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The assessment of impact of «Kirovskaya» mine on the state of a soil and plant cover of the industrial site

In the article technogenic influence of Kirovskaya mine on a soil and plant cover of a sanitary protection zone of the enterprise is considered. During the analysis it was revealed that the selected tests of soils contain the significant amount of the heavy metals exceeding maximum permissible concentration. The analysis showed that great values reach such substances as chrome, copper, zirconium, zinc and nickel. Migration and accumulation by plants of substances of the 1–2 classes of danger in high values were set. Active migration from soil into plants is observed in such metals as boron, copper, chrome, zinc. Manifestation of toxic effect of heavy metals happens, as a rule, at a top level of anthropogenic pollution of soils by them and in many respects depends on properties and peculiarities of behavior of concrete metal.

Keywords: heavy metals, industrial site, pollution of soils, migratory properties of plants

Modern scales of mining production are characterized by the intensive use of natural resources, increase of wastes and deterioration of environment. In this connection increasing attention is given to the question of economically reasonable and ecologically safe functioning of the mining enterprise. Specifics of influence of the concrete mining enterprise on environment is caused by geological and geochemical features of deposits and the applied equipment and technology for its development [1, 2].

Burning dumps, pit refuse heaps, high dust and gas content in the air, water reservoirs-clarifiers and settlings, tailing damps, pollution of surface and ground waters, dumping of highly-mineralized mine waters into the hydrographic network, dangerous geotectonic processes and invasion into the underground hydrosphere, provoking sagging of the terrestrial surface, swamping of areas and regions, creation of artificially increased seismicity and so forth, it is far not a full list of anthropogenic pressure on the environment in mining regions. Even with closing of mines consequences of their former activity will negatively affect for decades on the state of the environment and safety of life of the population of adjacent to them territories [3, 4].

For all methods of mining it is characteristic to influence on biosphere, affecting practically all its elements: water and air basins, land, subsoil, plant and animal world. This influence may be both direct and indirect, being the consequence of the first. The size of the zone of distribution of indirect influence considerably exceeds the size of the zone of localization of direct influence and, as a rule, to the zone of distribution of indirect influence gets not only the element of the biosphere, directly exposed, but also other elements [1, 2].

The most adverse is the open way at which off-balance ores and mineralized overburden breeds are stored on a surface in large quantities, turning into a powerful source of pollution of soil and water for tens and hundreds of years. The atmospheric moisture, accumulating in a dump body, turns into the saturated with metals sulfuric acid, resetting by gravity with the drainage waters into the subjacent soil dumps, ground waters and further into the streams and rivers [5].

At such scales of destruction of natural landscapes coal-mining areas correspond to criteria of reference to zones of «ecological disaster». Extent of impact on the environment of these anthropogenic landscapes is such that it can't be estimated only as the damage caused to rural or forest farms any more. The cardinal changes of nature of biological and soil and geochemical processes caused by mining works are followed by a loop of negative ecological consequences, turning local environmental pollution in regional [6].

Materials and methods of research

The studied object: the industrial site is located in the Oktyabrsky district of Karaganda. The industrial site — the field of Kirovskaya mine is located in the northeastern part of the Karaganda pool. To the south of the industrial site of the mine, at the distance of 3 km, there is the field of the mine of the 50 anniversary of October revolution, which is liquidated nowadays, to the southeast (in 4 km from the mine) there is the field of the mine of Kostenko, in 2,5 km the field of the mine of Gorbachev is located.

The nearest distance to a residential zone is 350 m to the northwest (the settlement Finsky). The large settlement Prishakhtinsk is 1000 m to the northwest from the enterprise. Posts of supervision over a state of the environment are absent.

During researches the following works were performed:

1. Selection and studying of tests of soils on the content of heavy metals
2. Selection and analysis of tests of vegetation of industrial platforms

Sampling of soil (grounds) was made on the territory adjacent to anthropogenic objects (pollution sources) — 8 tests, and on the border of sanitary protection zone (SPZ) of the industrial area — 4 tests. Tests are selected layer-by-layer from the depth of 0–5 and 5–20 cm, weight not exceeding 200 g each.

Plants were selected in 3 samples on the route posts located on the border of SPZ of the industrial platform of the enterprise; 1 sample- in 20 km from the enterprise (background sample).

To obtain representative samples of plants on each route post from the area of 100×100 m the joint test, consisting of 5 individual tests of plants (on 50 g. each), was selected. Selection of plants of the same species was made. Due to the widespread prevalence and high sorption properties the wormwood was selected.

Analysis of tests was carried out in the branch of JSC «Azimut Energy Services» in Karaganda, in chemical analytical laboratory.

The assessment of impact of the Kirovskaya mine on the environment

The soil cover carries out functions of the biological absorber, the destroyer and converter of various pollutants. If this link of the biosphere is destroyed, then the developed functioning of the biosphere will be irreversibly broken.

If atmosphere and water environment can self-clean, soil doesn't possess such property: toxic substances (including oxides of metals) constantly accumulate in it and lead to changes in its structure, it causes changes in a plant and animal world.

The conducted researches showed that some elements in the soil cover of the Kirovskaya mine exceed MPC (maximum permissible concentration) (Table).

Table

Data of the chemical analysis of soil and plants of industrial platform of the Kirovskaya mine

	Substances	Class of Danger	MPC of soils (mg/kg)	Soil (mg/kg)	Harm indicator (trans-located)	Plants (mg/kg)
1	Boron	2	100,0	170,30	–	95,6240
2	Cadmium	1	2,0	2,45	–	0,1232
3	Cobalt	2	5,0	1,81	25,0	<0,005
4	Chrome	1	6,0	21,94	6,0	8,1230
5	Copper	2	3,0	26,87	3,5	19,9980
6	Manganese	3	1500,0	170,40	3500,0	34,82
7	Molybdenum	2	50,0	<0,005	–	<0,005
8	Nickel	2	4,0	3,84	6,7	8,171
9	Lead	1	32,0	1,84	35,0	<0,06
10	Antimony	2	4,5	0,30	4,5	<0,01
11	Vanadium	3	150,0	9,36	170,0	<0,05
12	Zirconium	3	6,0	66,13	–	<0,003
13	Zinc	1	23,0	22,91	23,0	49,1280
14	Arsenic	1	2,0	<0,02	2,0	<0,02
15	Beryllium	1	10,0	<0,0005	–	<0,001
16	Selenium	1	10,0	<0,001	–	<0,001

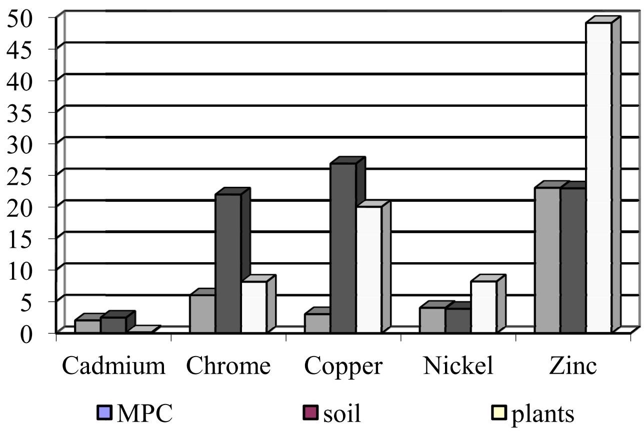
The analysis showed that great values reach such substances as chrome — 21,94 mg/kg, while maximum permissible concentration makes 6,0 mg/kg, accordingly there is an excess of a share on 3,657 maximum permissible concentration, migration of chrome in a plant makes 8,1230, the amount of chrome in plants is controlled generally by the content of its soluble connections in soils. In spite of the fact that the majority of soils contain significant amounts of this element, its availability to plants is very limited [7]. Low rates of assimilation by plants of soluble forms of chrome are caused by features of the mechanism of absorption of soluble forms of chrome by root system. Symptoms of toxicity of chrome are shown in withering of elevated part and damage of root system of plants.

Copper considerably exceeds the share of maximum permissible concentration (MPC), that makes 8,96 mg/kg, and by the index of harmfulness there is exceeding of share of copper in 7,68 MPC, migration of copper into a plant is 19,99. Mobility of copper in vegetable fabrics strongly depends on the level of its receipt, however copper has smaller mobility in plants in comparison with other elements [8]. The most important factor in contamination of soil by copper is a strong tendency of the surface layer of soil to its accumulation.

The size of the content of zirconium in the soil is 66,13 mg/kg, that exceeds the share of maximum permissible concentration on 11,021. Boron in the soil makes170,30 mg/kg, while maximum permissible concentration is 100 mg/kg, accordingly there is an exceeding of the share on 1,703 maximum permissible concentration, migration in a plant practically reaches the limit of maximum permissible concentration and is 95,6240 mg/kg.

The analysis of the content of zinc in the soil showed that in these tests there is no exceeding of values of maximum permissible concentration, wherein high performance of this substance is observed in the tests of vegetation and corresponds to the value of 49,13 mg/kg. The soluble zinc forms are available for the plants, and from reports the consumption of zinc linearly increases with the increase of its concentration in the feeding solution and in soils. Speed of absorption of zinc varies greatly depending on the plant species and environmental conditions of growth. Some authors consider that zinc is very mobile element, others suppose that it possesses moderate mobility. In fact, at the optimal receipt of zinc some species of plants move noticeable quantities of this element from old leaves to generative organs. Summarizing various data, it is possible to believe that zinc concentrates in mature leaves [9].

The quantity of nickel in the soil is 3,84 mg/kg, indicating no excess of MPC, thus its value in plants is 8,171 mg/kg, which is higher than the content of nickel in the soil (drawing). Nickel is quickly and easily extracted from the soil by plants, soluble forms of nickel are actively absorbed by roots of plants, and while concentrations in plant tissues do not reach certain values, absorption rates positively correlate with the content in the soils. With an excess of nickel absorption of nutrients sharply decreases, growth of plants is slowed down and metabolism is disturbed [10].



Drawing. Excess of maximum permissible concentration by some substances of the1st-the 2nd classes of danger in the soil and plants

Active migration from soil into plants is observed in such metals as boron, copper, chrome, zinc. Excess of the contents of nickel and zinc in plant samples unlike soil samples can testify to high migratory properties of plants, accumulation of heavy metals in plants and arrival of elements in plants through leaves (or foliar absorption), which occurs mainly by not metabolic penetration through a cuticle.

Translocation indicator considers ability of a chemical element to accumulate in plants and to get into a human or an animal organism when being used in food. The contents in soil of heavy metals, and connected with it translocation of heavy metals into plants, is a difficult process, which is influenced by many factors, in the majority of cases a limiting index is the translocation — transition of a pollutant from soil into a plant.

Manifestation of toxic effect of heavy metals happens, as a rule, at a top level of anthropogenic pollution of soils by them and in many respects depends on properties and peculiarities of behavior of concrete metal. But in nature ions of metals seldom may be found isolated. Therefore various combinative intermixtures and concentrations of different metals in the environment lead to changes of properties of separate elements as a result of their synergetic or antagonistic impact on living organisms.

For example, the mixture of zinc and copper is five times more toxic, than arithmetically received sum of their toxicity, this is caused by synergism at joint influence of these elements. Likewise works the mixture of zinc and nickel [11]. However there are sets of metals, the combined effect of which acts additively. The striking example of it are zinc and cadmium, showing mutual physiological antagonism [11], also copper and iron show antagonism, toxic effect of copper can be reduced with introduction of iron, and their optimum ratio is various for different plant species [8].

About interaction of copper and manganese in the process of their consumption by plants there is the information both about synergic and antagonistic relationships, depending on conditions and values of the concentrations [8]. Synergism and antagonism of metals are obvious in their multi component mixtures. Therefore, the total effect of the poison pollution of the environment by heavy metals depends not only on the set and the level of the maintenance of specific elements, but also on the characteristics of their mutual impact on biota [11].

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Өндірістік ауланың топырақ және өсімдік жамылғыларының жағдайына «Киров» шахтасының әсерін бағалау

Мақалада «Киров» шахтасы мекемесінің санитарлы-қорғау аймағының топырақ және өсімдік жамылғыларына техногендік әсері қарастырылған. Талдау барысында алынған сынамалардың құрамында ауыр металдардың шекті концентрациядан жоғары екені байқалды. Үлкен мәнді хром, мыс, цирконий, мырыш, никель сияқты заттар көрсетті. Қауіптіліктің 1–2 санатына жататын заттар көп мөлшерде өсімдіктерде жиналып, көшірілетіні белгіленді. Топырақтағы өсімдіктердің көші-қон қызметі бор, мыс, хром, мырыш сияқты металдардың көп мөлшерін байқатты. Ауыр металдардың көрінісі фитотоксикалық іс-қимыл әдетте топырақтың техногендік ластануының жоғары деңгейде орын алады және, атап айтқанда, металл қасиеттері мен сипаттамаларына байланысты екендігі дәлелденді.

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Оценка воздействия шахты «Кировская» на состояние почвенного и растительного покрова промышленной площадки

В статье рассмотрено техногенное влияние шахты «Кировская» на почвенный и растительный покров санитарно-защитной зоны предприятия. В ходе анализа было выявлено, что в отобранных пробах почв содержится значительное количество тяжелых металлов, превышающих предельно допустимую концентрацию. Анализ показал, что больших значений достигают такие вещества, как хром, медь, цирконий, цинк и никель. Установлены миграция и накопление растениями веществ 1–2 класса опасности в высоких значениях. Активная миграция из почвы в растения наблюдается в таких металлах, как бор, медь, хром, цинк. Проявление фитотоксичного действия тяжелых металлов происходит, как правило, при высоком уровне техногенного загрязнения ими почв и во многом зависит от свойств и особенностей поведения конкретного металла.

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