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Characterization of CO_2 leakage into the freshwater body

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Current research into Carbon dioxide Capture and Storage (CCS) is dominated by improving the CO_2 storage capacity. However, potential leakage of CO_2 can cause environmental problems, particularly if freshwater resources are nearby. In this regards, it is important to understand the chemistry of CO_2 and the water system. CO_2 leakage across the fluid interface (CO_2 and water) is controlled by the difference in the partial pressure of CO_2 in the storage and in the freshwater body. Once the CO_2 is in solution, it equilibrates with the bicarbonate and carbonate ions. According to Millero (1994)such a system can be characterized by two parameters out of the four: total alkalinity (TA), total carbonate (TCO_2), fugacity of CO_2(fCO_2) and pH.

In the present modeling study, we are interested in the (i) CO_2 leakage into a freshwater body (while injecting CO_2 for storage) through an inclined fracture and (ii) characterization of the system by measuring fugacity of CO_2 and pH. According to work presented by Singh et al. (2012), about 31% of injected CO_2 leaks into the freshwater body. Solubility of CO_2 in water follows Henry's law, while the Henry constant, K0 is calculated by an empirical relation developed by Murray and Riley (1971), which is a function of salinity and temperature. According to our results, pH and fugacity both appear to be a linear function of temperature.

To simulate the discussed problem, a corresponding numerical module has been developed for multi-component fluid flow coupled with heat and mass transport processes. Governing equations and Volume Translated Peng-Robinson equations of state are implemented within the object-oriented finite element code OpenGeoSys (Kolditz et al., 2012; www.opengeosys.org). Primary variables are pressure, temperature and salinity which are obtained by solving the governing equations in a monolithic way The governing equations are discretized spatially within the context of a Galerkin approach, whereas the temporal discretization is performed using a generalized single step method.

References:

Singh AK, Böttcher N, Görke U-J, Delfs J-O, Taron J, Kolditz O; A benchmark study on compositional fluid flow. Energy Procedia, 2012, (Accepted).

Millero FJ (1995) Thermodynamics of the carbon dioxide system in the oceans, Geochimica et Cosmochimica Act 59: 661-677.

Murray CN, Riley JP (1971) The solubility of gas in distil water and sea water. Deep-sea Res. 18:533-541.

Kolditz O. et al. (2012) OpenGeoSys: an open-source initiative for numerical simulation of thermo-hydro-mechanical/chemical (THM/C) processes in porous media. Environ. Earth Sci. 67, 589-599.