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The State of Stress of the Mw7.9 Wenchuan Earthquake Faulting and Its Implication to the Aftershock Hazard

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With an integration of in-situ borehole strain-meter data recorded at the Central Longmenshan Fault Zone, seismological observations, including the near-fault strong motion records, and fault slip inversion given by worldwide earthquake research groups, we have tried to investigate earthquake faulting processes and source parameters related to the M_w7.9 Wenchuan faulting processes based on the fault mechanic theory. In order to put different data sets together for analyzing and interpretation purposes, the Anderson's fault classification theory, Coulomb failure criterion and earthquake energy partition principle have been used in the determination of the strength and stress state of the fault by involving the slip-weakening frictional model. For a fault subject to slip-weakening friction, the energy density is the difference between an elastostatic work density spent in fault dynamic rupture and relaxation work if the fault frictional overshoot occurred during the fault dynamics. Strong motion records from Qingping station, the nearest location to the main fault (~5 km), has been used to quantitatively estimate the averaged dynamic stress drop during the earthquake rupture. The primary results show that, for the Wenchuan main event, the seismic radiation efficiency and seismic efficiency are 0.4 and 0.1, respectively, and the critical slip distance (D_c) is about 1.2m and the fracture work is about $2.0*10^{16}$N.m. The relaxing work remained inside the fault zone is about 1 order less than the total radiated seismic energy from the main shock. We present a simple model predicting that the size and time length of aftershock sequences based on the elastostatic mechanism and regional deformation model. We propose that, if the faulting mechanism of the aftershocks inside the main fault zone obeys the same energy partition process of the Wenchuan mainshock, the largest aftershock in which the radiated energy could by release by remained relation work inside the fault zone should be less than M_w7.0 or much more smaller events will occur later on, and the aftershock sequences within the slowly deforming region are predicting to be significantly longer than decade typically observed at rapidly loaded plate boundaries (Stein & Liu, 2009). This infers that the aftershock sequences after the Wenchuan main shock will continue for many decades based on the current aftershock activity patterns.

Keywords: Radiated seismic energy, Overshoot, Slip-weakening friction, Relaxation work, Fracture work, Radiation efficiency