Phosphorus cycling in a euxinic Precambrian ocean analogue

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From ~2.7 billion years onwards, euxinic (anoxic and sulfidic) conditions were a major feature during periods of ocean anoxia. Furthermore, euxinic conditions are also important in many modern environments. However, mineralogical controls on P cycling under euxinic conditions remain poorly constrained. Here, we present new geochemical and mineralogical data for dissolved and particulate phases in the water column and sediment of Lake Cadagno, Switzerland. This modern basin is charaterised by low sulfate concentrations, with persistent euxinic water column conditions beneath the chemocline, and is considered a mid-Proterozoic ocean analogue. We find evidence for the transient formation of Fe(II) phosphate minerals in the water column while in the euxinic sediment core, phosphate is removed permantly at depth in the form of Fe(II) phosphates. These results highlight an important and under-appreciated feature of P cycling under euxinic conditions, which would have exerted a strong influence on P release to the water column in the mid-Proterozoic ocean.

Under anoxic, Fe-rich (ferruginous) water column conditions, partially oxidized minerals such as green rust have been shown to form, rather than Fe(II) phosphates [1],. We have performed experiments which suggest that this mineralogical difference is controlled by the availability of dissolved phosphate, which is anticipated to be higher under euxinic relative to ferruginous conditions. Our combined approach suggests that the formation of authigenic Fe(II) phosphate minerals would have significantly affected the bioavailability of P under the expansive euxinic conditions envisioned during the mid-Proterozoic and during other euxinic episodes in Earth history.

[1] Zegeye, A. et al. (2012) *Geology,* **40**, 599-602.