Variations in Frictional Properties Depending on Temperature in Tectonic Mélanges of Ancient Accretionary Prisms

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Silica redistribution is an important process for fault healing likely to control the slip behavior of the subduction interface. The structure of tectonic mélanges in ancient accretionary prisms likely records the relative motion of tectonic plates and is typically marked by veined sandstone blocks within scaly mudstones, with silica diffusing from shearing mudstones and precipitating in fractures of sandstone blocks. This temperature-dependent process involves mineral precipitation and fracture healing and could strengthen subduction faults during the interseismic period by increasing the contact area across the fault zone in the time between slip instabilities. For mélanges that were accreted at different temperature, we suggest that the temperature variations are likely to result in different silica kinetics that are recorded in microstructural variations that may reflect different frictional properties along plate interfaces. The slip behavior of the plate interface depends on temperature as evidenced by down dip variations in slip mode and differences in earthquake size distributions for subduction zones with different age crust. Based on vitrinite reflectance and fluid inclusion analyses, there are two fossil accretionary prisms, the Kodiak accretionary complex and the Shimanto belt, that have undergone a range of temperatures that correspond to the full range of the seismogenic zone. Rocks from these complexes record variations in clay mineralogy with increasing temperature. Here, we present the results of a series of rock deformation experiments using mélange samples collected from the Kodiak accretionary complex and the Shimanto belt to evaluate how mineralogical changes within the seismogenic zone impact the frictional properties. The samples were powered, sieved to $<125\,\mu m$ grain size, and prepared to layers with area of 5 x 5 cm and proper thickness according to the content of clay minerals in the powers. The layers were then sheared under low normal stress to measure the frictional strength as a function of shear strain based on the assumption that the mélanges were under low effective stress. After steady-state sliding was achieved, multiple velocity steps were conducted. The velocity dependence of steady-state friction and the critical slip distance were determined by fitting the data with rate and state friction laws. The experiments serve as the first step to test the relationship between the paleotemperatures and friction properties.

Keywords: Silica Redistribution, Subduction Zone, Shimanto Belt, Kodiak Accretionary Complex, Slow Earthquake, Rock Deformation Experiment

