

## On the Formation of Technogenic Changes in the Geological Environment in the Deposits of the Almalyk Mining Region

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### Abstract

*The article deals with the issues of the emergence of a new stressed state of rocks during the development of deposits and the formation of several deformations of the sides of the quarries. It is noted that among which gravitational slope deformations in the form of landslides, talus and mudslides are of decisive importance. All these types of deformation are observed in the Sary-Cheku, Kalmakyr, Kurgashinkan and others deposits. As a result of the analysis of the deformation of the quarry walls, the main conclusions were made, which can serve as a basis for the study and forecasting of landslide and other types of deformations.*

*The issues of the technogenic (anthropogenic) impact of industrial enterprises and quarries of the Almalyk region on the environment are also considered. As a result of the infiltration of polluted waters of quarries, dumps, slag ponds and tailing dumps of factories, there is a penetration of polluting components into underground groundwater. Under the influence of the infiltration flow, the chemical composition of soils changes, and several polluting chemical compounds accumulate on their solid particles. Surface wastewater associated with the washing out of sludge and slag from industrial waste storage facilities is also susceptible to pollution.*

**Key-words:** Stresses, Deformation, Geoecology, Environment, Technological Processes, Dumps, Tailing Dump, Self-cleaning, Water-bearing Rocks, Infiltration, Adsorption, Chronic Pollution.

### 1. Introduction

The rapid socio-economic development of our country entails intensive use of its ore resources. Increasing the rate of growth of industrial production, discovering new deposits of minerals, quarries, mines for the extraction of mineral raw materials, factories for their processing,

mankind has created many problems for the geological environment, the solution of this issue is impossible without a scientifically grounded system of rational nature management.

Almalyk mining region is located in the north-western part of the foothills of the Kuramin ridge on the left bank of the Akhangaran River. The industrial centre is the city of Almalyk, located 65 km from the city of Tashkent, the capital of the Republic of Uzbekistan.

The development of mineral deposits, an increase in the area of dumps and tailings of copper-dressing factories, slag ponds of a copper smelting plant and the production association "Ammophos" in the Almalyk mining region is one of the most active forms of the impact of human engineering and economic activities on the geological environment, leading to a radical change natural landscapes (primarily natural geological massifs) and the emergence of new complex natural technical systems-technogenic massifs and as well as changes in the natural regime of groundwater.

Of the above, they are manifested in the developed deposits of the porphyry copper formation Kalmakyr, Sary-Cheku, Yoshlik and others, as well as the developed polymetallic deposit Kurgashinkan. All deposits are located within the Almalyk ore region and occupy an area of about 280 square kilometres in the basin of the small rivers Almalyk, Nakpay, Urgaz, Saukbulak and Karakiya.

## **2. Research Methodology**

As a result of the study of the geological tectonic structure, it should be noted that the history of the geological development of the region covers the period from the Lower Paleozoic to the Meso-Cainozoic and is characterized by the manifestation of all stages of geosynclinal development of the earth's crust and sedimentary, volcanogenic, intrusive formations are disseminated by tectonic faults (faults) of different directions and orders [1].

At present, active human interaction with the geological environment is taking place at the deposits, causing changes in the mining-geological and engineering-geological and hydrogeological conditions of the region. Thus, during the development of deposits, the natural stress state of rocks (natural stress field) changes, stress redistribution occurs. As a result, in some areas of the geological space inside and around the quarries, there are zones of influence of stresses with two zones of unloading and support pressure. Such a stressed state of rocks in the above-mentioned deposits is manifested in various forms of geological phenomena, which can be summarized as deformations, destruction, displacements and movements of rocks. In this case, a significant impact on the

efficiency and safety of development is primarily influenced by geological factors: geological structure, bedding conditions of rocks, petrographic composition, natural stress state, physical condition, i.e. the degree of fracturing of magmatic and sedimentary rocks, fragmentation, the presence of tectonic ruptures and disturbances, the degree of water cut, physical and mechanical properties. These are the main leading geological factors that determine the nature, the magnitude of rock pressure and its development over time, and, consequently, the complexity of engineering and geological conditions. The stability of the walls, benches and dumps of open pits and many other important issues related to the development of deposits in the Almalyk ore region was largely determined by the properties of ore-hosting intrusive rocks, represented by diorites, syenite diorites  $C_1^2$ , quartz porphyries  $D_1^2$  as well as andesites with dunite porphyries  $D_1^3$ . In addition, dolomites and limestones  $D_2$ - $D_3$  of sedimentary origin are involved in the geological structure. In the upper part of the section, it is loess-like (sandy loam, loam) and loess of diluvial-proluvial genesis.

It can be considered that at present the study of the properties of the above-mentioned rocks of the region is quite complete and to a large extent satisfies the needs of specialists-developers. Most non-geological specialists consider and study rocks as “material” that composes the sides and slopes of a quarry, as an environment of mine workings without taking into account their genetic and petrographic features, without observing the rules of geological homogeneity, without taking into account geological and engineering-geological conditions, then there is not a complete engineering and geological plan.

The main types of mining and geological phenomena occurring at the deposits are landslides and taluses. Semi-rock igneous rocks that make up the scarps and sides of the quarries, which have undergone metamorphism, are fragmented by tectonic ruptures, cracks inherently prone to deformation, which are associated with surface erosion, weathering, leaching and dissolution of rocks. Despite the improvement of methods for determining the properties and state of rock mass and assessing the stability of benches and sides of open pits, there are many cases of violation of the stability of slopes, which leads to the need to perform additional volumes of mining operations.

A special position in the emergence of geotechnical processes and phenomena is assigned to loess rocks. Loess massifs occupy the upper vertical side of the mined-out area of the quarries.

In many places on the surface of the earth, 10-15 meters from the edge of the slope, cracks can be traced, running parallel to the micro slides. They create a picture of smooth deformation of the loess massif in the preparatory (hidden) phase of the development of the landslide process. Over time, as atmospheric precipitation arrives, a gradual concentration of micro sliding will be observed in a

certain zone of the massif, and then in the general mixing surface of a complex curvilinear outline, the side massif will shift.

Of the geological factors, tectonic disturbances of rocks, which take place at all deposits, are of primary importance. As noted above, rocks strongly dissected by faults, cracks of large and shallow extent, rocks compose the sides, scarps of open pits. During seismic events, the possible force, which in this area is 5-6 points, according to the Richter school, and as a result of drilling and blasting operations in areas where tectonic faults develop in the ledge massif, a zone of strength decreases is formed, which contributes to the development of deformations of benches and quarry sides.

### **3. Results and Discussion**

Even though in the literature there are numerous descriptions of landslide deformations of quarry walls of various morphological types and scales, the mechanism of landslide deformations of quarry walls during open development of mineral deposits is still poorly studied [1,2,3,4,5].

In the quarries under consideration, the depth of development and production capacity are growing every year, which cause great changes in the geological environment. In this regard, zones of unloading and redistribution of stresses in rock massifs are formed in open pits.

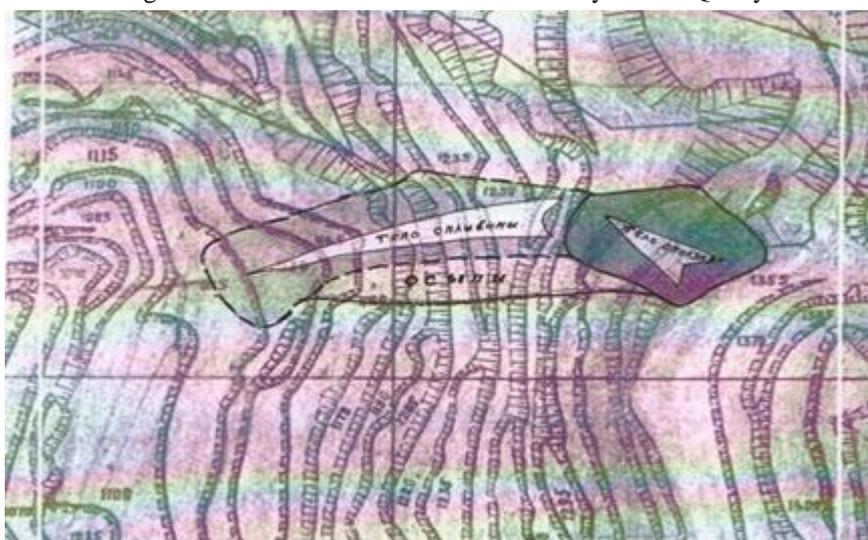
The formation of slope surfaces and a new stress state of rocks during opencast mining creates conditions for the occurrence of several deformations, among which gravitational slope deformations are of decisive importance in the development of mineral resources.

Analysis of observations of the deformations of the sides of the quarries of the Sary-Cheku, Kalmakyr and Kurgashinkan and others deposits shows that all their morphological diversity (upper sides) is represented by loess-like loams (Sary-Cheku) and strongly altered weathered igneous rocks (Kalmakyr and Kurgashinkan) within the thick zone crushing by tectonic disturbances. There was also a decrease in the strength of rocks and, as a result, landslide deformations occurred. The largest landslide with a rock mass of 591 thousand m<sup>3</sup> occurred at the Sary-Cheku quarry at a horizon of 1355 m. A mountain mass (in the northern direction) with a capture depth of more than 10 m, a width of 120-130 m, a length of 160 m is involved in mixing. Further, the mountain mass, in the form of a flood, stretched in the western direction to the horizon of 1115 m. The flood length is 380m, the width is 100-110m (Fig. 1). The hydrogeological conditions of the deposit are favourable for development since the underground waters are very deep. Therefore, groundwater did not participate

in the formation of this landslide. Collapse on the slopes of the ledges is widespread and associated with fracture cracks.

The available material allows us to draw some conclusions on the problem of cracking of the near-side parts of the open pit of the Sary-Cheku deposit, composed of loess rocks, which are the natural boundary of the formation of a section of a new stressed state of rocks and create conditions for the emergence of several cracks on the surface of the loess massif along the side of the open pit, which significantly reduces slope stability coefficient. A characteristic feature of such slopes is the penetration (that is, infiltration) of autumn-spring atmospheric precipitation along cracks and decompaction along the entire collapse prism.

Figure 1 - Landslide Deformation at the Sary-Cheku Quarry



The stability of such slopes depends on the sliding capabilities at the stresses that are characteristic of this surface. Thus, the softening of the rock mass occurred due to the watering of the loess rock mass from the side of the surface atmospheric waters. In this case, a series of sub-parallel lapped cracks formed. In addition, the formation of cracks in rocks along the side does not exclude the possibility of deterioration of the dynamic environment of the open pit, in particular, seismic stresses during blasting operations. Taking into account the influence of the rate of application of gravitational loads, the only artificial source of the formation of such cracks in the rocks is seismic stresses during blasting operations. Technogenic fractures in the near-side parts of the quarry develop inherited, contributing to the clear manifestation and opening of the cracks that previously existed in the rocks and usually hidden from direct observation, and their increase in length.

Development of the Kalmakyr deposit has been going on for over 60 years. During this period, many different deformations (deformations, landslides, taluses, mudslides) with different volumes of rock mass occurred on the sides of the quarry. In all cases, the displacement involved weathered igneous rocks of the zones of crushing by tectonic faults. The places of their formation are always confined to areas of decrease in the strength of rock massifs.

The most significant deformation occurred on the northwestern side of the Kalmakyr open pit. The slope deformation process began after several days of rain, in the area of weathered, developed tectonic cracks in igneous rocks (Fig. 2).

Figure 2 - Deformation of the Side of the Kalmakyr Open-pit Mine



The manifested landslide deformations of the northeastern flank of the Sary-Cheku open pit and the northwestern flank of the Kalmakyr open-pit show that in both cases the characteristic critical shear deformation occurred slowly and smoothly inside the open pit. At the same time, the balance of the rock mass was disturbed and the structural strength of the rocks was overcome. Analyzing landslide phenomena in the described deposits, three main conclusions can be drawn, which should be used as the basis for studying and predicting the landslide process of loess rock strata of the Sary-Cheku deposit and a mass of highly weathered fragmented magmatic rocks of syenite-diorites of the Kalmakyr deposit.

First, the shear resistance of a mass of loess rocks with different mechanical properties with depth during joint deformation is less than the expected resistance, which can be determined as a weighted average from the ratio of the areas occupied by these rocks in the shear zone. This provision

gives grounds to believe that when calculating the stability of temporary slope structures, it is necessary to introduce an amendment into the design characteristics, depending on the indicator of the degree of influence of moistening of the loess massif and seismic stresses. Hence, it follows that under such conditions it is necessary to study the shear resistance on a wet massif of samples simulating the rock mass in the slope, taking into account seismic factors.

Secondly, in the crushing zones, magmatic weathered syenite-diorite rocks of the Kalmakyr deposit have minimum-low strength indicators (cohesion 15-18 kg s/cm<sup>2</sup>, internal friction angle 28-31°) and critical shear fracture deformation. These indicators are determined by the composition, structure, density, especially moisture, the nature of structural connections, stress state and dynamic environment (rock stress during blasting operations). The specifics of the conditions for the development of the deformation process of the strata in the pit wall, presented here, makes it possible to re-evaluate the mechanism of landslide phenomena and, most importantly, improve the quality of predictions when calculating the stability of the walls, using not only the strength but also the deformation characteristics of the rocks composing the sides of the quarries.

In this regard, it is necessary to identify the main factors that directly cause landslide deformations of the pit walls. In our opinion, in the given example, such factors are mechanical (seismic) forces, under the influence of which the conditions of equilibrium of the rock mass change. When studying the patterns of occurrence and development of processes on the sides of open pits, insufficient attention was paid to the above factors. The analysis of these factors shows that, in the loess massifs that make up the sides of the Sary-Cheku open pit and in the heterogeneous massifs of Kalmakyr, a slow displacement of rocks occurred along a stationary massif. The deforming mass moved relative to the stationary part along the sliding surface. These types of deformations are the largest in terms of the size of the gripping areas (fig.1 and 2).

Thirdly, among the mining technical factors influencing the stability of the slopes of solid rocks (Kalmakyr deposits) and the value of the slope angles of the sides, the method of drilling and blasting operations is of the greatest importance. Under the action of the blast wave, the stress state of the rock mass changes, which reduces the friction forces on the weakest surface and, with a small margin of stability, leads to the sudden collapse of the side. The width of the cleaning berms and transport berms, the frequency of their location, as well as the type of exit have a significant effect on the values of the angles of inclination of high sides, composed of weathered igneous rocks, and on the safety of workers in the open pit. The stability of weathered rocks, prone to soaking, is influenced by the profile of the ledge areas, which ensures the flow of atmospheric waters. As the Kalmakyr quarry deepens, according to engineering and geological information, an increase in the strength of the rock

mass is noted. Therefore, the likelihood of deformations of near-side areas at great depths decreases. Thus, as the depth of mining increases, it becomes possible to increase the slope angles of non-working benches at deep horizons.

The depths of mining and production capacity in open pits are growing every year, which cause great changes in the geological environment. In this regard, zones of unloading and redistribution of stresses in rock massifs are formed in open pits.

The formation of slope surfaces and a new stress state of rocks during opencast mining creates conditions for the occurrence of several deformations, among which gravitational slope deformations are of decisive importance in the development of mineral resources.

The Kalmakyr field has been in operation since 1954. Over the long-term operation of the quarry, for several reasons, there are practically no work sites left on the North Side, the width of which would allow mining operations. The convex shape of the side in the inner part of the quarry creates a constant tension of the massif, and since mining operations are not carried out in this area, of course, the massif is not unloaded, blasting and excavation of the rock mass does not occur. The mountain range is in the process of natural balance.

The northern flank of the Kalmakyr open pit is mainly composed of syenite-diorite and diorite rocks, cut through by shtogo and vein-like granodiorite-porphyry bodies and diorite porphyry dikes. The breeds are subject to intensive secondary transformations. Syenite-diorites are characterized by changes leading to the formation of quartz-sericite-biotite-chlorite metasomatized, as well as the development of albitized and carbonated rocks. The upper part of the section is composed of loose formations up to 15-20 m thick. Syenite-diorites are uniform-grained massive rocks, intensively transformed by hydrothermal processes: the development of sericitization, chlorination and silicification is especially characteristic.

Diorites within the area under consideration are recorded immediately south of the Kalmakyr fault and are represented by fine- and medium-grained rocks, the plagioclase of which is usually replaced by sericite, carbonate, less often albite and potassium feldspar, and amphiboles and pyroxenes are replaced by actinolite, chlorite, secondary fine-scaled biotite.

Granodiorite porphyries are found in the form of large bodies along the Kalmakyr and Northern faults. These are light pink porphyry rocks with K feldspar phenocrysts and fine-grained groundmass. The bulk is dense and makes up 45-55% of the rock volume. Granodiorite-porphyry is less transformed than syenite-diorite, but they are also characterized by sericitization and silicification.

The rocks of the dike series are represented in the area of the Northern side of the quarry by single diorite porphyrites of northeastern striking, thickness up to 8-10, steep (650) southeastern dip.

The structure of the described section of the northern wall of the open pit is determined by two large sub-latitudinal faults: the Karabulak and Kalmakyr and one by the northeastern Togap fault; as a result, the side is divided into a number of tectonic blocks.

The Karabulak fault limits the ore stockwork of the deposit from the north and is represented by a thick (50-60 m) crushing zone, composed of highly altered, expanded quartz-sericite rocks, within which strips of clay material are distinguished, clearly limited by tectonic surfaces - seams. The thickness of such strips ranges from 1 to 14 m. The dip of the Karabulak fault is steep, to the north at an angle of 75-800, the Kalmakyr fault has a dip to the south at an angle of 65-750 and is characterized by a lesser thickness (15-20 m) of the zone of sheared, sericitized and chloridized rocks and their more intense fragmentation. In the hanging wing of the fault, a zone of increased fracturing and fragmentation of rocks with a thickness of 70-80 m is recorded.

Between the Kalmakyr and Karabulak faults, during the development of the field, a number of smaller tectonic faults were recorded, a steep dip, both to the south and to the north (Northern faults 1,2,3) located at a distance of 50-10 m from each other. The thickness of the zones crushing of these faults exceeds 15-17m.

To the south of the Kalmakyr fault, numerous small faults and a crushing zone of mainly sublatitudinal and northeastern striking - Togap fault are distinguished. It has a steep (60-800) northerly fall. Apparently, small ore or barren tectonic cracks and numerous zones of crushing and fracturing were renewed as a result of tectonic movements along the Karabulak, Kalmakyr and other faults only in the pre-ore and in the process of ore formation.

In addition, the described area is marked by a large number of smaller faults underlying the listed faults. The faults of the Northeast and Northwest strike prevail with steep (70-800) dip angles to the southwest and southeast.

400 m north of the Kalmakyr quarry is the Kurgashinkan flooded waste quarry (lead-zinc deposit) (Fig.3(1)). The area (area) of the mountain range between the Kurgashinkan and Kalmakyr quarries, divided by the above-described Karabulak fault, passing from west to east, has a very complex character.

At present, the mined Kurgashinkan open pit has accumulated about 25 million m<sup>3</sup> of water, which poses a real threat to the Kalmakyr open-pit (fig.3 (2)). The excess water level in the flooded Kurgashinkan quarry above the bottom of the Kalmakyr quarry is already more than 110 m. Both quarries are spatially gigantic reservoirs with leaking walls and bottom. The presence of worked-out

mine workings and karsts, information on the volume and location of the voids of which is insufficient and tectonic faults, karst voids, natural and man-made cracks, maybe a factor in the existence of water filtration in the Kalmakyr quarry. As a result, it can reduce the stability of the northern side of Kalmakyr.

At the Kurgashinkan, Kalmakyr, Sary-Cheku and Yoshlik deposits there are three types of groundwater: alluvial-proluvial deposits, fractured carbonate rocks and fractured intrusive rocks. Of the described, areal distribution and practical significance in the process of further exploitation of the quarry are the aquifers of intrusive formations of the Paleozoic [3]. The aquifer of alluvial deposits in the Almalyk industrial region is confined to the valleys of the Akhangaran, Almalyk and Nakpaysay rivers and their tributaries. The water-bearing rocks are pebbles with different content of boulders on sand and gravel aggregate. The thickness of the deposits is 18-25 and less often up to 50 meters.

Figure 3 - Kurgashinkan (1) and Kalmakyr (2) Fields



The underground waters confined to the formations of the Middle Devonian and Lower Carboniferous do not have within the boundaries of open pits. The aquifer of intrusive rocks of the Upper Palaeozoic occupies the main part of the quarry area. The water-bearing rocks are

syenite-diorite, syenite, diorite, gabbro diorite, granodiorite-porphyr. The water content of these rocks is predetermined by fracturing and depends on the degree of the voidness of the fractures. The aquifer of intrusive formations has a pressure-free flow regime. The water abundance of these rocks is insignificant. As the quarries deepen, the flow of quarry water into the drainage system is 170 m<sup>3</sup>/hour, the leach increases to 360-570 m<sup>3</sup>/hour. The pumping of water from the quarries is carried out by mobile pumping stations.

Groundwater is the most important element of the geotechnical conditions of deposits. In many fields, their relative role in comparison with other factors is exceptionally great, this necessitates the production of large works on drainage, the fight against the harmful effects of groundwater. Naturally, much attention was paid to the study, development of methods for assessing and predicting the degree and conditions of water cut, development and design of technical means for protecting open pits during the exploration and industrial assessment of the described Kalmakyr deposits. However, the study of the hydrogeological conditions of the described fields is aimed at solving the problems of drainage of the field. At the same time, such important issues as pollution of groundwater, surface water, soil - soil and the influence of groundwater on changing the properties of rocks that make up the deposit, on the development of various geological phenomena, on the stability of ledges and slopes are often not considered. The hydrogeological factors influencing this stage of the development of the deposit include: the presence of groundwater in the host rocks and the ore body, manifested in the filtration of water in the quarry and the entrainment of the moisture content of the minerals; filtration deformations of slopes.

When studying the impact of industrial waste on the natural environment, special attention is paid to the following factors: area of distribution, impact on the relief, soil, surface and underground waters.

At present, the area of land on which the waste of copper concentrating factories (CCF-1 and CCF-2) is located, and the waste of the copper smelting plant (CSP) and production association Ammophos is more than 10 km<sup>2</sup>. The base of the tailings storage ponds (old) of the CCF, slag storage ponds of the CSP and waste of the Ammophos production association is the II accumulative terrace of the Syrdarya complex of Quaternary deposits. It is represented from above by a thin (0,5-1,5 m) sandy-loamy soil-vegetation cover, below by gravel-pebble deposits with a thickness of more than 15-20 m and with a groundwater depth of 8-10 m and more [3].

The combined tailing dump (new) CCF-1 and CCF-2 are located within the III terrace of the Holodostep erosion-accumulative cycle, represented by a 2 and 3 m cover of loam, and below bedrock and coarse (gravel) deposits.

Uplands formed from the waste of the Ammophos Production Association (Fig. 4), CSP (Fig.5) tailing dumps CCF-1 and CCF-2, exceeding the absolute elevations of the territory by 15-35 m. The natural micro-relief disappeared, a new anthropogenic relief was formed.

Figure 4 - Waste PA "Ammophos"



Figure 5 - Slag Storage CSP



The thickness of the soil and vegetation layer on the territory is 0,2-0,5 m. Due to the action of the totality of soil organisms, chemical and biochemical reactions, plants can feed on organic substances, the required amount of which in the last century Liebig called the law of minimum [1]. Now this pattern is violated by the presence in soils of increased concentrations of nitrogen, Na,  $\text{NO}_2\text{NO}_3$  and  $\text{SO}^{-2}_4$ ,  $\text{SO}^{-3}\text{NH}_4^4$ , HF.

Changes in the properties and composition of soils that make up the territory occur in three directions. This is, firstly, the compaction of rocks under the body of storage ponds, which leads to a change in physical and mechanical properties, an increase in moisture and a decrease in the porosity of rocks, a change in density, strength parameters. So, the density values of sandy loamy-loamy soils from the weight of technogenic massifs change from 1,45 to 2,20  $\text{g/cm}^3$ , porosity from 55% to 40%, the value of the angle of internal friction from  $28^\circ$  to  $24^\circ$ , shear resistance depending on moisture and soil density from 0,062 to 1,175 MPa.

In the zone of influence of the tailing dumps CCF-1 and CCF-2, due to the action of the infiltration flow, changes in the physical composition of soils occur, readily soluble compounds (bicarbonates -  $\text{HCO}_3^{-1}$ . Sulfates -  $\text{SO}_4^{-11}$ . Chlorides- $\text{Cl}^{-1}$ ) are sorbed on solid soil particles several chemical compounds: copper, cadmium, bismuth, lead, molybdenum, manganese, zinc, rhenium, arsenic and others [3; 4].

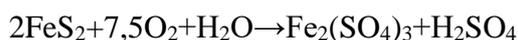
There is information about the intense contamination of soils in the area around the tailing dump to a depth of 10 m with heavy metals and other toxic elements (lead, zinc, arsenic, copper, antimony, tungsten, vanadium, etc.) reaching 50-80 MPC. Copper contamination of soils is accompanied by carbonate contamination [5].

The main sources of pollution of surface and underground water bodies are the mined mines of Kurgashinkan, Kauldy, Sary-Cheku, Kalmakir, tailing dumps CCF-1 and CCF-2, dumps of PA Ammofos, CSP, sulfuric acid workshop and other facilities of the enterprise.

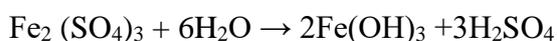
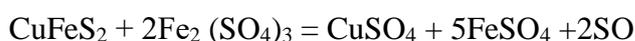
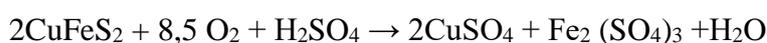
The ores of the Almalyk ore region contain many minerals represented by chemical compounds:  $3\text{MgO } 4\text{SiO}_2 \text{ H}_2\text{O}$ ,  $\text{Al}_2\text{O}_3$ ,  $4\text{SiO}_2 \text{ H}_2\text{O}$ ,  $\text{CuFeS}_2$ ,  $\text{Cu}_2\text{O}$ ,  $\text{Cu}_5\text{FeSO}_4$ ;  $\text{CuS}$ ;  $\text{FeS}_2$ ;  $\text{Fe}_2\text{S}_3$ ;  $\text{Sb}_2\text{S}_3$ ;  $\text{FeAsS}$ ;  $\text{As}_2\text{S}_3$ ;  $\text{HgS}$ ;  $\text{CoAsS}$ ;  $\text{As}_2\text{O}_3$ ;  $\text{MoS}_2$ ;  $\text{Ag}_2\text{S}$ ;  $\text{S}$ ;  $\text{Fe}_3\text{O}_4$ ;  $\text{Fe}_2\text{O}_3$ ;  $\text{CuSiO}_3$ ;  $\text{HH}_2\text{O}$ ;  $\text{PbSO}_4$ ;  $\text{PbS}$ ;  $\text{ZnS}$ ;  $\text{ZnSO}_3$ ;  $\text{BaSO}_4$  and others. Dumps of PA "Ammophos" contain:  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  или  $(\text{CaO}; \text{SO}_3; \text{H}_2\text{O})$ ;  $\text{MgCO}_3$ ;  $\text{SiO}_2$ ;  $\text{Fe}_2\text{O}_3$ ;  $\text{P}_2\text{O}_5$ ; HF; and etc.

CSP dumps contain:  $\text{FeO}$ ;  $\text{Fe}_2\text{O}_3$ ;  $\text{Fe}_3\text{O}_4$ ;  $\text{ZnO}$ ;  $\text{CuO}$ ;  $\text{CaO}$ ;  $\text{FeOSiO}_2$ ;  $\text{Al}_2\text{O}_3$ ;  $\text{Al}_2\text{O}_3$ ;  $\text{As}_2\text{S}_3$ ;  $\text{As}_2\text{O}_3$ ;  $\text{SiO}_2$ ;  $\text{FeAsS}$ .

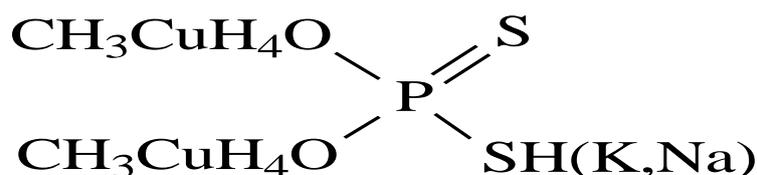
With the assistance of groups of bacteria, converters of mineral substances, when deposited in ore dumps containing the above chemical compounds, chemical weathering occurs. It is known that theon bacteria are capable of leaching copper and other non-ferrous metals, sulfide compounds. Ferrobacillus Ferrooxidons bacteria can oxidize 0,02% He (3) in three days [6; 7]. The optimum temperature for the activity of bacteria is 28-30 °C, which is typical for this region. Iron oxidation by bacteria occurs according to the reaction:



Copper minerals are chemically and bacterially oxidized:



In the wastes of the tailing dump of the CCF, the predominant ions are  $\text{Cu}^{2+}$ ,  $\text{Fe}^{3+}$  and they can be oxidized by the residues of flotation reagents added at the factories.



Interacting with  $\text{Cu}^{2+}$  and  $\text{Fe}^{3+}$  ions



Ditophosphates are often present in the waters of tailing dumps, where intensive filtration of water takes place.



Reactions of this type can take place in the tailings of the concentrating factories. The process of pollution as a result of infiltration of water from quarries dumps slag ponds, settling tanks (tailing

ponds) CCF-1 and CCF-2, as well as leakage of reagents from the sulfuric acid shop through the rock aeration zones, has been going on for 5 decades. Thus, the filtration zone of the Akhangaran river valley is represented mainly by rocks with high water filtration properties (10 m/day). The rate of contamination spreading depends on many factors: due to the lack of high-quality insulated bedding at the base of the waste accumulators; from a sharp rise in the level of groundwater: from abundant atmospheric precipitation; due to the emergence to the surface of the water-bearing rocks of the first aquifer from the surface [5].

The groundwater of Quaternary sediments within the region, due to the insignificant thickness of loess-like loams, is poorly protected from the harmful effects of technogenic loads and the possibility of rapid penetration of polluting components into the aquifer. In the Akhangaran valley, water-bearing rocks come to the surface and do not have a regional aquiclude. They are the main source of water supply for large settlements in the Pskent region, located hypsometrically below the Almalyk industrial region.

As you know, according to R. Carbienard, chemical pollution of groundwater at the first stage, which is of a temporary nature, then becomes chronic. In the case of chronic pollution, a group of pollutants inhibits the self-cleaning process [7].

Mechanical pollution of surface waters is an occasional one-time discharge of waste (sludge, slag, etc.) by Ammophos Production Association, CCF-1, CCF-2, CSP, sulfuric acid shops and other enterprises in canals and ditches as a result of pipeline accidents, tailing dumps, which are not an exception in this respect.

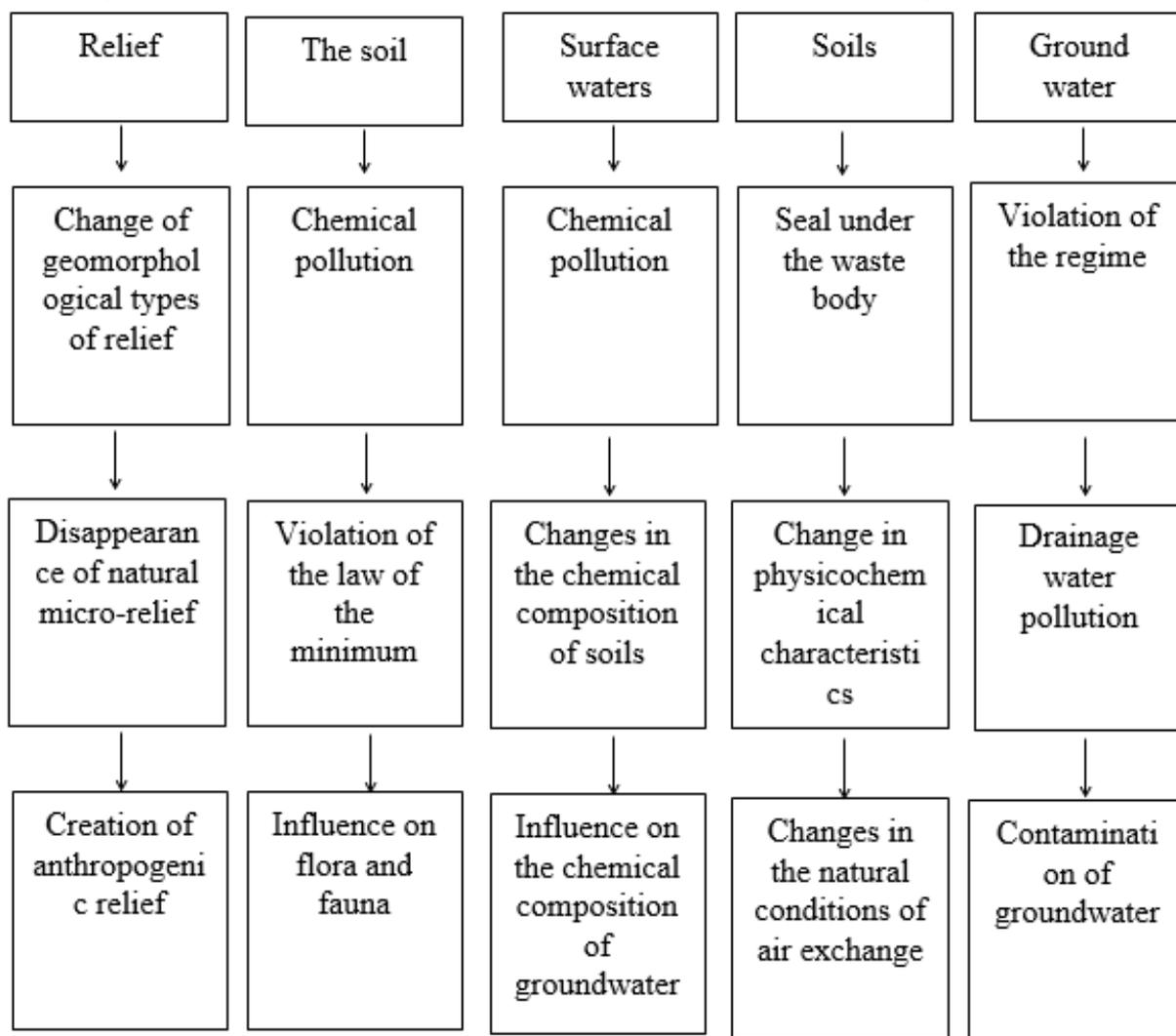
This information shows the general nature of pollution. However, this is not enough and it is necessary to determine the necessary indicators that follow in the whole region and depending on the branch industry and the type of industrial enterprise.

#### **4. Conclusion**

Based on the results of studies of the Almalyk mining and industrial region and other regions, a diagram of the technogenic impact of industrial enterprises of the Almalyk region on the geo-ecological environment was drawn up (Fig. 6). The main tasks of further research can be considered the study of quantitative factors characterizing the variability of the natural geological environment under the influence of the industry of the region.

Thus, the earliest possible solution to urgent problems of minimizing the harmful effect of industry on the natural environment, processing of existing man-made massifs (waste) and the introduction of waste-free production technology will improve the state of geo-ecological conditions and prevent environmental pollution.

Figure 6 - The Influence of the Industry of the Almalıyk Region on the Geoecological Environment



Studies have shown that the deterioration of the state of the geological environment, including surface and ground waters, has been going on for more than 70 years since the beginning of the development of the Kurgashinkan polymetal deposit at the Kalmakyr and Sary-Cheku copper deposits and the construction of industrial enterprises in the city. As a result of the infiltration of polluted waters of quarries, dumps, pits of the copper smelting plant (CSP) and the production association (PO) "Amмоos", the tailings of the copper concentrating plant (CCF-1 and CCF-2), acid,

the penetration of polluting components into the groundwater occurs. Due to the action of the infiltration flow, the chemical composition of soils changes, and a number of polluting chemical compounds accumulate on their solid particles.

## References

*National report on the state of the environment and the use of natural resources in the Republic of Uzbekistan State Committee of the Republic of Uzbekistan for Nature Protection (2001)*. Tashkent. Publishing house Ihikor EHK, 2002 21p.

Isomatov Yu. P. (2002). Features of the technogenic impact of the industry of Almalyk on the natural environment. *Abstracts of the city scientific and technical conference "Science of Almalyk and problems of development of the region"* Almalyk. pp. 43-44.

Isomatov Yu. P. (1991). About the interaction of technological processes of the industry of the city of Almalyk and the geological environment. Optimization of complex technological processes in the mining and metallurgical industry. *Collection of scientific papers Tashkent. Publishing house. Tash. PI.* pp. 52-55.

Isomatov Yu. P. (2014). *Features of the technogenic impact of the industry of the Angren-Akhangaran region on the environment*. Theses of reports of the international scientific and technical conference "Problems and prospects for the development of science and practice in Uzbekistan." Tashkent. p. 29.

Khudoyberganov A.M., Nurmukhamedov K.Sh., Tuichieva M.A. et al. (2014). Geocology and seismic ecology of the cities of Uzbekistan. *Toshkent "Iqtisodiot"*. P.101.

Nikitin D.P., Novikov Yu. V. (1980). Environment and people. *Moscow. Nedra*. P.11.

Agas P. (1982). Key to ecology. Leningrad, *Gidrometeoizdat*. P.9.

Isomatov Yu. P. et al. (2019). About changes of mining-geological conditions of Kalmakyr deposits shortening. *International Journal of Advanced Research in Science, Engineering and Technology (IJARSET)* No. pp. 10975-10979.

Isomatov Yu. P. (2020). On the formation of the technogenic regime of groundwater during the development of the Kalmakir deposit. *Mountain Bulletin of Uzbekistan*. No. 4 Navoiy, P.48.

Tukhtaev T. (1994). Khamidov "Fundamentals of Ecology and Nature Protection" Tashkent. "Teacher". p.160.

Isomatov Yu.P, Shamaev M.K, Akhmedov M.K. (2019). About mechanisms of bort deformations and benching banks during Almalyk ore district mining. *International Journal of Advanced Research in Science, Engineering and Technology (IJARSET)*, 6(12), 12299-12302.

Pulatovich, I.Y., & Kidirbaevich, A.M. (2021). On the influence of rock mass fracturing on the development of mining and geological processes in the Almalyk ore region (on the example of the Kurgashinkan, Sary-cheku, Kalmakyr and Yoshlik deposits. *International Engineering Journal for Research & Development*, 6(3), 5-5. <https://doi.org/10.17605/OSF.IO/V9XAK>

Isomatov Yu. P, Akhmedov M.K., Ibadlayev S.I. Features of influence of industrial Enterprises Almalyk city on the Geological Environment. *The American journal of interdisciplinary innovations and research* December 25, 2020. Volume 02, issue 12-08 pages:54-62. Article DOI: <https://doi.org/10.5958/2279-0667.2020.00023.1>

Zh, K.M., & Akhmedov, M.K. (2020). About features of technogenic influence on groundwater and geological environment. *Asian Journal of Multidimensional Research (AJMR)*, 9(11), 60-68. <http://dx.doi.org/10.5958/2278-4853.2020.00303.1>