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Methodology of scientific forecasting based on GIS of precious metal deposits in eastern Kazakhstan

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SUMMARY

Experience of forecast studies testifies the lack of dominant factors of ore systems development and deposits location. In this connection, the necessary element of a forecast is studying and modelling of self-organized ore-formation systems based on understanding of interrelation between deposits formation and earth interior evolution.

Ore formation must be reconstructed on the basis of system analysis methodology. The information for such analysis can exactly be represented by GIS that will enable to find common regularities and common approach to assessment of studied territory perceptivity.

Introduction

Forecast metallogenic studies were carried out in the region in different year and are actively carried out currently. Synthesis of geologic and geophysical materials of different year enabled to develop three basic models of precious metals deposits formation: structural-metallogenic, multiple-factor, geological-genetic ones. All these models are characterized by different degree of completion and credibility of geological information that according to the opinion of the article authors, result in forecast results decrease.

The researches relevance is defined by the demand to create scientifically-based system of displaying principal information about deposits and further usage of GIS as a unified data bank. This data bank will be the basis for further forecasting and prospecting surveys. It will enable to realize geological prediction and to identify new prospective areas.

Methodology of investigation

Synthesis of geological and geophysical materials about different gold ore objects of East-Kazakhstan served as the basis for development of models basic types: structural-metallogenic, multiple-factor, geological-genetic ones.

The first is structural-metallogenic models refer to the models of volumetric structure of structural-formational zones and they can specify ore distribution from the perspective of ore belts and metallogenic zones. The second one is multiple-factor models of ore clusters and ore fields take into account tectonic position within structural-formation zones, peculiarities of tectonics and its connection with ore deposits location, geophysical and geochemical characteristics etc. The third type is represented by models of typical deposits and contains characteristics of ore-hosting structures, parameters and shape of ore bodies, geophysical characteristics of ore fields, zones of rocks metamorphic conversion, material composition of ores, their geological-industrial types and basic stages of ore formation (Thomson, 1988), (Letnikov, 1992).

All these models are characterized by different degree of completion and credibility of geological information that according to the opinion of the project authors, result in forecast results decrease.

Some researchers (Vasiliev, 1990; Tretyakov, 2009) believe that the paradigm of modern forecast should be perceptions of deposits formation in the process of ore formation systems development. Structural and statistical connections between the elements of geologic space and deposits must be interpreted as regularities of minerals location. Probable forecast mapping is based on these regularities.

Experience of forecast studies testifies the lack of dominant factors of ore systems development and deposits location. In this connection, the necessary element of a forecast is studying and modeling of self-organized ore-formation systems based on understanding of interrelation between deposits formation and earth interior evolution.

According to opinion of some authors (Mizerny et al., 2017; Rafailovich, 2009), as applied to minerals forecasting, the important methodological rules are the following: consideration of ore formation systems autonomy concerning material-structural features of geological environment; rejection of the concept that there are “dominant factors” in formation and location of ore deposits. The concept of ore control structures uniformity complies with the data about principal similarity of geological factors that determine location of gold ore fields in different regions of the world. According to the (Tomson, 1988), local areas of endogenous ore are controlled by uniform by nature superimposed tectonic-magmatic local structures. They include areals of minor intrusions development and juvenile magmatic fluids according to (Marakushev, 1983).

Thus interaction of the limited number of endogenous geological factors cause formation of ore substance commercial accumulation (deposits), i.e. appearance of totally new body, that is impossible for a one separate factor. Such a combination of lithosphere elements or in modern sense magmatogenic - ore system (MOS) has certain common properties. Ore formation must be reconstructed on the basis of system analysis methodology. The information for such analysis can

exactly be represented by GIS that will enable to find common regularities and common approach to assessment of studied territory perceptivity.

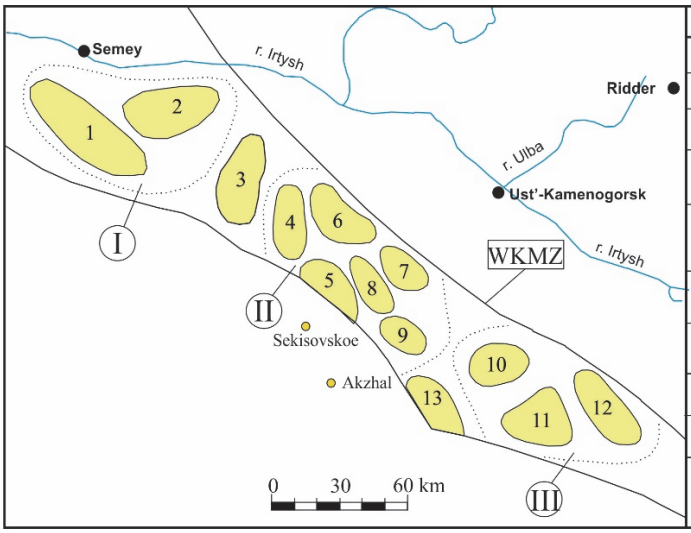
Initial and geological data

Nowadays the priority goal for Kazakhstan is to replenish raw material base of precious metals that can be achieved by solving the following tasks:
1) to improve scientific-methodological technology for forecasting, prospecting and assessment of gold ore deposits at all stages of exploration work;
2) to study promising reserve semi closed and closed areas basing on modern technologies of geophysical and geochemical research methods, significant amounts of drilling operations, space sounding and highly-precise laboratory analyses;
3) to reassess the understudied ore fields and suspended fields in order to find out and assess concealed precious metals ore at their flanks and deeps (Rafailovich, 2013);
4) to develop modern technologies for assessment of medium and small deposits of precious metals as possible extra source of ore (Mizernaya et al., 2019).

In this relation East Kazakhstan region appears to be very prospective for developing GIS deposits of precious metals.

The most promising structures here concerning precious metals deposits are considered to be Rudny Altai (with gold-silver-base metal ore and high content of rare and rare earth elements), West-Kalba (proper gold ore deposits of different genetic types with silver ore, MPG, and rare metal ore occurrence) metallogenic zones.

More than 450 gold ore deposits and occurrences have been found out within West-Kalba gold ore belt, however many of them are understudied and require more detailed researches(Figure 1). Peculiarity of studying gold ore deposits at this territory is that main task of forecasting is “sorting” of the known gold ore objects in order to define potentially big deposits among them that require further exploration. Re-assessment of medium and small deposits and occurrences of precious metals is also relevant on this territory (Antonov, 2010). The great majority of medium and small deposits of precious metals of East Kazakhstan are located within West Kalba (gold reserves of small deposits - 25 t, medium deposits – 25-100 t.). There are more vein deposits among them that mainly belong to gold-quartz formation. Deposits of gold-sulfide-quartz formation (sometimes represented by mineralized zones) and deposits of gold-silver- adular- quartz formation are of minor significance. Ores from these deposits are characterized by comparatively simple composition. The development of small deposits of precious metals is profitable due to complete ore extraction as well as due to available infrastructure of enterprises that can be used maximally.



Deposit	Typomorphic minerals
Bakyrchik	Au, Py, Apy, Ant
Kazan-Chunkur	Au, Py, Chp
Akzhal	Au, Py, Apy, Gn, Chp, Sp
Sekisovskoe	Au, Py, Chp, Sp, Mt, Il, Rt, Fh, Bmt, Tet
Baybura	Au, Py, Apy, Gt, Mt, Ant, Gn
Zherek	Au, Py, Ant
Baladzhal	Au, Py, Apy, Gn, Ms, Clv
Kedey	Au, Py, Apy
Sentash	Au, Py, Apy, Gn, Gt

Figure 1*- West Kalba metallogenic zone*

Results of investigations

The essence of the method is the following: systematization of all the materials on geology and mineral constituent of basic deposits obtained in different years; further studying of geological structure, mineralization conditions, and peculiarities of mineral compositions of the understudied deposits in the region; development of a single unified geo-information system (GIS) that will include all the available and new information about the known deposits developed in different years, the understudied deposits or suspended deposits, precious metals deposits occurrences; geographic position; genetic types of deposits, degree of their development; current state of basic and secondary components reserves; deep structure of the territory, models of basic ore deposits formation, geologic structure of the ore field and deposit region itself.

The information will be provided in the forms of maps, sections, schemes, tables, photos of main minerals and characteristics of major mineral associations, models of basic stages of ore genesis, tables and graphs of ore chemical composition basic components distribution, applied and supposed schemes of useful components extraction, that are united by a single software with updatable database.

In general, the developed scientific-methodological technology is focused on a reliability of source materials for geologic studies of new promising areas, further studying of the known ore-bearing structures and creation of a uniform system of precious metals deposits assessment, It significantly differs from the known approaches in Kazakhstan and world practice. So the authors consider the project financing is reasonable.

Recommendations and conclusions

Work on the creation of GIS for gold ore objects in East Kazakhstan consists of the following stages: collect complete data about geology and mineralogical and chemical composition of basic genetic types of precious metals deposits of East Kazakhstan.
Complete data about location, degree of processing, mineral reserves, geological structure, structural and tectonic characteristics, position of main ore bodies, mineralogical and chemical composition of basic genetic types of precious metals deposits of East Kazakhstan were collected. The following information resources were used in the course of the work: analysis and synthesis of space images, air photographic survey, and materials of geological surveying, geophysical operations, prospecting and exploration work of previous years, and literary references.

Achievement of this objective will enable to find out incomplete blocks of information about geology and mineral composition of deposits for further field and laboratory studies on these objects.

Next stages are: - To carry out revision work within the known and little-studied ore objects to clarify the geological structure, tectonics and features of ore formation, create 3D models of ore fields, deposits and occurrences. analytical research; to develop leading geotectonic, geological-geophysical, geological-structural criteria for forecasting and prospecting of precious metal deposits of different geological-genetic types including concealed and buried ones for GIS development;) to develop GIS deposits of precious metals in East Kazakhstan with updatable database on the server; to systemize and analyze the GIS criteria and ore control factors identified on GIS basis for providing recommendations and to find of new prospective areas for exploration work. Development of a single database.
As a result the Geological Information System with updatable database will be developed that will include all the available and new information about the known deposits developed in different years, the understudied deposits or suspended deposits, precious metals deposits occurrences. Geotectonic, geological-structural, ore-petrological, mineralogical-geochemical, and forecasting-prospecting criteria and prerequisites will be developed, prognostic-metallogenic maps and detailed insert maps on prospective ore areas, ore fields and deposits will be compiled on GIS basis.

References

Antonov, Yu.A. [2010] About some structural and lithological factors of control of gold mineralization of the Bolshevik deposit in East Kazakhstan. // Geology and protection of mineral resources, **2**, 15-26.

Vasiliev, S.V. [1990] Forecasting based on the system-information approach // Computer forecast of mineral deposits. - M. Nedra, 208-225.

Letnikov, F.A. [1992] Synergetics of geological systems. Nedra, Science, 85-122.

Marakushev, A.A. [1983] The nature and metallogenic significance of deep fluids. Metallogenis of the Ural-Mongolian folded belt: Abstract. X All-Union Metallogenic Meeting. Alma-Ata. Nauka, **38**, 145-156.

Mizernaya, M.A., Miroshnikova, A.P., Pyatkova, A.P. and Akylbaeva, A.T. [2019] The main geologcal-industrial types of gold deposits in East Kazakhstan. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, **5**, 5-11.

Mizerny, A.I., Miroshnikova, A.P., Mizernaya, M. and Diachkov, B.O. [2017] Geological and structural features, magmatism and mineralization of Sekysivske and Vasylkivske Stockwork gold deposits (Kazakhstan). Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, **2**, 5-13.

Rafailovich, M.S. [2009] Gold deposits of Kazakhstan: geology, metallogeny, exploration models. Almaty, 89-119.

Rafailovich, M.S. [2013] Gold geology of Central Asia: mineralization evolution, metasomatic formations, explosive breccias. - Almaty, 423 p.

Thomson, I.N. [1988] Metallogeny of ore regions. Nedra, 183-187.

Tretyakov, A.V. [2009] Formation, distribution patterns and prospects of placer gold content in the East of Kazakhstan. – Almaty. – 212-267 p.