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Frictional properties of sediments on the Cocos Plate collected during the IODP Exp334, CRISP

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Knowledge of the frictional properties of input sediments to subduction zones is fundamental in modeling of the subduction-related faulting processes. However, experimental studies on frictional properties of diverse composition of the input sediments are still limited. On the Cocos plate, which subducts at Middle America Trench offshore Costa Rica, clay, silty clay, and biogenic sediments such as silicic to calcareous ooze are deposited on basalt. They have some tephra layers. In this study, frictional properties of the sediments collected at a reference site of offshore Costa Rica (Site U1381) during the IODP expedition 334 were examined.

The sediments were observed under the microscope and analyzed with X-ray diffraction. The tested samples can be divided into three groups: clastic material, volcanic glasses and biogenic sediments. Frictional experiments were performed at steady slip velocity (v = 0.28 mm/s) to study the shear strength of them, and under a velocity-stepping condition to study the friction velocity dependence of the samples. Experimental results reveal that the shear strength is similar for all the samples at the initiation of the slip. However, the friction values of the silty clastic material reduce to ˜0.2 at the steady state, while those of the volcanic glasses and the biogenic sediments are high at 0.6˜0.8. These results suggest that shear zones are likely to be formed in the uppermost silty clay sediments. The silty clay material shows velocity-strengthening at $0.0028 < v < 2.8$ mm/s. In contrast, the volcanic glasses and the biogenic sediments show velocity-weakening at $0.0028 < v < 0.28$ mm/s and velocity-strengthening at $0.28 < v < 2.8$ mm/s. Stable slip would occur in the silty clay unit. On the contrary, the velocity weakening behavior at slow velocities could provide a condition to initiate unstable fault motion at shallow depths along the fault channel.

Keywords: subdaction zone, frictional experiment, CRISP