Structural Interpretations of Co-Seismic Faults of the Wenchuan Earthquake in the Rejuvenated Longmen Shan Thrust Belt, China

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The 12 May 2008 Wenchuan earthquake (Mw=7.9) of China occurred in the Longmen Shan thrust belt and is a consequence of the ongoing uplift process of the eastern margin of Tibetan plateau. The coseismic surface ruptures coincide with the pre-existing thrust fault trace. Destruction of buildings and the location of seismically induced landslides are located in the hanging wall of the reactivated thrust faults. In this paper, we construct a 3D structural model of the geometry of the co-seismic faults and related structures of the Wenchuan earthquake integrating geological investigations, relocated aftershocks, and seismic reflection profiles. In the 3D structural model, the differences between the southern and northern segments of the rupture are highlighted. The structural transition zone between the two segments contains a major geometric segment boundary, reflecting differences in the structural configuration of the thrust ramp and the tectonic evolution of the fault system, which appears to have localized significant damage from Anxian to Beichuan. In the southern segment (the Yingxiu–Hongkou–Hanwang segment), two coseismic surface rupture zones coincide with two preexisting thrust faults (the Yingxiu–Beichuan and Pengguan faults) in the seismic profiles and both coseismic active thrusts become incorporated into the deep main detachment. This through-going thrust fault connecting directly from the hypocenter to the surface break, but cannot be easily extended to the northern segment along the Yingxiu–Beichuan thrust fault zone. In contrast, only one shallow coseismic active thrust fault with oblique-slip occurs as the active passive roof of imbricate thrust sheets in the northern segment (Beichuan–Qingchuan segment). Based on this association, the southwestern segment of the Longmen Shan, south of the Wenchuan earthquake, is likely active and presents a significant earthquake hazard, despite the lack of historical earthquakes in this region. This study illustrates the importance of building 3D models to study active faulting and folding, as well as to assess earthquake hazard. Our results show ramp-flat geometry and the wedge characteristics at the blind front of the rejuvenated thrust belt. We emphasize that there is a potential 15–17 km-deep main detachment associated with this large earthquake in the Longmen Shan belt, and infer that some active displacements along the 6–9 km depth shallow detachment have propagated into the Sichuan basin since late Cenozoic.