INFLUENCE OF CERTAIN NATURAL GEOLOGICAL
AND MINING-TECHNOLOGY FACTORS ON THE STABILITY
OF A DEVELOPMENT WORKING

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As the depths of workings increase, there is a rapid change in the quantitative and qualitative aspects of rock pressure phenomena, leading to deformations and breakage of the supports and incurring extra expense on maintaining workings. Particularly large amounts are expended on maintaining development workings. It is enough to mention that, of the total work on repairs and resupporting of mine workings, about 70% falls to the share of haulage roads and ventilation headings.

Owing to the complexity of the deformation processes in rock around the working and to the presence of a large number of interrelated factors, analytical prediction of the stability of a development working does not always prove accurate. At present we use engineering methods of prediction, based on field observation data. The relations thus obtained can be successfully applied to different regions with identical or similar mining and geological conditions. In this case a theoretical solution serves as an auxiliary means of establishing quasi-analytical and empirical relations from field observation data on the stability of workings. However, this in no way detracts from the value of the theoretical solutions, but only indicates the necessity of further development of analytical methods as the most general means of predicting the stability of mine workings.

The most reliable data on the nature of rock pressure phenomena in workings can be obtained from combined field research, including studies of the load distribution on the supports as a function of time, research on the laws of rock movements in the solid rock around a working by means of contour and depth survey marks, and visual observations for the purpose of qualitative assessment of the state of the side rocks. Combined research with measurements of the load on the supports and depth survey marks is difficult and costly. In addition, the distribution curves thus obtained for the load on the supports indicate different pressures at adjacent points on the arc and corresponding points on adjacent arcs. This is apparently due to the stochastic nature of the variation in contact conditions between the supports and the rocks, to changes in the properties of the rocks, to the mechanical characteristics of the support, etc. The number of such investigations must therefore be limited.

Sufficient information on the stability of a working can be obtained by processing the results of measurements of movements of the support and in the solid rock around the working with the aid of contour datum marks.

In 1964-1967, to assess the stability of workings in pits of the "Luganskugol" combine, we made visual and instrumental observations on the behavior of the country rocks in the workings. These observations were made in development workings in pits of the "Kadievugol", "Lisichanskugol", "Pervomaiskugol", "Kommunarskugol", and "Kirovugol" trusts. This region is distinguished by complex geological conditions of the seams, which make it possible to trace the influence of various geological factors on the stabilities of the workings. The angles of dip of the seams vary over a wide range, from flat to steeply-dipping; these changes are observed within a single mine take. The region abounds in large and small disjunctive and plicative faults, which make drivahe and maintenance of the workings difficult. The depths of the workings vary between 400 and 900 m.

The stabilities of the mine workings depend on many factors, which act simultaneously, and it is not always possible to distinguish the effects of any one of them. To distinguish the influence of a single factor, we therefore chose workings in which the influence of the other factors on the stability had been eliminated or minimized.
To predict the stability of development workings, it was of interest to establish the law of movement of the peripheries (contours) of the workings in relation to time. This relation was found from the results of instrumental observations on rock movements in rock headings not subject to the influence of extraction operations. The law of variation of the relative displacement \( \varepsilon_t \) of the periphery of the working can be conveniently expressed in dimensionless parameters as follows:

\[ \varepsilon_t = \frac{d - U_t}{d} = \varphi(t), \]  

where \( d \) is the cross-sectional dimension (width or height) of the working in millimeters, \( U_t \) is the displacement of the periphery in time \( t \), in millimeters, and \( t \) is the time in months.

Figure 1 is a plot of the logarithms of the relative displacements of the peripheries of preparatory workings versus time.

Data from field observations were processed statistically [1]. The form of the empirical law was determined by the method in [2]. As a result we got a formula for the time dependence of the displacement of the periphery:

\[ \ln \varepsilon_t = -\beta N \sqrt{t}, \]  

where \( \beta \) is a constant coefficient equal to 0.054.

Substituting the value of \( \varepsilon_t \) from (1) and transforming the expression, we get

\[ U_t = d \left( 1 - e^{-\beta N \sqrt{t}} \right), \]  

where \( N \) is an unknown coefficient which depends on the depth of the working, the strength of the rocks, the type of support, the number and compliance of the supports, and the cross-sectional dimensions of the working.

Using (3), we can determine the convergence of the roof, floor, and sides of a working, on condition that the displacements remain equal along its perimeter as time passes. In addition, as shown by the observations, the displacements are not proportional to the cross-sectional dimensions of the working. The effects of these factors are allowed for by the extra coefficients \( k_1, k_2, R_h \), and \( R_b \). We thus get expressions for the roof-floor and wall convergences;