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Assessing Seawater $\delta^{114}Cd$ as a High-Resolution Fingerprint of Local Primary Productivity

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Targeted investigations of geochemical proxies for modern and ancient marine productivity have significant implications for carbon cycling in the global ocean, as biological activity partially mediates carbon uptake and burial in marine environments. Stable carbon isotopes ($\delta^{13}C$) in marine carbonates are the traditional archives for these reconstructions; however, over interannual timescales, the use of $\delta^{13}C$ as a productivity proxy is increasingly confounded by the artificial lightening of atmospheric and surface ocean $\delta^{13}C$ caused by anthropogenic fossil fuel burning (i.e. the Suess Effect). This decoupling of $\delta^{13}C$ from natural biological signals necessitates the development of independent proxies that capture primary productivity cycles without interference from atmospheric and oceanic CO_2 shifts. Dissolved cadmium (Cd) in seawater exhibits a macronutrient-like behavior, serving as a critical cofactor in carbonic anhydrase for many photosynthetic algae. The cadmium isotopic composition ($\delta^{114}Cd$) of seawater should reflect the amplitude of productivity cycles because lighter isotopes are preferentially sequestered during biological uptake, isotopically enriching the remaining seawater. While this relationship is established in open-ocean settings, the sensitivity of $\delta^{114}Cd$ to rapid metabolic fluctuations experienced within coastal and shallow water ecosystems (such as coral reefs) remains poorly constrained. This study investigates the extent to which reef seawater $\delta^{114}Cd$ can resolve high-frequency biological signals of primary productivity. Samples were collected from a reef flat in Curaçao (Southern Caribbean) in May 2025 at 6-hour intervals over a 36-hour period to capture peak metabolic transitions. We compare these $\delta^{114}Cd$ fluctuations against previously measured samples of $\delta^{13}C$ in seawater dissolved inorganic carbon (DIC), which can range from 1 – 2‰ in amplitude in reef locations. Our approach rigorously tests the capacity of double-spike MC-ICP-MS to resolve sub-permil variability in seawater Cd, which often exists at nanomolar concentrations. By determining whether $\delta^{114}Cd$ tracks the metabolic pulse of the reef ecosystem, we provide a foundational knowledge of its responsiveness to local productivity. Establishing this mechanistic link in the study location is a fundamental prerequisite for the application of $\delta^{114}Cd$ in local marine carbonates, ultimately providing a robust, high-resolution toolkit for paleoproductivity reconstructions that are immune to anthropogenic overprinting.