Frictional strength of montmorillonite gouge: Effects of orientation and adsorbed water

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Clay minerals have been found in the sliding zones of natural faults and landslides. Most clay minerals show lower friction coefficient than common rocks and minerals: therefore, the presence of clay layers can control the sliding behavior of faults. Clay minerals are composed by the stacking of 1-nm thick structural layers, and shows large surface specific area. The surface of most clay minerals has high affinity with water and such water reduce the frictional resistance of simulated gouges composed by clay minerals. The preferred orientation of layered clay particles along with the sliding plane can change the frictional properties of gouge [1]. Since the degree of orientation of clay particles depends on the environment of clay mineral formation [2], frictional properties of simulated gouge having clay minerals should be investigated for various degrees of orientation.

Previously reported frictional coefficient of montmorillonite vary widely from 0.04 to 0.8 [3]. Here we measured the shear stress of montmorillonite gouges at dry condition. The degree of orientation and the presence of adsorbed water were precisely controlled to reveal these effects on the frictional properties of montmorillonite.

The thermal analysis (TG-DTA) was conducted before the shear measurements to confirm the presence of adsorbed water as a function of drying temperature. Shear experiments were performed at the normal stress from 5 to 40 MPa. The effect of adsorbed water strongly depends on the degree of orientation. Highly orientated montmorillonite gouges show high shear stress and strong normal stress dependence compared to the gouges of low orientation. This implies the cohesion force acting between montmorillonite basal planes at dry condition and/or the increased real area of contact have a large effect on the frictional properties of highly orientated montmorillonite gouges.

References

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