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Formation and diagenetic alteration of Bahamian carbonate mud found in deep-water settings using clumped isotope analyses

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Carbonate mud (particle diameter < 63 µm) is an important constituent of carbonate sediments both today and throughout Earth's history. Chemical and isotopic composition of carbonate mud commonly are used to reconstruct past environmental conditions over geologic time. Abiotic (i.e. non-biomineralized) carbonate contributes significantly (~87%) to the formation of Bahamian carbonate mud [1]. Some of this mud is deposited to the seafloor at >1 km water depths, where banktop precipitates accumulate and mix with pelagic components (e.g., coccoliths and planktonic foraminifera), and then undergo diagenesis at higher pressures and colder temperatures compared to their formation environments. To better understand the formation and alteration of shallow-water-derived carbonate mud in deep-water settings, we conducted clumped-isotope measurements of bank-top sediments and piston cores samples from the Bahamas periplatform (*n* =65). Our samples cover the past two glacial-interglacial cycle, thus enable us to study differences and similarities of initial carbonate mud endmembers formed in varied environments altered by different diagenesis mechanisms.

We use clumped-isotope-based temperatures (Δ_{47} temperatures) as a measure of diagenesis because the carbonate mud forms with average temperatures ~24°C along the bank margin, while diagenetic carbonate formed in bottom water has low temperatures (~5°C at 1km water depth). Therefore, we expect diagenesis to lower measured clumped-isotope temperatures relative to formational temperatures and increase $\delta^{18}O$ values. We observe a clumped-isotope temperature range of ~4.0 to 27.5°C and $\delta^{18}O_{VPDB}$ range of -0.7 to 3.3‰, and they are linearly and negatively correlated as expected. Additionally, mixing ratios of aragonite, high-Mg calcite, and low Mg-calcite correlate with $\delta^{18}O$ and clumped isotope data such that, as low Mg-calcite abundances increase relative to aragonite and high-Mg calcite, clumped-isotope temperatures decrease and $\delta^{18}O$ values increase. We interpret this pattern to indicate that the aragonite and high-Mg calcite are replaced on the seafloor by a diagenetic low Mg-calcite endmember that reflects the low temperature of the bottom waters. We observe that glacial samples show an elevated extent of diagenesis relative to interglacial samples. We will discuss these results in the context of a quantitative model of carbonate diagenesis on the seafloor.