

Evidence for an AD 800-1000 great earthquake along the Longmen Shan Thrust Belt prior to the 2008 Wenchuan earthquake

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The magnitude (M_w) 7.9 Wenchuan earthquake occurred on 12 May 2008 in the Longmen Shan region of China, 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, 2009a,b, 2010; Lin and Ren, 2009). The steep, high-relief eastern margin of the Tibetan Plateau has undergone rapid Cenozoic uplift and denudation accompanied by folding and thrusting, yet no large thrust earthquakes are known prior to the 2008 Wenchuan earthquake.

The historic record of earthquakes along the Longmen Shan Thrust Belt in the Sichuan region over the past 2000 years reveals only four earthquakes of M > 6 (M 6.5 in 1657, M 6.2 in 1958, 1970, and 1972), with a remarkable lack of large earthquakes of M > 6.5 (EBSSB, 1989; EBASP, 1998); however, there exist many historical earthquakes that caused great damage in the Sichuan region but that are not cited in the catalog of historical earthquakes because of uncertainty regarding their seismic intensity, magnitude, and epicenter due to imperfect or lost historical documents that pre-date the Song Dynasty (AD 960-1279) (EBASP, 1998).

Here, we present paleoseismic and archaeological evidence for a great earthquake that occurred along the Longmen Shan Thrust Belt—the same zone that triggered the 2008 Mw7.9 Wenchuan earthquake during the period between the late Tang and Song Dynasties (AD 800-1000).

Field and excavation investigations reveal that a great historic earthquake occurred in the Sichuan region, that ruptured a >200-km-long thrust fault within the Longmen Shan Thrust Belt, China, which also triggered the 2008 Mw 7.9 Wenchuan earthquake. The average co-seismic slip amount produced by this historic earthquake is estimated to be 2-3 m, comparable with that caused by the 2008 Wenchuan earthquake. Paleoseismic and archaeologic evidence and radiocarbon dating results show that the penultimate great earthquake occurred in the Sichuan region during the late Tang-Song Dynasty, between AD 800 and 1000, suggesting a recurrence interval of 1000-1200 years for Wenchuan-magnitude (M 8) earthquakes in the late Holocene within the Longmen Shan Thrust Belt. This finding is in contrast with previous estimates of 2000-10,000 years for the recurrence interval of large earthquakes within the Longmen Shan Thrust Belt, as obtained from long-term slip rates based on GPS and geological data, thereby necessitating substantial modifications to existing seismic-hazard models for the densely populated region at the eastern marginal zone of the Tibetan Plateau.

References

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