Resolving discrepancies between bulk organic matter and *n*-alkane PETM carbon isotope records from the Bighorn Basin, Wyoming

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The Paleocene-Eocene Thermal Maximum (PETM), a period of abrupt, short-term, and large-scale global warming fueled by a large release of isotopically light carbon, is a relevant analogue for episodes of rapid global warming and recovery. This event is recorded in pedogenic carbonate, bulk organic matter, and long-chain *n*-alkanes as a prominent negative carbon isotope excursion (CIE) in paleosols exposed in the Bighorn Basin, Wyoming.

Here we present a high-resolution composite stable carbon isotope record from *n*-alkanes and four bulk soil organic matter carbon isotope records from individual sections spanning the PETM interval in the Cabin Fork area of the southeastern Bighorn Basin. The *n*-alkane curve shows an abrupt, negative shift in $\delta^{13}C$ values, an extended CIE body, and a rapid recovery to more positive $\delta^{13}C$ values. The shape of this high-resolution *n*-alkane curve, with a prolonged and sustained core of the CIE followed by a rapid initial recovery, is similar to the newest ^{3}He-based timescale for the PETM using data from Walvis Ridge, IODP site 1266 (Murphy *et al*., 2010). In contrast, although the bulk organic carbon records show similarly abrupt negative shifts in $\delta^{13}C$ values, the CIE appears to be compressed as well as smaller in magnitude, and the return to more positive $\delta^{13}C$ values is often more gradual. Furthermore, the stratigraphic thickness of the most negative CIE values and the pattern of the recovery phase are not consistent among the four bulk organic carbon records.

Why do we observe such discrepancies between the bulk organic matter $\delta^{13}C$ records and the *n*-alkane composite stable carbon isotope record? Bulk soil organic matter $\delta^{13}C$ values can be influenced by degradation and selective preservation whereas *n*-alkanes are resistant to diagenesis and isotopic exchange. *n*-Alkane stability suggests that they offer a more reliable record of the PETM CIE. To explore why the bulk organic matter $\delta^{13}C$ records fail to capture the full duration of the CIE, we calculate predicted bulk organic matter $\delta^{13}C$ values from the *n*-alkane record by applying an enrichment factor (approximated as the difference between δ_{lipid} and $\delta_{total\ plant\ tissue}$) to the $\delta^{13}C$ values of the *n*-alkanes, assuming $\delta^{13}C_{total\ plant\ tissue}$ approximates soil organic matter $\delta^{13}C$ values. The anomaly, or the difference between the expected and observed bulk organic matter $\delta^{13}C$ values, is calculated for each of the four PETM records. The anomaly is then compared to various soil characteristics (weight percent carbon and grain size) and the possibility of contamination of older transported (Jurassic-Cretaceous) marine organic matter is considered to evaluate potential reasons for the disparities between the bulk soil organic matter and *n*-alkane carbon isotopes.

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