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Relationship between sedimentation rate, carbonate content, and carbon isotope records of marine carbonates

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Carbon isotope records from marine carbonates have been frequently used to reconstruct the dynamics of the global carbon cycle as well as to create chemostratigraphic correlations for sections or cores within a basin. These approaches are based on a theoretical framework which suggests that shifts towards more positive carbon isotope values are the result of periods of enhanced organic matter burial on a global scale. In contrast, shifts towards more negative carbon isotope values are interpreted to reflect a period of intense oxidation of organic material, which contributes carbon depleted in carbon-12 to the global carbon cycle. For accurate global carbon cycle reconstructions and chemostratigraphic correlations, it is imperative that the correlations being made between shifts in carbon isotope values are based upon variations in the global carbon cycle and not a result of diagenetic alteration. This is especially important in mixed siliciclastic-carbonate settings where the potential for rock-buffered values to be maintained is reduced. Exacerbation of such negative excursions can occur in mixed carbonate-siliciclastic settings where the ability of the deposit to be 'rock-buffered' is reduced. In this study, the effects of asynchronous periods of low-sedimentation rate on carbon isotope records are evaluated in the mixed carbonate-siliciclastic sediments deposited on the slope of the Great Barrier Reef during ODP Leg 133. This reef-rimmed mixed system is an ideal location in which to test this influence since it exhibits hallmarks of variable sediment contributions recorded at Sites 821, 819, 820 and 823, which are aligned in a proximal to distal transect, including a 200 kyr depositional hiatus constrained by biostratigraphic age datums. The results of this study show that negative excursions in carbon isotope values are produced during periods of low sedimentation rate where a virtually unlimited supply of sulfate ions are able to diffuse into the pore waters, providing electron acceptors to oxidize organic material. Importantly, in this setting, the shifts towards more negative carbon isotope values are not accompanied by sedimentological evidence of alteration, such as the formation of firmgrounds or hardgrounds. Calculations of the time required to shift the carbon isotope values by -2‰ as was observed in the measurements of ODP Sites 821, 820, 819, and 823, require less than 200kyr. As a result, consideration for complicated and uneven distribution of sediments must be accounted for when interpreting carbon isotope records from mixed carbonate-siliciclastic environments.