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Can Lithium Isotopes ($^{7}Li/^{6}Li$) Trace Reverse Weathering over the Cenozoic?

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Reverse weathering reactions in marine sediments lead to the formation of in-situ authigenic clays and the release of CO_2 back into the ocean-atmosphere system. As a result, reverse weathering may play a significant role in the global carbon cycle and climate regulation over geologic timescales. Recent studies suggest that a decline in reverse weathering rates and the associated reduction in CO_2 emissions may have contributed to the Cenozoic climate cooling[1]. However, direct records of variations in marine authigenic clay abundance remain uncertain, which is mainly due to the difficulty in isolating authigenic phases from bulk marine sediments. To address this, here we propose to use lithium isotope ratios ($\delta^{7}Li$) of bulk marine sediments as tracers of marine authigenic clay formation with the ultimate goal of applying this tool to quantify marine reverse weathering rates. We analyzed $\delta^{7}Li$ compositions of bulk marine sediments from the South Pacific Gyre (SPG), collected during Integrated Ocean Drilling Program (IOPD) Expedition 329. SPG sites are ideal case study locations due to lower sedimentation rates and therefore less dilution of authigenic phases by detrital material. Bulk sediment analyses of SPG sediments yielded $\delta^{7}Li$ values ranging from +2.87‰ to +11.73‰ in samples spanning 97.1 Ma to 0.1 Ma from Holes U1366D/F and U1369C. A main feature of these results is a marked decrease in $\delta^{7}Li$ compositions of marine sediments from +9.09‰~+11.73‰ to +2.87‰~+6.31‰ over the last 70 million years. Integrated with existing multi-element and $\delta^{26}Mg$ analyses from the same cores, this decrease in $\delta^{7}Li$ of bulk SPG sediments supports a decline in authigenic clay abundance over the Cenozoic as previous studies suggested. Paired with multivariate statistical modeling of sediment compositions at these SPG sites[1], we show that Li isotopes are effective tracers of reverse weathering in marine sediments.

[1] Dunlea et al. (2017) Nature Communications 8, 844. doi:10.1038/s41467-017-00853-5