斑レイ岩の中-高速度域速度急変実験において観察された過渡的摩擦挙動
Transient Frictional Behavior Observed in the Velocity-Stepping Test of Gabbro Conducted at Intermediate to High Slip Velocities

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Since Brace and Byerlee [1966] suggested that frictional stick-slip sliding plays an important role in seismic faulting, a number of friction experiments have been carried out. One of the greatest achievements is a proposal of rate- and state-dependent friction constitutive law by Dieterich [1978]. This law has been widely used for simulating earthquake cycles, but the law was originally proposed at low slip velocities of the order of sub-mms^{-1}, and it has not been clarified whether rate- and state-dependent friction constitutive law can be applied to frictional phenomena at seismic faulting slip velocities (the order of ms^{-1}).
In this study, we modified a rotary-shear friction apparatus at Kyoto University and performed a series of intermediate to high slip velocity friction experiment with velocity stepping by using this apparatus. In this experiment, we used a pair of hollow cylindrical gabbro blocks with an inner-diameter of 26 mm and an outer-diameter of 40 mm, and changed the rotation rate of the servomotor in this apparatus from one value to another; hereinafter we call the former value *IRPM* and the difference value between the former and the latter *ΔRPM*, respectively. We selected all the combinations of IRPM and ΔRPM throughout this experiment: a value of IRPM of either 10, 20, 50 or 100 RPM, and a value of ΔRPM of either 30, 80, 150, 200, 300 or 400 RPM. This experiment was carried out under a constant normal stress of 1.5 MPa.
The friction response to the imposed slip velocity steps is characterized by two strength peaks and slip-weakening phases that follow each of the peaks. Typical behavior of the transient was observed in the tests conducted at an IRPM value of 20 RPM and a ΔRPM value of 200 RPM. Rotation rate overshoots the target value once and is converged to the value while oscillating because of high value of the speed loop gain integration time constant of the servomotor in this apparatus during this experiment. Considering this servomotor behavior, the first strength peak is reached while the rotation rate is accelerating, and the second peak is reached when the rotation rate reaches its peak value. Interestingly to note, the transient behavior of friction response recorded in this study is similar to those observed in friction melting experiments [e.g., Hirose and Shimamoto, 2005]. There are many kinds of friction constitutive law, but existing friction constitutive laws may not describe this behavior. A constitutive model for frictional sliding that is capable of describing the transient behavior observed at intermediate to high slip velocity tests in this study is required to be developed.

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