Progress, pitfalls, and future directions developing the $\delta^{238}U$ paleoredox proxy

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Since the pioneering works of Stirling et al. [1] and Weyer et al. [2], many labs have contributed to a careful and systematic effort to understand $^{238}U/^{235}U$ isotope geochemistry of shales, carbonates, oxides, as well as riverine fluxes and igneous minerals. These early works suggested that natural variations in the $^{238}U/^{235}U$ ratio of marine sedimentary rocks could provide a potentially powerful paleoredox proxy that would complement similar approaches using other redox sensitive metals (e.g., Mo, Fe, Cr).

Here we provide a summary of progress in the field, discuss the advantages and disadvantages of various lithologies for U-isotope paleoredox reconstruction, highlight emerging trends, and point out gaps where more research is needed. Key topics include: (1) developing a mechanistic of understanding U isotope fractionation during incorporation into marine muds, carbonates, and oxide phases; (2) the role of pore-water diffusion in controlling the effective isotope fractionation factor of authigenic uranium in sediments; (3) the behaviour of U in restricted marginal and epicontinental basins; (4) providing an updated marine U isotope mass balance; and (5) validating the reliability of the U isotope proxy via comparison of time-correlative cores.

In the near future, the wide availability of the IRMM3636 double spike combined with the relative ease of obtaining U isotope measurements ensures a proliferation of $^{238}U/^{235}U$ data. Similar to Mo and Fe isotope systems, detailed interpretation of this $^{238}U/^{235}U$ data will require consideration of numerous factors related to both the local depositional environment and the global U isotope mass balance. To this end, we will suggest a set of best practices for interpreting $^{238}U/^{235}U$ as a paleoredox proxy based on observations from a variety of modern marine settings, laboratory experiments, and models.

[1] Stirling *et al* (2007) *EPSL* **264**, 208–225. [2] Weyer *et al* (2008) *GCA* **72**, 345-359.