Brine flow up a well caused by pressure perturbation from geologic carbon sequestration: Static and dynamic evaluations

GCCC Publication Series #2011-02

J.T. Birkholzer

J.P. Nicot

C.M. Oldenburg

Q. Zhou

S. Kraemer

K. Bandilla

Keywords: structural, monitoring

Cited as:

Birkholzer, J.T., J.P. Nicot, C.M. Oldenburg, Q. Zhou, S. Kraemer, and K. Bandilla, 2011, Brine flow up a well caused by pressure perturbation from geologic carbon sequestration: Static and dynamic evaluations, GCCC Publication Series #2011-02, originally published in *International Journal of Greenhouse Gas Control*

Abstract

Industrial-scale storage of CO_2 in saline sedimentary basins will cause zones of elevated pressure, larger than the CO_2 plume itself. If permeable conduits (e.g., leaking wells) exist between the injection reservoir and overlying shallow aquifers, brine could be pushed upwards along these conduits and mix with groundwater resources. This paper discusses the potential for such brine leakage to occur in temperature- and salinity-stratified systems. Using static mass-balance calculations as well as dynamic well flow simulations, we evaluate the minimum reservoir pressure that would generate continuous migration of brine up a leaking wellbore into a freshwater aquifer. Since the brine invading the well is denser than the initial fluid in the wellbore, continuous flow only occurs if the pressure perturbation in the reservoir is large enough to overcome the increased fluid column weight after full invasion of brine into the well. If the threshold pressure is exceeded, brine flow rates are dependent on various hydraulic (and other) properties, in particular the effective permeability of the wellbore and the magnitude of pressure increase. If brine flow occurs outside of the well casing, e.g., in a permeable fracture zone between the well cement and the formation, the fluid/solute transfer between the migrating fluid and the surrounding rock units can strongly retard brine flow. At the same time, the threshold pressure for continuous flow to occur decreases compared to a case with no fluid/solute transfer.