The Accumulation of Authigenic Metals in Marine Sediments: Proxies for the Ocean's Carbon Cycle

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Continental margins represent important focal points for biogeochemical cycling. These locations are where terrestrially derived nutrients are delivered to the oceans, and it is here where ocean physics generates the conditions conductive to the upwelling of nutrient rich waters. This combination results in continental margins being locations of high biological production and it is where much of the ocean's carbon burial occurs. Despite the global importance of this region, understanding how global ocean change impacts the continental margin carbon cycle remains uncertain. This contribution examines the relationship between the rate of organic carbon delivery to the seabed and the accumulation rate of uranium, molybdenum, rhenium, and cadmium in reducing continental margin sediments. The central hypothesis advocated here is that above some "critical" rain rate of organic carbon, which is metal dependent, the decomposition and burial of organic carbon at the sea floor is the primary process responsible for authigenic metal accumulation. This idea does not exclude the possibility that low bottom water oxygen availability may also play a direct role in fostering the reducing conditions necessary for metal authigenesis, but an implicit implication here is that such a role is minor in comparison to the importance of organic carbon cycling. We also suggest that the conditions that impact the efficiency of organic carbon burial, impact authigenic metal preservation, i.e., in locations where organic carbon preservation is poor, authigenic metal preservation will be low—independent of other chemical factors. The ideas presented here imply that using metal enrichments or concentrations as semi-quantitative proxies for ocean chemistry is not tenable in part because the sediment accumulation rate is a necessary constraint for interpreting the sedimentary record. Future advances in authigenic metal paleoproxy geochemistry lies in developing elemental and isotope ratios as proxies. The use of ratios, either isotopic or elemental, removes the requirement for detailed sediment accumulation rate information, and initial work suggests that when used in combination, the authigenic metals or their isotope ratios may indeed provide quantitative constraints on ocean chemistry.