Frictional properties of Akiyoshi greenstone: implications for the seamount subduction and earthquake generation

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Subducted seamounts may act as seismic asperities (e.g., Cloos, 1992), or as barriers (e.g., Kodaira et al., 2000). On the other hand, Mochizuki et al. (2008) assumed that interplate coupling is weak near subducted seamounts because the southern end of the Japan Trench near a seamount has been mostly aseismic over the past 80 years. Frictional properties of seamount materials have been poorly explored despite their possible importance on earthquake generation. We thus started (1) field work on faults associated with subducted and accreted seamount rocks, and (2) friction experiments on greenstones derived from seamounts. Akiyoshi terrane is a classical area with huge Carboniferous to Permian limestone accreted during the Permian time (e.g., Sano, 2006). Thin basaltic rocks are distributed over 10 km in length adjacent to a fault, and the rocks are likely to have derived from a seamount. Unfortunately, we could not find outcrops of the fault, and we used a hyaloclastite sample collected at Mitou, Yamaguchi in our friction experiments.
Experiments were performed at normal stresses of about 4.0 MPa under dry or wet (40 wt% H_2O) drained conditions, using a rotary-shear low to high-velocity frictional testing apparatus in Beijing. Crushed rock powders of about 1 mm in thickness were mounted between cylindrical pistons (Ti-Al-V alloy, 40 mm in diameter) with a Teflon sleeve outside. Two and three velocity-cycle tests were conducted for dry and wet gouges, respectively, by reducing slip rate V from 0.021 mm/s to 0.21 μm/s and by increasing V to 0.21 mm/s at each cycle. Friction experiments were done at V = 0.021 mm/s after each velocity cycle test by changing the normal stress from 3, 2, 1, 2 and to 3 MPa. This allows to determine the Teflon friction (its maximum) and friction coefficient from shear stress versus normal stress plots. Total slip was 0.91 and 1.37 m for dry and wet runs, respectively.
Experiments are still preliminary, but results show that friction coefficient (Teflon friction corrected) μ of dry gouge increases from around 0.3 to 0.7 from the first to the second V cycles. Whereas μ of wet gouges increases from about 0.25, 0.35 to ca. 0.5 from the first to the third V cycles; wet gouge is weaker than dry gouges by about 0.05 to 0.2. Such increases of μ with V cycles are likely to have been caused by shear-induced compaction. Those friction coefficients are consistent with those determined from tests at different normal stresses. The frictional strength of the wet Akiyoshi greenstone is notably greater than those of typical subduction zone materials with $\mu < 0.2$ (cf. Sawai et al., 2014), and hence the seamounts might become seismic asperities due to their high frictional strengths. However, our current results exhibit slight velocity strengthening at both dry and wet conditions and a seamount may not be a site of earthquake nucleation. Those tentative conclusions will be tested by more detailed work in the future.

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