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High-velocity weakening of the black fine-grained fault rock from the Ghost Rocks Formation, Kodiak Island, Alaska

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In Kodiak Island, Alaska, an accretionary complex that has been interpreted as an analogue of paleo-decollement zones exposes (Fisher and Byrne, 1987). Recently, dark gray to black, locally vitreous, ultra-fine grained fault rock (black fault rock, BFR) was reported from the fault zones in the Kodiak accretionary comlex (Ghost Rocks Formation), as a possible rare example of rocks that preserved a record of seismogenic faulting along subduction zones (Rowe et al., 2005). The fault rock is characterized with the following features; In the BFRs, pseudotachylyte occurs as a possible evidence for the operation of frictional melting (Meneghini et al., 2009), and on the other hand, the BFRs contain ductile deformation fabrics, which suggests association of cataclastic flow (liquefaction) process at high slip rates (Brodsky et al., 2009).

In this study, frictional properties of cataclastic melange rock exposed adjacent to the BFRs was investigated using a rotary-shear frictional testing machine at Kyoto University. The samples for the experiments were collected from cataclastic argillaceous melange rock, which is likely the source of the BFRs. The collected samples were manually disaggregated and sieved in order to eliminate clasts larger than about 0.17 mm. Frictional experiments on the assembled samples were performed at a constant slip velocity of 300 mm/s over a range of normal stresses from 0.4 MPa to 1.0 MPa at dry condition.

At the lowest normal stress of 0.4 MPa, the experimental fault exhibited slip weakening behavior. Upon initiation of slip, shear stress decreased exponentially from initial peak value to residual almost steady-state value after about 20 m displacements. Thickness of the sample monotonically decreased during the run, suggesting a gradual compaction of the sample with the slip. On the contrary, for the tests at higher normal stresses from 0.6 to 1.0 MPa, frictional behavior of the argillaceous rock sample comprises of three stages; weakening stage from initial peak value, which is followed by a rapid friction increasing stage toward the second peak value, and a further gradual friction decreasing stage following the second peak friction. Interestingly to note, the sample started to dilate (expand) following the initial compaction stage. The beginning of the dilation roughly correlates with the onset of the increasing period of shear stress towards the second peak value. Our experimental results suggest that frictional heating plays an important role for the stress increasing behavior of the sample following the initial slip-weakening at normal stresses $>$ 0.4 MPa.

Keywords: rock friction, pelitic rock, Kodiak Island