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The molybdenum-uranium isotope system at the Cambrian-Ordovician transition in black shales of northern Estonia, Baltic Paleobasin

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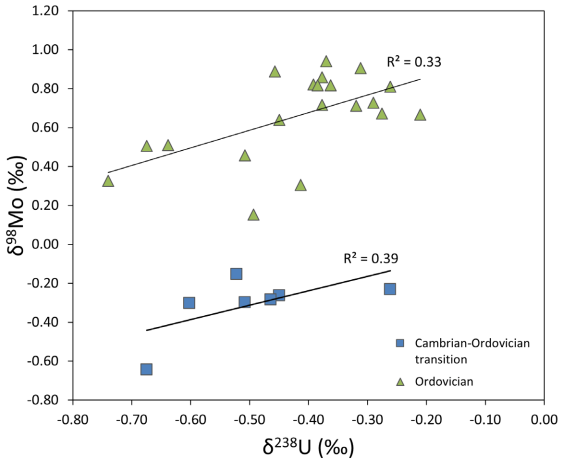

The coupled molybdenum (δ^{98}Mo) and uranium (δ^{238}U) isotope system was studied in the Cambrian-Ordovician black shale in Estonia, Baltic Paleobasin, to assess paleoredox conditions. This black shale, locally known as graptolite argillite, is a Tremadocian-age (Lower Ordovician) equivalent of the Scandinavian Alum Shale and was deposited at time known for alternating extinction-recovery cycles following the Cambrian Explosion and prior to the Great Ordovician Biodiversification Event, the timing of which has been tied to expansions and contractions of anoxia in the oceans [1].

Samples across the Cambrian-Ordovician boundary beds were analysed for their δ^{98}Mo and δ^{238}U composition along with bulk geochemical assays. Samples at the Cambrian-Ordovician boundary show significantly lighter δ^{98}Mo (−0.31 ± 0.14‰) compared to the succeeding Tremadocian samples characterized by δ^{98}Mo of 0.66 ± 0.21‰ (Figure 1). However, δ^{238}U is rather similar in samples on the Cambrian-Ordovician transition (−0.50 ± 0.12‰) and in Tremadocian beds (−0.42 ± 0.14‰). Both sample sets show weak positive correlations between δ^{98}Mo and δ^{238}U, whereas a linear covariation between Mo and U concentrations suggest no significant influence of a Fe-Mn particulate shuttle that could also have influenced the isotope fractionation.

The δ^{98}Mo and δ^{238}U recorded in the Tremadocian shales of the north-Estonian sector of the Baltic Paleobasin are lower than reported in the Paibian-age Alum Shale successions (δ^{98}Mo ca. 1.0‰, δ^{238}U ca. 0.0‰) [2,3]. However, the large variability in δ^{98}Mo as well as the slightly-more-negative-than-seawater δ^{238}U (< −0.38‰) are similar to those reported recently in Cambrian-Ordovician transition beds in Green Point shales in Newfoundland [4], possibly implying large redox variations and expansion of marine euxinia during this period of time. These results lend support to the importance of dynamic redox conditions in major Cambrian-Ordovician biotic events and highlight the variability in “global” redox proxies even across different parts of the same basin.

[1] Dahl et al. (2010), *Geochim. Cosmochim. Acta*, 74, A202-A202. [2] Gill et al. (2021) *Palaeogeogr Palaeoclimatol Palaeoecol*, *581*, 110623. [3] Zhao et al. (2023) *Earth Planet Sci Lett*, *604*, 118013. [4] Li et al. (2022) *Chem Geol, 602*, 120882.