22 Myr-climate history recorded in the eolian deposits in China

Z.T. Guo1,2, Q.Z. Hao2, J.J. Wei2, S.Z. Peng2, Z.S. An1 & T.S. Liu1,2

1. Institute of Earth Environment, Chinese Academy of Sciences, P.O. Box 17, Xi’an 710071, China
2. Institute of Geology and Geophysics, Chinese Academy of Sciences, P.O. Box 9825, Beijing 100029, China

1. A 22-Myr eolian history in northern China

The history of eolian dust deposition in northern China has been traced back to 22 Myr (Guo et al., 2002). Eolian deposits include the well-known loess-sequence layers of the last 2.6 Myr (Fig. 1a), containing more than fifty loess and soil layers, the Haplohumus Red-Loam, also referred to as Red-Clay, 2.6-8.0 Myr of eolian origin in the eastern Loess Plateau (Fig. 1a) and the Miocene-Pliocene loess-soil sequences (3.5-7.1 Myr, Fig. 1c) and the Miocene loess-soil sequences (6.2-22 Myr, Fig. 1d) in the western Loess Plateau that contain several hundred pairs of loess-soil layers. The combination of these formations provides a nearly continuous terrestrial stratigraphic record since the early Neogene.

2. Evidence of eolian origin of the Miocene sequences

The Qinian region was characterized by two distinct tectonic/seasonal settings. i.e. the plateau setting where Miocene loess-soil sequences were developed, and the basin setting where waterlain deposits were developed (Fig. 2). The eolian origin of the Miocene sequences is evidenced by (1) the presence of several hundred of paleosols (Fig. 1a and 3a), as confirmed by micro-morphological studies (Fig. 3b and 3c) interbedded with loess-layers with the lateral occurrences of the fluctuations of paleo-
topographic surfaces (Fig. 4); (2) the similarity of quartz grain morphology (Fig. 3d), geochemical properties and grain-size distributions (Fig. 3e-h) to those of the Quaternary loess; (3) the variations of grain-size along the sequences (Fig. 5) characteristics of eolian deposits; (4) the presence of terrestrial mollusks along the sequences and the lack of aquatic species (Fig. 6, Li et al., 2005); (5) the spatially correlated stratigraphy, susceptibility and grain-size distributions (Fig. 7) (see also Liu et al., 2005), and (6) the cyclical changes of various paleo-climate proxies along the sequences (Fig. 8), similar to those recorded by Quatery loess-soil sequences. Pollen analyses indicate more humid conditions for soil layers and drier conditions for loess layers (Fig. 9).

3. Continental climate changes from over-orbital to millennial scales

At over-orbital scale, the eolian deposits document millennial-scale and centennial-scale climate changes in the Asian inland (Fig. 10). The onset of loess-soil formation by 22 Myr indicates the existence of sizeable inland deserts in Asia as dust sources, a energetic winter monsoons as dust carrier and a summer monsoon as a supply of moisture, 22 to 6 Myr, evolution of the aridity was not strongly correlated with the global cooling trends (Fig. 10). However, the drying history since 6 Myr matches the ongoing high-latitude cooling and the consequent expansion of Arctic ice (Fig. 11 and 12). Some events also coincide with proposed uplift of portions of the Tibetan Plateau and the eolian scale, the Miocene loess-soil sequence documented climate changes at Milankovich frequencies (Fig. 13). Pliocene changes were dominated by ~41 ka cycles, consistent with the marine records (Fig. 14). Most of the Quaternary palaeoclimates yield frequency patterns essentially similar to that of the marine record (Fig. 15). Chemical weathering of loess-soil records in China shows the dominance of millennial climate changes in the last 2.6 Myr, including a strong correlation with the 21-kyr cycle (Fig. 16). The ~100-kyr cycle is responsible for the major shift in the climate of the last 800,000 years, and the 21-kyr cycle is the dominant cycle of the last 100,000 years.

Main references related to the contents


Correspondence: Guo Zhengtang, ztguo@mail.iggcas.ac.cn