Effect of confining pressure on fracture permeability in granitic mylonite and pelitic schist

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We measured the gas permeabilities of the samples with artificial single fracture of mylonite derived from tonalite and pelitic schist with gas-medium tri-axial deformation apparatus. When we calculated the aperture of fractures from measured permeability with the cubic law, it is found that the aperture reduction with Pc increasing can be approximated to be in proportion to the n-th power of effective pressure Pe (=Pc-Pp), where the exponent n is negative and depends on samples. For both cases of mylonite and pelitic schist, n of #3000 is larger than that of #6000, and that of pelitic schist is larger than that of mylonite. This may show that the small aperture deforms more than the large one, and the aperture of mylonite deforms less than that of pelitic schist as Pe increasing.

It is important for discussing the whole crust fluid flow to study the permeability of fractures. In this study, we measured the gas permeability of fracture in mylonite derived from tonalite and pelitic schist under confining pressure with high-pressure apparatus.

Fractures effect drastically on the fluid flow in the Earth's crust. Especially, fracture permeability relates strongly to estimation of the flow in the deeper part of the crust, which may consist mainly of low porosity rocks and fractures form significant pathway for fluid migration for such rocks. For discussing the whole fluid flow in the crust, it is necessary not only to investigate how fractures distribute but also to study the permeability of a single fracture under various condition (ex. depth). In this study, for the purpose to investigate the dependency of fracture permeability of low porosity rocks on confining pressure, we measured the gas permeabilities of the samples with artificial single fracture of mylonite derived from tonalite and pelitic schist with gas-medium tri-axial deformation apparatus.

We collected mylonite and pelitic schist for the samples from Ryoke and Sambagawa metamorphic belts along MTL at Ohshika-mura, Nagano prefecture, central Japan. The Samples were cored by laboratory coring machine using a 20mm diamond cores nearly parallel to the slip direction of the MTL and were shaped into cylinder. We cut the samples nearly parallel to the coring direction and to foliation of rocks and the cut surfaces were polished with Carborundum to the roughness of #3000 or 6000. With the pore pressure Pp fixed at 20MPa, the confining pressure Pc was incrementally increased from 30MPa to 200MPa. Measurements were made by with nitrogen as a pore fluid at room temperature. Permeability was measured using the pore-pressure oscillation method.

Results of measurements showed that, for both cases of mylonite and pelitic schist, samples of which fracture surface were polished with #3000 Carborundum shows larger permeability than those polished with #6000, and samples with fracture were more permeable than those of intact rocks. When we calculated the aperture of fractures from measured permeability on the assumption that we can apply the cubic law for laminar flow of fluid through parallel planar plates in these cases, it is found that the aperture reduction with Pc increasing can be approximated to be in proportion to the n-th power of effective pressure Pe (=Pc-Pp), where the exponent n is negative and depends on samples. For both cases of mylonite and pelitic schist, n of #3000 is larger than that of #6000, and that of pelitic schist is larger than that of mylonite. This may show that the small aperture deforms more than the large one, and the aperture of mylonite deforms less than that of pelitic schist as Pe increasing.