

## Short communication

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# Geochemical heterogeneities of lithosphere and hydrosphere in the Irkutsk Reservoir as the indicator of the geo-ecological state

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**ABSTRACT.** Differentiation of the elements and formation of lithochemical and hydrochemical heterogeneities occur in the Irkutsk Reservoir. Lithochemical heterogeneities are represented by two fields: with the predominated elements of lithophile-chalcophile association or lithophile-siderophile association. The bottom sediments have a pollution degree from permissible to moderately hazardous. Hydrochemical field is characterized by lithophile and chalcophile association of the elements. The elemental composition of the water corresponds to quality standards of the unpolluted water.

**Keywords:** Irkutsk Reservoir, geochemical heterogeneities (fields), bottom sediments, water, geo-ecological state

## 1. Introduction.

Formation of the cascade of the Angara reservoirs led to the changes in lithosphere in the south of the Siberian platform and occurrence of the specific newly-formed geochemical fields (heterogeneities). Geochemical heterogeneities of the Irkutsk Reservoir, the main in the cascade, are represented by lithochemical and hydrochemical fields that indicate its geo-ecological state. Lithochemical fields are related to the geochemical specialization of the rocks, forming the abrasion coasts in the reservoir. Hydrochemical fields to a large extent arise from the composition of the water inflowing to the Irkutsk Reservoir from Lake Baikal, which is the regulator of flow into the Angara reservoirs.

## 2. Material and methods.

The study of the bottom sediments and the water of the Irkutsk Reservoir included fieldwork, laboratory and analytical methods as well as calculation methods. During fieldwork, the bottom sediments were sampled along seven profiles referred to the observed areas over the formation of reservoir coasts. Sampling was carried out using the tube for soil sampling, a bottom-sampling device of various modifications from the board of the research vessel and the boat. The study of migration and fields of the elemental concentration in the water by the method for the direct water sampling using the Molchanov bottle was performed along the

same profiles and at the same sites as a sampling of the bottom sediments. The chemical compositions of the bottom sediments and the rocks of beach scarp were determined using the conventional complete chemical analysis and the method of quantitative X-ray spectral fluorescence analysis. Before the analysis, the water was prepared according to the recommendations (Vetrov and Kuznetsova, 1997). Direct multielement determination of the elemental composition in the water was performed by the ICP-MS method using the VG PlasmaQuad 2+ and Element 2 instruments.

## 3. Results and discussion.

The abrasion material of the coasts of the Irkutsk Reservoir and the runoff from Lake Baikal form migration of the elements to the Irkutsk Reservoir. The regional background composition of the elements in the above sources is significantly lower than values for the lithosphere clarks. The extension of the abrasion coasts covers 150 km of the coastline, which is approximately 54% of its total length. The coasts formed by the Jurassic sandstones and the Quaternary diluvial loess loams are subject to the abrasion. These rocks are part of the East Siberian lithophile and chalcophile geochemical province according to their geochemical specialization (Atlas..., 2004). In the composition of the sandstones and the loess loams, the elements from lithophile and chalcophile groups predominate. At the same time, loess loams are much more enriched with the elements of these groups than sandstones. From

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the abrasion material composition, 4700 tons of iron, 154 tons of manganese and approximately 220 tons of microelements inflow to the reservoir. With the Baikal water, 760 tons of iron, 581 tons of manganese and approximately 740 tons of microelements inflow to the reservoir (Karnaukhova, 2018).

Differentiation of the elements and formation of lithochemical and hydrochemical heterogeneities (fields) occur within the Irkutsk Reservoir. Lithochemical heterogeneities are related to natural lithological and geochemical specialization of the rocks in the coastal zone of the reservoir. Lithochemical heterogeneities reflect the ability of elements to become more concentrated in the bottom sediments. Hydrochemical heterogeneities manifested themselves in the elemental composition of the water from the reservoir. They arise from the concentrations of the elements inflowing with the water from Lake Baikal and the composition of abrasion material as well as from their migration capability.

*Lithochemical heterogeneities (fields)* form in the bottom sediments. Their main types are represented by sands, large siltstones and fine aleurolitic silts. We identified two main lithochemical fields in the bottom sediments of the reservoir. The first lithochemical field is located along the left coast, starting from the 35th km along the navigable channel to the hydroelectric dam. The bottom sediments reflect the geochemical specialization of the Jurassic sandstones forming the abrasion coasts. Heterogeneities are represented by the predominance of the elements of lithophile-chalcophile association (Mn–Cr–V–Zn–Cu). The total value of the elemental concentration coefficients in the bottom sediments varies from 12.46 at the 35th km to 11.75 in front of the dam. The second lithochemical field includes the bottom sediments along the right coast between the 40th km along the navigable channel and hydroelectric dam. Heterogeneities are represented by the elements where lithophile-siderophile association (Mn–Co) prevails. This association reflects the geochemical specialization of the Quaternary diluvial loess loams forming the abrasion coasts along the right coast of the reservoir. The total value of the elemental concentration coefficients in the bottom sediments varies from 8.39 at the 40th km to 44.22 at the 50th

km and decreases in front of the dam to 18.85.

*Hydrochemical heterogeneities (field)* mainly arise from the composition of water inflowing to the reservoir from Lake Baikal and its overlapping by the composition of suspended material coming from the eroding rocks of the coastal zone. Hydrochemical field of the Irkutsk Reservoir is represented by lithophile and chalcophile association of the elements where Mn–Zn–Cu prevail. The elemental composition in the water from the reservoir corresponds to quality standards of the unpolluted water according to the Russian state standards for surface water protection (SanPiN 2.1.5.980-00, 2004).

#### 4. Conclusions

The assessment of the geo-ecological state of the Irkutsk Reservoir indicates the presence of the areas with both the permissible degree of pollution for the bottom sediments and the moderately hazardous degree of pollution, inside of which there is the area with the hazardous degree of pollution. Hydrological features of the Irkutsk Reservoir do not contribute to sedimentation and retention of the elements. The bulk of them passes through the reservoir as transit.

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