Changes in the Earth's surface seen through the looking glass of 60 million years of marine isotopes?

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Since it was first proposed that the radiogenic strontium isotope record of past seawater composition reflects changes in continental inputs to the oceans, geochemists have been fascinated with understanding whether marine isotopic proxies illuminate fundamental changes in processes at Earth's surface. Early euphoria about application of radiogenic strontium gave way to growing skepticism and eventually to a consensus that lithological variability may undermine interpretation. But continued efforts have yielded other isotopic records of seawater chemistry, including radiogenic Os, rock-derived ^{9}Be, and stable δ^{7}Li, that all may shed light on inputs from the continental surface. We consider some of the complexities and some of potential insights from variation in these isotope systems over the Cenozoic.

We have re-analyzed the global oceanic Li cycle and identified the potential importance of variable fractionation during removal of Li from seawater as an important control on the past isotopic composition of the oceans. Considering a range of scenarios for Li supply and removal, we conclude that plausible explanations for the ~9‰ rise in seawater δ^{7}Li most likely require significant increase in the δ^{7}Li of continental inputs. These changes were probably associated with changes in denudation regime, consistent with a shift towards lower weathering intensities, although inferred early Cenozoic continental δ^{7}Li (which could have been as high as 8-9‰) does not require globally supply limited weathering.

We assess the meaning of Li isotope variations in the context of other isotopic records and dynamics of the long-term global carbon cycle. Is decreasing weathering intensity consistent with the ^{9}Be record, which implies relative stability in long-term weathering flux at least for the Neogene? If radiogenic Os reflects the weathering of shales that contain abundant pyrite and organic carbon, does the increasingly radiogenic seawater Os reflect enhanced release of CO_2 from the sedimentary reservoir? How important might such C release be in reconciling the Cenozoic records? We consider current knowledge that helps address these questions and speculate on how further work might answer them.