A trial to detect nucleation processes by transmission waves across a fault that contains fault gouge

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A number of seismological and experimental observations and numerical studies have shown that there is a slow stage of precursory slips prior to a dynamic rupture propagation. We call the region where slow precursory slips occur nucleation zone. If we could detect the growth of nucleation zone in some way, then it would provide useful information to predict the forthcoming dynamic rupture.

We had made a laboratory experiment in which elastic waves were transmitted across a simulated fault to detect the precursory slips. The fault was made of contacting rough, bare surfaces of brass. The results showed that the transmission waves could be a good indicator of the contact state of a fault. We also found in the experiment that there were remarkable increases in amplitude of transmission waves throughout the stress accumulation process. The increase began immediately after the shear stress application, i.e. from under a considerably low stress condition. This seems to be caused by the mechanism of junction growth at real asperity contacts.

We are now constructing an apparatus to apply the method above to a fault which contains grains or gouge between fault surfaces. The system is simple: the grains are sandwiched between the upper and lower plates. The upper plate is slowly driven by a linear motor via a leaf spring and three-dimensional movement of the plate is monitored by three vertical displacement transducers and two horizontal LVDTs. The velocity of the linear motor is controlled by a driver, ranging from 0.05 micron/s to 2 mm/s. Transmission waves are generated and received by PZTs buried in the lower and upper plates, respectively.

Because an aggregate of grains forms a number of contacting junctions, it is expected that junction growth takes place as the shear stress is applied. Further the junction growth may bring about a change in bulk volume of fault gouge. We will observe any change in contact state just before the dynamic rupture. These changes may be detected by transmission waves across a fault from the beginning of shear stress application through the final dynamic rupture propagation.

Although we have not yet had any solid results of experiments, we expect that the experimental observations will clarify the details of stress accumulation process and preparation process of the final dynamic rupture.