Geophysical Research Abstracts
Vol. 13, EGU2011-3283, 2011
EGU General Assembly 2011

Numerical Investigations of Geologic Storage of Carbon Dioxide in Sedimentary Rock with Faults

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Numerical Investigations of Geologic Storage of Carbon Dioxide in Sedimentary Rock with Faults

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=Abstract=
To understand the risk of leakage of CO2 from injection zones to ground surface the migration pathways along borehole wells or gas permeable faults are typically considered for most investigations. Faults also act as boundaries for CO2 plume, which divide the reservoir into independent zones. The different rock properties of the faults may cause significant impact on the distributions of CO2 during and after injections. This study employs TOUGH2 model with an ECO2N module to investigate the structural trapping and solubility trapping process during the sequestration of carbon dioxide in highly permeable sedimentary rock associated with fault formations. A synthetic two-dimensional profile domain (1000m in length and 300m in depth) was considered for the illustrative example. Hydrogeological conditions of rocks and faults, including different anisotropy ratios in permeability, different degrees of permeability heterogeneity, and dip angles of faults, are systematically compared by analyzing the patterns and magnitudes of CO2 plumes for specified injection events and simulation times. The simulation results show that the variation of permeability will propagate to the velocity variation and lead to significant variation of CO2 plumes in spatial and temporal spaces. We obtain conclusions similar to previous investigations showing that the density difference of dissolved CO2 will enhance convection between CO2-rich and aqueous phase and then accelerate carbon dioxide dissolution in local areas. The CO2 migrations under different anisotropy ratios of rock permeability show different patterns and maximal magnitudes and obtain high pressure changes near injection areas. Depending on the moving direction of a CO2 plume, the dip angle of a fault plays an important role in controlling the leakage of CO2 from rock formations. The CO2 leakage time-scale for different dip angles can vary from few years to tens of years depending on the depth and permeability of rock formations.

Keywords: geologic storage, carbon dioxide, CO2, heterogeneity, anisotropy, fault