Towards an improved understanding of the Mo and U isotope proxies using correlated Mo-U isotope signatures

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Due to their redox-sensitive behavior, Mo and U isotopes are frequently used as proxies to reconstruct the paleo-redox evolution of past oceans. However, both Mo and U isotopes in sediment archives are sensitive to the local conditions during sediment deposition, and their isotopic signal may be further modified during diagenetic overprint. Here, we show that Mo and U isotopes in organic-rich sediments frequently show a negative correlation and that the combined use of both isotope systems may help to improve the reliability of paleo-redox constructions. As Mo reduction occurs in the water column and U reduction is thought to take place mainly in the sediment pore water, a direct coupling of authigenic Mo and U isotope signatures may not necessarily be expected, and only weak correlations are observed in modern organic-rich sediments (e.g. from the Black Sea). However, our data for Phanerozoic black shales deposited during the Cretaceous (OAE2)[1], early Jurassic (T-OAE) and early Cambrian[2] show remarkable correlations between Mo and U isotopes. The strongest correlation is observed for early Cambrian rocks that experienced strong enrichment of several redox-sensitive metals, resulting in the formation of V ores with low δ^{98}Mo and high δ^{238}U. We infer from these observations that Mo and U isotopes have been fractionated during both primary deposition and post-depositional metal mobilization. According to the largely unidirectional charcter of Mo-U isotope fractionation, the combined use of both proxies still allows to use them for paleo-redox reconstructions and potentially even to distinguish between predominantly anoxic or euxinic conditions. Application to the investigated sediments indicates that the expansion of seafloor anoxia (likely euxinia) were significantly enhanced during the OAE2 and T-OAE, while in the early Cambrian, deep oceans were likely only slightly less oxic than today[3].

References

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