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Microbiological research program in deep HRW repository «Yeniseisky»: plans and first results

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The concept of engineered geologic disposal has been developed for the safe long-term management of long-lived high-level radioactive waste (HRW) by many countries. Russian Federation evaluates the “Yeniseiskiy” Nizhnekansky granite-gneiss crystalline formation, in Krasnoyarsk region. To this date microbiological studies became an integral part of safety assessment in Russia like other countries.

A multi-barrier concept was used to create super-container (SC). SC contains a primary vitrified radioactive waste package, placed in the carbon steel casing, bentonite and aluminate concrete layers placed between the casing and inner IC surface. All selected barrier materials are potential areas for biogenic processes.

The talk presented a plan of experimental research of biogenic processes and first step results. Microbiological studies at the first stage are carried out in laboratory conditions, at the second stage they will be carried out under the conditions of URL and include:

- changes of host rock sorption and diffusion properties due to biofilms formation,
- assessment of the possibility biocolloidal particles formation and determination clay and ferruginous colloids stability during biogenic processes;

To date, the study of the phylogenetic and functional diversity of the microflora of the granite-gneiss massif, near-surface waters, and clay materials that will be used in disposal has been carried out. It has been established that microorganisms, isolated from samples, collected nearby the zone of the future repository are capable of participating in a number of undesirable processes, including steel corrosion acceleration, the formation of biogenic gases, and changes in the properties of clay materials. Our studies also show that microbial communities of clays are activated by hydrogen, which is a product of steel corrosion and water radiolysis. At the first stage, we found an increase in the corrosion of carbon steel in the presence of microorganisms sampled from the study area.

An acceleration of the corrosion rate of carbon steel (from 1.3 to 1.9 $\mu\text{m}/\text{year}$) was observed with an increase in temperature from 20 to 50⁰C, the calculated value of the activation energy was 22

kJ/mol * K. Based on the data obtained, a kinetic model of carbon steel corrosion in the presence of microorganisms was created, including both the inclusion of the activation energy and the inhibition of corrosion by the formed corrosion products.