Reconstructing global ocean redox conditions by coupling the Mo and U isotope systems of euxinic organic-rich mudrocks

XINZE LYU[1]*, TAIS W. DAHL[2], WANG ZHENG[3], SU WANG[1], BRIAN KENDALL[1]

[1]Dept. of Earth & Environmental Sciences, University of Waterloo, Waterloo, Ontario, Canada (*correspondence: xlv@uwaterloo.ca)
[2]GLOBE Institute, University of Copenhagen, Copenhagen K, Denmark
[3]Institute of Surface-Earth System Science, Tianjin University, Tianjin, China

The molybdenum (δ^{98}Mo) and uranium (δ^{238}U) isotope compositions of euxinic organic-rich mudrocks (ORM) have been used as novel global ocean redox tracers. However, inverse correlations between the δ^{98}Mo and δ^{238}U of sediments from modern euxinic basins suggest local depositional conditions (e.g., bottom water sulfide concentrations, basin restrictions) may influence the δ^{98}Mo and δ^{238}U of euxinic ORM, including stratigraphic trends. Here we further develop the coupled use of Mo-U isotope data from ancient euxinic ORM to better constrain global ocean redox conditions. New U isotope data were measured for eight late Neoproterozoic to middle Paleozoic ORM units that have previously reported δ^{98}Mo and Fe speciation data. Compilations of the coupled Mo-U isotope data of post-Archean euxinic ORM units from this and previous studies show an overall lack of correlation between δ^{98}Mo and δ^{238}U. However, the individual ORM units show negative, positive, and no correlations. A negative correlation between δ^{98}Mo and δ^{238}U in the Kettle Point Formation (Fm.) is similar to the observations from modern euxinic basins, reflecting mainly local depositional controls (e.g., bottom water sulfide concentrations). A positive correlation in the Fjäcka Shale is likely caused by changing global ocean redox conditions, which shift both isotope systems in the same direction. A lack of correlation may be caused by specific local depositional changes (e.g., variable local basin restrictions for the Zaonega Fm.), a combination of local and global environmental changes (e.g., Member IV, Doushantuo Fm.), or is an artifact of limited data. We estimated the potential ranges of coeval seawater Mo and U isotope compositions based on a coupled Mo-U isotope mass balance model and the observations from modern euxinic basins. Our study highlights the importance of examining the local depositional environment and using large datasets of coupled δ^{98}Mo-δ^{238}U from euxinic ORM units to reconstruct global paleocean redox conditions.