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Bases of the Explosion Theory of Industrial Explosives and Determination of the Radius of Mine Massage Cracking Zones in the Explosion of Focused Extended Charges

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ABSTRACT: This article discusses the dependences of the maximum radius of the zones of cracking in the depth of the massif on the radius of the charge, explosion conditions, acoustic rigidity of the rock mass, Poisson's ratio of rocks and the magnitude of the radial compressive stresses.

KEY WORDS: maximum radius of cracking zones, charge radius, explosion conditions, acoustic rigidity of rock mass, Poisson's ratio, values of radial compressive stresses.

I.INTRODUCTION

In modern conditions, explosions of industrial explosives during the development of vein deposits of non-ferrous metals are the most optimal way to destroy a rock mass.

II. SIGNIFICANCE OF THE SYSTEM

A significant contribution to the development and improvement of methods of rock destruction by explosion during the extraction of non-ferrous metal ores was made by such scientists as Agoshkov M.I., Galchenko Yu.P., Zaitsev R.P., Rafienko D.I. other. In their works, the laws of explosive detonation, the effect of the explosion energy of explosive charges on a rock are sufficiently deeply covered, and a model of rock destruction by a concentrated explosive charge was created.

This model includes three main zones of rock deformation and destruction:
1. The zone of fine crushing near the charge;
2. The zone of radial cracking;
3. The zone of elastic deformation by a seismic wave.

Subsequently, these provisions were clarified and supplemented.

III. LITERATURE SURVEY

In the mining industry, blasting in most cases uses elongated charges, the destruction mechanism of which is somewhat different from the action of an explosion of concentrated charges.

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During the production of mass explosions, it was found that the rock mass is not only destroyed, but also a change in their physical-mechanical and mining-technological properties [1-5], which leads, in particular, to a weakening of rock strength in the depth of the massif [5].

IV. METHODOLOGY

Experiments on samples of rocks and ores [6] showed that after a single explosive loading, the strength of the samples of limestone and magnetite ore was 38.6 and 40.8% of the initial, respectively.

Studies [7] conducted on granites also showed that explosive loads lead to a decrease in the strength of granites and an increase in their porosity and water absorption.

In later studies [8-10], various options were considered to increase the use of the directed influence of explosion energy on the internal structure of rocks. It is established that due to changes in the intensity of explosive loading and the choice of the corresponding direction of the explosion, the microstructure of the ore and its strength characteristics change. It was established [10] that the level of decrease in the strength of rock samples is 23-57% of the initial strength.

To describe the process of destruction of a rock mass by detonation products, we consider a diagram of the hydrodynamic process of crack formation of a rock mass created by an explosion of an camouflage elongated explosive charge.

To determine the fracture value of the reservoir, we will establish the radius of crack formation in the depth of the massif, according to the methodology described in [11]. Moreover, we assume that the radius of crack formation of the massif is determined by the action of the explosion of a camouflage cylindrical explosive charge with a diameter equal to d_o.

According to the laws of elasticity theory, the radius of crack formation of a rock mass depends on the magnitude of the tangential tensile stresses arising in the rock mass, which is determined by the following empirical formula:

$$\sigma_{tensile} = \frac{\mu \cdot \sigma_{compression}}{(1-\mu)} \qquad (1)$$

where $\sigma_{compression}$-radial compressive stress, MPa; μ - the Poisson's ratio.

The radial compressive stresses at the detonation wave front and the mass displacement velocity of the rock mass are related by the following relationship:

$$\sigma_{compression} = \frac{U \cdot \rho \cdot C_p}{g} \qquad (2)$$

where $\rho \cdot C_p$ - the acoustic rigidity of the rock mass, equal to 1.5×10^5 - 15×10^5 g cm / cm^3 s; g - acceleration of gravity (9.81 m / s^2).

The mass displacement rate of the reservoir is determined by the well-known formula of Academician M.A.Sadovsky:

$$U = A \cdot \left(\frac{\sqrt[3]{Q}}{R_{crack\ radius}}\right)^m \qquad (3)$$

where A is a coefficient depending on the conditions of the explosion, taken 200-250;
Q - mass of explosive charge, kg; $R_{crack\ radius}$ is the distance from the center of charge to the point in question, m; m is the energy absorption coefficient for camouflage cylindrical explosive charge, m = 2 [12].

Substituting the values $Q = 2\pi R_0^3$ in the equation, we have:

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$$U = 3.54\left(\frac{R_0}{R_{crack\ radius}}\right)^n \qquad (4)$$

Solving equation (3) with respect to R and setting the values U, $\sigma_{compression}$, we obtain the following empirical formula:

$$R_{crack radius} = R_0\sqrt{\frac{3.5A\rho C_p\mu}{\sigma_{tensile}(1-\mu)}} \qquad (5)$$

The maximum radius of the zones of cracking in the depths of the rock mass is finally determined from the condition$\sigma_{tensile} = |\sigma_{tensile}|$

$$R_{crack radius} = R_0\sqrt{\frac{3{,}5A\rho C_p\mu}{[\sigma_{tensile}]\cdot(1-\mu)}} \qquad (6)$$

V. EXPERIMENTAL RESULTS

As a result of studies of the dependence of the maximum radius of cracking zones on the radius of the charge, the conditions of the explosion, the acoustic rigidity of the rock mass, the Poisson's ratio of rocks and the magnitude of the radial compressive stresses, the following was established:

1. With increasing radius of the charge, the maximum radius of the cracking zone increases (Fig. 1).

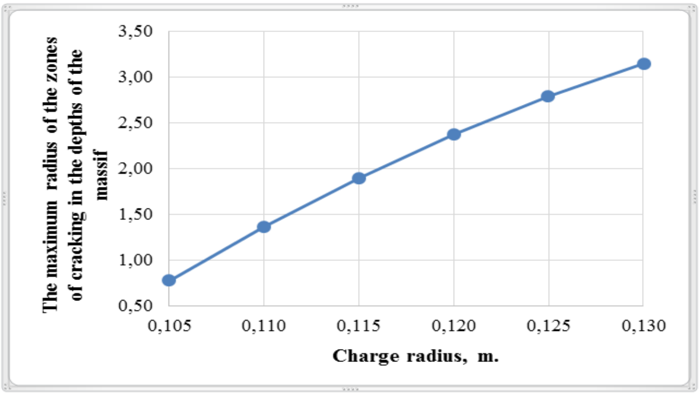

Fig. 1.

2. With an increase in the coefficient depending on the conditions of the explosion, the maximum radius of the cracking zone increases (Fig. 2).

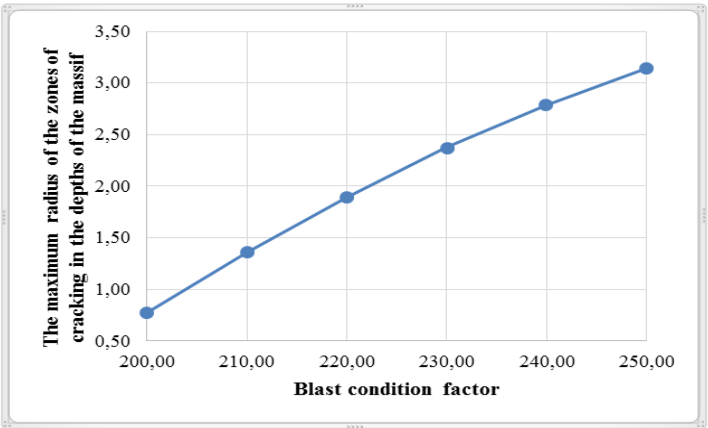

Fig. 2.

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3. With increasing acoustic stiffness of the massif, the maximum radius of the cracking zone increases (Fig. 3).

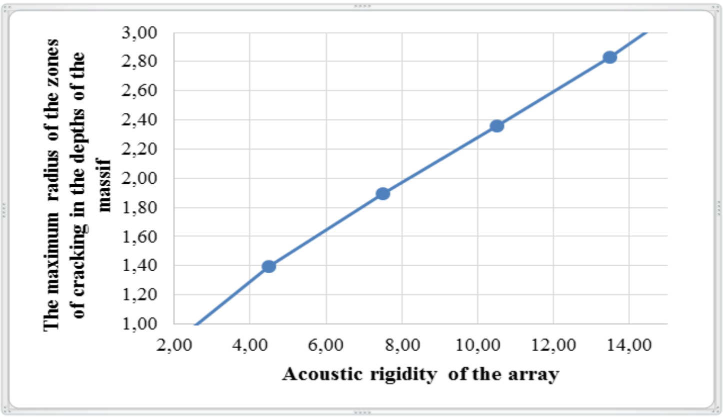

Fig. 3.

4. With increasing Poisson's ratio, the maximum radius of the cracking zone increases (Fig. 4).

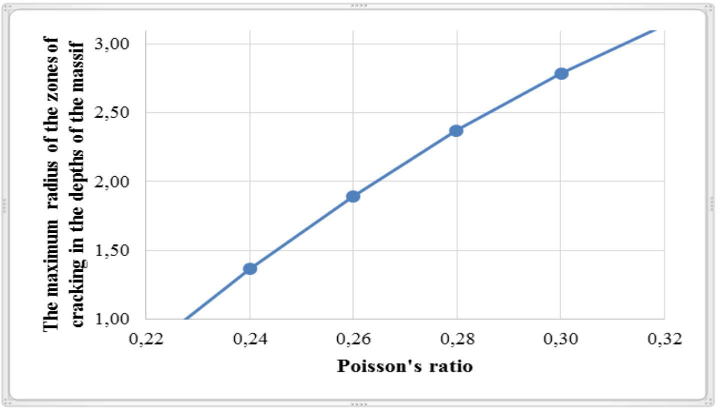

Fig. 4.

5. With an increase in the magnitude of the radial compressive stresses in the array, the maximum radius of the cracking zone increases (Fig. 5).

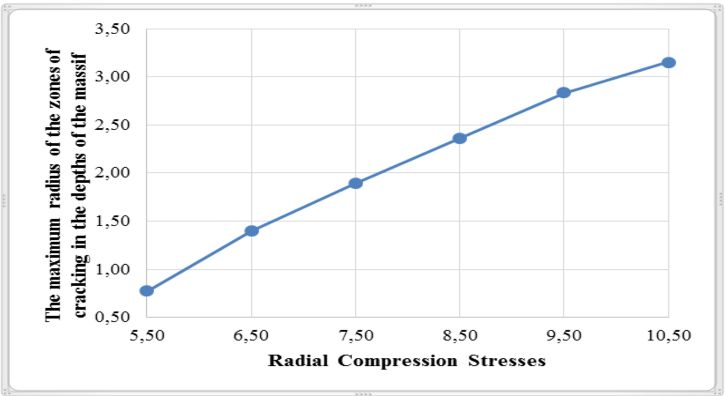

Fig. 5.

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VI. CONCLUSION

These graphs show that the maximum radius of the cracking zones in the interior of the massif depends on the radius of the charge, the conditions of the explosion, the acoustic rigidity of the rock mass, the Poisson's ratio of the rocks, and the magnitude of the radial compressive stresses.

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