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Terrestrial records of Eocene Thermal Maximum 2 (ETM2 / H1 / Elmo) and H2 in the Bighorn Basin (USA)

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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_2. Eocene Thermal Maximum 2 (ETM2; also known as the Elmo event or H1) is the second largest of these events after the PETM and is followed after $\sim$100 kyr by the smaller H2 event. ETM2 has only been documented in a few high-resolution marine successions and suggested in 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 $\sim$3.8 and $\sim$2.8 per mille in paleosol carbonate in the floodplain sedimentary record of the Bighorn Basin, Wyoming (USA). The C24r/C24n magnetochron boundary is pinpointed above the base of the larger CIE in our 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.

Mammal finds in the McCullough Peaks area where we documented the CIEs indicate that the Wa4-Wa5 biozone boundary occurs well below ETM2. If rapid faunal turnover at the Wa4-Wa5 boundary (known as '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, when placed in an astronomically-calibrated timeframe, a very similar pattern to records recovered from marine successions. The magnitudes of the ongoing CIEs are similar to those found in western India that has been tentatively linked to ETM2. Also, the CIEs of PETM, ETM2, and H2 in paleosol carbonate records from the Bighorn Basin seem to scale linearly with CIEs in marine carbonate records from the same events.