

Structural features of the coseismic shear zone of the 2008 Mw 7.9 Wenchuan earthquake, China

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The magnitude (Mw) 7.9 Wenchuan earthquake, China, occurred on 12 May 2008 in the Longmen Shan region, the transition zone between the Tibetan Plateau and the Sichuan Basin, producing a 285-km-long surface rupture zone along pre-existing active faults along the Longmen Shan Thrust Belt (Lin et al., 2008, 2009, 2010; Lin and Ren, 2009). Although many studies have investigated on the ground deformation features and seismic mechanism of the Wenchuan earthquake, and the deep structure of the Longmen Shan Thrust Belt, in the year following the Wenchuan earthquake, the nature of the seismogenic fault zone, including the internal deformation structure of the fault zone and faulting behavior, remains unclear because of a lack of geological data regarding the coseismic fault zone.

The present study reports the analytical results of meso- and microscopic structures of the coseismic shear zone developed in the main fault zone of the Longmen Shan Thrust Belt, which triggered the 2008 Mw 7.9 Wenchuan earthquake, based on observations of fault rocks in outcrops and trenches. The seismotectonic implications of these results are then discussed. Field investigations were initiated immediately following the Wenchuan earthquake, and continued for 1 year, during which time the samples of fault rock were collected. These timely investigations, conducted so soon after the seismic event, and the analysis of fresh samples of fault rocks taken from exposures of the fault plane along which coseismic surface ruptures occurred, provide ideal materials with which to study the nature of rupturing and the active faulting history of a seismogenic fault zone.

Field investigations reveal that the surface rupture of the 2008 Mw 7.9 Wenchuan earthquake, China, occurred along a pre-existing shear zone in the Longmen Shan Thrust Belt. Meso- and micro-structural analyses of the coseismic fault zone and fault rocks show that i) the main coseismic shear zone consists of a fault core that includes a narrow fault gouge zone of <15 cm in width (generally 1-2 cm), pseudotachylyte fault veins and networks, and a fault breccia zone of <3 m in width, and a wide damage zone of >5 m in width that is composed of cataclasite; ii) the foliations developed in the fault core and damage zones indicate a dominantly thrust slip sense, consistent with that indicated by the coseismic surface rupture; and iii) coseismic slip was largely localized to within a narrow fault gouge zone of <2-3 mm in width. The structural characteristics of the coseismic shear zone and cataclastic rocks indicate that the location of coseismic slip zone associated with the 2008 Wenchuan earthquake was controlled by a pre-existing shear zone and that the main active fault of the Longmen Shan Thrust Belt has moved as a thrust since the formation of cataclastic rocks along the fault during the late Miocene or early Pliocene.

Keywords: 2008 Mw 7.9 Wenchuan earthquake, coseismic shear zone, coseismic slip zone, fault gouge zone, fault core, Longmen Shan Thrust Belt