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A Survey of Environmental Rdiation in Gunma Prefecture

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1. INTRODUCTION

Some research institutes in Japan report natural radiation level of the each every prefecture and the distribution for the purpose of that it grasps natural radiation exposure dose of the inhabitant and that it clarifies the variability of the every region. However, administrative divisions of the un-measurement have also been left in great numbers, if it is observed by the level of the municipality unit.

We carried out environmental radiation measurement of Tokai area (Gifu, Mie and Aichi Prefectures) that the survey at the municipality unit was not carried out using the vehicle-borne survey technique (=car-borne survey) from 1992 to 1996 (1). And this time (for 1998 years), we carried out environmental radiation survey in the all 70 municipalities in Gunma prefecture with car-borne survey and clarified the distribution of dose rates. And, with the survey of the environmental radiation, as the calculation of the natural radionuclide concentration in soil was also carried out, we make a report of those result.

In this paper, we call the gamma-ray from soil "terrestrial gamma-ray" and call secondary particles of cosmic radiation excluded neutron "cosimc-ray" and put both together and call it "environmental radiation".

2. METHOD OF SURVEY

2-1 Measurement Meriod and Measurement Route

We carried out environmental radiation survey in the all 70 municipalities in Gunma prefecture in 5 days from August 27, 1998 until the 31st day and show measurement route to Fig.1.

2-2 Measuring Devices and The Quantity of The Measurment

Measuring devices were used in this survey and the quantity of the measurement are shown to the following ① ～ ③.

① 1" ϕ ×2"NaI(Tl)scintillation spectro-survey meter (= ss- γ)

Counts rates of gamma-ray was measured by hand every 1 minute. Measuring time is 1 minute. The counts rates were converted into absorbed dose rate in air (nGy/h) in the data adjustment stage. Calibration graph was used for conversion. Calibration graph is shown to Fig.2. Conversion factor of 0.015 (nGy/h/cpm) is obtained from Fig.2.

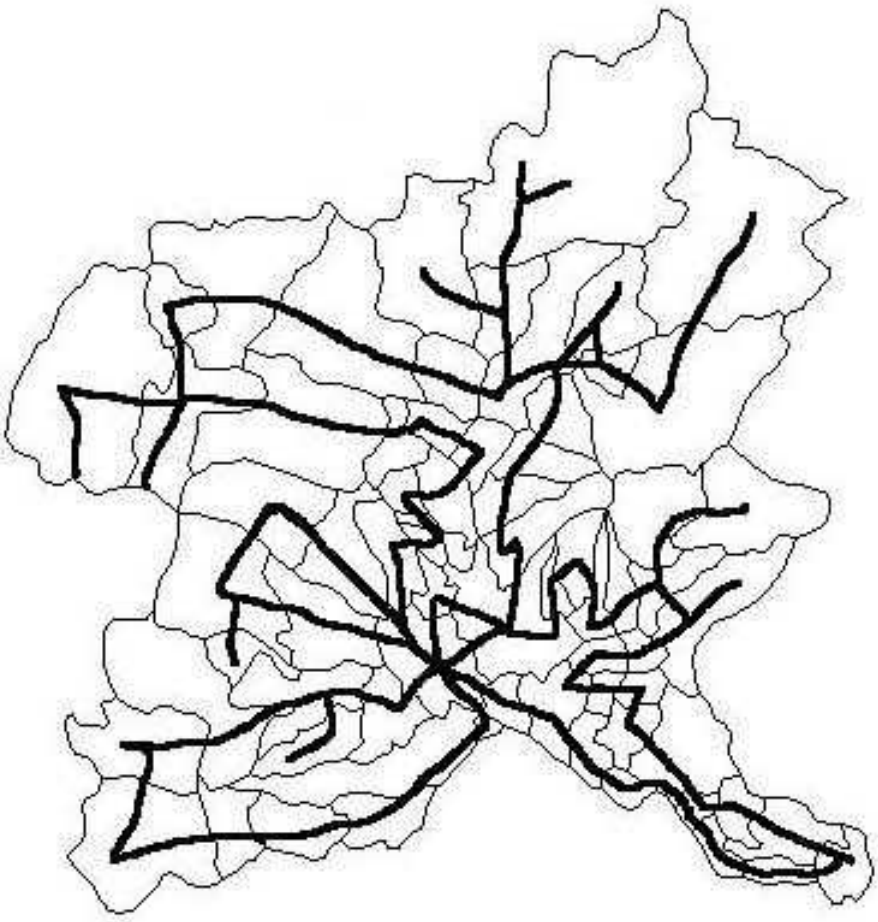


Fig. 1 Survey routes for measurments of environmental gamma ray in Gunma prefecture.

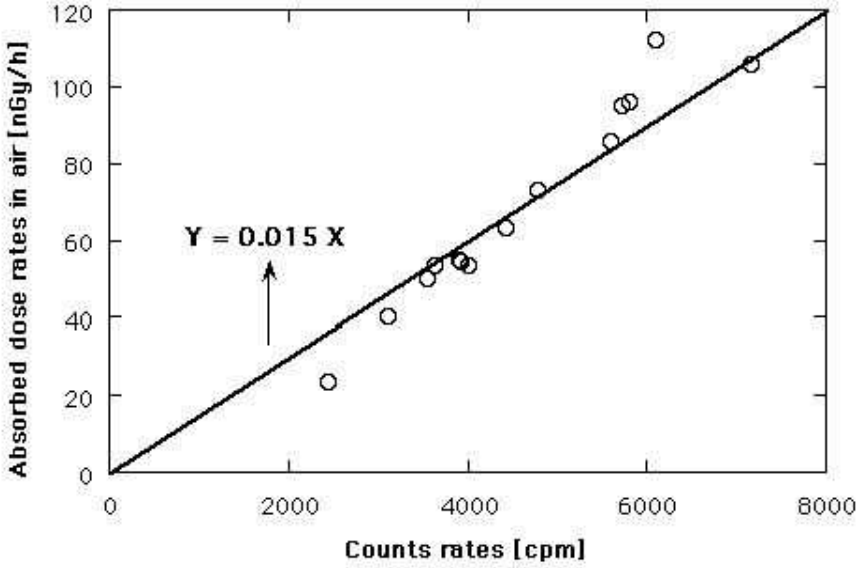


Fig. 2 Calibration curve between counts rates measured by ss-γ and absorbed dose rate in air measured by NaI(Tl) scintillation

② 3" ϕ ×3"NaI(Tl)scintillation spectrometer (= TSM-105)

The measurement of gamma-ray energy pulse-hight was repeated automatically and continually. The measuring time is 30 minutes. The pulse-hight distribution was transpoted to caluclation program and concentrations of potassium (%), uranium (ppm) and thorium (ppm) in soil were estimated by respose matrix method.

③ Handy-Type Barometer

The pressure data was recorded in a notebook every 2 minutes. The data adjustment stage, cosmic-ray dose rates (nGy/h) of each region were estimated from substitutig the pressre data for an empirical formula.

2-3 Considered Factors

We considered the following matter ① ～ ④ during the front or the measurement period when this survey was carried out. Because the detail are described by refrences (1, 2), it is not described here.

① Shielding Effect by The Car Body

The terrestrial gamma-ray are somewhat shielded by the car body. Therefore, gamma-ray counts rates and pulse-hight distribution obtained from this measurement must be converted into value of car outside except influence of absorption by the body.

So we measured counts rates of car inside and outside in different several places of situation of circumference and, calculated the ratio of the counts rates both of (the car outside/the car inside) and multiplied the counts rates of inside car by those means (1.55) and converted it to value of car outside. And the case also when calculated the natural radionuclide concentration in the soil used similar conversion method. As a result, potassium, uranium and thorium, each conversion coefficient was 2.19, 2.06 and1.89, respectively.

② Influence of Road-Pavement

To get data to compare it with a geological feature, we need to grasp radioation level of the soil just under the road-pavement. However, It is impossible to directly measure radiation level of the soil in car-borne survey.Hence, we need to estimate the infruense of road-pavement in advance.

Fig.3 is the graph which compared the measurement on uncovered surface value on road-pavement at various kinds of measurement spots. Considering the regression coefficient obtained in this case, no correction for the influence of road- pavement was made in this survey.

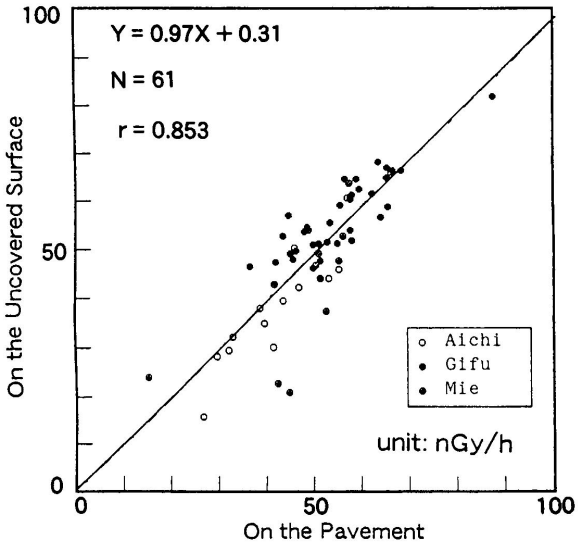


Fig.3 Correlation of the dose rate measured on the pavement to that the uncovered surface.

③ Influence of Precipitation

Radon and radon progeny in atomosphere down on the surface of the earth when rainfall or snowfall, and therefore, the dose rate near the surface of ground sometimes increases (3). But we examined the influence

in survey of Tokai area, we were not able to recognaize increase of the dose(Fig.4), and therefore, in survey of this time, we did not consider influence of precipitation too.

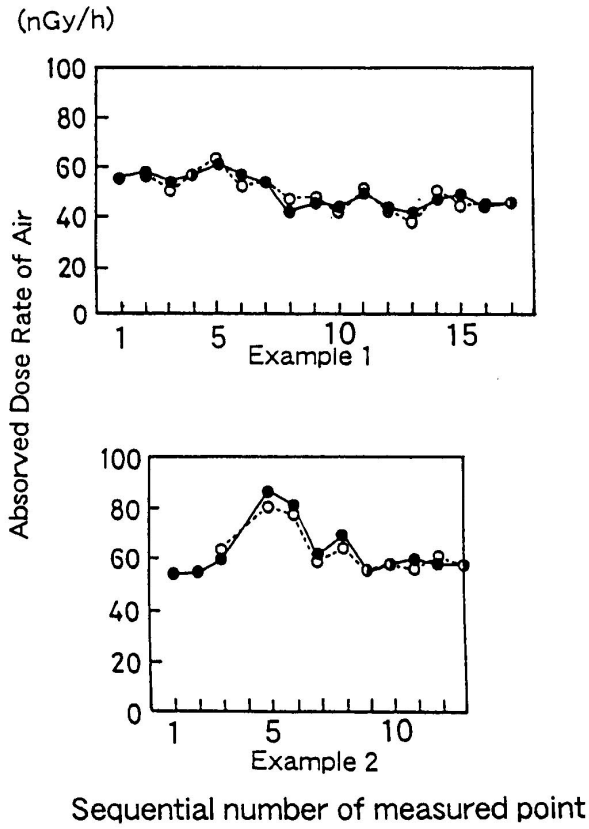


Fig.4 Influence of precipitation. (●: rain, ○: fine)

④ Influence of Cliff and Tunnel

For evaluating the terrestrial gamma-ray dose rates, we must considered influence of the gamma-ray which is exposured from a cliff and a tunnel. But it is difficult to estimate the influence.

In this survey, we decided to remove the influence with a following method simply.

We mark the dose rate data whenever passed near cliff or in tunnel. And the additional components of the dose are substracted by linearly interpolating with the values taken at the beginning of a cliff and tunnel in data processing. Further, the error by this method is estimated with an average of 10-20 % (2).

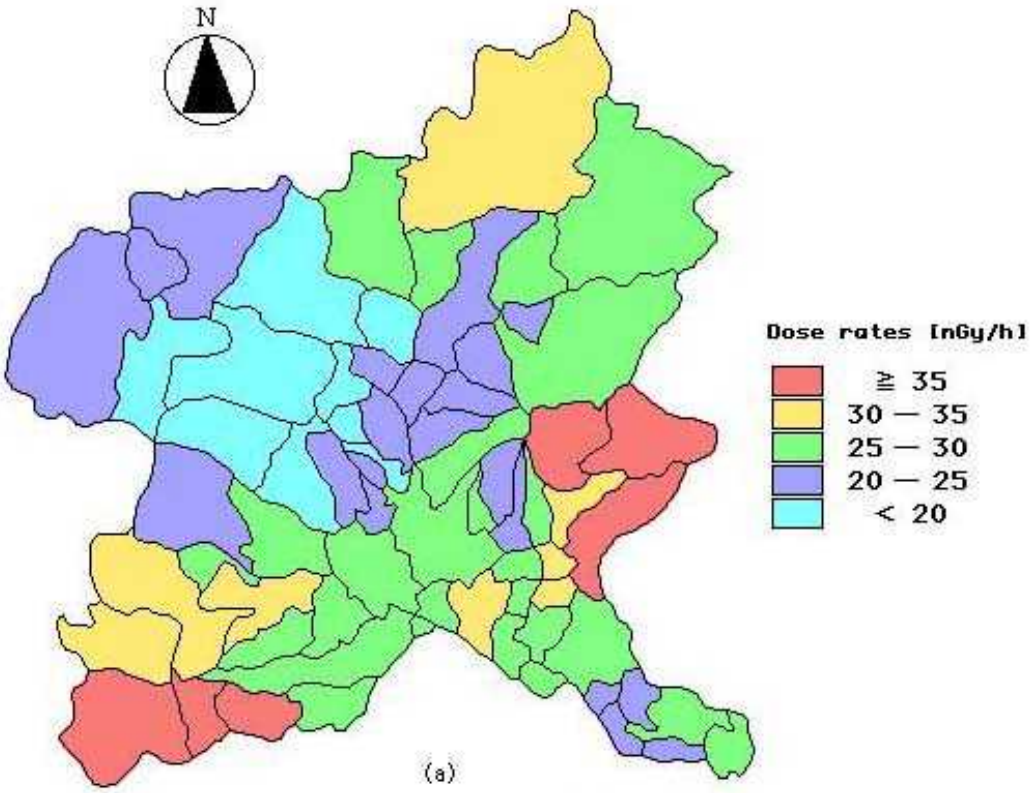
3. SURVEY RESULTS

The mean, maximum and minimum of the terrestrial gamma-ray, the cosmic-ray and environmental radiaition dose rates were summarized in Table1 in Gunma prefecture. And the distribution maps of dose rates which represent the level of terrestirial gamma-ray and environmental radiation are shown to Fig.5(a), (b), respectively.

The mean of environmental radiation level in Gunma Prefecture is lower than another region (4), and the cause is terrestrial gamma-ray level rather than cosmic-ray level. For example, the mean of terrestrial gamma-ray Gunma prefecture was the approximately 57 % when compared it a mean of terrestrial gamma-ray obtained in Tokai area. In this way, it is though that influence of volcanic ashes (the Kanto loam layer) that the terrestrial gamma-ray level is low. And, the terrestrial gamma-ray dose rates of every municipality was distributed from minimum 17.1 nGy/h (Agatsuma) to maximum 42.7 nGy/h (Ueno). From a geologic map (5), the geological feature of Ueno consisited of metamorphic, and that the geological feature of Agatsuma consisted of Asama volcanic sediment was identified. As the radioactivity level of metamorphic have from low level to high level (6), the terrestrial gamma-ray level of Ueno can not argue only in a geological features. But terrestrial gamma-ray dose rates of Agatsuma may be the result that reflected influence of volcanic sediment. And, from Fig. 5, it can identify the eastern part of Gunma prefecture (Kiryu, Kurohone, Azuma) that terrestrial gamma-ray

level is high comparatively too. This will have shown influence of granite which spread through the upper reachs of Watarase-river.

Measurement result of natural radionuclied concentration in soil is shown to table 2. Characteristic of variation every region of potassium, uranium and thorium was discovered, but in particular, the thorium concentaration is low and the mean of Gunma Prefecture compared it with the mean of Tokai area and was approximately 40 %. The concentrations of potassium and uranium were 56% and 104%, respectively. From these results, we estimated that lowness of terrestrial gamma-ray level originate in potassium and thorium concentrations.



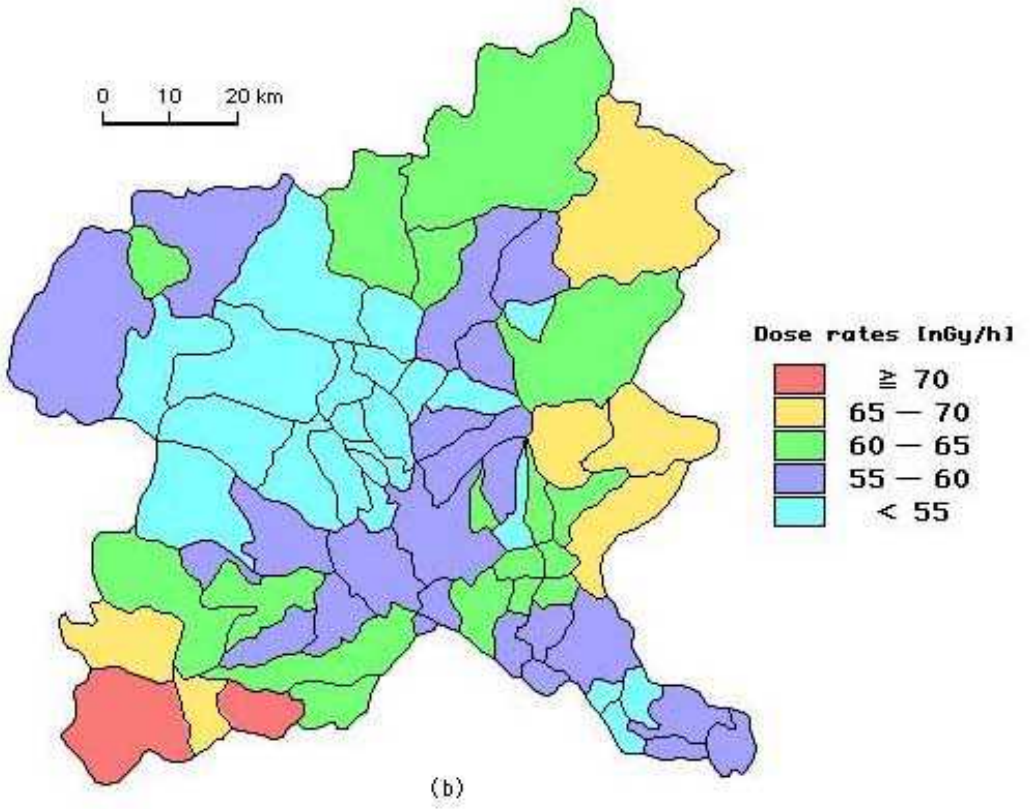


Fig. 5 Radiation dose rates map of Gunma prefecture ;
(a) terrestrial gamma ray
(b) environmental radiation

Table 1 The results obtained from car-borne survey with ss-γ in Gunma prefecture.

Sample No. 718	Explored 941.5 km	Tunnel and Wall 9 %	
	Absorbed dose rates in air (nGy/h)		
	Terrestrial gamma ray	Cosmic ray	Environmental radiation
Mean of district	26.2	32.4	58.5
S.D. 1σ	5.4	1.6	5.3
Maximum (Municipality)	42.7 (Ueno)	38.4 (Kusatsu)	77.6 (Ueno)
Minimum (Municipality)	17.1 (Agatsuma)	30.6 (Ora, Itakura)	50.0 (Agatsuma)

Table 2 The mean of concentrations of potassium, uranium and thorium in soil obtained from car-borne survey with TSM-105 in Gunma prefecture.

potassium [%]	uranium [ppm]	thorium [ppm]
1.13 ± 0.18	2.41 ± 0.88	2.95 ± 0.87

4. CONCLUSION

We carried on survey of terrestrial gamma-ray, cosmic-ray, environmental radiation and natural radionuclied concentration in the all 70 municipalities in Gunma prefecture with car-borne survey.

The dose rates of terrestrial gamma-ray, cosmic-ray and environmental radiation were 26.2 nGy/h, 32.4 nGy/h and 58.5 nGy/h, respectively. The mean of potassium, uranium and thorium concentrations in soil were 2.95 %, 2.41 ppm and 2.95 ppm, respectively. And on the basis of this survey results, the dose rate map due to terrestrial gamma-ray and environmental radiation which were divided into every each municiplity were drawn up.

5. ACKNOWLEGEMENT

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6. REFERENCES

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