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Amorphization of dolerite gouges and its effects on their frictinnal properties

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We have ground crashed and sieved grains of dolerite using an automated flint mill for 10 minutes, and 6, 12, 24, 36, 48 and 60 hours. Grinding was interrupted for about 15 minutes at every three hours in order to prevent oxidation caused by frictional heat during grinding. TEM observations reveal the abundant presence of submicron-size rounded amorphous grain in ground gouges. Quantitative XRD analyses indicate that amorphous phase is absent in the gouges ground for 10 minutes, but that its amount increases linearly up to ?40 wt% with grinding time up to 36 hours. Grinding for more than 36 hours, however, does not result in any further increase in the amount of amorphous phase. This is probably due to the grinding power of the mill used. SEM observations of ground gouges reveal the abundant presence of the rounded grain with an angular clast core and amorphous mantle, likely grown by accretion of amorphous material around a clast grain as accretionary lapilli. Similar rounded grains have been found in natural and experimentally produced clay-rich fault gouges, and are called ”clay-clast aggregates”. This ”clay-clast aggregate”-like grain increases in amount with grinding time.

We have then conducted friction experiments on the gouges ground for 10 minutes and 36 hours at a normal stress of 7 MPa and displacement rates changed stepwise between 1 and 10 micrometer/s by using a biaxial shear apparatus. The gouge ground for 10 minutes lacking amorphous phase has a larger friction (˜0.6), and exhibits velocity-weakening behavior, whereas the gouge ground for 36 hours containing ˜40 wt% amorphous phase has a smaller friction (˜0.55), and exhibits a quasi-neutral velocity dependence of friction. Thus amorphization of gouge not only reduces frictional strength, but also affects to velocity dependence of friction.