G210-007 **Room: 101A** **Time: May 25 15:30-15:45**

Evaluation of fracture aperture and flow path by numerical modeling coupled with flow-through experiment under confining pressure

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Fluid flow through rock fractures has been extensively studied because of its significance in various engineering and scientific applications. In recent years, the discrete fracture network (DFN) modeling has enabled a fracture network to be precisely described. Contrary to the realistic description of a fracture network, each rock fractures has still described by a simple model (the parallel prate model). Since a natural rock fracture have a heterogeneous aperture structure due to its rough surfaces, the simple model has difficulty even in a prediction of fracture permeability, indicating less benefit in usage of the simple model. A development of a realistic model of a rock fracture under a wide range of geological conditions has become a fundamental issue of significance. However, first of all, relationships between aperture structures and geological conditions have not been clear, particularly with respect to relatively higher confining pressures than 10 MPa. The objectives of the present study were therefore to determine aperture structures and resulting fluid flow of rock fractures at various geological conditions including the relatively high confining pressures, and to evaluate their heterogeneous nature.

A numerical modeling on the basis of a flow-through experiment under confining pressure was used for determination of aperture structures and resulting fluid flow. Measurements of fracture surface geometries before the experiments provided numerical models of aperture structures at the room pressure, and measurements of fracture permeabilities under confining pressures enabled the models to be determined as a function of the confining pressures by matching model permeabilities with the experimental ones through numerical simulations on the normal displacement (close together) and fluid flow. Artificial granite fractures with different shear displacements of 0-10 mm (100 mm x 150 mm) were prepared, and fracture surface geometries were measured in a 0.25 mm x 0.25 mm square grid system using laser scanning equipment. Fracture permeabilites were measured under confining pressures of 10-100 MPa. Aperture structures and resulting fluid flow were determined at confining pressures of 10, 60 and 100 MPa.

The fracture peameabilitis (10^{-12}-10^{-9} m^2) were significantly greater than rock matrix permeability (10^{-19}-10^{-18} m^2), suggesting rock fractures can play significant roles in flow and material/heat transport under confining pressures exceeding 100 MPa. The aperture structures changed depending on the shear displacement and confining pressure conditions. Particularly, shear displacement caused remarkable changes in spatial correlation. The aperture distributions were characterized by lognormal distributions of non-zero local apertures (geometric means and geometric standard deviations) with percentages of zero local apertures (contact areas). The mean apertures were 0.065-0.89 mm, which were usually greater than the hydraulic apertures. The contact areas were 34-66 %, indicating areas that might contribute fluid flow (total aperture area) were 34-66 % of the total fracture area as well. The spatial correlation lengths were 2-35 mm, with 1.5-2.6 times greater values for the direction perpendicular to shear displacement. Fluid flow in the aperture structures clearly showed developments of preferential flow paths (channeling flow). Complexity and/or area of the flow paths changed with the shear displacement and confining pressure conditions. The areas of the flow paths (total flow area) were 11-37 % of the total fracture area. The total flow areas were usually smaller than the total aperture areas by a factor of 0.2-0.8, suggesting fluid flow in a fracture network may be significantly different from conventional predictions.