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Original Research

Variation of total beta activity in air by years on Obiliq

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Abstract
At the Institute of Occupational Medicine, respectively Radiation Protection Service since 1975 to 1989 there was radioactive monitoring system of environment air and fallout, also are done measurements activity of ^{137}Cs and ^{90}Sr in foods, waters and soils.
In this paper we have presented the results of measurements of total beta activity in air of Obiliq town in Kosovo.The highest annual average of total beta activity was recorded in 1986, it is 281.03 mBq m^{-3}, and it belongs to the year when the Chernobyl nuclear accident occured. While the average daily value recorded was 2,06 mBq m^{-3}.
Continuous monitoring during the observed period showed that the activity concentrations of total beta activity of the radioactive matter in surface of Obiliq air, never exceeded allowed values.

INTRODUCTION

Radioactive aerosols can be classified in the following categories: (a) radioactive aerosols associated with radioactive nuclides of cosmogenic origin, such as ^{7}Be, ^{22}Na, ^{32}P and ^{35}S, (b) radon and thoron decay product aerosols associated with ^{218}Po ^{214}Pb, ^{212}Pb, ^{210}Pb, ^{210}Bi and ^{210}Po, (c) fission product radionuclide aerosols associated with ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{103}Ru, ^{131}I, ^{132}Te and ^{140}Ba, (d) radioactive aerosols associated with the operation of high-energy accelerators, such as ^{7}Be, ^{22}Na, ^{24}Na and ^{52}Mn, (e) plutonium aerosols due to nuclear weapons testing or nuclear reactor accidents, and (f) mine aerosols[1].

Radioactive contamination of the environment was formed as result of nuclear weapon test and accidents at the nuclear power station. The most part of residual radioactive products of nuclear explosions penetrated into the stratosphere and then slowly (for months and years) deposited on the earth surface and formed more or less uniform contamination with the maximum in the middle attitudes of northern hemisphere [2].

Global radioactive fallout had maximum value in 1963, originating from atmospheric nuclear weapons testing in 1950s and 1960s, conducted by the USA and Soviet Union [3]. The most powerful atmospheric nuclear test 50-58 megatons was exposed on 30 October 1961 at the height of 4000 m above Novaya Zemlya [4]. Also impacts on radioactive contamination of air have nuclear power plant accidents, which contribute to increas radiation contamination in generally.

Radioactive materials released into the atmosphere were transported to a large distance in different direction depending on the change of wind directions [5].

Fission products generally decayed by beta (in most cases) and gamma emission, it is the reason why we have made measurement of total beta activity in air sample.

Among anthropotropic (i.e. man – made) radioactive nuclides fission products, ^{90}Sr and ^{137}Cs have been regarded as fission products of great potential hazard of living beings due to a unique combination of their relatively long half-lives and their chemical and metabolic properties resembling those of potassium and sodium, respectively[6].

Total beta activity in the air of Kosova has been measured since 1975, but investigation of ^{90}Sr and ^{137}Cs involving radiochemical methods started in 1978.

MATERIALS AND METHODS

The total beta activity in the air of Kosova has been measured continuously since 1975 to 1989, it has been stopped for different reason. We have restarted to make measurement of radioactivity in air when Fokushima nuclear accident happened. Sampling place is garden of Institute of Occupational Medicine-IMP, in Obiliq, Kosovo (latitude 42^0 67' and longitude 21^0 09') for both cases.

The air is continuously pumped through the Schneider & Poleman filter paper (blue), height of air sampled is carried 1 m above the ground, and volume of air circulated ranging from 40 to 60 m^3 per day (24 hours), air volume is measure by flow meter.

Total beta activities of the air filter samples were measured in the IMP laboratory five days after the end of sampling, when short lived daughter nuclides of radon (^{222}Rn) have decayed to lead (^{210}Pb) and radon (^{220}Rn) progeny have decayed to stable lead [7]. Level of radioactivity encountered in environmental samples is low, long counting times were necessary. The background of detector was determined before use, by the same time and was subtracted from sample counts.

Total beta activity was measure by Amperex Low-Level Beta Counter, designed to measure the low level radiation associated with radioactive contamination in air, water, food etc. The combination of the anticoincidence shield and the use of detector materials containing very low levels of natural occurring radionuclides resulted in a background of approximately 1 cpm. In operation, the small inner end window detector would respond to both the radiation from the sample and cosmic rays. The guard detector only responded to cosmic rays. Pulses produced by the end window detector would not be counted if there was a simultaneous pulse from the guard detector - these would be pulses due to cosmic rays. Pulses from the end window detector would be counted if there was no simultaneous pulse from the guard detector - these pulses would be due to radiation from the sample. This system is called LARA 5.

To find the detector efficiency we use the two standards of ^{137}Cs with different activities, one with low activity and another with high activity. For each standard is found the number of impulses by time of measuring. From the obtained values we have found a line which is used to find efficiency of the detector to the respective sample.

The high voltage for total beta activity counting was 1000 volts and samples were counted for 3 cycles of 1000 sec per cycle. The count rate and beta activity were calculated using the formula:

$$A_\beta = \frac{N_\beta - B_\beta}{E_d * E_f * Q} * \mathrm{k} \qquad (1)$$

When: A_β-Beta activity of sample, N_β-measured beta sample counts, B_β-measured beta background counts, E_d-Efficiency of detector, E_f-Efficiency of air filter, k-factor of convert to the desired reporting units.

RESULTS AND DISCUSSION

From 1975 to 1989, every day air samples were collected in the garden of IMP; those data are presented in Figure 1. From data of activity we understand the value of total beta in air didn't change much from year to year, except 1986, where the average value recorded for this year was 280.88 mBq/m3, this was the year when the nuclear accident occurred in Chernobyl.

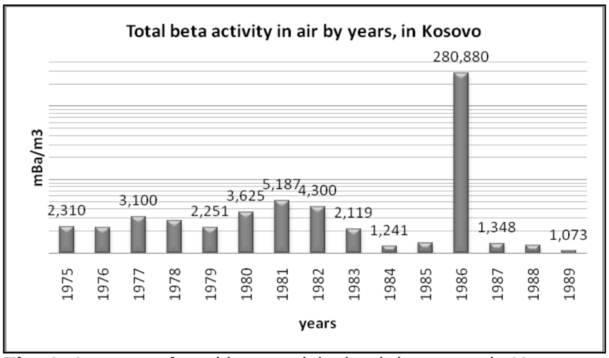

Fig. 1. Average of total beta activity in air by years, in Kosovo

Although some other mathematical models can lead to a better fit of experimental data, the best physically acceptable fit for the experimental data is the exponential function:

$$A(t) = A(0)e^{-kt} \qquad (2)$$

Where *A(t)* and *A(0)* are the activity concentrations at times *t* and zero, respectively, and *k* is the constant. The reciprocal value of the constant *k* mean residence time T_m of tine observed radionuclide in the air, i.e.:

$$T_m = \frac{1}{k} \tag{3}$$

For the total beta activity in the air, the fit of experimental data to a function (1) was obtained by regression analysis, leading to the equation:

$$A(t) = 11.356\, e^{-0.207t} \tag{4}$$

With *P<0.006*, the time is in years, the starting year being at t=1 for 1975.

The data in Figure 1, shows the average annual value of total beta activity in air. The maximum value recorded was in 1986 with 280.880 mBq m-^{3}, this value is incrised due to the Chernobyl nuclear accident.

On April 26, 1986 at about 1.24 a.m. two successive explosion that followed the reactor runaway at Unit IV of Chernobyl NPP destroyed the reactor active zone and the unit building[8]. During ten days a large amount of radioactive materials released into the atmosphere were transported to a large distance in different directions depending on the change of wind direction [**Hata! Yer işareti tanımlanmamış.**,9].

The highest level of radionuclide deposition was formed in the territories of Ukraine and Belarus adjacent to Chernobyl NPP [**Hata! Yer işareti tanımlanmamış.**]. While Chernobyl depositions were found in most countries of Europe [**Hata! Yer işareti tanımlanmamış.**].

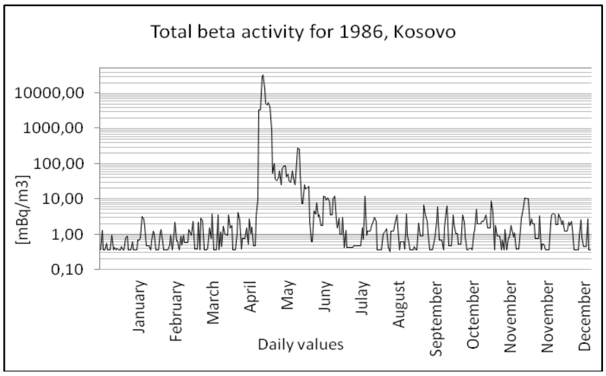

Fig. 2. The data of the daily total beta activity in air, during the year 1986 in Obilic

In Kosova daily values of total beta activity of recorded during 1986 are presented in Fig 2. By which we mean that from the beginning of the year until 28/04/1986 The average recorded values are about 0.91 mBq/m3 behave, but the date 29 of the same month recorded an increase of 10 mBq/m3, which follows the 3330.22 mBq/m3 in next day, the maximum value registered on 03/05/1986 which is 33028.06 mBq/m3, around this point the results are for a short period, immediately after 9 days we have decrease. A stable state was reached in the second half of the July, the values was around 649.8 mBq/m3. But finally by the beginning of July we had similar results to the period before the Chernobyl nuclear accident. Detailed measurements in Obiliq have shown the presence and increase value of 137Cs and 90Sr radioisotopes in food during this period [10].

The histogram of all the data of 1986 year has two peaks, so it is bimodal distribution. The second mode is coming from value of days after Chernobyl happened, so bimodality is indicated from those data, this is mainly caused by the change of wind direction and speed. This situation is just for 1986 year, all another years are unmoral.

Gamma radiation was measured after accident of nuclear power plant in Chernobyl, in some regions of Kosova. Results of exposed dose per day indoor and outdoor shows that outdoor value are for two times higher than indoor value [11]. Exposed doses and the integrals of gamma radiation was done in parallel way, by thermoluminescent dosimeter(TLD), the higher value was recorded in Podujeva municipality, it was around 0.56 µSv/h, and lowest is

Knowing that the monitoring of total beta activity system was shown quite successful in case of Chernobyl nuclear power plant, on 20.03.2011 we restarted measurements in the same sampling place (garden of IOM) with same conditions to convey possible changes to the total beta activity in the air after the Fukushima nuclear power plant accident of Japan, following the earthquake and tsunami on 11 March 2011.

After Fukushima accident we recorded results show by Fig 3. This graph is presenting the daily variation of total beta activity in the air, from 20.03.2011 to 15.05.2011.

There are two peaks, the first is 7 mBq/m3 and the second 5.5 mBq/m3, and there are higher values than others from Fig. 3. We have not made other additional analysis to be sure if this increase of total beta activity is originated from incident at Fukushima nuclear reactor facility. Some other scientific work has confirmed impact of Fukushima incident in their place such as Italy [12], Europe, [13] and USA [14].

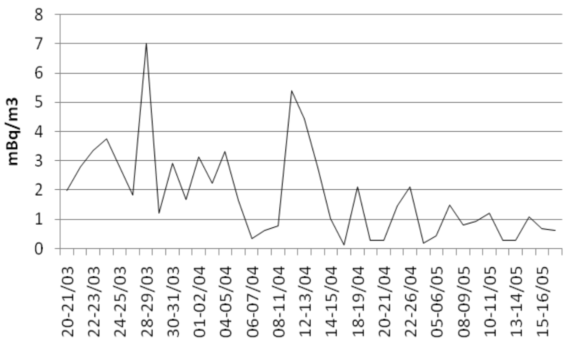

Fig. 3. Total beta activity of the Obiliq air, post nuclear power plant accident of Fukushima.

CONCLUSION

On basis of presented data, for whole observation period, in the surface of air in Obiliq, can generally be concluded that the highest value of total beta activity concentration is year 1986 than other observed years; subsequent years were not affected by this contamination which originated from the nuclear accident in Chernobyl. Daily average value for the entire 1975-89 period is 2.06 mBq m^{-3}, from this daily values exclude the month of May and June of 1986, because this is the period after the nuclear accident of Chernobyl. While recorded values of Fukushima incident have showed nine consecutive days higher value than 2,06 mBq m^{-3}, but all other values are smaller.

Continuous monitoring during the observed period showed that the activity concentrations of total beta activity of the radioactive matter in surface of Obiliq (Kosova) air, never exceeded allowed values.

In order to protect the general public, monitoring is necessary, also as part of general emergency preparedness and in case of nuclear accident also. It is cheap and fast. When total beta activity in air is increased, supplement detailed analysis should follow this parameter, to determine the percentage of certain isotopes in total value.

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