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Effects of Fault Irregularities on Activity of Strong Earthquakes along a Fault Zone: An Experimental Study

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It is well known that map traces of strike-slip faults are characteristically discontinuous and irregularities occur on faults at all scales. To better understand the effect of fault irregularities on activity of strong earthquakes along a natural fault zone, we have performed a series of experiments under biaxial compression to study deformation of faults with different geometric irregularities in macroscopic scale. Here we present the results of faults with compressional and extensional jogs, and the main points are as follows.

(1) The sample containing faults with a compressional jog shows steady increase of differential stress with time. Stick-slip events with obvious stress drop occur at higher stress level, accompanied by slip along one or two faults, and the magnitude of stress drops increase with time. The complete failure of the compressional jog near the end of the experiment causes an unstable slip of the whole fault system with a very large stress drop and a large fault displacement. The stick-slip events are preceded by acoustic emission events located within the jog, indicating that the microfractures within the jog provide necessary condition for fault slip before the complete failure of the jog.

(2) The sample containing faults with an extensional jog behaves like a homogeneous fault, displaying relatively weak increase of differential stress with time and regular stick-slip during the sliding stage. The fracturing of the jog occurs before the fault system goes to the sliding stage and the failure of the jog does not cause an evident slip of the whole fault system. This shows that extensional jog has little effect on sliding of faults. However, many stick-slip events are also preceded by acoustic emission events located within the jog, indicating that the fracturing of the jog is indicative of slip along faults.

(3) It is deduced from the experimental results that the presence of a compressional jog in a fault zone makes the sliding of the fault zone more difficult because of its high strength, but the microfractures, i.e. small earthquakes, within the jog can provide condition for occurrence of fault slip, i.e. strong earthquakes. Therefore, strong earthquakes may occur in faults near the jog before the jog is completely broken. The complete failure of the jog will make the faults be linked and slip together, causing a large earthquake. The presence of an extensional jog in a fault zone has little effect on the sliding of the fault zone because of its low strength, meaning that the activity of strong earthquakes zone will not be affected by such a jog. For both compressional and extensional jogs, seismicity in jogs may be indicative of strong earthquakes along a fault zone.