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Research Advances

Cenozoic Tectonic Evolution of the Arcuate Structures in the Northeast Tibetan Plateau

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The northeast Tibetan plateau contains important information on the northeastward growth of the Tibetan plateau. It is bounded by the Ordos Block to the east, the Alxa Block to the north, and the Tibetan Plateau to the south (inset in Fig. 1; Tapponnier et al., 2001), and has undergone complex intracontinental deformation during the Cenozoic. In this region, the northeast-convex arcuate structures developed northeastward, and are composed of a series of Cenozoic NW–SE-trending basin-and-range terrain, i.e., the Haiyuan–Xingrenbu basin, Tongxin basin and Hongsipu basin, the Yueliang Shan-Nanhua Shan-Huangjiawa Shan, Xiang Shan-Xiangjing Shan, Yantong Shan and Luo Shan-Niushou Shan, which is geometrically similar with the American basin-range tectonics. The front edge of the basin-range is associated with the Haiyuan Fault (F_1), Xiang Shan–Tianjin Shan Fault (F_2), Yantong

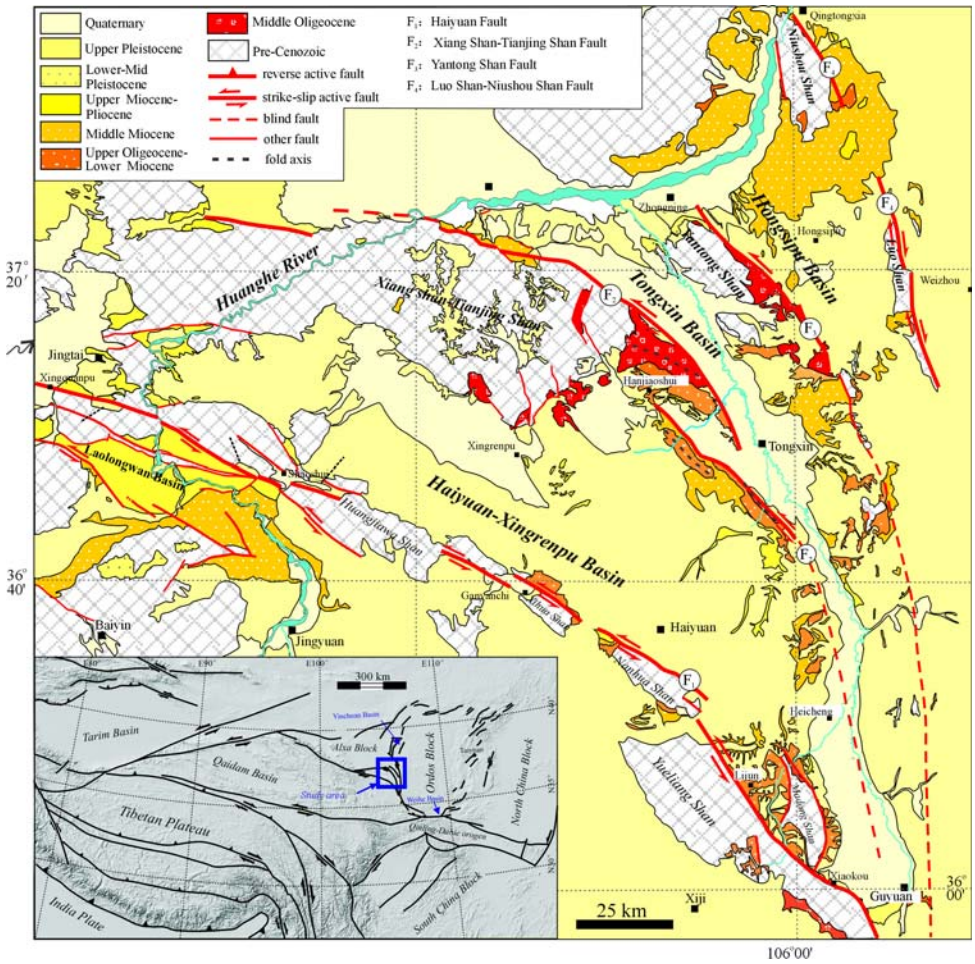

Fig. 1. Sketch geological map of the northeastern Tibetan Plateau (geological map modified from the regional geological maps (1:200000) of Ningxia Hui Autonomous Region and Gasu Province, and DEM from https://wist.echo.nasa.gov/wist-bin/api/ims.cgi?mode=MAINSRCH&JS=1).

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Shan Fault (F_3) and Luo Shan–Niushou Shan Fault (F_4) from southwest to northeast, showing four convex-to-the-northeast oroclinal structures (Fig. 1; IG & SBNHAP, 1990; Zhang et al., 1990； Wang et al., 2013).

There is still considerable debate about the Cenozoic tectonic evolution of the arcuate structures in the northeast Tibetan plateau, especially the formation time and mechanism (Tapponnier, et al., 2001; IG & SBNHAP, 1990； Burchfiel et al., 1991; Zhang et al., 1990； Duvall, 2013； Shi, et al.， 2013). This study conducted detailed structural measurements and fault kinematic analysis, and proposed the growth process of the arcuate structures integrated with new geochronological data. The results are indicative of a two-stage Cenozoic tectonic evolution in the region. The first stage is characterized by the widespread sedimentary basin formed in the western Ordos block during the Oligocene to Late Miocene (ca. 30–10.5 Ma) under NW–SE extension regime, and the subsequent event was basin-inversion triggered by NW–SE compression in the Late Miocene (ca. 10.5–9.5 Ma). These events were induced mainly by the northwestward subduction of the Pacific Plate and partly by the plateau growth (Shi et al., 2013). The second stage was a strong mountain building process and following re-deformation since the Late Miocene (ca. 9.5 Ma), resulted dominantly from the northeastward growth of the Tibetan plateau and partially by the Pacific Plate subduction (Zhang et al., 1990; Burchfiel et al., 1991; Wang et al., 2013). The second stage is further divided into three alternating episodes of shortening and extension events. The first episode was from the Late Miocene to Early Pleistocene (ca. 9.5–1.8 Ma), when the NE–SW compression induced active crustal shortening, resulting in the regional uplift (Zheng et al., 2006; Duvall et al., 2013) and the significant mountain building (Shi et al., 2013) in this region. The second episode was in the Late Pleistocene (?–ca.18 ka). During this stable period, the gentle NE–SW extension was subsequently dominated, characterized by the widespread appearance of paleo-lakes along the NW-striking boundary faults. The last episode was at the end of the Late Pleistocene (ca. 18 ka), which was the ENE-WSW transpression, causing strong left lateral strike-slip activities along the normal faults and small pull-apart basins along the Haiyuan Fault. This research demonstrates that the intensive shortening deformation of the NE-SW fold from the Late Miocene to Early Pleistocene resulted in the present northeast Tibetan Plateau, and that the ENE-WSW transpression induced strong strike-slip activities along the faults and changed the local landform.

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