Rates of authigenic carbonate precipitation in marine sediments using Ca and Sr: Implications for the marine $\delta^{13}C$ record

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The marine carbonate $\delta^{13}C$ record is characterized by globally synchronous, high amplitude, relatively long-term positive and negative excursions throughout Earth history, interpreted as reflecting large perturbations to ocean-atmosphere oxygenation. It was recently proposed that these excursions could be due to the precipitation of authigenic carbonate (AC) with depleted or enriched $\delta^{13}C$ within marine sediments, which would lessen the requirement for large changes in oxygenation. In this study, we evaluate the magnitude of possible marine $\delta^{13}C$ excursions caused by AC precipitation, which depends on (1) the fraction of total sedimentary C that is AC and (2) the isotopic composition of the AC. We determined the AC fraction for a variety of sites sampled in the Oceanic Drilling Program using Ca and Sr pore fluid concentrations and a reactive transport model. Sites included in our analysis span a range of sedimentation rates, organic C and carbonate contents, and extents of sulfate reduction, and can be broadly classified as either carbonate-dominated or mixed-mineralogy. The results of our analysis show that carbonate-dominated sites with low organic C and little sulfate reduction have high AC fractions (up to 0.4), but no anomalous $\delta^{13}C$, and therefore cannot impact marine $\delta^{13}C$. Mixed-mineralogy sites, with comparatively higher organic C and significant sulfate reduction, have very low AC fractions ($\leq$0.03), so although these sites have a net addition of AC with potentially anomalous $\delta^{13}C$, they too have a negligible impact on marine $\delta^{13}C$. The formation of AC with non-marine $\delta^{13}C$ is limited ultimately by sulfate availability, and since oceanic sulfate is higher today than at any other point in Earth history, authigenic carbonate formation is unlikely to be significant enough to explain globally synchronous excursions in $\delta^{13}C$.