Coseismic deformation and shear stress derived from pseudotachylytes in exhumed accretionary complexes

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Pseudotachylytes (solidified frictional melts produced during seismic slip) are expected to provide crucial information on earthquake faulting. We examined coseismic deformation and shear stress during earthquake faulting in subduction zones, based on field and laboratory analyses on pseudotachylytes in exhumed accretionary complexes of the Shimanto and Mino Belts, Japan. The Shimanto pseudotachylytes are typically ~1 mm thick and sharply cut the foliated cataclasite derived from the argillaceous mélange. Marginal melting of albite and K-feldspar grains, vesicles, and idiomorphic acicular microlites of mullite or muscovite are observed in the glassy matrix of the illite composition, suggesting frictional melting at temperatures higher than 1100 ˚C. The Mino pseudotachylyte is a few millimeters thick and bounds the fractured/brecciated gray chert above from the cataclasite below. The wall rocks of the pseudotachylyte are embayed/rounded or intensely cracked. Cracked gray chert fragments are commonly observed in the dark matrix. These cracked wall rock and fragments are absent in the Shimanto pseudotachylytes. The Raman spectra of carbonaceous material indicate advanced carbonization in the Shimanto and Mino pseudotachylytes relative to host rocks. However, the wall rock ~2 mm from the Mino pseudotachylyte also shows progress in carbonization. The measured thermal conductivities are several times higher in the host rock (gray chert) of the Mino pseudotachylyte than in the host rock (sandstone blocks in the argillaceous matrix) of the Shimanto pseudotachylyte. These features suggest thermal cracking associated with heat diffusion from the molten zone was pronounced within the gray chert, possibly representing off-fault damage during earthquake faulting. In contrast, the temperature in the molten zone may remain high due to the host rock with lower thermal conductivities. The coseismic shear stress determined from the correlation between experiment and Raman data is lower in the Shimanto pseudotachylyte than in the Mino, which may result from pronounced dynamic weakening promoted by less diffusive heat loss to the wall rock.

