The American Journal of Applied Sciences
(ISSN – 2689-0992)
Published: December 27, 2020 | **Pages:** 50-60
Doi: https://doi.org/10.37547/tajas/Volume02Issue12-09

IMPACT FACTOR
2020: 5. 276

OCLC - 1121105553

Main Features Of Ore Potential And Statistical Metallogenic Assessment Of The Zeravshan-Alay Belt (South Tian-Shan)

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ABSTRACT

This work reflects the geological structure, history of development and ore content of the Zirabulak-Ziaetda and Kuldzhuktau ore-bearing complexes. The types of placement of structures are considered: focal-zonal, belt, nodal and frame-nodal. In the Zeravshan-Alai metallogenic belt, regularities have been established for the distribution of endogenous mineralization of ore regions and provinces. A metallogenic map was compiled using GIS technology using statistical analyzes to identify promising areas

KEYWORDS

Apogranites, deciphering of space images, structural formation map, electronic metallogenic map, focal-zonal, belt, frame, nodal, Hercynian folding, complexing signs, maps of lineaments and ring structures.

INTRODUCTION

ore regions of the Tien Shan, a significant variety of formations of apogranite, pegmatite, greisen, plutonogenic-hydrothermal, volcanogenic-hydrothermal and volcanogenic-sedimentary deposits of non-ferrous, rare, radioactive and noble metals has been established.

The relationship between endogenous mineralization and magmatism has been considered by many researchers. Kh.M. Abdullaev specially considered the genetic relationship of endogenous mineralization with intrusions. Petrological, mineralogical-geochemical and other studies of subsequent years have confirmed many scientific ideas of Kh.M. Abdullaev, Kh.N. Baimukhamedov, I.Kh.

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Khamrabaev, V.I. Popov, V.P. Fedorchuk, V.I.Korolev, T.N. Dalimov and other scientists - geologists.

In recent years, the study of mineral deposits involves the creation of a model by a complex metallogenic analysis of the geological structure, history of development and ore content of the region. Methods of metallogenic analysis provide for formation studies in order to identify criteria for ore content and predictive assessment of the prospects for the type of mineral under study and the significance of non-traditional types of mineralization [1, 2].

In the world practice of geological research in recent years, modeling is carried out using modern computer GIS technologies. A.B. Goipov (2016) noted that "GIS technology allows you to combine large volumes of cartographic and thematic information into a single system, and thereby create a consistent data structure for analyzing available and received information. ERS and GIS technologies make it easy to integrate and analyze research data for decoding satellite images " [3].

METHODOLOGY

Convolution of the available information in graphical form is performed as the most capacious tool for reflecting and visualizing geological data, accompanied by a quantitative assessment of factors by statistical analysis, plotting graphs, diagrams, etc.

Interpretation of the results is: 1) determination of the role of ore-controlling factors (host rocks, physicochemical properties and mineralogical and geochemical composition); 2) compilation of the taxonomy of regional and local promising areas and deposits - scheelite-bearing skarns, pegmatite-rare-metal, pegmatite-quartz-feldspar, greisen-rare metal, skarn-tin-polymetallic, skarn-lead-tin-hydrothermal ore, gold-ore-hydrothermal ore , hydrothermal-copper-metal, copper-nickel-graphite, hydrothermal-mercury, uranium ore occurrences and anomalies. Prospective volcanogenic - sedimentary manganese band. Copper-nickel-graphite mineralization in Kuldzhuktau is associated with endo- and exocontact zones of layered intrusions of the Late Carboniferous peridotite-norite-gabbro complex.

The research used metallogenic, formation, computer cartographic analyzes, geodynamic reconstructions, remote sensing and other types.

A.K. Nurkhodzhaev et al. (2017) noted "on the basis of space survey materials, the geological structure of the territory is being refined, new information appears on the localization and structure of mineral resources, and as a result, on the basis of all that has been done, the main set of maps is compiled" [4]. We have compiled a structural formation (SF) map and a composite electronic metallogenic map.

RESULT AND DISCUSSION

The issues of geological-geophysical and geochemical study of magmatic complexes, metallogenic provinces and ore regions are very contradictory and still remain controversial. There are ore regions where this issue has been sufficiently studied, the generalization of which allows us to note the presence of three groups of endogenous mineralization, these are plutonogenic, volcanic and metamorphogenic deposits. A close association and temporal relationship of skarn-scheelite, skarn-molybdenite-scheelite formations with granodiorites, apogranite-cassiterite, greisen-cassiterite, quartz-cassiterite formations with leucocratic granites of the Chakylklyan-Karatyubin-komplektubinskie, Ziiraklyan-Karatyubin and Ziraetu-djarite copper-molybdenum, quartz-polymetallic formations with small intrusions of diorite-granodiorite composition, quartz-adularia-gold ore, gold-silver and pyrite-

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polymetallic formations with volcanogenic formations. Endogenous mineralization of ore regions transforms into one another, forming formation series, where there is a transition of skarn-magnetite to magnetite, magnetite-hematite; skarn-base-metal to quartz-base metal and carbonate-base metal, skarn-scheelite, skarn-scheelite-sulfide, quartz-gold, quartz-carbonate-ash

The Zeravshan-Alai belt is associated with the folding phases of the Middle and Late Carboniferous. The tectonic movements of the end of the Paleozoic led to the closure of these troughs and to the formation of the Late Hercynian folded zones.

Table 1

Regularities of placement of endogenous ore mineralization districts and provinces

(compiled by O.T. Razikov based on the materials of Kh.N. Baimukhamedov (1987))

Structural types of distribution	Formations and formation types of ores	Spatial and genetic relationship with intrusive formations and folded structures
Focal-zonal	Skarn-magnetite, skar-new-scheelite, skarn-molybdenite-scheelite, skarn-sulfide-gold-copper, skarn-polymetallic, greisen-rare-metal.	With large granitoid intrusions belonging to the batholithic stage of geosynclinal development.
Belt	Rare-metal-pegmatite, hydrothermal-tin-gold ore, mercury-antimony and other formations.	With folded structures of the second and third order, fault zones, they stretch out for tens, and sometimes hundreds of kilometers, forming ore belts, depending on the history of geological development, the nature of magmatism and the features of metallogeny and specialize in certain types of minerals.
Junction	Skarn-hydrothermal, hydrothermal, volcanic-hydrothermal deposits of lead, zinc, copper, gold, fluorite, etc.	In ore regions, they are closely associated with small intrusions and dikes of various compositions, volcanic stocks and other formations.
Frame-nodal	Plutonic-hydrothermal and volcanogenic-hydrothermal deposits of non-ferrous, rare	They are located at the intersection of deep faults, folded structures with faults, where small intrusions, dikes

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	and precious metals.	and volcanic centers, and apparatuses are located.

In terms of its metallogenic essence - in terms of the leading meaning of "through" rare metal and gold ore specialization - it is related to the adjacent Zeravshan-Turkestan zone. The study area belongs to the Zirabulak - Karatyubinsky tin-tungsten belt (Fig. 2), within which skarn-ore deposits and occurrences with tungsten, molybdenum, tin, gold-silver and polymetallic mineralization are known [8].

When studying the patterns of distribution of endogenous mineralization of ore regions and provinces, Kh.N. Baymukhamedov (1987) identified four types of distribution: focal-zonal, belt, nodal and frame-nodal

[nine]. In the studied Zeravshan-Alai metallogenic belt (table No. 2), the patterns of distribution of endogenous mineralization of ore regions and provinces are presented.

Computer simulation to identify

informative signs. The study of the statistical patterns of the placement of gold and other mineralization made it possible to formulate criteria and create a prospecting model for gold, the main provisions of which are as follows:

- The type of gold mineralization corresponds to the model of mesothermal deposits formed near the elastic boundary, at a depth of 10-20 km, in the setting of an accretionary tectonic regime in Kuldzhuktau.
- The ore-bearing for gold is the Taushan Formation sediments, which are volcanic-siliceous-terrigenous (flysch-stroma) C2 formation. Considering that the Kamysta Formation belongs to this formation, it can also host gold or paragenic mineralization.
- The metallogenic specialization of the region with the highest density of gold mineralization is determined by the following complex of elements: gold, silver, antimony, bismuth.

The factors are:

1. Structural factor. Analysis of the relationship between gold mineralization and the direction of the faults shows that sublatitudinal (76 gold objects are located in 2 km buffer zones) and northwestern (71 gold objects are located in 2 km buffer zones) fault systems.
2. Stratigraphic-lithological factor. An analysis of the relationship between gold mineralization and host rocks shows that ancient Silurian-Devonian undifferentiated and Silurian strata are favorable for ore deposition (diagram 2).
3. Geochemical factor. The intervals of gold anomalies from 0.01 to 0.03 g/t turned out to be favorable for gold.
4. Geophysical factor.

The scheme of metallogenic zoning of noble metals in the Zirabulak-Ziaetdinsky mountains according to the density of their distribution was built for 104 objects. Within the entire Zirabulak-Ziaetdinsky ore complex, there are on average 3 objects per 100 km2. 5 large regions were identified: No. 3 (ore occurrence 733), No. 4 (Karmana), No. 5 (ore occurrence 735), No. 6 (Azhdarbulak ore occurrence), No. 13 (Lolazor). A diagram of the frequency of occurrence of objects of noble metals in the host geological deposits by age in the Zirabulak-Ziaetdinsky ore complex is presented. It can also be seen here that most of the gold objects (over 50%) are in the Middle Silurian-Lower Devonian sediments.

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Essentially, this is metallogenic zoning in terms of the density of ore objects. The diagram clearly shows that the areas of concentration of ore objects (expressed in the diagram in the form of thickening of isolines) alternate with areas with much lower concentrations. The scheme is based on 154 objects. Within the entire Zirabulak-Ziaetdin region, there are on average 4 objects per 100 km2.

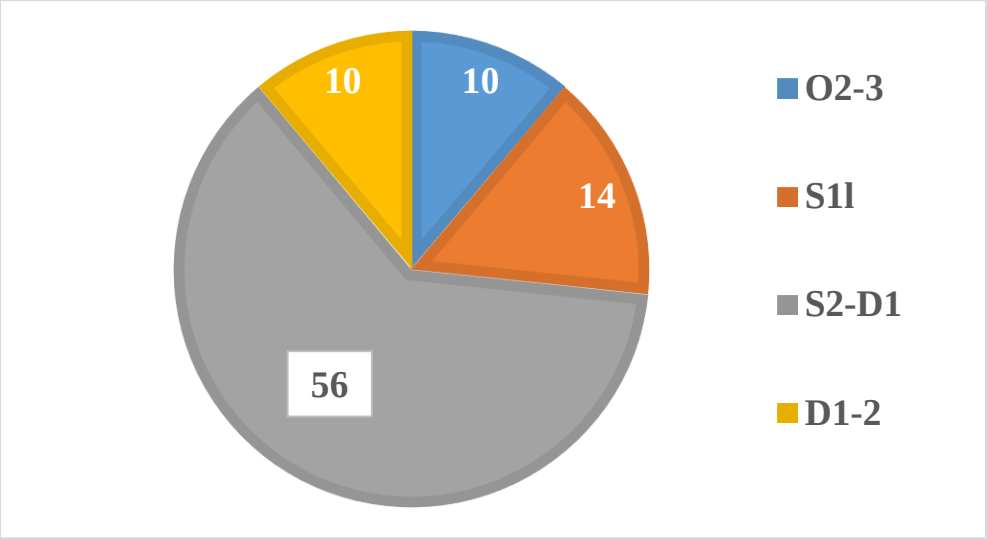

Diagram. Frequency of occurrence of Au-ore objects (number) in the host geological deposits by age in the Zirabulak-Ziaetdinsky ore-bearing complex

Areas where the density of objects' placement is greater than this value are highlighted in dark on the diagram. They represent metallogenic anomalies corresponding in size and isometric shape to ore regions. The diagram shows 5 large ore regions (№№ 4, 5, 6, 7, 16), named by us the region of Ore occurrence 733, Karmana, Ore occurrence 735, Kapkanli and Lolazor region.

Consider the influence of folded structures on ore formation. In the Zirabulak-Ziaetdinsky mining region, as mentioned above, the large folded structures are the sublatitudinal Katarmai anticline (23), the Zirabulak northeastern strike (25) and the Rabidzhan northwestern strike (26). To analyze the patterns of distribution of ore objects in the Zirabulak-Ziaetdinsky mining region relative to folded structures, buffer zones with a radius of 2 km were created (Fig. 1).

Analyzing the above, it can be noted that most of the gold objects are located in the deposits of the Middle Silurian-Lower Devonian - in the Katarmay Formation. This formation is recorded in the Ziaetdin Mountains in the eastern part of the northern slope. The formation includes crystalline schists albite-chlorite, albite-chlorite-

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actinolite, albite-amphibole, albite-epidote-amphibole, quartz-albite-mica, graphitic, carbonaceous rocks.

The most important structural element of the ore field is the Karakutan fault zone, represented by a series of extended latitudinal and sublatitudinal faults, which form two main subparallel zones of crushing and silicification. Practically all deposits and ore occurrences of gold known in the ore field are confined to them. The most significant deposits of Karakutan and Beshkuduk are located in the eastern part of the ore-bearing zone.

In the Zirabulak Mountains, gold mineralization is localized mainly among the limestones of the Sapenskaya suite of the Lower-Middle Devonian, in the shales of the Altyaulskaya suite of the Middle-Upper Ordovician, in the sandy-shale sediments of the Silurian, in the granites of the Karnab intrusive massif.

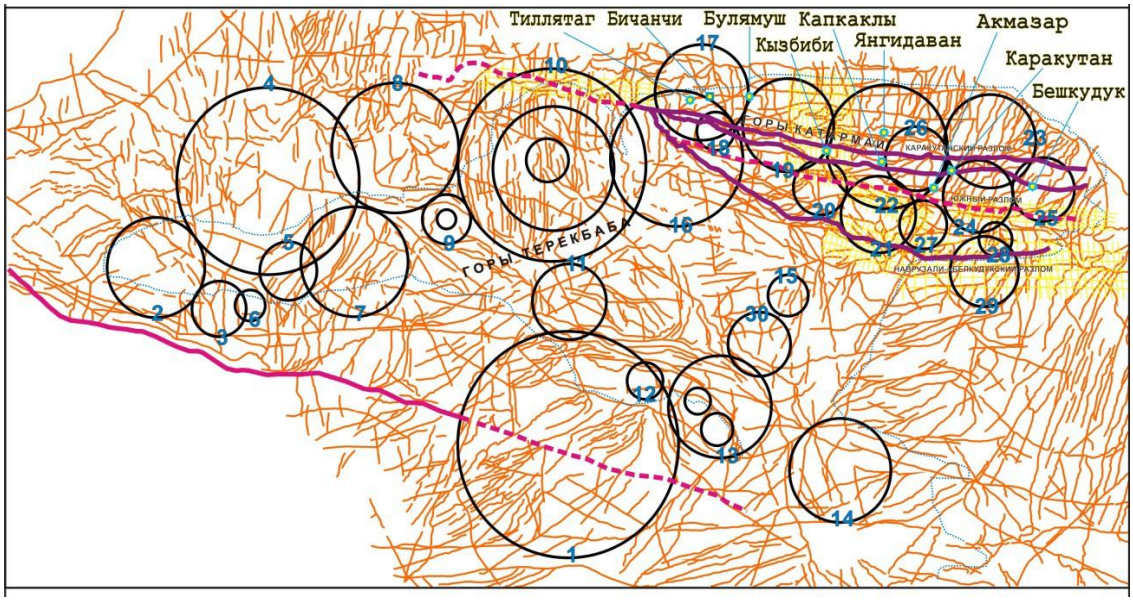

Figure: 1 Cosmostructural objects of the Ziaetda Mountains.

(based on the materials of O.T. Zakirov (2016)) [10].

Structures of the central type (SCT) are located: 1 - in the southern part of the Ziaetdin mountains; 2 - 9 - west-north-west; 10 - 13 -western endings - and a child structure; 19, 22, 23, 24, 26 - gold ore deposits (Karakutan, Kapkakly, Yangi Davon, Kyzbibi, Akmazar); 20, 21, 25, 27, 28 - crossing the southern, eastern and middle parts of Ziaetdin.

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Gold ore objects are closely associated with dyke formations. The youngest formations overlaid with gold mineralization are granodiorite-porphyries of the Karakutan complex.

Table No.2 presents a brief geological description of the gold ore objects of the Zirabulak-Ziaetdinsky ore complex (Tillatag, Bichanchi, Kapkakly), which will be used as benchmarks for forecasting new promising areas [11]. As a result of the combination of methods and favorable factors in the Zirabulak-Ziaetdinsky ore-bearing complex, the resulting electronic maps of the forecast-promising areas for gold were obtained (Fig. 2).

Prerequisites for identifying promising areas for gold. When identifying promising areas, the following prerequisites were taken into account, arising from the study of quantitative factors of mineralization in the Kuldzhuktau mountains, given in the previous chapter: 87% of the gold ore objects of the territory belong to the endogenous type and are localized in terrigenous strata, including sandy-shale rocks; the age, confirmed by the ratios of productive mineral associations with intrusive complexes, corresponds to the period of the Hercynian folding; the ore process takes place everywhere under conditions of regional compression; the gold-bearing area from the Upper Paleozoic represents a stable structural position in the Mesozoic and Cenozoic.

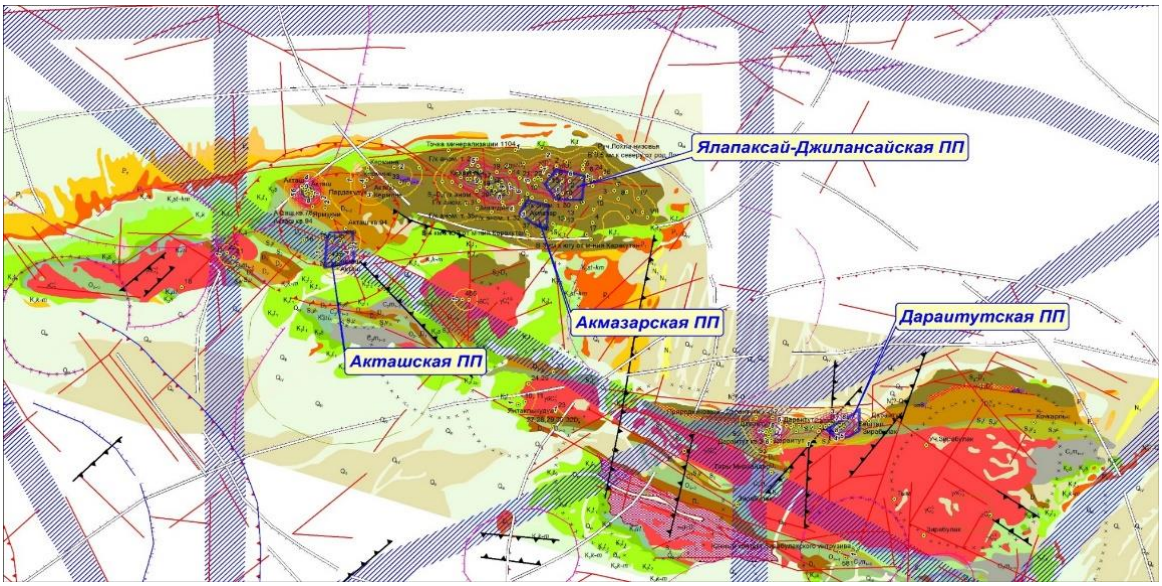

Figure: 2. Map of prospective gold areas in the Zirabulak-Ziaetdinsky ore-bearing complex, identified by the integration of methods of statistical metallogeny

(compiled by Razikov O.T. (2018) based on materials from Maripova S.T., Kasimova Sh.R., Nefedova G.R. and others).

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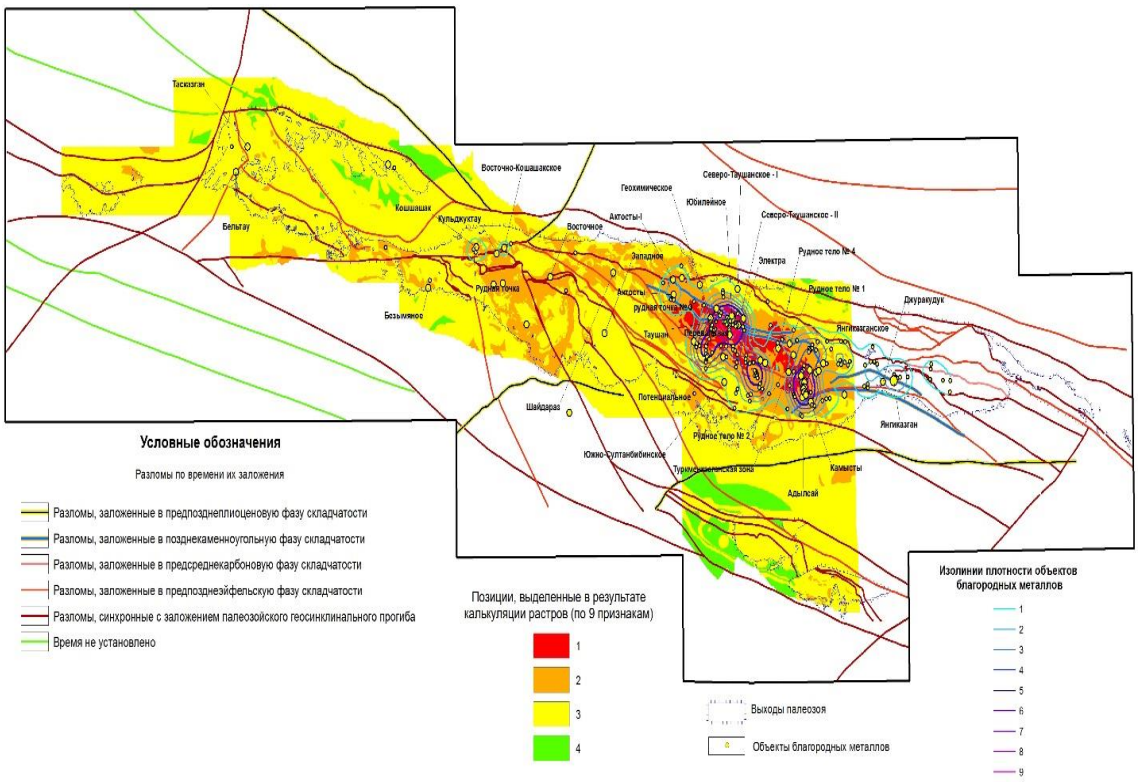

Figure: 3. Map of promising areas for gold of the Kuldzhuktau ore-bearing complex, identified by the integration of methods of statistical metallogeny. (compiled by O.T. Razikov et al. 2019).

Table 2

BRIEF GEOLOGICAL CHARACTERISTICS OF GOLD-MINING OBJECTS ZIRABULAK-ZIAETDIN MINING REGION (TILLATAG, BICHANCHI, KAPKAKLA)

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Name object, location	Scale object	Genetic type	Rudnaya formation	Main and accompanying components	Orebody morphology	Degree development	Brief geological characteristics
Tillatag, Ziaetdin mountains, Samarkand region	Shallow place-birth	Hydrothermal-plutonic	Gold-sulfide-quartz	Au	Stockworks, lenses	Intelligence service	Siliconization zones among shale-carbonate deposits of the Katarmay Formation PR?
Bichanchi, Ziaetdin mountains, Samarkand region	Ore occurrence			Au	Stockworks	Search score	Mineralization is confined to the intersection of sub-latitudinal silicified zones with NE-trending faults. The host rocks are metamorphic shales and amphibolites of the Katarmay Formation (PR?).
Kapkakli, Ziaetdin mountains, Samarkand region	Shallow place-birth			Au(Ag)	Quartz veins	Operated	Mineralization is confined to crushing zones among the metamorphic shales of the Katarmay Formation PR?

In areas of this type on the localization of mineralization, as shown in works on quantitative forecasting [12, 13, 14], the decisive influence is exerted by factors of concentration of industrial ores, which can be combined into four groups: 1. stratigraphic-lithological; 2. structural and tectonic; 3. magmatic; 4. mineralogical and geochemical.

At the same time, structural and tectonic signs are of decisive importance, especially at the stages of assessment and exploration of gold deposits.

The search and evaluation process is a sequential chain of tasks that is solved as information arrives, and at the early stages (shooting and searches), information comes mainly of a qualitative nature, at the final stages - measuring, digital.

Maps of perspective areas of the Kuldzhuktau ore complex. Forecasting and allocation of promising areas in the open part of Kuldzhuktau. The compiled electronic forecast map of promising areas of noble and rare-rare-earth elements in Kulzhuktau is based on the created structural-formational map M1: 200000 using statistically studied informative features.

The methodological process was carried out as follows. On each electronic map included in the bank of cartographic information, the features were ranked into several classes according to the degree of perspective, then all features were combined by graphical overlay of informative features of each map. As a result, a map of promising areas for gold was created (Fig. 3).

Forecasting overlapped mineralization to a depth of 150 meters in the frame of the Kuldzhuktau mountains. When predicting the overlapped mineralization in the framing of the Kuldzhuktau mountains, the following materials were used: a map of iso-depths of the basement and a structural-lithological map of the Kuldzhuktau mountains with the removed sedimentary cover of the Kuldzhuktau mountains on a scale of 1: 200000, geophysical maps of the overlapped part of the Kuldzhuktau mountains [15, 16].

Conclusion. As a result, two predictive-promising areas were identified in the Oguztau depression on the northern framing

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of the Kuldzhuktau mountains with accompanying U, V, Mo, Ag, W (conventionally called Overburden) and on Hg, possibly combined with undiscovered gold mineralization located lower in the ore column (Northern Mercury) and one area in the south - Kyngyrtauskaya, promising for prospecting for gold, uranium, silver, scandium, yttrium and other elements.

The resulting forecast map. The prospective areas (PP) obtained by the integration of various factors and features on the electronic forecast map were subjected to expert analysis with the use of signs of real ore content (the presence on the PP of signs of real ore content - the manifestation of mineralization or anomalies of gold, arsenic, and other accompanying elements) and maps of lineaments and ring structures. Taking into account these data, all selected PP (more than 30) electronic forecast maps were ranked according to validity and reliability with the involvement of information on knowledge.

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