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Late Quaternary systematic stream offsets caused by repeated large seismic events along the Kunlun fault, northern Tibet

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Abstract

The Kunlun fault is one of the largest strike-slip faults in northern Tibet, China. In this paper, we focus upon the Kusai Lake–Kunlun Pass segment of the fault to understand the geomorphic development of offset streams caused by repeated large seismic events, based on tectono-geomorphic analysis of high-resolution satellite remote sensing images combined with field studies. The results indicate that systematic left-lateral stream offsets appear at various scales across the fault zone: Lateral offsets of small gullies caused by the 2001 M_w 7.8 Kunlun earthquake vary typically from 3 m to 6 m, meanwhile streams with cumulative offsets of 10 m, 25–30 m, 50–70 m, 250–300 m and 750–1400 m have resulted from repeated large seismic events during the late Quaternary. An average slip rate of 10 ± 1 mm/year has been estimated from the lateral stream offsets and ^{14}C ages of alluvial fan surfaces incised by the streams. A three-dimensional model showing tectono-geomorphic features along a left-lateral strike-slip fault is also presented. The Kusai Lake–Kunlun Pass segment provides an opportunity to understand the relationship between geomorphic features produced by individual large seismic events and long-term geomorphic development caused by repeated large seismic events along a major strike-slip fault.

Keywords: Lateral offsets; Streams; Large seismic events; Strike-slip faulting; Northern Tibet

1. Introduction

The pattern of stream courses in tectonically active regions may contain important clues to understand fault movement and its interaction with stream development (Jackson et al., 1996). The lateral displacement of a stream may result from active strike-slip faulting (Wallace, 1968). Some workers assume that fault-bounded geologic structures are also grown by repeated seismic events (e.g., King et al., 1988; Bilham and King, 1989), and this assumption has been confirmed by field examples (Stein et al., 1988; Bilham and King, 1989). The amount of the lateral offset of a stream across a strike-slip fault increases with time (Wallace, 1968, 1990; Sieh and Jahns, 1984; Huang, 1993).

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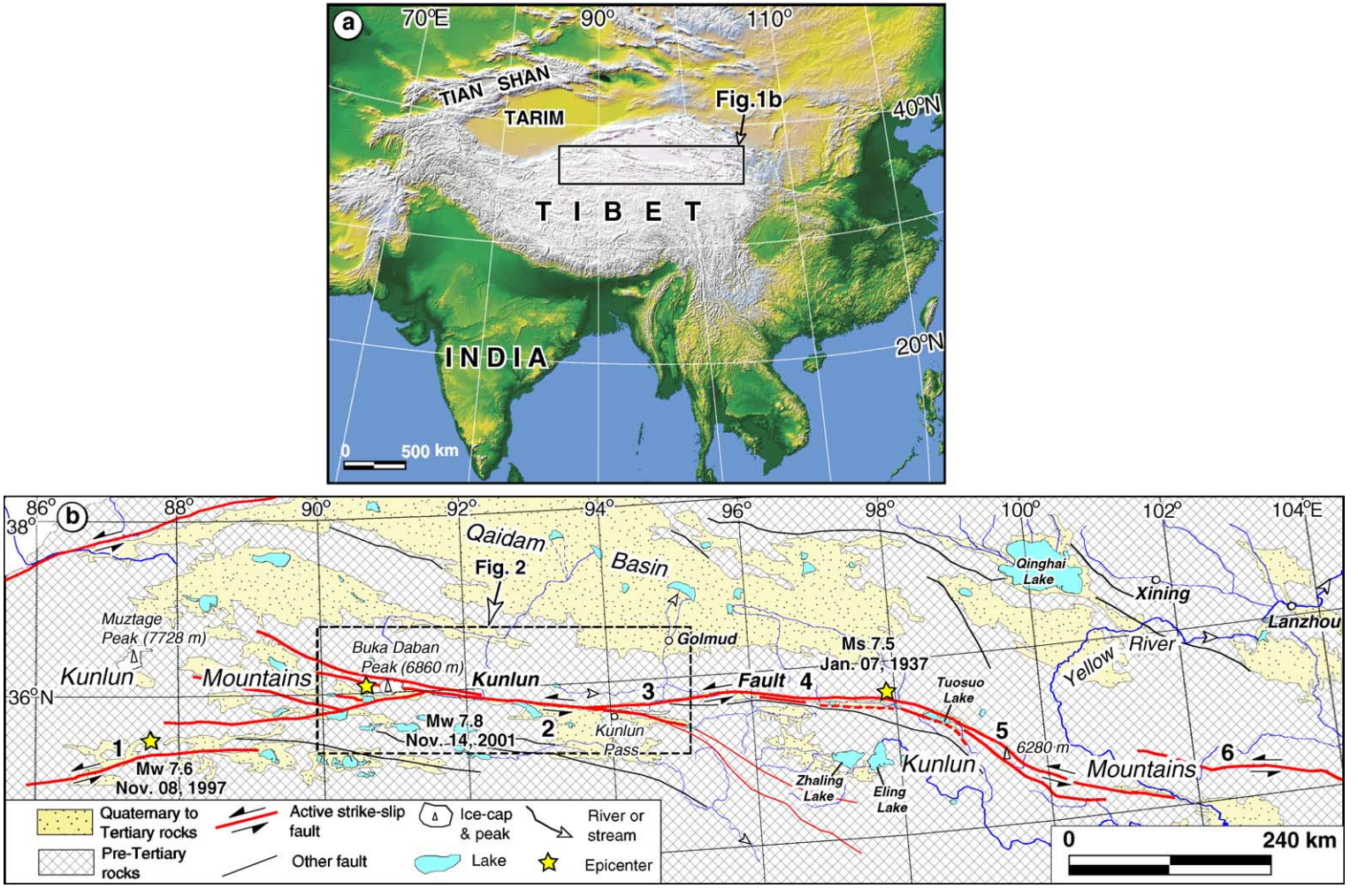

Fig. 1. (a) Shaded-relief image of the India–Asia collision zone generated from the Shuttle Radar Topography Mission Digital Elevation Models (SRTM DEMs). (b) Segmentation of the Kunlun fault system between 86°E and 104°E. 1: Manyi segment; 2: Kusai Lake–Kunlun Pass segment; 3: Xidatan–Dongdatan segment; 4. Tuosu Lake segment; 5. Maqu segment; 6: Min Shan segment.