Research Advances

Cenozoic Denudation and Vertical Faulting History of the Central Segment of the Longmenshan Thrust Belt

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Objective

The uplift process and uplift mechanism of the Tibetan Plateau has been a research focus among geologists in recent years. This work put emphasis on the Cenozoic exhumation histories of the blocks bounded by the major faults at the central segment of the Longmenshan thrust belt, and the vertical faulting history, including the starting time and the total vertical displacement, of the major faults. Then we quantitatively established a complete active process for the central segment of the Longmenshan thrust belt, combining with the previous geophysical data in the deep and geologcial data. This study is critical for deeply and completely understanding the Cenozoic uplift history of the Longmenshan, and also provides thermochronology constraints to the different models for the uplift of the eastern margin of the Tibetan Plateau.

Methods

We mainly utilized low-temperature thermochronology, including apatite and zircon fission track and (U-Th)/He. For different blocks (except the Peng-Guan Massif, as previous researches have got the detailed Cenozoic exhumation history), we took profile samples with different elevation and then dated the samples with the above methods. We obtained the Cenozoic exhumation history on the basis of the thermochronology data, and understood the vertical faulting of the major faults according to the differential exhumation of the blocks at both sides of the faults. Finally, we translated the exhumation histories of the blocks into the active process along the fault plane, according to the deep structure of the faults revealed by seismic reflection profiles.

Results

A total of 19 new zircon fission track ages and 17 new apatite fission track ages were accquired at the central segment of the Longmenshan thrust belt (Fig. 1).

We collected ten samples in a vertical profile at the Xuelongbao Massif, and got ten zircon fission track ages ranging from 8 Ma to12 Ma and three apatite fission track ages ranging between 1.5 and 2.3 Ma. According to these new fission track ages and the previous thermochronology data, we got the cooling history of the Xuelongbao Massif from 12 Ma to the present. The total cooling and average cooling rate were about 260°C and 22°C/Ma, respectively.

At the hanging wall of the Jiangyou–Guanxian Fault absent with thermochronology data, we obtained 12 fission track ages, with ten apatite fission track ages from ca. 5–33 Ma, indicative of the late-Cenozoic differential exhumation along the fault. The differential exhumation shows positive a correlation with the co-seismic vertical offset along the Jiangyou–Guanxian Fault during the 2008 Wenchuan Earthquake. The total exhumation on the hanging wall of the Jiangyou–Guanxian Fault and its low-angle dip revealed by the seismic reflection profiles indicate that there is obvious up-crustal shortening from the Miocene to the present.

Conclusion

The total exhumations of the Xuelongbao Massif at the hanging wall of the Wenchuan–Maoxian Fault from 12 Ma and 2 Ma to the present are much bigger than those of the Peng–Guan Massif, which indicates the Wenchuan-Maoxiao Fault is a reverse fault. The differential exhumation along the Jiangyou–Guanxian Fault shows a positive correlation with the co-seismic vertical displacement along the Jiangyou–Guanxian fault during the 2008 Wenchuan Earthquake, and there is obvious up-crustal shortening from the Miocene to the present. The above results do not support the channel flow model for the uplift of the Longmenshan Mountain.

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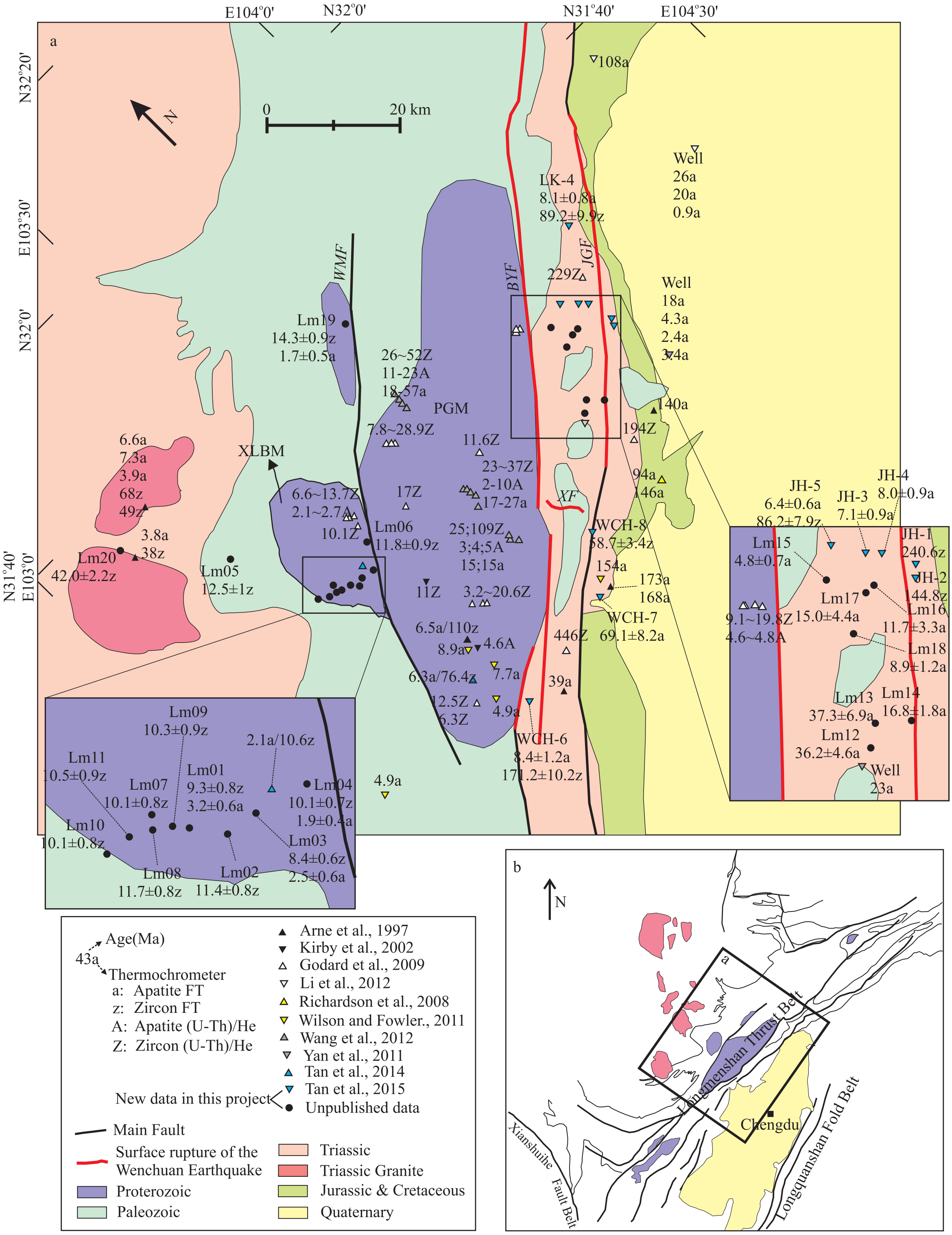

Fig. 1. (a), Geological map and low-temperature thermochronology data at the central segment of the Longmenshan thrust belt; (b), Sketch map of regional geology around Longmenshan thrust belt.

Abbreviation: XLBM, Xuelongbao massif; PGM, Peng-Guan massif; WMF, Wenchuan-Maoxian fault; BYF, Beichuan-Yingxiu fault; JGF, Jiangyou-Guanxian fault.