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Geochemical modeling of strontium transport in nitrate solution. focus on dispersion edge processes

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The practice of liquid radioactive waste (LRW) injection in deep stagnant aquifers in Russia dates back to 1963 year. The safety assessment and safe operation of existing LRW repositories require complex modeling of basic geochemical processes. Sorption onto mineral phases tends to be the main process affecting the dynamics of migration of radioactive and other contaminants in geological media. Meanwhile, the behavior of macrocomponents in contaminated subsurface aquifers depends on a number of parameters, including microbial processes.
The purpose of this paper is to create a multiparametric model of strontium migration in subsurface aquifers, with such a model to consider the contribution of nitrate ions as the main macrocomponents of radioactive waste, highlighting the role of microbiological denitrification, the effect of concentration blurring on the dispersion surface.
The ion exchange adsorption and transport models were complemented by nitrate biodegradation process due to bacterial denitrification. Calculations of migration were carried out in the PhreeqC 2.18 software.
Sorption experiments were performed with a sandy–clay rock taken from the geological stratum into which the liquid radioactive waste was injected. The cation exchange capacity (CEC) of native rock is 4.40 mg-eq. per 100 g. The model draws on the assumption that ion sorption occurs at Sr Selective (8.12% of total quantity) and Sr Nonselective ion exchange sites.
Calculations for denitrification parameters were made during laboratory experiments with microbial communities isolated from samples collected from Russian deep LRW repository in Krasnoyarsk region. Laboratory modeling of microbiological processes was used to establish that the denitrifying microorganisms inhabiting the Severny MCC repository are capabale of living in solutions with up to 8 g/l of nitrate ions, i.e. on the waste dispersion surface and in the low-active radioactive waste repository area, while the denitrification rate will be suppressed as nitrate ion concentration increases over 3 g/l.
It was revealed that biodegradation of a nitrate-ion can strongly influence strontium transport. It follows from the outputs provided in this work that biodegradation of the nitrate ion is observed due to the dispersion front dilution, while the strontium complex with nitrate ion does not participate in sorption, and the strontium front is advancing faster.

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