Natural radiation levels in Niigata Prefecture
II. Natural radiation levels in Chuetsu and Joetsu districts

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The natural radiation levels in Niigata Prefecture were studied from the aspects of the gamma-ray dose rate in Chuetsu and Joetsu districts. The former Chuetsu district was divided into three parts (Kashiwazaki, Nagaoka and Uonuma area). In the Uonuma area, the dose rates were higher than those of the other area, probably reflecting the geological circumstances. The most of the measuring points showed radionuclide contribution to the dose rates in the order of \(^{40}\text{K}>\text{Th-series}>\text{U-series}\) and the dose rates were significantly dependent on the different composition of radionuclides in the soils reflecting the original base rocks. In Niigata Prefecture, annual dose equivalent due to natural radiation from ground has the same level as the 0.34 mSv average value for Japan.

Introduction

The natural radiation levels in Niigata Prefecture was investigated in order to know the practical and realistic background around the nuclear power station. In the preceding paper,\(^1\) the natural gamma-ray dose rate was studied in Kaetsu district and in Sado island. In the northern area of Kaetsu district the dose rates were higher than in the southern parts, probably due to the geological circumstances of this area, mainly consisting of granitic base rock.

The most of the measuring points showed radionuclide contribution in the order of \(^{40}\text{K}>\text{Th-series}>\text{U-series}\) and the dose rates were significantly dependent on the different composition of the radionuclides in the soils, reflecting the original base rocks.\(^1\)

In the present paper the natural radiation levels of Chuetsu and Joetsu districts were investigated. Chuetsu district was further divided in three regions (Kashiwazaki, Nagaoka and Uonuma), because Kashiwazaki area has the largest nuclear power station sites in the world as described in a previous publication.\(^2\)

Experimental

Measuring locations

In Kashiwazaki twelve points were selected as measuring points within 10 km radius of the nuclear power station as a center and two points excluding this area (Fig. 1).

For the collection of samples playgrounds, shrines and parks were selected as measuring points because these locations possess uncultivated flatter land as well as authigenic soils as mentioned in the preceding paper.\(^1\)

For one district, we have selected samples from six to ten points which represented the geological characteristics as well as possible.

Measuring techniques

The total dose rates were measured using a survey meter. A NaI (TI) scintillation detector (2.54 cm diameter and 2.54 cm in length) was horizontally equipped on a tripod at 1 m above the ground and the measurements were carried out for 20 times in 10 second intervals. The relative activity of gamma-rays of the U- and Th-series nuclides, and \(^{40}\text{K}\) in the soil was determined by an in situ \(\gamma\)-spectrometry method or \(\gamma\)-spectrometry was performed on soil samples in the laboratory.\(^3\)

The computer programs for the analysis of in situ spectra and calculation of dose rate were based on the improved BECK's method.\(^4\) In this calculation, the following conditions were assumed: the nuclides of the U- and Th-series are in radioactive equilibrium with their daughters and \(^{40}\text{K}\) and are distributed uniformly, \(^{137}\text{Cs}\) is distributed exponentially by depth and the soil moisture content is 10%.

In Kashiwazaki and Nagaoka area, almost all points were measured by the in situ method. However, the soil samples collected in Uonuma and Joetsu districts, were analysed, only by \(\gamma\)-spectrometry carried out in the laboratory. This method was applied as well, when there were no transportation possibilities for the \(\gamma\)-spectrometer because of lack of wide driving roads.

Results and discussion

Table 1 summarizes the results obtained by the survey meter and by the in situ method or the soil collecting method. Respective dose rates due to the nuclides of U- and Th-series and \(^{40}\text{K}\) are given. Figure 2 shows fractional dose contributions of each nuclide.
Fig. 1. Measuring points

Fig. 2. Gamma-ray dose rates due to the U- and Th-series nuclides and $^{40}$K