Problems and perspectives of the ineffective gold-bearing deposits development

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Abstract. This article discusses the problems and prospects of mining placer gold not only in the Trans-Baikal Territory but also in Russia as a whole. The reduction of reserves in placers and a decrease in the quality of minerals in them open up new prospects for the extraction of this precious metal. The ineffective placers, of which, according to preliminary estimates, there are approximately 600 in the Trans-Baikal Territory, can become promising objects in gold mining. However, there are some negative factors that will complicate the gold mining operations. The mining of alluvial gold, even with the best existing technologies, remains a sector of high environmental risk; in many settlements, a gradual decrease in the population and the “extinction” of settlements is predicted, whereas illegal gold mining is gaining traction. Neither the regional nor the federal institutions of environmental supervision are now able to resist the destruction and degradation of nature from the mining of placer gold. In general, this leads to an increase in the negative impact of alluvial gold mining on natural systems and the socioeconomic sustainable development of the regions and municipalities, in which this type of activity is carried out, as well as an increase in accumulated environmental damage. The presented organizational and economic mechanism for the development of ineffective placers will contribute to solving the problems observed in the industry and will allow the implementation of measures proposed by public persons.

1. Introduction
Under the influence of anti-Russian sanctions, Russia continues to increase its gold reserves to save the economy. From January to June 2020, the Russian gold production increased by 2.8% compared to the same period in 2019.

The current situation in the global economy under the influence of COVID-19 stimulates domestic demand for the Russian gold, which, in turn, allows gold mining companies to function effectively even during the period of restrictions. As a result of the global crisis, some favorable conditions have developed for the gold mining industry. Gold has traditionally been a defensive asset, and its prices are now at attractive levels (figure 1). The growth of marginality can be facilitated by the depreciation of the national currency. The price of gold has quadrupled over the past 20 years and reached almost $ 2000/troy in August 2020 [1].

The described picture in the gold mining industry also testifies to the high demand and interest of the potential and the existing subsoil users. Gold production in Russia has tripled over the past 20 years (figure 1) [2].
Figure 1. Mining and production of gold in the Russian Federation [3].

Placer deposits are considered to be easily developed mineral resources, which make up the majority of the gold mined in Russia. Today, the Trans-Baikal Territory is considered one of the richest regions in Russia. Among the Russian regions, the region ranks fifth in terms of gold reserves and tenth in terms of production. The main volume of gold production in Transbaikalia falls on placers; in 2019, the total volume amounted to approximately 13 tons of gold. 327 deposits of balance and more than 600 deposits of off-balance reserves make up the mineral resource base of placer gold the Trans-Baikal Territory.

The ineffective placers, i.e. the subsoil areas that are not of industrial interest for the large subsoil users (low in terms of the content and quality of minerals), in our opinion, are potential for the development of the gold mining industry. These include the deposits with off-balance reserves as well as the objects with predicted resources, i.e. all small streams located in the creeks of the main river channel, and many man-made objects, such as various types of dumps, pillars, raft areas containing gold in pockets and sinkholes, tailings of concentrating factories and installations; diluvial sites on the slopes of terraces, modern alluvial plumes as well as streak placers are all among them. In the regions of Russia, there are more than 10,000 such placers, including approximately 600 in the territory of the region (approximately 217.269 tons of gold are concentrated in them), which is still an underestimate. The lack of an inventory makes it difficult to analyze, with the help of which it is possible to take into account the majority of such subsoil areas [4, 5].

Most of the deposits developed in the Trans-Baikal Territory are based on a rotational method and with the involvement of residents from other regions and even countries, which reduces the importance of alluvial gold mining to almost zero for maintaining the welfare of local communities and the socioeconomic development of municipalities. As the current pandemic has demonstrated, rotational work is also associated with epidemiological risks and significantly increases the negative sentiment of the local population. In many settlements, there is a gradual decrease in the population and the “extinction” of settlements, which in the recent past were a necessary infrastructure platform for the development of many territories of placer gold mining. The mining of placer gold in the overwhelming majority of cases makes a minimal contribution to the socioeconomic development of regions and municipalities [6]. All income from the sale of licenses and a large share of tax and non-tax payments of gold mining enterprises go to the federal budget, leaving the regions and, especially, the municipalities with only a small share of budget revenue. It should also be noted that a
significant part of gold mining enterprises is registered and, thus, pay taxes not in the territory of the municipalities where they operate but in the region and regional centers.

Placer gold mining, even with the best available technologies, remains a high environmental risk sector. A cardinal solution to the problem would be a complete rejection of this type of nature management. Historical experience suggests that the alluvial gold mining process has fatal flaws that cannot be completely overcome even with the improvement of technology. Most developed countries have followed the path of a radical reduction in alluvial mining, up to a complete rejection of it in favor of the development of ore gold deposits. Such strategy is being implemented not only in developed countries but, in recent years, also/even in the PRC and Mongolia [7]. Mining of placer gold changes the natural channels of rivers, leading to a serious transformation of the slopes of river valleys. The muddy plumes in the rivers stretch for tens and sometimes hundreds of kilometers downstream of the alluvial gold mining sites. This changes the chemical composition, temperature and oxygen content of the water. Consequently, valuable fish leave such rivers, and the river ecosystems degrade. At the same time, an increasing number of licenses are issued for the alluvial gold mining sites that are either directly adjacent to the boundaries of specially protected natural areas (PAs) or located in river basins flowing through these PAs. Gold mining in such areas increases the anthropogenic pressure on the protected natural complexes, increases the threat of pollution of protected areas and the areas with a significant environmental value that are slightly disturbed by the economic activity.

2. Data and methods
The research was carried out using comparative analysis as well as economical and statistical methods based on open information from official databases and Internet resources. To analyze and assess the mineral state of gold in the Trans-Baikal Territory, we used the reports on the geological study of subsoil and developed deposits, data from the Russian Federal Geological Fund, Rosstat and the Federal Tax Service as well as the opinions of experts in the field of geology and field development.

3. Results and discussion
The difficulty of developing the ineffective gold-bearing placers is that most of them are not taken into account; there is no reliable data on the number of reserves in them. The development of such deposits using traditional technologies is economically inexpedient due to the small reserves of the metal.

Their development requires the same amount of permits and funds for the development of large or medium-sized placers. Therefore, the existing large gold mining enterprises are not engaged in them. In recent years, the number of licenses has sharply increased (for example, in 2019, approximately 150 licenses were issued) for the purpose of exploration of minerals, which, according to our research, can be classified as ineffective deposits.

Nevertheless, the current situation is developing in such a way that today these objects are mastered in a "barbaric" way by the so-called "black" prospectors, i.e. subsoil users who do not have the right to conduct such activities. Moreover, the licenses for many of these objects are acquired by various companies for geological exploration, but in fact, they also mine gold. These groups of subsoil users, in view of the current “favorable” circumstances for them, cause environmental damage, since they do not comply with the necessary measures of environmental legislation.

The main part of the ineffective gold placers is located in the regions of the Trans-Baikal Territory, which were previously large mining companies; today they are, to a certain extent, “dying or fading” settlements. Taking into account such an advantage as the ubiquitous distribution of these deposits across the territory of the Trans-Baikal Territory, their competent exploitation will contribute to an increase in national economic efficiency, sustainable socioeconomic development of the territories and the establishment of an ecological, legal and economically sound order.

The public organizations of Russia, relying on the analysis of the impact of alluvial gold mining on the environment, as well as taking into account the socio-economic factors in the regions of gold mining, believe that the growth in the number of places where alluvial gold is mined and its spread to
rivers untouched by mining in modern conditions directly contradict the main development objectives of the regions of Siberia and the Far East of Russia.

In particular, this activity:
- hinders sustainable socioeconomic development on the ground;
- destroys and pollutes key natural complexes of rivers and, thus, significantly worsens the quality of life of the local population;
- creates social tension, worsens environmental conditions for the indigenous people and, ultimately, contributes to the outflow of the population from the regions of Siberia and the Far East [8].

With the increase in the number of licenses for the exploration and development of alluvial gold deposits, there is also a significant increase in the number of violations committed by these enterprises: the pollution of rivers with untreated industrial waters, the use of water bodies without a decision or a water use agreement, refusal to reclaim disturbed lands. This is a systemic and not an episodic character that has developed because the enterprises working in the licensed areas with minimal gold reserves are trying to minimize their costs by ignoring the requirements of environmental legislation in order to achieve profitability of their activities.

![Organizational and economic mechanism for the development of ineffective gold-bearing placers.](image)

**Figure 2.** Organizational and economic mechanism for the development of ineffective gold-bearing placers.
In addition to environmental problems, it is necessary to take into account the fact associated with illegal gold mining in the areas of ineffective placers. To solve the accumulated problems, it is necessary to comprehensively change the subsoil use system in terms of gold mining from placers. Therefore, we propose a mechanism involving a number of restrictions that will favorably affect the gold mining process from the point of view of ecology and improve the socio-economic situation of the territories [9] (figure 2).

**Table 1.** Recommendations for improving the environmental situation in the alluvial gold mining [8].

| Event                           | Act                                                                 |
|--------------------------------|----------------------------------------------------------------------|
| Moratorium on the issuance of licenses | Suspend the issuance of licenses for exploration and production of alluvial gold in watercourses previously not affected by such mining for a period of 10 years. |
| Do not license sites            | No license issuing for the areas adjacent to the boundaries of specially protected natural areas or located within the specially protected natural areas, as well as the areas on rivers flowing through the protected areas and located upstream of them, and are not subject to licensing and mining operations in them. |
| Prohibition to issue a license  | No license issuing for the rivers with a special fishery status (commercial) salmon populations (on which the local population depends) (spawning zones). |
| Local participation             | Prohibit the issuance of licenses for geological exploration of subsoil, prospecting, exploration and production of placer gold in the areas that can have a negative impact on the living conditions in settlements located near or downstream of rivers from these areas, without obtaining approval for the implementation of these works by residents of settlements and local governments through public consultation procedures. |
| Changes to the competition regulations | Include mechanisms for taking into account the opinion of the state authorities of the regions, local government bodies and the local population of the territories, where the development of alluvial gold deposits is planned, in the documents required for participation in the tender for subsoil use. |
| Improving the control system    | Introduce an effective and transparent system of control over the activities of gold mining enterprises by the territorial bodies of the Federal Service for Supervision of Natural Resource Use (Rosprirodnadzor). |
| Additional sanctions            | The use of methods of remote (space) monitoring of river pollution and the introduction of the results of remote (space) monitoring into regulatory legal documents as an evidence base for the identification and fixation of pollution. |
|                                | Increase the size of fines to a level comparable to the amount of damage caused to natural complexes, and the strict application of such measures as the suspension and termination of licenses for carrying out gold mining activities in relation to the areas where violations were committed, including refusal to issue them to persistent violators for other areas, until the full implementation of measures to compensate / eliminate the admitted negative impacts. |

Experts from public organizations have proposed recommendations that will contribute to
improving the environmental situation in the regions of Russia, which are affected by alluvial gold mining (table 1, figure 3).

Figure 3 presents recommendations for the inclusion of environmental components that must be taken into account when making changes to the regulations on the competition for a license.

Figure 3. Environmental components of the mechanism of placer gold mining [8].

4. Conclusion
Neither the regional nor the federal institutions of environmental supervision are now able to resist the destruction and degradation of nature from mining placer gold. First of all, due to the small number and poor technical support of the supervisory officials in the gold mining regions, who are simply physically unable to control a large number of enterprises in vast (and often remote) gold mining areas.

State authorities, local self-government bodies and the local population of the territories where it is planned to develop alluvial gold deposits are completely excluded from the decision-making process on putting up for auctions and issuing licenses for certain areas. This leads to the issuance of licenses for gold mining in respect to the areas that are important as habitats for the rare and economically valuable species of flora and fauna and play an important role in the economic activities of the local population as a place of traditional residence of the indigenous peoples of the North and the Far East, the hunting lands, the places for placement of apiaries, hayfields and pastures.

In general, this leads to an increase in the negative impact of alluvial gold mining on natural systems and the socioeconomic sustainable development of the regions and municipalities, on the territory of which this type of activity is carried out, as well as an increase in the accumulated environmental damage. This, in turn, leads to an increase in protest sentiments among the local population and social tension in the regions where gold mining is carried out.

The paper presents a mechanism for the development of ineffective auriferous placers, which allows solving the accumulated problems as well as the proposals set forth in the analytical note of public organizations [10].

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