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Evaluating the potential of the bulk carbonate sediments as reliable archives of seawater zinc isotope signatures

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Profound changes in marine productivity in Earth's oceans have significantly influenced global carbon cycle and climate changes. Understanding the productivity history of Earth's surface environment is therefore essential to comprehending the evolution of the Earth as a planet capable of hosting complex life. Typically, insights into marine productivity history are obtained from geochemical signatures sensitive to organic carbon production – so called "paleo-productivity proxies". Marine carbonates, as major archives of Earth's history, have the potential to preserve seawater zinc isotope signatures. However, the extent to which zinc isotope records are affected by post-depositional alteration, challenging the application of this archive. This study presents zinc isotopic data from modern carbonate push cores collected in the South China Sea (SCS), specifically 39 bulk carbonate sediment samples from two shallow-water drill cores (core A and core B, Jiuzhang Atoll). Our dataset reveals relatively consistent $\delta^{66}Zn$ values, averaging +0.28 ± 0.11‰, with exceptionally low zinc concentrations, ranging from 0.06ppm to 0.17ppm, and an average of 0.12 ± 0.06 ppm. These core-top samples, dating from 1400-2000 CE exhibit minimal diagenetic influence, as evident from weak correlations with proxies such as Mg/Ca, Sr/Ca, $\delta^{18}O$, and aragonite proportion. Their open-sea setting, distant from terrestrial inputs and hydrothermal vents, supports oxic pore water conditions, inferred from low redox-sensitive elements concentrations (e.g. U, V, Cd), distinguishing our finding from previous studies in regions like the Bahamas. These results suggest that shallow bulk carbonates have a strong potential to serve as reliable archives for reconstructing past ocean environments. Finally, it is important to acknowledge that geological carbonates typically exhibit zinc concentrations several orders of magnitude higher than those in our samples, suggesting potential extra zinc addition in those materials, therefore, caution should be exercised when interpreting their zinc isotope signatures.