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Analysis Of Methods And Means Of Bump Hazard Prediction

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ABSTRACT

The article analyzes the methods and tools for predicting the impact hazard in the conditions of underground mining of gold deposits. To assess the stress state of a rock mass, the core disk method is proposed as a basic method. The degree and categories of impact hazard of sections of the rock mass are estimated. Due to the impossibility of solving many problems by geomechanical only field studies.

The reliable efficiency of the use of the finite element method and the boundary element method in predicting the impact hazard of the field sites a priori is shown.

KEYWORDS

Rock pressure, geodynamics, geodynamics, impact hazard, geomechanical state, rock displacement, stress-strain state, collapse, tectonics

INTRODUCTION

The difficulties, associated with the research of rock pressure, caused by the fact that the results of the research in a mine or in a certain mine are very specific to the location, where the research is carried out, which means that the results usually do not have a trend to be generalized and sometimes may be contrary to the results of other studies.

In order to study the rock pressure, monitoring and measuring must be provided in real underground conditions, also in the laboratory. These observations usually are provided in very different conditions, on different species and at different depths. As a result, the theory can be accepted, which is applicable to both the coal mines as well as to the development of salt, metal ores and others.

Also the problem of creating a safe environment for developers (miners), where rock formations were exposed to shock waves, possible through an integrated consideration of all the issues from the field of exploration, type of mining, methods of preparations and development schemes, transportation, and with the organization of labour at the facility.

MATERIALS AND METHODS

Naturally, the decision of such questions requires a special approach to the setup of research. It is essential that the study can provide exploration of rock pressure and displacement of rocks within the mining area as a whole and in its individual parts, also to develop an idea of the size and boundaries of the rock pressure and pressure discharge zones. In addition clear understanding of special stress concentration zones, formation of shock sources and shocks as a result of

mining must be developed. Another task is to develop technics to identify the shock hazards and forecasting of rock bursts at the places of their occurrence.

The successful solution of this task is possible with the right combination of scientific research at the mine, laboratory and mine conditions. These experiments must be repeated several times on real mountain conditions in order to develop recommendations and conclusions, based on scientific research and tests. Experiments on real mountain condition, in turn, must be accompanied by appropriate scientific research, designed to evaluate the effectiveness of the implemented activities and to give impetus to their further improvement.

At present, extensive experience of creation and application of methods and tools are collected for evaluating the stress-strain state of rock masses. Developed methods of deformation measurements of the total values of the stresses acting in the rock mass (methods of decreasing stress and fracturing), based on the recording of mechanical shiftings and deformations in the process of changes of stressed condition of rock masses [1, 2, 3]. These instrumental methods, having a number of advantages, have several disadvantages, caused by their labour intensity, by necessity to determine the elastic characteristics of rocks on the place of mining, as well as the complexity of extrapolation of measurements results to the large volumes of rock. In addition to pressure decreasing methods used instrumental methods of stress changes and deformations, which includes methods of hole deformometers, hydraulic insertions,

photoelastic sensors, coatings, deep and contoured frames and others. [4].

Based on the experience of working in bump hazardous deposits has been found out that the great effect is achieved by the use of a multi-tiered system in which regional methods and technical means are added to local methods.

By the degree of bump hazard portions of the array are divided into three categories [5]:

Category I - area with increased risk for the appearance of mining impact, visual signs - mountain bursts and micro-blows. These mining zones are subject to mandatory reducing stress and bringing them into a safe state from possible bursts, also must be taken additional safety measures of people employed in these studies;

Category II - areas dangerous for the occurrence of the mining impact. Visual symptoms - tremors, spalling, intensive weir formation. The mining zone should be brought into a safe from bump hazard state.

Category III - an area that does not pose a bump hazard from the impact of mining, can be operated without additional safety measurements.

The degree of bump hazard area is established by at least two methods and the most dangerous category [5]. Known methods of bump hazard assessment: a method for estimating core diskings at the base and the second method: electric, acoustic, electrometric, Poisson indentation in to stop back etc.

The study of rock pressure began with direct observation in the mines; this method is limited, as can be observed not the developing pressure, but only its after impact effect on the rock. Therefore, we can approach an understanding of the effects of the pressure based on these visible effects.

Research of rock pressure is conducted using the following methods:

Generalization of mining experience in order to conduct mining operations on arrays with possible mountain bump hazards. All cases of rock bursts must be analyzed and classified in order to find measures to prevent rock bursts. On the routes of planned developments constitute the basic types of structural elements in descending proportionate order in the overall structure of the orefield. By compiling a catalogue of rock bursts their frequency occurrence can be calculated in the areas outside of the zones of influence of each factor. Evaluation of the importance of structural factors is carried out using random balancing method using a scatter diagram of statistical data;

- Measurement of rock and ore deformation can be observed by measuring stations in mines and wells. Developed and widely used method of deep frames allows carrying out measurements in the depths of rocks.
- Testing of mechanical properties of rocks and ores in the conditions of uniaxial compression with the measurement of their strength and elasticity;
- Testing mechanical properties of the rock mass conditions in the field, based on an assessment of the fragility of the state of stress in the rocks with different

mechanical properties and the degree of tension have different resistance to the introduction of a rigid stamp.

- Studying conditions of rock transition to extreme conditions and their brittle fracture. The tendency of rocks to brittle fracture during over-limited characteristics. It was found out that the ratio of E/M can serve as an estimate of rock bump hazard (E - modulus of elasticity of the enclosing rocks, M - recession module degrading material, which characterizes the rate of the absolute value of tension decreases with an increase in the absolute value of the absolute distortion at the descending area).
- During micro seismic zoning of rock bursts and studying of their seismic energy. This method is based on the dependence of the velocity of propagation of elastic waves in the rocks on the magnitude of rock pressure. The greater the load, the greater the velocity of seismic waves in the elastic range, and vice versa.
- Seismic acoustic method of studying the stress state is based on the wave of indignation caused by the dynamic redistribution of the local stresses due to changes in the crystal structure or the movements of micro-and macroscopic defects. Acoustic emission accompanies the entire process of deformation of the material starting at the stage of displacement and exposing the dislocation on the surface up to the total destruction of the object;

A method of fracture analysis. A system of cracks, exposed on the perpendicular surface to the stretch of the ore body, is an indication of the bump hazard of the ore. When the direction of mining follows the running down

cracks in the array tension level is high, and vice versa. In the first case, the plane of maximum shear stress is normal to the plane of the fracture. Bump hazard increases when running down transverse cracks are exposed; the plane of maximum shear stress coincides with the plane of the crack. Bump hazard is reduced.

- Discharging method for determining stress level is based on the use of the characteristics of the elastic restoring of the deformation of elements by the way of artificial destruction of bond with the main array.

Method of estimation of stresses in the rock mass by the deformation of the contour of holes, which can be determined by the hydro deformation measuring device. It is used to quantify the stress level of rock, which is different from the method of discharge based on the measurement of sensors and calculation of stress level. The basics of the method are to calculate the stress level of the measured integral radial deformations of the good contour as in the stress discharge method or during long observation of the stress-strain state of the array.

- Electrical measuring method of the changes of stress level is based on the dependence of the electrical resistance of rocks from their stress level. When the stress level increases the electrical resistance of most rocks during elastic deformation decreases and vice versa.
- Modelling of the conditions and processes of formation of discharge pressure zones in the rock mass and withholding pressure using suitable materials, volts mass and optically active materials.

These methods can be used alone or in a combination of two or three or more at a time during tests and researches, depending on the complexity of the issues and the nature of their

connection with other matters and phenomena.

Table 1. A comprehensive method for studying rock bursts

Objectives	Methods
Terms and character of manifestation of rock bursts	Conditions of appearance and parameters of rock bursts. Connection of rock bursts with manufacturing processes. Classification of rock bursts.
Conditions of formation and size of the hazard source	Measuring the impact of stress and strain in the core zone. Seismic- acoustic observation. Method of decreasing tension. Deep benchmarks. Modelling.
The mechanism and energy of rockburst	studding conditions of transition of the rock mass to an extreme state. Research of the Laws of brittle fracture of rocks in the laboratory and on the field. Micro-seismic studies. Simulation of rock bursts.
The effectiveness of the measures to combat the bursts	Micro-seismic, seismic acoustic and strain monitoring. Field tests of the mechanical properties of the formation.
Protective layers	Measuring deformation of the rock mass. Modelling of equivalent materials, valets-weight and optically active materials. Methods for calculating the limits and the degree of protection.
Prediction of rock bursts	Full-scale testing of mechanical properties of the array. Micro-seismic, tilt-metric and seismic acoustic research. Measurement rock deformation.
Using rock pressure energy to reduce a mining zone	Studying the behaviour of rock mass at recess sinking mines. Mining and experimental work. Modelling.
The study of similarities and differences of rock bursts and sudden rock falls	Testing of mechanical properties of the array on the field, the analysis of materials in the case of rock bursts and rockfalls in different mountainous geological conditions.

The results of a comprehensive study of the stress-strain state of rock mass, showing the compatibility of the measured tensions with tensions, defined by tectonic methods [6] indicate that the geological structures, including tectonic faults, provide information about modern stress fields in the Earth crust.

Improving the efficiency and reliability of the forecast as a bump hazard fields, also regional prediction in the process of development can

give knowledge about block structure of the rock mass in the area of the field and the interaction of the blocks and as a result of this - the stress state of the undisturbed array in each block.

Using the advantages of geological-structural methods of rock mass stress evaluation in solving many problems of the mining practice is strongly associated with the development of geodynamic zoning of deposits (GZD) in recent

years, unifying complex of geomorphology and tectonic methods [7]. The tectonic-physical methods, which are the foundation of the GZD method, do not allow to obtain quantitative values of operating tensions in the array. Planning of high rate mining in bump hazard conditions is often necessary and sufficient to use relative characteristics of stress state, compared with hazards of occurrence of dynamic events or difficulties in maintaining of extraction zones in mountains [8].

Given the complexity of the challenges we have to deal with, none of the above methods can independently address the issue of the behaviour of rocks; all of these methods should be combined to achieve this goal. It is impossible to develop any suggestions before the results, obtained by different methods, do not confirm each other, and will not correspond to the real facts, which are recorded during the direct observation in the mine. The general conclusion can be made when the proper explanation of rock pressure will be observed in all types of developments, and all provided observations will be comparable.

All research methods are based on the fact that the phenomena occurring in rocks, controlled by the weight of the rocks above the mining cavity.

Analyzing the discussed methods of measurement and evaluation of the state of stress and methods of bump hazard control should be noted that in order to solve many problems of mining geomechanics it must not be limited to results of research in nature. It is explained by the following circumstances:

- First, the empirical relationships established on the basis of these studies valid only for a certain range of conditions and factors in which they were received, and when a change of conditions occur, then needed studies must be repeated;
- Second, forecasting ahead of time characters and parameters of geo-mechanical processes is not possible due to insufficiency of the required information and empirical dependency, necessary because of the high labour intensity and longtime of field research.
- Third, field studies do not allow to provide the most important practical knowledge about extreme conditions of the objects, as this condition can lead to unacceptable violations of mining safety, or may cause economic loss. [9].

These shortcomings are eliminated by a combination of field studies with physical and mathematical modelling of situation. The results of field studies serve as boundary conditions at the modelling of geo-mechanical processes, and vice versa. Important behavioural tendencies of rock mass, identified during modelling, allow better plan full-scale field studies, specify the combination of the methods to be used, and the volume of necessary measurements.

Lately, various digital methods are being used in order to study the impacts of mining and theoretical solution of various geomechanical problems, among them outstanding methods are the finite elements method (FEM) and boundary element method (BEM). Especially these methods are widely used for the modelling of tensions of techno-genetic fields due to the influence of mining operations, as well as calculations of the stability of various

elements of mining developments and mining cavities [9].

CONCLUSION

Summarizing the above mentioned, it is possible to make the following conclusions:

- Up to the present, a large number of methods and means of field studies of geo-mechanical state of the array are developed, the area of effective application of which is determined by the particular geo-mechanical and mining-technical situation;
- For reliable prediction of dangerous dynamic rock pressure necessary to apply complex of regional and local methods of geo-mechanical monitoring and control of bump hazard in conjunction with the methods and conditions of modelling of the conditions and processes that cause rock bursts;
- Full-scale practical and theoretical methods have to be adapted as close as possible to geological and mining-technical conditions of development of a particular field and provide continuous monitoring of geo-mechanical and geodynamic processes, occurring in the rock mass.

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