Development of composite-planer fabrics and its physical aspect

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The coefficients of friction in rocks have been systematically investigated over a wide range of slip rates from 1 nm/s to 1 m/s. Although the friction coefficients of most rocks fall between 0.6 and 0.85, at high slip rates (above ca. 0.1 m/s) friction coefficients decrease between 0.1-0.4. In order to understand such fault slip behavior, seismic slip has been reproduced in laboratory experiments reproduced seismic slip and microscopic observation have been explored. However, in a wide range of slip speeds of the same rock type, the relationship among slip behavior and mineral assemblage and microstructural fabric remain poorly understood.

Here we conducted laboratory friction experiments using volcaniclastic sediments and characterized their mineralogies and microstructural fabrics before and after the experiments. The samples were sheared at a wide range of slip rates ranging from 0.0002 to 1.0 m/s. As a result, in the low slip rates where the slip weakening did not occur, broken mineral grains and the preferential orientation of elliptical grains parallel to shear planes and shear fabrics such as R1-shear planes were also observed. However, in the high slip rates where the slip weakening occurred, the Y-shear planes developed.

In order to reveal the mechanism of structural development therethically, we simulated the development of shear fabrics with slip by using the numerical model (Distinct Element Method, DEM), and investigated the relationship among the friction behavior, the force on particles, and the relative displacement in adjacent particles. As results, at high slip rates, slip weakening occurred in DEM simulation. Moreover, shear-localized line was formed in parallel with the shear formation. On the other hand, at high slip rates, it was found that the force of particles and the slip between particles were localized, and repeated stick-slip behaviors.

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