Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35189

Co-application of Re, V, Mo and U as paleo-redox proxies

SEN LI[1], PAUL B. WIGNALL[2] AND SIMON W. POULTON[3]

[1]State Key Laboratory of Geomicrobiology and Environmental Changes, China University of Geosciences
[2]School of Earth and Environment, University of Leeds
[3]University of Leeds

Numerous approaches have been developed for determining past redox conditions in marine settings (e.g., Fe speciation, redox sensitive trace metal (RSTM) systematics, pyrite morphologies, I/(Ca+Mg) ratios), enabling a broad range of redox conditions, from fully oxic to euxinic, to be potentially identified. However, many points along this spectrum remain difficult to constrain, including dysoxic and highly versus weakly euxinic conditions. This limits the broader scale inferences that can be drawn from paleoredox studies, including links between oxygen availability and biological evolution, and the potential for isotope systems (e.g., Mo) to record water column signals. Here, we develop a new approach using RSTM ratios (Re/Mo, Re/U, Re/V, Mo/U), in combination with Mo_{EF}- U_{EF} cross-plots, that potentially enables a robust, highly resolved reconstruction of ancient water column redox conditions to be achieved. We initially document the differential behaviour of RSTM EF values and ratios in modern settings that range from fully oxygenated, through weakly (30-90 μM O_2) and highly (<30 μM O_2) dysoxic, to anoxic non-sulfidic and euxinic conditions. This redox behaviour is further resolved when the drawdown mechanisms for Mo are evaluated by Mo_{EF}-U_{EF} cross-plots. We subsequently ground-truth this approach by considering samples from the Carboniferous Bowland Basin, which have previously been studied for redox conditions via independent geochemical and mineralogical techniques, as well as the Jurassic Kimmeridge Clay Formation, where redox conditions have been defined based on paleoecological characteristics. A strong degree of consistency between RSTM behaviour in modern and ancient settings highlights that weakly to highly dysoxic conditions are characterised by increases in Re/Mo, Re/U and Re/V ratios, accompanied by RSTM EF values that only become notably enriched under highly dysoxic conditions. Non-sulfidic water column anoxia is indicated by increased U_{EF} values and low Re/Mo ratios, while euxinia is readily identified by high Mo/U, low Re/U and very low Re/Mo ratios, alongside high Mo_{EF} values. In addition, highly euxinic conditions may be distinguished from weak euxinia by particularly high Mo/U ratios and Mo_{EF} values. This combined approach has the potential to provide a hitherto unprecedented level of insight into paleodepositional redox conditions.