

ANNOTATION

dissertation for the academic degree of Doctor of Philosophy PhD in the specialty 6D071100 – Geodesy

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Dissertation topic: « Improving the risk management method in conditions of intensive field development based on the use of GIS technology»

The purpose of the dissertation: to establish the dynamics of changes in the sinking hazard of the earth's surface for risk management in conditions of intensive field development.

The idea of the work lies in the spatial localization of areas of the earth's surface with a high degree of failure and control over their condition using modern methods of ground and space monitoring.

The object of the study – Annensky mine, which is part of the Zhezkazgan field.

The subject of research is the displacement and deformation processes of the Annensky mine.

Research tasks, their place in the performance of research work in general:

- analysis of the study of the issue of geodetic support for observations of the displacement and deformation of the earth's surface in the undermined territories;
- to establish the value of the limiting subsidence of the earth's surface on the parameters of geoenergy;
- substantiate the objective criteria for zoning the earth's surface of the deposit according to the degree of failure risk;
- development of a method for zoning the earth's surface of the deposit according to the degree of weakening based on the energy criterion.

Research methods consist in the use of experimental graphic-analytical methods and mathematical methods for processing results. Analytical solutions based on the fundamental laws of physics and continuum mechanics are used. The studies were carried out using the methods of causal analysis.

The main methods of research and analysis used in the performance of the dissertation work include:

- detection of anomalous (risk) areas on the territory of the Annenskoye field using space radar interferometry;
- application of space radar monitoring systems and SAR interferometry methods to build a continuous map of deformations of the earth's surface of the field based on the results of geomonitoring;
- application of the method of zone zoning of the surface of the ore deposit according to the degree of potential danger to collapse, based on the change in the geoenergy of the rock mass during the transition from the initial state to the current one.

Provisions for Defense:

1. The value of the limiting subsidence of the earth's surface varies from the geoenergy parameters according to the hyperbolic dependence;
2. The change in geoenergy, determined by the sum of the potential energies of gravity and elastic deformation, during the transition of a rock mass from the initial state to the current one, is an objective criterion for zoning the earth's surface of the deposit according to the degree of failure risk.

Main results of the research:

The studies carried out made it possible to improve the main provisions for obtaining reliable information on weakened zones based on a comprehensive method of geomechanical monitoring, which includes mine surveying and geodetic, high-precision space technologies and methods for zoning the surface of the deposit according to the degree of weakening:

1. Due to the disturbance of the earth's surface by quarries and dumps, it has been established that there are no profile lines for observing the movement of rocks in the places of the collapses, which makes it difficult for the geomechanical service of the Annensky mine to conduct geomechanical monitoring using mine surveying, topographic and geodetic methods in full.

2. Mining in the collapse zone is allowed only after the completion of the process of displacement and stabilization of the geomechanical situation, which can be determined by means of complex monitoring of the massif. According to the results of visual observation of the state of mine workings and the development of manifestations of rock pressure by the simplest beacons, marks, gatehouses, as well as by the attenuation of the seismic activity of the massif and the displacement of the earth's surface.

3. Analysis of the data obtained for the period from August 2013 to October 2018 revealed a zone of intensive subsidence of the earth's surface in the area of profile line No. 1 passing through the dump. In the area of profile lines No. 215, No. 216 and No. 216 bis, there is a tendency to stabilize the process of subsidence of the earth's surface.

4. Displacements of the earth's surface were determined and recorded according to observational data for the period using satellite images in 2018, 2019 and 2020 on the territory of the Annensky mine. The maximum absolute value of subsidence of the earth's surface within the subsidence trough of the Annensky mine from October 2018 to August 2020 was 0.8 cm. .

5. A method of zonal zoning has been developed, which allows, under conditions of heterogeneity of the rock mass, to determine areas that are at the stage of involvement in the process of displacement and are not determined by instrumental observations. This significantly increases the reliability and reliability of forecasting a crisis situation and contributes to the development of technological solutions to prevent them.

6. The results of zonal zoning were compared with the data obtained from ground-based geodetic measurements and space radar interferometry. Verification of the results based on a retrospective analysis showed an increase in the accuracy of the zoning method by 15-20% relative to the traditional ones and by 10% in

comparison with the method, the criteria of which is limited by taking into account only the potential energy of gravity.

7. A technique for optimizing geodetic measurements based on the geoenergy potential of a mountain range has been developed.

8. The resulting correlation ratio allows one to obtain the expected maximum permissible deformations depending on the change in geoenergy, determined by the state and properties of the rock mass, the depth and thickness of the development, and also to solve inverse problems, i.e. choose such dimensions of voids and depths at which the deformations of the earth's surface will not exceed the maximum allowable for undermined objects.

9. The criterion makes it possible to increase the accuracy of determining the boundaries of zones by 20% or more relative to the known ones.

Scientific novelty and importance of the obtained results.

1. A criterion has been developed for solving the problems of zoning the earth's surface of the deposit according to the degree of failure risk based on changes in geoenergy, including the potential energies of gravity and elastic deformation of the rock mass, taking into account its heterogeneity.

2. A correlation has been established between the magnitude of the limiting subsidence of the earth's surface and the change in the geoenergy of the rock mass.

3. A technique for optimizing geodetic measurements based on the geoenergy potential of a mountain range has been developed.

The personal contribution of the author lies in the generalization and analysis of domestic and foreign methods for calculating the displacements and deformations of the undermined earth's surface; conducting topographic and geodetic observations, mathematical and statistical processing of measurement data; construction of a mining-geometric model of displacement processes, in the development of a methodology for substantiating the processes of crack formation and recommendations for their observations in mine workings.

The practical significance of the dissertation. The proposed method of zonal zoning of the earth's surface based on the potential of geoenergy and the established relationship between the magnitude of the limiting subsidence and changes in the geoenergy of the rock mass made it possible to identify sink-prone zones.

The results of the research are introduced into the educational process of KazNRTU named after. K.I. Satpayev for the specialty 5V070700, 5V071100 in the discipline, "Geometrization of the structural and qualitative indicators of the deposit" (Act of implementation, APPENDIX B).

Compliance with the directions of scientific development or state programs.

The work is based on the results of fundamental research on the topic No. AP05133929 "Development of a forecasting system and geomonitoring methods for displacements of a rock mass in hazardous areas of the earth's surface during the development of subsoil resources based on innovative methods of GIS technology" for 2018-2020, scientific supervisor - Doctor of Engineering .sci., professor Baygurin Zh.D.

On the topic of the thesis, 11 publications were published, in which the doctoral student was directly involved as an author and co-author:

1. Sadykov B.B., Baygurin Zh.D., Altayeva A.A., Kozhaev Zh.T., Stelling W. New decision of the method of zone division surface of the deposit on the degree of safety. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu № 6, 2019 g. Ýkraina, s.34-41, ISSN 2071-2227, 47-1 protsentil, citescore (2018) 0.77, Q3, <https://doi.org/10.29202/nvngu/2019-6/5>.

2. Sadykov B.B., Altaeva A.A., Imansakipova B.B., Kojaev J.T., Spitsyn A.A. Sovershenstvovanie energeticheskogo kriteriia pri zonirovani zemnoi poverhnosti po stepeni oslablennosti. Vestnik KazNITÝ №4, 2018 g. Almaty, s.32-38, ISSN: 1563 - 0234.

3. Sadykov B.B., Altaeva A.A. SAR interferometriia ádisimen WISMUT (Germaniia) ýran kenornynyń jer betiniń jyljýyn baqylaý. Taý-ken jýrnaly, № 4, 2020 j., Almaty q., b. 26-30, ISSN 2227-4766.

4. Sadykov B.B., Altayeva A.A., Stelling W. Monitoring of displacements and deformations of the earth's surface at the Annensky field. Complex Use of Mineral Resources.2022; 322(3):43-50. ISSN2224-5243. <https://doi.org/10.31643/2022/6445.27>.

5. Rysbekov K.B., Soltabaeva S.T., Kojaev J.T., Baigýrin J.D., Sadykov B.B. Vlianie trenovatosti gornyh porod na geomehaniicheskie protsessy. Vestnik NAGN, № 1(2), 2018 g., Astana, s.73-76, ISSN 2518-797.

6. Altayeva A.A., Sadykov B.B. Review of analytical methods of construction of digital elevation models. International Scientific Conference "XVIII Satpayev Readings", Almaty, 2018, pp.95-97. ISBN 978-601-323-034-4.

7. Sadykov B.B., Kojaev J.T., Baigýrin J.D., Nýkarbekova J.M. Teoreticheskii podhod k opredeleniiy obemov opolznevnyh smeeni. Sbornik trýdov mejdýnarodnoi naýchno-prakticheskoi konferentsii «Ratsionalnoe ispolzovanie mineralnogo i tehnogennoogo syria v ýsloviiah Indýstrii 4.0», 2019 g., Almaty, s. 137-139, ISBN 978-601-323-168-6.

8. Sadykov B.B., Týrdakymbai A., Kojaev J.T., Baigýrin J.D. Rezýltaty skanirovaniye gornyh vyrabotok dlia povysheniia tochnosti podshchetov zapasov rýdnyh tel slojnogo stroeniia. Sbornik trýdov mejdýnarodnoi naýchno-prakticheskoi konferentsii «Ratsionalnoe ispolzovanie mineralnogo i tehnogennoogo syria v ýsloviiah Indýstrii 4.0», 2019 g., Almaty, s. 139-141, ISBN 978-601-323-168-6.

9. Sadykov B.B., Altaeva A.A., Taýkebaev O., Shakieva G.S. Metodika optimizatsii geodezicheskikh nabliýdenii za zemnoi poverhnostiý rýdnogo mestorojdeniia na osnove ee zonirovaniia po stepeni oslablennosti. Mejdýnarodnaia naýchno-prakticheskaiia konferentsiia "Ratsionalnoe ispolzovanie mineralnogo i tehnogennoogo syria v ýsloviiah indýstrii 4.0". 2019 g., Almaty, s. 128-132, ISBN 978-601-323-168-6.

10. Sadykov B.B., Baigýrin J.D., Imansakipova B.B., Altaeva A.A. Energeticheskii kriterii zonnogo raionirovaniia poverhnosti mestorojdeniia po stepeni opasnosti k obrýsheniiam. Jýrnal izvestiia výzov «geodeziia i aerofotosemka», № 9, 2018 g., Moskva, ISSN 0536-101X (print), ISSN 2618-7299 (online).

11. Sadykov B.B., Altaeva A.A. Taý-ken óndirisinde geoaqparattyq tehnologiualardy qoldanýdyń tiimdiligi. "Geoqaqparattyq tsifrlyq injeneriadaǵy innovatsiualyq tehnologiualar"atty Halyqaralyq ǵylymi-praktikalıyq konferentsiua. 2022, Almaty q., b. 214-219, ISBN 978-601-323-277-5.