

Dose Assessment of Natural Radiation and Distribution of Natural α -emitting Radionuclides in the Environment

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Abstract

Natural background radiation doses for residents and the ecosystem in Rokkasho, Japan are important for evaluating the significance of the dose from the small amounts of radionuclides discharged from the first commercial spent nuclear fuel reprocessing plant located there. In this study, the aims were to establish methods for measuring the environmental γ -ray radiation dose to people in their actual living environment and the natural radiation dose to biota in the aquatic environment of Lake Obuchi neighboring the plant. Since the background level of natural α -emitting radionuclides is also useful as a reference for such radionuclides as Pu assumed to be discharged from the plant, this study also had another purpose of obtaining the concentration level of natural α -emitting radionuclides in various environmental samples.

Environmental γ -ray radiation dose rates to people in Rokkasho were measured seasonally by using personal monitoring meters which logged data for 1 week in each season in FY 2011. Dose rates in various working and living environments were also measured for a year with glass dosimeters. The mean personal radiation dose for 5-10 volunteers was 36 nGy h^{-1} and higher than the value of 27 nGy h^{-1} estimated with the measurement results in the various environments using mean spending time in each environment from the literature.

To estimate external radiation dose to biota in Lake Obuchi, environmental γ -ray dose in lake water was measured with glass dosimeters in air-tight boxes sank under water. Concentrations of radionuclides in a seagrass (*Zostera marina*) were also measured to estimate internal dose. The environmental γ -ray dose rate at the surface of the lake water was found to be 27 nGy h^{-1} , and the dose rate decreased with the water depth. The radionuclide in the highest concentration in the seagrass was ^{40}K , and its contribution to internal dose was about 60% using the dose conversion coefficients of a vascular plant calculated by FASSET. A voxel phantom of the seagrass was constructed with a 3-dimensional scanner for dose calculation in future work.

Natural α -emitting radionuclides were determined for samples of various environmental media in Rokkasho: soil, sediment, lake water, precipitation, and aerosol samples. Un-disturbed soil samples from two sites in Rokkasho were analyzed, and it was found that ^{210}Po was present in the highest concentration among natural α -emitting radionuclides. Concentration of ^{210}Po in the 0-2 cm surface layer of these soil samples was 9500-15000 times larger than that of Pu assumed to be discharged from the plant. Polonium-210 also was found in the highest concentration in sediment samples from the Obuchi River and Lake Obuchi, and atmospheric deposition and aerosol samples collected in IES, while ^{238}U originating from seawater was the highest in lake water samples from Lake Obuchi.