ABOUT THE MAIN CAUSES OF DEFORMATIONS OF BOARDS AND LIPS IN THE ALMALYK ORE DISTRICT

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ABSTRACT: The article deals with the issues of the occurrence of various deformations in rock massifs during quarrying. It is noted that among which gravitational slope deformations in the form of landslides, screes and mudslides are of decisive importance. All these types of deformation are observed during open-pit mining of large deposits of the Almalyk ore region. As a result of the analysis of the deformation of the pit walls, the main conclusions were made. which can serve as a basis for studying and predicting landslide and other types of deformations, as well as for the construction of new quarries.
Key words: deformation, landslide deformations, quarry, crushing zones, fracturing, slush, collapses, landslides, scree, fault, tectonic cracks, reverse-slip shear, ledge stability, seismic stresses, structural strength of rock masses.

Introduction

Despite the fact that in the literature there are numerous descriptions of landslide and other deformations of the sides on the slopes of ledges of quarries of various hydrogeological and engineering-geological conditions, morphological types and scales, the mechanism of landslide deformations of the sides of quarries during open-cast mining of mineral deposits is still poorly understood (1; 2;3;4; and others).

In the Sary-Cheku and Kalmakyr quarries discussed below, mining depths and production capacities are growing every year, which cause great changes in the geological environment. In this regard, zones of unloading and redistribution of stresses in rock masses are formed in quarries.

The formation of sloping surfaces and a new stress state in rock masses during open-pit mining creates conditions for the occurrence of a number of deformations, among which gravitational slope deformations are of decisive importance.

Main part

Analysis of observations of the deformations of the sides of the quarries of the Sary-Cheku, Kalmakyr and exhausted Kurgashinkan deposits show that all their morphological diversity (upper sides) are represented by loess-like loams (Sary-Cheku) and heavily altered weathered igneous rocks (Kalmakyr and Kurgashinkan) within the crushing zone tectonic disturbances, a decrease in the strength of rocks was noted, and as a result, landslides and other types of

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deformation occurred. The largest landslide with a volume of rock mass of 591 thousand m3 occurred at the Sary-Cheku quarry in 2004 at a horizon of 1355m. Involved in the mixing are rock mass (to the north) with a capture depth of more than 10 m, a width of 120-130 m, and a length of 160 m. Further, the mountain mass, in the form of a slush, stretched to the west up to the horizon of 1115m. The length of the swamp is 380m, the width is 100-110m (Fig. 1).

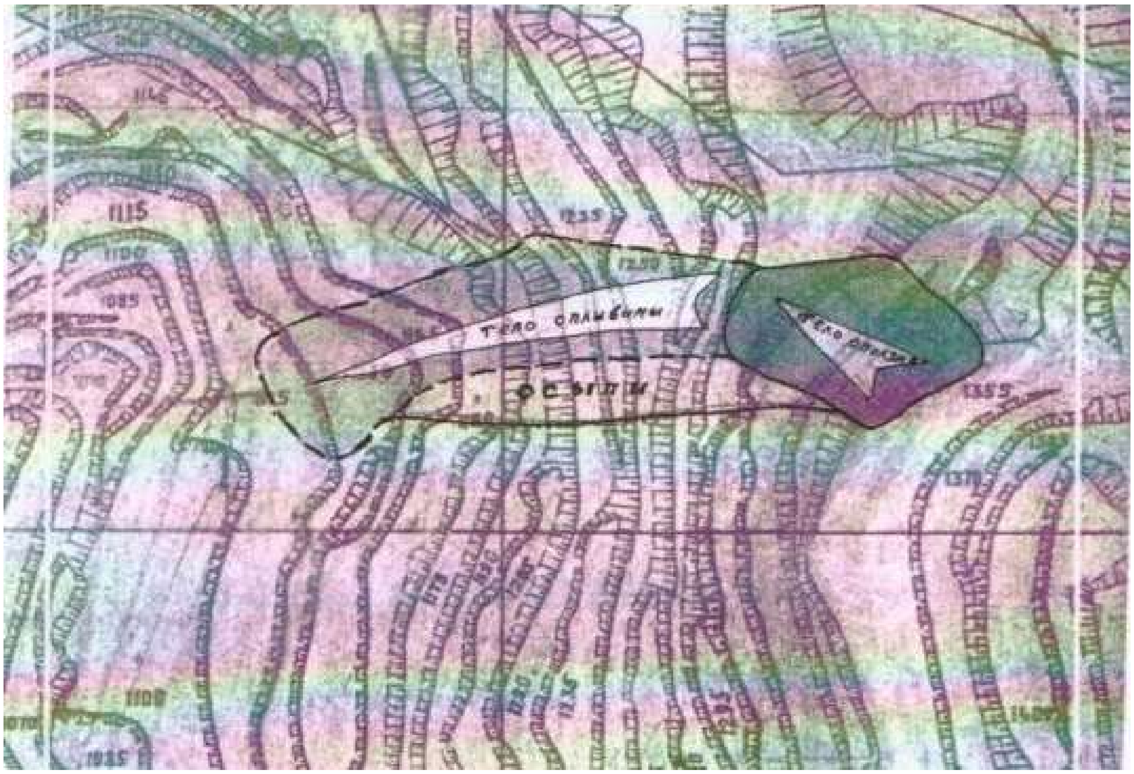

Fig.1. Landslide deformation at the Sary-Cheku quarry.

The hydrogeological conditions of the deposit are favorable for mining, as groundwater is very deep. Therefore, groundwater did not participate in the formation of this landslide [7]. In a quarry, collapses on the slopes of ledges are widespread, they are associated with a crack by a fault zone.

The available material makes it possible to express some considerations on the problem of cracking of the near-side parts of the quarry at the Sary-Cheku deposit, which are composed of loess rocks, which were the natural boundary for the formation of a new stress state of rocks, creating conditions for the emergence of a number of cracks on the surface of the loess massif along the side of the quarry, which significantly reduces slope stability coefficient. A characteristic feature of such slopes is the penetration (i.e. infiltration) of autumn-spring precipitation through cracks and decompaction along the entire collapse prism. The stability of such slopes depends on the possibility of sliding under the stresses that are characteristic of them on this surface. Thus, the softening of the rock mass occurred due to the moistening of the loess massif by atmospheric waters. In this case, a series of subparallel ground-in cracks were formed. In addition, the formation of cracks in the array along the side does not exclude the possibility of a dynamic situation in the quarry, in particular, seismic stresses during blasting operations carried out in order to loosen rock masses. 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 rock masses of ledges are seismic stresses. Such technogenic cracks in the near-wall parts of the quarry also develop inherited, contributing to the clear manifestation of cracks that previously existed in rocks, usually hidden from direct observation, their opening, and an increase in length.

The Kalmakyr field has been developed for more than 65 years. During this period, a lot of different deformations (collapses, landslides, screes, slushes) with different volumes of rock mass occurred on the sides of the Kalmakyr quarry and the exhausted Kurgashinkan quarry. In all cases, the mixing involved weathered igneous rocks of zones of crushing by tectonic faults and associated zones of fracturing. The places of their formation are always confined to areas of decreasing strength of rock masses.

Visual observation established that the cracks are mostly filled with clay and calcareous material. In weathered rocks, cracks are often less pronounced. A lot of weathering microcracks were noted, invisible to the naked eye, but contributing to the destruction of rocks under the influence of weathering.

The crushing zones of tectonic disturbances are characterized by low strength properties of the rock mass and a high degree of fracturing.

The study of the nature of the deformation of large massifs of fractured rocks showed that non-continuous cracks do not affect the stability of the slopes. As for continuous cracks of considerable length, their occurrence can have a decisive influence on the stability of slopes.

The Kalmakyr reverse-slip-slip and the Karabulak fault passing in the latitudinal direction within the contour, the Kalmakyr and Kurgashinkan quarries are the largest weakened zones. Between them, a large tectonic block is formed, dissected by numerous faults of various directions of a smaller order into massive sections with various configurations of large cracks. During the development of the deposit, when discontinuous faults or large cracks develop parallel to the wall and dip at angles of 30-600 towards the quarry bowl, landslide deformations, collapses and screes will develop. The largest screes will be confined to the weakened zones. Usually the shedding rate depends on the time factor, i.e. ledge renewal time, climatic factors and slope angles.

Results and Discussions

The most significant deformation occurred on the northwestern side of the Kalmakyr quarry in 2012 (Fig. 2). The process of deformation of the slope began after several days of rain, in the area, developed tectonic cracks of weathered igneous rocks.

The manifested landslide deformations of the northeastern side of the Sary-Cheku quarry and the northwestern side of the Kalmakyr quarry and the southern side of the Kurgashinkan quarry show in both cases the characteristic critical shear deformation occurred slowly and smoothly inside the quarry. In this case, as a rule, the balance of the rock mass was disturbed and the structural strength of the rocks was overcome.

Conclusion

Analyzing landslide phenomena in the described deposits, three main conclusions can be drawn, which should be taken as the basis for studying and predicting the landslide process of loess rock strata of the Sary-Cheku deposit and an array of highly weathered fragmented igneous rocks of the Kalmakyr and Kurgashinkan deposits (Fig. 3 and 4).

First, the shear resistance of a massif of loess rocks with different mechanical properties with depth under 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 sloping structures, it is necessary to introduce an amendment into the calculated characteristics, depending on the indicator of the degree of influence of moisture in the massif of loess rocks and seismic stresses. Hence it follows that under such conditions it is necessary to study the shear resistance on a wet array of samples simulating the rock mass in the slope, taking into account seismic factors.

Fig.2. Deformation (landslides-screes) of the southwestern side of the Kalmakyr quarry.

Fig.3. Landslide deformation of the southwestern side of the Kurgashinkan quarry.

Fig.4. Screes of the side of the Kurgashinkan quarry.

Secondly, in the crushing zones, igneous weathered syenite-diorite rocks of the Kalmakyr and Kurgashinkan deposits, which have minimally low strength characteristics (adhesion 15-18 kgf / cm2, internal friction angle 28-31 °) and critical shear failure deformation, which is determined by composition, structure, density, especially humidity, nature of structural relationships, stress state and dynamic environment (rock stresses during blasting).

The specifics of the conditions for the development of the process of deformation of the strata in the pit wall, outlined here, makes it possible to re-evaluate the mechanism of landslide phenomena and, most importantly, to improve the quality of forecasts when calculating the stability of the sides, using not only the strength, but also the deformation characteristics of the rocks that make up the sides of the pit. .

In this regard, it is necessary to identify one of the main questions about the leading factors that directly cause landslide deformations of the pit walls. In our opinion, in our example, the main factors are the conditions in which the processes develop, under the influence of which the equilibrium conditions of the mechanical (seismic) forces involved in the process change. When studying the patterns of occurrence and development of processes on the sides of open pits, no attention was paid to the factors described above. The analysis of the factors described above shows that in the loess massifs that make up the sides of the Sary-Cheku quarry and the heterogeneous massifs of Kalmakyr, the slow mixing of rocks occurred along the immovable massif. The deforming array was mixed relative to the fixed part along the sliding surface. This type of deformation is the largest in terms of the size of the gripping areas (Fig. 1, 2,3 and 4).

Thirdly, among the mining engineering factors influencing the stability of slopes of hard rocks (Kalmakyr and Kurgashinkan deposits) and the magnitude of the angles of inclination of the sides, the most important is the method of drilling and blasting. Under the action of the blast wave, the stress state of the massif changes, which reduces the friction forces along the weakest surface and, with a small margin of stability, leads to sudden collapses 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 impact on the angles of inclination of high sides, composed of weathered igneous rocks, and on the safety of work in a quarry. The stability of weathered, prone to soaking rocks is affected by the profile of the ledge areas, which ensures the flow of atmospheric water. As the Kalmakyr quarry deepens, according to engineering and geological data, an increase in the strength of the rock mass is noted. Therefore, the probability of deformation of the near-edge sections at great depths is reduced.

Thus, as the depth of mining increases, it becomes possible to increase the slope angles of non-working ledges at deep horizons.

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