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Permeability evolution by high velocity friction using core samples from IODP Expedition 316 (NantroSEIZE)

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Understanding dynamic change in permeability at fault zone by rapid shear deformation is important not only for the dynamic hydrological and hydro-geochemical processes that occur during earthquakes at shallow levels but also for the dynamic fault process at deep crustal levels. Permeability of fault zone can be changed by the formation of the wear materials, frictional heating and chemical reactions under high velocity friction during large earthquakes. Therefore, in our study, we measured permeability after high velocity friction test (1 m/s of slip velocity) using core samples from IODP Expedition 316.
We performed constant-velocity friction tests by using the rotary shear testing apparatus in the Kochi Core Center. The powdered core sample was placed between a pair of solid-cylindrical rock specimens (porosity = 10 %, permeability at 3MPa of effective pressure = $6*10^{-17}m^2$) 25 mm in diameter. The weight of the core sample used for a run was about 1 g. Permeability was measured by steady state flow method with distilled water as the pore fluid. Core sample from Decollement (site C0007, mbsf=437m) was sheared at 1MPa of normal stress with 38 m of total displacement, and permeability after high velocity friction test showed $4*10^{-18}m^2$, which was about one order of magnitude lower than that before test ($4*10^{-17}m^2$). The reduction of permeability after high velocity friction is probably caused by the shear compaction and grain size reduction in the gouge zone. If the shear-induced permeability reduction is effectively occurred during larger earthquake, much sudden and larger pore pressure increase is expected within fault zone by thermal pressurization process.

Keywords: permeability, friction coefficient, Nankai Trough, thermal pressurization, NantroSEIZE, decollement