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A link between primary productivity and marine redox in the Mesoproterozoic McArthur Basin, Australia: Insights from Cd isotopes

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Cadmium isotope variations ($\delta^{114}Cd$) serve as a valuable tracer in ancient organic-rich sediments, reflecting past marine productivity and redox conditions. These variations are influenced by Cd scavenging via organic matter and CdS formation in anoxic or euxinic settings [1].

This study investigates the bio-geochemical and isotopic variations in organic-rich facies of Velkerri Formation from the Beetaloo Sub-basin (McArthur Basin, north Australia), with a focus on the following proxies: cadmium isotopes ($\delta^{114}Cd$), organic carbon isotopes ($\delta^{13}C_{org}$), total organic carbon (TOC), and redox-sensitive trace metal proxies (Mo, U). These proxies are used to reconstruct primary productivity and redox conditions during deposition across three key organic-rich intervals of the Velkerri Formation, namely the organofacies A, B and C, separated by organic-lean intervals (intra A–B and intra B–C) from the Marmbulligan-1 well. Notably, the B-organofacies exhibits more positive $\delta^{114}Cd$ values (average 0.04 ± 0.05‰, 2σ; n=10), accompanied by higher $\delta^{13}C_{org}$ values and TOC contents, compared to other organofacies. Additionally, significant Mo and U enrichment in studied organofacies suggests predominantly anoxic conditions during the deposition of these intervals. In contrast, samples from the lower part of the formation (A-organofacies) represent less reduced conditions, with lower TOC content and a shift towards more negative $\delta^{13}C_{org}$ values. This suggests that less reduced pore water conditions may have broadly controlled organic carbon preservation in this interval. However, it appears that the interval retains moderate and positive $\delta^{114}Cd$ values (average +0.09 ± 0.04‰, 2σ; n=5), indicating a moderate level of primary productivity in the water column during the deposition of the A-organofacies.

Overall, our results suggest that the combination of elevated primary productivity (inferred from Cd isotopes) and favourable anoxic conditions (indicated by Mo and U) played a crucial role in the production and preservation of organic matter (TOC) in the studied Mesoproterozoic marine sediments from the McArthur Basin.

References

[1] Janssen, D. J., Conway, T. M., John, S. G., Christian, J. R., Kramer, D. I., & Pedersen, T. F. (2014). Isotopically light Cd in the northern Pacific Ocean: Evidence for significant biological uptake. Earth and Planetary Science Letters, 394, 174-185.