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# Contact state of simulated fault via electrical resistance

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Earthquake is a frictional sliding of fault. If we can monitor the frictional strength of fault with maintaining the contact state between rocks, therefore, we will obtain valuable information which can help us to understand the frictional property of rocks and the fault sliding mechanisms during earthquake. From the point of view, we focused on electrical property of fault plane. In the previous experiment, we successfully observed decrease in the electrical resistance of simulated fault caused by increase in the normal stress and formation of molten layer. In this meeting, we will show the estimated contact state of simulated fault via the electrical resistance during rotary-shear frictional tests. We adopted an electrometer (Keithley 6514) to measure extreme high resistance of dry rocks. This instrument enables us to measure resistance up to 210 G ohm by impressing high voltage of 250 V. At first, we conducted simple press test. We used two cylindrical gabbros from India as rock samples with the diameter of 25 mm and the length of 30 mm. The rock samples were installed into the rotary-shear frictional testing apparatus (Shimamoto and Tsutsumi, 1994; Mizoguchi and Fukuyama, 2010). The normal stress was changed between 0 and 8 MPa by 0.5 MPa in each step after maintaining the state for 300 s. The electrical resistance of fault should be more than 210 G ohm with the normal stress of 0 MPa, because the electrometer could not work at the stress. The resistance decreased from 90 G ohm at 0.5 MPa to 30 G ohm at 8 MPa accompanying with the increase in normal stress. This can be interpreted that increase in the normal stress enlarged real contact area of the fault, which causes decrease in the resistance. Next, we monitored the resistance of fault during low-velocity frictional test. We used the same rock samples of the press test. The normal stress of 3 MPa and the equivalent slip velocity of 5.3 x $10^{-3}$ m/s were maintained during the test. Frictional strength, which is defined as the ratio of shear stress to normal stress here, suddenly increased up to 0.8, weakened to 0.2, and fluctuated between 0.2 and 0.6. The electrical resistance drastically decreased from 130 to 8 G ohm after starting the frictional test, and fluctuated between 10 and 30 G ohm after the first decrease. Comparison between changes in the frictional strength and the resistance revealed that the increase in frictional strength synchronized with the decrease in resistance, and vice versa. This observation can be explained by the idea that the increase in real contact area of fault causes the increase in frictional strength as well as the decrease in resistance. Next, we conducted high-velocity rotary-shear frictional test with frictional melting. We maintained the normal stress of 3 MPa and the equivalent slip velocity of 1.3 m/s. The amount of slip distance was attained to 52 m. During one second after starting frictional sliding, the fault showed the first weakening, and after that, the fault showed the second strengthening and weakening associated with the frictional melting introduced by Hirose and Shimamoto (2005). The electrical resistance decreased from 70 G ohm to 3 G ohm just after the start of sliding and continued to decrease up to 1 G ohm. Detailed investigation of the early stage of sliding revealed that rate of the decrease in resistance became greater with transition from the first slip weakening to the second strengthening. This would correspond to the stage that local melting at some asperities stated to connect each other. After that, the frictional strength attained to the second peak, which looks to synchronize with temporal stop of the decrease in resistance. This can be interpreted that the melt patches grew to molten layer in the fault. We also observed step-like decreases in the resistance, which should be associated with growth of the molten layer. We will quantitatively discuss the frictional mechanisms of fault by detail analysis.

Keywords: Electrical resistance, Fault, Friction, Frictional melting, High-velocity rotary-shear frictional test