions for correct prediction of the consequences of CO_2 input; however characterization may not be necessary if DIC is used as the primary monitoring parameter.