Climate of the Past
An Interactive Open Access Journal of the European Geosciences Union

Clim. Past, 4, 153-174, 2008
www.clim-past.net/4/153/2008/

A major reorganization of Asian climate by the early Miocene

Z. T. Guo[1], B. Sun[1,2], Z. S. Zhang[1,3], S. Z. Peng[1], G. Q. Xiao[4], J. Y. Ge[4], Q. Z. Hao[1], Y. S. Qiao[1], M. Y. Liang[1], J. F. Liu[1], Q. Z. Yin[1], and J. J. Wei[1]

[1]Key Laboratory of Cenozoic Geology and Environment, Institute of Geology and Geophysics, Chinese Academy of Sciences, P.O. Box 9825, Beijing, 100029, China

[2]Shandong Institute and Laboratory of Geological Sciences, Jinan, 250013, China

[3]Nansen-Zhu International Research Center, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, 100029, China

[4]State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, P.O. Box 17, Xian, 710075, China

Abstract. The global climate system experienced a series of drastic changes during the Cenozoic. In Asia, these include the climate transformation from a zonal pattern to a *monsoon-dominated pattern*, the disappearance of typical subtropical aridity, and the onset of *inland deserts*. Despite major advances in the last two decades in characterizing and understanding these climate phenomena, disagreements persist relative to the timing, behaviors and underlying causes.

This paper addresses these issues mainly based on two lines of evidence. First, we compiled newly collected data from geological indicators of the Cenozoic environment in China as paleoenvironmental maps of ten intervals. In confirming the earlier observation that a zonal climate pattern was transformed into a monsoonal one, the maps within the Miocene indicate that this change was achieved by the early Miocene, roughly consistent with the onset of loess deposition in China. Although a monsoon-like regime would have existed in the Eocene, it was restricted to tropical-subtropical regions. The latitudinal oscillations of the climate zones during the Paleogene are likely attributable to the imbalance in evolution of polar ice-sheets between the two hemispheres.

Secondly, we examine the relevant depositional and soil forming processes of the Miocene loess-soil sequences to determine the circulation characteristics with emphasis on the early Miocene. Continuous eolian deposition in the middle reaches of the Yellow River since the early Miocene firmly indicates the formation of inland deserts, which have been constantly maintained during the past 22 Ma. Grain-size gradients between loess sections indicate northerly dust-carrying winds from northern sources, a clear indication of an Asian winter monsoon system. Meanwhile, well-developed Luvisols show evidence that moisture from the oceans reached northern China. This evidence shows the coexistence of two kinds of circulations, one from the ocean carrying moisture and another from the inland deserts transporting dust. The formation of the early Miocene paleosols resulted from interactive soil forming and dust deposition processes in these two seasonally alternating monsoonal circulations. The

much stronger development of the early Miocene soils compared to those in the Quaternary loess indicates that summer monsoons were either significantly stronger, more persistent through the year, or both.

These lines of evidence indicate a joint change in circulation and inland aridity by the early Miocene and suggest a dynamic linkage of them. Our recent sensitivity tests with a general circulation model, along with relevant geological data, suggest that the onset of these contrasting wet/dry responses, as well as the change from the "planetary" subtropical aridity pattern to the "inland" aridity pattern, resulted from the combined effects of Tibetan uplift and withdrawal of the Paratethys seaway in central Asia, as suggested by earlier experiments. The spreading of South China Sea also helped to enhance the south-north contrast of humidity. The Miocene loess record provides a vital insight that these tectonic factors had evolved by the early Miocene to a threshold sufficient to cause this major climate reorganization in Asia.

Final Revised Paper (PDF, 3678 KB) Supplement (39 KB) Discussion Paper (CPD)

Citation: Guo, Z. T., Sun, B., Zhang, Z. S., Peng, S. Z., Xiao, G. Q., Ge, J. Y., Hao, Q. Z., Qiao, Y. S., Liang, M. Y., Liu, J. F., Yin, Q. Z., and Wei, J. J.: A major reorganization of Asian climate by the early Miocene, Clim. Past, 4, 153-174, 2008. Bibtex EndNote Reference Manager