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Grain size distribution and microstructures of experimentally sheared granitoid gouge at coseismic slip rates – criteria to distinguish seismic and aseismic faults?

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In order to assess whether seismic and aseismic fault rocks can be distinguished on the basis of their microstructure, the grain size distribution and the microstructures from high velocity friction experiments are compared with those of slow deformation experiments of Keulen et al (2007, 2008) for the same material (Verzasca granitoid). The mechanical behavior of granitoid gouge in fast velocity friction experiments at slip rates of 0.65 and 1.28 m/s and normal stresses of 0.4-0.9 MPa characterizes the slip weakening in a typical exponential friction coefficient vs displacement relationship. The grain size distributions yield similar D-values (slope of frequency versus log grain size curve $\approx$ 2.2 – 2.3) as those of slow deformation experiments (D = 2.0 – 2.3) for grain sizes larger than 1 µm. These values are independent of the total displacement above a gamma value of about $\approx$ 20. The D-values are also independent of the displacement rates in the range of $\approx$1 μm/s to $\approx$1.3 m/s and do not vary in the normal stress range between 0.5 MPa and 500 MPa. Grain shapes evolve towards more rounded and less serrated grains with increasing displacement. The progressive grain shape evolution while the grain size distribution remains constant suggests that the wear at clast boundaries produces a range of grain sizes by instant crushing rather than by gradual comminution and abrasion.
The results of the study demonstrate that most cataclastic and gouge fault zones may have resulted from seismic deformation but the distinction of seismic and aseismic deformation cannot be made on the basis of grain size distribution.