Oligo-Miocene evolution of the Tuotuohe Basin (headwaters of the Yangtze River) and its significance for the uplift history of the central Tibetan Plateau

Zhifei Liu†*, Chengshan Wang‡§, Xixi Zhao¶, Wei Jin‡, Haisheng Yi‡, Yong Li‡ and Yalin Li‡

† Laboratory of Marine Geology, Tongji University, Shanghai 200092, CHINA
‡ State Key Laboratory of Oil and Gas Reservoir Geology and Exploitation, Chengdu University of Technology, Chengdu 610059, CHINA
§ China Univesity of Geosciences, Beijing 100083, CHINA
¶ Institute of Tectonics and Earth Sciences Department, University of California, Santa Cruz, CA 95064, USA

** To whom correspondence should be addressed. E-mail: lzhifei@online.sh.cn, Fax: +86-21 6598 8808*

The central part of the Tibetan Plateau between the Kunlun and Tanggula ranges provides unique Eocene-Oligocene sediments in the Fenghuoshan Basin of northern part of the Hoh Xil Basin to recognize the early uplift history of Tibet (Liu et al. 2001, 2003; Wang et al. 2002). The Fenghuoshan Mountain region to the south of Jinsha River Suture Zone was recommended as Eocene Tibet and northern part to the Jinsha Suture Zone as Oligo-Miocene Tibet (Tapponnier et al. 2001). However, previous studies have failed to discover any continuous Oligocene to Miocene sequence that precludes our understanding of early evolution history of the central Tibetan Plateau, because a regional discordance developed between the overlying Early Miocene grey limestone of the the Wudaoliang Group and the underlying Eocene-Oligocene grey-violet sandstone, mudstone, and conglomerate complex of the Fenghuoshan and Yaxicuo groups (Liu and Wang 2001; Wang et al. 2002). Our recent fieldwork during summers of 2002 and 2003 in the Tuotuohe Basin as the southern part of the Hoh Xil Basin, about 120 km northward of Tanggula Pass, however, discovered a well-outcropped Oligo-Miocene section.

The Tongtianhe section (N33º55'45", E92º37'13") in the southeastern part of the Tuotuohe Basin, situated in the modern headwaters region of the Yangtze River, consists of the underlying fan-delta-fluvial Fenghuoshan Group sandstone and conglomerate, the middle part of fluvial-lacustrine Yaxicuo Group sandstone and mudstone (~2192 m thick), and the overlying lacustrine Wudaoliang Group limestone (~200 m thick). The Fenghuoshan and Yaxicuo groups were paleomagnetically dated in the Fenghuoshan Basin as Eocene-Early Oligocene (51-30 Ma) with an age of 31.3 Ma for the boundary of the two groups (Liu et al. 2003). In this Tuotuohe Basin, because of poor-outcropped Fenghuoshan Group, our measurements started from the boundary of the Fenghuoshan and Yaxicuo groups upwards to finish at the top of the Wudaoliang Group for atotal thickness of 2392 m. 380 individually-oriented paleomagnetic samples, spaced at 125m stratigraphic intervals, were collected from the Tongtianhe section. Progressive thermal and alternating field demagnetization experiments were conducted by a 2G cryogenic magnetometer at the Paleomagnetic Laboratory of the University of California, Santa Cruz (UCSC). On the basis of distinct magnetic reversal zones with a reference of Cande and Kent (1995) and biostratigraphic data, this section is paleomagnetically dated as 31.3-21.8 Ma (Early Oligocene-Early Miocene), i.e. the Yaxicuo Group as 31.3-23.8 Ma and the Wudaoliang Group as 23.8-21.8 Ma. This result fits very well the boundary age of 31.3 Ma for the Fenghuoshan and Yaxicuo groupswhich was earlier recognized in the Fenghuoshan Basin (Liu et al. 2003).

Our comprehensive basin analysis along with the new paleomagnetic data from the Tongtianhe section suggests that the basin could have been formed as a foreland basin and undergoing an (Eocene?)-Oligocene accelerated subsidence mainly with fan-delta-fluvial to fluvial-lacustrine environments. During the Oligocene, provenance analysis and predominant paleocurrents with northeasterly directions from the Yaxicuo Group suggest the uplift process of the Tanggula Mountain orogenas a major source area of the Yaxicuo Group clastics. The average sediment accumulation rate is 29.2 cm/ka for the Yaxicuo Group. However, during Early Miocene, a relative stable lacustrine environment with a low accumulation rate of about 10 cm/ka developed in the Tuotuohe Basin indicating a peneplanation process accompanying an interior water system in central Tibet. Thus, geomorphic conditions strongly suggest the Yangtze River was not established in central Tibet until after the Wudaoliang Group formation, i.e. 21.8 Ma. This work is advancing our understanding of the Oligo-Miocene tectonic-sedimentary events recorded in the central Tibetan Plateau, which have a direct relationship to the early uplift of Tibet and to the evolution of the Yangtze River water system.

References

Cande SC and DV Kent. 1995. Revised calibration of the geomagnetic polarity time-scale for the Late Cretaceous and Cenozoic. *J Geophys Res* **100**: 6093-6095

Liu Z and C Wang. 2001. Facies analysis and depositional systems of Cenozoic sediments in the Hoh Xil basin, northern Tibet. *Sedim Geol* **140** (3-4): 251-270

Liu Z, C Wang and H Yi. 2001. Evolution and mass-balance in the Cenozoic Hoh Xil basin, northern Tibet. *J Sedim Res* **71 (6)**: 971-984

Liu Z, X Zhao, C Wang, S Liu and H Yi. 2003. Magnetostratigraphy of Tertiary sediments from the Hoh Xil Basin: implications for the Cenozoic tectonic history of the Tibetan plateau. *Geophys J Inter* **154**: 233-252

Tapponnier P, Z Xu, F Roger, B Meyer, N Arnaud, G Wittlinger and J Yang, 2001. Oblique stepwise rise and growth of the Tibet Plateau. *Science* **294**: 1671-1677.

Wang C, Z Liu, H Yi, S Liu and X Zhao. 2002. Tertiary crustal shortening and peneplanation in the Hoh Xil region: implications for the tectonic history of the northern Tibetan plateau. *J Asian Earth Sci* **20** (3): 211-223