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RESULTS OF RADIATION LEVEL STUDY IN SOME TERRITORIES OF MONGOLIA

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The outdoor terrestrial gamma-ray background in the urban environment of provincial centers and several cities of Mongolia was studied in order to assess the absorbed gamma dose rates in the open air and determine the activity concentrations of ^{238}U, ^{232}Th and ^{40}K in soil samples, collected from the selected locations.

Изучен территориальный фон гамма-излучения в городской окружающей среде нескольких провинциальных центров и городов Монголии. Оценена мощность поглощенной дозы гамма-излучения на открытой местности и определена концентрация радиоактивных элементов ^{238}U, ^{232}Th и ^{40}K в собранных образцах почвы.

INTRODUCTION

Mongolia is situated in the northern part of Central Asia and covers an area of 1.5 million km^2 and it extends from 40 to 52 northern latitudes. In general, Mongolia is a mountain country. Its mean elevation is 1500 m above sea level. The total population of Mongolia is 2.5 million. The radiation situation in Mongolia is mainly determined by the geographic location and the elevation above sea level. The global radioactive fallout from nuclear and thermonuclear weapon tests depends on the latitude.

A study of environmental radiation level in Mongolia during the 1980s was performed with respect to scientific and health aspects. Within the scope of this study, the Nuclear Research Center (former Nuclear Research Laboratory) of the National University of Mongolia carried out investigations of the radioactivity in samples of air, soil, different types of coals, building materials and other environmental samples. The laboratory is also determining the external exposure dose rate caused by environmental radioactivity and the radiation burden of the population of Mongolia. The basic instruments used for our investigation were portable scintillation gamma spectrometry and laboratory semiconductor detector gamma spectrometry. Also we were using thermoluminiscent dosimeters, which have been found suitable for integrating terrestrial exposures.

1. MEASUREMENT AND RESULTS

The studies of the environmental radiation level are being carried out in all provincial centers and in several cities of Mongolia, in which live more than 55% of the country total population. The study areas include all geographic soil zones of Mongolia.

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Large samples of soil, coal and building materials (1–2 kg) were collected from the study area for measurement of the activity concentration of the natural radioactive isotopes and ^{137}Cs. The radioactivity of the sample was measured by low-background gamma spectrometry based on high-purity Ge detector of about 15% efficiency and 1.85 keV resolution for the 1332.5 keV ^{60}Co line. The measuring time was usually 4000 s or more. The activity concentration of radionuclides, such as ^{238}U (^{226}Ra), ^{40}K, ^{232}Th and ^{137}Cs, was also determined quantitatively through their gamma lines. The activity concentration of the natural radioactive elements in soil samples was calculated using the formula [1]

$$A = \frac{N(E)}{k\varepsilon_0(E)k_\gamma mt},$$

where A is the activity concentration (Bq/kg); $N(E)$ is the net area of the gamma line; k_r is the yield of gamma quanta; $\varepsilon_0(E)$ is the absolute efficiency of the detector; k is the constant; m is the weight of sample (kg); t is measured time (s).

Table 1. **The activity concentration of natural radioactive nuclides in soil samples for some territories of Mongolia (Bq/kg)**

Names of cities and provincial centers	^{40}K	^{238}U	^{232}Th
Altai	322.4 ± 27.3	18.1 ± 2.4	11.3 ± 2.2
Baruun-Urt	725.9 ± 52.0	41.4 ± 4.3	50.7 ± 5.6
Bayanhongor	781.5 ± 48.1	19.3 ± 2.5	22.2 ± 3.0
Bulgan	895.4 ± 104.3	21.2 ± 3.5	26.3 ± 4.3
Dalanzadgad	778.0 ± 60.7	29.0 ± 4.1	28.0 ± 3.1
Darkhan	736.0 ± 53.1	45.1 ± 4.4	32.7 ± 4.3
Zuunmod	741.5 ± 54.2	20.0 ± 2.9	54.6 ± 5.5
Mandalgovi	939.0 ± 56.3	23.8 ± 2.9	21.5 ± 3.1
Muren	897.9 ± 57.0	35.6 ± 3.8	27.3 ± 3.5
Ulgii	530.1 ± 36.6	14.2 ± 1.9	25.8 ± 3.3
Undurkhaan	1031 ± 60.8	25.4 ± 3.1	28.5 ± 3.7
Sainshand	780.4 ± 57.3	22.5 ± 3.0	36.4 ± 4.5
Sukhbaatar	850.6 ± 57.8	38.6 ± 4.2	36.3 ± 4.9
Ulaanbaatar	881.9 ± 94.3	33.2 ± 9.4	39.0 ± 7.3
Uliastai	1330.0 ± 88.3	23.4 ± 3.7	38.1 ± 5.6
Khovd	826.0 ± 67.7	35.0 ± 4.5	39.0 ± 4.9
Tsetserleg	1181.0 ± 82.0	49.0 ± 5.4	42.2 ± 5.6
Choibalsan	965.7 ± 60.5	15.5 ± 2.4	13.9 ± 2.6
Erdenet	677.8 ± 54.0	36.6 ± 4.0	30.7 ± 5.0
Mean value (changed range)	840.7 (322–1330)	28.2 (15–49)	31.8 (11–55)
World mean (changed range)	370 (100–700)	25 (10–50)	25 (7–50)

In Table 1 some results of the measurements of soil samples are shown. The obtained results show that the concentration of radionuclides in soil samples, which have been taken from different soil zones, depends on the type of soil. For instance, in the table the maximum of soil radioactivity was found in Tsetserleg, Uliastai and Baruun-Urt. These stations are located in the sierozem soil zone on granite rocks, in which the concentration of natural radioactive elements is known to be high.

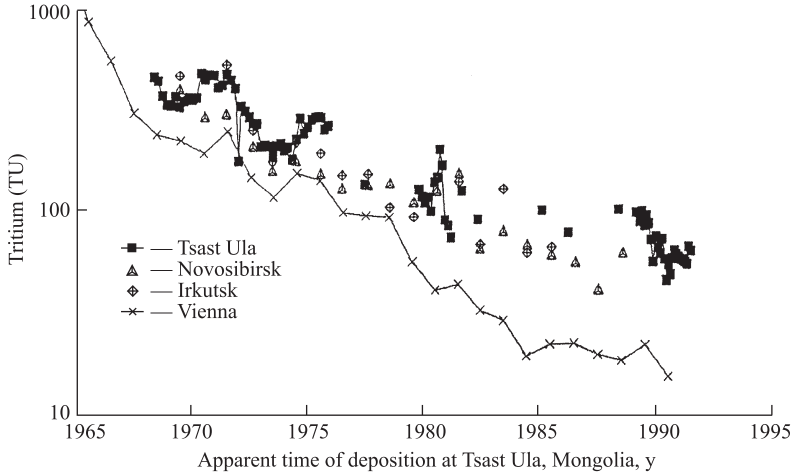
Radioactivity measurements were performed in building materials and building raw materials [1].

It is an important issue to study coal radioactivity and its ash products. In Mongolia, electric energy is basically produced by coal-fired power plants. On the other hand, in the provincial centers and in cities private households use coal for heating. Consequently air pollution increases in these cities. In addition, the ash products of coal are rich in natural radioactive elements. In the Nuclear Research Center, air pollution in several cities such as Ulaanbaatar, Choibalsan and Baganuur is being studied and the radioactivity of coal measured [2, 4]. Among other things, we have found that the coal ash has a rather high radioactivity so that the ash cannot be used as constituent building material.

Naturally occurring radionuclides in soil or rock near the surface of the earth represent the source of an important component of exposure to the population. The external outdoor radiation level was measured by portable scintillation spectrometry with $3 \times 3''$ NaJ(Tl) detectors and thermoluminescence (TL) technique with TLD-100 dosimeters, product of Harshaw Co. Ltd., USA. We selected weather stations in the provincial centers as measuring locations. Every three months the dosimeters were sent by mail to the stations, where they were exposed in instrument shelters at precisely difined place. Average values of outdoor absorbed dose rate in the air of measured points are shown in Table 2. The values cover the period from 1987 to 1991.

Table 2. **The values of outdoor terrestrial gamma dose rate for urban environments in Mongolia, measured by TL technique**

Measured points (administrative centers, cities)	Dose rate, $nGy \cdot h^{-1}$
Arvaiheer	110.1 ± 33.0
Altai	73.5 ± 27.0
Baruun-Urt	103.5 ± 32.0
Bayanhongor	102.0 ± 31.9
Bulgan	95.3 ± 30.9
Dalanzadgad	76.8 ± 27.7
Zuunmod	68.9 ± 26.2
Mandalgobi	83.4 ± 28.9
Muren	97.2 ± 31.2
Ulgii	86.7 ± 29.4
Undurhaan	96.2 ± 31.0
Sukhbaatar	77.1 ± 27.8
Sainshand	88.6 ± 29.8
Ulaangom	60.1 ± 24.5
Uliactai	100.2 ± 31.6
Hovd	82.7 ± 28.8
Tsetserleg	119.4 ± 34.5
Choibalsan	65.8 ± 25.6
Darkhan	79.4 ± 28.2
Erdenet	72.6 ± 26.9
Ulaanbaatar	85.3 ± 29.3
Mean value	86.9 ± 15.0



Tritium variation in precipitation

In June 1991, the Nuclear Research Center of the National University of Mongolia took part in an expedition organized by the International Atomic Energy Agency (IAEA) and Government of Mongolia to a high-mountain glacier in Western Mongolia. The main objective of this study was to reconstruct the tritium input function for Mongolia. Results of the tritium measurement carried out on the firn samples taken during the expedition are shown in figure. One can see that there is a fairly good correlation between the firn tritium and the tritium in precipitation of Siberian stations neighbouring to Mongolia. It is interesting to note that Vienna tritium values are much lower than the ones of Siberia and Mongolia [3]. For us, these studies are very important because they have shown that firn and ice of Mongolian high-mountain glaciers are very good archives for reconstructing the composition of precipitation in the past. We are especially interested in past fallout of radionuclides, more generally, in radioactivity burden of the Mongolian population.

CONCLUSION

In Mongolia, gamma rays from natural radionuclides on the surface of the earth produce outdoor absorbed dose rate in the air ranging from 60 to 119.4 $nGy \cdot h^{-1}$. The obtained average value is 1.7 times higher than the average world value 50 $nGy \cdot h^{-1}$.

We did not find samples of building materials which have high activity.

The values of tritium in the high-altitude glacier samples from Tsast Ula found for the last 23 years from the 1960s show that the investigation of high-altitude glaciers is very important to reconstruct the level of radioactive contamination in the territory of Mongolia after first nuclear weapon tests.

REFERENCES

1. *Shagjjamba D., Norov N.* A present situation of study of natural radioactivity of Mongolia // Sci. Trans. of the Nat. Univ. of Mongolia. 1996. No. 2(125). P. 119.

2. *Norov N. et al.* Study of uranium distribution in coal samples // Sci. Trans. of the Nat. Univ. of Mongolia. 1998. No. 4(137). P. 68.

3. *Froehlich K. et al.* First results of an isotope study of firn at a high-altitude glacier in Mongolia. Report of the TC Project MON/8/009/. IAEA, 1993. 15 p.

4. *Dalhcuren B. et al.* Determination of heavy metals in the air of the city of Ulan-Bator // Abstr. of the 3rd intern. meeting «Nuclear Physics for Protection of the Environment» (NPPE-95), Dubna, May 23–28, 1995. P. 53.

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