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Uranium immobilization at microbial biofilms on upper water horizons loams nearby sludge repository

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Sludge and slurry uranium repositories of ore processing wastes built in the middle of the 20th century lost their waterproofing properties over time, which leads to the upper aquifers pollution with uranium, heavy metals, sludge macrocomponents: anions of nitrates, sulfates, carbonates, calcium and iron. It is known that the uranium behavior in the environment depends on its oxidation-reduction potential, which determines its oxidation state and solubility. High nitrate content in aquatic systems leads to the uranium migration in the highly oxidized form and minimizes its sorption on the rocks minerals.

Biogenic elements solution in waters can lead to the microbiota activity stimulation and biogeochemical uranium immobilization. Nitrate consumption leads to the redox potential decreasing and uranium reduction to insoluble forms. It is known that the most stable form of microorganisms in the environment is microbial biofilms. Their development on rock surface changes its physicochemical characteristics and sorption properties. This paper focused on changing the physicochemical and mineralogical parameters of rocks after microbial growth and its effect on the uranium immobilization. It should be noted that in situ bioremediation is one of the promising and inexpensive methods of groundwater remediation. Therefore, an assessment of the role of microbial biofilms in the immobilization of uranium will provide important information for predicting the effectiveness of the bioremediation.

Angarsk Electrochemical Combine AECC (Irkutsk Region, Russia) is engaged in the processing of uranium ores and concentrates; has sludge storage facilities on the territory, which for a long time have contaminated the upper aquifers with nitrate ions, ammonium, uranium and other components. The main minerals of upper aquatic horizons weathered sandstone are: quartz, plagioclase, K-feldspar, kaolinite, smectite, specular stone, illite-smectite, vermiculite, chlorite, amphibole and apatite in trace amounts. The clay component is more than 20% with a kaolinite predomination.

In laboratory experiments, the modeling of the growth of microbial biofilms on rocks from contaminated and uncontaminated areas of the formation was carried out by adding organic substrates. Samples were dominated by representatives of the family *Pseudomonadaceae*, known for their ability to form biofilms and wide range of metabolic capabilities. An uneven distribution of biofilm on the sand was established, presumably in areas containing an increase in the amount of biogenic elements - Ca, Fe, etc., as well as organic carbon. On average, after 15 days, the coverage area of the polysaccharide matrix was 20-30%. The appearance of a polysaccharide matrix can lead to a change in the sorption capacity of rocks and to formation of local zones of uranium accumulation in organic matter.

As a result of microbial action, the dissolution of carbonate minerals and a number of changes in the composition of clay sandstones is noted. The microbial effect on rocks leads to a multidirectional change in their sorption capacity in relation to uranium. The formation of an exopolysaccharide matrix increases the sorption capacity of rocks due to the appearance of new functional groups. Moreover, with strong microbial fouling, it can lead to a decrease in uranium sorption.

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