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When are Global Changes in the Carbon Isotopic Composition Not Indicative of Global Processes Involving the Global Carbon Cycle?

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Changes in the δ^{13}C of carbonate and organic material throughout the geological record are widely interpreted to reflect differences in the balance between the burial of reduced carbon and its oxidation. While the most reliable records are contained in deep-sea sediments, throughout the majority of the Earth's history δ^{13}C signals are measured in carbonates and organic material deposited on carbonate ramps and platforms and in epeiric seas. Such records cannot only be affected by diagenesis, but also contain a variety of carbonate and organic carbon produced by different organisms, confounding the δ^{13}C signals contained in both archives. An argument often used to support the primary origin of the δ^{13}C values (and therefore that the values are related to the global carbon cycle), is the similarity of the signal in different basins. It is argued that a δ^{13}C signal affected by local or diagenetic effects would not be found at geographically disparate locations. Therefore, a globally similar signal must be primary and related to changes in the global carbon cycle. In this presentation, we describe two mechanisms, controlled by sea level, that produce global changes in the δ^{13}C values which are unrelated to changes in the global carbon cycle. The first of these is caused by rates of sediment production on carbonate ramps and platforms during sea level high stands. During high stands high amounts of isotopically positive sediments admix with lighter pelagic material. This produces global correlations. For example, over the past 10-20 myrs sediments adjacent to carbonate platforms in the Bahamas and in Australia have produced similar δ^{13}C profiles which can be correlated to each other, but are unrelated to the global δ^{13}C changes. The second mechanism is diagenetic. During changes in sea level related to glaciations, shallow-water carbonates are exposed to freshwater. Similar diagenetic zones (i.e., vadose, phreatic, mixing zone, & marine phreatic) develop on a global basis producing similar C isotopic records with changes in excess of 10 ‰ irrespective of geographic location. For example, similar δ^{13}C profiles are seen in sediments from the past 10 myrs in cores from the Bahamas and Enewetak Atoll in the Pacific. These examples show that a global distribution of a δ^{13}C pattern cannot necessarily be considered to be proof of the primary nature of the signal.