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# RELATION BETWEEN RADIOACTIVE EQUILIBRIUM COEFFICIENT AND SAMPLE AGE

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**Abstract:**
This article presents the results of determining the composition of U, Ra, Pb in some uranium samples, the radioactive equilibrium coefficients between radionuclides 226ra/238U - the Krm value and the age of some uranium samples. This article shows for the first time the relationship between sample age and radioactive equilibrium coefficients.

**Keywords:** uranium-lead method, radioactive equilibrium, decay chain

## Introduction

In nature, the parent nuclei of the uranium decay chain are the uranium isotopes $^{238}$U and radionuclides $^{235}$U.. The radioactive decay chain of these families ends with stable isotopes of lead - Pb [1-3]. To determine the age of the Uranium Sample under study, it is sufficient to determine the relationship between lead and uranium isotopes. When determining the age of a uranium sample, the difference between the upper and lower limits of deviations from the actual value should not be large. In order to approach or find the maximum correct value, it is necessary to increase the number of repeated measurements and at the same time avoid error in obtaining the result. [4-6]. Considering that the specified age is very important, it can be said that the most effective method is to obtain the average value of the results determined in parallel measurements.. Deviations from the mean must be taken into account before giving the final result and conclusion. Despite the fact that the classical uranium-lead method using nuclear physical methods is optimal in terms of obtaining the correct result, it takes a lot of time. [7-10].

Determining the age of a uranium sample is possible using the method of measuring the values of the radioactive equilibrium coefficient between the radionuclides of the uranium decay chain.

Using the formula developed in this article, the relationship between the age of the samples and, alternatively, the radioactive equilibrium coefficient is given.

## The purpose of this study

It consists in determining the age of uranium samples from some deposits in redcurrant using the radiometric uranium-lead method of determining the radioactive equilibrium coefficient between radionuclides of the natural decay chain of uranium to solve the pressing problems of nuclear energy. physics, Geochronology, radioecology, etc.

## Theoretical foundations of research.

The uranium-lead method is based on the fact that the isotopes uranium - $^{235}$U, $^{238}$U and thorium $^{-232}$th become lead isotopes $^{207}$pb, $^{206}$pb and $^{208}$Pb, based on the following, as a result of a chain of consecutive alpha-decay:

$$^{235}U \rightarrow {}^{207}Pb + 7\alpha \qquad (1)$$

$$^{238}U \rightarrow {}^{206}Pb + 8\alpha \qquad (2)$$

$$^{232}Th \rightarrow {}^{208}Pb + 6\alpha \qquad (3)$$

In this chain of radioactive decay, the age of uranium ores is determined from the ratio of concentrations of $^{207}pb/^{235}U$, $^{206}pb/238U$, $^{208}Pb/232th$ in the sample.

$$\frac{^{207}Pb}{^{235}U} = (e^{\lambda_1 t} - 1) \qquad (4)$$

$$\frac{^{206}Pb}{^{238}U} = (e^{\lambda_2 t} - 1) \qquad (5)$$

$$\frac{^{208}Pb}{^{232}Th} = (e^{\lambda_3 t} - 1) \qquad (6)$$

From the classical formula (7), which describes the logarithmic dependence of the change in Pb on U.:

$$Pb=U \cdot e^{-\lambda_U t} \qquad (7)$$

we find the time "t"and have the following equation: $t=\frac{\ln\frac{U}{Pb}}{\lambda_U}$ (8)

The radioactive equilibrium coefficient between radionuclides $^{226}ra$ and $^{238}U$ can be determined by the formula below.:

$$K_{pp} = \frac{Ra}{U \cdot 0{,}34} \qquad (9)$$

From there we find the uranium concentration U:

$$U=\frac{Ra}{0{,}34 * K_{pp}} \qquad (10)$$

In the formula (10) we substitute it and get the following equation:

$$t = \frac{\ln\left(\frac{Ra}{0{,}34 \cdot K_{pp} \cdot Pb}\right)}{\lambda_U} \qquad (11)$$

(11) - in formula aid, the bond between the radioactive equilibrium coefficient and the age of uranium samples can be seen.

The environment of radiometric methods has the advantage of the uranium-lead method that changes in the composition of uranium, thorium and lead in samples are mainly associated with radioactive decay and are less dependent on geological and temperature changes.

The content of the study conducted is based on determining the age of the samples using the values of the radioactive equilibrium coefficient between the radionuclides 238U, 206pb and 226ra/238U.

**The results obtained and their discussion.** Experiments were carried out to determine the concentration of Ra, U, Pb, and based on the results obtained, the values of the radioactive equilibrium coefficient - $K_{rm}$ and the age - T values of the selected samples were calculated, the results obtained are presented in Table 1.

**Table 1. Results obtained to determine the calculated values of Ra, U, Pb and radioactive equilibrium coefficient - Krm and the age - T of selected samples**

| № | Sample composition, (g/t) | | | $K_{RM}$ | Age of selected specimens – T, (mlrd. year) |
|---|---|---|---|---|---|
| | $^{226}Ra$ | $^{238}U$ | $^{206}Pb$ | | |
| 1 | 41,5 | 72,2 | 23,6 | 3,75 | 2,089±0,104 |
| 2 | 36,6 | 65,1 | 22,7 | 3,43 | 2,110±0,106 |
| 3 | 28,0 | 60,3 | 20,3 | 2,90 | 2,180±0,109 |
| 4 | 30,2 | 71,5 | 24,1 | 2,60 | 2,270±0.112 |
| 5 | 32,4 | 80,2 | 27,6 | 2,40 | 2,364 ±0,118 |
| 6 | 27,8 | 73,5 | 25,9 | 2,15 | 2,500±0,125 |

Columns 1, 2, and 3 in Table 1 show radionuclides-$^{238}U$, $^{226}ra$, and $^{206}pb$ in the sample. In the samples under study, values of - $^{238}U$ ranging from 60.3 g/t to 80.2 g/t, $^{226}ra$ ranging from 28.0 g/t to 41.5 g/t, 206pb ranging from 20.3 g/t to 27.6 g/t were found. In Column 4, radioactive equilibrium coefficients - $K_{rm}$ values in the range from 2.15 to 3.75-were determined.

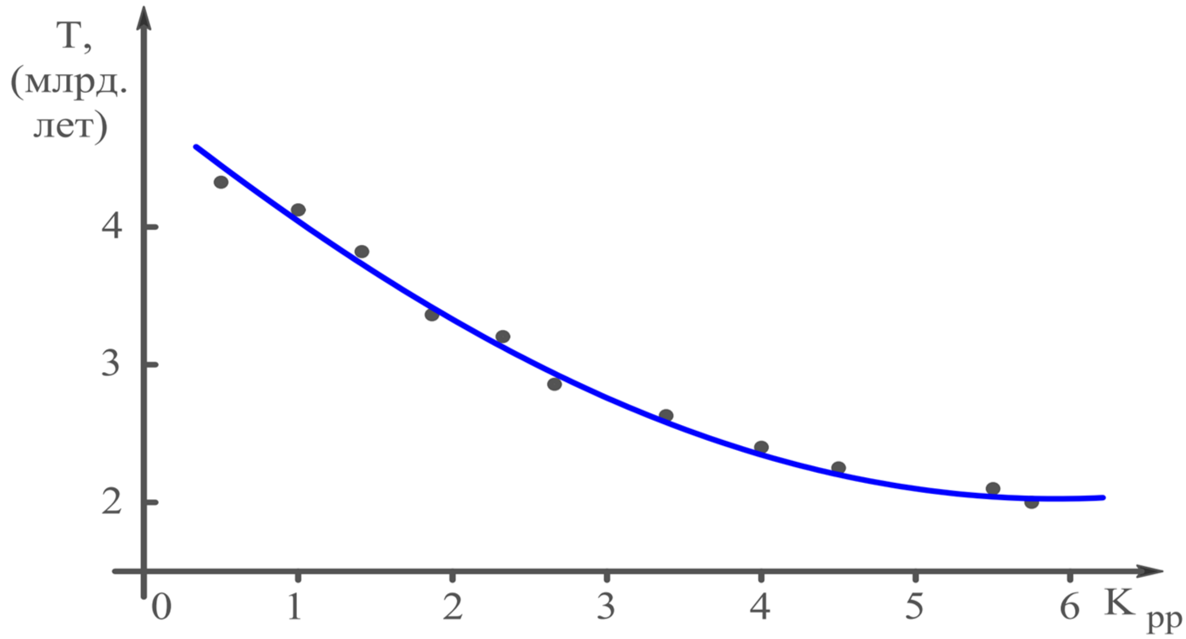


**Figure 1. Radioactive equilibrium coefficient-bond graph between $K_{rm}$=$^{226}ra/^{238}U$ and sample age**

Column 5 (2,089±0.104) shows the calculated age of selected specimens from billion years (2,500±0.125).

Based on the results obtained in Column 4 and Column 5 of Table 1, a graph of the linear correlation between the equilibrium coefficient $K_{rm}$=$^{226}ra/^{238}U$ and the age of the sample was constructed..

It can be concluded that in samples from the same mine, one of the factors that the radioactive equilibrium coefficients are different is their age. $^{238}U$, which is at the beginning of the uranium decay chain, decreases over time and Pb increases. During this time, $^{226}Ra$ is constantly reduced, and the radioactive equilibrium coefficient also changes in a certain range.

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