Geophysical Research Abstracts, Vol. 9, 11124, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-11124

Reactive Modelling of Chemical Retention and Caprock Seal Capacity for CO_2 Storage in Aquifers

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The results of a numerical study conducted to investigate the effects of chemical interactions on the retention and caprock sealing capacity for CO_2 aquifer storage is presented. TOUGHREACT which is applicable to a variety of reactive fluid and geochemical transport systems is used as the numerical tool. Using TOUGHREACT, transport of any number of aqueous and gaseous species by advection and molecular diffusion is considered in both liquid and gas phases. Mineral dissolution and precipitation can proceed either subject to total equilibrium or kinetic constants and their effect on porosity and permeability is taken into account.

A 2D aquifer section model was created using typical petrophysical properties for a sandstone reservoir with cartesian grid geometry with finer vertical and horizontal discretisation for the zones of interest. As a conservative scenario, the overlying caprock of 450 m is designed so that it is cut with a fault. Two different lithology, first one quartz rich and the second one clay rich are entered to model the aquifer rock and caprock mineralogy successively. The initialisation is performed due to expected geothermal and hydrostatic gradients. The CO_2 injection is modelled by a given source term in aquifer blocks.

The modelling results of long term dissolution and precipitation behaviour are evaluated in terms of mineral trapping as well as the fault induced leakage from the caprock. The reactive products of the equilibrium and/or kinetic controlled reactions are evaluated as CO_2 sequestration capacity. The possible self sealing is investigated focusing on the fault conductivity based on various runs. The aim is to contribute on the sensitivity of the rocks when exposed to the fluids and to evaluate the chemical integrity of the caprocks.