Geophysical Research Abstracts
Vol. 15, EGU2013-595-1, 2013
EGU General Assembly 2013

Shear induced transport property in impermeable fault rocks and its effect on the mechanical property

Wataru Tanikawa (1), Osamu Tadai (2), Hideki Mukoyoshi (2), and Takehiro Hirose (1)

(1) Japan Agency for Marine-Earth Science and Technology, 1. Kochi Institute for Core Sample Research, Nankoku, Japan (tanikawa@jamstec.go.jp, 81-88 878 2192), (2) Marine Works Japan Ltd., Nankoku, Japan

Transport property in fault zone will change by shear deformation during and after earthquakes, and the change in transport property may lead to the fault strength transition as well. Previous study by Tanikawa et al. (2012) revealed that, for permeable rocks, shear induced permeability in medium to high slip velocity is mainly controlled by the fluid viscosity that changes due to frictional heating. However, impermeable fault rocks may show different evolution process for the fluid transport property compared to permeable fault rock. In this study, rock-to-rock friction tests was conducted on granite samples to see a shear induced transport property in impermeable fault rocks.

We measured flow rate during and after friction test using a rotary shear apparatus. Two 20-mm-long hollow cylindrical specimens (outer and inner diameters of 25 and 9.5 mm, respectively) of low permeable Aji Granite (permeability of 10^{-19} m^2) were used in all tests. One cylindrical specimen was fixed and the other rotated under a fixed axial stress of 2 MPa. We applied the total slip displacements of 1.5 and 3 m at various constant slip rates from 0.076 to 150 mm/s. To measure shear-induced fluid transport property, radial flow from the inner wall to the outer wall of the specimen was induced by applying a differential pore pressure between the inner and outer walls. Nitrogen gas was used as a pore fluid.

Friction coefficient typically decreased from 0.9 to 0.5 with an increase of slip velocity. At the same slip rate, friction coefficient increased with an increase in apparent permeability of specimen. Apparent permeability during and after friction test were over one order of magnitude larger than that of intact granite. At slower slip rate below 0.01 m/s, permeability decreased soon after sliding ceased, though at high slip rate, permeability increased after sliding. By comparing initial permeability and permeability after 10 minutes of friction tests, results show a reduction in permeability that occurred when initial permeability is high. In contrast, permeability increases with sliding when initial permeability is low. This transition transport property is (intrinsic) transmissivity of $\sim 2*10^{-21}$ m^3 that is equivalent to fracture aperture of ~ 0.3 μm assuming that threshold aperture is equivalent to hydraulic aperture evaluated by cubic law. We assume that the permeability change during sliding is caused by the production of gouge and smoothing of slip surface that changes aperture size and real contact area of specimens. The change of surface property resulted in change of friction property as well. The reduction of permeability immediately after sliding is probably caused by the thermo-elastic effect on aperture due to frictional heating.