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Permeability measurements of mudstone in the Mugi melange

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Determination of the hydrogeologic properties of active accretionary prism fault zones is critical for understanding relationship between fluid flow and deformation. It has been hypothesized that near-lithostatic fluid pressures along the decollement zone enable the decoupling of overlying accreted sediments from underlying subducting sediments. Furthermore, thermal and geochemical evidence suggests that accretionary prism fault zones provide high permeability pathways for fluid, heat, and geochemical migration (Moore and Vrolijk, 1992). Previous studies demonstrated that the decollement zone was much more permeable than other srounding rocks so the decollement zones played an important role in fluid pathways in the accretionary complex. However these measurements were conducted at shallow level of the subduction zone. Therefore it is necessary to measure the permeability of the samples that had subducted to the depth, in order to reveal the synthetic fluid role in the accretionary complex. Therefore, we measured permeability of nearly intact mudstones, which is major components of Mugi melange in the direction of parallel and normal to their foliation, and elucidate the relationship between the melange deformation stages and fluid flow.

The mudstone sampled at Mugi melange contains quartz, feldspar, chlorite, and illite, based on the XRD analysis. Cylindrical test specimens (length = 15 mm, diameter = 20 mm) were cored from the sampled block, to an accuracy of within 0.01 mm. The porosity of the sample ranges from 1 % to 2%. The mudstone in the Mugi melange has two preferred orientations such as foliation parallel and foliation normal. A transient pulse method was used to measure the permeability up to 10-21 m2 orders in these two preferred orientations. Permeability of mudstones has been measured under confining pressure up to 140 MPa, and pore water pressure up to 115 MPa in a triaxial pressure apparatus at the Earthquake Research Institutive, University of Tokyo.

Every specimen shows similar tendency that permeability decreases with increase in effective confining pressure and ascends as effective confining pressure reduces. However, the permeability never returned to the initial value after the unloading due to inelasticity of the sample. The permeability at room temperatures ranges from 10^(-17) to 10^(-18) m^2 at effective confining pressure of 25 MPa, and from 10^(-19) to 10^(-21) m^2 at effective confining pressure of 125 MPa. The dependence of permeability on temperature was investigated at temperature of 200 C and effective confining pressure of 25 MPa. The permeability at 200 C slightly reduces with increase in hold time, and finally converges into the almost constant value. By comparison with the distributions of the veins in Mugi melange, it seems that the region with abundant veins has lower permeability than where there are few veins. This result suggests that, in the lower permeability zone, fluid migration surpassed fluid expulsion and effective confining pressure decreased as pore pressure increased, which induced rocks to rupture and then veins would precipitate.