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Geochemical Flows of Heavy Metals in Aquatic Systems of the Volga River Delta

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The paper presents the results of the long-term environmental-geochemical studies of aquatic systems of the Volga River mouth area. It occupies a special place among the world's largest river deltas. The strong interest of researchers from different fields of science in the problems of the Volga River delta is associated with the high rate of periodic fluctuations of the Caspian Sea level, and also many factors of the technogenic geochemical impact on the aquatic systems. They range from the local impact of pollution sources in the delta to the regional impact of pollution sources located upstream. Aquatic systems of the Volga delta are highly diverse in morphology, hydrodynamic regime, lithology, sediments, and biota. This diversity determines the considerable spatial and temporal variability of the conditions of migration of heavy metals (HM) and other chemical elements.

The study showed that the present contamination of the aquatic systems is manifested mainly in excess of heavy metals (Cu, Pb, Cd) in suspended matter over the global background values, most notably, in the flood period. In general the content of HM in the water and sediments during the last decades remains low; pollution of the bottom sediments is largely insignificant and of local character. We have identified the significant role of the water plants due to migration and accumulation of heavy metals in the shallow near-shore zones. Higher aquatic plants may serve as biogeochemical indicators of aquatic systems pollution. The metal content in macrophytes varies substantially depending on the ecological and morphological characteristics of species, as well as on conditions of their habitat. The difference between the minimal and maximal HM content may reach two to three orders of magnitude. Thickets of hornweed (Ceratophyllum demersum) and of other macrophytes in the mouths of the watercourses at the near-shore mouth area play the role of the biofilters precipitating a significant part of the river suspended matter.

We have determined a number of complex geochemical barrier zones in the Volga mouth area where the bulk of metals brought with the water flow are deposited. The first one formed in the stream mouths at the deltaic sea edge. Due to the combined effect of the hydrodynamic, sorption, oxygen, and biogeochemical barriers, the deposition of suspended matter that carries HM takes place there. As a result, Zn, Mn, Ni, and Co accumulate in the bottom sediments of the mouths of the watercourses. The maximal HM concentrations in some samples exceed the average value by three and more times. The finest fractions of suspended matter migrate via delta to the near-shore mouth area where the further geochemical barrier zones are formed.