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An experimental trial to detect nucleation processes by transmission waves across a simulated fault with a gouge layer

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Using a sandwich type direct shear apparatus, Iwasa and Yoshioka [1] made an experimental trial to detect nucleation processes in which P- and S- waves were transmitted across a simulated fault throughout the shear stress loading process until a final stick slip occurred. They found two distinct features in the observed waves: First, the amplitude of the transmission waves was significantly increased. The increase amounted to more than several tens percent. This cannot be explained by indentation creep at asperity contacts (Scholz and Engelder [2]). Second, the increasing rate of amplitude slightly decreased as a detectable precursory slip began. The first feature is quantitatively explained by "junction growth" first proposed by Tabor [3] which is a combined effect of shear and normal stresses, resulting in an increase of real contact area. The second one may be attributed to the replacement of an asperity-contact population (Dieterich [4]).
We are now performing a new experiment on a simulated fault which consists of an upper block, a lower block and a gouge layer between them. The upper block is loaded through a leaf spring by a linear motor. The loading velocity of the linear motor ranges from 0.1 μm/s to 2 mm/s. The normal force is the constant gravitational force of the upper block. We measure the loading force, the horizontal and vertical displacements of the upper block by two horizontal LVDTs and three gap sensors, respectively. Elastic waves are continuously transmitted across the fault, which are measured at a constant time interval during the shear stress application up to a final stick-slip event. The results so far obtained show that the upper block significantly climbs up the gouge layer prior to a stick-slip. This suggests that "dilatancy" of the gouge layer occurs in the final process before the dynamic rupture. The amplitude of the transmission waves exhibit significant decrease at the rear end of the fault and remarkable increase at the front end, both seen from the beginning of shear stress application. These observations indicate the complicated re-distribution of stress chains within the gouge layer, which commences at the early stage of shear stress application.

References

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