RADIOCESIUM SORPTION–DESORPTION PROCESSES IN LAKE SEDIMENTS

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The kinetics of radiocesium sorption and desorption by cation solutions and the corresponding radiocesium distribution profiles in sediment cores were investigated. The results have shown that a significant percentage of radiocesium is adsorbed in the sediments during the first 3 d. Radiocesium reaches rapidly (< than 5 d) at a depth which does not exceed 3.5 cm. The desorption of radiocesium was found to depend on cation concentrations. Empirical laws are derived both for cesium adsorption and desorption.

In the aquatic environment, radionuclides are carried by water. The migration of radionuclides can be slowed by various effects, largely by reversible and irreversible fixation to sediment material. Thus sediments are an important component of the aquatic environment, functioning either as a sink or as temporary repository for radionuclides. Basically, the fixation processes are related to the physical and chemical properties of the radionuclides and the sediment material. Of the most important nuclides for radiation protection is radiocesium (137Cs). Once in water, 137Cs migrates to bottom sediments by direct sorption or by sorption on suspended solids that later deposit on the bottom. The sediments usually serve as a sink for radiocesium, but they may also become a source, as they are resuspended in periods of turbulence or when desorption occurs.

Cesium kinetics in lakes were monitored by Hakonson and Whicker1 and also by Eyman and Kevern2. The sources, distribution and mobility of plutonium and radiocesium in sediments and water of the Hudson River Estuary and watershed was studied by Linsalata3. After the Chernobyl accident, the redistribution of 137Cs in lake sediments was investigated by
Broberg and Maubert studied experimentally the kinetics of $^{137}$Cs sorption in lake sediments. The main conclusion of these investigations is that radiocesium is trapped in the first 2-3 cm of the sediment.

The purpose of the research presented here was to study experimentally the kinetics of radiocesium sorption-desorption processes in lake sediments, with emphasis granted to the desorption process as a secondary source of pollution. Of the possible desorption processes, we consider the exchange with $K^+$, since it has been shown by sorption studies that $K^+$ is of the primary cations in competition with $Cs^+$.

**MATERIALS AND METHODS**

A quantity of lake water (28 L) was introduced into a tank containing $^{137}$Cs. The initial activity concentration in water was measured by $\gamma$-ray spectroscopy. The sediments were packaged in containers, each simulating a sediment core, and placed in the bottom of the lake water tank. Only the surface of the cores was exposed. The radiocesium concentration in water was monitored daily. The profile of radioactivity due to radiocesium adsorbed in the sediments was measured non-destructively using a scanning $\gamma$-ray design, described in detail elsewhere. Briefly, the design included a lead collimator in front of a 3" X 3" sodium iodide scintillator detector. The detector was allowed to view only radiation originating from the region directly in front of the collimator's slit. Since the width of the collimator's slit was 5 mm, it was possible to measure the radioactivity confined in 5 mm sections. Also, the desorption of radiocesium was studied as a function of potassium concentrations. As in the sorption study, sediment cores of similar dimensions were placed in the bottom of tanks filled with different $K^+$ concentrations. The profiles of remaining radioactivity were measured with the scanning $\gamma$-ray arrangement.