НАУКИ О ЗЕМЛЕ

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STUDY OF SLOW MOTIONS OF THE EARTH SURFACE

Abstract. Information about copper deposits of Kazakhstan, development of which is carried out in the Saryarka region, and its role in the development of the mining industry are considered in the article. Geological, structural and tectonic features of the deposits are presented. Research results on improvement methods of studying and geomechanical processes management in the development of mineral resources are presented. It is shown that the problem of geomechanical processes management can be solved on the basis of a methodology for rock condition geomonitoring considered in this article, which provides comprehensive accounting and analysis of all-natural and technogenic factors, as well as use of control tools developed by the authors.

The article presents technical solutions to ensure operational safety during the development of Saryarka region field reserves, which occur in difficult mining and geological conditions. Ore bodies of the deposit have different sizes and are located at different depths, therefore, seismic surveys are carried out. The geodetic network of provisional seismic surveys at the field has been substantiated. It is proposed to conduct surveys using modern geodetic instruments, such as satellite technologies, electronic, digital geodetic instruments. The geodetic survey methods proposed by the authors provide information on the bowels of the earth with a high degree of accuracy.

Key words: copper ore deposits, geology, structure, tectonics, disturbance, fracturing of rocks, seismic exploration, geodetic network, geodetic surveys, satellite systems, electronic tacheometers, laser scanners.

Introduction. In recent years, objects with complex geology and great stratification depth have been increasingly included in the development and operation of ore deposits, which requires special conditions for the development of these objects. The percentage of drilled “empty” wells does not decrease, which is also largely due to the complexity of the structure of the prospective ore objects under study. On the other hand, practical experience has proved the presence of ore deposits at great depths.

In his work named « Dzhezkazgan copper - ore region and its mineral resources » (1932) and during creating of metallogenic forecast map of Kazakhstan (1950) K.I. Satpayev wrote: «.... copper reserves accounted for today have not yet exhausted all the possibilities of the Dzhezkazgan ore-bearing region. Here I do not take into account the deposits of the Zhilandinsky group: Kipshakpai and Saryoba, ore reserves in them are laid very deeply and they need huge finance and technologies for their development. I will leave them for future generations» [1].

We see prophecies of prominent scientist today.

The content of the work. The bowels of Kazakhstan are rich in mineral deposits, including copper. The Saryoba deposit (Vostochnaya and Zapadnaya) located 30-35 km north of the Zhezkazgan mine is the special among them [2-6].

In general, ore field has been explored and approved reserves in categories B + C1 + C2 in quantities that allow it to be nominated as large industrial facility. Ore field structure includes equal red-colored complex of interstratified rocks with ore-bearing deposits of the Taskuduk horizon of the Middle Carboniferous Formation Taskuduk and Serpukhov layer of the Lower Carboniferous.11 ore deposits were discovered in the ore field where 109 ore bodies were explored. The largest deposits are confined to the Taskuduk horizon. Their stretch is northeastern, with length of up to 3200 m, thickness of 0.5 to 17 m, and dip size of up to 1400 m (Fig. 1).

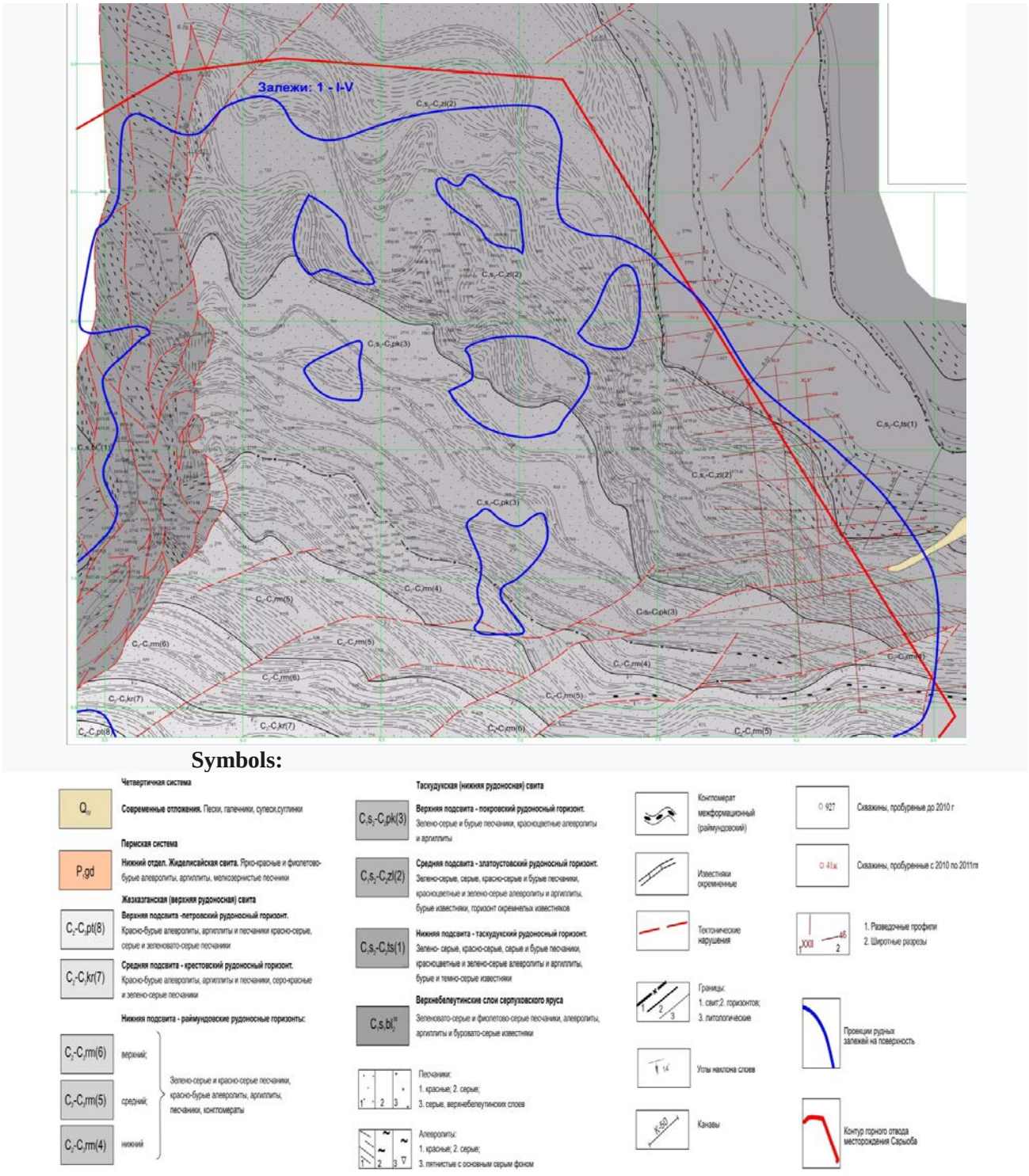

Fig.1. Geological map of the East Saryoba field

In addition, they are complicated by both pre-ore and post-ore disjunctive dislocation which greatly complicates their exploration. At the initial stage of development of mineral deposits, use of seismic exploration is important for the sustainable development of the territory. This method has proved to be powerful tool for detecting geostructures that concentrate deposits in the bowels of the Earth, contributing to optimal planning of mining and reducing the number of wells. Moreover, effectiveness of seismic exploration (as well as any geological and geophysical method) directly depends on the quality of its geodetic support. In other words, how accurately point's position of explosion and geophones is determined

in the coordinate space position in plan and height (depth) of any geostructures will be so accurately determined [7-11].

In this regard, in recent years, regulatory requirements for the quality of geodetic support for seismic surveys have been tightened. Creation of information geological and geophysical space involves the representation of it in uniform spatial coordinates.

The analysis of methodology state for conducting geodetic observations on mine territory particularly related to the lack of effective methods for determining deformations scale which necessitates methodology improvement of geodetic observations of rock deformations using modern instruments. Geodetic observations provide opportunity to identify the massif deformation, which is essential for geomechanical situation assessment in mining area. But they do not provide complete picture of deformation processes in time. This can be done only with using integrated methodology of geomonitoring of adjacent rock mass (Fig. 2)

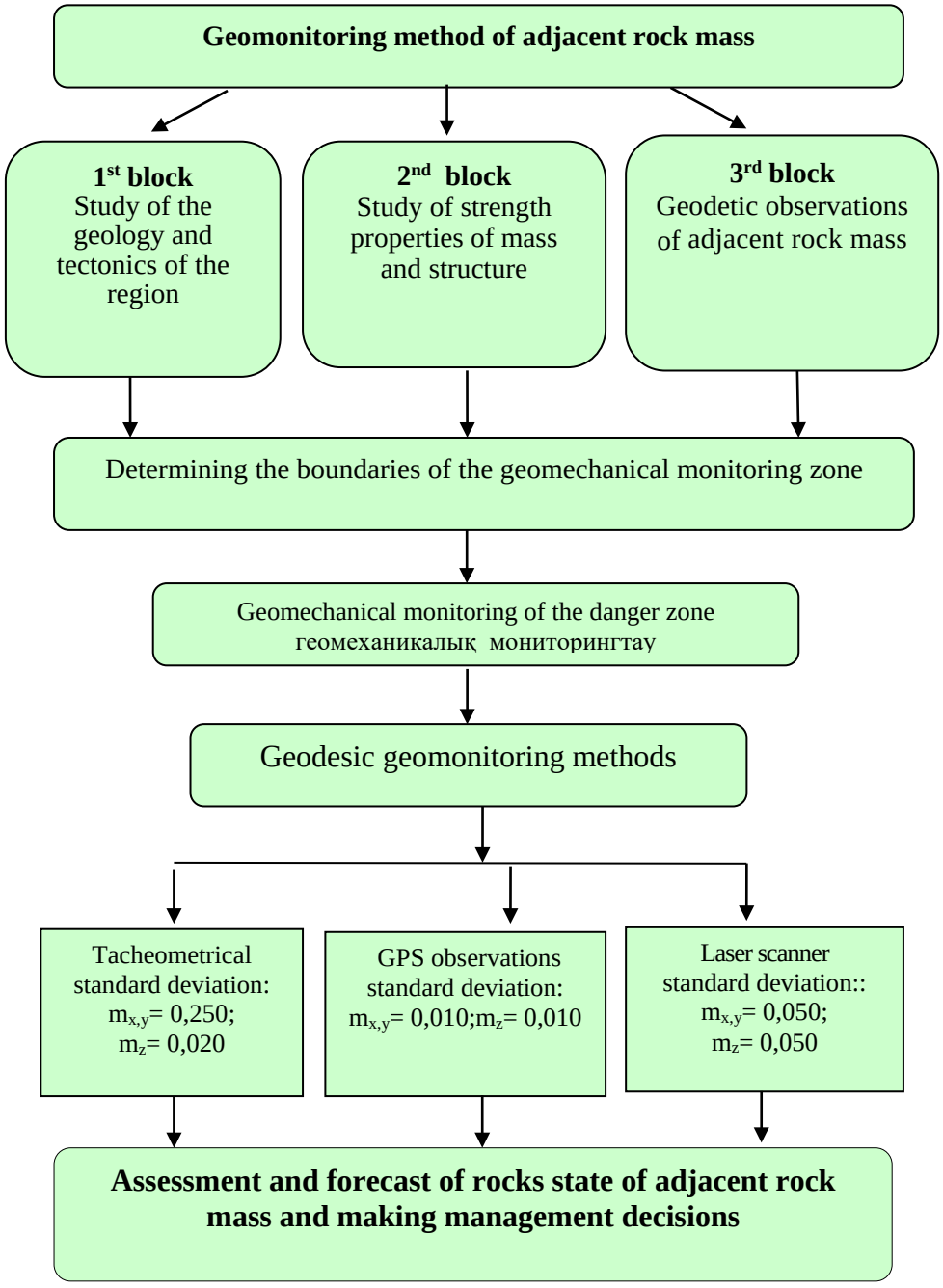

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Fig.2. Scheme of complex geomonitoring methodology

According to 1st and 2nd blocks of recommended methodology (Fig. 2), engineering-geological and mining-technical conditions of development and geomechanical state of the instrument arrays, structural-tectonic features and physical-mechanical properties of rocks of the field were studied in detail [12-15].

Monitoring of mountain massif state (3rd block), especially during exploration processes on the territory of giant copper deposit, occupying large area, consisting of several deposits and occurring in various deep horizons requires creation of highly accurate geodetic control. Basis for network creation of geodetic points is topographic map of area. Total area of mining allotment of Saryoba deposit, which was left to us by K.I. Satbayev - is 24 479 373, 66 m^2 (Fig.3). Depth of the mountain allotment of East Saryob is 510 m, the absolute elevation is 60 m. Based on the materials of existing cartogram object and existing coordinates, total area is calculated 2447, 94 ha.

Figure shows the triangulation points location (441, 465, 466, 470, 424, and 451) of the State Geodesic Network (SGN). Bridging process is done based on these points of SGN. In order to provide huge area using classic option of geodetic networks creation on fields is quite laborious and requires large financial costs. During large-scale and long-term development of deposits, geodynamic processes along with geomechanical deformation processes can be developed)[8]. Therefore, geodynamic testing ground is created during development of deep-lying ore bodies, where repeated geodetic observations are carried out.

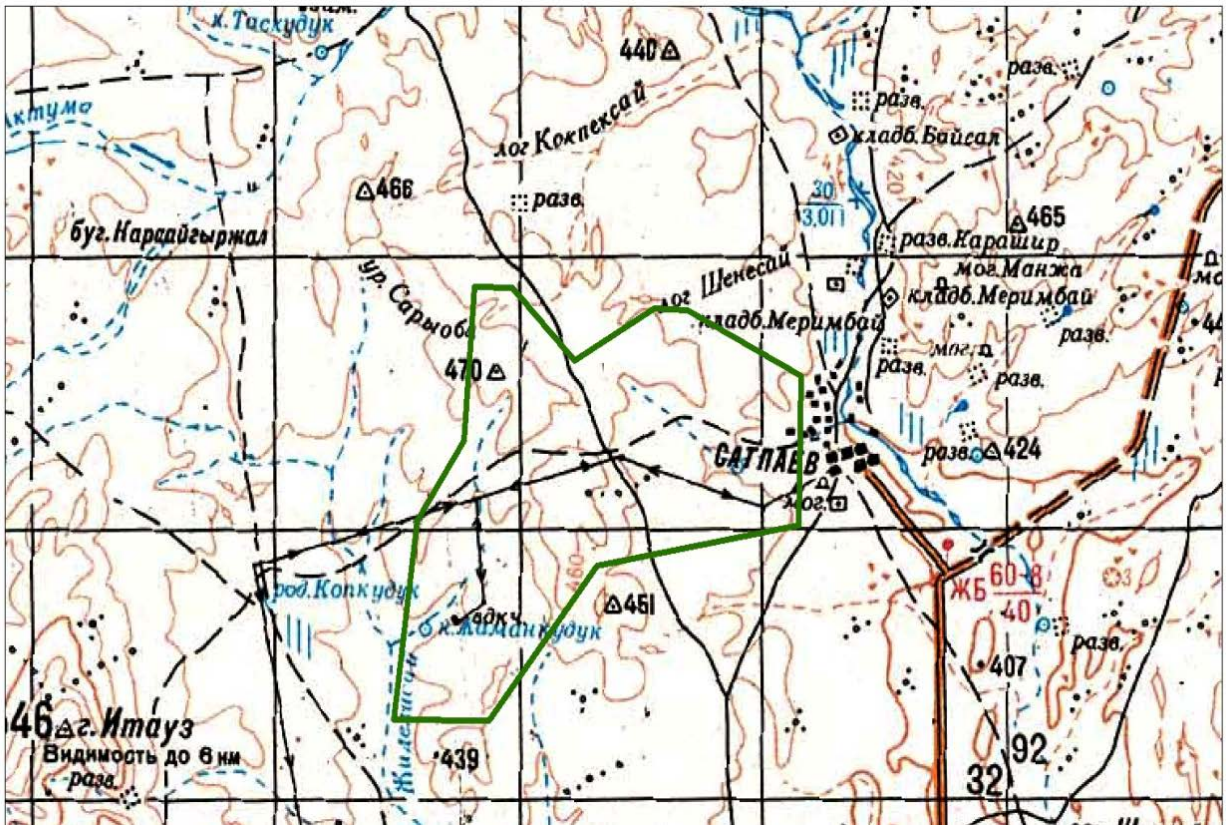

Fig.3. Topographic base and boundary of mining allotment

In this regard, we propose to replace long leveling lines with local geodetic constructions in the form of profile lines and control “bushes” of geodetic and leveling points. Complex application of ground and space geodetic methods will allow covering by monitoring observations the entire territory of the field, as well as increase observations efficiency and reduce capital costs of their production.

Thus, for differentiated study of geodynamic and geomechanical processes development that occupy large area and intended for deep tabulars, we propose creating “nodal” branches consisting of *basic* (reference), *control* (initial) and *deformation geodetic and leveling* points (Fig. 4))[6].

All nodal points are located in accordance with the ore veins (see fig. 1) and are tied to SGN points (see fig. 3)

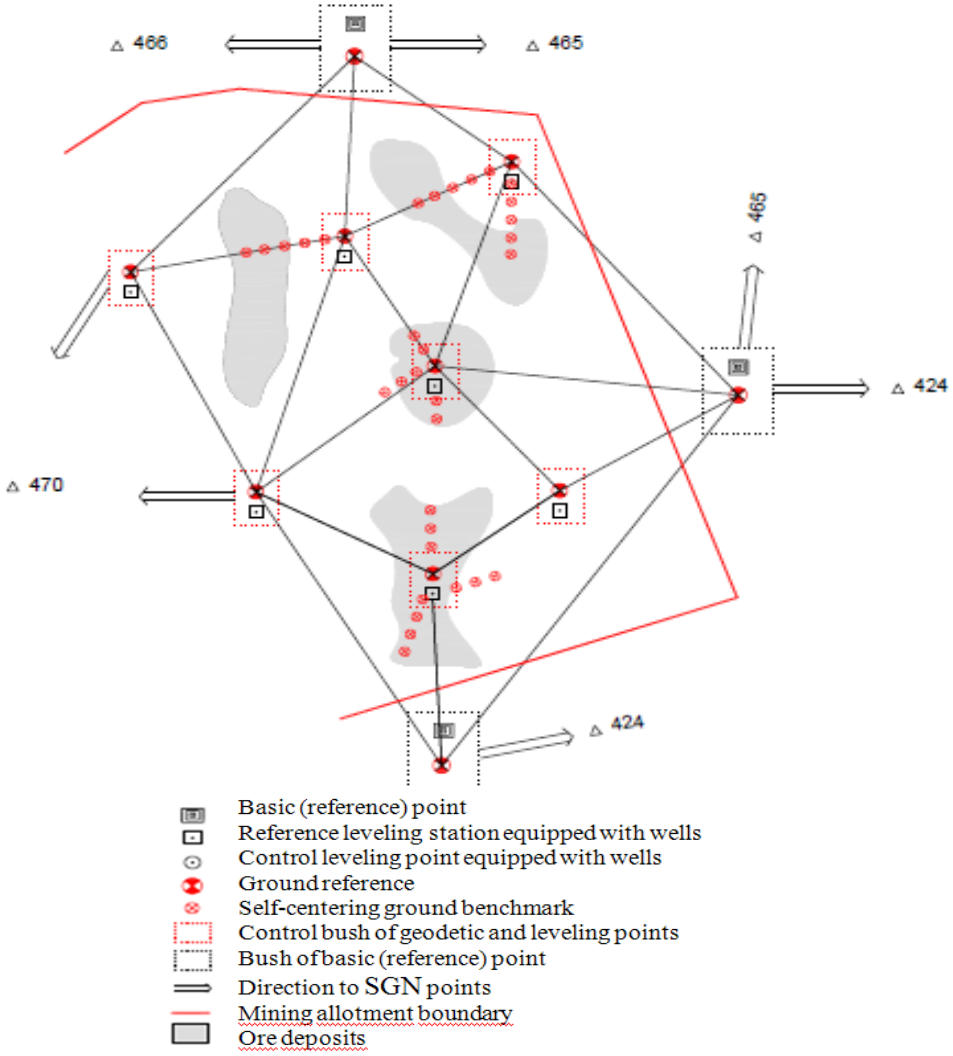

Fig.4. Structural diagram of the observation network of the geodynamic test site

Network of basic (reference) points is designed to assess the geodynamic state of the deposit territory on regional scale and serves as the initial geodetic basis for the network development of *control* (initial) points. In this regard, basic (reference) points should be located outside the field and influence zone of technogenic geomechanical processes due to its development, as well as at distance from tectonic fault zones.Basic point's quantity is determined as following from of deposit outline configuration of the field and should be at least two. Their coordinates are determined relative to GNSS stations included in the international reference geodetic network[10].

Network of control (initial) points is the initial geodetic basis for observing geomechanical and modern geodynamic processes in zones of tectonic disturbances, as well as for assessing the geodynamic state of the field's territory. We propose to locate control (initial) leveling points vertically off-line of the field under conditions that exclude the impact of geomechanical processes on their stability. Exploration wells existing in the field (abandoned or being put into conservation), base of which is buried below developed deposits can be used as control (initial) points.

Network of deformation points is designed for observation of technogenic, geomechanical and modern geodynamic processes.

All these works are carried out using modern geodetic technologies. Moreover, high efficiency of geodetic works is achieved only through satellite technology (Fig. 5). Use of modern technical equipment opens up great opportunities for solving problems of geodetic support for seismic exploration at qualitatively new level.Rapid development of geodetic base centralization, profiles production on the

ground with high accuracy, measurement and automation of data processing, ability to work in difficult physical, geographical and climatic conditions is carried out only on the basis of modern instruments [11].

Fig.5. Coordinates determination of points (a) and boreholes (b) by GPS technology

At the moment experimental works on the experimental site “Vostochnaya Saryoba” is being completed. Also, ore mining works are being carried out at Zhylandy field, remote from Zhezkazgan deposit: “Vostochny Saryoba”, “Itauyz”, “Zapadny Saryoba”, “Kipshakbai” and “Karashoshak”. “Kazakhmys” corporation successfully continues investment projects.

Conclusions. 1. On the basis of analysis of domestic and foreign scientific and technical literature, work experience in the field of studying geomechanical and geodynamic processes, as well as deformation monitoring tools, complex geomonitoring technique using modern highly-accurate geodetic instruments is recommended.

2. According to the 1st and 2nd blocks of recommended methodology, geology and tectonics of deposit area were studied, researches on strength properties and structural features of rocks massif were conducted. Geological, structural and tectonic features of the giant copper deposit in Kazakhstan “Vostochnaya Saryoba” are presented.

3. Modern approach to setting and making observations of geodynamic and geomechanical processes in solid mineral deposits is analyzed. New "nodal" method for constructing geodetic observation systems at geodynamic test site has been substantiated, which allowing covering of monitoring control of ongoing seismic surveys as well as increasing observations efficiency and reducing capital costs for their production.

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ЖЕР БЕТІНІҢ БАЯУ ҚОЗҒАЛЫСТАРЫН ЗЕРТТЕУ

Андатпа. Мақалада күрделі кен-геологиялық жағдайда және терең қабаттарда, Жезқазған аймағында игеріліп жатқан, Шығыс Сарыоба мыс кен орны, оның тау-кен өндірісін дамытудағы рөлі туралы ақпарат қарастырылған. Шығыс Сарыоба кен орнының қорларын игеру кезінде қиын геологиялық жағдайларда қауіпсіз жұмыс жағдайларын қамтамасыз етудің техникалық шешімдер ұсынылған.

Ақпараттық геологиялық-геофизикалық кеңістікті құруға тек бірыңғай кеңістік координаталар жүйесін ғана мүмкіндік жасайды. Игеріліп жатқан кенорны аумағында геодезиялық бақылаулар жүргізу әдіснамасының жай-күйіне талдау жасуда, ең алдымен, деформацияланудың масштабын анықтайтын тиімді әдістердің жоқтығына байланысты, бұл бақылауды тек кешенді геомониторинг әдісі негізінде ғана жүргізуді қажет етеді.

Жер беті қозғалыстарына геодинамикалық мониторинг жүргізу үшін Сарыарқа мыс кенінің аймағының пландық және биіктік негіздерін құру мәселелері қарастырылған. Мақалада геодинамикалық полигонында геодезиялық байқау жүйесін құрудың жаңа «бұталы» әдісі негізделеді, ол сейсмикалық және тау-кен жұмыстарының мониторингін бақылауға, сонымен қатар бақылаудың жылдамдығы мен тиімділігін арттыруға, сонымен қатар, кен өндіруге кететін шығындарды азайтуға мүмкіндік береді. Бұл әдісті тек қатты пайдалы қазбаларды кең көлемде игеруде ғана емес, сонымен бірге мұнай мен газ кен орындарын игеруде де осындай проблемаларды шешу үшін қолдануға болады.

Негізгі сөздер: мыс кенорнындары, геология, құрылым, тектоника, бұзылыстар, тау жыныстарының жарықшақтылығы, сейсмикалық барлау, геодезиялық торап, геодезиялық түсірістер, жерсеріктір жүйелер, электронды тахеометрлер, лазерлі сканерлер.

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ИЗУЧЕНИЕ МЕДЛЕННЫХ ДВИЖЕНИЙ ЗЕМНОЙ ПОВЕРХНОСТИ

Аннотация. В статье рассматривается информация о медных месторождениях Казахстана, освоение которого осуществляется в регионе Сарыарки, его роли в развитии горнодобывающей промышленности. Представлены геологические, структурные и тектонические особенности месторождений.

Приведены результаты исследовании по совершенствованию методов изучения и управления геомеханическими процессами при освоении недр. Показано, что проблема управления геомеханическими процессами может быть решена на основе рассмотренной в данной статье методике ведения геомониторинга состояния массива горных пород, предусматривающей комплексный учет и анализ всех природных и техногенных факторов, а также использования разработанных авторами средств контроля.

В статье представлены технические решения, позволяющие обеспечить безопасность работы при освоении запасов месторождения Сарыарки, залегающих в сложных горно-геологических условиях. Рудные тела месторождении имеют разные размеры и расположены на различных глубинах, поэтому проводятся сейсморазведочные работы. Обоснована геодезическая сеть, провордимых сейморазведочных работ на месторождении. Предложены проводить съемки с использованием современных геодезических приборов, как спутниковые технологий, электронные, цифровые геодезические приборы.. Предложенные авторами геодезические методы съемки позволяют получить информацию о недрах земли с высокой степенью точности.

Ключевые слова: меднорудные месторождения, геология, структура, тектоника, нарушенность, трещиновтость горных пород, сейсмческая разведка , геодезическая сеть, геодезичские съемки, спутниковые системы, электрондые тахеометры, лазерные сканеры.