Experimental study on the effect of changes in pore water pH on friction coefficient of rock

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It is necessary to evaluate the reactivation of pre-existing faults caused by the reduction of effective stress due to the injection of CO_2. Fault reactivate would induce the forming of new damage zones in a direction parallel to the fault plane, therefore, the reactivation of the pre-existing fault increases the risk of forming new water pathways towards the ground. From this kind of circumstance, a lot of studies have been conducted on the mechanism of fault reactivation (e.g., Pluymakers et al., 2014; Tenthorey et al., 2018), especially on the frictional properties at the fault plane (e. g., Noda & Shimamoto, 2010; Giorgetti et al., 2015). However, many of these experiments use water as pore water, and few studies have discussed the effects of pore water quality such as pH. In this study, the friction test was carried out to evaluate the frictional properties of carbonate rock and how the dissolution of calcite affects the friction coefficient when using low pH aqueous solution as pore water.
The experiment was carried out using a shear testing equipment, and the friction coefficient of a solid sample of limestone and a powder sample (ϕ 125 μm or less) simulating gouge were measured. The experimental conditions were dry and wet (pure water, pH=1-6). As a result, the solid-solid friction coefficient was 0.1 to 0.3 for a dry state, 0.6 to 0.7 for a wet state, and 0.4 for pH = 0.8. When the sample surface after the experiment with low pH water was observed by means of the scanning electron microscope, it was confirmed that the surface irregularities became smooth. The powder-powder friction coefficient was 0.58 to 0.60 for a dry state, 0.50 to 0.60 for a wet state. In experiments with the pH controlled solution, a slight change was observed in the coefficient of friction. However, the solution could not reach the inside of the sample, and the effect of pH on the coefficient of friction was considered to be limited. At least in solid samples, the friction coefficient of limestone could depend on the pH. It can be said that pore water quality is related to the reduction of friction coefficient associated with a chemical reaction. In the future, in order to obtain more accurate friction coefficient, the experimental method using the pH controlled solution will need to be further improved.

Keywords: coefficient of friction, pore water, fault reactivation

