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Mechanical properties of foliated cataclasites from the Nobeoka thrust

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Understanding the mechanics of plate boundary earthquakes requires a sound investigation of the deformation style and mechanical behavior not only within plate boundary faults but also in the surrounding rocks. It is critical to quantify the strain accumulation and accommodation in the entire subduction systems. Recent studies suggest that heterogeneous deformation and strain distribution in mélanges observed in many ancient accretionary prism outcrops are related to slow slip events and low frequency earthquakes [Fagereng and Sibson, 2010; Kitamura and Kimura, 2011]. However, there are few experimental studies to describe mechanical properties of mélanges and foliated cataclasites. Here, we report on triaxial deformation experiments on foliated cataclasites from the footwall of the Nobeoka thrust, Japan.

The Nobeoka thrust, which is exhumated in Kyushu, southwest Japan, is considered as one of the ancient out-of-sequence faults. The Nobeoka thrust fault core, hanging wall, and foot wall rocks were recently cored and logged in a vertical borehole as a NOBELL project [Hamahashi et al., in press]. The Nobeoka thrust is recovered at 41.3 m from the ground. The hanging wall (0-41.3 m coring interval) is composed of the Kitagawa Group of phyllite of alternating beds of sandstone and shale, while the footwall (41.3-255 m) is composed of the Hyuga Group of foliated cataclasite consisting of scaly shale, tuffacious shale, sandstone, and acidic tuff. For deformation experiments, we used foliated catacalsite core samples, which are in better quality and less weathered than outcrop samples. Cylindrical samples with a diameter of 20 mm and a length of 30 mm were subsampled from the cores. The cylindrical specimen were deformed at an axial displacement rate of 0.05-0.5 μm/s, corresponding to strain rates of 1.6 $\times 10^{-6}$-1.6 $\times 10^{-5}$ s^{-1}, and at a temperature of 250 °C and an effective pressure (P_e) of 120 MPa (confining pressure of 200 MPa and pore pressure of 80 MPa) or 20 MPa (confining pressure of 200 MPa and pore pressure of 180 MPa). The temperature was chosen based on the estimated temperature (250-300 °C) at which the footwall foliated cataclasites were formed [Kondo et al., 2005]. The two different effective pressures of 120 MPa and 20 MPa correspond to the stress conditions at $\sim$8 km (geothermal gradient of $\sim$30 °C/km) with hydrostatic pore pressure and lithostatic pore pressure, respectively.

The preliminary results show that the foliated cataclasite samples, taken from the coring interval of 153 m, deform in a brittle manner at P_e = 20 MPa. The strengths reach at 80-90 MPa at peak following a strain weakening to residual strengths of 40-60 MPa. At P_e = 120 MPa, on the other hand, the foliated cataclasite deforms in a brittle-ductile transition manner and steady-state strength is $\sim$ 300 MPa. We will present more experimental results and microstructure observations of the experimentally deformed samples.