Effect of shear displacement inclined to macroscopic water flow on fracture permeability.

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Abstract

It is very important to estimate fracture permeability for performing the underground disposal of nuclear waste and developing geothermal energy as an alternative of fossil fuel. To evaluate the permeability of a fracture system, it is necessary to know fluid flow in a single fracture connected with each other. Previous studies were mostly conducted on water flow perpendicular or parallel to the direction of shear displacement, which showed that there is remarkable anisotropy since the permeability is high when shear displacement is perpendicular while it is low when the shear displacement is parallel to macroscopic water flow. However, the direction of macroscopic water flow is not always perpendicular or parallel to the direction of the shear displacement.

The purpose of this study is to obtain a general evaluation formula for the effect of the angle between macroscopic water flow and shear direction by using synthetic fractures.

A simulation of water flow was performed by using synthetic fractures and by solving the Reynolds equation with a finite difference method to obtain a hydraulic aperture of the fractures. As a result of the analysis, I have established a formula for the relation between the fracture permeability and the angle between macroscopic water flow and shear direction, as given by

$$e_h / e_m = A - B\cos 2\theta ,$$

where e_h is hydraulic aperture, e_m is the mean aperture, θ is the angle between macroscopic water flow and shear direction and A, B are coefficient that depend on the mean aperture, fracture size and shear displacement. Thus, the permeability increases as θ increases.