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Timing of initiation and fault rates of the Yushu-Xianshuihe-Xiaojiang fault system around the eastern Himalayan syntaxis.

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In eastern Tibet, the left-lateral strike-slip Yushu-Xianshuihe-Xiaojiang fault system (YXX-FS) is ∼1400 km long, veering from N100° to N175° broadly following a small circle whose pole is located in the eastern Himalayan syntaxis. Several competing models are proposed to explain the geological evolution of eastern Tibet, and in particular of the YXX-FS: fault following slip-lines in a plastic media, book-shelf fault in a large right-lateral shear zone, or fault bounding a lower channel flow veering around the syntaxis. In this contribution we document the timing of onset of the YXX-FS, its propagation through time, its rate at various time-scales; and discuss how these relate to the deformation models.

The YXX-FS comprises four segments from east (Tibetan Plateau) to west (Yunnan): Yushu-Ganzi, Xianshuihe, Anninghe, and Zemuhe–Xiaojiang. It is one of the most tectonically active intra-continental fault system in China along which more than 20 M>6.5 earthquakes occurred since 1700. Slip-rates of 3.5 to 30 mm/yr along the YXX-FS have been suggested by matching geological offsets of ∼60-100 km with initiation ages of ∼2 to 17 Ma. Late Quaternary rates deduced from morphological offsets, InSAR, paleoseismology and GPS also show a large range: between 3 and 20 mm/yr.

The timing of initiation of the Yushu-Ganzi segment has been constrained at ∼12.6±1 Ma and its total offset to 76 - 90 km (Wang et al., 2009) yielding a rate of 6.6+0.8-0.7 mm/yr. By measuring the offsets of moraine crests and fan edges across the fault using LiDAR and kinematic GPS, and dating their surfaces using 10Be, we determined slip-rates of 7+1.1-1.0 mm/yr, 3 – 11.2 mm/yr and 8.5+0.8-0.7 mm/yr at three different sites. This suggests a constant rate of 6-8 mm/yr along the fault segment since ∼13Ma.

The timing of initiation of the Xianshuihe segment was thought to be prior to 12.8±1.4 Ma (Roger et al., 1995), but new field studies and geochronological ages suggest that the fault initiated later. Using thermochronological data and thermokinematic modeling, we show that rapid exhumation started along the fault in the north of the Gongga batholith at ∼9 Ma and slowed down at ∼4 Ma. Since then, very fast exhumation takes place in the South Gongga batholith where the Gongga Shan (7556 m) stands. This exhumation pattern is explained by the switch of motion between different fault strands within a restraining bend. This constrains the fault onset at ∼9Ma, and together with an offset of ∼60 km, yields a slip rate of ∼7 mm/yr. Dating of an offset debris flow yield a similar Late Quaternary slip-rate of 7.6+2.3-1.9 mm/yr.

These data suggest that the YXX-FS (a) initiated at ∼13 Ma, after a major faults reorganization following the end of Indochina extrusion at ∼17 Ma, (b) propagated from west to east to reach the Gongga Shan area at 9Ma, and (c) has a constant slip rate of 6-8 mm/yr along the Yushu-Ganzi and Xianshuihe segments. This allows reconstructing SE Tibet's structural evolution around the East Himalayan syntaxis and discussing the various models proposed for that evolution.