Frictional behavior of the CDZ gouge at seismic slip rates
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The lack of a heat flow anomaly and the large angle between the San Andreas Fault and the maximum principal compressive stress orientation has led scientists to conclude that the fault system is weak. However, the strength of the fault and the weakening mechanisms are still debated. Recent friction experiments on fault gouge recovered from the Central Deforming Zone (CDZ) at SAFOD show small friction coefficients (0.14-0.2) and velocity-strengthening behavior at low slip rates (0.01-300 micron/s) [Carpenter et al., 2010, 2011; Lockner et al., 2011; Coble, 2010]. Although these findings are consistent with observations of active creep and a weak San Andreas Fault, the frictional behavior of the fault gouge at seismic slip rates and the possibility of seismic slip along the actively creeping segment have not been studied experimentally.

In order to characterize the frictional behavior of CDZ fault rocks at seismic slip rates, we conducted friction tests on SAFOD core samples at slip velocities of 0.1-1.3 m/s and normal stresses of 0.3-1.5 MPa. Flaked fault gouge from the CDZ and disaggregated samples of four distinct fault rocks from the 3067 m MD subsidiary fault were deformed in a high-speed rotary-shear apparatus at Japan Agency for Marine-Earth Science and Technology (JAMSTEC) Kochi Core Center (KCC). Samples were sheared between host blocks of gabbro under both room-humidity (dry) conditions and water-dampened conditions. The 3067 m fault samples sheared at 1.3 m/s have peak friction coefficients of 0.5-0.6, which decrease to steady state values of 0.05-0.12 after approximately 10 m of slip. The frictional behavior is similar to that of Punchbowl fault ultracataclasite reported by Kitajima et al. [2010]. On the contrary, the CDZ samples shows peak friction coefficients of approximately 0.3 and steady-state friction coefficients of 0.29 (0.1 m/s), 0.2 (0.35 m/s), and less than 0.02 (0.7 and 1.3 m/s). The friction coefficients of the CDZ at both low and high slip-rates are small relative to the other fault-rocks sampled at SAFOD. The low coefficients of friction for the actively creeping CDZ are consistent with the lack of a heat flow anomaly near the San Andreas Fault. The low peak friction coefficient at the onset of rapid slip implies a small mechanical barrier to dynamic rupture propagation along the creeping segment. Although the CDZ currently is creeping, the high-speed friction results suggest that seismic slip in this material also is possible.