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タルクおよび蛇紋岩の摩擦特性における間隙水圧と応力履歴の影響
Effect of pore pressure and stress paths on frictional properties of talc and serpentinite under high normal stress

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Pore fluid pressure is a critical parameter governing the overall mechanical strength of plate boundary faults. Recent geophysical observations have suggested the importance of fluids in seismogenic processes. Previous works on rock mechanics have suggested that the yield strength of rocks is governed by effective stresses $S_e = S - aP_p$, where S is total stress, P_p is pore fluid pressure, and a is a factor between 0 and 1. The observations in the brittle regime are well accounted for by a = 1 [1]. However, it is not well documented how pore fluid pressure influences frictional properties of faults at the brittle-ductile transition zone. Ductile deformation might play important roles in contacts of topographies of fault surfaces, or asperities, at the the brittle-ductile transition zone, and therefore there is a possibility that a in the effective stress law may not be 1 and/or pore pressure distributions on the slip surfaces may be inhomogeneous and time-dependent due to reduction of permeability between the slip surfaces. It is also expected that shear stress may depend highly on stress history in the brittle-ductile transition zone. It is generally difficult to conduct laboratory friction experiments at high pressures and temperatures that are comparable to the middle to lower crust and mantle. To overcome the limitation of experimental conditions, we conducted friction experiments by using talc and serpentinite (antigolite) as an analogue material, which shows brittle-ductile transitional behaviors at relatively low pressures and temperatures. In addition, investigating frictional properties of these rocks under high stress is important because these rocks receive attention as a material giving important influences on fault mechanics. Cylindrical samples of talc (Gvangjsih, China) and serpentinite (Nagasaki), 20mm in diameter, were cut at an angle of 30^o to the sample axis. The surfaces were ground with carborundum (#400 and #80 for talc and serpentine specimens, respectively). A small hole (3mm in diameter) through the center of each piece ensured adequate communication of the water between the precut surfaces with the rest of the pore pressure system. The specimen was loaded by a triaxial apparatus and sheared under an axial displacement rate of 1 um/s. We used water as a pore fluid. All measurements were performed under conditions of room temperature. Experiments were conducted under several paths of confining pressure and pore pressure. The results indicate a possibility that the shear stresses of these rocks under high normal stress may not be able to be simply explained by an effective stress law with a = 1, and stress paths affect the shear stress.

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References: [1] M.S. Paterson and T.-F. Wong, Experimental rock deformation - the brittle field, 2nd ed., 2005.

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