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Oxygen isotope biogeochemistry of phosphate in brackish marginal seas: II. The Baltic Sea

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Phosphorus (P) is an important limiting nutrient for primary production in aquatic ecosystems. Therefore, it is important to understand the sources and biogeochemical cycling of different P species. Biotic and abiotic processes, like the uptake and metabolism of inorganic and organic P compounds, enzymatic regeneration of P, redox controlled sorption and release of phosphates and precipitation of apatite or other P containing solids can alter the isotopic composition of oxygen in dissolved and particulate phosphorus matter. P is known to be one of the major limiting nutrients for primary production in the Baltic Sea, especially during summer when cyanobacterial blooms occur. The development of pelagic redoxclines in anoxic basins results in transformations of Fe(III) phases, thereby affecting different P compounds, thereby controlling partly cycling, fluxes, and burial efficiency of P.

In addition to the absolute concentrations, the isotopic compositions of oxygen in dissolved and particulate P are altered by abiotic and biotic processes, for example extracellular enzymatic regeneration of P or redox-controlled sorption.

The here applied 18O method allows to distinguish between the different influences on the P cycle in the sediment as well as in the water column.

For the first time, the oxygen isotope signature of DIP was measured in the water column of the anoxic basins (Landsort Deep and Gotland Deep) of the Baltic Sea and of inorganically bound P in different sediments of the Gulf of Finland and the Gotland Deep.

Besides hydrographical and physical parameters, particulate P and Fe, as well as dissolved constituents, like DIP, O2 and H2S, were analyzed for water column samples. Oxygen isotope compositions of phosphate were measured after conversion to silver phosphate, and results were compared with published values for the water column.

We were able to detect variations in d18OP directly at/ or below the redoxcline of the Landort Deep water column. The changes are probably due to reduction of Fe-P compounds, which were built up under oxic conditions. In the water column, both abiotic (mixing, sorption-desorption) and biotic (organic matter mineralization) processes are the main reasons for differences in the isotopic compositions of DIP. Whereas fractionation/exchange of DIP in the sediments also depends on organic matter mineralization and is influenced by sedimentary P deposition rates (low accumulation – low activity). Therefore the measured isotope differences between the inorganic phosphate in pelagic DIP? water column? and sediment samples are induced by an enhanced benthic microbial decomposition of organic matter, which has a large kinetic isotopic effect.