Reconstructing the Phosphorus Cycle: Untangling Primary Signals from Secondary Overprint

Contact persons
Torsten Vennemann, Thierry Adatte ; Research assistants: Franziska Blattmann

Context

Phosphorus is a quintessential nutrient for all life. Its cycle plays a vital role in governing productivity and thereby interacts with all biogeochemical cycles in particular the carbon cycle. Understanding and reconstructing the phosphorus cycle in modern and ancient settings has been the aim of many past studies (Mort et al. 2007, Westermann et al. 2013, Van Mooy et al. 2015). Despite phosphorus being essential for reconstructing climate, environment and ecology little is known regarding its behaviour during diagenesis when exhibited to temperature and pressure. This lack of comprehension has possibly led to misinterpretations of the paleo-phosphorus cycle.

Objectives and Methods

The aim of this study is to gain a better understanding of how phosphorus signals can shift once sedimentary rocks have undergone diagenesis. This will be achieved by reworking sections from the Cenomanian-Turonian (Cretaceous) from Spain and Italy, which have seen different burial histories (Charbonnier et al. 2020, Mort et al. 2007). If the Covid-19 situation allows fieldwork in Italy or Spain would be possible. The total phosphorus as well as the sedimentary P reservoirs will be determined for all sections. Different sequential leaching protocols (SEDEX) used for determining sedimentary P reservoirs will be compared (Ruttenberg et al. 1992, Ruttenberg et al. 2009, Thompson et al. 2019). In order to reconstruct the shifts in P concentrations between the various reservoirs oxygen isotope ratios of phosphate ($\delta^{18}O_P$) will be analysed (Tamburini et al. 2010).

Literature

Charbonnier, G., Adatte, T., Föllmi, K. B., & Suan, G. (2020). Effect of Intense Weathering and Postdepositional Degradation of Organic Matter on Hg/TOC Proxy in Organic-rich Sediments and its Implications for Deep-Time Investigations. Geochemistry, Geophysics, Geosystems, 21(2), e2019GC008707.

Mort, H. P., Adatte, T., Föllmi, K. B., Keller, G., Steinmann, P., Matera, V., ... & Stüben, D. (2007). Phosphorus and the roles of productivity and nutrient recycling during oceanic anoxic event 2. Geology, 35(6), 483-486.

Ruttenberg, K. C. (1992). Development of a sequential extraction method for different forms of phosphorus in marine sediments. Limnology and oceanography, 37(7), 1460-1482.

Ruttenberg, K. C., Ogawa, N. O., Tamburini, F., Briggs, R. A., Colasacco, N. D., & Joyce, E. (2009). Improved, high-throughput approach for phosphorus speciation in natural sediments via the SEDEX sequential extraction method. Limnology and Oceanography: Methods, 7(5), 319-333.

Tamburini, F., Bernasconi, S. M., Angert, A., Weiner, T., & Frossard, E. (2010). A method for the analysis of the δ18O of inorganic phosphate extracted from soils with HCl. European Journal of Soil Science, 61(6), 1025-1032.

Thompson, J., Poulton, S. W., Guilbaud, R., Doyle, K. A., Reid, S., & Krom, M. D. (2019). Development of a modified SEDEX phosphorus speciation method for ancient rocks and modern iron-rich sediments. Chemical Geology, 524, 383-393.

Van Mooy, B. A. S., Krupke, A., Dyhrman, S. T., Fredricks, H. F., Frischkorn, K. R., Ossolinski, J. E., ... & Sylva, S. P. (2015). Major role of planktonic phosphate reduction in the marine phosphorus redox cycle. Science, 348(6236), 783-785.

Westermann, S., Stein, M., Matera, V., Fiet, N., Fleitmann, D., Adatte, T., & Föllmi, K. B. (2013). Rapid changes in the redox conditions of the western Tethys Ocean during the early Aptian oceanic anoxic event. Geochimica et Cosmochimica Acta, 121, 467-486.

Choice of orientation

Geochemistry, Carbon-Phosphorus cycles, Isotopes, Sedimentology, Diagenesis