LETTER

Unsettled puzzle of the Marlboro clays

Global warming during the Paleocene-Eocene thermal maximum (PETM) was associated with the release of large amounts of ^{12}C-enriched carbon, as reflected in the carbon isotope excursion (CIE) observed globally in sedimentary records. The New Jersey shelf PETM sequences are expanded relative to deep-sea settings, offering high temporal resolution to unravel the pathway of carbon release, although the exact amount of time represented is unknown because of unconformities (1, 2). Wright and Schaller (1) propose an almost instantaneous atmospheric carbon release, based on the assumption that rhythmic couplets in the New Jersey sediments represent annual layers, and that the CIE onset occurred over 13 couplets. Understanding these sequences remains challenging because of complex and extreme environmental changes during the PETM, including eustatic sea-level changes (3) and the development of a river-influenced shelf with high accumulation rates of fine-grained sediment (2). We argue that: (*i*) there is no compelling evidence for annual rhythmic layers; (*ii*) the accumulation rates of 2 cm/y are highly improbable in view of the microfossil content; (*iii*) the cross-shelf $\delta^{13}C$ gradient in bulk carbonate does not reflect overall dissolved inorganic carbon; and (*iv*) the paleodepth estimates are significantly less than published estimates (2, 3).

First, Wright and Schaller (1) do not present compelling evidence for seasonality in the rhythmic layers, such as internal microstructures. Modern offshore laminated muddy sediments may be influenced by various mechanisms, such as variable freshwater discharges, irregular passages of hurricanes, and erosional to nondepositional events (4), all potentially variable on a time scale similar to that of the Atlantic multidecadal oscillation (5). Therefore, the rhythmic New Jersey sedimentary patterns are not necessarily in conflict with published age models and rates of the PETM onset (2) (Fig. 1*A*).

Second, in the offshore areas of modern deltas, very high sedimentation rates occur, but in highly turbid waters in which symbiont-bearing planktic foraminifera and calcareous nannoplankton are extremely rare or absent. However, such microfossils are common and widespread in the New Jersey CIE-sediments (2), so that foraminiferal accumulation rates would be several orders-of-magnitude higher than in similar modern environments. The microfossil evidence thus indicates a clear photic zone in a rather deep shelf setting during the PETM.

Third, the CIE shelf gradient during the PETM is not present in species-specific foraminiferal carbonate, but only in the bulk carbonate record (Fig. 1*B*). This record is easily affected by fluctuations in the proportions of nannofossil species, as well as diagenesis, which in modern mobile mud belts may produce authigenic ^{13}C-depleted carbonates.

Fourth, the paleodepth estimates (30–73 m during the PETM) are important for the discussion of environmental propagation of the CO_2 perturbation (Fig. 1*B*) and its timing, but are significantly less than all published estimates (~120–150 m) based on benthic foraminiferal species and benthic/planktic values (2, 3).

Given these inconsistencies, we think that Wright and Schaller (1) do not present a convincing case that the transition into the PETM occurred within about a decade. More conservative age models and a more gradual onset are better in line with their observations.

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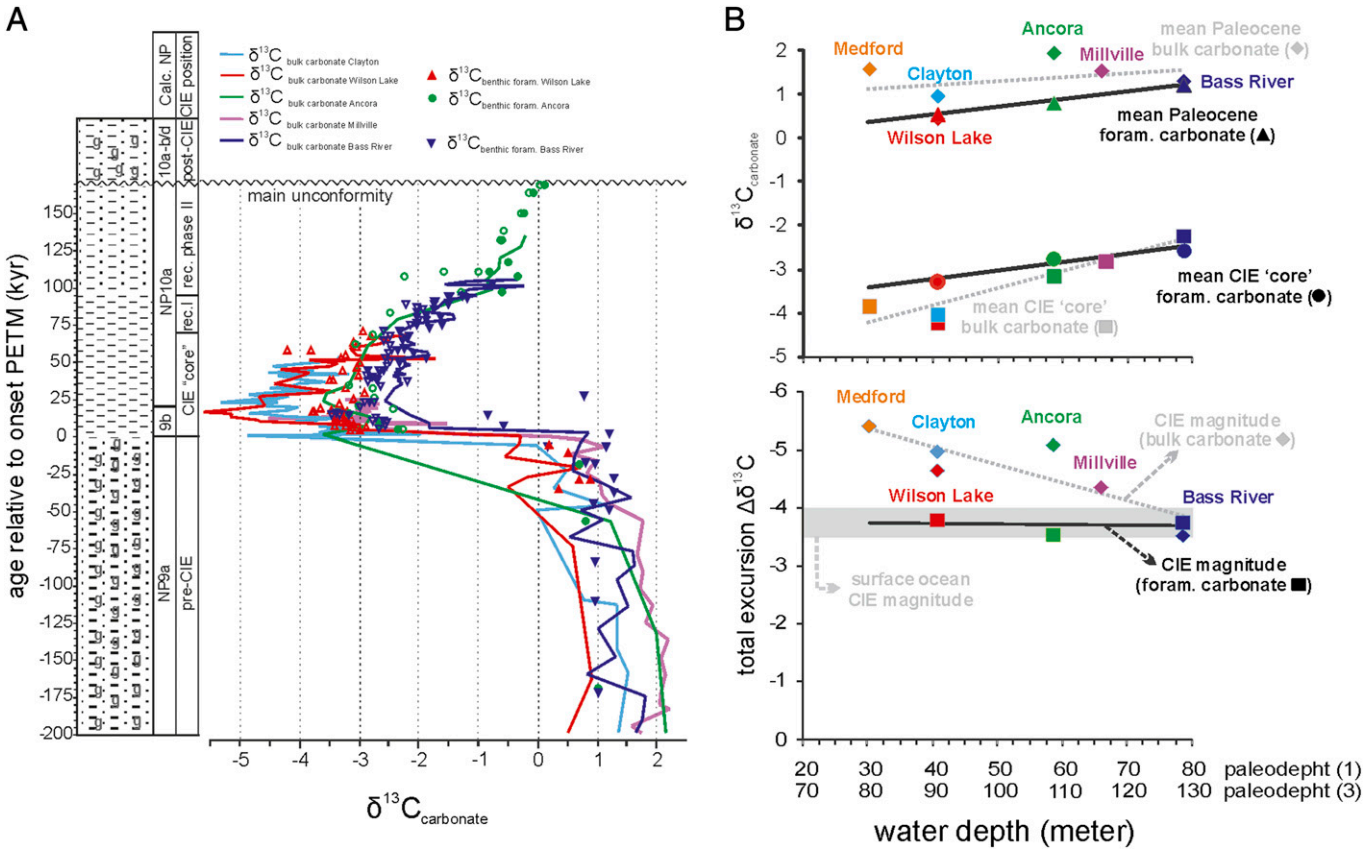

Fig. 1. (*A*) Age model of the PETM sequence in the New Jersey Coastal Plain (1, 2). (*B*) Comparison of the marine bulk carbonate and benthic foraminiferal isotope gradients (mean values), and the relation between total CIE values and the PETM paleodepth estimates of refs. 1 and 3. Note the difference between the bulk carbonate record and the benthic foraminiferal record, which mimics the surface ocean mixed layer CIE magnitude of 3.5–4‰.