

Volcanic Degassing and Organic Carbon Burial During the Middle Miocene Climatic Optimum

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The Middle Miocene Climatic Optimum (MMCO, 14-17 Ma) marks a pivotal time in Earth's climatic evolution, characterized by a global temperature increase of approximately 3-4°C and significantly elevated atmospheric CO₂ concentrations. During this period, the global climate system transitioned into a warmer state, with reduced continental ice volume and widespread changes in marine and terrestrial ecosystems. However, despite the recognition of the warming, the precise mechanisms driving the carbon cycle dynamics—especially the role of volcanic activity in influencing carbon cycling and organic carbon burial—remain unclear.

To better understand these mechanisms, we analyzed mercury (Hg) concentrations, organic carbon content (TOC), and inorganic carbon isotopic compositions ($\delta^{13}\text{C}$) of sediment samples from ODP Site U1501, located in the South China Sea. Our results reveal that the elevated Hg/TOC ratios observed during this period suggest that volcanic degassing was a prominent driver of environmental change, which in turn may have stimulated marine biological processes. These volcanic emissions, primarily CO₂, would have contributed to global warming by increasing atmospheric greenhouse gases, further enhancing oceanic temperatures. This warming likely created favorable conditions for increased primary productivity in the oceans, as evidenced by the carbon isotope positive excursion, where $\delta^{13}\text{C}$ values increased from 0.67‰ to 1.96‰. As a result, more organic carbon was produced and buried in marine sediments, reflecting an oceanic carbon sequestration mechanism. Notably, the burial of this organic carbon could have acted as a form of negative feedback, mitigating the increase in atmospheric CO₂ by drawing down carbon from the atmosphere into oceanic sediments.