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Kinematics of the double-layered dipping fault rupture of the 2008 Wenchuan earthquake

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It is found that southwestern part of the 2008 Wenchuan earthquake fault consists of double-layered dipping fault coseismic rupture from the investigation of surface fault scarps (e.g., Xu, et al., 2008, Geology). And southwestern part of the double dipping fault zone, there is a joint vertical left-lateral fault perpendicular to the dipping faults called Xiaoyudong Fault. To investigate how these coseismic fault slips were created along such complicated fault geometry, we conducted a forward modeling of kinematic slips to explain the near-fault strong motion records.

One of the key observations is the strong motion waveform at Wolong (WCWL) and Bajiao (SFBJ) stations. WCWL is located close to the hypocenter and SFBJ is located close to the fault trace of the shallower dipping fault (Pengguan Fault) in the double-layered fault zone. The waveform at WCWL includes two wavetrains, suggesting the contributions from two high slip asperities. In contrast, the waveform at SFBJ has a single wavetrain indicating a single asperity.

We first constructed a fault model based on the surface fault traces and InSAR fault models. It consists of three planar faults, Fault 1 (SW Beichuan Fault), Fault 2 (Xiaoyudong Fault) and Fault 3(Pengguan Fault +NE Beichuan Fault). Strike, dip and rake angles, length, width and upper western location of the fault are as follows: Fault 1: (N223E, 50, 135), (130km, 45km), and (30.82 N, 103.28E). Fault 2: (N131E, 90, -28), (10km 19km), and (31.23N, 103.72E). Fault 3: (N222E, 3 7, 90), (206km, 35km), (31.01N and 103.28E). It should be noted that we only focus on the southwestern part of the fault in the present study, so that northeastern fault segments are omitted in this modeling.

Based on the above fault model, we computed near-fault ground motions assuming the hypocenter location of (31.061N, 103.333E, 17.3km). We used the discrete wavenumber simulation code (AXITRA, Coutant, 1989, 2008, http://www-lgit.obs.ujf-grenoble.fr/~coutant/), which is based on Kennett (1979, GJRAS) and Bouchon (1981, JGR). Because we are interested in the rupture evolution on the fault system, we assumed a static slip distribution estimated by InSAR analysis and try to investigate the rupture propagation pattern by a trial and error way.

Unfortunately, as the strong motion accelerograms did not have accurate timing information, we could not perfectly constrain the rupture scenario of this earthquake, but we could propose some possible scenarios for this earthquake to explain the observed waveform paradox based on our proposed fault model.

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Keywords: Wenchuan earthquake, Rupture propagation, Kinematic rupture modeling