実験室での破壊開始と伝播の特徴
Characteristics of Rupture Initiation and Propagation in the Lab

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We have conducted large-scale bi-axial shear friction experiments using the NIED large-scale shaking table (e.g. Fukuyama et al., 2014, Yamashita et al., 2015). One of the main targets of these experiments was to investigate the rupture initiation and acceleration process of the stick slip events, which are proxies of natural earthquakes (hereafter, we call them labquakes). The experiments were done under constant loading rate conditions of between 0.01 and 0.1 mm/s under the normal stress of between 1.3 and 6.7 MPa. The rock sample is made of metagabbro from India. We compiled the results obtained in the series of experiments and discuss what we understood and what we need to understand. There are some key observations as follows. 1) We sometimes observed labquakes that did not reach the end of the rock sample. Such labquakes are more similar to the natural earthquakes in a sense that the total stiffness was controlled by the surrounding rock materials. In these events, highest stress drop occurred at the beginning while termination of the rupture was rather gradual. 2) Mainshocks were preceded by the precursory slow slip and/or foreshocks. Sometimes, foreshock activity dominates but in most cases, precursory slip occurred just before mainshocks. 3) The foreshocks tend to be more often observed when the sliding surface was pre-damaged due to previous fast sliding so that more gouge particles were generated under the same loading conditions. 4) After the friction experiment, many grooves were observed on the sliding surface, in which gouge particles were filled. The area where precursory slow slips occur does not have many grooves comparing to the other area, suggesting that slow slip might initiate mainly on the smooth surface where no grooves were created. 5) The hypocenters of the labquakes were located at the edge of the grooves based on the AE sensor array data. This suggests that grooves were created at the initial acceleration stage of the rupture. Based on the above observations, we are constructing the rupture model. And there are several issues that we do not clearly understand. a) Under what conditions, foreshock activity dominates? b) When gouge particles and grooves are created? c) Why precursory slip starts to occur at some point on the fault and expand to both slip perpendicular and slip parallel directions? These key questions will help to solve the rupture dynamics that occurred during the large-scale rock friction experiments.

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