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Stability of clay buffer systems in the conditions of deep geological disposal of radioactive waste in the presence of microorganisms

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Clay minerals are the main promising materials for engineering safety barriers in the disposal of radioactive waste in geological formations. Clays have high chemical stability, good sorption properties, and low diffusion coefficients. Bentonite clays combine the most optimal properties - high swelling pressure, low diffusion coefficients. At the moment, there is no unified international concept of the clay barrier density and its composition. Also, the parameters of the influence of biogenic processes on the properties of clay materials have not been correctly determined. It is planned to use of bentonite barrier between the metal container and the external environment in the design of the supercontainer for the new disposal of radioactive waste in the Nizhnekanskiy gneiss massif.

Within the studies of microbiological processes in the Yeniseisky disposal site, big attention will be paid to clay barriers as sources of biogenic elements in the system and microflora and organic and inorganic carbon.

Special attention will be paid to thermophilic microorganisms characterized by high growth rates and high levels of metabolic processes, which, along with the extreme impact of radioactive waste (temperature, gas release) on a site in the mountain range, can lead to the destruction of safety barriers.

Based on the data of phylogenetic analysis of the 16S rRNA gene sequences in clay materials, which are planned to be used as a barrier material, bacteria of the fermentative type of metabolism, capable of forming biogenic gases and organic acids, sulfate-reducing microflora, and a wide variety of microorganisms of the iron cycle were found. We investigating the processes under conditions corresponding to both the internal and external conditions of the clay barrier. As a result of our studies, in model experiments, the effect of microflora activation by radiolysis products, carbon steel corrosion products, hydrogen, and carbon dioxide was found. A thermophilic microbiota was found in samples with bentonite clays of the Khakass and Dinosaur deposits cultivated at temperatures of 50, 70, 90° C. High content of aluminum and silicon amorphous oxide phases was found in the liquid phase after cultivation, and an increase in bioleaching was observed with increasing temperature. Screening of biocidal additives was performed to suppress microbial activity, primarily sulfate reduction. The most effective, thermally

stable biocide with prolonged action was polyhexamethylguanidine at a concentration of 0.5 wt. %.