EARLIEST EOCENE COOLING? COMPARISON OF ISOTOPIC AND PALEOBOTANICAL ESTIMATES OF TEMPERATURE DURING THE PALEOCENE- EOCENE TRANSITION.

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Oxygen isotope analysis of benthic and planktonic foraminifera, physiognomy of terrestrial floras, and the wide latitudinal distribution of thermophilic plants and animals provide evidence for very warm condition in the early Eocene. These records also indicate major warming at middle and high latitudes beginning in the late Paleocene during Chron 25. As a first approximation, the warming has been thought to continue uninterrupted, except for a brief event in the latest Paleocene in which temperature first warmed and then cooled over a period of approximately 0.1 m.y. Carbon isotopes also underwent a rapid excursion at this time. Following this "terminal Paleocene event," marine records indicate resumed warming, with temperatures reaching their Cenozoic acme about 1.5 million years later, during Chron 24n.

Perhaps the thickest and most continuous late Paleocene-early Eocene sections in the world occur in the Bighorn Basin of Wyoming. Typical rates of rock accumulation were 15-65 cm per thousand years. Temperature estimates for this area have been derived from both oxygen isotope analysis of authigenic minerals in soils and the physiognomy of fossil leaves. Isotopic reconstructions of paleoclimate rely on the strong correlation between the oxygen isotope composition ($\delta^{18}O$) of meteoric water and mean annual temperature (MAT) in modern mid- to high-latitude regions. The $\delta^{18}O$ of hematite, which precipitates in soils from meteoric water, is insensitive to temperature of formation at low, earth surface temperatures, thus providing a direct proxy of meteoric water $\delta^{18}O$, and ultimately, MAT. Estimates of meteoric water $\delta^{18}O$ were derived from analysis of hematite encrustations on fossil bones, then MAT was estimated by assuming the modern meteoric water/MAT relationship. Temperature estimates drop from 15-20 °C in the million years prior to the terminal Paleocene event (56-55 Ma) to 5-10 °C in the earliest Eocene (54.5-53.5 Ma), before rising to 15 °C by 53 Ma. MAT estimates were derived from fossil floras using the leaf margin percentage method, appropriate for floras that grew under adequate moisture and mild winters. Successive MAT estimates in the last million years before the terminal Paleocene event are 12.9 °C, 14.1 °C, and 18.4 °C. Estimates during the first million years of the Eocene drop from 18.2 °C to 16.4 °C to 10.8 °C. The strong temperature decline is followed by a rapid increase to 15.2 °C then 22.2 °C in the lower part of Chron 24n. The standard error of these estimates is ±0.8 °C.

Isotopic and paleobotanical estimates of paleotemperature are congruent in showing an earliest Eocene cool period that is revealed by high temporal resolution studies of the thick Paleocene-Eocene sections in the Bighorn Basin. If the earliest Eocene temperature decline proves to be a global phenomenon, it complicates the interpretation of both physical causes and biological effects of late Paleocene-early Eocene warming, and illustrates the value of the increased temporal resolution possible in thick continental sections.