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Was the Late Paleocene-Early Eocene Hot Because Earth Was Flat? An Ocean Lithium Isotope View of Mountain Building, Continental Weathering, Carbon Dioxide, and Earth's Cenozoic Climate

Authors | Abstract | Full Article | Citation | References

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Abstract

Hothouse climates in Earth's geologic past, such as the Eocene epoch, are thought to have been caused by the release of large amounts of carbon dioxide and/or methane, which had been stored as carbon in biogenic gases and organic matter in sediments, to the ocean-atmosphere system. However, to avoid runaway temperatures, there must be long-term negative feedbacks that consume CO_2 on time scales longer than the ~ 100,000 years generally ascribed to ocean uptake of CO_2 and burial of marine organic carbon. Here, we argue that continental chemical weathering of silicate rocks, the ultimate long-term (multi-million year) sink for CO_2 , must have been almost dormant during the late Paleocene and early Eocene, allowing buildup of atmospheric CO_2 to levels exceeding 1,000 ppm. This reduction in the strength of the CO_2 sink was the result of minimal global tectonic uplift of silicate rocks that did not produce mountains susceptible to physical and chemical weathering, an inversion of the Uplift-Weathering Hypothesis. There is lack of terrestrial evidence for absence of uplift; however, the δ^7Li chemistry of the Paleogene ocean indicates that continental relief during this period of the Early Cenozoic was one of peneplained (flat) continents characterized by high chemical weathering intensity and slow physical and chemical weathering rates, yielding low river fluxes of suspended solids, dissolved cations, and clays delivered to the sea. Only upon re-initiation of mountain building in the Oligocene-Miocene (Himalayas, Andes, Rockies) and drifting of these continental blocks to low-latitude locations near the Inter-Tropical Convergence Zone and monsoonal climate belts did continental weathering take on modern characteristics of rivers with high suspended loads and incongruent weathering, with much of the cations released during weathering being sequestered into secondary clay minerals. The δ^7Li record of the Cenozoic ocean provides another piece of circumstantial evidence in support of the Late Cenozoic Uplift-Weathering Hypothesis.

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