

Evaluation of spatial relationship between asperities and fluid flow in a fault on the basis of lab-scale experiments

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We report on an evidence of anisotropy in flow path in a single fracture on the basis of measurements of a contact area in a fracture with shear offset of up to 5 mm undergoing normal stress of up to 90 MPa. An area of contact in a fracture undergoing normal stress is measured by using a pressure-sensitive sheet inserted between fracture surfaces. This method allows simple measurements of contact area in the stressed conditions. Our results show that contact area increases with an increase in normal stress, on the contrary, contact area decreases with an increase in the offset. These dependencies in a contact area suggests that an open area, i.e., aperture area, which is illustrated as an area except for contact area in a fracture, can change associated with normal stress even under the condition of 100 MPa. In addition, we observed that contact area distributes in the direction perpendicular to the direction of offset, which indicates an anisotropy in aperture distribution that become possible flow path in a fracture. Results of numerical simulation of fluid flow in a fracture support the anisotropy in aperture distribution and consequent anisotropy in fluid flow in a fracture. The anisotropy in aperture distribution suggests an anisotropy in fracture permeability since tortuosity in a flow path could be affected by the aperture distribution.