Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11679

On the relationship between allochem diversity and bulk carbonate $\delta^{13}C$ values in reefal sediments

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The stable carbon isotope ($\delta^{13}C$) values of carbonate sediments have been interpreted to record dynamic changes in Earth's biogeochemical cycles through geological time [1]. One of the only remaining archives of changes in paleoclimate and biogeochemical cycling from the Paleozoic are bulk carbonate $\delta^{13}C$ records of sediments that were deposited in shallow marine environments, often within ancient reefal settings [2]. However, bulk carbonate $\delta^{13}C$ values can be complicated to interpret because they can be composed of variable proportions of skeletal and non-skeletal sediments that reflect the cumulative impacts of local environmental conditions, mineralogy, and vital effects [3]. Thus, it is likely to be important to quantify the diversity of the sedimentary constituents within a sediment sample prior to interpreting the significance of its bulk carbonate $\delta^{13}C$ value. Here we test the hypothesis that diversity of reefal sediment constituents drives variability in bulk carbonate $\delta^{13}C$ values by conducting bulk and constituent-specific analyses of carbonate $\delta^{13}C$ values conducted on surface sediment samples collected from Fakarava and Rangiroa Atolls in the Tuamotu Archipelago, French Polynesia. In addition, we calculated diversity indices like richness, evenness, Shannon-Weaver, and Gini-Simpson Indices of the sediment samples to evaluate whether correlations between bulk carbonate $\delta^{13}C$ values and diversity indices exist using Pearson's Correlation Matrices and Principal Component Analysis (PCA). Our results from the Tuamotu Archipelago show that variability in bulk carbonate $\delta^{13}C$ values from Rangiroa and Fakarava were driven by changes in allochem diversity indices, and in particular, the abundance of *Halimeda* fragments. When compared to published datasets, sediment allochem diversity was found to be a significant control on bulk carbonate $\delta^{13}C$ values in atoll settings from the Indian, Pacific, and Atlantic Oceans. Insights from this study highlight the importance of adequately constraining the composition of the sediments as a prerequisite to developing interpretations of dynamic changes in global carbon cycling.

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