Modeling of fracture-permeability of soft rocks for CCUS technologies

*Takashi Fujii[1], Xinglin Lei[1]

1. National Institute of Advanced Industrial Science and Technology

There now are various types of caprocks associated with CO_2 capture, utilization and storage (CCUS) technologies across the globe. Such caprocks may have generally a potential of rock deformation induced by change in effective pressure with injecting CO_2 into reservoir rocks, and an understanding of a relationship between fluid flow transport and geomechanical responses play a significant role for the development of CO_2 geological storage safety. To date, many previous studies on the investigation of permeability changes during brittle and ductile deformation have been reported under various triaxial stress conditions for a wide variation of rock types, including argillaceous sediments and rocks (e.g. clay, mudstone, and shale), sandstone, crystalline rocks (e.g., granite, marble) and halite. But most results did not take into account change in hydraulic properties in response with fracturing in the post-failure regime. To model precisely the process of fluid flow transport within such reservoirs, relationship between fluid transport and geomechanical response in the whole regime pre- and post-fracturing of deformation including shear-fracturing and post slipping should be well addressed.

The purpose of this study is to examine experimentally permeability changes in low-permeable rocks during deformation, shear-fracturing, and post-failure slipping depending on changes in effective pressures, which assumes that permeability changes in fracturing rocks in the course of CO_2 injection under conditions of geological storage of CO_2.

Our results demonstrated that the obtained stress-strain curves showed different trends on each types of low-permeable rocks tested, and particularly, harder mudstones (e.g. shale, slate) had a significantly more slowly change in permeability compared to softening mudstone, as effective pressure decreases. In terms of modeling of fracture permeability, in pre-failure regime, the obtained fitting curves based on permeability change as a function of volumetric strain showed a harmony with previous literature data related to dilatancy. Whereas, our predicted model in post-failure regime could not be explained fully by a conventional model of fracturing permeability including normal stress, and fracture aperture.

Keywords: soft rocks, fracture permeability, modeling

