Coupled cycling of iron, manganese and phosphorus in the water column of the Black Sea and its implications for phosphorus burial

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Recent work suggests that reduced iron (Fe) phosphates are present in the deep basin sediments of the Black Sea. This could be due to the formation of mixed Fe, manganese (Mn) and phosphorus (P) particles in the redoxcline that survive transport through the sulfidic water column. An alternative hypothesis is that only Fe(III)-rich particles reach the surface sediments, where they are then transformed to Fe(II)-P phases.

In this study, we combine various techniques (including SEM-EDS and X-ray absorption spectroscopy) to investigate the water column transformations of Mn, Fe and P in the sulfidic deep basin of the Black Sea. In addition, we performed ^{33}P radiotracer experiments with surface sediments from the deep basin to assess the potential for in-situ Fe(II)-P formation. Our results show that most mixed Fe(III), Mn(III/IV) and P phases present in the redoxcline do not survive transport through the sulfidic water column. However, the deep sulfidic water column does contain particles that are rich in Fe(III), likely in the form of Fe(III)-rich clays. We also observe a fast uptake of ^{33}P in the surface sediments of the deep basin in a form that is extracted with citrate-dithionite-bicarbonate (CDB), a strongly reducing solution (pH 7.6). The nature of this P pool is still under debate. We discuss whether the CDB-extractable P fraction may represent Fe(II)-P phases in the deep basin sediments and might be linked to the presence of Fe(III) particles in the deeper water column.