Evaluation of the Mo isotope paleoredox proxy in Late Cretaceous ocean sediments

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Ocean oxygenation has varied through geologic time, but the timing and extent of these variations are not well understood. Mo stable isotopes have emerged as a valuable new tool in investigation of paleoredox because (1) organic-rich shales deposited under sulfidic conditions can record contemporaneous global marine Mo isotope ratios and (2) the $\delta^{97/95}$Mo seawater value varies with the relative magnitude of the oxic (~-0.5‰), suboxic (0.3 to 1.1‰) and anoxic (~1.5‰, modern values) depositional sinks in the world ocean [1,2,3].

Several Late Cretaceous events are widely agreed to be characterized by extensive marine anoxia. Laminated sediments spanning these events and the intervening intervals are recorded in ODP Hole 1258A (Demerara Rise, tropical western North Atlantic), providing an excellent test of Mo isotopes as a global paleoredox proxy.

Systematic variations in Mo concentrations and isotopes correlate with positive $\delta^{13}C_{org}$ excursions at the mid-Cenomanian event and OAE2 [4]. During these events, $\delta^{97/95}$Mo values increase to 0.8‰ from a background of ~0.4‰. We hypothesize that the Mo isotope data record a shift from locally suboxic to euxinic conditions during the δ^{13}C excursions. In this case, the maximum $\delta^{97/95}$Mo represents seawater, while $\delta^{97/95}$Mo before and after the δ^{13}C excursions is fractionated by local processes linked to suboxic bottom waters. Inferred seawater values are lower than modern seawater (1.56 ± 0.13‰), consistent with widespread ocean euxinia contemporaneous with the δ^{13}C excursions. In addition, the concentration of Mo during OAE2 and the mid-Cenomanian event decreases from a background of 80-170 ppm to 18-70 ppm, consistent with drawdown of the ocean Mo inventory during periods of widespread euxinia. However, independent controls on local bottom water oxygenation are required to validate the hypothesis.

References

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