The theory and practice of rock massifs control in the ore mining

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Abstract
It was determined that for the rock deposits the hypothesis of controlling stress-strain protection on the basis of the mechanics of deformable media is more acceptable. It is shown that the optimization of massif control processes is provided by an adequate equivalent ratio between the subjects of mining. It is recommended to ensure the safety of massif by stress minimizing in its parts by dividing deposits in safe sections.
Key words: MINING PRODUCTION, MASSIF SEPARATION, SAFE SECTION

Increase in mineral production is followed by the involvement in exploitation of deposits, development of which requires a secure combination of the massif elements within geomechanical system [1].

Despite technological innovations, the massifs control techniques, allowing to provide high quality and completeness of extraction of ore from the interior need to be improved. In the calculation of the massif control parameters the dynamic effects on massif are taken into account insufficiently and that is accompanied by not only the loss of stock during an intensive destruction of the massif, but also an increase in ore dilution. Optimization of massif control parameters of the existing deposits provides economic effect, the value of which is often comparable to the effective development of a new deposit [2]. Improving the efficiency of rock deposits underground mining by optimizing control parameters of ore-bearing massif depends on the correctness of the assessment of stresses and strains in the natural and man-made system. The researches made in [3, 10] are devoted to the quality management and increase of complete extraction of ore mineral resources. The stated problem is solved by proving the fact, which optimizes the management processes on the geomechanical base massif by economic criterion. It is possible if geomechanical massif state and quality parameters of deposit development are associated by adequate equivalent ratio. Massif stability loss occurs by adding the potential energy of the rocks elastic compression and the elastic deformation energy, so the methodological basis for the prevention of massif fracture processes is to minimize the stresses in its elements. It is achieved by cutting of deposits to safe areas considering the seismic activity, and the effectiveness of the massif control state depends on the conformity assessment of the values of stress and strains in terms of massif development. Currently the priority of development gets the evaluation of the stress-strain state of the massif without losing continuity, based on mechanics of deformable media: elasticity, plasticity, creep, etc. [4-6].

The stresses in the massif depend on the natural stresses field and not always correlative. The stressed state of massifs is determined by the joint action of gravitational forces and the fault structure impact on them. In the hanging walls of fractures planes the horizontal stresses are 2-3 times more than vertical. Inside the geological block the strains are aligned [7].

In the area of the workings the zone of disturbed rock is appearing. It is characterized by the decrease in strength and weakening of massif. The rocks with a strength of 70-100 MPa or high strength, with 100-150 MPa and a medium-attenuated (K_o = 0.25-0.35) on the contour of workings the rocks weakening decreases. Attenuation rate (K_o) in the broken rock area is reduced up to 0.04 - 0.15. Zone power around the small cross section workings is about 0.5 - 2 meters, around the large - 4 - 5 m. Outside the out-contour zone the attenuation rate K_o is increased to 0.1 - 0.15. In the near-contour zone K_o is reduced as compared to the massif by 2.5 - 6 times, in the region of broken rocks - by 1.5 - 2.5 times (Figure 1) [8]. The solution of the geomechanical problem is provided by the cutting of the mine field into geomechanically balanced sites by stopes, which can be hardened by support of hardening laying and tails of underground leaching [9].

The massif control problem is to establish an adequate relationship between the technology parameters and the value of existing strain in the massif. The criterion of efficiency is reduction of losses and dilution values, which finally determine the economic effectiveness of the minerals deposits development [11]. The development of trends of resource saving is possible by interlinking of natural deposits fields, the effects of man-made production, processes expenses for metals obtaining and ecosystem condition. The establishment of the mechanism of these relationships creates a separate problem, which involves setting of poly-factor experiments in rock mechanics, geotechnical methods of development, ecology, economy and many others [12-15]. The issues of mining technology require further detailed research: massif control with environment safe maintaining while minimizing loss of high quality ore in stope. Ore mining technologies are classified on the basis of massif control factor by adjusting the level of strain in its elements (Table 1).

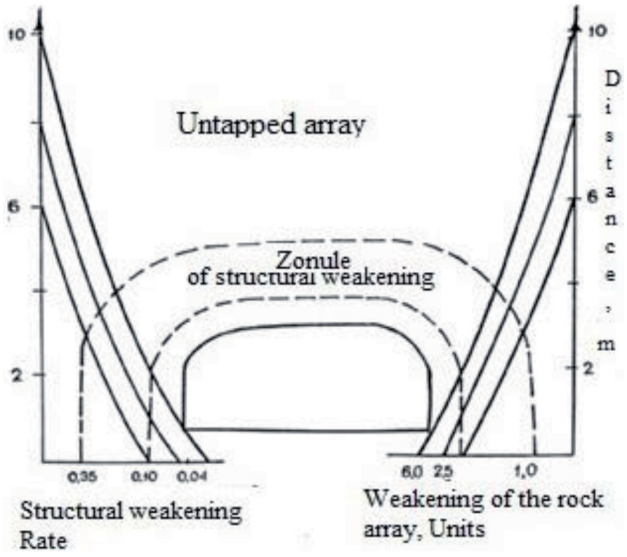

Figure 1. The influence of the working on the massif

Table 1. Typification of massifs technologies control

Class	Group	Defining characteristics
Without strain compensation	Caving rocks in isolated mines	Width of the mine passage
Particular strain compensation	Forced or self-caving	Height of mine, strength of rocks
	Local support	Pressure on the stopes and structures
	Filling with bulk material	Compression of material
Full strain compensation	Filling with hardening mixtures	Strength and delivery condition of mixtures
Combined	Combining elements of both classes	Volume of control elements using

The first strain field depends on the gravitational and tectonic forces acting in the massif and the second one - is determined by the technology of development. Redistributed strain in the mining operations process produces the massif fragile destruction. The strains, which concentrated in the edge parts of mines, and over the stopes are connected with the stress fields of nearly placed areas, which allows to control the massif condition using development technologies focused on tension and strain. The systems with full strain compensation are most reliable. The combined systems allow to achieve a comparable control effect by cheaper ways [15-19]. The review of theoretical views and analysis of underground mining practice of complex-structured deposits allows to determine the solution steps of geomechanical problems: massifs stressed-strain state evaluation; development of methods for massif control with maximum usage of mineral resources and ecosystems preserving; justification of technological feasibility and ecological and economic efficiency of development complex deposits with a decrease in metal losses and winding of not caused technological rocks.

The concept basis of massif state control is set up by the provisions: the massif control efficiency depends on the geomechanical balanced stressed-strain media; the perspective ways for massif control are associated with an increase in the carrying capacity of rocks by the deformation control; the massif control is based on the behavior of deformed rocks and can be effective in improving the strength of the carrying elements, including stopes.

Conclusions

The methodical basis of rocks state control is the evaluation of the stressed-strain state of the massif on the basis of deformed media mechanics. Optimization of the massif control process on the geomechanical basis is provided by the existence of adequate equivalent relations among the subjects of mining production. Massif stability can be achieved by minimizing the strain in its elements by splitting deposits into safe areas.

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