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Methodology for Studying the Geodynamic Situation of Formation of Ore Deposits

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Annotation **- The work highlights the current state of the science of geodynamics. Based on this, it has been established that today the urgent problem is the question of the geodynamics of ore fields and deposits. The paper describes the basic principles developed by the authors of the methodology for reconstructing the geodynamic conditions of ore deposits in the period of ore formation. The results of testing this method at the Daugaztau gold ore deposit (Central Kyzylkum) are presented.**

Keywords - Deformation, Deposits, Faults, Geodynamics, Mineralization, Structures, Tectonophysics, Tension.

JUSTIFICATION

Exploration is one of the most important structural units of geology. On their basis, mineral and raw material bases are created for all sectors of the national economy and industry.

Since the end of the 20th century, the task of expanding the mineral resource base has become the main problem for all countries of the world. It is vitally important for all countries of the world, which arises on the basis of their economic growth and political development of states.

The scientific and technological revolution in the aerospace and military industries, in agriculture, and in the chemical, fuel, energy, and electronic industries has required an increase in the mineral resources base of noble non-ferrous, ferrous, radioactive, and other metals, as well as oil and gas. To meet the needs of industry, all sectors of the economy, it is necessary to increase the mineral resource base. And for this, first of all, expansion of the volume and quality of exploration work will be required. Hence the improvement of the search and reconnaissance methods, their integration in production, the development of new research methods that allow us to discover new facets of the genesis, patterns of mineralization formation and placement.

Currently, in the geology of Uzbekistan, special attention is paid to areas where the ore-bearing structural floor, horizons, favorable ore-bearing formations and structures are covered by a cover of Mesozoic-Cenozoic rocks. Geological exploration in these conditions requires an increase in the volume of work and investment in their implementation.

Under such geological and economic conditions, an increase in the efficiency of prospecting and exploration and further operational work can be achieved by improving the theoretical foundations and methodological principles of studying the

laws of formation and placement of mineralization, forecasting and searches in the conditions of closed territory, by effectively integrating the methods of prospecting and exploration, as well as using new technologies and techniques.

The basis for the development of a geodynamic methodology was integrated geological, geochemical, geophysical, aerospace, biostratigraphic and other studies of planetary and regional scales, aimed at studying surface and deep geological phenomena, physico-chemical processes that cause tectonomagmatic activation, new structures, metasomatic changes and ore formation which is accompanied by the migration of chemical elements and their concentration in the earth's crust.

In the world of the development of geodynamics, the development of its theoretical foundations and the application of the results of complex geological research in applied geology, new concepts have been formed, such as historical geodynamics, regional and deep geodynamics, geodynamic analysis, geodynamic (structural-material) complexes, geodynamic models, geodynamic maps, geodynamic processes and others (Planet Earth. 2008). For each of them, a methodology for conducting geodynamic research was developed and goals and objectives were determined, and the expected results were established.

Today, for many countries of the world, the main problem of geology is the expansion and strengthening of the mineral resource base. One of the ways to solve this problem is to study and evaluate the flanks and deep horizons of known and developed deposits, where the laws of their formation and mineralization conditions with the identification of the main (lithological, structural and magmatic) ore-controlling factors are established:

As shown by studies of ore deposits of the Central Asian metallogenic belt Kh.M. Abdullaeva, I.Kh. Khamrabaev H.N. Baimukhamedov A.V. Koroleva, P.A. Shekhtman, V.A. Queen, H.A. Akbarova, V.P. Fedorchuk, F.I. Wolfson, N.A. Nikiforov, E.M. Nekrasova, N.P. Laverov, V.A. Nevsky, P.V. Pankratiev, V.F. Chernysheva et al., The main factor controlling hydrothermal mineralization is structural, i.e. in the formation of deposits and the placement of endogenous mineralization in them, the main role is played by discontinuous and folded structures. In this regard, when studying the flanks and, in particular, the deep horizons of the studied deposits, it became necessary to decipher the mechanism of formation and development of these ore-controlling structures. Their formation and development, as well as other geological phenomena occur against the background of tension and deformation of the earth's crust, which are closely interconnected. The manifestation and combined influence of the internal and external forces of the Earth change the structure, structure and composition of the earth's crust, and directly affect its activity (movement), strengthening or decreasing it. This activity affects tectonic tension and deformation, activates previously laid structures and forms new structures, which in the future may become the main cause of the manifestation of various geological phenomena, including ore ones. All these processes in the complex determine the geodynamics, that is, the geodynamic situation of the earth's crust.

METHODOLOGY DEVELOPMENT

Research by H.M. Abdullaev, K.L. Babayev, I.Kh. Khamrabaev, A.V. Korolev, P.A. Shekhtmen, V.P. Fedorchuk, H.A. Akbarova, P.V. Pankratieva, V.A. Koroleva, Yu. Shikhina and other geological and structural conditions for the placement of endogenous mineralization of various geological and industrial types of gold, silver, lead-zinc deposits. The Central Asian folded belt makes it possible to clearly distinguish ore-controlling structures incorporated before ore formation and in ore formation processes.

In this regard, one of the supporting element of the method for decoding the geodynamic conditions of ore deposits of the ore formation period developed at the Institute of Mineral Resources of the Goscomgeology of Uzbekistan is the result of studying the geological and structural conditions for the formation and placement of hydrothermal mineralization. The technique allows reconstructing the geodynamic situation of the area of mineralization (ore fields and deposits) before the processes and during ore formation.

Deciphering the geodynamic conditions of ore formation, first of all, begins with the study of regional geological processes that caused this geodynamics, the results of which allow us to determine and clarify the direction of regional tectonic efforts acting on the study area.

The study of the geodynamics of ore fields and deposits consists in determining the active structures, the influence of their activity on the stress and strain, on the movement of tectonic blocks and on the process of new structure formation, in establishing the relationship of the processes of activity of block-discontinuous structures, tension and deformation with the manifestation of ore mineralization. But the most important thing is that the developed technique allows you to decipher the kinematics of the formation and development of ore-controlling structures, to trace their physical condition before and in the time of ore formation. In addition, it will establish the reason why endogenous mineralization is localized in certain local areas (structural positions) of ore-controlling structures, despite the fact that they are very long.

Thus, the study of the geodynamic conditions of ore fields and deposits of the ore formation period will allow: to establish regional causes that determine the activity of structural elements in the ore deposition stage; identify the causes

(fault activity, structure and composition of the ore-containing medium, tension, deformation) that determined the ore localization in ore-controlling structural positions; establish the nature and intensity of the tectonic activity of ore-controlling structures; determine the zones of local compression and tension deformation with the establishment of the reasons for their formation; to analyze the results of decoding the geodynamic situation, with manifestations of ore mineralization. All these data are the basis for the development of geodynamic forecasting criteria and the search for new industrial clusters of ore elements.

As noted above, a feature of geodynamic research is that it primarily relies on the results of studying the geological and structural conditions for the formation and placement of endogenous mineralization, where the main method is geological and structural. Analysis of the conditions of formation and placement of mineralization, where special attention is paid to the surrounding medium and its heterogeneities, gaps and folds, however, this method can record the results of geological processes at certain stages of the development of the object, including the ore stage. This does not allow us to trace the mechanism of formation and development of ore-controlling structures, the formation of favorable structural positions, the stress-strain of the area of the ore object during ore formation. The solution of these problems of the geodynamics of ore fields and deposits is carried out by the method of physical modeling of tectonophysics, the essence of which is to study the tension and deformation of the model of the structures of the ore object by optical modeling.

Thus, the basis of the developed methodology for the geodynamic studies of ore fields and deposits is not only the data of geological and structural studies of the conditions for the formation and placement of mineralization, as well as the results of a study of their stress-strain state.

A comparative analysis of the results of geodynamic studies with the metallogenic feature of the studied ore objects allows us to determine the dynamics of the formation of favorable structural positions for mineralization, and this will allow us to develop geodynamic criteria for forecasting and searching for new ore deposits on the flanks and deep horizons of known and developed deposits.

The developed methodology for studying the geodynamics of ore fields and deposits was tested on gold deposits of the East (Guzaksay, Kyzylalmasay, Kauldy, Kochbulak and others) and Western Uzbekistan (Muruntau, Daugiz, Amantaytau, Marzhanbulak, Kokpatas and others).

TESTING METHODOLOGY

Geodynamic conditions of ore formation in the Daugiztau ore field. The geological and structural position of the Daugiztau ore field is determined by its confined to the site of intersection of the Daugiztau dislocation zone with the Beltau-Daugiz folded-fractured structure (Ore deposits of Uzbekistan 2006). One of its main objects is the Daugiztau gold deposit, confined to the interface section (structural position) of the Daugiztau and Asauk faults. In its geological structure, two structural floors are distinguished: the Lower Paleozoic structural floor, composed of metaterrigenous formations of the Besapan Formation, and the upper Mesozoic-Cenozoic sedimentary cover Ore-bearing formations of the lower structural floor. The spatial distribution of ribbon-like and lenticular ore bodies is controlled by the northwestern and northeastern, submeridional faults.

At the initial stage of reconstruction of the geodynamic environment of the ore formation of the Daugiztau ore field, it is necessary to determine the geodynamic position of the Beltau Upland, in the central part of which there is an ore field, in the geodynamics of Central Kyzylkum in its Hercynian era of development.

Central Kyzylkum are characterized by the complexity of the geological structure, the diversity of the manifestation of folded-fault faults and tectonic blocks. A study of the geodynamics (Fig. 1) of the Hercynian stage of development of the Central Kyzyl Kum region made it possible to establish that under the influence of regional tectonic efforts of the northeastern direction, northeastern, submeridional faults, which are the boundary elements of large tectonic blocks, became more active. The activity of the faults caused the movement of the blocks, which was reflected in the internal structure and the stress-strain state of each block. The Beltau Mountains is one of these elongated blocks, where its western and eastern borders are anti-Tien Shan transverse deep faults, which also began to move under the influence of regional tectonic compression forces on the region (the influence of microplates according to L.P. Zonsanshayn, T.N. Dalimov, Yu.S. Savchuk, R.Kh. Mirkamalov and others) The movement along the boundary faults occurred counterclockwise, and therefore, the eastern part of Beltau is relatively shifted to, southwest and western to northeast.

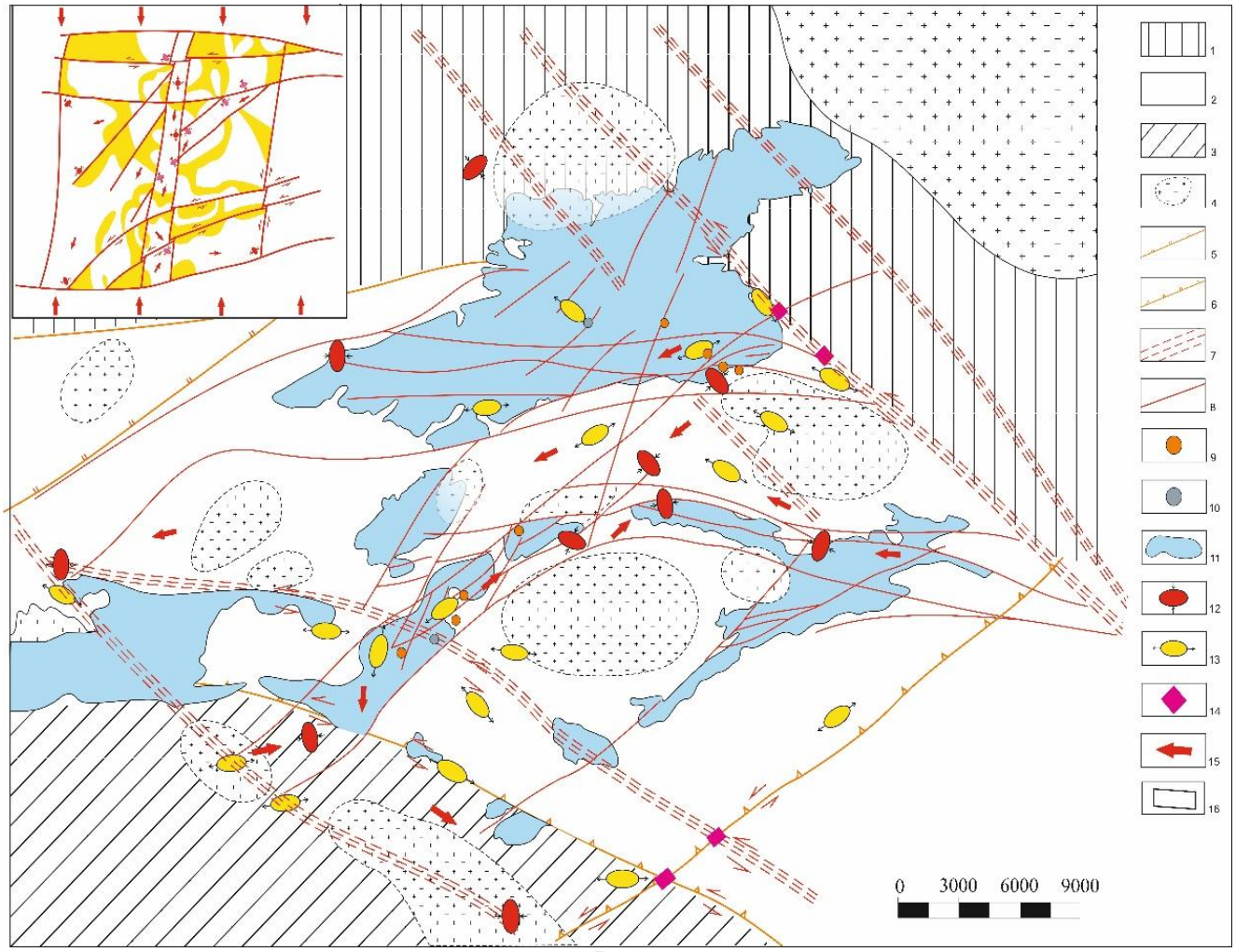

FIG. 1
MAP OF GEODYNAMICS AND ORE-CONTROLLING STRUCTURES OF THE TAMDYTAU-BELTAU, AMANTAYTAU-BELTAU, AUMINZATAU, BELTAU-SANGRUNTAU REGIONS

1 - South Bukantau Turkestan-Alai PPS; 2 - Zerafshan-Turkestan PPS; 3 - Zerafshano-Alai SFZ; 4 - acid and basic intrusions; 5 - longitudinal faults restricting the PPS; 6 - transverse faults; 7 - through ore-controlling fault; 8 - ore-controlling faults; 9 - boundary of the volcanic structure; 10 - gold ore objects; 11 - silver objects; 12 - outputs of the Paleozoic; 13 – zone of local compression; 14 – zone of local tension; 15 – slightly open fault sections; 16 – direction of combination of blocks.

The impact on the Beltau block of regional tectonic efforts caused the activity of its boundary structures, and together these processes led to the formation of ore-controlling fault systems of the north-eastern direction. In addition, they affected the tension, which weakened simultaneously with the deformation. In addition to boundary transverse faults, latitudinal and northwestern fracture systems were also active. Activity is manifested in the form of a fault-shift with a small amplitude.

In such a geodynamic setting of the Beltau mountains, due to the influence of regional tectonic efforts, the process of ore formation took place with the formation of numerous ore occurrences and deposits (Daugiztau, Amantaytau, Asaukat, Vysokovoltnoe) of gold

A study of the geodynamics of the Daugiztau ore field of the period of the location of gold mineralization (Fig. 2) based on geological, structural and tectonophysical data shows that by the stage of ore formation, faults of northeastern, latitudinal systems and transverse anti-Tien Shan deep structures existed. The phased formation of these fault systems divided the ore field into a series of small tectonic blocks. Thus, the block structure and the system of discontinuous structures determines the structural framework of the ore field.

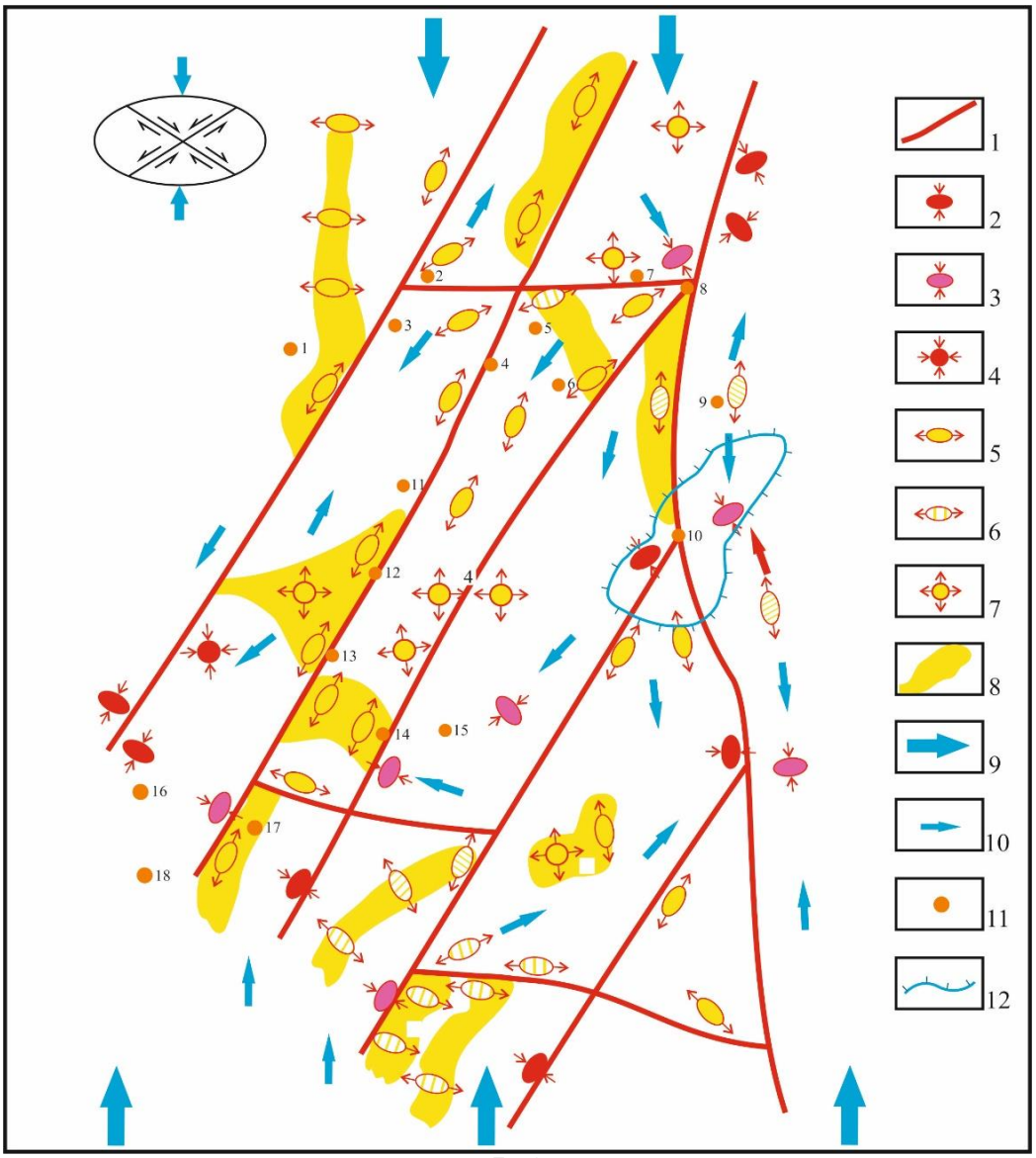

FIG. 2
SCHEME OF THE GEODYNAMIC SITUATION OF THE ORE FORMATION PERIOD OF THE DAUGIZTAU ORE FIELD. OPTION 3. (THE BASIS IS IN M-BE 1: 50000). TECTONIC DEFORMATION PLAN LEGEND.

1 - faults; 2 – zone of local compression; 3 - estimated compression zone; 4 - zone of comprehensive stretching; 5 – zone of local tension; 6 - proposed stretch zone; 7 – zone of comprehensive stretching; 8-stretching area; 9 – direction of regional compression force; 10 – direction of displacement of local sections; 11 - ore display; 12 - border of the Paleozoic basement.

Based on structural positions, morphological features of mineralization, their association with discontinuous structures and other geological data, ore-controlling roles of northeastern, transverse deep, and latitudinal structures have been established. Their activity caused a displacement of tectonic blocks, which served as the main cause of tectonic activity of intra-block structures, changes in tension and deformation. These changes are especially clearly observed along ore-controlling structures, as well as in the zones of their conjugation and intersections. The dominance of horizontal tectonic forces in the geodynamics of ore formation led to increased activity of the northeastern structures along the horizontal plane

in the form of a shift. Fault movement caused block displacement. The blocks to which the Dargyztau, Asaukak, and Vysokovoltnoye deposits are confined experienced a displacement in the southwest direction. Despite the slight displacement of the blocks, it was reflected in their stress-strain state. The joint manifestation of the activity of the boundary structures and tectonic blocks and their stress - strain determined the internal geodynamics of the blocks, where there is an update of previously laid intra-block structures and new structure formation. In addition, these processes contributed to the formation of opening cavities along ore-controlling structures in the zones of their conjugation with the Daugiztau deep fault, creating structural positions favorable for the placement of endogenous gold mineralization. It was in these structural positions that the formation of the Daugystau and Asaukak deposits took place. Their structural position is confined to a block with a wedge-shaped form formed due to the conjugation of the northeastern faults with the Daugiztau depths of the faults. The geodynamic situation of the areas of these deposits is due to the horizontal displacement of tectonic blocks, the displacement of which is characteristic, the wedge-shaped morphology of their northern sections under the influence of regional tectonic compression forces contributed to the formation of opening cavities. And simultaneously with these processes, new separation structures were formed, complicating the internal structure of the ore-controlling structures and their near the fracture space, which led to the decompression of the host medium, which was one of the reasons for the arrival of ore-bearing solutions from the depths of the Earth and, subsequently, the formation of gold ore deposits.

CONCLUSION

Thus, the geodynamic situation of the Daugiztau ore field with gold mineralization is due to the regional tectonic regime, where horizontal movements dominate. Horizontal forces caused the activity of northeastern, latitudinal ore-controlling faults, and they, in turn, tectonic blocks. These tectonic phenomena were reflected in tension and deformation, there was a redistribution of tectonic stresses both on faults and inside tectonic blocks. Zones of local deformation of compression and tension were formed. The latter, characterized by a drop in tectonic tension, a weakening effect of tectonic forces, which was a favorable situation for the manifestation of gold mineralization. The geodynamic processes observed in the ore-controlling fault, tectonic blocks, contributed to the formation of cavities ajar, new structure formation, which also was a favorable environment for the formation of gold ore objects.

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