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Research Advances

Seismogenic Capability of the Northeastern Segment of the Longmenshan Thrust Zone and its Tectonic Role at the Eastern Tibetan Plateau

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Objective

The occurrence of the devastating Wenchuan earthquake not only caused huge economic loss and deaths but also raised a question whether or not it would trigger any destructive earthquakes on its neighboring segments in the Longmenshan Thrust Zone (LTZ) in the future. Five years afterwards, the Lushan earthquake, occurred to the immediate southwest of the Wenchuan earthquake ruptures, seems to confirm such triggering mechanism in the LTZ and transfers the concern to its northeastern segment.

Before the Wenchuan earthquake, there was rare strong earthquake (M≥6) along the northeastern segment of the LTZ, whereas several strong earthquakes occurred within the Minshan Uplift (MU) (Fig. 1a). Such distinct difference in seismicity seems to suggest that the northeastern segment of the LTZ is inactive and no longer plays a role as boundary fault at the eastern margin of the Tibetan Plateau (TP). This study thus focuses on the late Quaternary strong earthquake behaviour and seismogenic capability of the northeastern segment of the LTZ, and further attempts to reveal its tectonic role at the eastern TP.

Methods

This study firstly conducted paleoseismological trench excavations along the Qingchuan fault (QF), the most significant fault in the northeastern segment of the LTZ. On the basis of the paleoseismological results, integrated with the distributions of the surface ruptures and aftershocks caused by the Wenchuan earthquake, it is analyzed the capability of strong earthquake along the northeastern segment of the LTZ and its tectonic role at the eastern margin of the TP.

Results

Through the trench excavations at two sites along the QF, one (and the latest) faulting event is revealed at each trench site (Figs. 1c and 1d). Because of their overlap of age ranges by radiocarbon dating, they are suggested to be the same faulting event occurred during 4115–3820 B.C. Further, based on the minimum rupture length (>50 km) estimated from the distance between two trench sites, as well as empirical scaling law between rupture length and magnitude, the faulting event identified is thus proposed to be greater than M_S 7.4. And therefore, it is confirmed that the QF is active in Holocene and is able to generate earthquakes of M_S >7.

On the other hand, the Wenchuan earthquake surface rupture and aftershocks along the central segment of the LTZ extended beyond the MU instead of linking them together (Fig. 1a), showing that the break both at and below the ground surface did not follow the proposed boundary faults (central segment of the LTZ-MU) of the eastern TP. Furthermore, beyond the surface trace of the QF, some aftershocks appears to spread along the strike direction of the QF illustrating that the QF have ruptured at subsurface along with the central segment of the LTZ during the Wenchuan earthquake (Fig. 1b).

Moreover, there are 3 aftershocks greater than M_S 6.0 near the QF, including the greatest one (M_S 6.4) of the Wenchuan earthquake sequences. Focal mechanisms of some great aftershocks reveal nearly pure right-laterally strike slips which is in accordance with the slip sense of the QF (Fig. 1b). Thus, it could be suggested that the QF has hosted some great aftershocks of the Wenchuan earthquake implying its ability for strong earthquakes.

Conclusion

Through the paleoseismological investigations on the northeastern segment of the LTZ as well as the analysis of the characteristics of the Wenchuan earthquake surface

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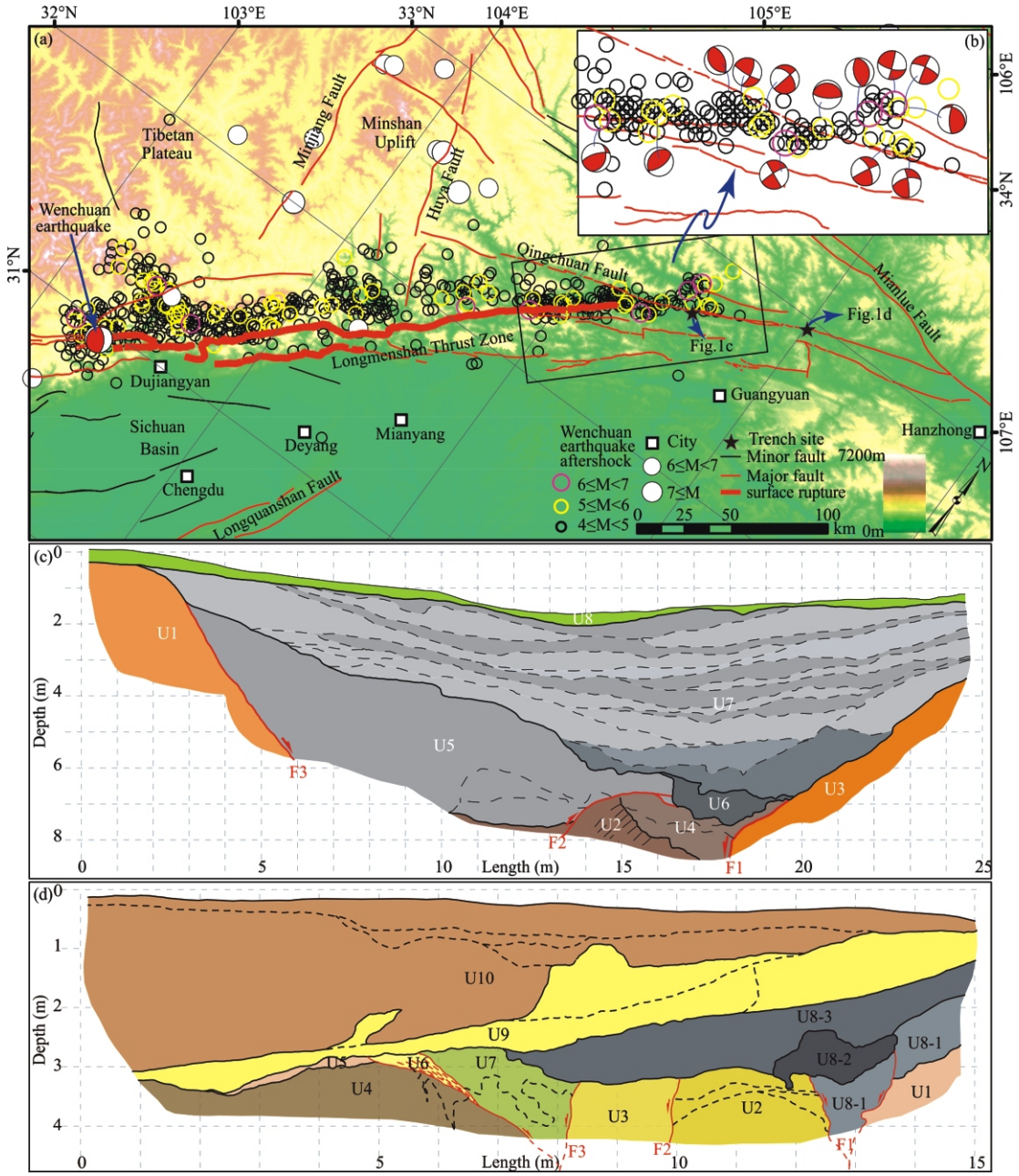

Fig. 1. (a), Major faults and seismicity in the eastern Tibetan Plateau; (b), Distributions of aftershocks near the Qingchuan fault; (c) and (d), Interpretations of trench walls on the Qingchuan fault.

ruptures and aftershocks, the northeastern segment of the LTZ is verified to be active in Holocene and to possess strong seismogenic capability. Under the consideration that the northeastern segment of the LTZ with its central segment, as a whole, has ruptured below the ground surface during the Wenchuan earthquake, it is playing a significant role as part of the boundary fault(s) at the eastern margin of the TP.

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