



Role of Fe (III) ions in anthropogenic load of surface waters of West Siberian Arctic zone

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The paper summarizes joint investigations of the Tyumen State University (Russia, Tyumen) and the Geochemistry and Analytical Chemistry Vernadsky Institute of Russian Academy of Sciences (Moscow, Russia) during 2012-2018 periods. It presents the results of research of chemical composition of about 70 small lakes located in the area of tundra and northern taiga of West Siberia Arctic zone (Russia, Yamal-Nenets and Khanty-Mansi Autonomous Districts of the Tyumen region).

The investigation involves analysis of chemical complexes of heavy metals in surface waters of Arctic zone on the example of West Siberia region. Analysis was executed by determination of the following parameters of natural water samples:

- content of trace elements (Al, Fe, Mn, Cr, Cu, Ni, Zn, Cd, Co, Pb, etc., total more than 60 elements) by emission method with an inductively coupled plasma (ICP-MS) using mass spectrometrometre Element 2;
- content of inorganic and total carbon (TIC and T) by elemental analysis. The difference between the total and inorganic carbon gives the organic carbon content (TOC);
- pH value by potentiometric method;
- content of basic ions (Na⁺, Ca²⁺, K⁺, Mg²⁺, NH₄⁺, Cl⁻, SO₄²⁻, NO₃⁻, PO₄³⁻) by ion chromatography;
- free and bounded forms of metals were defined by ion change method in ionit Dowex column.

Determination of the chemical composition of samples was conducted in the accredited laboratory of Tyumen State University according to standard procedures with regular quality control of results, ICP-MS analysis was conducted in Geochemistry and Analytical Chemistry Institute laboratory.

Heavy metals in natural waters can exist in various forms: free (hydrated) ions, ions bound in complexes with organic substances, complexes with inorganic ligands, and in colloid solutions. Previous investigation had established that the most stable complexes are organic ligands with ions Fe³⁺, Al³⁺.

The form of metal existence has a significant influence on their availability to transport in aquatic organisms. Metal ions associated in stable complexes with organic substances are considered less toxic.

In order to extract metals in organic complexes from total content in water the water samples filtered through ionit column under 1.6 ml/min rate. The outflow contents only dissolved metal organic complexes.

The main conclusion of the present research is the following. If the total content of aluminum, iron and manganese ions (meq/dm³) is equal to or greater than the concentration of dissolved organic carbon (TOC, mg/dm³) in water other heavy metals will exist predominantly in free, ionic or bound form with inorganic ligands. This statement has paradox consequence that the increase of dissolved Fe content will lead to toxicity rise of other heavy metals. The reason is that Fe ions obstruct to bind other heavy metals with organic substances thus they stay in free toxic forms.

Arctic part of Western Siberia undergoes significant anthropogenic load due to extensive oil and gas recovery in this zone and presence of heavy metals in surface waters makes the situation more serious.