Numerical simulation of frictional melting: Can we calculate earthquake source parameters from pseudotachylytes?

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Existence of pseudotachylytes clearly indicates frictional melting followed by coseismic slippage of a fault. Di Toro et al. (2005) have measured extensively thicknesses of natural pseudotachylytes and displacements of faults. By conducting a numerical simulation, we show that we can calculate the shear stress, sliding velocity, and temperature distribution in a melt layer from a thickness of pseudotachylytes and a displacement of a fault.

We conducted numerical simulation of one-dimensional heat conduction with moving boundary condition. We found that 1) the thickness of a melt layer increases as square root of time, and 2) shear stress decreases as the inverse of square root of time. This result indicates the solution is self-similar.

If we know the material parameters of both solid and melt layers, the only free parameter is the sliding velocity V. From the numerical simulation, we can get a relation between V and the thickness of a melt layer. From this relation and the self-similarity, we found that the shear stress, sliding velocity, and temperature distribution in a melt layer can be calculated from the thickness of pseudotachylytes and displacement of a fault.

Comparison to the data by Di Toro et al. (2005) shows that thermal conductivity of a melt layer should be larger than that for a solid layer by a factor of 10, which implies the importance of heat transfer by radiation in a melt layer.