

# PROBLEMS OF PROGNOSTICATION OF DANGEROUS PHYSICAL AND GEOLOGICAL FACTORS IN OPEN-PIT MINING SITES

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## **Introduction**

When building and exploiting mines they meet different geological processes influencing on putting into production and developing deposits of minerals. Almost all modern geological processes are of some interest in evaluating the influence of engineering and geological conditions in mining-building and exploiting works, but the most interesting are those followed by intensive ruining of rocks on developing, building and exploiting production sites which causes rapid and sometimes disastrous landslide of rocks with powerful dynamic influence on the buildings [3,6]. Studying and prognosticating these processes is the important part while forming the territories of land using in open mining sites. However the practice shows that the problem of studying these factors of influence is not paid proper attention in mining enterprises. A modern mining enterprise is a territory with dynamically changeable space and huge amount of rapid engineering and geological processes. That is why more often the data about physical and geological processes characterizing this territory soon become out of date and require additional continuous studying when exploiting the deposit. The majority of such processes cause negative influence on the mining works so after studying, systemizing and creating a model of forecasting these processes they can considerably reduce their influence in the production.

## **Setting a problem**

Long exploitation of land using in mining enterprises (in some cases 30 years or longer [4])

testifies that the process of forming territories has a changeable character. Modern tendencies of developing open mining mineral deposits include deposit exploitation of complex mining geological conditions and developing ones under conditions of limited mining pipe-bend. However using new territories for developing deposits does not always bring a desirable economic effect. One of the causes is the absence of seeing the processes of rational forming of land using mining and mechanisms of influence of physical and geological works in mining production.

## **Recent researches and publications analysis**

The papers of such scientists as Kagan A.A., Smirnova V.B., Lukinova V.V., Sidorenko P.F. and others are dedicated to the problem of prognostication of dangerous physical and geological phenomena. However searching for universal prognostication methods of dangerous physical and geological factors, to our opinion, requires further researching as they are not universal enough and are not widely used in practice. There are certain difficulties in physical and geological factors prognostication despite a wide range of prognostication methods nowadays. Although existing methods help solve these difficulties however a specific character of their applying in solving some tasks is not studied in full. There is not a universal methodology either helping in combining of prognostication methods in a unit.

## **Setting a task**

Forming of land using of open mining sites should be based on scientific system analysis methodology and prognostication of dangerous physical and geological factors should be taken into account. So the task of clearing modern prognostication methods and finding methods

which will help use prognostication system approach is described in this paper.

The main purpose of this paper is in clearing the problems of prognostication of physical and geological factors and searching for the most suitable methods based on system approach.

### **The main contents**

Nowadays the main methods of prognostication which are widely used in practice for mining and geological phenomena prognostication are methods of analogy and evaluation of existing factors, analytical and modeling [1].

The method of analogy is based on using engineering and geological data of studied mineral deposit for forecasting factors on a new deposit having the same conditions. The method of analogy gives the most satisfactory results in prognosticating physical and geological methods while exploiting a deposit some part of which was being used.

The method of evaluation of existing factors is based on finding and assessing possible different natural and technological factors influence on the exploitation of a dangerous physical and geological process. As a rule, specific for those conditions complex of existing factors is chosen in every case. But more often such factors as the structure and tectonics of the territory, litological and petrographic rock composition, deformation resistance rock characteristics, voltage distribution character and magnitude in the rock massif, water in the rock, the depth of mining works, the way of deposit exploitation, artificial change of rock state and properties (drying, irrigation, chemical fortification and so on) are used. Numerous factors and their various influence make difficult the evaluation and finding the most important among them.

Analytical methods have been widely used for the last decades [7]. They are based on calculating the parameters characterizing physical and geological factors. But it should be taken into account that mechanical and mathematical model allows to get only approximate physical and geological factors change influencing the possibility and reliability of obtained prognostication results. The problem

consists also in the number of influencing parameters.

Modeling method is based on choosing and creating a physical and mathematical model with fixed and manageable parameters that shows the possibility of real physical and geological phenomena and conditions of their origin. Modeling possibilities are quite limited because of numerous factors influence and the absence of adequate ranging.

Prognostication of natural and anthropogenic factors on different territories (not only mining works) is becoming rather successful while using methods of solving practical tasks with many criteria (for example the method of hierarchy analysis) [8].

Prognostication of dangerous physical and geological factors on the territory of open-pit mining exploitation is realized on approximate factual material and it requires correction during the construction and open-pit exploitation [2]. It appears sometimes that very important project data having some drawbacks are absent in obtained geological material. Among those drawbacks are incompleteness and imperfection of composition study, technological, physical and mechanical rock properties and covering rocks, chemical composition of additional rocks and interlayers, engineering-geological and hydro-geological exploitation conditions, insufficient geological, hydro-geological and engineering-geological study of the deposit nearby territory [2].

Drawbacks found in prognostication calculation of the territory state during exploitation cause the cost increase of ready-made products, review of projects and mining works, break the manufacturing process in open-pit, cause idle time and damage of mining equipment.

Prognostication of development, influence and spread of dangerous physical and geological processes after stopping the exploitation of open-pit works on the territory damaged by mining exploitation is also important [5].

While exploiting an open-pit it is important to follow the widely known principle: it is cheaper and much easier to prevent these or those processes and phenomena than to fight with their consequences [4].

Data obtained in the course of constant instrumental and visual observations can help to conclude about the danger of one or another

process taking place on the territory of open-pit mining.

The analysis of existing prognostication methods shows that while prognosticating physical and geological factors they should have a method combining low-cost, low laboriousness and use of available information and specialist experience in full. It is necessary to combine these prognosticating methods for increasing of prognostication probability.

Taken as a base four main prognostication methods we shall analyse everyone about prognostication of physical and geological factors:

- 1) the method of analogy can be used only on some territories of the deposit with the same mining-geological conditions. The method of analogy can not give the possibility to express the degree of physical and geological factors influence. It does not answer the question how the physical and geological influence factors will change when the parameters influencing their origin change (slope angle change, geological rock structure and so on) and when analogical data that could be used in prognostication are absent. The method of analogy is not very flexible and can not be widely used.
- 2) the method of evaluation of existing factors gives the possibility to get some model of physical and geological processes. While choosing factors of influence of possible variants, the person trying to make prognostication takes into account the degree of influence of some parameters on his own. More often one specialist is not able to imagine all influence factors and may not know about some of them. So the list suggested by that specialist is not always complete and contains only the factors that are really important to his mind. Naturally the more factors will be studied, the more accurate will be prognostication, but artificial increasing of the factors list will pile up and it will make prognostication more difficult. Using the experience of many specialists in different fields can help eliminate this drawback.
- 3) the analytical method meets the requirements of prognostication when the number of parameters that can be expressed mathematically is fixed. One should not forget that the majority of factors influencing physical and geological phenomena are natural, so it is very difficult to express them in figures in some cases. For example, to

prognosticate the inundation of some area they must know the speed of filtration through rock and the amount of precipitation (or another source of water). The magnitude of filtration can be calculated with some accuracy but it is difficult to forecast the amount of precipitation (long rainfall or periods of drought are not included in average annual or monthly data) [6]. They must not forget that surface drainage character of the territory and adjacent territories which could not be calculated, influences inundation. Many factors: territory geological structure, variety of plants, territory slope angle and others influence the surface drainage character. So while prognosticating besides mathematical parameters it must be taken into account the magnitudes which could not be expressed in figures that is why the analytical method could not be always used.

- 4) the method of modeling in prognostication of physical and geological factors allows to define the causes of origin and the mechanism of influence.

All prognostication methods mentioned above have some advantages and disadvantages but using only one of them will not bring good results.

While prognosticating dangerous physical and geological factors it should be applied methods of system analysis of poorly structured systems, the evaluation of information volume, establish connection with components, search possible assessment of some parameters, transfer the problem in the structured category where mathematical approach can be applied.

There are connections between system components the value and the degree of influence of each one on its existence and functioning within the limits of system analysis. We have defined the main aspects that should be taken into account when studying such a complex system as an ore mining and processing enterprise, in particular open-pit mining works, namely while forming open-pit mining works territory projects and prognosticating their condition it is necessary to analyze and take into account a complex system of interdependent parameters and components: available resources, natural and technical conditions, limiting factors; the difficulty in open-pit territory state prognostication is that besides engineering objects with the ultimate number of parameters (length, height, width, slope, etc) some processes that could not be expressed in figures take place; to connect modeled engineering system component with poorly structured natural

components it is necessary to use such a mathematical mechanism that help express the priority of some or another process; using a mathematical model it is possible to imagine open-pit mining works territory with many controlled or uncontrolled elements as a whole unit, having received an adequate territory model with elements grouped in sharp hierarchy interdependence.

It should be noted that calculation of natural process influence while forming open-pit mining works territory they should know both the origin cause and the degree of influence in figures.

To evaluate the complexity of a deposit while building and exploiting open-pit mines it is necessary to analyze the influence of different groups of factors, what defines the conditions of open-pit mine exploitation, what is the matter of research of different specialists (geologists, mine-surveyors).

While using a system approach in creating a model of land use territory natural and anthropogenic factors are found, the forms are studied, evaluation of their influence on mining works technology is given, the recommendations on reducing dangerous influence of engineering-geological factors are given after careful study. An optimized hierarchy model of the open-pit mine exploitation territory will be the result of using a system approach. An effective modern way of solving this problem is the method of hierarchy analysis when using theoretical approach and practical results of an open-pit mine exploitation probable data of dangerous processes could be calculated. Applying the method of hierarchy analysis for prognostication Poltavsky ore mining and processing enterprise land using allowed to find out the ways of eliminating the negative effects during exploitation.

#### **Conclusion**

Some recommendations about territory exploitation prognostication based on the analysis of dangerous physical and geological factors on the territory of open-pit mine exploitation are given.

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Problems of prognostication of dangerous physical and geological factors in open mining sites are analyzed in the paper. The method of hierarchy analyzing is proposed for their evaluation.