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Impacts of Climate Changes During the Mid-Pleistocene Transition on the Carbon Cycle: Evidence from Lake Sediments in the Hetao Basin, Inner Mongolia, China

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The Mid-Pleistocene Transition (MPT) represents a pivotal epoch in Earth's climate history, marked by a shift from 41,000-year to 100,000-year glacial-interglacial cycles. This period is critical for understanding the dynamics of climate systems and the role of carbon cycling in climate feedback mechanisms. To investigate the impact of the MPT climate changes on the carbon cycle, we conducted a high-resolution analysis of carbon isotopes, total organic carbon (TOC), gamma ray (GR), Rb/Sr ratios, and grain size in a 545m drill core from the Hetao Basin in Inner Mongolia, China. We reconstruct paleoclimate and paleoenvironmental changes and construct a 2 Ma long astronomical time scale. The results shows that the lake sediments in the Hetao Basin record the Middle Pleistocene transition at ca. 1.1 to 0.8 Ma. Before MPT, the short warm and cold cycle limited the accumulation and preservation of organic carbon, and could not achieve the enrichment of organic matter. After MPT, the temperature gradually decreased and the glacial-interglacial cycle extended, which provided more stable conditions for the generation, accumulation and long-term preservation of organic matter in lake sediments. During interglacials, the warm climate was conducive to the input of terrestrial materials, leading to organic matter enrichment. During glacials, the accumulation of organic carbon in lake sediments provided rich substrates for anaerobic microbial decomposition, facilitating methane production. The increase in methane could further affect climate change, forming a positive feedback mechanism. This study underscores the importance of terrestrial archives, such as lake sediments, in reconstructing past climate and environmental changes. By providing detailed records from the Hetao Basin, we contribute to the broader understanding of the MPT and its implications for future climate variability and carbon cycling processes.