

IRON AND MANGANESE SPECIES IN THE REDOX ZONE IN TWO DIFFERENT BASINS WITH ANOXIC CONDITIONS: THE BLACK SEA AND THE OSLO FJORD

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Abstract

The joint analysis of the data of iron and manganese species distributions (dissolved Fe(II) and Fe(III), dissolved Mn(II), dissolved bound Mn, particulate Fe and Mn) obtained in the Black Sea and the Oslo Fjord allowed to reveal the common features, that testify the similarity of the mechanism of the redox layer formation in these regions.

Keywords: *Black Sea, Redox, Vertical Profile, Metals, Anoxia*

Distributions of chemical parameters in the redox zone were studied in the Black Sea (northeast region, central and coastal parts) and Oslo Fjord (Bunnefjorden and Baerumsbassenget), during spring-summer 2008 and 2009. The specific features of the hydrochemical structure observed in the studied objects are summarized in Table 1.

Tab. 1. Parameters of Mn and Fe distributions in the redox zones of the Black Sea and the Oslo Fjord

	Black Sea		Oslo Fjord	
	Center stable hydrophysical structure	Periphery enhanced mixing due to RIM current	Bunnefjorden flushing ones per several years	Baerumsbassenget anoxygenic photosynthesis and river inflow
Depth, m max / redox interface	2100 / 70-90	500 / 140-155	160 / 80-90	31 / 16-23
Thickness of suboxic zone, m	10-17	0-12	14	1-6
c(Mn_diss)max, uM	8-9	7-8	8-10	4-4.6
c(Mn_part)max, uM	0.2-0.4	1-2	1.3-2.1	0.7-1
c(Mn_bound)max, uM	1.8	0.5	1	0.6
grad(Mn_diss)max, uM/m	0.55	0.4	1.1	5.5
c(FeII)max, uM	0.34	0.45	0.33	0.4-1.4
c(FeIII_diss)max, uM	0.08	0.05	0.03	0.04
c(Fe_part)max, uM	0.15-0.29	0.22-0.48	0.18-0.22	0.60-0.85
grad(FeII)max, nM/m	5-10	5	19	500

Iron and manganese species distributions and redox zone structure at all are very similar in the Black Sea and the Oslo Fjord/Bunnefjorden. The abnormality of the biogeochemical structure in the Baerumsbassenget can be connected with the influence of a river or/and anoxygenic photosynthesis, because this redox interface is in a very shallow position, about 20 m. The suboxic zone in this fjord has a reducing character [1].

Our investigations demonstrated that Mn bound in stable complexes with hypothetically organic matter or pyrophosphate is observed in the redox zones in significant concentrations (up to 2 uM) [2], and is likely presented by Mn (III), an intermediate product of Mn(II) oxidation. On the base of the recent data obtained in the 100th cruise of RV "Professor Shtokman" (March-April, 2009) it was found that the bound Mn could exist in two forms – colloidal (0.02-0.40 um) and truly dissolved (<0.02 um) that perhaps results from complexing with different types of ligands. Bound Mn in colloidal form amount to 50-90% of total bound Mn in coastal and central parts of the Black Sea respectively.

Redox interfaces are characterized by a formation of a so-called "phosphate dipole" with a minimum above the sulfidic boundary and a maximum just below, with a steep increase in concentrations between the two. The hypothesis that P and Mn cycles are interconnected by the formation of complexes between Mn (III) and P-containing ligands can explain the presence of the shallow phosphate minimum above the sulfide-interface [2, 3]. The presence of the deep phosphate minimum (below the sulfidic boundary) is probably due to the formation of P-containing iron particles [4]. This dipole structure serves as a geochemical barrier that decreases the upward flux of phosphate from the anoxic layer.

Modeling results shown that exactly manganese cycle (formation of sinking down Mn(IV) and presence of dissolved Mn(III)) is the main reason of oxygen and hydrogen sulfide direct contact absence [3]. The model experiments

enabled the role of a number of factors (amount of Mn, intensity of mixing, sinking rate, anoxygenic photosynthesis) to be assessed [1]. We suggest that in nature all the factors analyzed are not constant and can vary from region to region and from time to time. Their exact combination results in the shape of the distributions of the observed parameters.

References

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