Estimation of frictional melting energy by using spatial distribution of pseudotachylyte layers

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Estimation of frictional heat energy is important to understand total energy release during a large earthquake, because most of released elastic strain energy is considered to be assigning to frictional heat. However, yet the quantitative estimation of frictional heat has not been performed either geological or seismological methods. Only Kanamori et al (1998) and Tanaka et al (in submission) could estimate the energy using seismic data and temperature measurement of slip zone, respectively. We present here the quantitative estimation of ratio of melting energy to frictional heat by direct observation of ancient seismic fault rocks in Nojima fault zone. Pseudotachylyte would be a indicator of frictional melting on fault surfaces. Thus, once extent of pseudotachylyte is determined, melting energy can be easily calculated. Fortunately, down-dip distribution of pseudotachylyte has been already confirmed by drilling researches (e.g. Tanaka et al., 2001) along the Nojima fault. Pseudotachylyte layers are obtained at the surface outcrop (Otsuki et al., 2003) as well as in the drilled core (GSJ core) penetrating Nojima fault at 623 m depth. However pseudotachylyte layers are not observed in the core penetrating Nojima fault at 1140 m depth (NIED core). Thus down dip extension of pseudotachylyte layer might be limited to the depth range from 624 m to 1140 m. We performed geological investigations and short drillings along the Nojima surface rupture at around Nojima-Hirabayashi. As a result horizontal extension of pseudotachylyte is clarified to be about 500 m.

The elastic strain energy released during an earthquake is partitioned between frictional heat, Eh, fracture energy, Ef, and radiated energy, Er (Kanamori et al., 1994). We assumed here that the molten region is regarded as asperity, at least a part of fossil of a large earthquake and examine how large energy is consumed by melting, using the equation Em / (Eh+Ef), where Em is energy consumed by frictional melting of rocks.Frictional energy (Eh + Ef) of 1995 Hyogoken Nanbu earthquake is calculated from equations of energy budget (Kanamori et al., 1998). Result of our calculation shows 2.03 - 2.48 x 10^15 J of frictional energy and shows that minimum estimation of melting energy is 5.6 x 10^12 J. Energy consumed by frictional melting energy is inferred to be less than 1.0 percentage.