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Perturbations of the marine phosphorus cycle in Earth's past

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Phosphorus (P) is an essential nutrient for all life forms. Through its control on oceanic primary productivity, changes in P availability can affect organic carbon burial and atmospheric concentrations of carbon dioxide and oxygen. The availability of P in the ocean, in turn, is determined by riverine input of P, burial of P in sediments and P recycling. The geological record provides a wealth of evidence for perturbations of marine P cycling in Earth's past. Accurate reconstructions of P cycling are frequently hampered, however, by diagenetic and post-sampling alteration of sediments [1] and the difficulty to obtain estimates of dissolved P concentrations in the past ocean.

In this talk, I will first briefly review the processes determining the recycling and burial of P as deduced from modern coastal and deep-sea sediments. I will pay specific attention to the formation of apatite and vivianite, which are key mineral sinks for P. I will then discuss various examples of perturbations of marine phosphorus cycling in Earth's past as deduced from the sedimentary record and potential consequences for carbon and oxygen cycling. Examples will include (1) precession-driven changes in P input to the ocean in the Proterozoic prior to the Great Oxidation Event (GOE) [2] and (2) the enhanced recycling of phosphorus during past oceanic anoxia (e.g. during the Toarcian and the Cenomanian-Turonian Oceanic Anoxic Event 2) [3]. I will conclude with a discussion of potential implications for long-term projections of P cycling in the future ocean.

[1] Kraal et al. 2009. *Geochimica et Cosmochimica Acta* 73, 3277–3290

[2] Lantink et al. 2023. *Earth and Planetary Science Letters* 610,118117

[3] Papadomanolaki et al. 2022. *Science Advances* 8, eabn2370