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Systematical deflections and offsets of the Yangtze River drainages along the Xianshuihe Fault, Tibetan Plateau

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During the past two decades, the integration of geologic, geomorphic, seismic, and geophysical information has led to increased recognition and understanding of the tectonic significance of geomorphic features caused by strike-slip along active strike-slip faults. Tectonic landforms developed along active strike-slip faults are mainly characterized by systematic deflections and offsets of streams and terraces, and fault sags which are regarded as reliable displacement markers useful for reconstructing the long-term activity of active faults. It has been demonstrated that stream offsets and fault-bounded geologic structures such as pull-apart basins have resulted from repeated large strike-slip earthquakes. The study of tectonic geomorphology will provide a new insight into the seismic activity, longevity and structural evolution of active strike-slip faults.

The Ganzi-Yushu-Xianshuihe Fault Zone is a typical strike-slip active fault, which triggered the 2010 Mw 6.9 Yushu earthquake in the central Tibetan Plateau. This fault zone extends for >800 km from the central to the southeastern margin of the Tibetan Plateau, which changes its strike from WNW-ESE to NNW-SSE. In this study, we investigated the systematical deflections and offsets of the Yangtze River and its main branches as well as small stream channel systems along the fault traces of the Ganzi-Yushu-Xianshuihe Fault Zone. The analysis of deflected small stream channels is carried out using Google earth images, 15m-resolution ETM+ L8 images, 30m-resolution ETM+ Mosaics images, and 0.5-1m high resolution World View images. The analytical results show that i) the drainage system of the Yangtze River and its branches have been systematically sinistrally-deflected; ii) the main river channels of the Yangtze River have been sinistrally offset 60-85 km; iii) the offset amount are cumulated on the offset river channels along the fault zone. Geomorphic and geologic evidence confirms that the systematical offsets of streams and gullies are the results of repeated large earthquakes and these topographic features are reliable indicators of seismic displacements accumulated on active strike-slip faults. Our findings support the idea that the strike-slip faults developed in the Tibetan Plateau have played an important role in the eastward extrusion of the Tibetan Plateau and accommodate the ongoing northward penetration of the Indian plate into the Eurasian plate.

Keywords: Tibetan Plateau, Ganzi-Yushu-Xianshuihe Fault Zone, Yangtze River system, systematical deflections and offsets, sinistral strike-slip fault