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КЕНДЕРДИН ТҮНДҮК КАВКАЗДЫН ТООЛУУ АЙМАКТАРЫН ЧАҢ МЕНЕН БУЛГАШЫ

Жумушта Түндүк Кавказдын тоолуу аймактарынын кендерден чыккан чаң менен булганышынын өзгөчөлүктөрү изилденген. Жер үстүндөгү чаңдын таркалуу механизми метеорологиялык шарттардын негизде аныкталган, (роза жана шамалдын интенсивдүүлүгү, атмосфералык басымдын чоңдугу), ошондой эле рельефтик факторлор (тоолор жана капчыгайлар), чаңдын физико-механикалык касиеттери изилденген. Минералдык чаңдардын жер үстүнө түшүшү негизинен гравитациялык (65 %), электродинамикалык (10 % -чейин) жана турбуленттик (5 %) кубулуштардын, ошондой эле жамгыр жана тумандын (20 % - чейин) негизинде болот. Чаңдын таркалышынын геохимиялык закончнемдүүлүктөрү негизинен тоо-кен өндүрүшүндөгү жана жараянындагы кээ бир жумуштар менен байланышкандыгы көрсөтүлгөн. Кендерге жакын аймактарда чаң менен жер кыртышынын булганышынын эволюциясына, нано бөлүкчөлөрдүн ролун жана өзгөчөлүктөрүн эске алуу менен талдоо жүргүзүлгөн. Ага чектеш аймактардагы топурактын чаң менен булгануу эволюциясы талданып, нанобөлүкчөлөрдүн ролу жана өзгөчөлүктөрү чагылдырылган. Кендерден чыккан жана алыска таркала турган чаңдын нано бөлүкчөлөрүнүн морфологиялык касиеттерине эсептөө жүргүзүлгөн.

Негизги сөздөр: *чаңдын таркалышы; жер үстү атмосферанын мүнөздөмөсү; жердин тоо рельефти; нано бөлүкчөлөр; миграция.*

ПЫЛЕВОЕ ЗАГРЯЗНЕНИЕ НАГОРНЫХ ТЕРРИТОРИЙ СЕВЕРНОГО КАВКАЗА РУДНИКАМИ

В работе исследованы особенности пылевого загрязнения нагорных территорий Северного Кавказа полиметаллическими рудниками. Обоснован механизм пылевого рассеяния в приземной атмосфере, основанный на проявлении метеорологических условий (роза и интенсивность ветров, величины атмосферного давления), рельефных факторов (горы и ущелья), а также физико-

механических свойств пыли. Показано, что выпадение минеральной пыли из приземной атмосферы происходит за счет гравитационного (65 %), электродинамического (до 10 %) и турбулентного (5 %) осаждения, а также вымывания дождевыми осадками и туманами (до 20 %). Установлено, что геохимические закономерности пылевого загрязнения, представленные в виде зональной структуры техногенных геохимических ареалов рассеяния, связаны с отдельными производствами или процессами горных работ. Проанализирована эволюция пылевого загрязнения почв прилегающих территорий, с выделением роли и особенностей наночастиц. Осуществлен учет морфологических свойств наночастиц выделяемой пыли, которая имеет значительную дальность перемещения в приземной атмосфере, существенно увеличивающей площадь загрязнения прилегающих территорий полиметаллическими рудниками.

Ключевые слова: *выбросы пыли; характеристики приземной атмосферы; нагорный рельеф местности; наночастицы; миграция.*

DUST CONTAMINATION OF UPLAND AREAS OF THE NORTH CAUCASUS BY MINES

The features of dust pollution of the upland territories of the North Caucasus by polymetallic mines are revealed. The mechanism of dust scattering in the surface atmosphere, based on the manifestation of meteorological conditions (rose and the intensity of winds, the value of atmospheric pressure), relief factors (mountains and gorges), as well as the physical and mechanical properties of dust, has been substantiated. It is shown that the fallout of mineral dust from the surface atmosphere occurs due to gravitational (65%), electrodynamic (up to 10%), and turbulent (5%) deposition, as well as washout by rainfall and fog (up to 20%). It has been established that the geochemical patterns of dust pollution, presented in the form of the zonal structure of technogenic geochemical dispersion areas, are associated with individual industries or mining processes. The evolution of dust contamination of soils in the adjacent territories is analyzed, highlighting the role and characteristics of nanoparticles. The morphological properties of the emitted dust nanoparticles, which have a significant range of movement in the surface atmosphere, significantly increasing the area of contamination of adjacent territories by polymetallic mines, has been carried out.

Key words: *dust emissions; characteristics of the surface atmosphere; mountainous terrain; nanoparticles; migration.*

Introduction. The main object of the study was dust emissions from the Sadonsky polymetallic mine (Figure 1), located in the upper reaches of the Alagirsky gorge, in the territory of North Ossetia (RF), as well as atmospheric migration and distribution of dust over adjacent territories, with subsequent deposition and evolution in soils.

Figure 1 - The adit of the Sadonsky polymetallic mine

Dust emissions from the enterprises of the mining-processing complex should be investigated by the mapping method [1-4], which allows to identify the areas of technogenic soil contamination by mineral dust precipitated from the surface atmosphere.

Dust scattering mechanism in the surface atmosphere. When studying the dynamics of the formation of changes in the quality of the surface atmosphere (both in space and in time), i.e. pollution caused by dust emissions from the Sadonsk lead-zinc plant, it was taken into account that these processes are significantly influenced by the relief of the location, the existing features of the existing meteorological parameters, as well as the properties of the dust itself [5].

The mountainous region under consideration is characterized by a pronounced gorge of the territories, at the base of which, as a rule, a river flows, and on the river terraces, almost all surface infrastructure of mining is located. The Alagir Gorge (Figure 2) has a pronounced ravine relief, which can be considered a kind of wind tunnel, in which air masses mainly rise up into the mountains during the day, and, on the contrary, descend from the mountainous part to the plain zone at night.

Figure 2 - Beginning of the Alagir Gorge (North Ossetia, RF)

In the course of field studies, it was revealed that the average wind speed in the Alagir Gorge during the daytime ranges from 2.8-4.5 m/s. The altitude of the airspace of the Alagir Gorge, within which the main negative changes occur under the influence of dust emissions from mining enterprises and their accompanying infrastructure, according to the author's observations, is taken equal to 2000 m. As a result of the carried out field studies, the dynamics of changes in the dust content in the No.22 of the Arkhonsky mine in the air of the gorge during daylight hours (Figure 3).

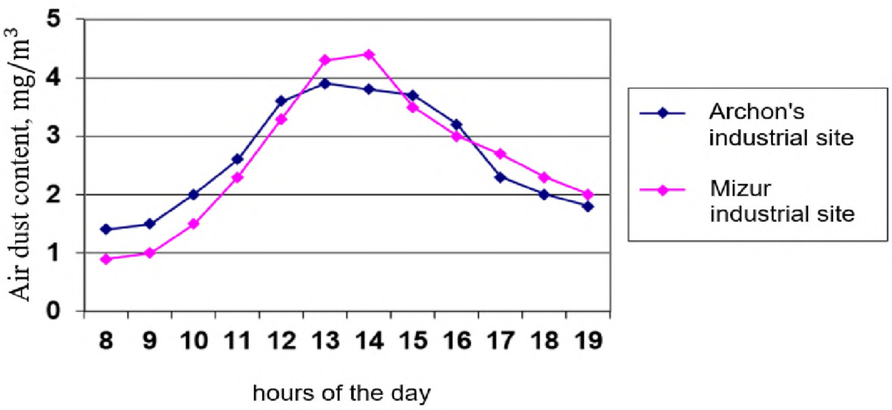


Figure 3 - Dustiness of air in the surface layer of the atmosphere during daylight hours

The processing of the data of the carried out measurements along the vertical by the method of mathematical statistics revealed an explicit correlation dependence of the dust content of the surface air along the height, which is expressed by the formula:
where: - respectively, dustiness of the air at the height and at the level of the mouth piece. No. 22, mg / m3;

H - sampling height above the mouth piece, m;

l is the base of the natural logarithm.

Subsequently, a pronounced dependence of the dust content of the near-ground atmosphere at dusty surfaces at various air velocities was experimentally established (Fig. 4).

a *b*

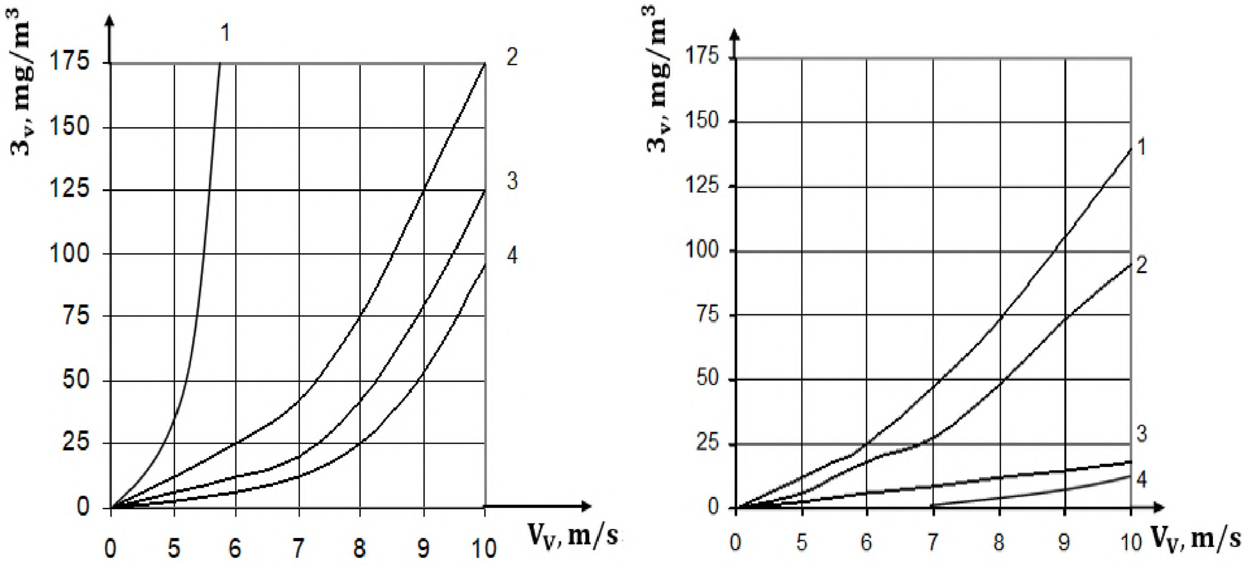


Figure 4 - Curves of changes in air dust content Sv from unorganized sources (dusty surfaces) at a wind speed Vw, depending on:

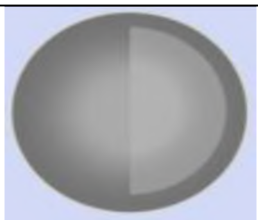
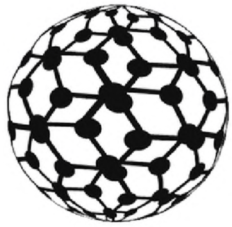
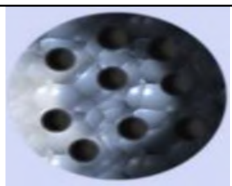
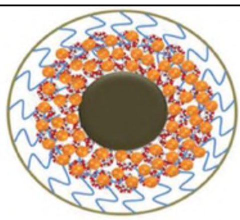
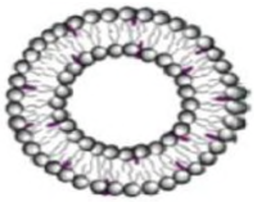
a - from the starting material, humidity 0.1 ÷ 0.2%: 1 - heaped ore with f = 12 ÷ 14; 2 - skarnated marbles, f = 13 ÷ 15; 3 and 4 - hornfelses, f = 13 ÷ 15 and f = 18 ÷ 20;

b - from dust moisture (skarn marbles with f =16÷20): 1-0-1%; 2 - 3 - 4%; 3 - 5 - 6%; 4-7- 8%.

In the course of the carried out field studies, it was found that the processes of emission and subsequent transfer of dust in the surface atmosphere primarily depend on a combination of meteorological (including wind rose and pressure), which have a probabilistic nature in time and space, and relief factors (mountains and gorges), as well as from some physical and mechanical characteristics of the directly emitted dust and the surface atmosphere (including their electrokinetic parameters).

There is a pattern of dust falling out by size and weight. When studying particles emitted by mining enterprises and metallurgical plants, mineral dust, of particular interest are its nanoscale fractions, which have a very significant dispersion range (up to 4-6 thousand km laterally), and which are much more rapidly subject to biochemical transformation in soils. According to the geometric shape, we have identified several types of mineral nanoparticles emitted by quarries, mines and metallurgical plants (Table 1).

Table 1 - Variety of forms of mineral nanoparticles

No.	Name of nanoparticles	Geometric the form	No.	Name of nanoparticles	Geometric the form
1	Layered spherules, globules or nanospheres		4	Nanofullerenes	
2	Porous silicates		5	Polyhedra	
3	Nanostar			Wire nanospheres	
4	Magnetic nanoparticles		6	Nanotori	

Over time, mineral nanoparticles of dust fall out of the surface atmosphere due to gravitational (65%), electrodynamic (up to 10%) and turbulent (5%) deposition, as well as washout by rainfall and fog (up to 20%). In this case, the quantitative value of the coefficient of the deposition rate of particles of mineral dust emitted by mining sources is determined as a numerical ratio between the value of the deposition rate of particles (determined by their size and mass) and the average value of the wind speed, mathematically expressed based on the Stoke law.

It was also experimentally established that the behavior of dust nanoparticles in the surface atmosphere, in addition to the factors considered above, is primarily influenced by their morphology (flatness, sphericity, aspect ratio, etc.) [6]. It should be noted that nanoparticles with a high aspect ratio include nanotubes and nanowires of various shapes (such as spirals, zigzags, ribbons, and possibly nanowires with a diameter that varies with length). Nanoparticles with small aspect ratio morphology include spherical, oval, cubic, prismatic, spiral, or columnar shapes. Here we demonstrate that the shape of nanoparticles is one of the critical factors during their migration in the near-ground atmosphere, which modulate the magnitude of the movement velocity and the deposition mechanism.

In addition, it seems important that nanoparticles entering the surface atmosphere from mines can take different forms and their interaction with air (during air migration), water, soil, and biota, respectively, can dramatically change at the interface.

In addition, it was found that the real values of the deposition rate of mining (mineral) dust varied depending on the season of the year (for example, the highest levels of dust pollution were observed in the spring months).

Dust contamination of soils in adjacent areas. Almost all mineral dust precipitated from the surface atmosphere (which consists mainly of Zn, Pb and Cu sulfides, oxides SiO_2, FeO, Fe_2O_3, Al_2O_3, etc., as well as carbonates $CaCO_3$ and $MgCO_3$ composing ores and rocks of the developed Sadonskoye deposit) is deposited by soils, which significantly alters the existing, evolutionarily developed, their geochemistry, forming, over time, pronounced areas of technogenic pollution. So, in addition to natural halos associated with the natural destruction and dissolution of ore bodies, here in the territories adjacent to mines and quarries, processing plants, technological roads [7-9], tailings and metallurgical plants and their cake and sludge dumps, significant zones of soil pollution were formed , alluvial deposits, surface and groundwater. This is the cumulative result of all stages of exploration, mining, transportation and concentration of ores, as well as wind transport from the surfaces of tailings dumps and beaches, discharge (especially actively until 1984) of sludge from the Mizur concentration plant, etc.

Previously, it was believed that the area of mining and industrial soil pollution (with dangerous levels of chemical elements) in the North Caucasus has reached 40 km2. We have found that this pollution is much larger. Thus, we identified lithobiogeochemical anomalies of profile elements with an area of up to a thousand square kilometers, and their boundary was shifted east of the metallurgical plants of Vladikavkaz, to Ingushetia and Chechnya, although the developed deposits of polymetals themselves are located at 5060 km to the west and south (Figure 5).

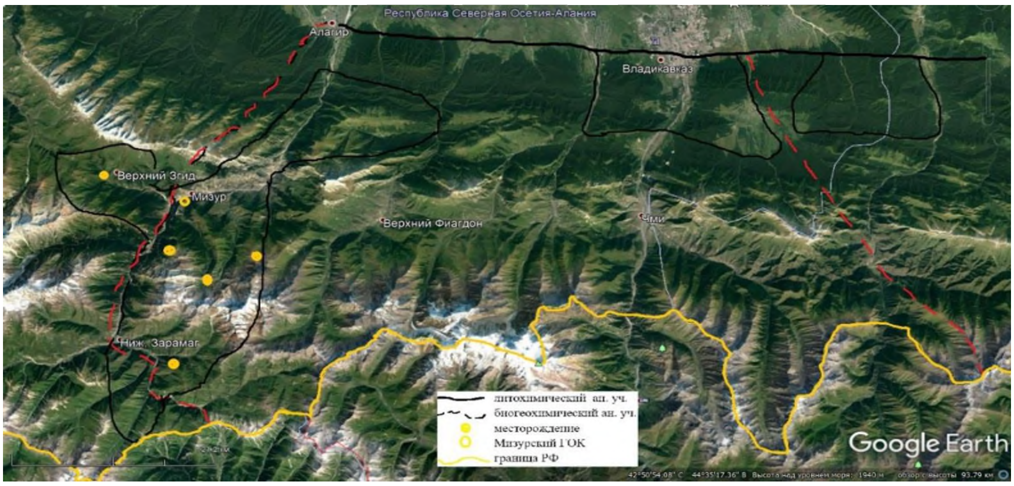


Figure 5 - The area of dispersion of chemical elements from the Sadonsky mine

Attention is drawn to the averaged morphology and structure of the technogenic anomalies identified in the soils. So, in the zone of extraction and enrichment of polymetals, their anomalies cover the area not only of the allotments themselves, but also the entire valley of the river. Ardon in its mountainous part. At the same time, there is a geochemical regularity of dust pollution common for mining regions, presented in the form of a zonal structure of technogenic geochemical dispersion halos, clearly associated with individual production or mining processes.So, in the implementation of technological processes of mining the main (Zn and Pb, as well as My W) and accompanying (Cu, Fe, Ag, As, etc.) metals contained in the ores of developed polymetallic and molybdenum deposits through dust emissions and subsequent sedimentation of mineral dust, accumulate, as a rule, in the central parts of geochemical anomalies. During further processing of mined ores (concentration and metallurgical processing), characterized by a deeper destruction of the mineral matrices of metal ores, the separation of the emitted dust particles is carried out by capturing them by air flows, transferring them to the peripheral parts of the pollution areas, as a result of which the area of geochemical anomalies increases significantly.

At the same time, submeridional soil anomalies of Zn, Cu, Ag, Pb, W and Mo replace each other, partially overlapping and forming a continuous anomalous area, expanding due to polymetallic deposits in the left and right banks of the North Jurassic depression zones.

It should be noted that the anomalous site of technogenic geochemical soil pollution, located south of Vladikavkaz, on both banks of the river. Terek, has an isometric area, and is more complex (since it includes the same chemical elements, as well as additionally W and Cd). The core of this anomalous area is formed by the anomaly of cadmium and all other trace elements, adjacent to the city of Vladikavkaz from the south. Moreover, cadmium, due to concentration by technological processes of processing, with dust emissions into the surface atmosphere, has here the highest concentrations in the entire North Caucasus (including the field being developed itself).

Conclusion:

1. The analysis of all the received and collected information speaks in favor of the aerial mechanism for the spread of dust pollution and the formation of anomalous areas of geochemical pollution in the adjacent territories;

2. First, along the river. In Ardon, the spread of mineral dust, formed as a result of mining, transportation and enrichment of ore, is observed by valley winds. As a result, a linearly oriented anomalous area was formed here, expanding in the North Jurassic depression in the zone of polymetallic deposits;

3. Secondly, geochemical anomalies to the south of Vladikavkaz cannot have any other genesis except as an aerial spread of gas and dust emissions from metallurgical plants, which leads to the formation of an anomalous area of hundreds of km2 and the achievement of high 2000 m;

4. Thirdly, this anomalous area has a pronounced temporal dynamics, which we found when comparing with the results of previous studies. Fourth, this rather huge area of lithobiogeochemical anomalies is mainly formed due to aerial fallout and combines both lithochemical anomalous areas with a similar set of trace elements (quite consistent with the existing type of mineralization and the profile of open pits, mines, and metallurgical plants). It is this territory of biogeochemical anomalies that reflects a real, albeit mostly low-contrast, pollution zone.

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УРУП – БУРУЛУУЧУ ЭЛЕКТРОМЕХАНИКАЛЫК ПЕРФОРАТОРДУН ТОГООЛОРУНУН РАЦИОНАЛДЫК ПАРАМЕТРЛЕРИН АНЫКТОО

Бул берилген жумушта уруп-бурулуучу кыймылдуу электромеханикалык перфоратору изилденет. Жумуштун максаты уруп-бурулуучу кыймылдуу электромеханикалык перфораторунун звенолорунун рационалдык көрсөткүчтөрүн аныктоо жана кинематикалык схемаларды анализдөө ыкмалары жана уруп-бурулуучу кыймылдуу электромеханикалык перфораторунун звенолорунун жайгашуу планы изилденет. Өткөрүлгөн теориялык изилдөөлөрдүн негизинде бурулуу механизминин звенолорунун рационалдык көрсөткүчтөрү тандалып алынган. Изилдөөлөрдүн негизинде, бир циклдин ичинде инструменттин бурулуу бурчу 55°ка барабар болгон, шатундун жана коромыслонун рационалдык узундугу 70 жана 30 миллиметрге барабар деп аныкталган жана бурулуу механизминин звенолорунун параметрлеринин мындай геометриялык катнашы электромеханикалык перфоратордун рационалдык иштөө режимин камсыз кыла алат. Алынган жыйынтыктардын негизинде, уруп-бурулуучу кыймылдуу электромеханикалык перфораторунун иштөө принцибиндеги келечектүү түзүлүшү жана жогорку эффективдүү түзүү жолдору аныкталган. Изилдөөлөрдүн жыйынтыгы, илимий-изилдөө институттарына жана электромеханикалык перфораторлорду иштеп чыгуу, түзүү жана эксплуатациялоо менен алектенген өндүрүштүк ишканаларга сунушталат.

Негизги сөздөр: *электромеханикалык перфоратор; уруп-бурулуучу механизм; рационалдык параметр; тогоо; коромысло; шатун.*