

Source fault and rupture process of the 2008 Wenchuan earthquake as inferred from teleseismic and strong motion data

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We studied the source fault and rupture process of the 2008 Wenchuan earthquake using not only teleseismic waveforms observed by FDSN/IRIS but also strong motion waveforms observed by the Institute of Engineering Mechanics of the China Earthquake Administration. We first defined a two-segment source fault according to surface rupture investigations, the aftershock distribution by the United States Geological Survey, and results of our point sources analyses. The surface investigations suggested two parallel fault planes in the southern segment. However, the point sources analyses indicate low-angle reverse faulting for this segment, implying that only the fault plane closer to the Sichuan basin is geometrically realizable. Therefore, each of the southern and northern segments was assumed to consist of a single fault plane, and they were given similar strikes, but different dip angles, again based on the results of the point sources analyses. We next carried out a finite source inversion of the teleseismic waveform data. The result of this inversion indicates MW 7.9, the maximum slip of about 9 m, and two asperities in the southern and northern segments. The southern asperity is much stronger than the northern one. Mostly reverse faulting occurred up to 60km from the hypocenter, but strike slips are dominant beyond 60km. Significant slips appear in a 250 km long region (10,000 km²) of the source fault. These length and area are close to the averages for MW 7.9 low-angle reverse-faulting earthquakes. We then performed a joint inversion of both the teleseismic and strong motion data. The result of the joint inversion still keeps similar features to those found in the result of the inversion of the teleseismic data only. We can also find some discrepancies such as strike-slip components in the southern asperity and shallow slips in the southern segment. The detailed structures of the asperities are shown in the result of the joint inversion. The strong motion records closest to the source fault mainly consist of the ground motions from the southern asperity and the slips around the hypocenter. They overlap each other because of the rupture velocity (V_r) nearly equal to the S-wave velocity (V_s), resulting in strong directivity effects at the northern end of the southern segment. Heavily damaged towns such as Yingxiu and Beichuan and the zones of seismic intensity XI were located just above the southern asperity or at the northern end of the southern segment.

Keywords: Wenchuan earthquake, source fault, rupture process, teleseismic data, strong motion data