Experimental Investigation on Diffusion Properties of some Radionuclides in Crystalline Rocks

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Diffusion experiments has been carried in crystalline rocks to determine the diffusivities of some radionuclides. A rock mass can provide retardation and dilution effects by removing radionuclides from flowing groundwater. Thus, diffusion into the rock mass is one of the important process for the radiological safety assessment in the radioactive waste disposal.

The experimental setup was designed as a through-diffusion type, which was separated a cylinder into two blocks by a rock slice. The rock disk was fixed in the middle of a acrylate column and sealed with a silicone or epoxy resin. Rock sample was immersed in the groundwater for a month prior to the diffusion experiment. The rock was sampled at the east coast of Korea, which has a porosity of 0.004, the specific surface of $1m^2/g$ by BET method, the density of 2.55g/ml, and the cation exchange capacity of 6.8meq/100g. Both sides of the column were filled with the groundwater and the radionuclides as diffusing species were added in the source side. Tritium and anions were used as nonsorbing tracers, while, strontium, cobalt, cesium, and uranium used as sorbing tracers. The 1 *ml* of solution was taken from the sampling hole at both sides to measure the concentration change at a certain time interval. When a rock coupon is kept in contact with the solution in the through-diffusion system, radionuclides sorb and diffuse through the rock. Because tritium and anions do not sorb on the rock surface, they migrate mainly by pore diffusion. The apparent diffusivity of tritium is obtained about $8.5*10^{-6}cm^2/s$ from the experimental curve. The molecular diffusivity of tritium is $2.4*10^{-5}cm^2/s$ at 25℃, the geometric factor of the granite can be obtained as 0.35. On the other hand, when the sorbing tracers diffuse into the rock pores, probably the most portion of the solutes sorbs on the pore surface, and some portion of the sorbed solutes desorb and diffuse again, or some of them may migrate on the sorbed phase, which is called the surface diffusion. The apparent diffusivity of cesium is obtained about $1.5*10^{-7}cm^2/s$ from the experimental curve. The measured K_d value of the granite is about 800*ml/g* in a separated batch test. And the molecular diffusivity of cesium is $2.0*10^{-5}cm^2/s$ at 25℃, thus the pore diffusivity of cesium is obtained about $7.2*10^{-6}cm^2/s$ and the surface diffusivity of cesium is about $3.8*10^{-8}cm^2/s$.