Frictional properties of greenstone: Effects of the seamount subduction on faulting at the subduction zone

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Subducting seamounts are thought to generate large earthquakes by increasing the normal stress on the subduction interface and to act as asperities (e.g., Cloos, 1992). There is also a possibility that they act as barriers for rupture propagation due to the large resistance (e.g., Kodaira et al., 2000). On the other hand, since a seamount near the southern end of the Japan Trench has been mostly aseismic over the 80 years while many earthquakes have occurred in its adjacent areas, Mochizuki et al. (2008) suggested that the interplate coupling is weak there. In spite of many studies on subducting seamounts, frictional properties of seamount materials are still poorly understood. In this study, we conducted friction experiments to reveal the frictional strength of seamounts and investigate how the seamounts act at subduction zones.

We conducted friction experiments on gouges of a greenstone from the Akiyoshi terrane in Yamaguchi, where a huge seamount with Carboniferous to Permian limestone accreted during the Permian time (e.g., Sano, 2006). Thin layer of greenstone underlying the limestone is distributed over 10 km along a fault. Experiments were performed at slip velocities of 0.0013 to 1.3 m/s, normal stresses of 0.7 to 4.0 MPa, and wet but drained conditions, using a rotary-shear apparatus installed at AIST.
At a slip velocity of 1.3 m/s, typical slip-weakening behavior was observed; friction coefficient μ rapidly increased at the onset of sliding and then progressively decreased to ~0.1 with displacement. Steady-state friction coefficient μ_{ss} at this velocity clearly decreases with increasing normal stress. μ_{ss} is high up to ~0.7 at low velocities, and decreases to ~0.1 at a seismic slip velocity of 1.3 m/s. The sample deformed at this high velocity shows a clear localized shear zone, whereas the sample deformed at a low velocity does not. μ_{ss} of the Akiyoshi greenstone is higher than μ_{ss} of typical subduction zone materials especially at low velocities; μ_{ss} of sediments at the Tohoku subduction zone is <0.2 (Sawai et al., 2014) and μ_{ss} of those at the Nankai Trough is <0.4 (Tsutsumi et al., 2011). Hence a seamount possibly acts as a barrier for rupture propagation due to its high frictional strength.

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