

Sliding behavior and deformation textures of simulated gouge: A review

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A core of typical fault zone consists of a narrow tabular zone of fault gouge, in which most recent shear deformation has been accommodated. There have been many experimental studies on frictional properties of simulated fault gouge in view of the importance of the possible effect of the gouge constituent materials on the sliding behavior and the strength of faults. Fault gouge has distinct features to the surrounding brittle fault rocks with respect to its grain size, deformation textures, and composition. Owing to these characteristics, a different mechanical property of a fault is expected other than that of bare host rock surfaces. Previous experimental studies of simulated gouge materials have yielded considerable information with respect to the effects of simulated fault gouge on the sliding behavior of faults. The studies so far have covered the topics as (1) process of gouge generation; (2) effect of confining pressure and temperature; (3) effect of thickness and mineralogy; and (4) nature of deformation within the gouge zone. Results of these studies have shown almost consistently that the gouge tends to stabilize the sliding motion and that the stabilizing effect is highly dependent on the gouge material. However, experimental evidence of the stabilizing effect of gouge is not definitive, since some experiments showed that slip mode of a simulated gouge changes from stable to unstable sliding within a small displacement. Among these experimental studies of simulated fault gouge, relationship between the mechanical response of the fault and the resultant deformation textures were examined. A tendency was found within a series of experiments that distributed deformation results from stable sliding and localized deformation results from stick-slip mode of sliding, however, question still remains as to whether certain deformation structures within the gouge are uniquely associated with slip behaviors of faults. Most importantly, total fault displacement was limited in these early experiments. Recent large displacement experiments demonstrated that simulated fault gouges show a large but systematic variation of friction, velocity dependence of friction, and degree of localization with displacement. Natural faults experience much larger amount of displacement than that of simulated faults. Large displacement experiments on various types of gouge materials is desired to understand mechanical properties of gouge, which can be extrapolated to natural fault. In addition to the large displacement, severe conditions such as high-velocity sliding and hydrothermal fluid should be incorporated into the future experiments, since both of these extra-conditions might effect mechanical properties of simulated fault through temperature rise and a solution-precipitation assisted healing process of granular materials.