Results of geoecological state investigations in settlements of the Dniprovsk region adjacent to the tailings dump Shcherbakivska beam

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SUMMARY

The report presents the results of investigations of geoecological state of settlements of the Kryvyi Rih district of the Dniprovsk region adjacent to the tailings dump of the East GOK of the Shcherbakivska beam. In the report are rationalized the complex of geological and geophysical methods for assessing the geoecological state of technogenic-loaded areas near the radioactive waste tailings dump, taking into account the peculiarities of the tectonic structure of the territory and possible geodynamic changes in the state of the geological environment. In the article are presented recommendations on the complex geological and geophysical methods for the effective solution of ecological monitoring problems with the purpose of possible changes of the geological environment under the influence of natural and man-made processes around the tailings of radioactive waste of the Shcherbakivska beam.
Introduction

The settlements of Chervonensky village council of Kryvyi Rih district of Dniprovsk region: the villages Kalynivka, Chabanove, Chervone are located in the adjacent to the tailings dump of the East GOK of the Shcherbakivska beam. On the territory of the specified tailings pond the increased content of radionuclides is the primary source of radioactive contamination of soil, surface and groundwater, vegetation (Shapar, 2009; Shapar et al., 2011). Type of waste – solid waste from uranium ore processing – pulp, area – 256 hectares, storage is operated from 1959 to the present, filling of storage – 28.3 million tons – 70% (Kalashnyk, 2017; Kalashnik and Kalashnik, 2005). The chemical composition of the solid part of the tailings is close to the source ore, from which the main part of uranium was removed.

Method and Theory

Carrying out of complex geological and geophysical researches of settlements of the Chervonensky village Council. Determination of background characteristics of environmental components, in particular air environment (determination of equivalent equilibrium volumetric activity (EEVA) of radon-222 in atmospheric air), aquatic environment (water sampling at agreed points, in particular: surface water, groundwater in wells and their analysis in accordance with current methods in Ukraine to determine macrocomponents of chemical composition, microcomponents of chemical composition, radionuclide composition, analysis of water samples for compliance with GOST for drinking water, measurement of volumetric activity of radon and its daughter decay products in water of individual wells in settlements). Works were carried out to identify sources of man-made and natural anomalies of radioactivity, to determine their geometric dimensions, concentrations of radionuclides.

Examples

Analysis of the results of dosimetric survey of the territory of settlements showed that: 1) the radiation background of the territory is characterized by the power of the absorbed dose of gamma radiation, which varies from 0.08 to 0.17 μSv/h (village Chervone 0.08 - 0.17 μSv/h, the village of Chabanovo 1 – 0.09 - 0.15 μSv/h, the village of Chabanovo 2 – 0.09 - 0.15 μSv/h, the village of Kalinina – 0.08-0.17 μSv/h) ; 2) the minimum value of the dose rate of gamma radiation refers to arable land (0.08 - 0.13 μSv/h); 3) a slightly higher value of the gamma radiation dose rate (0.13 - 0.15 μSv/h) is on unused land (land withdrawn from agro-industrial production); the maximum value of gamma radiation dose rate (0.15 - 0.17 μSv/h) is confined to dirt roads. The average value of the absorbed gamma radiation dose rate in the study area of settlements is 0.13 ± 0.02 μSv/h. As a result of the performed works, 6 local anomalies with the gamma radiation exposure dose rate from 209 to 449 μR/h were detected.

Measurements of equivalent equilibrium volumetric activity (EEVA) of radon (toron) were performed in residential premises and social facilities of the studied settlements: Chervone village (5 objects – 11 premises) and Kalinina village (2 objects – 2 premises)). Together, they were investigated in 13 rooms of EEVA Rn-222 (radon) and in 7 rooms of EEVA Rn-220 (toron). Control measurements of EEVA Rn-222 and Rn-220 were also performed in two rooms in which the average value of EEVA Rn-222 exceeded 50 Bq/m³. The values of EEVA in the studied rooms were distributed as follows: 0-49 Bq/m³ – in six rooms; 50-99 Bq/m³ – in two rooms; 100-149 Bq/m³– in one room; 150-200 Bq/m³– in two rooms, more than 200 Bq/m³ – in two rooms. EEVA 222Rn has exceeded 50 Bq/m³ in seven rooms, which is 54% of the volume of the studied rooms. In five rooms, EEVA 222Rn has exceeded 100 Bq/m³, which is 39% of the total research volume. The values of EEVA Rn-220 (toron) (norm is up to 3 Bq/m³) were distributed as follows: 0-2 Bq/m³ – one room; 3-5 Bq/m³ – five rooms; 14-20 Bq/m³ – 1 room. Thus, in six rooms EEVA Rn-220 (toron) has exceeded the norm (3 Bq/m³) (Radiation Safety..., 1997), which amounted to 46% of the volume of the studied premises.

According to the results of research, the main pollutants that entered the air basin of the area of the studied settlements at the time of the measurements were carbon monoxide, nitrogen dioxide, non-
methane volatile organic compounds. In much smaller quantities, specific substances were released into the atmosphere: sulphur dioxide, methane, nitric oxide, benzopyrene, ammonia. No significant radiation impact of the tailings pond of Shcherbakivska beam on the air was detected.

Groundwater in 8 studied wells is not contaminated with uranium radionuclides (ΣKs less than 1.0); there is only a slight excess of standards for drinking water from groundwater sources in total alpha activity, less often - total beta activity.

According to engraving and electrical exploration methods, the position of fault zones and tectonic faults was determined directly in the studied settlements and in the adjacent territories (Fig. 1 - 4). Thus, when performing complex geological and geophysical studies, the influence of tectonic factors on possible dynamic changes in the distribution of halos of radioactive contamination existing near the tailings through fault zones and aquifers were studied.

**Figure 1** The layout of tectonic faults in the village Chabanivka of Kryvyi Rih district according to the data of complex geophysical researches (engraving, electric exploration by the method of dipole electroprofiling of DEP A50V70M50N): 1 - measuring point and its number; 2 - geophysical profile number; 3 - reference gravimetric point, 4 - tectonic faults, which are determined according to profile geophysical surveys; 5 - zones of tectonic faults are defined according to complex geological and geophysical researches.
**Figure 2** The layout of tectonic faults in the village Chervone of Kryvyi Rih district, according to complex geophysical surveys (engraving, electrical exploration by the method of dipole electrical profiling DEP A50V70M50N): 1 - measuring point and its number; 2 - geophysical profile number; 3 - reference gravimetric point, 4 - tectonic faults, which are determined according to profile geophysical surveys; 5 - zones of tectonic faults are determined according to the data of complex geological and geophysical researches; 6 - water sampling points from wells.

**Figure 3** Three-dimensional model of the gravitational field of village Chervone of Kryvyi Rih district and adjacent territories.
Conclusions

According to the results of the research, an assessment of the geoecological situation in the settlements adjacent to the tailings dump of the East GOK of the Shcherbakivska beam was provided. Recommendations for reducing the exposure of the population of these settlements, including decontamination and anti-radon measures were developed. Based on the results of the analysis of the results of complex geological and geophysical surveys, the most optimal locations of wells were determined for the installation of equipment in them and further continuous monitoring studies of the geoecological situation.

References


