Frictional melting of argillite at high slip rates: Implications for seismic slip in subduction-accretion complexes

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Discovery of pseudotachylytes from exhumed accretionary complexes indicates that frictional melting occurred along illite-rich, argillite-derived slip zones during subduction earthquakes. We conducted high-velocity friction experiments on argillite at a slip rate of 1.13 m/s and normal stresses of 2.67-13.33 MPa. Experiments show the slip-weakening followed by the slip-strengthening. The slip-weakening is associated with the formation and shearing of low viscosity melt patches. The subsequent slip-strengthening occurred despite the reduction in shear strain rate due to the growth (thickening) of melt layer, suggesting that the viscosity of melt layer increased with slip. Microstructural and chemical analyses suggest that the viscosity increase during the slip-strengthening is not due to an increase in the volume fraction of solid grains and bubbles in the melt layer but could be caused primarily by dehydration of the melt layer. Our experimental results suggest that viscous braking can be efficient at shallow depths of subduction-accretion complexes if substantial melt dehydration occurs on a timescale of seismic slip. Melt lubrication can possibly occur at greater depths within subduction-accretion complexes because the ratio of viscous shear to normal stress decreases with depth. Argillite-derived natural pseudotachylytes formed at seismogenic depths in subduction-accretion complexes are more hydrous than the experimentally-generated pseudotachylytes and may be evidence of nearly complete stress drop.