

Interpreting the Carbon Isotope Record of Canyon Fill Sequences from Eastern Mexico in the Context of Carbonate Sediment Mixing

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Abstract

Bulk marine carbonate $\delta^{13}\text{C}$ records have long been used for stratigraphy and for understanding past changes in the carbon cycle. However, the bulk $\delta^{13}\text{C}$ values are a cumulative signal comprised of individual carbon isotope ratios of different components, each of which may have a different origin. Thus, interpretations of bulk carbonate $\delta^{13}\text{C}$ records can become challenging, especially if the various carbonate components are unknown. Here, we analyze the carbonate content and bulk $\delta^{13}\text{C}$ of Paleocene-Eocene marine samples from a canyon-fill sequence in the Chicontepec formation from the petroliferous Tampico-Misantla Basin, eastern Mexico. We show that samples are exceptionally depleted in ^{13}C compared to contemporaneous marine sediments from elsewhere. As they span the uppermost Paleocene-lower Eocene, we nevertheless expected the carbon isotope record to exhibit a well-known series of long-term and short-term negative carbon isotope excursions (CIEs), especially including that characteristic of the Paleocene Eocene Thermal Maximum (PETM). However, the record looks completely different than those generated at numerous locations, and there is no evidence of a sharp negative CIE. High sedimentation rates in the study area the time of deposition could have led to a thick succession of sediments having overall low $\delta^{13}\text{C}$, thus “widening out” the normally sharp excursion. However, we hypothesize that the Paleocene-Eocene $\delta^{13}\text{C}$ template is masked by abundant detrital carbonate grains that constitute the main CaCO_3 fraction of the sediments. Scanning electron micrographs confirm that the carbonate in these samples mostly consists of these detrital grains. The detrital carbonate could have been sourced

from multiple Mesozoic formations from multiple sources in the nearby Sierra Madre Oriental fold belt. Primary carbonate and organic carbon are negligible in these samples, and hence the externally derived carbonate grains control the $\delta^{13}\text{C}$ values. Thus, we demonstrate that the bulk carbonate $\delta^{13}\text{C}$ of marine sediments, though relatively immune to diagenetic alteration as compared to $\delta^{18}\text{O}$, can be unreliable in cases where there is a mixture of biogenic “primary” carbonate and detrital grains derived from pre-existing carbonate rocks.