THE USE OF MINERAL AND ELEMENTAL COMPOSITION OF HUMAN BLOOD IN ECOLOGY

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In the conditions of long-term residence in the territories adjacent to nuclear industry enterprises, nuclear weapon testing sites, the population is exposed to chronic effects of ionizing radiation. In this regard, there is a need to assess the level of environmental burden on the environment and population health, determine the extent of the impact of enterprises on the adjacent territory. In this context, the use of human tissues has the advantage of using them both for assessing the state of the environment and for revealing its relationship with the health of the population.

Human blood has recently been actively used to assess the ecological and geochemical state of the environment, where the subject of research is primarily its elemental composition. Studies have shown that the elemental composition of human blood can represent the geochemical specificity of its place of residence [1].

To date, scanning electron microscopy and instrumental neutron activation analysis are among the most highly accurate and optimal methods for analyzing the morphology and structure of environmental and biological objects. [5,3]. The use of analytical capabilities of these methods in a complex will allow to present the solution of the task of ecological and geochemical assessment of the territory of the impact of nuclear technogenesis in a new way, to obtain important additional information with the possibility of its further introduction as new integrated methods of ecological and geochemical evaluation.

This work's target is showing of possibility and advantage of a comprehensive study of the levels of accumulation and the forms of presence of chemical elements in the blood of a person living in a territory with a complex ecological situation. Our researches were carried out on the example of studying of the elemental composition of blood of residents of settlements located at different distances from the former Semipalatinsk nuclear test site (SNTS).

The territory adjacent to the former Semipalatinsk nuclear test site is characterized as a region with a non-uniform dose load on the environment and on the human body. [3] We investigated settlements located in three areas, which were the main dose-traces of nuclear tests at different distances from the territory of SNTS (Table 1). The background territory is the settlement of Kokpekty, which is located 307 km from the SNTS and classified as the minimum radiation risk zone [3].

Table 1

Distances investigated settlements from the territory SNTS

number	The test location	The direction of the main dose-forming tracks	Distance from SNTS, km	Conditional association distances
1	Bodene	Northeast	100	near zone
2	Dolon		127	middle zone
3	Kanonerka		153	far field
4	Sarzhal	Southeast	102	near zone
5	Medeu		135	middle zone
6	Karaul		179	far field
7	Novopokrovka	East	200	near zone
8	Zenkovka		217	middle zone
9	Kokpekty	control zone	307	far zone (control)

In each investigated settlement 5 to 10 blood samples were taken. The main criterion in the choice of respondents was the fact of living in the study area for at least 10 years. The dry residue of blood was analyzed. Drying was carried out at a temperature of + 60 ° C for 2 hours. As a result, 60 blood samples were taken. Blood was selected only with the informational consent of the respondents. Instrumental neutron activation analysis (INAA) was used to determine the elemental composition of the blood.

As a result of instrumental neutron activation analysis, the concentrations of the following chemical elements were measured in the blood of residents of the studied settlements: Na, Ca, Sc, Cr, Fe, Co, Zn, As, Br, Rb, Sr, Ag, Sb, Cs, Ba, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Hf, Ta, Au, Th, U. The concentrations of such elements as Sc, Sr, Ag, Sb, Cs, Nd, Sm, Eu, Tb, Yb, Lu, Hf, Ta in 50% of cases were at or below detection limit. According to the literature data for small samples, when estimating the average values, geometrically average values should be used [4].

A comparison of the elemental composition of the blood was carried out by remoteness in three directions of distribution of the main tracing traces of nuclear tests: in the northeast, east and southeast directions (Fig. 1). As a result of comparison of geometric averages in remoteness from the territory of the SNTS, the levels of accumulation of chemical elements in human blood were ambiguous. Subsequently, the elemental composition of the respondents' blood

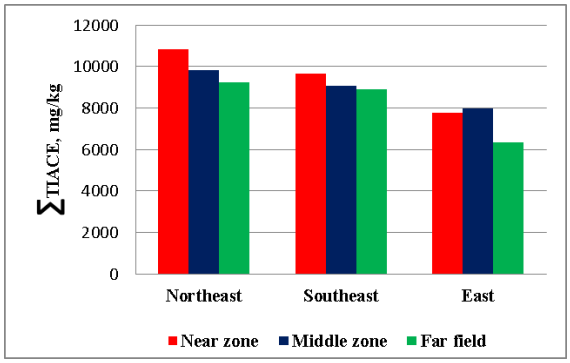

Fig.1. The change of total index of accumulation of chemical elements (TIACE) in the human blood by distance from the territory SNTS

was compared by the additive index - the sum of the geometric mean values of all elements determined by the INAA method, which made it possible to exclude certain individual features of the accumulation of chemical elements in human blood and to reveal the territorial features of the accumulation of chemical elements in the human body as a whole.

As a result, a clear correlation was established between the total index of accumulation of elements with the distance from the SISP territory for the blood of the population residing in the territories located in the Northeast and South-East directions. In blood of residents of settlements located at a distance from the SISP in the eastern direction there was no significant difference, except for the control zone. This fact can be explained by the fact that the distance between the selected settlements is only 17 km. Probably, this distance is not essential for changing the elemental composition of biosubstrates of human living in these territories.

When studying the biogeochemical series of accumulation of chemical elements in the blood of residents of the study areas, it was found that a significant contribution to the elemental composition of the blood of the population residing in nearby zone, making elements such as Ba, La, Ce, Nd, Sm, Th, U. In this connection, it was interesting for us to study the forms of finding these elements in blood samples, where abnormal concentrations of these elements are noted.

The study of mineral forms of chemical elements in human blood held in International innovation research and education center "Uranium Geology" at the Department of Geoecology and Geochemistry of TPU with a scanning electron microscope (SEM) Hitachi S-3400N with EMF Bruker X@Flash 4010/5010 for X-ray analysis. To do this were applied powder preparations made with blood drying at a temperature of + 60 ° C for 2 hours. For the reliability of the results, all 60 blood samples were studied. As a result, in all blood samples were detected trace minerals such as calcite, iron oxide, aluminum silicates. In the blood samples with an abnormal concentration of La, Ce, trace minerals containing these elements were detected. Occurrence of these microminerals is 96% (n = 30), that led to the conclusion of the specificity of these trace minerals for the composition of the studied blood samples.

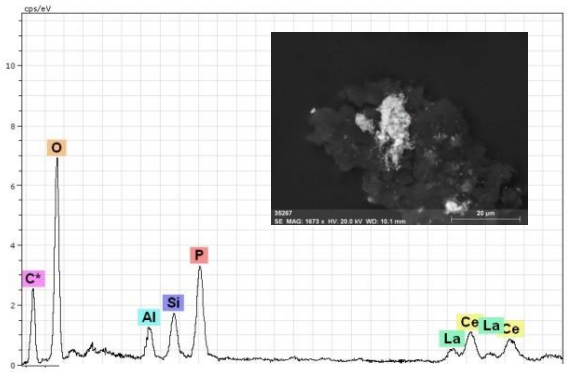

Fig.2. The spectrum characteristic of micro-blood respondent number 1 locality Bodene.

O-39,9%; Al-3,4%; Si-4,1%; P-11,3; La-11,9; Ce

Thus, in the result of the conducted studies it was found that the total indicators of accumulation of chemical elements in blood of a person living in the territories adjacent to the SNTS are directly proportional to the distance from the place of his/her residence to the territory of the SNTS. For blood of the population living in the near zone to the territory of the SNTS were characterized by the higher concentrations of such elements as Ba, La, Ce, Nd, Sm, Th, U. At the same time, abnormal concentrations of elements such as La, Ce promote their finding in the form of micromineral inclusions in the human blood.

References

1. Baranovsky N.V., Ilyinskikh N.N., Ilyinskikh E.N.,Truschenko E.V. The content of chemical elements in the human blood as the environmental indicators and their impact on health .// Actual problems of biology and medicine: Collection of scientific papers. - vyp.2.- Tomsk SSMU, 2003.- p.142 - 146.
2. Elinder C. G. et al. Biological monitoring of metals. – 1994.
3. Zhou W., Wang Z. L. (ed.). Scanning microscopy for nanotechnology: techniques and applications. – Springer science & business media, 2007.
4. Panin M.S., Solodukhin V.P. Topical issues of Kazakhstan Radioecology. Issue 1, Izd.2. Radioecological state of the "northern" part of the territory of the Semipalatinsk test site. Institute of Radiation Safety and Ecology NNC. Reviewers: Pavlodar, "Printing House," 2011.
5. Nakahara H. et al. Trace element analysis of human blood serum by neutron activation analysis //Journal of Radioanalytical and Nuclear Chemistry. – 1979. – Т. 54. – №. 1-2. – С. 183-190.