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slip rates at various time scales of the left-lateral strike-slip Xianshuihe fault system, Eastern Tibet

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Determining the slip-rates of major active faults is essential to understand continental tectonics and assess regional seismic hazard. However, such slip rate estimates often depend on the time scale at which they are measured, depending on the method used, from geodetic time-scale (tens of years), to late Quaternary and geologic time scale (thousands and millions of years). To assess these problems, we compare the slip rates at various time scales for the left-lateral strike-slip Xianshuihe fault system located in the eastern Tibetan Plateau. It is considered as one of the most tectonically active intra-continental fault in China, along which more than 20 M>6.5 and more than 10 M>7 earthquakes occurred since 1700. Studying its slip rate at different time scales is essential to evaluate the regional earthquake hazard.

Using thermochronological data and thermokinematic modeling, we constrain the timing of late Miocene exhumation of the northern portion of the Gongga batholith, located along the Selaha segment of the Xianshuihe Fault. We show that rapid exhumation started at ∼9 Ma at a rate of ∼1.85 km/Myr and slowed down since ∼4 Ma (Zhang et al., 2017). Considering that the onset of motion along the Xianshuihe Fault is contemporaneous with the onset of rapid exhumation recorded in the Gongga batholith at ∼9 Ma and a total offset of ∼62 km documented for the fault, the average slip rate is ∼7 mm/yr since 9 Ma. Along the same segment, by matching the emplacement age of the moraines using 10Be cosmogenic method with their offsets, we obtain late Quaternary horizontal average slip-rates between 9.6 and 9.9 mm/yr, more than 20-30% faster than the geologic rate (Bai et al., 2018). Geodetic slip rates on the Selaha fault have been estimated between 7 and 16.7 mm/yr depending on the authors. Among the most robust estimations, a study from the joint inversion of GPS and InSAR data conclude to a slip-rate between 7 and 7.4 mm/yr (Jiang et al., 2015), compatible with the geologic estimation, while the estimate based on the longest GPS record conclude to a slip-rate between 8 and 10.2 mm/yr (Zheng et al., 2017), compatible with the Quaternary estimation. This relatively high variability in geodetic rate estimates emphasizes that caution is needed when using geodetic data to discuss the precise present-day rate and the seismic risk of a continental strike-slip fault such as the Xianshuihe fault system, where the instrumental effort made in recent years in the area is not sufficient yet to assess the fault rate. Nevertheless, the high slip rate along the short (∼60 km) and discontinuous Selaha fault suggests a high hazard for a M>6 earthquake in the Kangding area in the near future, which could devastate that densely populated city.

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Zhang et al, DOI: 10.1016/j.epsl.2017.02.025
Jiang et al, DOI:10.1002/2014JB011492.2015
Zheng et al, DOI:10.1002/j.JGR.2017.09.021