THE DETERMINATION OF IMPURITIES, COMING FROM RADIOACTIVE POLLUTION, IN TEMPORARY TEETH SAMPLES, USING THE NEUTRONS ACTIVATION ANALYSIS METHOD

Porumb Anca *, Romanul Ioana *, Bungău Simona *,

*University of Oradea, Faculty of Medicine and Pharmacy, P-ta 1 Decembrie, nr. 10, E-mail: anca.porumb@yahoo.com

Abstract

The mining exploitation in BH county, constituted the motivation for the present study concerning the evaluation of the risk of apparition of dental anomalies due to the radioactive element, among the population from this area.

Measurements have been made to determine/find some impurities such as U, Th.

Temporary teeth have been prevailed, being at the age of replacement at patients from three locations: Baita-Plai, Baita-Sat and Oradea.

The samples have been analyzed through activation with neutrons using the standardization method of the bi-isotope or the zirconium method

Key words: *uranium, radioactivity, impurities, isolated dental anomalies.*

INTRODUCTION

The uranium mining exploitation in BH county stood for the motivation for this study concerning the evaluation of the risk of apparition of dental anomalies among the population in this area. The rapid development of the mining activity in the area led to the pollution of the environment [1].

During the process of uranium mining exploitation, the contamination of the personnel has been possible (through all the elements belonging to the uranium family) as well as the contamination of the population from the areas where the mining activity has carried on [1,2].

Due to the radioactive, physical, chemical and biological characteristics of some of these elements as well as to the way of spreading the main radio-nuclides responsible for the contamination were:

- genuine uranium – has polluted the atmosphere(as dust) and water (in developed form or suspension);
- radium 226 – the same conditions as genuine uranium;
- radon 222 – in the rock it has been found with maximum concentration [3,4].

The natural radioactivity, major part of the environment, is determined by the presence in air, soil, water, vegetation, human body and animals of the radioactive substances naturally existing from ancient times. During the

last 50 years, the natural radioactivity in the area of interest for this study presents significant variations due to human activity [1,4].

MATERIAL AND METHOD

Temporally teeth have been prevailed, being at the physiological age of replacement, from three areas: Baița-Plai, Baița-Sat and Oradea city which constituted three samples.

The samples were ground, weighed with a METTLER TOLEDO device with a precision of 10^{-5} g.

The three samples were analyzed using the neutrons activation method and the standardization of the bi-isotope foil method or the zirconium method [1,2].

The samples have been closed in Teflon cartridges and irradiated in the pneumatic mail in the J-7 tube from the beryllium reflector in the TRIGA 14MW reactor. During the irradiation the reactor was operating at the power P=2.02MW and in order to correct the power variations during the process, a self-powered neutron detector has been put in the next tube [1,2].

In order to calculate the mass concentration within the samples, a zirconium monitor has been irradiated together with the analyzed samples.

The induced reaction ratio in this monitor made possible the calculation of the proportion of thermal neutrons and epithermal neutrons.

The induced ratio in Zr allows transforming it into a comparison unit. The thermal neutron flow in the irradiation tube (the neutrons with energy smaller than the cadmium cutting energy, E_{Cd}=0.55 eV), flow determined by the method of activation of gold foils with and without cadmium, was: $\Phi_{Scd}=8.39x10^{12}$ n/cm^{2}s. the proportion of the thermal neutrons flow and epithermal neutrons flow in this tube is: f=12.16, and the proportion in cadmium was: $R_{Cd}=R_{Au}/(RAu)_{Cd}=2.08$. Taking into account the fact that in the analyzed samples, the main elements (Ca, Na, etc.) weren't of interest, the irradiations and measurements to determine the induced activity did not take into account these elements [1,2].

RESULTS AND DISCUSSIONS

The measurements and irradiations have been made to determine some impurities as U, Th. The size of samples as well as the irradiation time are shown in Table 1.

After the irradiation the samples were let to soothe, before the first measurement of gamma activity, 170 hours, in order to allow disintegration:

- firstly of the ^{24}Na isotope that results from the reaction ^{23}Na(n,γ)^{24}Na (the ^{24}Na isotope has the halving time $T_{1/2}$=14.93 h and sends out two

gamma quantum's which have the energies E_1=1368.6 keV and E_2=2754.03 keV)

- secondly the isotopes resulted from the activation of calcium, ^{47}Ca, isotope that is the result of the reaction $^{46}Ca(n,\gamma)^{47}$ and sends out a gamma quantum with the energy E=158.8 keV and $T_{1/2}$=3.46 h.

Table 1

Values of concentration in analyzed samples

Sample	Iradiation time [s]	Thermic flow [n/cm^{2}s]	Elemental concentration		
			Zn (ppm)	Incert std. U_c (k=2)	Std. dev $S_{n(n-1)}$ (k=2)
			$^{64}Zn(n,g)^{65}Zn$		
Oradea	963	8.390E+12	144.123	6.05	3.31
Băița Plai	963	8.390E+12	103.05	4.33	3.19
Băița village	1157	8.390E+12	122.37	5.14	9.46

We have also observed the disintegration of the ^{45}Ca isotope, which is beta transmitter and together with the already mentioned isotopes has a major contribution in forming the Compton continuum, that can cover the eventual lines in the gamma spectrum, lines emitted by the elements in an absolute minority.

The measurement of the induced gamma activity that is of proportional value with the concentration of the measured element in the sample, was made using a high resolution spectrometric gamma system constituted of a 20% efficiency HpGe germanium detector and a multi channel Aquspec analyzer.

The interpretation of the specters has been made using the GENIE2000 software. The spectrometric system has been calibrated in efficiency using a set of standard sources. Within the analyzed specters, besides the majoritary elements that weren't of interest, only the ^{65}Zn element has been put into light, element that is generated in the $^{64}Zn(n,\gamma)^{65}Zn$ nuclear reaction [1,2].

The nuclear characteristics of his radionuclide are presented in Table 2, in order to determine the concentration, multiple measurements for different sample-detector instances have been made. The average values of this element's concentration within samples are presented in Table 1. The standard deviation is the deviation to the average value and U_c represents the absolute uncertainty based on the standard uncertainty for a coverage factor k=2, that provides a certainty level of 95%. The evaluation of uncertainty has been made according to the UKAS demands [1,2].

Table 2

Neutronic characteristics of analyzednucleus

Target isotope	Abundance [%]	Thermal neutron cross-section (b)	Resonance Integral (b)	Reaction
^{64}Zn	48.6	0.760	1.49	$^{64}Zn(n,g)^{65}Zn$

Daughter product	Half-life [h]	Gamma ray energy [KeV]	Br. Ratio [%]
^{65}Zn	5863.200	1115.500	50.750

In figures 1, 2, and 3 are presented the registered gamma specters for the three samples: Oradea, Baița-plai and Baița-village, specters obtained after a soothing period of about 1000 h.

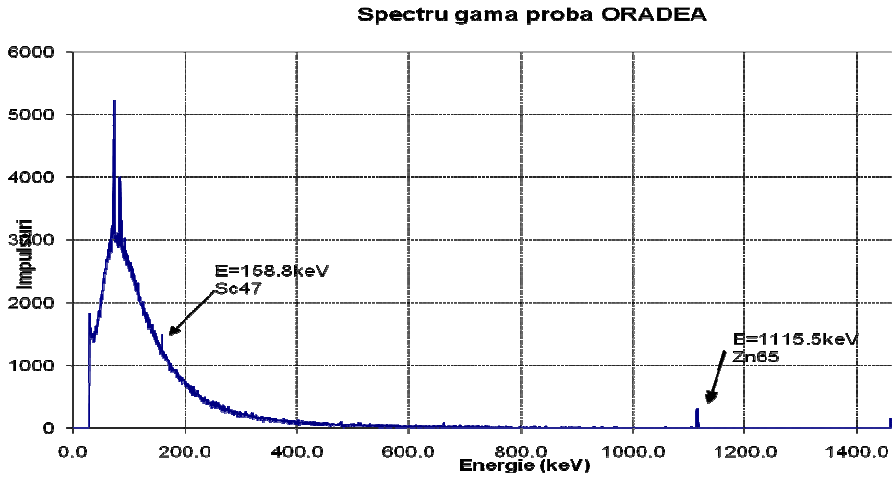

Fig.1. Gama spectrum – Oradea sample

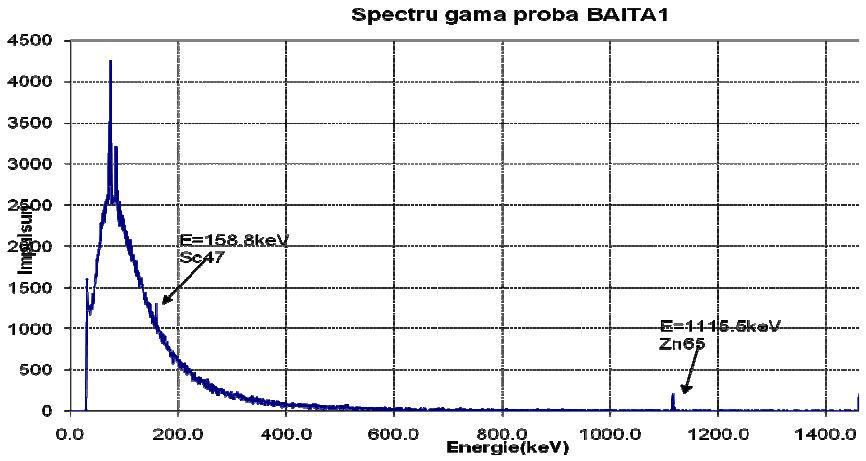

Fig.2. Gama spectrum - Băița-Plai sample

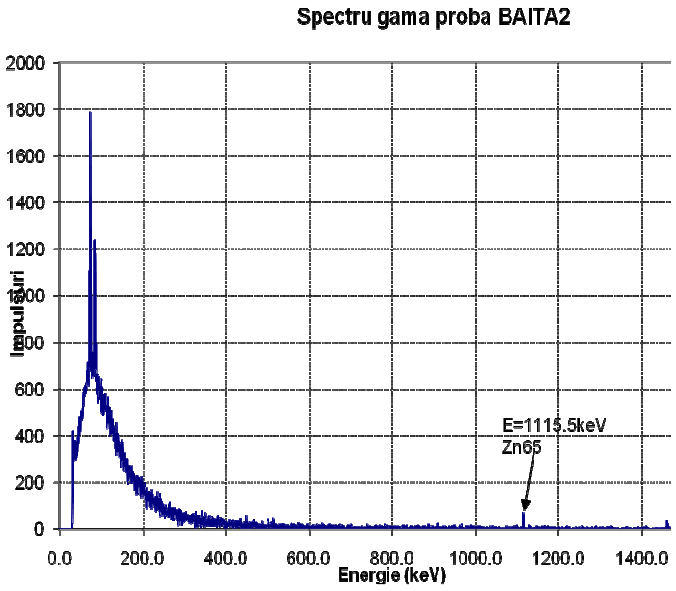

Fig.3. Gama spectrum - Băița village sample

The measurements have been made for a sample-detector distance d=5 cm. Though the Compton continuum cooling has cooled for 1000 h, continuum caused firstly by the ^{45}Ca and ^{41}Ca beta active isotopes, within the three specters the gamma peak can be seen with the energy E=1115.52 keV, sent out by the ^{65}Zn. The 1 and 2 specters show the peak with the energy E=158.8 keV sent out by ^{47}Sc, radionuclide that is offspring of ^{47}Ca.

CONCLUSIONS

Within the teeth enamel certain elements can be present as impurities in minute quantities (traces). According to the measurements carried on, we didn't succeed in emphasizing in the enamel of the temporary teeth prevailed at the age of physiological replacement, the presence of U or Th with any of the three analyzed samples, the patients from which the teeth were pulled out didn't have radioactive elements deposits in the teeth enamel. This can be explained by the reduced presence (as time) on the arch of these teeth – only 6-7 years, not enough to accumulate the studied radioactive elements.

The information has been given by:

- The Radioprotection, Work Conditions and Ecology Research Laboratory, Ştei;
- Technical Service and The Protection of The Environment and Work Security of The Mining Branch, Ştei.

REFERENCES

1. Porumb A., Radiodiagnosticul în anomaliile dentare izolate, Teză de doctorat, UMF „Iuliu Haţieganu", Cluj- Napoca, 2008, pp. 61-65
2. Cosma C., Jurcuţ T**.,** Radonul şi mediul înconjurător, Editura Dacia, Cluj- Napoca , 1996, p.10
3. Şandor Gh., Dinca G., Peic T., Stoici D., Proc. of IRPA VIII Congress, Montreal, Canada, 1992, p. 1371.
4. Edelstei M., Makofake W., Radon's Deadly Daughters, Science, Environmental Policy and the Politics of Risk, 2007.