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Use of 3H for characterisation of crystallinne rock migration properties

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Crystalline rocks are considered as potential host rock for deep geology repository (DGR) of radioactive waste in many countries. In order to define safety functions of host rock and gained performance assessment relevant input data, detailed examination of rock migration parameters, for relevant radionuclides has to be performed. DGR is usually planned to be constructed at the depth 400 –600 m below the surface within as the least heterogeneous and fractured rock segment. The main processes that radionuclide might undergo during their potential way from the repository towards human and biota are advection in rock fracture, diffusion into the rock matrix and sorption onto fracture mineral surfaces.
Therefore, the aim of the presented project was to determine relevant migration properties (porosity, diffusivity and formation factor) for Czech crystalline rock samples. The migration properties were determined in relation with several other parameters (hydraulic conductivity K, sampling depth, sample age, hydraulic conductivity).

102 granitic samples from ten different granitic bodies, comprising rock material of different structure and grain size, were subjected to test in order to determine porosity (⊠), effective diffusion coefficients (De), formation factor (Ff) and hydraulic conductivity (K). Porosity was determined using water-saturation method [1]. The effective diffusion coefficient De was measured using 3H as a tracer in through-diffusion experiments. The activities in both input and output reservoirs were regularly monitored using liquid scintillation spectrometry (LSC). Hydraulic conductivity K was measured in pressure cells.

Porosity values differed from 0.3 –2.7 %; while the effective diffusion coefficient De ranged from 1.6 x 10-13 to 7.41 x 10-12 m2.s-1, eventhough samples with De of 10-11 m2.s-1 were also found (namely altered by metasomatosis). On the other hand, several low-grade metamorphosed samples proved lower diffusion rates than undisturbed samples. General positive trend of De dependence on porosity was spotted with the major cluster of De and porosity values. The trends between De and K, however, were not so clear.

In order to put the measured values of hydraulic conductivity K and effective diffusion coefficient De into relation, numerical simulations of both through-diffusion and pressure cell experiments were undertaken using finite-element code NAPSAC. A discrete fracture network approach with stochastically generated microcracks was used for constructing granite rock matrix.

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[1] Melnyk T. W., Skeet A. (1986): An improved technique for determination of rock porosity. Can. J. Earth Sci. 23, 1068 - 1074.

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