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Coupling of Mn, Fe, and P cycles during mineral formation at pelagic redoxclines: Examples from the Baltic Sea and the Black Sea

O. Dellwig (1), T. Leipe (1), E. V. Yakushev (2), B. Schnetger (3), H.-J. Brumsack (3), M. E. Böttcher (1)

(1) Leibniz Institute for Baltic Sea Research (IOW), Marine Geology,

18119 Rostock, Germany

(2) Southern Branch of P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, Gelendjik, Russia

(3) Institute for Chemistry and Biology of the Marine Environment, Microbiogeochemistry, University of Oldenburg, 26111 Oldenburg, Germany

(olaf.dellwig@io-warnemuende.de / Fax:+49(0)381-5197-352)

Mineral formation close to pelagic redoxclines of anoxic basins and deeps is supposed to be an important carrier of various components like nutrients or trace metals between oxygenated and euxinic water masses. In this contribution we present data from the water column of anoxic deeps from the Baltic Sea (Gotland Deep and Landsort Deep) and from three sites of the SE Black Sea.

The combination of SEM-EDX and element analysis of particles from the water column evidences the occurrence of several detrital minerals (e.g. clay minerals and feldspars) but also the formation of authigenic species. In addition to well known MnO_x we observed the formation of "Fe-PO_4" phases, which were postulated earlier by Shaffer (1986). Between the maximum abundance of almost pure mineral species, transitional phases containing Mn, Fe, and P in varying amounts are detected as well. Interestingly, both minerals and the transitional phases are similar in morphology and appear as stellate-like or globular particles.

While MnOx formation is caused by bacterial oxidation via Mn(III) intermediates in suboxic parts of the redoxcline (e.g. Tebo, 2004), "Fe-PO_4" phases are most likely formed by chemical oxidation of upward diffusing Fe(II). The resulting Fe oxyhydoxides precipitate on sinking MnO_x thereby adsorbing phosphate as seen in decreasing values of the dissolved phase. Thus, mineral formation close to the redoxclines seems to act as a phosphate trap and prevents an unimpeded diffusion of phosphate towards the surface waters. In case of the Baltic Sea, this phenomenon possibly influences seasonal cyanobacteria blooms where phosphate serves as an important nutrient. We postulate a conceptual model for authigenic mineral formation in anoxic basins which bases on a tight coupling of Mn, Fe, and P cycles.

References

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