

## A high-resolution terrestrial record of Eocene Thermal Maximum 2 (ETM2 / H1) and H2 in the Bighorn Basin (USA)

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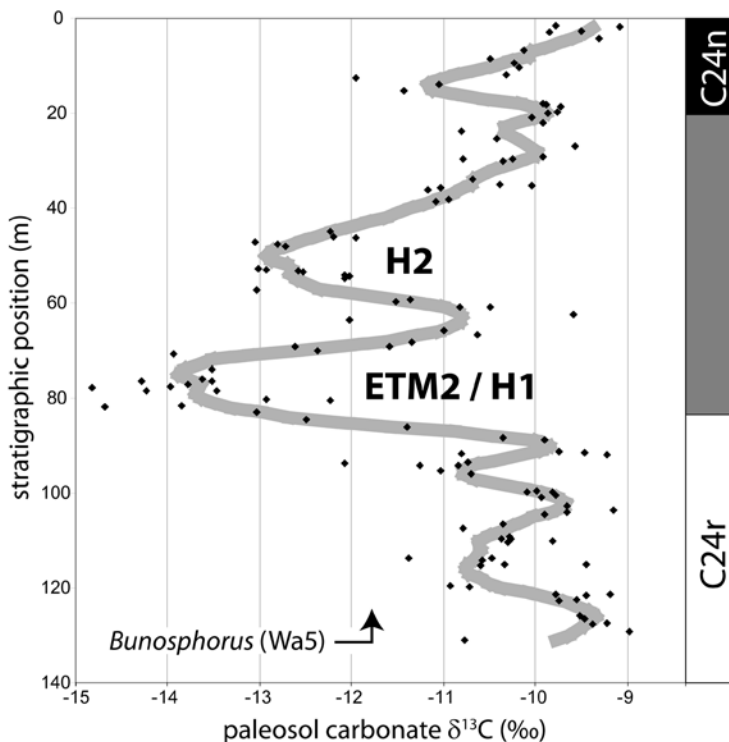
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Late Paleocene and early Eocene hyperthermal events are short-lived periods of rapid greenhouse warming related to massive increases in the concentration of atmospheric CO<sub>2</sub>. Eocene Thermal Maximum 2 (ETM2; also known as the *Elmo* event or H1) is the second largest of these events (after the PETM) and followed after ~100 kyr by the smaller H2 event. ETM2 has only been documented in a few high-resolution marine successions and possibly one low-resolution terrestrial record. Thus the impact of ETM2 on continental climates and biotas remains largely unknown.

Recently, we located two successive negative carbon isotope excursions (CIEs) of ~-3.75 and ~-2.5 per mille in paleosol carbonate in the floodplain sedimentary record of the Bighorn Basin, Wyoming (USA). These are in the Upper Deer Creek section, in McCullough Peaks exposures of the lower Eocene Willwood Formation. The C24r/C24n magnetochron boundary is pinpointed above the base of the larger CIE in our preliminary paleomagnetic results (Fig. 1). This stratigraphic position and the pattern and magnitude of the events indicate that the CIEs are the ETM2/H1 and H2 events, respectively.

New finds of the mammalian genus *Bunophorus* in and slightly below the Upper Deer Creek section indicate that the Wa4-Wa5 biozone boundary occurs well below ETM2. The Wa4 mammals *Ectocion* and *Haplomylus* have not been found in large samples from and slightly below the section. If rapid faunal turnover at the Wa4-Wa5 boundary ('biohorizon B') involved extinction of *Ectocion* and *Haplomylus* and the first appearance of *Bunophorus*, as commonly assumed, then faunal turnover at biohorizon B cannot be explained by greenhouse warming at the ETM2 hyperthermal event.

Our new terrestrial carbon isotope record of ETM2/H1 and H2 reveals a very similar pattern to records recovered from marine successions. Preliminary cyclostratigraphic analysis corroborates a short eccentricity trigger behind both hyperthermal events, with additional precession-pacing of background climate variability. The magnitudes of the ongoing CIEs are similar to those found in a terrestrially-influenced record from the Arctic basin and to a low-resolution excursion found in western India that has been tentatively linked to ETM2.



**Figure:** Paleosol-carbonate carbon isotope results from the Upper Deer Creek section in the Bighorn Basin, Wyoming (USA). Lowest finds of the mammalian genus *Bunophorus* in the section are indicated. To the right, the interpreted polarity from preliminary magnetostratigraphic results is shown. The two carbon isotope excursions are linked to the ETM2 / H1 and H2 hyperthermal events. Stratigraphic position (depth) is measured down from the top of the section.