[JJ] Evening Poster | S (Solid Earth Sciences) | S-CG Complex & General

[S-CG63]Rheology, fracture and friction in Earth and planetary sciences

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The aim of this session is to join people from various research area in the earth and planetary sciences and to stimulate discussion beyond the boundaries of each research area. Our goal is to deepen our understanding of dynamics in geosciences by looking over whole areas in the earth and planetary sciences from the viewpoint of PHYSICS OF DEFORMATION, FLOW, AND FRACTURE. We welcome any field (e.g., earthquake, volcano, earth surface, crust, mantle and the core, and other planets and satellites) and any approach (e.g., laboratory experiments, numerical simulations, field observations, and theories).

[SCG63-P04]Dependence of the Parameters of RSF Law on Slip Velocity under Low to High Slip Velocity Conditions

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1. Introduction

Rate- and state-dependent friction constitutive law (RSF law) has contributed to earthquake cycle simulations because it can describe several characteristic frictional behaviors, such as slip weakening and frictional healing. This law was originally proposed to explain the results of friction experiments at low slip velocities (<mm/s), and it has not been clarified whether RSF law can describe the frictional weakening behaviors observed at intermediate to high slip velocities: gradual weakening at intermediate slip velocities, and sudden weakening at high slip velocities.

RSF law consists of three parameters, a , b , and L . The values of these parameters are frequently treated as constant, but they are dependent on the condition of the friction experiment, and several previous studies has reported these values from their friction experiments at low slip velocities as a and b are in the order of 10^{-3}-10^{-2} and L is in the order of micrometer, respectively. However, these values of the parameters of RSF law cannot explain the frictional weakening behaviors observed at intermediate to high slip velocities. Therefore, to discuss the applicability of RSF law to the frictional behaviors at intermediate to high slip velocities, it is required to conduct friction experiments at intermediate to high slip velocities practically, and to estimate the values of the parameters of RSF law from the resultant data.

In this presentation, we report the results of the friction experiments and the parameter estimation. Note that the slip velocity condition of the friction experiments in this study is "low" to high.

2. Method

The friction experiments in this study were carried out using a rotary-shear, intermediate- to high-velocity friction testing machine in Kyoto University at a normal stress of 1.5 MPa under room temperature and room humidity conditions. As specimen, we used a pair of hollow cylindrical gabbro collected from Zimbabwe with an inner/outer diameter of 26/40 mm. The slip velocities were from 88.1 µm/s to 881 mm/s, and we conducted two types of experiments at these slip velocities: slip velocity step experiments, and constant slip velocity experiments. Finally, the values of the parameters of RSF law were estimated from the results of these experiments using Levenberg-Marquardt method.

3. Results

3.1 Constant Slip Velocity Experiments

The values of the steady-state friction coefficient are nearly constant at slip velocities lower than ~200 mm/s, whereas those decrease dramatically with increasing the slip velocity at higher than ~200 mm/s. This slip velocity weakening can be fitted with the description of flash heating proposed by Rice [2006]. Therefore, this result implies that flash heating occurred at slip velocities higher than ~200 mm/s in these experiments.

3.2 Slip Velocity Step Experiments

The dependence of the values of the parameters of RSF law estimated from these experiments on slip velocity is following; (1) the values of a are lower than 0.05 and are nearly constant, (2) the values of b are lower than 0.5, and they are nearly constant at lower than 0.1-1 mm/s and suddenly increase at higher than this slip velocity, and (3) the values of L are lower than 0.3 meter and linearly increase with increasing slip velocity.

Considering the difference in threshold slip velocity between b and steady-state value of the friction coefficient, both values are quite different; the former is 0.1-1 mm/s, and the latter is ~200 mm/s. This difference implies that the change in parameter b is not attributed to flash heating.

About the dependence of L , it has been reported that the values of L estimated from laboratorial friction experiments are quite different from those from natural faults analysis. A scaling law has ever been used to explain this difference, but a linear dependence of the values of L on slip velocity observed in this study is a completely different description. This dependence of parameter L can contribute to interpreting the frictional property of a fault from a different point of view.