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# Late Miocene-Quaternary Synchronous-But-Magnitude- Differentiated Episodic Rapid Uplifts of The NE Tibetan Plateau: A Synthesis From Flexural Basins

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The NE Tibetan Plateau is a huge terrain, tectonically confined by the large sinistral Altyn Tagh fault to the West, the giant sinistral Kunlun - West Qin Ling faults to the South, the Qilian-Haiyuan faults to the North and the Liupan Shan transpressional fault to the East (Fig. 1). It consists of a series of alternative characteristic NWW-trending rhombic basins and NWW-directing ranges with high topography (ca. 4000-4500 m in elevation) in the West and low relief (ca. 1500-2000 m) in the East. Enveloped by the NE-directing Altyn Tagh fault, two sets of faults are bordering these ranges and basins. The first set aligns in NWW to EW direction, it consists of left-lateral transpressional faults and plays a major controlling role in regional tectonics, whereas the second set lies in between the first one, is NW directed and right-lateral transpressional. Along the margins of these ranges, various scales of thrust-fold belts are developed, especially along the NWW-trending ranges.

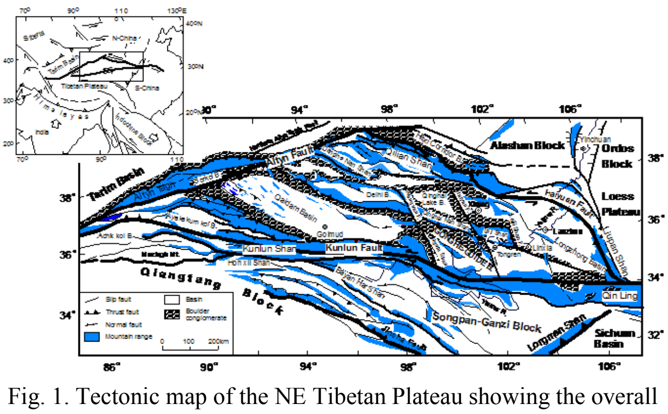


Fig. 1. Tectonic map of the NE Tibetan Plateau showing the overall pattern of tectono-sedimentologic and geomorphologic features. The distribution of massive boulder conglomerates (molasse) is highlighted (after Fang et al., 2005a).

How and when this tectono-geomorphologic pattern formed holds the key to the deformation and uplift of the NE Tibetan Plateau and is also crucial to understand the plateau growth and its mechanism in general. It has generally been thought that the NE plateau was the latest uplifting part of the Tibetan Plateau (Meyer et al., 1998; Tapponnier et al., 2001). Based on few results of apatite fission track cooling histories (George et al., 2001; Julivet et al., 2001) and mostly also on old geologic maps, it was estimated that this part of the plateau grew northeastwards starting from at its southwestern part, the Qaidam Basin and the Danghe Nan Shan (South Qilian Shan) (Mts.), at ~11 Ma, followed by the Yema Shan (Central Qilian Shan) at ~8 Ma, the North Qilian Shan and Hexi (Corridor) Basin at ~5 Ma and its NE part, the Yumu Shan, at ~1 Ma (Meyer et al., 1998; Tapponnier et al., 1990, 2001) (Fig. 2). The northeasternmost part of the plateau, the Liupan Shan was regarded to have uplifted at even later time during the mid to late Pleistocene (Burchfiel et al., 1991; Zhang et al., 1991).

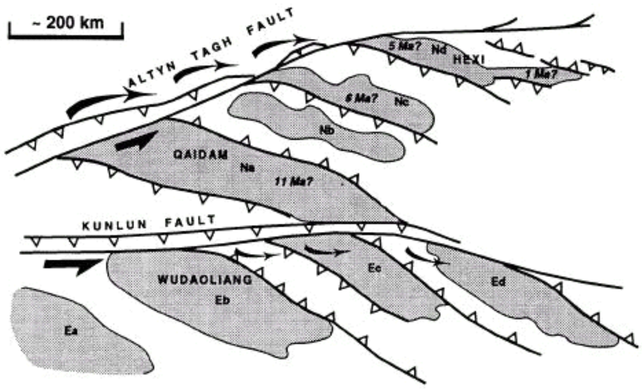


Fig. 2 Schematic diagram showing the northeastward propagation of the strike-slip related faults and growth of the mountains with estimated ages on the NE Tibetan Plateau (after Meyer et al., 1998).

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This paper synthesizes our work during the past decades on the basin stratigraphic and tectonic evolution (e.g., Li et al., 1995, 1996, 1997a,b, 2006; Li and Fang, 1999; Fang et al., 2003, 2005a,b, 2007, 2012; Yan et al., 2006, 2012; Wang et al., 2012; Zhang et al., 2012), together with new data, to reconstruct the history of the deformation and uplift of the NE Tibetan Plateau. Detailed multiple dating (paleomagnetism, OSL and $^{14}$C) of the Cenozoic sediments, thrust-fold belts, growth strata and block rotations in flexural basins over the NE Tibetan Plateau has established high resolution stratigraphic chronologies and tectonic deformation and uplift event sequences for the region. The results demonstrate that the NE Tibetan Plateau experienced three major roughly synchronous phases of tectonic deformation and uplift. The first phase began at about 52-42 Ma in initial response to the collision of India with Asia; it is expressed by reactivation of the large boundary strike-slip faults and their related transpressional faults, which led to slow mountain uplift and initial loading, flexing and infilling of the basins after long denudation of the whole region since the early Cretaceous. The second uplift phase commenced in late Oligocene to the early Miocene at about 30-21 Ma, manifested by two pulses of deformation and uplift, causing a clear angular regional unconformity over the entire NE Tibetan Plateau and increasing the basin foredeep warping. The third phase of the uplift was the strongest and is still on-going. It began at ~ 8±1 Ma, followed by stepwise accelerated rises at ~3.6 Ma, 2.6 Ma, 1.8-1.7 Ma, 1.2-0.6 Ma and 0.15 Ma. This phase is characterized by synchronous episodic (later accelerated) but magnitude-differentiated rapid uplifting of the mountains, thrust-folding, shortening, rotating and flexing of the basins, and the development the growth strata in the NE Tibetan Plateau. The magnitudes of deformation and uplift weakened eastwards, which finally determined the overall patterns of the tectono-geomorphologis and sedimentologic features and large river drainages (such as the Yellow River) of the NE plateau.

**Key words**: Late Miocene-Quaternary, NE Tibetan Plateau, basin analysis, tectonic uplift

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