Intermediate-velocity friction experiments on shallow sediments from Nankai Trough IODP Expedition 316

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INTRODUCTION

From the experimental studies to investigate the behavior of faults, slip rate- and state-dependent constitutive laws were proposed. The laws empirically explain the laboratory derived friction data especially for the low slip velocity (less than 0.1 mm/s) experiments (for example Dietrich, 1979). The constitutive laws enabled us to simulate the behavior of faults with parameters **a**, **b** and **Dc**. It is important to evaluate these constitutive parameters for fault materials experimentally in order to understand the behavior of faults from different geological settings. In this study, intermediate-velocity friction experiments were performed on shallow sediments from Nankai Trough IODP Expedition 316, and the fault constitutive parameters of the material as sheared gouge were estimated through velocity-step tests.

METHOD

The shear deformation experiments were performed on discrete core samples from NanTroSEIZE drilling sites C0006 (Exp.316), at normal stresses of 5 MPa and at slip rates from 0.003 to 30 mm/s, with a rotary-shear, intermediate- to high-velocity friction apparatus at Kyoto University. The maximum shear displacement was around 1.5 m. To be used in the experiments, collected discrete samples were disaggregated, oven dried at 90 degrees C for 24 hours and then sieved to eliminate clasts larger than about 100 micron. The experimental fault was composed of thin layer (less than 1 mm) of the disaggregated materials, which was put between a pair of 24.85 mm diameter granite cylinders. A Teflon ring surrounded the fault in order to avoid a leak of the sheared material during the experiment. To estimate the parameters, data was fitted with the least-square method. After the shear tests, microstructural observation of the deformed samples was performed.

RESULTS

Our preliminary results show that the constitutive parameter **a** increases with the slip velocity and that the dependence of the friction on the slip rate could be depending on such parameter as the slip rate and the accumulated amount of slip. Though sample tested in this study (C0006E-25X-2W) exhibits mostly a weak velocity weakening behavior to a step change in loading velocity from 0.003 to 0.3 mm/s or for smaller accumulated amount of slip, it exhibits a larger velocity weakening behavior to a step increase in velocity from 0.3 to 3 mm/s. It seems that the constitutive parameter **a-b** decreases with the displacement. Microstructural observation of the deformed samples shows that localized shear zone characterized by a reduction of the grain size is developed during the shear. The thickness of the localized shear zone appears to increase with the displacement with a rate of about 0.02mm growth for 1m displacement. The decrease in constitutive parameter **a-b** with the increase in the slip rate and in the displacement could be probably related with shear localization process, which could affect the mode of sliding of faults within a shallow portion of the Nankai subduction zone.