Shapes of comminuted materials formed in sliding shear tests at different slip velocities

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Comminution of rock grains and gouge formation with fault movement are ubiquitous in brittle faults at all scales. Pseudotachylyte is well known as a fault- related rock that occurs as a result of frictional fusion in earthquakes. However, in the case of some of the fault-related rocks formed by seismic slip-for example in fault gouge sampled immediately after the Majhabeng earthquake in South Africa-no evidence of melting has been found (e.g. Kita and Otsuki, 2005). Fine-grained gouge is commonly formed by quasi-static shear along pre-existing fault zones. Other recent studies have reported that fine gouge is not related to shear slip, but rather formed by dynamic rock pulverization induced by the unloading-loading cycles of normal stress during the propagation of a single earthquake rupture (e.g. Brune, 1993; Wilson et al., 2005). Recently, slow slips differing from the slips in regular earthquakes have been discovered. Very low frequency earthquakes are estimated to occur at depth shallower than 2 km (e.g. Obara and Ito, 2005). Accordingly, it is suggested that the materials within fault zones are comminuted under various stress fields and slip velocities.

We conducted two different shear tests with different slip velocities of 5.00×10^{-3} mm/s and more than 10 mm/s. The comminuted materials formed by the tests were observed by scanning electron microscopy and transmission electron microscopy. We sheared quartz, biotite, and granite samples with a displacement of about 1 cm at normal stress of 0.35 MPa at room temperature and humidity.

In the low-speed shear tests, the fragments of a few microns in size are angular with a platy shape. Most of the submicron fragments are sub-rounded and have spherical or polygonal shapes. In the high-speed shear tests, the fragments of a few microns in size have a platy shape, and some have saw-like edges. Most of the submicron fragments are angular to sub-angular with elongated shapes. Shape characteristics therefore differed between the low-speed and high-speed shear tests of fragments-particularly the submicron-scale ones. This was true for all sample types (i.e. quartz, biotite, and granite).