Evaluation of frictional melting in subduction-zone faults on the basis of geochemical analyses of fault rocks

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Pseudotachylytes (solidified frictional melts produced during seismic slip) found in exhumed accretionary complexes are considered to have formed originally at seismogenic depths, and help our understanding of the dynamics of earthquake faulting in subduction zones. The frictional melting should affect rock chemistry. Here, toward better understanding of the frictional melting using chemical means, we carried out detailed major and trace element and Sr isotope analyses for pseudotachylyte-bearing dark veins and surrounding host rocks. The samples collected from the Mugi area of the Shimanto accretionary complex, which were previously investigated by Ujiie et al. (2007 JSG), were used. About one milligram each of samples was collected from a rock chip along the microstructure by using the PC-controlled micro-drilling apparatus, and then analyzed by ICP-MS and TIMS. Host rocks showed a series of compositional trends controlled by mixing of detrital sedimentary components. Unaltered part of the pseudotachylyte vein, on the other hand, showed striking enrichment of fluid-immobile trace elements, consistent with selective melting of fine-grained, clay-rich matrix of the fault rock. Importantly, completely altered parts of the dark veins exhibit essentially the same characteristics as the unaltered part, indicating that the trace element composition of the pseudotachylyte is well preserved even after considerable alteration in the later stages. These results demonstrate that trace element and structural analyses are useful to detect preexistence of pseudotachylytes resulting from selective frictional melting of clay minerals. It has been controversial that pseudotachylytes are rarely formed or rarely preserved. Geochemical analyses on clay-rich localized slipping zones shed light on this topic.

Keywords: earthquakes, fault rocks, frictional melting, geochemistry, subduction zones

