THE GAMMA - RADIATION FIELD IN HUE CITY

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Abstract The gamma - radiation field in Hue city was detected by gamma-ray semtillation spectrometer GAD - 12 and CPII-68-01. The concentration of Uranium was detected through the 1,76 MeV photopeak of Bi^{214}. The concentration of Thorium was detected through the 2,62 MeV photopeak of TJ^{208}. The concentration of Potassium was detected directly by the 1,46 MeV photopeak of K^{40}. The gamma-ray activity has been calculated from the concentrations of Uranium, Thorium and Potassium. The deteced radiation exposure rate I (μR/h) agrees with the measured mean values by CPII-68-01 ranges from 3.5 (μ R/h) to 14,5(μ R/h). Average value of the external radiation level is 8,25(μ R/h).

1. Introduction

In order to have scientific foundations for the master plan and building the country it is necessary to evaluate sufficiently parameters on environmental geophysics. Definitely, the evaluation of parameters on environmental geophysics has a great significance for residential, urban, tourism and resort areas. Nowadays, in the world, after a series of events caused by calamities such as earthquake and volcano, this work has been paid much more attention by nations. Evaluating the parameters on environmental geophysics in the work should be done before the master plan of residential and urban areas. Gamma ray radiation field, which is one of the parameters of environmental geophysics, is interested when implementing the evaluation of the specifications on environmental geophysics. Defining the gamma ray radiation field in these areas will allow us to evaluate the total dose of annual radiation that inhabitants in these areas have been suffered. In the geology, the gamma ray radiation field, together with other geophysical parameters lets us know some information on the underneath geologic ground substance. Evaluating the gamma ray radiation field in the whole territory of our nation is a heartfelt aspiration of the research group on the environment affected by radioactivity at the experimental nuclear physics, formerly the Natural University and now the Natural Scientific University. Many years ago, this work was only implemented step by step in large cities. From 1980 up to 1990, through the implementation of two state projects with the codes of 52D and 52D, the gamma ray radiation field in Hanoi, VietTri and HaiPhong cities have been defined. In the above mentioned projects, the evaluation of gamma ray radiation field was only

implemented by defining the concentrations of radioactivity elements such as Uranium, Thori and Kali at each point of measurement. Defining the intensity of the gamma ray radiation field sites of measurement was not implemented, the major contents of this work are to research the radioactive dose based on contents of Uranium, Thori, Kali in soil, simultaneously, measure directly the radiate dose by using dosimeter (CPII 68 - 01) of the formal Soviet Union at places of action.

II. Experimental Method

The gamma - ray radiation field in Hue city was measured by the spectrometer with 4 channels, a size 80 x 80 NaI (TI) scintillation (GAD - 12).

The spectrometers give counts of N_u, N_{th}, N_k at channels for U, Th, K elements simultaneously. The concentration values of U, Th, K were determined by photopeaks: 1.76 Mev (BiBi^{214}), 2.62 Mev (Tl^{208}), 1.46 Mev (K^{40}) respectively. The formulas for calculating the concentratation values and counts of U, Th, K were found by the relation between their concentration value and counts of these elements. The standard samples in which the concentration value of U, Th and K are 250 ppm, 490 ppm and 49% respectively to be used for finding the formulas. By matrix method, the formulas are obtained as follows

$$q_u = 4.96N_u - 4.46N_{th};$$
$$q_{th} = 9.4N_{th} - 0.85N_u;$$
$$q_k = 0.59N_k - 0.61N_{th}. \tag{2.1}$$

where

q_u is Uranium concentration in unit (ppm);

q_{th} is Thorium concentration in unit (ppm);

q_k is Kali concentration in unit : percent (%)

N_u, N_k, N_{th} are counts per second at channels U, Th, K respectively. The external radiation level $I(\mu R/h)$ depends on the concentration values of U, Th and K [4] by formula as follows

$$I = 0.65q_u + 0.29q_{th} + 1.5q_k \tag{2.2}$$

where I is the external radiation level in unit $(\mu R/h)$.

The external radiation level at some sitter was measured directly by the dosimeter CPII68 − 01. The working level of the dosimeter is from 30 Kev t0 3 Mev from gamma ray. The standard samples and Rn_a^{226} source - 1^{mCi} were used as standards. As a resul:, an empirical formula is obtained as following

$$I = a.N, \tag{2.3}$$

where

N is number indicator given by dosimeter.

a is proportional coefficient depended on measurement level to be used.

Using the dosimeter CPП68 – 01 and standard samples for calculating the external level (2.2 formula). the result of this calculation is obtained in the range error 10%.

The results of measurements agree with the results obtained by calculating by formulus within an error range 25%. To be obtained concentration value of U, Th, K in soils, rock located at 120 sites by formula (2.1). To calculate the dose based on the data measured by the dosimeter CPП68 – 01 and formula (2.3). Besides to be used the formula (2.2) for calculating dose.

Thuong River divide Hue city into two areas, the North of Thuong River is Hue citadel, of which Royal palace is the center. The South of Thuong River is new urban area including mausoleums scattered in the suburb area of Hue ancient capital. The experimental work is divided into 3 parts.

- Mausoleum area,

- New urban and residential area,

- In the areas related to production activities which produce the radio - activity elements and in varied geologic areas.

The sites of measurements are equally distributed along streets and mausoleums. In each site, measurements were carried out within 3 minutes in the manner that the statistic error at the Thory channel is not larger than 10%. Measurements were repeated three times in each site.

III. Results and Discussion

a. In Hue City

There is no abnormal value of gamma ray radiation field in the Hue city and Mausoleums. It is different from VietTri city and Hanoi capital. Gamma ray radiation field in Hue city does not change much and lie in the normal level. Value of concentration of Kali, Uranium and Thory is 1.53%, 44.7 (ppm) and 11.1 (ppm), respectively.

The intensity of gamma ray radiation is I_t that is calculated by using formula (2.2) and the dose is I_d that is derectly measured by using device CPП68 – 01.

The value of dose I_d varies from 3.5 to 14.5 ($\mu R/h$). The places which the value of dose lie in the range from 7 to 11 ($\mu R/h$) appear with the largest frequency. The average value of dose (I_d) in the mausoleums and city is 8.0 ($\mu R/h$).

The value of dose I_t varies from 3.9 to 13.3 ($\mu R/h$). The sites which the value of dose lie in the range from 8 to 11 ($\mu R/h$) appear with the largest frequency. The average value of dose (I_t) in the mausoleums and city is 8.5 ($\mu R/h$).

In the total of 127 sites of measurement, the distribution of value (I_d) and (I_t) in the Hue city were defined by two methods explaining in the diagram 1a and 1b. From these diagrams we could see that the shape of two graphs are not very different. The sites having values of dose lie in the range from 7 to 11 ($\mu R/h$) appear with the largest frequency. So that the average radioactive intensity in the Hue city is 8.25 ($\mu R/h$).

From that, to be calculated external dose in a year about 0.068 msv/y. This value is smaller than values published in Japan and France [4,6].

Value of intensity	<4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	>13
Number of measurementa places	2	8	13	16	23	21	19	13	6	4	2
Rate of occurence (Pi)	0.016	0.063	0.102	0.126	0.181	0.165	0.15	0.102	0.047	0.032	0.016
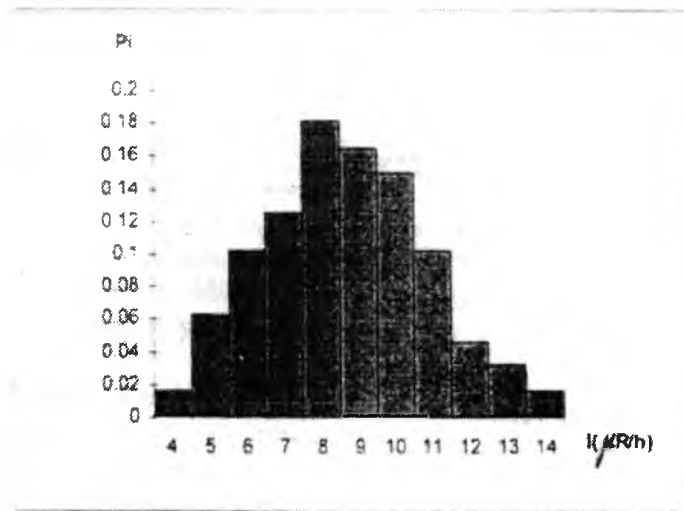
(a)

Value of intensity	<4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	>13
Number of measurementa places	2	7	9	13	21	22	20	17	9	5	2
Rate of occurence (Pi)	0.016	0.055	0.071	0.102	0.165	0.173	0.157	0.134	0.072	0.039	0.016
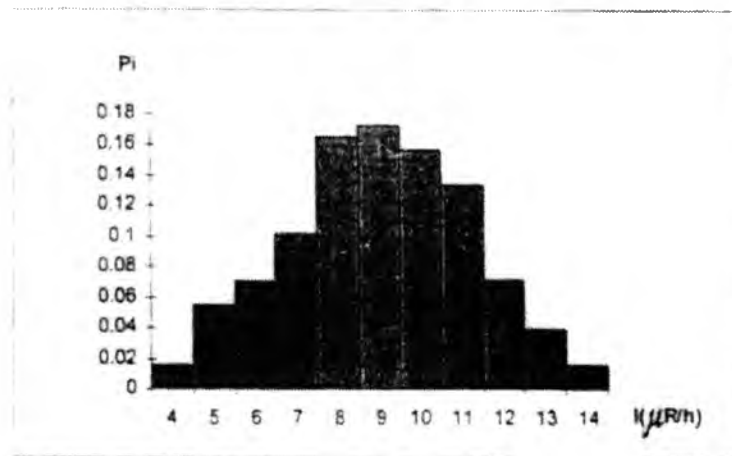
(b)

Fig 1.

The distribution of the external radiation level in Hue city

b. Mineral exploiting and processing area that belong to Binh Tri Thien mineral exploitation enterprise

Depending on each site of measurement in the area of the enterprise, the concentration of the radioactive elements as Thory varies in a large range from 30 (ppm) in place far from production area up to 3800 (ppm) in the production area. It is respectively, the intensity of gamma ray radiation external dose is variable in the range from 22 ($\mu R/h$) to 2200 ($\mu R/h$). At other places in enterprise, the concentration of Uranium is also higher than those in the city and mausoleums, specifically the concentration of Uranium varies from 12 to 300(ppm). Concentration of Kali lie in the normal range from 1 to 2.6%. Therefore, the gamma - ray radiation field in the area of the enterprise is mainly caused by radioactive elements in the Thori series. Especially, in the place near the storage where containing finished products, the concentration of Thori rise up to 1.2% and the dose in here go up to 3500 ($\mu R/h$). The works, who work continuously at the center of ore selecting, have been suffered the dose up to the level of 18 msv/year. During the time of ore selecting to collect Zircon, Titan, Mangan, the rest elements are discharged to the environment. When the contents of the dressed elements in the waste reduced to the concentration of elements such as Uranium, Thori existing in the waste will increase. The concentration of Kali in the mineral sand is small, it could be said that, the concentration of Kali in the factory area is mainly caused by the contributin of the soils underneath.

c. Area of having geologic varies

Gamma ray radiation field at the area of having geologic varies such as Xuoc Du hamlet, Huong Ho commune in the outskirts of the Hue citadel is higher than the urban area of the Hue city and mausoleums. Through 20 sites, we could found that:

Concentration of Kali with the value varies from 1 to 2.5 %;
Concentration of Uranium with the value varies from 6 to 18 (ppm);
Concentration of Thory with the value varies from 13 to 60 (ppm).

The respective dose varies in the from 14 to 45 ($\mu R/h$) higher than measured value in the urban of the Hue citadel about 3 times.

Contents of Uranium and Thory are higher than those of sites measured in the area without geologic varies may be due to the gradient temperature pressure push the radioactive elements from the below level up ward or other place to these areas. Especially when there is a crack the emission of Radon gas from the entrails of the earth with the large amount.

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