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Tectonic evolution of the frontal Longmen San thrust belt

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The Longmen Shan thrust belt in the eastern margin of the Tibetan Plateau underwent deformation associated with the eastward growth of the Tibetan Plateau. Many geological features indicate that this range is not a typical active convergent mountain belt. Some of the features that indicated that this range is atypical are the fact that it is a young, high mountain, has a thickened crust with a very low GPS shortening rate, and has no corresponding foreland subsidence. Many geologists believe that the crustal thickening that occurred in this area is caused by ductile deformation rather than by thrust faulting or crustal shortening. This hypothesis successfully explains why the upper crust is largely uplifted although the horizontal shortening at the surface is still very small. However, some recent studies based on quantitative structural analysis and a balanced cross-section indicates that a large increase in shortening occurs near the range front, and the structural relief produced by folds and faults is also closely related to the topography of this front. These imply that upper-crustal deformation is the primary mechanism for generating uplift and topography in the foothills of Longmen Shan Range. This idea obviates the need for lower-crustal flow and inflation to produce and maintain the Longmen Shan Range. Scientists have created many different conceptions for the mode of tectonic deformation across the eastern margin of the Tibetan Plateau. However, almost all scientists agree that the eastern Tibetan Plateau has an exceptionally low mechanical strength, inherited from Mesozoic tectonics of the region.

On the 12th of May 2008, Mw 7.9 Wenchuan earthquake occurred in this area provides a direct manifestation of the active crustal shortening and documents the importance of active crustal shortening in developing and supporting the Longmen Shan Range. The co-seismic surface rupture pattern of Wenchuan earthquake, involving multiple structures, is one of the most complicated patterns of recent great earthquakes. Our detail field investigations reveal that the surface rupture of the Wenchuan earthquake cascaded through several pre-existing fault segments. The displacement amount, the rupture pattern and the stress orientation calculated from the fault slickenside striations between the different segments are all different. Some secondary faults can also be observed between the segments. These faults are partially active and control the development of river terraces and the shape of streams. We suggest that the multi-segment rupturing model is a better approximation than a single-segment model for estimating the maximum magnitude of the Longmen Shan fault zone.