

ANNOTATION
of the dissertation work on the topic:
**«IMPROVEMENT OF GEODETIC METHODS OF
GEOMONITORING FOR THE STABILITY OF THE OPEN PIT WALLS»**
submitted for the degree of Doctor of Philosophy (PhD)
in 6D071100 - "Geodesy" specialty
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The relevance of the dissertation topic.

Improvement of methods for geomonitoring of geomechanical processes occurring in the rock massif, using modern high-precision geodetic instruments, improves the safety and efficiency of mining operations during the extraction of minerals at the deposit. The relevance of the work also demonstrated by the implementation of research work in the grant funding project of the Ministry of Education and Science of the Republic of Kazakhstan AP08053410 "Development of innovative methods for predicting and assessing the state of a rock mass to prevent anthropogenic emergencies", conducted by the Department of "Mine Surveying and Geodesy" KazSRTU named after. K.I. Satpayev in the period from 2020 to 2022.

The aim of the study is identification of factors affecting the stability of the pit walls and on the basis of which geodetic geomonitoring methods should be improved to ensure industrial safety and increase the efficiency of mining operations by ensuring the stability of fractured rock.

The main idea of the work is considering the physical and mechanical properties and structural features of the massif as changing parameters depending on mining-engineering factors.

Object and subject of research. The object of the study is deposit Akzhal. The subject of the study is deformation processes in adjacent rock mass of an open-pit mine.

Research objectives:

1. Analysis of the current state of the study of the stability of the open-pit mine walls, study of the strength properties of rocks and structural features of the rock mass;
2. To establish the variability of the strength properties of rocks depending on the depth of their occurrence;
3. To reveal the factors influencing on the accuracy and productivity of geodetic measurements and to substantiate the method of geomonitoring based on high-precision geodetic technologies.
4. Create a geomechanical model of deformation processes;
5. Introduce research results into lecture materials and practical exercises for undergraduates, as well as into the production process.

Research methods. Aggregative methods were used to solve the tasks set. That includes literary sources analysis, rich experience in the field of geomechanical processes investigation, methods for conducting geomechanical monitoring, modern instruments and technologies for geodetic observations,

accuracy evaluation of measurement methods and modelling of geomechanical processes.

Scientific provisions submitted for defense:

1. The strength properties of rocks vary from the depth of their location along a logarithmic.

2. The characteristics of the performer's qualifications, measurement methods, environment and centering of the equipment influence on the accuracy and performance of geodetic measurements and the prompt attention to determining the deformation processes of open pit walls. Centering is one of the main factors and the improvement of the centering device lowers centering error is 2 times, which significantly increases the accuracy and performance of the measurements, minimizes the influence of human and technical factors..

Scientific novelty of the results of the work:

1. A logarithmic correlation of the physical and mechanical properties of rocks with the depth of their occurrence has been established, which will allow to predict the geomechanical state of the adjacent rock massif and ensure industrial safety during intensive development of the deposit.

2. The design of the ground-based reference point has been improved due to the forced centering of instruments, which provides a high accuracy of centering, targeting and efficiency in determining the parameters of deformation processes for taking safety measures (this novelty is confirmed by the patent of the Republic of Kazakhstan No. 35798 dated 19.08.2022).

Conclusion:

1. Based on the analysis of scientific and technical literature in the field of geodetic methods and modern instruments for geomechanical monitoring, ways to reduce the negative effects of geomechanical processes formed in the subsoil during mining, a flowchart for geomonitoring in an technogenic system was developed.

2. A logarithmic correlation between the physical and mechanical properties of rocks and their depth was obtained, which makes it possible to predict the geomechanical state of pit walls massifs and take preventive measures to ensure industrial safety during intensive development of the deposit.

3. The design of the ground-based reference point has been improved due to the forced centering of instruments, which ensures a high accuracy of centering, guidance and efficiency in determining the parameters of deformation processes for taking security measures (this novelty is confirmed by the patent of the Republic of Kazakhstan No. 35798 dated 19.08.2022).

4. The developed method of strengthening a open pit slope by drilling of inclined boreholes, installing reinforcement in them and filling them with a new fixing solution, allows to improve geomechanical conditions in the near-slope zone and ensures safe development of the deposit.

5. New cementing solutions have been developed based on the use of mining and processing waste and polymer powders.

The results of research, such as the study of the strength properties of rocks and their changes with the depth of their occurrence, as well as the improved

design of the ground-based point of forced centering of high-precision instruments are introduced into the educational process in the discipline "Geomechanics" at the Department of Surveying and Geodesy of KazSRTU named after K.I. Satpayev and confirmed by the act.

The author's personal contribution consists in setting the goals and objectives of research, generalizing and analyzing the data obtained, processing the results, establishing the dependence of the strength properties of rocks on the depth of their location, improving the design of a ground point due to the forced centering of instruments, writing articles.

The validity and reliability of scientific provisions and conclusions is confirmed: correct use of well-known research methods, such as correlation and regression analyses, application of the results in practice.

The scientific significance of the work consists in obtaining new scientific knowledge on the change in the strength properties of rocks depending on the depth of their location, identifying factors that affect the accuracy of geophysical measurements and their productivity, and a method for predicting the stability of an open pit wall.

The practical significance of the work consists in the substantiation of technical solutions and methods of geomonitoring, the use of which increases the safety and efficiency of mining operations at the deposit, associated with the stability of the open pit walls.

Approbation of work. The main provisions and results of the dissertation work were reported and discussed at the following scientific, practical and international conferences: "Rational use of mineral and technogenic raw materials in the conditions of Industry 4.0" (Almaty, KazSRTU, 2019), "The role of geodesy and mine surveying in the implementation of the program, Digital Kazakhstan" (Almaty, Satbayev Readings-19, KazSRTU, 2019), "Problems of subsoil development in the 21st century from the point of view of the young generation" (Moscow: IPKON RAS, 2019); "Problems and prospects for the integrated development and subsoil sustainability" (Moscow: IPKON RAS, 2020).

Publication of work. 16 scientific papers were published on the topic of the dissertation, of which: 2 articles in journals included in the Scopus and Web of Science database, 4 articles in journals recommended by the Committee for Control in Education and Science of the MES RK, 4 articles in international materials scientific and practical conferences, forums and congresses, 1 patent for an invention and 5 articles in other scientific journals.

The main provisions of the dissertation are published in the following works:

1. Modern methods of geotechnic - an effective way of providing industrial safety in mines. Eurasian Mining. - 2021. - Vol. 36, Iss. 2. - R. 18-21.

2. Preparing solutions based on industrial waste for fractured surface reinforcement. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences. - 2020. - Vol. 5, Iss. 443. - P. 13-20.

3. Management of geomechanical processes. Bulletin of KazSRTU, No. 1, 2019. - P. 7-11.
4. Innovative methods of geomonitoring at the Akzhal mine. Mining Journal of Kazakhstan, No. 4, 2018. - P.14-18.
5. Study of regularities of geomechanical processes in the combined development of the Akzhal field. "Proceedings of the University" KSTU, Karaganda, No. 4, 2019. - P.147-151.
6. Mathematical modeling of geomechanical processes arising from the interaction of open and underground mining. Bulletin of ENU. L.N. Gumilyov, Astana, No. 3 (128), 2019.
7. Study of manifestations of rock pressure in the combined development of Akzhal deposit. Mine surveying and subsoil use, No. 2, 2019. - P. 15-19.
8. Study of the relationship between the properties of rocks and their depth. M.: Mine Surveying Bulletin, No. 6, 2018. - S. 49-52.
9. Development of Geodetic Methods of monitoring of Open – Pit Sides Stability. Boisc Biotech Res Comm Special Issue Vol 12(5) September 2019. P. 67-78.
10. Study of the strength properties of rocks at the Akzhal mine in order to strengthen the weakened areas. International scientific journal "Young scientist". – Kazan; No. 33(323), 2020. S. 20-25.
11. Study of the stress state of the rock mass at the Akzhal mine of NOVA Zinc LLP. International scientific journal "Young scientist". – Kazan; No. 33(323), 2020. P. 35-39.
12. Methodology for conducting geomonitoring of edge arrays in open pits. Participation in int. conf. "Rational use of mineral and technogenic raw materials in the conditions of Industry 4.0" - Almaty: KazSRTU, 14-15.03.2019., P. 57-60.
13. Improvement of geodetic methods of subsoil geomonitoring. Participation in int. conf. Satbayev Readings - 2019, "The role of geodesy and mine surveying in the implementation of the Digital Kazakhstan program". - Almaty: KazSRTU, April 12, 2019.
14. Innovative methods of geomonitoring at the Akzhal mine. Proceedings 14 - Int. conf. "Problems of mineral resources development in the 21st century through the eyes of the young". - M.: IPKON RAN, 2019. - S. 126-129.
15. Creation of quarry wall stability maps using GIS technologies. 4th Conference of the International Scientific School Academician of the Russian Academy of Sciences Ph.D. Trubetskoy "Problems and prospects for the integrated development and conservation of the earth's interior", November 16-20, 2020, Moscow
16. Ground permanent geodetic point of forced centering of instruments. Patent of the Republic of Kazakhstan for the invention No. 35798. Astana, from 19.08.2022.