ИЗПОЛЗВАНЕ НА СЪВРЕМЕННИ OMICS – ТЕХНОЛОГИИ ЗА ОЦЕНКА НА ТОКСИЧНОСТТА НА ОКОЛНАТА СРЕДА БЛИЗО ДО УРАНОВИТЕ МИНИ В КАЗАХСТАН

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APPLICATION OF MODERN OMICS – TECHNOLOGIES TO ASSESS THE TOXICITY OF THE ENVIRONMENT NEAR THE URANIUM MINES IN KAZAKHSTAN

***Abstract**. The Kazakhstan is characterized by number of factors that define anthropogenic and natural manifestations of increased radioactivity the main of which are numerous sites of abnormal increases in natural radioactivity, uranium deposits, and ore. Long-term and large-scale activities of uranium mines and mining enterprises of other minerals associated with uranium mineralization have negative impact on public health. It has not been determined the radiation dose that people of Central Asia gets from radionuclides of uranium, a high level of radon in the contaminated areas. In the present study, uranium mine-workers in the Stepnogorsk mining-milling complex in Northern Kazakhstan were investigated for the expression of chromosome aberrations and for genetic factors that can modify the exposure-related expression of chromosome damage.The study suggests that uranium mine-workers in Northern Kazakhstan have excessive exposure that can cause an increased risk for health consequences such as cancer. In addition, GSTM1 and/or GSTT1 null genetically susceptible individuals may have higher health risk.*

***Keywords:** uranium radiation, chromosome aberrations, polymorphism of GSTM1 and GSTTI genes, radionuclides, uranium, uranium-degradation products, uranium mining enterprises, mutagenicity, chromosomal aberration, population health.*

1. Introduction

Relevance of the topic. In recent years there has been emerged a problem of consequences for the biosphere of practical development of nuclear energy. The radiation factor is admitted as one of the most significant according to the intensity of impact on the biosphere that is connected with constant increase of natural radiation background at the global, regional and local levels. Radioactive particles influence biological objects equally, both at emergencies at the Atomic Power Station, and under nuclear tests [1-2]. Hygienic rationing of radioactive pollution of the environment and studying of reaction of population of organisms under the ionizing radiation on long dwelling in a radiation biogeocenosis served as indispensable conditions of protective measures proves a platform of control and environmental monitoring of environment.

One of the global international problems in the field of uranium production is irrational production of uranium ores, their industrial wastes and environmental pollution by radionuclides and heavy metals. The largest regions where fields of uranium ores are concentrated, are Northern and the Southern Kazakhstan (fig. 1,2,3) [3-4]. About 15% of uranium resources are placed in the territory of northern areas of our country (Akmolinskaya oblast, North Kazakhstan and Kostanayskaya oblast). The volume of dangerous radioactive waste in the territory of Northern Kazakhstan makes about 61 million tons [5-6].

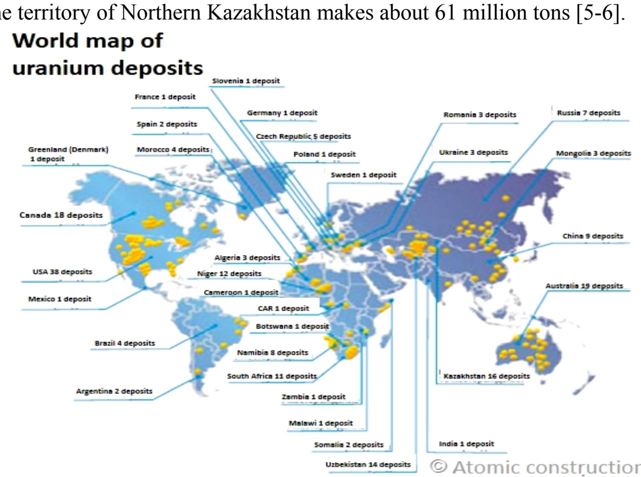

Fig.1. The main deposits of uranium in the world

One of the serious problems is placement of radioactive waste near the capital – in a radius of 250-300 km. Under unfavorable direction of wind, particles of radioactive and chemical dust can reach borders of Astana. In this regard at the present stage an environmental problem and rational use of natural resources are actual, and the complex assessment of impurity of environment by modern test systems is defined as one of priorities in work on environmental protection.

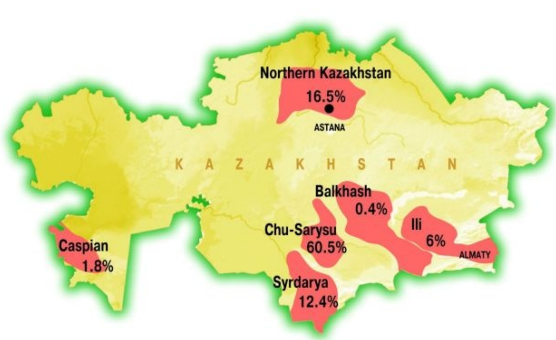

Fig. 2. The main deposits of uranium in Kazakhstan

The aim of the work is ecological and genetic studying of impact of radiation pollution on population of people (professional working) of uranium mining enterprises of Northern Kazakhstan with application of modern Omics - technology.

2. Materials and Methods

In the Republic of Kazakhstan researches of impact of factors of uranium production on health of professional workers and several generations of people were begun by scientists-biologists from the Institute of the general genetics and cytology MES RK and Al-Farabi Kazakh National University [7]. Cytogenetic examination was conducted on the professional workers living in Zaozyorny and Saumalkol villages, Kokshetau region, North Kazakhstan area relating to mine administrations No. 3 and No. 5 (RU-3 and RU-5) of the Tselinnyi mining and chemical combine occupied with production and enrichment of uranium ore. Samples of blood were taken from 26 inhabitants of Zaozyorny and 20 inhabitants of Saumalkol, in total 46 people. In control group 30 people, blood donors, were participated. They were from rather environmentally friendly area Pavlodar, not contacting to radiation. Preparations of chromosomes were taken from standard technique of cultivation of lymphocytes of peripheral blood. From each examinee 100-200 metaphase cages were studied, in total 7400 metaphase plates. By the accounting of two-shock reorganizations (dicentrics) the saved-up radiation dose at the working uranium enterprises was calculated which made 11-12 rem (0,11-0,12 Zv) that is above the corresponding indicator in control group – 0,9 rem (0,009 Zv) [8-9].

Slightly later scientists Toskobayeva G. A., Kakabayev A.A. and Bersimbayev R. I. conducted cytogenetic research as a result of which the interrelation of genotypes of genes of glutathione-S-transferase T1 and M1 was found in uranium miners with increase of frequency of chromosomal violations in comparison with control group, and also polymorphism of genes of a reparation of DNA. In this study,... uranium mine-workers in the Stepnogorsk mining-milling complex in Northern Kazakhstan were investigated for the expression of chromosome aberrations and for genetic factors that can modify the exposure-related expression of chromosome damage. From our interview of volunteers, 100 qualified workers occupationally exposed to uranium and 56 control people who had not been exposed to radiation or other hazardous agents were selected. The workers were subdivided into 3 groups according to the duration of exposure: group I – 1-10 years, group II – 11-20 years, group III – 21-25 years. Our data show that workers in all three exposure groups had higher frequencies of chromosome aberrations than the control group. Uranium-exposed workers who had inherited the null GSTM1 and/or GSTT1 genotypes had a significant increase in the frequency of chromosome aberrations compared with those who had the intact GSTM1 and GSTT1 genes for the different group of workers. Our study suggests that uranium mine-workers in Northern Kazakhstan have excessive exposure that can cause an increased risk for health consequences such as cancer. In addition, GSTM1 and/or GSTT1 null genetically susceptible individuals may have higher health risk [10-11].

During research works group of scientist - radiobiologists of the Kazakh State Medical Academy revealed high level of cancer incidence among the population living near tailings of Stepnogorsky mining and chemical combine, and a bioaccumulation of radionuclides and heavy metals in wild-growing plants, cytologic changes at hydrobionts, the raised content of radionuclides and heavy metals in meat of the animals living in the studied areas [10,12-14].

3. Results and Discussion

As a result of the conducted researches it was revealed that the average frequency of cages with chromosomal aberrations at professional workers authentically exceeds a control level (Pavlodar) on RU-3 by 4 times, and on RU-5 by 2,6 times (a difference of sizes is highly reliable, P<0,003). The analysis of a range of chromosomal aberrations showed that the frequency of aberrations of chromosomal type at workers from RU-3 exceeded a control level by 5 times, and from RU-5 – almost twice, while on the level of aberrations of chromatid type increase in frequency of reorganizations not so considerably - respectively by 2,2 and 1,1 times. An important aim of scientists Toksobayeva G.A., Kakabayev A.A., Bersimbayev R.I. study was to determine if there is a dose-dependent response to the expression of aberrations. This was analyzed on the basis of a minimum of 20 workers per group from each exposure category. In addition, we analyzed the impact of potential confounding factors, e.g. cigarette smoking. Our results demonstrate that the frequency of the CA in smokers and non-smokers of exposed group were higher than in the control groups. The data also show that the groups I (1-10 years) and III (21-25 years) workers had higher frequency of the CA in smokers compared with non-smokers. The results showed also that there is a significant increase in the frequency of the CA in the exposed heavy smokers (group II and group III) when compared to the light exposed smokers. We revealed a significant increase in dicentrics and acentric fragments. Acentric rings and ring chromosomes were observed only in the exposed groups.

The results indicate that workers who had inherited the null GSTM1 and/or GSTTI genotypes had a significant increase in the frequency of chromosome breaks compared with those who had the GSTM1 and GSTTI genes for the different group of workers. Therefore, these workers have increased risk for health consequences such as cancer. The risk is further increased by additional risk factors [10].

Fig. 3. Uranium mining in northern Kazakhstan

These decisions received as a result of the above researches indicate the need of more detailed studying of individual radiosensibility of chromosomes with coverage of more numerous selections both on groups of professional workers, and on number of the analyzed metaphase cages. All these facts say about need of studying of radon - and radioactive danger and carrying out similar researches in the territory of Northern Kazakhstan (in particular, Akmolinsky area), certainly, is priority. Identification of a true picture of impact of natural and artificial radiation factors on environment and health of the population forms a basis for taking measures to decrease in risk to health of the population and decrease in a psychological stress on the population from a radiation situation, which is often perceived not adequately by the population.

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