Molybdenum-isotope chemostratigraphy of the Toarcian Oceanic Anoxic Event

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It has been proposed that the global extent of low-oxygen environments in the oceans expanded during the Toarcian Oceanic Anoxic Event (T-OAE, ~183 Ma), and fluctuated over astronomically paced periods within the event itself. Given the lack of Jurassic oceanic crust available for direct sampling, these arguments have been supported by a molybdeum-isotope-based reconstruction of global redox from Yorkshire, England, which contains oscillations in $\delta^{98/95}$Mo between 0.5–1.2‰ (relative to NIST 3134).

Newly measured $\delta^{98/95}$Mo compositions of mudrocks from the T-OAE at Dotternhausen, Germany, are indistinguishable from an average composition of ~0.5‰, the lower bound of the Yorkshire $\delta^{98/95}$Mo fluctuations. $\delta^{98/95}$Mo does not increase to the ~1.2‰ maxima observed at Yorkshire, despite evidence for locally euxinic conditions. The offset can be explained by a difference in the palaeohydrography of the two locations. A restricted setting at Yorkshire likely sensitized the basin to periodic drawdowns in the dissolved molybdenum inventory, forcing sedimentary $\delta^{98/95}$Mo to increase. In contrast, drawdown of the basinal Mo did not occur at Dotternhausen, perhaps due to less severe basin restriction and/or lower dissolved sulphide concentrations. New $\delta^{98/95}$Mo data of marine mudrocks from Argentina and Italy are consistently lower than the compositions from the European epicontinental shelf, and suggest deposition in settings characterzied by the mixing of porewater Mo-sulphides and/or Mo adsorbed to sedimentary oxide phases.

The new data suggests: (i) The seawater $\delta^{98/95}$Mo composition for the T-OAE is likely to have been close to ~1.2‰, but is unlikely to have fluctuated within the event itself; (ii) evidence of palaeoeuxinia alone is not a sufficient criterion to distinguish a 'seawater' Mo-isotope composition in the palaeo-record, because $\delta^{98/95}$Mo is also sensitive to basin hydrography; (iii) the seawater $\delta^{98/95}$Mo for the T-OAE is identical to recently published estimates of the seawater $\delta^{98/95}$Mo for OAE-2 (~94 Ma).