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Research Article

ASSESSMENT OF TENSION AND IMPACT HAZARD FOR UNDERGROUND MINING AND A SET OF DATA BY ACOUSTIC EMISSION WITH THE SB-32 DEVICE

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ABSTRACT

The article examines the issues of forecasting the hazard category of rocks based on the assessment of the stress state of the massif in specific conditions and is aimed at identifying areas of the gold ore deposit mountain range that are dangerous due to the stress state of the rock mass, in order to take measures in advance to prevent them. The method of acoustic emission of the forecasting and the methodology of measurements are substantiated.

KEYWORDS

Mountain massif, acoustic emission, impact hazard, tectonic disturbances, stress, rock, hole, forecast, impulse, deformation, amplitude, fracturing, softening.

INTRODUCTION

In world practice, the forecast of the hazard category for a mountain impact and a stressed state of a mineral deposit during underground mining is one of the priority directions. Based on the assessment of the

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stressed state of the massif in specific conditions and the identification of areas that are dangerous for the stressed state of the rock mass, taking measures to prevent them, choosing the measuring site, preparing the measuring site, measures during the measurement and calculating the parameters of the acoustic emission process. The occurrence and propagation of pulsed elastic vibrations (acoustic waves) during deformations and the stressed state of the massif under specific conditions is aimed at identifying areas that are dangerous due to the stressed state of the rock mass, in order to take measures in advance to prevent them. It is one of the main tasks of mining production.

MATERIALS AND METHODS

For the study, the SP-32 M (SAPPHIRE) device was adopted, which makes it possible to apply methods of local prediction on the parameters of acoustic emission, the impact hazard of minefields and the determination of the parameters of the main stresses in the rock mass.

THE MAIN PART

The forecast of the category of impact hazard of rocks is made based on an assessment of the stressed state of the massif in specific conditions and is aimed at identifying areas that are dangerous for mountain impacts, in order to take measures in advance to prevent them.

Acoustic emission (AE) is the phenomenon of the occurrence and propagation of pulsed elastic vibrations (acoustic waves) during deformations and stress state of the material.

The principal possibility of determining the category of the stressed state of the massif by the parameters of the AE lies in the close connection of the AE with the process of extreme deformation of rocks in the mountain massif. The recording with the help of instruments of pulses resulting from micro-destructions when the rock reaches the ultimate strength allows us to assess the level of loads and the nature of deformation.

First, the presence of AE pulses indicates that the loads in the rock mass exceed the limit. The activity of the AE process (N) is the number of events per unit of time, it depends on the rate of irreversible deformation of rocks. With an increase in the deformation rate, the AE activity increases proportionally. At the impact of hazardous areas, the level of AE activity has a high value. However, a high level of AE activity is also observed in non-hazardous conditions, for example, in small-sized block. In these cases, irreversible deformation of rocks can occur at high speed, but at the level of residual strength, when the rocks are no longer capable of accumulating large reserves of elastic energy and destruction in the form of a rock impact.

In this regard, the activity of AE can only be judged on the fulfillment of the first condition of a mountain impact - the deformation of rocks beyond the limit of strength. A high rate of irreversible deformation is a necessary condition, but not sufficient to classify a section of the rock mass as dangerous for mountain impacts. The violent nature of destruction (mountain impact) is possible when the influx of energy from the external environment (surrounding rocks) exceeds its absorption in the area of extreme deformation. The energy and amplitude of the AE pulses accompanying these processes increase accordingly.

In other words, the characteristic of the unstable state of a section of the rock mass is the ratio between the AE pulses of different energy classes - the energy or amplitude distribution. With an increase in the impact

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hazard, the proportion of strong AE pulses increases. Reflects the ratio between AE pulses of different energy classes, the indicator of the amplitude distribution of pulses (B), the value of which is a characteristic of the unstable state of a section of the rock mass.

Selection of the measurement location for a data set on acoustic emission parameters. For a set of data on acoustic emission parameters, measurements with the SB-32 device are made in the workings during the hole break in the interval from 1 to 5 hours after blasting. The measurement form indicates the exact time elapsed after the blasting.

First of all, measurements should be carried out in areas with external signs of dynamic manifestations of mountain pressure (intense hardening, peeling, shot).

If there are no sites with external signs in the mine workings at the time of research, measurements are made at the sites of identified man-made and natural (geological) stress concentrators:

- tectonic disturbances; - contacts of rocks with various physical and mechanical properties; - in case of failure of workings, starting from the approach to the failure at a distance of 5h-7 m; - when approaching a single workings to the cleaning works (that is, in the zone of reference pressure from the cleaning excavation) starting from a distance of 10 m; - workings in the zone of influence of a mass explosion.

To install the sensor, holes with a diameter of 39-45 mm are heated at a slight angle to the horizon so that water flows out of them and does not remain in the hole (5°-15°). It is necessary to avoid contact of the device with water, including the sensor and the wire, make sure that the wire is not in water, and the sensor is not wet in the hole, in case the sensor gets wet in the hole, it must be completely dried before reuse.

The near-contour part of the workings is often peeled off (butyt), the marginal part of the massif is characterized by increased fracturing, softening of rocks, this is due to the influence of drilling and blasting operations and the loading of rock pressure along the contour of the workings. Depending on the physical and mechanical properties of rocks, this zone can reach from 0.5 to 0.6 m. It is recommended to install the sensor at a depth of 0.7 to 1.5 meters to cross the fracture zone. It is desirable to place the holes perpendicular to the wall of the mine. If the holes are located at an angle to the excavation, then it is necessary to increase the depth of the sensor installation. Figure 1 shows the holes with a length of one (bold line) and one and a half (dotted line) meters.

In the case of a tectonic disturbance, measurements should be carried out when the preparatory or treatment work is approaching at a distance of 10, 7, 5, 3 m and at its intersection. At the same time, the highest tension occurs when the production crosses the tectonic disturbance at an acute angle. When a tectonic disturbance enters the treatment excavation zone, its influence can spread over long distances.

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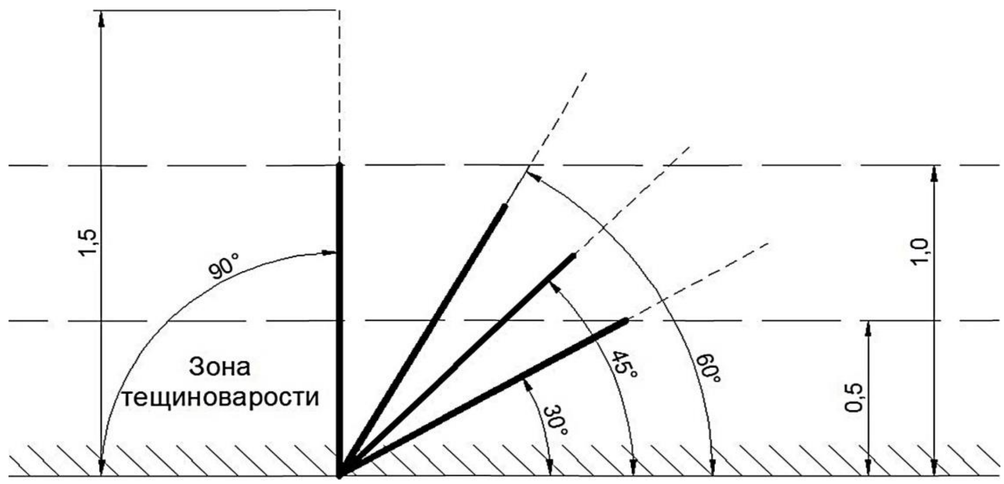

Fig. 1. Layout of measuring holes with a length of 1 and 1.5 m at an angle relative to the wall of the mine

If there is a geological uncertainty at the measuring site (rock contacts, tectonic faults, sliding mirrors), it is necessary to lay holes in both wings relative to the violation at a distance of at least a meter from the seam. The zone of influence of contacts of different strength rocks can be estimated by the measurements of AE when passing the workings through this contact. Measurements are recommended to be carried out directly at the contact in a more durable variety of rocks.

The activity of the AE process is significantly influenced by blasting operations. AE activity at the time of blasting increases dramatically. In the future, its attenuation occurs according to the exponential law. Therefore, measurements of AE parameters are carried out in the interval starting after 1 hour and no later than 5 hours after blasting operations in the face. However, the accepted measurement interval must be confirmed for the conditions of a particular mine during the research, if it is possible to drill measuring holes after blasting, it is recommended to place them in the sides of the mine, or in the interfaces and in the center of the face Fig. 2.

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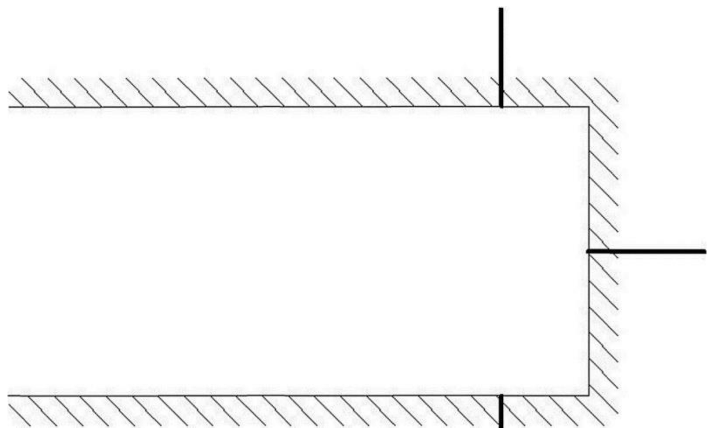

Fig. 2 Layout of measuring holes during drilling after blasting

In the absence of the possibility of drilling after blasting, the measuring holes are drilled together with the holes of the downhole cycle of the BVR passport. In the corners of the development of the direction of drilling holes - at an angle of 60 ° or more to the direction of the face movement and along the face of the development, the length of which will exceed the penetration cycle by 0.7-1.5 m Fig. 3.

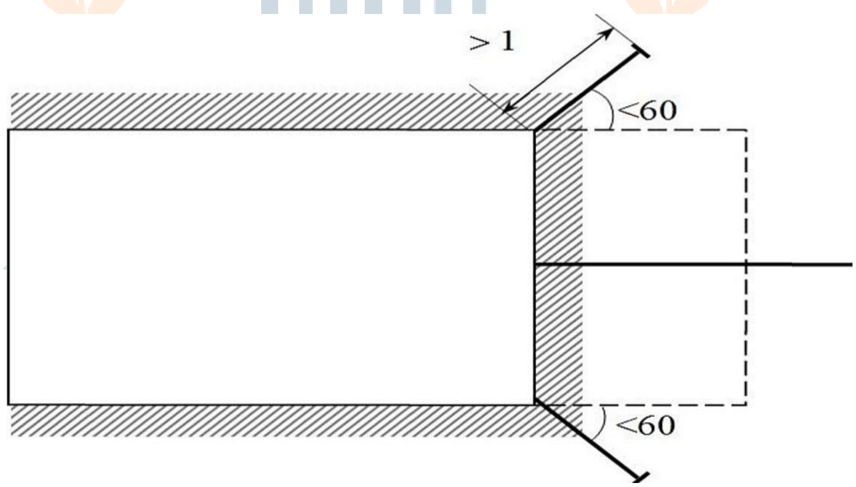

Fig. 3. The scheme of drilling measuring holes before blasting.

The algorithm of measurement. Before starting the measurement, make sure of the safety of the measuring site (the pins are removed and there is no peeling of the walls of the workings at the measuring site), it is necessary to clean the hole from the sludge in order to prevent the sensor from getting stuck and clogging it.

To avoid turning the sensor in the hole during installation, you should initially turn the rod 1/2 full turn relative to the extreme position when twisting. The sensor is inserted into the hole with a rod to a depth of 0.7 to 1.5 meters.

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By gently rotating the rod clockwise, we press the piezoceramic element of the sensor against the wall of the hole. We check the quality of the sensor installation by gentle jerks-pulling out the rod. After installing the sensor, the cable is connected and the device is powered on.

After installing the sensor, we check the quality of the acoustic contact with the array. By exciting acoustic pulses with a hammer along the wall of the mine, sequentially at a distance of 1, 2 and 3 m from the sensor. With the correct installation of the sensor (good acoustic contact), the device must register pulses from impacts on the wall of the mine at a distance of at least 3 m, which indicates a high-quality installation of the sensor.

If good contact with the array is not achieved when the sensor is split (the piezoceramic element exits the sensor housing), the spring should be loosened and the procedure for installing the sensor in the hole should be repeated by shifting the sensor in the hole by 2-3 cm from its previous place.

In the case of a broken hole or a large diameter hole, when it is not possible to achieve good contact with the array, an overlay made specifically for this device should be fixed on the sensor. So that the sensor is sure to "tap" at a distance of at least 3 m. Check the quality of the sensor installation at each measurement (at a distance of 1, 2 and 3 m from the installed sensor) and measuring distances to determine the position of the hole in the plan.

Activities carried out during the measurement. When connecting the cable from the sensor to the device, the power of the device is automatically turned on. The name of the device "SB - 32" is displayed on the display. When the "START" key is pressed, the device switches to measurement mode. During the measurement, the display shows the contents of the amplitude channels and the current measurement time. During the measurement, do not touch the wire running from the device to the sensor.

During the measurement process, the operator records in the measurement form the readings of the number of pulses in the channels every minute. If any external signs of dynamic manifestations occur during the measurement process: splitting of the pin from the array, clicks, and deep tremors - they should be noted in the form (column note) indicating the time of manifestation. Draw a diagram of the location of the measuring holes and workings where the measurement was made, with reference to the geological plan.

During the measurement, it is necessary to suspend drilling; the movement of machines, the hiss of air on drilling machines, the movement of people in the development, the cable running from the sensor to the device should not be touched. Intervals with interference (noted in the note) are excluded from calculations. When the measurements are completed, the device is turned off by disconnecting the sensor connector.

Calculation of acoustic emission process parameters. AE signals are a consequence of processes occurring during irreversible deformation and destruction of rocks. Due to the discreteness and random nature of these processes, AE signals are also random. Therefore, the analysis of AE signals and the determination of the main parameters of the AE process is carried out based on the theory of random processes and the apparatus of mathematical statistics.

The main parameters of the AE process include the average activity (Na1 - the number of pulses per 15

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second interval) and the pulse amplitude distribution index (B).

To calculate the parameters, the measurement results are used, which are displayed on the indicator of the SB-32 device:

- The number of pulses (a1 exceeding the first amplitude level for the entire registration period is displayed first on the indicator;
- The second shows the number of pulses (a2) exceeding the second amplitude level for the entire registration period;
- The third shows the duration of the measurement (T) in minutes.

The average AE activity (Na1) is calculated using the following formula:

$$Na_1 = \frac{a_1}{T*4} \quad \text{pulses in 15 seconds.}$$

The duration of measurements (the entire period of registration of T) should be 20 minutes. The number of 15-second intervals in the absence of interference is 80

The indicator of the amplitude distribution of AE (b) is calculated by the formula:

$$b = \frac{a_1}{a_2} \qquad (2)$$

CONCLUSION

Thus, the category of the stressed state of a section of a rock mass is sufficiently fully determined by two parameters of the process of natural AE — activity (N) and an indicator of the amplitude distribution of pulses (b), which makes it possible to predict the impact hazard of mine fields and determine the parameters of the main stresses in the rock mass.

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