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Elemental and Isotopic Signatures in Marine Sedimentary Carbonates vs. Foraminifera: Implications for Paleoseawater Reconstruction

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The biogenic carbonate components in marine sediments, such as foraminifera, are considered to be a good proxy for studying ancient seawater. However, the authigenic carbonate components in sediments are not only foraminifera but also include other carbonate components, and even detrital carbonate components. Whether the geochemical composition of the bulk carbonate components in marine sediments leached by specific acid solutions is consistent with the geochemical composition in foraminifera, that is, whether the acid-leachable components can replace foraminifera and become a record of ancient seawater, has always been an unanswered question.

In this study, we focused on sediment samples from core SCS01, retrieved from the northern slope of the South China Sea. Using a sequential leaching method, we isolated the sediment carbonate fractions and compared them with the elemental ratios and Sr isotopic compositions of planktonic foraminifera (Globigerinoides ruber) from corresponding layers. This experiment aimed to explore the geochemical characteristics of sedimentary carbonate components and their paleoceanographic implications. The results indicate that the trends of Li/Ca, Nd/Ca, Mn/Ca, and Ba/Ca ratios in the carbonate fraction of the SCS01 sediments closely resemble those observed in planktonic foraminifera, exhibiting higher values during glacial periods and lower values during interglacial periods. Additionally, the B/Ca, U/Ca, Cd/Ca, and Mg/Ca ratios, as well as the Sr isotopic compositions of the carbonate fraction, also display a glacial-high and interglacial-low pattern. However, these elemental ratios differ from those in foraminiferal shells, likely due to the influences of marine redox condition changes, groundwater exchange during burial, and the input of terrestrial detrital carbonates. Elemental ratios (e.g., Mg/Ca) in different types of biogenic carbonates exhibit species-specific variability. In contrast, the carbonate elemental ratios in sediments reflect a comprehensive signal that integrates contributions from foraminifera, other biogenic carbonates, and terrestrial detrital carbonates. Overall, some elements or isotopes in the carbonate components of sediments are consistent with the corresponding elements or isotopes in foraminifera, while others are not. By properly selecting certain specific elements or ratios, it is still possible for the carbonate components in sediments to replace foraminifera and become promising proxies for studying ancient seawater.