間隙水圧一定条件での大変位剪断摩擦実験におけるスメクタイトを含むガウジの摩擦性質
Frictional behavior of smectite-bearing fault gouges in large displacement frictional experiments under constant pore pressure

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Frictional properties of smectite-bearing material at large displacements should provide valuable information for the stability of slip in the shallow parts of subduction zone faults. However, most of the previous experiments are limited by the amount of displacement that can be achieved and the frictional behavior at large displacements remains poorly understood. In this study, we have conducted large displacement friction experiments on mixtures of montmorillonite and quartz at constant pore pressure. Our purpose of this study is to investigate the correlations between gouge textures and frictional velocity dependence of smectite-bearing faults.
We examined frictional behavior and internal textures of simulated gouge samples composed of montmorillonite/quartz mixtures. Two different compositions of the gouges were tested: mixtures of montmorillonite/quartz = 20/80 (abbreviated as Mnt20/Qtz80) and 40/60 wt% (Mnt40/Qtz60), respectively. We sheared the gouges in rotary shear to displacements of more than 1 m at a normal stress of 10 MPa and at a constant pore pressure of 5 MPa. During the shearing, these gouges were subjected to velocity step changes to examine the velocity dependence of friction for a range of slip velocities v from 0.003 to 0.3 mm/s.
Results of the experiments reveal influences of the composition, displacements and slip velocities on the frictional behavior. Both Mnt20/Qtz80 and Mnt40/Qtz60 gouges show slip-hardening behavior. Positive friction velocity dependence was observed in both gouges at short displacement for all the tested slip velocities. At large displacement (v > 30 mm), Mnt20/Qtz80 gouge shows negative friction velocity dependence for all the tested slip velocities. On the contrary, friction of Mnt40/Qtz60 gouge exhibits negative velocity dependence for lower velocities (0.003 mm/s to 0.03 mm/s) and positive velocity dependence for higher velocity stepping (0.03 mm/s to 0.3 mm/s). The SEM observation of the Mnt20/Qtz80 gouge reveals that montmorillonite particles are agglomerated initially to form montmorillonite-filled matrix domains. With continued displacement, the agglomerated distribution of montmorillonite becomes to be disaggregated; eventually the montmorillonite particles are incorporated into the fine-grained matrix of the gouge. Grain size of quartz decreases with displacement, during which change the grain shape of the quartz becomes to be more rounded. It appears that increasing degree of size reduction of quartz grains and a more scatter distribution of montmorillonite particles correlate with a more negative velocity dependence of friction.

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