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ROLE AND IMPORTANCE OF GEODETIC SURVEYS IN GEODYNAMICS

In science geodynamics has been actively developing as a new direction recently, especially in the last decade. For the first time this term was described in A. Liyav's monograph 90 years ago. A. Liyav himself formed this term as a relationship of the Earth and space factors, as well as a legal regmatic formation of cracks-light grid on the entire surface of the bottom and the entire planet surface. In the last 20 years, the meaning of geodynamics is often used in a slightly modified version, so geodynamics has become understood as the whole complex of development processes inside the Earth. In the foreign literature, geodynamics is understood to be a branch of geology engaged in the study of forces and processes that occur only in the interior of the Earth and cause the formation of disorderly structures and deformations in its shells. Subsequently, E. Og considered geodynamics as a section of tectonics, studying the forces affecting the planet and phenomena occurring on its surface. In other foreign sources, modern geodynamics is the science of Earth's movements in real time, which can be measured, identified and explained in the language of fundamental sciences. The purpose and task of this work is to make a general overview of the results of geodesic research in geodynamics, considering geodynamics as a new direction of science.

Key words: geodynamics, geodesy, geology, quarries, mineral extraction.

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Геодинамикадағы геодезиялық ізденістердің рөлі мен мәні

Ғылымда геодинамика жаңа бағыт ретінде соңғы уақыттарда, әсіресе соңғы он жылдықта белсенді дамып келеді. Ең алғаш рет бұл термин А. Лявтың монографиясында 90 жыл бұрын қолданылған болатын. А. Лявтың өзі бұл терминді Жер мен ғарыштық факторлардың өзара байланысы, сонымен қатар түбіндегі ағын мен планетаның барлық жоғарғы бетіндегі сызат-жарық торының заңды регматикалық түзілуі деп қалыптастырған болатын. Соңғы 20 жылда геодинамика сөзінің мағынасы біршама өзгеріске ұшырады. Кейбір мәліметтер бойынша, Э.Ог геодинамиканы Жерге әсер ететін күштерді сипаттайтын тектониканың бір бөлімі ретінде қарастырған. Геодинамиканың астарында Жердің ішкі қабатындағы процестердің кешенді дамуын қарастыруға болады. Басқа шетелдік дерек көздерде қазіргі геодинамика – бұл уақыттың нақты масштабындағы Жердің қозғалысы туралы ғылым, яғни іргелі ғылымдар ретінде өлшеуге, анықтауға және түсіндіруге болатын қозғалыстарға сілтеме жасау. Соңғы 30 жылдарда әлемдік ғылымның қалыптасуымен әр түрлі болжамдар мен ескертпелердің орнына литосфералық тақталар тектоникасы теориясының, мазмұнды термині көптеген көп қырлы монографияларда, сөздіктерде және кітаптарда айтарлықтай өзгерді. Шетел әдебиеттерінде геодинамика негізінде Жердің ішкі бөліктерінде болып жататын процестер мен оларға әсер ететін күштер арқылы геология саласы туралы түсінік пайда бола бастады. Бұл жұмыстың мақсаты мен міндеті – геодинамиканы ғылымның жаңа бағыты ретінде қарастыра отырып, геодинамикадағы геодезиялық ізденістердің нәтижесіне жалпы шолу жасау.

Түйін сөздер: геодинамика, геодезия, геология, карьерлер, пайдалы қазбаларды өндіру.

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Роль и значение геодезических изысканий в геодинамике

Наука геодинамика активно развивается как новое направление в последнее время, особенно в последнее десятилетие. Впервые этот термин был описан в монографии А. Лява 90 лет назад как взаимосвязь Земли и космических факторов, а также законное регматическое образование трещин – световой сетки на всей поверхности дна и всей поверхности планеты. В последние 20 лет определение геодинамики часто используется в несколько ином варианте, так под геодинамикой стали понимать весь комплекс процессов развития внутри Земли. В зарубежной же литературе под геодинамикой стала пониматься отрасль геологии, занимающаяся изучением сил и процессов, происходящих только во внутренних частях Земли и обуславливающих формирование разнопорядковых структур и деформаций в ее оболочках. Впоследствии Э. Ог рассматривал геодинамику как раздел тектоники, изучающий силы, воздействующие на планету и явления, происходящие на ее поверхности. В других же иностранных источниках современная геодинамика представляет собой науку о движениях Земли в реальном масштабе времени, то есть ссылаясь на те движения, которые можно измерять, идентифицировать и объяснять на языке фундаментальных наук. Цель и задача этой работы - сделать общий обзор результатов геодезических изысканий в геодинамике, рассматривая геодинамику как новое направление науки.

Ключевые слова: геодинамика, геодезия, геология, карьеры, добыча полезных ископаемых.

Introduction

Geodynamics was first used in the monographA. Liyav 90 years ago. A. Liyav formed it as a relationship between the dynamics of the Earth and space factors leading to the formation of tides in the crust and the formation of regular regmatical grid of cracks and ruptures across the surface of the planet. Over the past 20 years, geodynamics has often been used in a slightly modified way. Under geodynamics began to understand the whole complex of development processes inside the earth, at that moment in the foreign literature under geodynamics began to be understood the branch of geology engaged in studying of forces and the processes occurring only in internal parts of the earth and causing formation of various structures and deformations in its shells (Yudin, 2005:21-24).

The current geodynamics of the continental lithosphere should be considered as a result of the interaction of a complex of natural endo-dynamicand outsidedynamic processes(geological processes that occur in the Earth's interior depending on the internal energy, gravity, and forces that occur when the Earth rotates), the elucidation of causal links between which often represents an independent scientific problem. Its solution opens the way for revealing regularities of geodynamic processes variations in time and space. The most important is the medium-term forecast of socially dangerous phenomena, which are often catastrophic in nature. Integrated information on the geodynamic state of large regions is usually reflected in geological maps. At present, they are practically the most popular documents, which are the basis of the exploited and planned for the development of social and economic protections.

Fully completed tasks on the integration project, their generalization combined with some results of work on other projects, allowed to get a new idea of the geological structure of Asia and to draw a map of modern geodynamics of Asia. It is based on the data on the stress state of the lithosphere, which provides an opportunity to consider the relationship between the formation of structures and processes in the lithosphere of Asia from a new angle of view. At the current level of knowledge, only a comprehensive analysis of geological and geophysical observations allows us to create a model of geological development of the continental lithosphere that is close to reality. On its theoretical basis, socially important works on the forecast of natural, including cataclysmic, processes can be continued (Levi, 2005: 254-261).

Materials and methods of research

Geodynamics is a subfield of geophysics dealing with the Earth's dynamics. It applies physics, chemistry and mathematics to the understanding of how mantle convection leads to plate tectonics and geologic phenomena such as seafloor spreading, mountain building, volcanoes, earthquakes, faulting and so on. It also attempts to probe the internal activity by measuring magnetic fields, gravity and seismic waves, as well as the mineralogy of rocks and their isotopic composition. Methods of geodynamics are also applied forexploration of other planets.

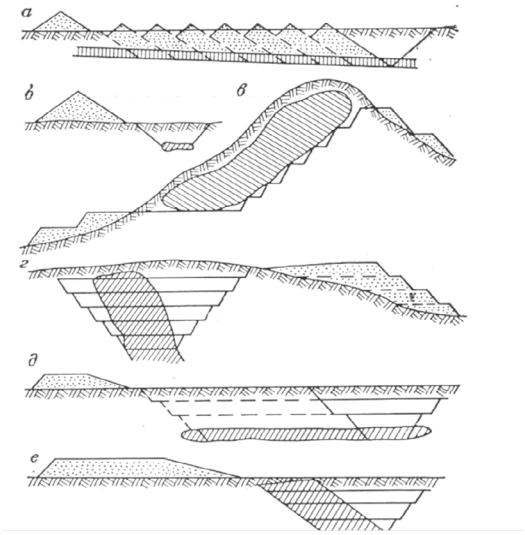

Figure 1 – Relief, which forms during the opencast development of various types of fields These measures lead to the most significant changes in terrain. The amplitude of heights between the bottoms of the deepest excavations and the highest dumps has now exceeded 1100 m. Information on changes in the relief of land during the extraction of solid minerals is systematized by V. A. Ovchinnikov

V. A. Ovchinnikov's data testifies to the fact that the peculiarities of the developed relief forms during the quarry production are determined by the conditions of the deposit occurrence (Figure 1). At the same time, the shape of accumulating bodies depends to a certain extent on the waste rock dumping technology.

Having analyzed the known maps of geodynamics (Zonenshain, et all., 1988: 112; Map of Newest Tectonics…, 1998), other editions and having taken all the best of them, the authors have come to toe conclusion that on maps of modern geodynamics it is necessary to display only the main complex of various components of endogenous and exogenous situations. This allows, on the one hand, to reveal the regularities of spatial distribution and variations of one process, and on the other hand, to determine the areas of "superimposition" of different processes, where their interaction can lead to the initiation of other processes, including catastrophic ones.

The most important endo-dynamic components that determine the state of the lithosphere at the present stage of its evolution have been estimated: the thickness of the lithosphere, its stress state, active faults and their density, seismicity, volcanism and kinematics of horizontal movements of large blocks.

The thickness of the lithosphere L (km) was estimated by the equation $\ln L=320.4e^{-0.017q}$, where q is the heat flux (mWt/m^2) averaged over a grid of 50*50 (Levi, 1991). The correlation ratio determined for this equation is 0.9 with a sample size of about 200 pairs of values. Variations in the thickness of the lithosphere reaches 200-250 km or more abruptly decreases to 70- 100 km under the modern mobile belts. Variations in the thickness of the lithosphere within different geodynamic regions cause changes in its stress-strain state, the de gradient of tectonic motion speed and density of active faults, without which the manifestation of block tectonic movements is impossible *(layer 1)*. The density of active faults was determined by honoring their number N in a window of 5°x5°. Within Asia, it varied from 0 to 40 units: the minimum on cratons is maximum in modern submerged areas. An increase in the number of active faults in the regions of the relatively thin lithosphere is clearly visible. The growth of their number leads to an increase in heat outflow from the bowels, additional heat due to the deformation of the lithosphere layers and friction on the fracture planes in the process of tectonic blocks movement. All this causes relative overheating of the upper lithosphere and changes in its rheological properties.

Results and discussion

Let's briefly characterize the active faults of Asia. They are usually understood as breaks with signs of tectonic movement in historical time or, more broadly, during the Holocene - the late Pleistocene. They reflect the manifestation of modern tectonic

activity. The undisputed signs of movement are the observed surface deformation and displacement of Late Pleistocene and Holocene sediments and relief elements (Fault Activity Map…, 1987; Geodynamics…, 2000). Rift activity indicators include geodetic data on modern movements in their planes, linear location of Holocene volcanoes and earthquake epicenters. Active faults are mapped by ground-based observation and interpretation of aerospace materials.

Taking into account the peculiarity of the stress-strain state of the lithosphere, they are offen classified by morphogenetic accessories. The known data on the size and age of Holocene displacements made it possible in many cases to estimate the velocity of movements along the fault plane. At impulse movements connected with earthquakes, the average speed for large time intervals was calculated taking into account the frequency of occurrence of seismic events.

Here is a brief regional overview of the largest active fault zones and their main parameters. In the Caucasus, Late Pleistocene – Holocene and modern active movements are carried out mainly through the already known modern faults. At the present stage the most active ruptures of the "Caucasian" (Western from the North-Western) and "anti-Caucasian" (North-Eastern) stretches are the most active (Koshelev, 1991).

Mining relocation activities

Pit mining. This way of extracting mineral resources, due to the possibility of its progressive cheapening, is increasingly replacing the competitive underground mining operations. According to E. P. Doronenko, the cost of extraction of 1 ton of raw ore by open-cut method is 3-3.5 times higher in comparison with the underground method of extraction of the mineral resource.

The open-pit mining method achieves a mere complete extraction of minerals. The possibility to create deep quarries (some of them have depths of more than 700 m) is associated with the use of highly profitable equipment. For example, in Canada, in preparation for open pit mining, a copper- nickel ore deposit for overburden removal of 11.5 million tonnes of overburden is being prepared. m3 a hydraulic suction dredge is used. Water for it was supplied from the nearest lake and there was also sucked rock. The elliptical excavation reaches a length of 1.1 km and a width of 0.6 km. Recently, Arizona (USA) began mining copper ore from the open pit, with a total of 113. 3 million tonnes of open pit material м3. Currently, the share of open-pit mining in the global mining industry is 66%. The share of ores of different metals extracted by this method is 57%, coal -34% and construction materials – 97%.

In the United States, the share of open pitor pitmining in mineral production is 84%. The open-pit mines receive 85% of the total number of ores mined and 42% of the coal.

In the USSR, the development of mineral deposits by quarrying is rapidly increasing. In 1975, the volume of stripping work in the USSR amounted to 2.2 billion and by 1990, it's increasing several times. The share of open-pit mining with the production capacity of up to 1 billion tons is decreasing. In 1975, as compared to 1970, the number of such quarries in the USSR Ministry of Economic Development and Trade decreased and amounted to 39.3% of the total number of quarries, with a specific weight of 3.1% of production volumes.

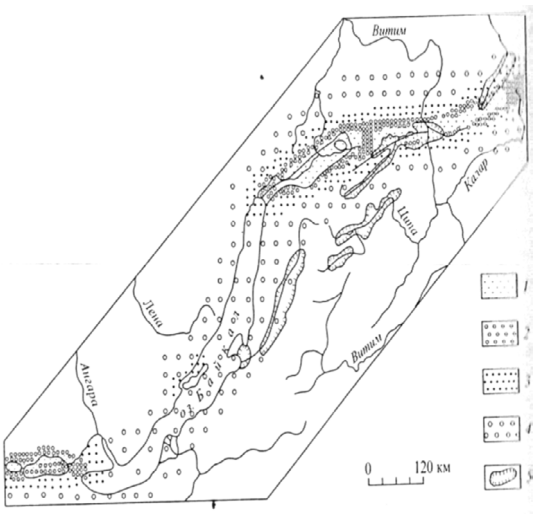

Figure 2 – The scheme of zoning of regional voltage fields in the Baikal rift zone (Sherman, 1989)

The depth of the quarries increased by 30-50 m or more from 1970 to 1975 at an average annual rate of deepening from 5 to 12 m. Thus, in 1975, the share of quarries with depths from 100 to 250 m increased from 28.3% to 36.1% in the USSR Ministry of Culture. According to N.A.Bykhover, the share of the open-pit mining method in its total volume is now 81% for iron ores and for others; for manganese ores – 78.7%, for ores of non-ferrous metals -64%, for mining and space raw materials -82% and for other non-metallic minerals and building materials – almost 100%. According to V. N. Novozhilov, as of the end of the 1970s, there were more than 3500 quarries in the USSR, of which more than 30 are over 150 m deep, the height of dumps in some quarries reaches 100 m (in the project - 400 m and more); the volumes of separate tailings dumps 100-250 million м3(in the project 500 million, м^3). The deepest are the Korkinsky coal pits in the Chelyabinsk Region - 470 m. The design depth of some quarries exceeds the mark of 600 and 700 m (Morgan, 2017).

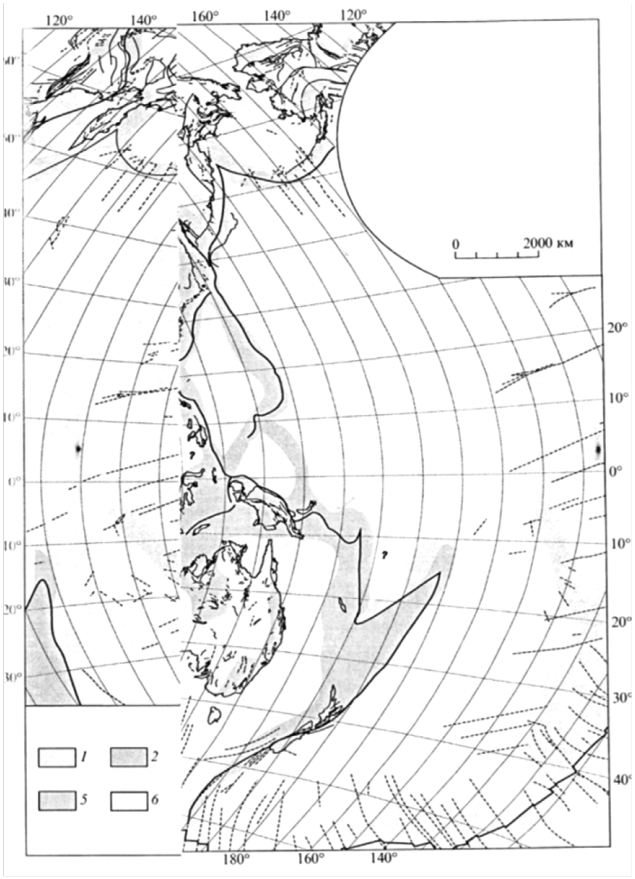

Figure 3 – International tectonic map of the world 1-6 – types of intense; 2 – shear tensile, $\sigma_Z = \sigma_y > \sigma_x$; 3 – shift, $\sigma_x > \sigma_Z > \sigma_y$; 4 – shear compression; 8 – the boundaries of the major plates of lithosphere; 9 – faults (a)

In case of quarry mining, the following operations are carried out: 1) removal of overburden rocks and formation of dumps, 2) construction of ditches for drainage of surface waters and accumulation of dumps, 3) extraction of mineral resources, 4) formation of dumps from tailings and ore concentration.

Geodynamics is a broad field which combines observations from many different types of geological study into a broad picture of the dynamics of Earth. Close to the surface of the Earth, data includes field observations, geodesy, radiometric dating, petrology, mineralogy, drilling boreholes and remote sensing techniques experiments

These measures lead to the most significant changes in terrain. The amplitude of heights between the bottoms of the deepest excavations and the highest dumps has now exceeded 1100 m. Information about

changes in the relief of land during the extraction of solid minerals is systematized by V. A. Ovchinnikov. Here are some of the data relating to the results of the quarrying and processing of mineral resources.

Geo ecological studies of the formation of very dangerous for mankind natural soufflars have shown that their geodynamic development depends on both toe peculiarities of the geological and tectonic structure of the mine fields (positive plicative structures, faults in the kernels of anticlines, gas weathering and other factors). Keywords: soufflars, geo-ecology, geodynamics, anticline nuclei, gas saturation. Kuznetsk coal basin (Kuzbass) is one of the largest coal deposits of the Russian Federation and is administratively located in the south of Western Siberia, in the territory of the Kemerovskaya oblast (Levi, 2005: 254-261). the practice of coal mining shows that almost all underground mine workings of the Kuznetsk basin connected with mines of various depths, in which methane with impurities of hydrocarbons, hydrogen and helium are mainly renewed everywhere, belong to explosive on gas. The most dangerous types of catastrophes associated with toe presence of soufflars in the rocks and coals of the described basin are given from the point of view of geo-ecology:

– sudden methane emissions,

– the explosion of methane soufflars together with coal dust,

– the soufflars and the underground fire connection with them. This article will focus on the nature and dynamics of the early Permian soufflar formation.

In the Kuznetsk Basin, there are three types of disturbance of the horizontal occurrence of rocks. plicated (folded), disjunctive (explosive) and injectable (amagmatic) dislocations. The most widespread, almost everywhere, are various, mainly with block movements of the ancient crystal bed of the basin in the category with horizontal movements of the Earth's crust of the collision type. Folded dislocations are represented by a wide range of structures of different orders – folds with the length of tens of kilometers and amplitude up to 1000 and more meters, up to microforms with the size of the first the early Permian soufflar formation. In the Kuznetsk Basin, there are three types of disturbance of the horizontal occurrence of rocks. plicated (folded), disjunctive (explosive) and injectable (amagmatic) dislocations. The most widespread, almost everywhere, are various, mainly with block movements of the ancient crystal bed of the basin in the category with horizontalmovements of the Earth's crust of the collision type (S.P.Gorschkov, 1996:184-197). Folded dislocations are represented by a wide range of structures of different orders – folds with the length of tens of kilometers and amplitude up to 1000 and more meters, up to microforms with the size of the first meters. Breaking dislocations are also excellent in shape and size - from regional faults with a length of more than 100 km and an amplitude of up to 1-3 km to subtle hollow cracks. Almost all large and overwhelming majority of ruptures with different amplitudes are represented by the structures of discharges and overthrust discharges formed, as our studies have shown, in the geodynamic conditions of large-scale compression and collision of the coal basin as a whole, especially in the mountainous Salaira part of it. Up along the section, the deep faults slowly fade out, which is well observed in the predominantly thick Paleozoic deposits of the roof of the composite section of the productive Paleozoic (S.P.Gorschkov, 1996:184-197).

Conclusion

This article was written according to theoretic materials and it gives general explanation of geodynamics. In conclusion, the current geodynamics of the continental lithosphere should be considered as a result of the interaction of a complex of natural endos and exo dynamic processes, the elucidation of causal links between which often represents an independent scientific problem. Its solution opens the way for revealing regularities of geodynamic processes variations in time and space. The most important is the medium-term forecast of socially dangerous phenomena, which are often catastrophic in nature. Integrated information on the geodynamic state of large regions is usually reflected in geological maps. At present, they are practically the most popular documents, which are the basis of the exploited and planned for the development of social and economic protections.

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