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Anisotropic strength and deformation behavior of antigorite serpentinite

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Introduction: Resent seismic wave analysis suggest that serpentinite exists along the subducting plate. Serpentinite is important to understand about subducting oceanic plate and high-pressure metamorphic rocks. Most Antigorite serpentinite which exist on the ground show lattice preferred orientation and they have foliation. Maximum strength of the rock with foliation varies with the angle between maximum compressional axis and foliation. This angle is said to be Azimuth. Deformation experiment using the metamorphic rock, peak of the maximum strength is when Azimuth is 0 degrees and 90 degrees, and least at 30˜45 degrees.(Nasseri et al., 2003) The value of strength decrease from peak to least differ from metamorphic rocks. The biggest strength decrease seen in the experiment is 75% at phyllite and the smallest is 11% at biotite schist. In this study, we have conducted axial compression deformation experiment using the solid state pressure deformation experiment apparatus to investigate the strength decrease and azimuthal anisotropy of serpentinite with foliation and lattice preferred orientation. And observed about the recovered samples to clarify the characteristics of plastic deformation of Antigorite.

Experimental: We have conducted constant strain rate experiment of Antigorite serpentinite, in order to understand the effect of microstructural anisotropy on deformation behavior. The sample is naturally deformed foliated Antigorite serpentinite which is characterized by preferential arrangement of (001) of Antigorites parallel to the foliation. We prepared three types of oriented starting samples, whose foliations were set at 0 degrees, 30 degrees and 90 degrees with respect to the axial stress. Experimental conditions were 500 C temperature at 1 GPa confining pressure with 500 um/h displacement rate of piston.

Results and Discussion: Maximum strength of the sample 30 degrees is lower than that of 0 degrees and 90 degrees.(Strength decrease is seen.) The experimental data indicate that the maximum strength of 0 degrees is 40 % bigger than that of 90 degrees, and 90 degrees is 35 % bigger than that of 30 degrees. Suggested from the micro-structure observation, sliding occurs along the foliation at sample 30 degrees and begin to fold since it cannot slide any more bound by upper and lower pistons. There is small plastic deformation area at sample 0 degrees that stress drop is suggested to be occur by brittle fracture. Those of 90 degrees were due to plastic deformation of antigorite itself and extensional breakage of antigorite grains, respectively. These experimental result show that serpentinite has very strong azimuthal dependence. Noticeable stress drop could occur at subducting plate in case serpentinite has lattice preferred orientation by shear stress.

Keywords: Antigorite Serpentinite, Deformation Experiment, SEM, Deformation Mechanism