AOGS 2005

Effects of Normal Stress on the Frictional Properties of Rocks During Frictional Melting

AKITO TSUTSUMI
Division of Earth and Planetary Sciences, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan

Understanding the frictional properties of faults over wide slip rates are essential for revealing the mechanical processes involved in the earthquake cycle. Recent friction experiments at high slip rates to about 2 m/sec have shown that frictional properties of rocks at high slip rates change dramatically due to the initiation of frictional melting. For example, shear strength of the rock specimen increased rapidly upon the onset of melting and the level of steady state friction during frictional melting decreased markedly with increasing slip rate (velocity weakening) [1]. These previous experiments have revealed important aspects of high velocity friction. However, mechanical data of high-velocity friction at higher normal stresses are quite limited in these previous studies. In this study, we performed a series of frictional melting experiments on gabbro at normal stresses to 6.5MPa to investigate the effects of normal stress on the frictional properties of rocks during frictional melting. In the experiments, we slid specimens at a constant normal stress firstly and the normal stress was changed when steady state of the melting has attained, while the slip rate was maintained at a constant rate during a run. Experimental results revealed that frictional behavior changes at a critical normal stress toward higher normal stress conditions. Within low normal stress range, shear strength of the fault increases only slightly with the increase of normal stress. In the higher normal stress range, however, shear strength becomes obviously dependent on the applied normal stress. In the case of the result at a constant slip rate of 1.24 m/s, for example, this change of the frictional behavior appears at about 2.5MPa. At low normal stresses, sliding surfaces of steady state are separated by a molten layer and the shear strength is determined by the viscosity and the strain rate of the molten layer [2]. As normal stress increases, it is expected that the sliding surfaces comes closer and solid-solid contacts between the two surfaces appears to contribute to the bulk shear strength level. Observation of the texture of the fault tested at high normal stress under the microscope gives evidences of the contacting surfaces.

References

[1] A. Tsutsumi and T. Shimamoto, *Geophy. Res. Lett.* **24**, 699-702 (1997).
[2] T. Hirose and T. Shimamoto, *J. Struct. Geol.* **25**, 1569-1574 (2003)