Fault Dynamics: Surface Fracture Energy and Possible Explosion during faulting

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Abstract

Some of the proposed physical explanations for non-double couple component for shallow earthquakes include source multiplicity, rupture on non-planar fault surfaces and tensile failure under high fluid pressure. The later explanation suggests that the existence of the non-double couple mechanism might be intrinsic to the source process. The Taiwan Chelungpu Fault Drilling Project (TCDP) drilled two vertical and one branch holes across the Chelungpu fault where slips for more than 10 m during the 1999 Chi-Chi (Mw7.6), Taiwan, earthquake. The retrieved cores from TCDP identified a slip zone associated with the Chi-Chi earthquake. The surface fracture energy estimated from the identified slip zone has about 2-6% to the seismic fracture energy. More than 90% of the seismic fracture energy might contribute to heat. The examination on the fault zone observed significant tensile cracks with arbitrary directions in the damage zone A gas monitoring carried out during coring observed a highly content of CH_4 at the depth corresponding to the identified fracture zone. The highly content of CH_4 along with a possible temperature rise of more than 200 degree by frictional heating could contribute to a source for explosion of the fault zone materials during faulting. We further examine the possible non-double components in focal mechanisms from close in strong motion waveforms, and the normal stress changes near the drill site to validate the observation of the explosion during faulting. The seismic data was used to invert the contribution of the possible non-double couple component during faulting. The normal stress changes were calculated from the temporal/spatial slip distribution over the fault. Thus, the evolution of the normal stress changes during faulting could be obtained. We will further compare these results for the region near the drill site to provide whether just the fluid pressure rise during faulting could provide reasonable explanations or explosion is more appropriate.