

On the geological and economic assessment of the Lower Amur region (Russia)

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Abstract. The development of regional economy is based on medium and long-term strategies (programs) for economic industrialization. These documents are of a sectoral or integrated nature. Republic of Sakha (Yakutia) and Kamchatka Territory have a scientifically substantiated strategy for the development of the mining industry. Despite its absence in Khabarovsk Territory, subsurface use in recent years has shown a steady growth in mining. The main volume of income comes from gold mining mainly in the northern and central parts of the region. Over the past 10 years, the most economically advantageous and geographically accessible minerals have been identified in the region. These include: coal, gold, platinum, tin, construction materials, groundwater. In the future, it is necessary to plan the development of copper-porphyry, alunite and polymetallic fields. The issues of increasing the resource base of liquid and strategic metals, formation of infrastructure, complexity of the use of mineral wealth and rational use of mineral resources remain problematic. A positive solution to problems is possible when developing and implementing an industry strategy. The basis for its formation is the geological and economic assessment of particular territories of the region.

Keywords: Khabarovsk Territory, industrialization, gold, non-ferrous metals, fields, resource assessment, economic potential.

1 Introduction

The purpose of the study is to form a geological and economic model for the development of a certain area of Khabarovsk Territory, which has a sufficiently high resource potential.

The geological and economic assessment of certain territories, called: a territory of advanced development (ADT), the mineral resource sector (MRC), the mineral resource center (MRCr), is carried out on the basis of established reserves and officially approved resources. At the same time, the category of resources includes accumulations of minerals identified by practical geologists, the verification of the quantity of which is limited to the stage of prospecting.

A large number of such objects were found even before the so-called market transformations. Their further study was discontinued either due to low and moderate metal grades, or due to their classification as “non-promising” ore formations. Currently, every five years, the number of resources is re-approved by the leading research institute. As a rule, there are no significant changes in the amount of resources.

This approach to assessing the potential of a territory is not always justified. Undoubtedly, experts take into account modern ideas about the prospects of some or other forma-

tional type of ore content, diagnostics of a certain area of the Earth's crust from the standpoint of plate tectonics, etc. However, the noted innovations often do not give any significant effect. The reason is that many primary sources of geological information that allow identifying the genetic type of an object, the relationship of ore accumulations with metasomatites, structural tectonic factors of ore localization and other features remain outside the field of view of researchers.

2 Situation analysis, problem statement

New approaches to assessing the potential and, accordingly, to the economic forecast are considered taking as a case study one of the areas in Khabarovsk Territory. Within the territory, on an area of about 787.6 thousand square km, there are 13 ore-bearing areas, namely the following (from north, southwards): Yudomo-Maisky, Okhotsk, Uchuro-Maisky, Dzhugdzhursky, Verkhneuchuro-Nemuisky, Udskey, Udsko-Toromsky, Kerbinsky, Melginsky, Bureinsky, Amgunsky, Lower Amur and Khorsko-Anyuisky. The most studied of them in terms of gold content is Lower Amur [3].

The Lower Amur area stretches in the submeridional direction for 570 km with a width of about 330 km. There are four gold fields in operation – Albazino, Mnogovershinnoye, Belaya Gora and Polyanka. As a result of geological exploration in recent years, the following objects have been assessed: Blagodatnenskoe (15.9 t), Delkenskoe (12 t), Dyappe (62 t), Polyanka (12.4 t), Chulbatkan (31.5 t), Kutynskoe (24.1 t); the gold reserves at the Mnogovershinnoye field were increased to 58 t. Prospects are associated with 5 more fields.

In connection with the discovery of the Malmyzh field, unique in terms of reserves, porphyry copper with gold (more than 5.2 million tons of copper and about 278 tons of gold), the value of 13 occurrences of similar type is increasing. The largest secondary quartzite objects Iskinskoe, Krugly Kamen, Shelekhovskoe can provide raw stock for the aluminum industry. The Chayatyn polymetallic field was prepared for development. The Seredochnoye zeolite field is located near the Niko laevsk-on-Amur – Mnogovershinnoye highway. The tungsten content of the area, as well as the oil and gas content of the Kizikadinsky depression, are assessed positively.

The scientific forecast for assessing the potential of the Lower Amur region methodically fits in two directions. The first is based on actual reserves and projected annual productivity of mining and processing plants (MPPs). The second (forecast) is based on the assessment of resources of the main minerals of the considered territory. Mean time, the choice of standards for constructing geological and economic models, the selection of promising objects from a significant number of small fields and ore occurrences, resource assessment and other issues are largely original. An integration of results of an analysis of the authors' research in the indicated areas provides a fairly high degree of forecast reliability.

Geological and economic models of a territory are composed of the following factors:

- real reserves of minerals;
- integration of data on reserves of particular fields into a single territorial system;
- geological and economic model of the territory of the first type;
- geological and structural models of reference objects;
- identification of promising objects by the main types of minerals;
- comparison of promising ore occurrences with reference fields for which specific productivity has been calculated;
- forecast of resources of the selected types of fields within the area;
- integration of data on the resources of the main types of minerals into a single territorial system;
- geological and economic model of the territory of the second type.

3 Results and Discussion

In the short-to-medium term, by 2025, it is planned to develop 5 gold ore objects Delken, Dyappe, Kutynskoye, Chulbatkan, as well as the porphyry copper Malmyzh deposit. The annual production of metals in concentrates will amount to 24.5 tons for gold and 125 thousand tons for copper. Based on the amount of reserves, market conditions, current state of the raw material sources and prices predicted for 2025, the expected amounts of production proceeds and taxes on mineral extraction were found, taking into account its repayment to the regional budget (Table 1).

Table 1. Calculation of economic indicators in the production of minerals

Type of minerals	Annual production, t	Throughout recovery factor	Estimated price for 2025, thousand rubles / t	Amount of proceeds, million rubles	MET to the Federal budget, mln rubles	MET to the regional budget, mln rubles
Gold 24.	5	0.9	4,527.33	99.8	5.9	5.9
Copper	125,000	0.77	680.51	65,499.3	5,239.9	3,144.0
Total	–	–	–	65,599.1	5,245.9	3,150.0

Taking into account the expected price for minerals for 2025, the annual revenue may amount to more than 99 million rubles for gold, and about 65 billion rubles for copper. According to the Budget Code, the mineral extraction tax (MET) is calculated at 6% for gold and 8% for non-ferrous metals. The entire amount of tax of 100% goes to the Federal budget of the Russian Federation, then it is redistributed among the constituent entities of the Federation. So the MET calculated from the volume of proceeds for gold is repaid to the regional budget in the amount of 100%, from non-ferrous metals the repayment is 60%. The total MET amount can provide revenues to the regional budget over 3 billion rubles worth [1, 2, 5].

The volumes of metal recovery are given in accordance with the internal corporate plans for the development. The potential of the area is determined by the presence of real reserves: gold (569.4 tons), copper (5.2 million tons), aluminum (4.54 million tons), lead (71 thousand tons), zinc (135 thousand tons), zeolites (81.33 million tons). Based on the above value of reserves and the forecast prices for minerals, the potential value of the said area for the period up to 2030 was found – option 1 (Table 2.)

As a result, an integrated assessment of the potential value of the area under consideration was obtained. The calculations used the data related to prices for mineral resources, taking into account the long-term socio-economic development of the Russian Federation. In monetary terms, the total potential value of this area for the study period may amount to more than USD 4,582 billion.

Table 2. Assessment of the potential value of the area in the long term

Type of minerals	Volume of expected reserves	Throughout recovery factor	Estimated price, thousand rubles / t	Potential value of object, bln rubles
Gold 569.	4	0.9	4,895.1	2.5
Copper 5,	200,000	0.77	794.6	3,181.7
Aluminum	4,540,000	0.65	202.9	598.9
Lead 71,	000	0.72	148.4	7.6
Zinc	135,000	0.7	180.7	17.1
Zeolites	81,330,000	0.85	11.2	775.0
Total	–	–	–	4,582.8

In the medium term, by 2025, gold fields Agnie-Afanasyevskoye, Blagodatnenskoye, Dylmenskoye, Levodzhedagskoye, Pokrovsko-Troitskoye, copper-porphyry fields Avlanbir, Zolotaya Gora, Zimovye, Kabachinskoye, Nochnoye, Poniyskoye, Tyrskoye, and

also Shelekhovskoye, Iskinskoye and Gryada Kamenistaya may be additionally involved in operation [4]. On the territory of the Lower Amur region, the production facilities of about 20 MPPs will be launched, providing for an output of about 40 tons of gold, 325 thousand tons of copper and 120 thousand tons of aluminum per year. Based on these indicators, the values of the expected production proceeds and MET were also calculated (Table 3).

Table 3. Calculation of economic indicators in the production of minerals

Type of minerals	Annual production, t	Throughout recovery factor	Estimated price for 2025, thousand rubles / t	Amount of proceeds, million rubles	MET to the Federal budget, mln rubles	MET to the regional budget, mln rubles
Gold 40		0.9	4,527.33	163.0	9.8	9.8
Copper	325,000	0.77	680.51	170,298.1	13,623.9	8,174.3
Aluminum	120,000	0.65	173.82	13,558.3	1,084.7	650.8
Total –		–	–	184,019.4	14,718.3	8,834.9

In monetary terms, the total proceeds from the sale of commercial products will amount to about 184 billion rubles, and tax receipts to the regional budget will amount to more than 8 billion rubles.

The resource potential of this area in the future for 2030 (Table 4) is shown as option 2, determined by the presence of gold (1,200 tons), copper (15 million tons), aluminum (10 million tons), lead (150 thousand tons), zinc (400 thousand tons), tungsten (150 thousand tons), zeolites (81.3 million tons).

Table 4. Assessment of the potential value of the area in the long term

Type of minerals	Volume of expected reserves	Throughout recovery factor	Estimated price, thousand rubles / t	Potential value of object, bln rubles
Gold 1,	200	0.9	4,895.1	5.3
Copper 15,	000,000	0.77	794.6	9,177.9
Aluminum 10,	000,000	0.65	202.9	1,319.3
Lead 150,	000	0.72	148.4	16.0
Zinc 400,	000	0.7	180.7	50.6
Tungsten 150,	000	0.55	3,970.3	327.6
Zeolites 81,300,0	00	0.85	11.2	774.7
Total –		–	–	11,671.3

To compare the potential value of the two areas, a diagram is built enabling to identify their conditional rating (Fig. 1). According to calculations, the value of the area as a percentage in the first option is almost three times less than in the second option (Fig. 1). This is due to the fact that in the assessment of the resource potential of the territory covers all the main types of minerals, and for gold and aluminum, an increase in reserves is predicted due to the exploration of new (or well forgotten old) small fields and ore occurrences.

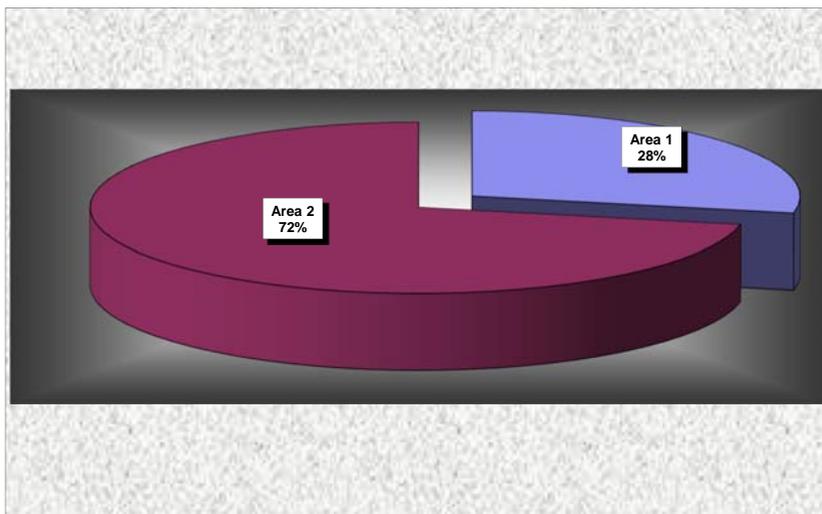


Fig. 1. Comparative assessment of the potential value of areas

The assessment of the potential value shows the priority of development of the objects under consideration in the current state of the regional raw material source. It can be expected that bringing these reserves to development will be economically viable in the medium and long term.

4 Conclusion

Thus, a new approach is proposed in the development of geological and economic models of fairly large territories, including several ore regions. So, within the Lower Amur area over the past 12-15 years, about ten gold fields considered small (Albazino, Belaya Gora, Dyappe, etc.) have been transferred to the category of medium and large. Reserves have been prepared at one of them and the prospects for copper-porphyry occurrences have been identified. The possibility of increasing the raw material sources by studying the tungsten, polymetallic and secondary quartzite manifestations of the Lower Amur region was estimated. The aforesaid allows one to give a forecast assessment of the area in a new way and form its geological and economic model.

For the area, two variants of the geological and economic model were formed. The first is based on real reserves of gold and copper. It includes the current production of metals, the corresponding revenues to the budgets of the Federation and the region, as well as a forecast due to the involvement of practically explored gold fields and the possible development of reserves of lead, zinc and zeolites. The second option is based not only on the reserves of minerals, but also on the resources identified by promising objects by comparing them with reference fields with known reserves. Increase in reserves of gold and copper is forecasted. The list of types of minerals is expanding due to tungsten. In general, according to the second option, the area seems to be more promising for its systematic development over the next decades.

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