Geophysical Research Abstracts
Vol. 17, EGU2015-2725, 2015
EGU General Assembly 2015

Parameter sensitivity analysis on potential fault reactivation induced by CO_2 injection in a multi-layer storage formation

Bruno Figueiredo (1), Chin-Fu Tsang (2), Jonny Rutqvist (2), Jac Bensabat (3), and Auli Niemi (1)

(1) Uppsala University, Sweden (bruno.figueiredo@geo.uu.se), (2) Lawrence Berkeley National Laboratory, California, USA, (3) Environmental and Water Resources Engineering Ltd, Haifa, Israel

Fault instability is studied in the context of the Heletz site which was chosen as a test site for scientific CO_2 injection experiment in the framework of the EU-MUSTANG project. The potential reservoir for CO_2 storage consists of three sandstone layers, separated by low-permeability shale layers of various thicknesses, and overlaid by a five-meter limestone and a thick impermeable shale as a caprock. A hydro-mechanical model has been developed to study the interaction between mechanical deformation and fluid flow in the storage formation bounded by two sub-vertical normal faults on either side during CO_2 injection and storage. The impact caused by the pore pressure build-up on the fault reactivation, the fault slip displacement, and potential CO_2 leakage through the caprock, is analyzed. Five key parameters have been identified for the hydro-mechanical model: the fault dip angle, the stress field, the offset of the layers across the faults, the fault initial permeability and the permeability of the confinement formations. A sensitivity analysis on these parameters has been conducted. It was found that results are not very sensitive to the fault dip angle. It was also found that the two faults are mechanically reactivated when (1) the ratio between the horizontal and vertical stresses is equal or smaller than 0.6, (2) the permeability of the confinement formations is smaller than 10-18 m2 and (3) the fault initial permeability is 10-18 m2. However, the impact is not significant. In the first case, the pore pressure build-up close to the faults is not enough to induce significant shear plastic strains and displacement along the faults. Results obtained in cases (2) and (3) showed that even when the total pore pressure at the storage layers is two and three times (respectively) the initial pore pressure, the maximum fault slip displacement is 1.5 cm and the maximum fault permeability is approximately only two times the initial permeability. No significant CO_2 leakage through the caprock was observed in any of the cases analyzed. The offset of the layers across the faults is identified to be an important site parameter, mainly because it limits the lateral extension of the plume and hence leads to an increase in CO_2 leakage through the caprock.