Biogenic safety of clay barrier materials for radioactive waste repository database

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Clay minerals are widely used as materials for construction of engineered barriers for nuclear waste and spent fuel repositories all over the world due to perfect isolation properties and high sorption capacity. Unwanted microbiological processes that occur in geological repository can cause deterioration of clay barrier materials, which may significantly affect long-term safety of the repository. It is important to note that such unwanted processes could be caused both by native microbial population and bacteria brought in from outside during the construction of the repository.

This paper aims to develop a general concept that could be used to prove the risk of unwanted microbial processes’ occurrence in clay materials.

Some features of mineral composition of clay materials, including the content of iron, sulphur, phosphorus, organic and mineral carbon, provide the basis for the concept. The ratios of free mono- and di-valent cations present in the solution (Na-K-Ca-Mg) are also taken into account. Another approach presumes microflora composition analysis by means of high-efficient 16S rRNA sequencing method. In addition, the results of several tests dedicated to microbial communities’ stimulation are discussed. These include tests on hydrogen or organic substance addition as electron donors with subsequent standard tests on metabolic activity evaluation, MTT test and respiration assessment of microbial population, which is represented by both planktonic cells and cells incorporated into biofilms. The developed concept was used to assess clay materials found in Russian Federation that could potentially be used to construct engineered safety barriers. These data formed the basis for the formation of a database of microbial safety of engineering barrier materials for radioactive waste storage.