Geophysical Research Abstracts,
Vol. 11, EGU2009-10638-1, 2009
EGU General Assembly 2009

Structure and Particle Size Distribution of Non-tectonic Faults – Difference from Tectonic Faults

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Non-tectonic faults are commonly formed by mass movements but their structures and formative processes have been scarcely studied in spite of their importance in slope development and slope stability. We observed structures of non-tectonic faults and analyzed particle size distribution of the material from the shear zones of non-tectonic faults and compared these results with those of tectonic faults.

We clarified the structures of non-tectonic faults in pelitic schist by observing X-ray computer tomography images and cross-sections of paraffin-impregnated core samples that have been recovered from the subsurface by the hybrid drilling technique. We identified structures at various stages of non-tectonic fault development. Shearing within black layers, which are rich in graphite, dominates at an incipient stage. Then, rotation, fracturing, and pulverization of rock proceed, forming breccias and fine fractions in a fracture zone. Fracture zone at an early stage have many open fractures, which indicates a low confining pressure during deformation. With the development of a fracture zone, open fractures decrease and fine fractions increase in amount. Finally shearing deformation would be dominated by cataclastic flow in fine fractions. This stage is at a mature stage, where the structure becomes very similar to that of tectonic faults so that it cannot be distinguished from a tectonic fault by structure only.

However, particle size distribution could indicate the formative condition of fine fractions in a fracture zone. We sampled "gauge" from several mature fracture zones in two landslide sites of pelitic schist, and analyzed their particle size distributions from 20 nm to 1 mm by using a laser diffraction particle size analyzer. The ultra micro particles in the fracture zone of a non-tectonic fault can be assumed to be primary particles which are less affected by alteration, and their particle size distributions could reflect the conditions of fracturing. The amounts of nanometer-order particles were very small in all the samples of the examined non-tectonic faults, and their dominant particle size were silt size. These results are very different from the reported particle size distributions from coseismic faults, which contained abundant nanometer-order particles.

The fact that the non-tectonic fault has fewer amounts of nanometers-order particles can be explained by the "theory of grinding limit", which is well known to powder technologist. This theory is that the size of minimum particle made by grinding is in inverse proportion to grinding force. If we want to make smaller size particles, the grinding process needs a larger force. In case of the fault, grinding force would increase with increasing the confining pressure, so the minimum particle size of a non-tectonic fault in low confining pressures would be bigger than that of the tectonic fault formed in the depths. We believe that the relative amount of ultrafine particles in a fracture zone could suggest the depth of its formation. The ultrafine particles and the structure of a fracture zone would thus provide a clue to identify whether a fault is non-tectonic or tectonic.