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High-Resolution Carbonate Variability in Red Earth Deposits: Implications for Water Cycling Dynamics during the Late Miocene

Tong He
Nanjing University of Information Science and Technology, School of Geographic Sciences, China (hetong@nuist.edu.cn)

The late Miocene provides the chance to assess the changing boundary conditions on a warmer world than present. While the climate variability is well understood for the oceanographic records, the water availability and dynamics in terrestrial environment in the densely populated East Asian remains enigmatic. Little is known about the precipitation response to the Antarctic ice-sheets during this time interval. To understand this critical relationship between low- and high-latitude climates, we use a new indicator based on the carbonate variability in Red Earth on the northern Chinese Loess Plateau to reconstruct water availability throughout the interval (7.5–6.9 Ma). Our high-resolution reconstructions show that the carbonate leaching/reprecipitation cycle is dominantly forced by the astronomical parameter obliquity (40-kyr) that is in accord with the Antarctic ice-volume controlled oceanography records at ~7 Ma. Supported by goethite and hematite records in the same site, soil temperatures and precipitations are fully coupled, interpreted as marking the climate pattern of Asian monsoon during the late Miocene. Cyclic correlation between the carbonate variability and the goethite, hematite data, reveal that the obliquity controlled precipitation oscillations were superimposed on a long-term increase of the Asian monsoon, which was synchronous with intensification of climate cooling, the declining of partial pressure of carbon dioxide, and the growing of Antarctic ice-volume. Combined with the atmospheric- and oceanic-adjustments, we suggest that the cross-equatorial pressure gradient has led to the rise of Asian monsoon.