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流体制御型摩擦試験装置を用いた高間隙水圧条件下における摩擦実験
Frictional property of gouge materials under high velocity and moderate water pressure condition

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Fluid can act as important roles in faulting and earthquake cycle processes. Geochemical analysis, recently, provided the chemical anomaly in the Chelungpu fault, and this anomaly is explained by the fluid-rock interaction in the fault zone induced by thermal pressurization during co-seismic friction (Ishikawa et al., 2008). However the role of fluid in a fault for a mechanical process and a chemical reaction is still a matter of debate. In addition, we had never achieved high velocity friction experiments to reproduce the water-rock interaction. Here, we designed the rotary shear apparatus that can perform shear deformation of powdered gouge materials with water as pore fluid under high pore pressure condition. We used core samples from the Taiwan Chelungpu fault Drilling Project (TCDP) of Hole B near the fault zones. We used sample holder with 30/60 mm internal/external diameter. We rotated gouge specimen until displacement reaches to 15 - 30 m, and 0.1 to 0.4 of the equivalent slip velocity were applied. We applied normal stress from 5 to 15 MPa and pore pressure from 2 to 5 MPa. We conducted two types of friction test: one is drained condition test that pore pressure is kept at a constant value, and the other is undrained condition test that normal stress is kept constant and that allows pore pressure change during sliding.

In the most of the drained test, shear stress gradually decreased with slip displacement and finally it reached to the stable value after 5 to 15 m displacement. Temperature at slip surface increased with sliding, and it peaked at several m of displacement. Then it kept at a nearly constant temperature till the end of slip. Steady state shear stress is proportional to effective pressure, and friction coefficient showed about 0.2. In the undrained tests, shear stress decreased with slip displacement as well. In addition pore pressure is gradually increased with sliding until the end of sliding. For example, pore pressure is increased from 2 to 9 MPa at 12 MPa of normal stress and 0.2 m/s of slip velocity. Temperature at slip surface increased dramatically as well. The maximum elevated temperature is about 310 degrees celsius for the drained test, and 320 degrees for the undrained test.

Our results indicate that pore pressure increase during sliding that associates with shear stress reduction in undrained condition is due to frictional heating that expanded the volume of water. However, shear stress reduction could be caused by the other mechanical process as well, such as slip localization or fluidization of gouge material.

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