Impact of geochemical kinetics at the reservoir/ shale interface on long term CO_2 storage

VICTOR N. BALASHOV[1], SUSAN L. BRANTLEY[1], GEORGE D. GUTHRIE[2], CHRISTINA L. LOPANO[2] AND J. ALEXANDRA HAKALA[2]

[1]Earth and Environmental Systems Institute, 2217 EES Building, Pennsylvania State University, University Park, PA 16802;

[2]U.S. Department of Energy, National Energy and Technology Laboratory, 626 Cochrans Mill Road, Pittsburgh, PA 15236.

Reactive diffusion calculations were run to simulate storage of supercritical CO_2 in a hypothetical reservoir at the sandstone/shale (ss/sh) interface at 348.15 K and 30 MPa. The shale functioned up to 2000 years as a low- permeable barrier (caprock), and the chemical reactions mostly occurred in the sandstone. In the second period (2000 – 4000 years), the CO_2 reactive transport begins to initiate the replacement of Mg-Fe chlorite by dolomite, ankerite and illite at the ss/sh interface. In the third period (4000 – 7500 years), this carbonation reaction in the shale led to complete closure of the porosity at the interface, sealing the reservoir and terminating further reaction. There were varied kinetic constants of feldspars and clay minerals. The reactive process in ss/sh contact is uppermost sensitive to the kinetic constants of kaolinite and illite. The increase in the kaolinite kinetic constant by 0.25, 0.5 and 1 logarithmic units resulted in auto-sealing of sandstone reservoir because of the chlorite carbonation at ss/sh contact by 4300, 650 and 107 years, respectively. The modeling output is useful in understanding the sustainability of CO_2 storage in sandstone reservoirs beneath shale caprock.