Effect of slickenside on the crustal strength

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Slickenside is a glossy and smoothly surface developed on the fault slip plane. Although the slickenside is a common and well-known microstructure, its microstructural characterization and effect on the fault behaviour have not fully studied so far. To understand these points, we characterized the microstructures of natural samples and conducted the frictional experiments. The recovery samples from the experiments were also characterized.

Samples and experiment: The natural samples we characterized were slickensides found on the following rocks collected from several localities. 4-Cherts, 3-Limestones, 1-Amphibolite, 1-Serpentinite, 1-Chromitite, 1-Sandstone, 2-Mudstones, 1-Coaly mudstone and 1-Tuff breccia. The frictional experiments were conducted using limestone and gabbro blocks, and calcite powder with 45 to 75 μm in grain size, with a biaxial friction apparatus. The experimental conditions were 3 - 80 MPa of normal stress, 0.1 m/s and 30 μm/s of slip velocity. The characterization methods of samples were optical microscopy, SEM, TEM, AFM and XANES measurements.
Results and conclusion: The present characterization of natural samples demonstrates that the slickenside is composed of nano-size grains, whose aspect ratio (h/d) of height (h) and diameter (d) is constant at about 0.02 –0.05 for each sample. These nano-size grains can be identified as same minerals, not amorphous, composed of the parent rocks with some minor exceptions. This fact indicates that the nano-size grains were created during fault slip only by grinding of parent rocks without any reaction including the heating-induced reaction. Therefore, our first conclusion is that the slickenside is a product of aseismic faulting. The slickensides were created by all frictional experiments. The characteristics of these slickensides are same as those of natural samples described above. The interesting results are that the aspect ratio (h/d) of nano-size grains is constant for each experiment and tends to decrease with increasing normal stress from ca. 0.23 to ca. 0.07. The h/d values of nano-size grains composed of natural samples are much smaller than those of the recovered samples, which suggests that the studied natural slickensides were created by faulting at the higher normal stress conditions than at least 80 MPa, and preserved during exhumation from original depth to earth’s surface. This consideration indicates that the fault having slickenside exists at depth corresponding to at least 80 MPa normal stress, ca. 3 km and more. The experimental results using limestone block having pre-existing mirror polished slip plane show that the static and dynamic friction coefficients are very low, ca. 0.3 and 0.2, respectively. In general, it is believed that the frictional sliding on pre-existing fault governs the crustal strength. Therefore, our second conclusion is that the slip behaviour of fault having slickenside might governs the crustal strength. However, the experiments using gabbro block did not show the low static and dynamic friction coefficients. Hence the further detail experiments using simulated slickenside are needed to understand the crustal strength.

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