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Resilience of the Asian atmospheric circulation to paleogeographic and climatic changes

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At the southwestern margin of the Chinese Loess Plateau in the Xining Basin, Eocene-Oligocene red mudstones have been interpreted as isolated remnants of dust deposits based on grain-size distribution and quartz grain morphology. These deposits have not received the focus that the Plio–Quaternary Loess Plateau strata have received though they could provide an opportunity to document late Paleogene regional atmospheric circulation and the early mechanisms of central Asian aridification. Here, we used single-grain U-Pb dating of multiple detrital zircons to constrain their provenance. Red mudstone strata yield statistically different age distributions when compared to coeval fluvial sandstones from the Xining Basin, thus corroborating distal aeolian transport. Comparison with Paleogene regional age distributions indicates that provenance of the red mudstones is well-explained by a combination of surface westerly, dust-generating winds blowing along the northern margin of the Tibetan Plateau and recycling of locally-sourced fluvial sediment.
We thus propose that dust accumulation in central China has been occurring during most of the Cenozoic but that Paleogene deposits are rare because of long-term deflation and recycling into younger terrestrial loess deposits and into the Northern Pacific Ocean. The inferred Paleogene arid surface conditions along the northern margin of the Tibetan Plateau, despite the presence of an extended seaway in central Asia -the Tarim Sea, suggest the presence of a strong subtropical high in central China. Evidence of orbitally-controlled lacustrine phases inter-fingered within the red mudstones indicates regular weakening or shifting of this subtropical high and mirrors the Plio-Quaternary monsoonal atmospheric circulation dynamics in central Asia. These findings thus indicate that synoptic-level atmospheric circulation over central Asia has changed little since middle Eocene time and suggest that the retreat of the Tarim Sea and the recent (Miocene–present) uplift of the Himalaya-Tibetan orogen have not been the main drivers of central Asian wind patterns and moisture supply.