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Formative Processes of a Sliding Zone in Pelitic Schist —Implications of Microscopic Analyses on High-quality Drilled Cores

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Pelitic schist has been known to be easily deformed by gravitational force to form characteristic topographic and geologic features, but little is known about how they develop. This is mainly due to the fact that deformed politic schist is so fragile that it could not be obtained from subsurface without disturbance.
We analyzed high-quality undisturbed cores obtained by using a sophisticated drilling technique from two typical pelitic schist landslide sites in Japan. We made analyses on physical, chemical, mineralogical properties and observations from mesoscopic to microscopic rock textures of these cores and found that a special layering of rock-forming minerals determines the locations of shearing by gravity and that there is specific water-rock interaction processes in pelitic schist.
Pelitic schist consists of thinly alternating beds of black layers and quartz-rich layers, and a black layer has numerous microscopic layers containing abundant pyrite and graphite grains (pyrite-graphite layers). Many of the black layers were observed to have microfractures connected to open cracks, suggesting that relatively thick, continuous black layers are easily sheared to form an incipient sliding layer. Thus unevenly distributed pyrite-graphite layers likely to determine the potential location of microscopic slip in a rock mass.
Shear displacement along black layers occurs unevenly, depending upon the microscopic heterogeneity in mineral composition as well as undulating shape of the layers. Open micro-cracks nearly perpendicular to the schistosity were commonly observed in quartz-rich layers in contact with black layers, suggesting that the shearing occurred with heterogeneous displacements along the black layer and that it occurred under the low confining pressure. This is in the incipient stage of a fracture zone. When shearing occurs along two thick neighboring black layers, the rock in between would be fractured, rotated and pulverized. In some cases, quartz-rich layers were fractured in a brittle manner and their fragments were rearranged to form micro-folds. Rocks are thus pulverized with multiple shear surfaces.
Incipient fracture zones and their surroundings have many voids because they are made under low confining pressures near the ground surface, so oxidizing surface water easily percolates through them. Oxidizing water reacts with pyrite which is contained in pelitic schist, producing sulfuric acid through. The rocks therefore become deteriorated by the water-rock interaction and would be easily deformed. Such a combination of the physical processes of deformation and fracturing and the chemical process of weathering develop a sliding zone.