Analysis of the behavior of radionuclide migration in fractured medium in different types of matrix rocky

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In the waste management, the current trend is to dispose of long-lived and high activity radioactive tailings in permanent, geologically stable and low permeability repositories. Thus, it is relevant to analyze the groundwater movement process, because the mechanism by which the radionuclides in a repository with fractures could return to the surface would be through the groundwater circulation system. A common problem encountered is the modeling of the migration of radionuclides in a fractured medium. The objective of this work is to evaluate the behavior of the migration of radionuclides in two types of rock matrix, considering the following properties: volumetric density, porosity, distribution coefficient and molecular diffusion coefficient. The physical system adopted consists of the matrix rock containing a discrete fracture in a porous medium saturated with water. The partial differential equations that describe the radionuclide movement were discretized by finite differences, and the Implicit Euler method was adopted. While the numerical scheme of progressive differences was used for the convective term.

A complete description of the physical and mathematical model can be found in [1].

To simulate the model, two cases of matrix rocks were considered: granite and basalt. The radionuclide considered was ^{237}Np which is one of the most important actinides in nuclear waste, due to its long half-life and high dose factor. Table 1 lists some of the data used to describe the physical model and the properties of the parent rocks. The values adopted in spatial and temporal discretization in finite differences were: $\Delta z = 1m$, $\Delta y = 0.1m$ and $\Delta t = 0.1$ years.

The behavior of ^{237}Np in the different media is in Figures 1 and 2.

Table 1 - Properties of Rocks and Fracture.

	Granite	Basalt	Fracture	
θ	0.01	0.059	$D_f(m^2/year)$	1.0
$D_p(m^2/year)$	0.01	8.84×10^{-6}	R_f	1.0
R_p	1.0	442	-	
$\rho_p(\mathrm{Kg}/m^2)$	0.00266	0.00277	$b = 0.0005\ m$; $v = 1\ m/year$.	

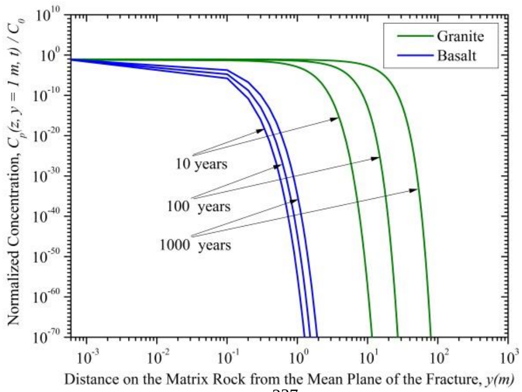

Figure1. Concentration of ^{237}Np in matrix rock as a function of the distance from the middle of the fracture.

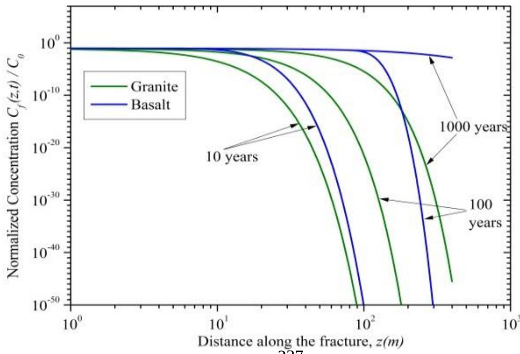

Figure 2. Concentration of ^{237}Np along the fracture.

Considering the behavior of the radionuclide concentration in the matrix rock (pore) observed in Figure 1, we can verify that the basalt has a smaller distance from the middle of the fracture when compared to the granite. This result is consistent with the porosity of basalt, which is smaller than that of granite. Figure 2 shows that the concentration along the fracture is higher when considering basalt. This result is compatible with the previous one, because as the radionuclide penetrated less in the basalt, then the radionuclide concentration increased in the region of the fracture.

Reference

[1] SILVEIRA, C. S. **Avaliação numérica do transporte de radionuclídeos em rocha fraturada**. Tese (Doutorado em Engenharia Nuclear) Instituto Alberto Luiz Coimbra da Universidade Federal do Rio de Janeiro. Rio de Janeiro, 2013. 127p.