AP22787307 «Development of technology for supporting mine workings on deep horizons based on the study of the geomechanical condition of rockmass» s.s. – Imashev A. Zh.

The relevance

The development of the mining industry in the Republic of Kazakhstan is accompanied by the commissioning of new horizons for mining, which requires a significant amount of mining capital and preparatory work.

With an increase in the depth of mining operations over 700 m, the solution of geomechanically problems and issues of managing the state of the massif becomes more and more complex, the intensity of deformation processes begins to manifest during the penetration and supporting of mine workings, and the number of cases of roof and side workings collapses also increases. The change in the stress-strain state of the rock mass around the workings at deep horizons occurs due to the action of high stresses on the production circuit.

The penetration of workings at great depths is always accompanied by a redistribution of the initial stress field, while a secondary stress field is formed. One of the main drawbacks in substantiating the parameters of the stability of rock outcrops in the contour part of the massif is the lack of knowledge of geomechanically processes. The reason for this is that the models used to describe geomechanically processes that occur near a rock mass of man-made outcrops do not quite correctly reflect the size of inelastic deformation zones.

Despite the large amount of theoretical and experimental research according to the assessment of the stress-strain state of the rock mass around the mine workings, there is still no final scientifically based approach to reliably determine the zones of inelastic deformations, especially at deep horizons. Ensuring the safety of mining operations is achieved by correctly justifying the geomechanically state of the massif and calculating the load on the support of mining workings. It is necessary to apply the experience of foreign countries, where the problems of rock stability are solved using the results of research that have practical testing at deposits based on rating classifications of rock quality.

Based on the analysis and review of the issue, the purpose of scientific and applied work is formulated - to determine the parameters of the zone of inelastic deformations around the workings at deep horizons, taking into account the fracturing of rocks, depending on depth of location and shape section of the workings, physical and mechanical properties and modulus of elasticity of rocks for the selection of types and parameters of fastening in accordance with the rating classifications of the rock mass.

The assessment of the power of zones of inelastic deformations during the penetration and supporting of mine workings in the mines of Kazakhstan, especially at depths of mining operations over 700 m, necessary for assessing the stability of the rock mass containing the mining, planning mining operations, choosing the parameters of support and fastening systems of workings, is currently not carried out or is methodically unreliable. Therefore, the prediction parameters of zones of inelastic deformations during the penetration of preparatory mine workings at deep horizons is an urgent scientific and practical research task.

Research Results in the first half of 2025:

Under underground mining conditions, investigations were carried out to determine the structural characteristics of the rock mass and the hydrogeological conditions, aimed at transitioning from the strength of individual rock samples to the strength of the rock mass using the Geological Strength Index (GSI). Initial data were prepared for numerical modeling to evaluate the geomechanical condition of the near-contour zone of the rock mass at deep mining levels. Key factors influencing the strength characteristics of the rock mass — including jointing, porosity, and the Geological Strength Index — were identified. Studies were conducted to assess the impact of rock mass jointing on the formation of inelastic deformation zones and the loading on the support systems of mine workings at deep levels. Structural features of the rock mass and hydrogeological conditions were also investigated under underground conditions to facilitate the

transition from sample strength to rock mass strength. Laboratory tests were carried out to determine the uniaxial compressive and tensile strength of rock samples. Strength envelopes of the rock were developed based on the Mohr–Coulomb and Hoek–Brown failure criteria. Initial data were prepared for numerical modeling aimed at evaluating the geomechanical condition of the near-contour zone of the rock mass at deep mining horizons

Underground studies were also conducted involving linear fracture mapping of the rock mass and identification of fracture systems. Ongoing work is focused on determining parameters and assessment criteria for rock jointing, recorded using a video endoscope — including fracture geometry, length, frequency, and orientation. An evaluation is being carried out to assess the effectiveness of video endoscopy for real-time monitoring of the rock mass condition, identifying its advantages and limitations in comparison with traditional methods.

Figure 1 – Underground investigations for determining the structural characteristics of rock formations

List of publications for the first half of 2025

1) A. Imashev, A. Mussin, Amoussou Coffi Adoko. Investigating an Enhanced Contour Blasting Technique Considering Rock Mass Structural Properties // «Applied Sciences», 2024, 14(23), 11461. https://doi.org/10.3390/app142311461 (percentile 79)

2) A patent application for the invention titled «Frame Hinged Support Made of Box-Section Profile», authored by A.Zh. Imashev, A.M. Suimbayeva, A.A. Musin, A.K. Mataev, G.B. Eskenova, N.K. Shaike, and G.Zh. Zhunusbekova, has been submitted for expert review

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Information for Potential Users

The subject of the research comprises domestic mining enterprises where the depth of mineral extraction has reached 800 meters or more. As of now, mining operations at the Orlovsky and Artemyevsky mines are conducted at depths exceeding 800 meters. In addition, a number of underground mines — «Voshod» (LLP «Voshod-Oriel»), «Ushkatyn-3» (JSC Manganese of Zhairem), and «Western Karazhal» (LLP «Orken») — are also projected to operate at greater depths in the near future.

Area of Application

Mining industry, specifically underground mine workings developed at depths of 800 meters and beyond.

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