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The competitiveness of gold fields

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Abstract

Relevance. *Russia currently ranks third in terms of global gold extraction and production, and the Urals is considered the birthplace of gold mining in Russia. Gold supply of Ural enterprises nowadays makes up 20–30 years of underground mining and 30–40 years of opencast mining. Reserves increment in Russia is mostly observed at primary deposits, while extraction from placers decreases continually. At the same time, gold prices rise creates prerequisites for the involvement of reserve gold fields into operation. Insufficient financial resources often make the development of new fields impossible; access to the most promising projects, the highly competitive gold fields, is the first priority for potential investors.*

Research aim *is to develop a methodological approach to the assessment of competitive gold fields at the stage of pre-investment study and its approval in the conditions of certain fields.*

Research methodology *includes the benchmarking method, analogue method, and the techno-economic assessment.*

Results. *In the course of research the main obstacles for the development of new gold fields were revealed. It has been proved that the crucial aspect of miners' competitive advantages is the cost of crude minerals based on in-place reserves and non-commercial reserves, hard rock and other rock in dumps, valuable components in tailings, etc. A formula calculating aggregated cost of the object is proposed, and the competitiveness of the revived Peshchernoe gold field is compared with three newly developed fields of Altyntashskoe, Shilovskoe, and Iagodnoe. Based on the basic indicators of field mining, the cost of mineral raw material was calculated making it possible to rank the compared fields as far as the degree of competitiveness is concerned.*

Summary. *The analysis has shown the gradual deterioration in the quality characteristics of gold fields with the accumulation of refuse mass. Institutional barriers and insufficient financial resources of subsoil users prevent from introducing new fields. Small and medium-sized mining enterprises' competitive growth requires: introduction and development of land provision declarative principle for geological exploration; simplified procedure of timberland registration for subsoil use; introduction of tax benefits and simplification of subsoil usage procedures as for technogenic objects; creation of favorable investment environment; improved mechanisms aimed at integrated cluster development.*

Key words: *gold fields; assessment; competitiveness; cost of crude minerals; comparison.*

Introduction. Russia possesses significant geological and industrial gold reserves and ranks (8.3%) third in global gold extraction and production. At the territory of Russia there are gold fields with various sequences and formations of enclosing rock, from the Baltic shield in the west to the folded structures of the eastern part of Chukotka and the Koryak region. There are all types of gold fields in Russia: primary gold fields (ore deposits), gold-containing primary gold fields, deposits of mainly non-ferrous metals (complex fields), and gold-bearing placers.

The Urals stands out among Russian gold provinces. It is a birthplace of Russian gold mining and the basis of past and present gold-mining industry of the country. "Gold belt" of the Urals stretches longitudinally for more than 2500 km with the width of 200–300 km. It crosses the territory of Russia from the Arctic Ocean to Kazakhstan. The middle and the southern parts of the "gold belt" have been developed since the 18th century and currently represent one of Russia's gold-mining centers. About 70% of the indicated area is situated at the territory of the subjects of the Ural Federal District, the Republic of Bashkortostan, Orenburg region, and Perm region (Volga District), and the Komi Republic (Northwestern Federal District). Nowadays, vein quarts deposits, vein-disseminated, and pyrite deposits are mostly developed in the Urals; open pits and underground shafts are used. Gold supply of Ural enterprises nowadays makes up 20–30 years of underground mining and 30–40 years of opencast mining. In-situ deposits of the biggest and oldest field in the Urals, Berezovsky, will be enough for two years, and non-commercial deposits will be enough for another 50 years and more (with small metal content – 1.8 g/t). With increased extraction, reserves supply will drastically reduce. About 15% of undiscovered resources (P_1 category) is focused at deep horizons and at the flanges of well-known deposits, and 85% (P_2 and P_3 category) are in new areas and objects.

There are about 475 gold-mining enterprises in Russia. Six largest companies extract about 50% of Russian gold. 35 largest companies account for (with the production of more than 1t of gold per year) not less than 75% of total gold mined in the country. The remaining 440 companies mine less than 25% of total gold. In general across Russia gold production in 2018 increased by more than 2%, and in 2010–2018 it increased by a factor of 1.5. In the Sverdlovsk region, on the contrary, extraction decreased by 46% in 2010–2018.

According to the data from the State Reserves Register (*A booklet of the State Reserves Register as of 01 January 2017. Minprirody of Russia. Moscow: 2017. Available from: old.rfgf.ru›18.htm*), at the territory of the Sverdlovsk region, more than 50 gold-mining enterprises are in operation, gold is extracted at ore deposits, placers, and complex field. The largest gold-mining enterprises are ZAO Zoloto Severnogo Urala, Neiva Gold-Mining Cooperative (mainly placers), AO Shemur, Berezovsky mine, and AO Safianovskaia med.

Gold production increment in Russia is mostly observed at primary deposits, while extraction from placers decreases continually. A great appreciation in the value of gold, especially in 2019 (as of September – 3183 rub/g), has created prerequisites for the involvement of considerable reserve gold fields in operation (they have not been developed earlier due to unfavorable mining and technological conditions and, consequently, high production cost). The number of small and medium-sized enterprises has grown. At the same time, subsoil users who work at minor fields do not have sufficient equity in order to effectively develop production, i. e. use modern hi-tech and more productive equipment and technological innovations for extraction and processing, the absence of which makes field development inefficient and often unprofitable. Dozens of small and medium-sized enterprises annually either do not start flushing and production due to lack of funds or close down due to bankruptcy (to be replaced by the like; money is wasted). Geological prospection is not carried out, gold resources are not increased, and production falls due to insufficient funds. The requirements of the Water and Forestry Codes often become impassable barriers.

Results. Fundraising is the most burning issue for mining enterprises. Only large Russian and foreign companies with significant assets, such as (in addition to the leading Ural companies listed above) Polyus, Polymetal, Kinross, Nordgold, UGC Gold Mining Company, and Highland Gold Mining, are able of sustaining

themselves with optimum credit conditions or adequate self-funding for development. However, international experience shows that small and medium-sized enterprises are the greatest economic powerhouse [1]. Companies and entrepreneurs aspiring to develop face the problem of budget constraints and insufficient financial resources. A problem of fundraising occurs. At the same time, investors face the problem of getting access to the most successful projects.

In order to achieve the required result, it is crucial for the investors to identify the most competitive enterprises. As it is observed by the authors [2, p. 12], "at the strategic level, the competitiveness of an enterprise is characterized by the investment attractiveness". Investment attractiveness, as defined by L. Valinurova and O. Kazakova is "a set of objective features, properties, resources, and capabilities, which are responsible for the potential investment demand" [3, p. 206], while according to I. Blank it is a generalizing characteristic of advantages and disadvantages of making investment in certain fields of activity and certain objects from the point of view of a certain investor [4]. A western investor centers the evaluation of investment attractiveness on the problems of determining the financial state of an enterprise, its solvency, liquidation, rate of return, and economic activity and market activity [5].

Even though large corporations possess significant assets, both tangible and intangible, international experience shows that small and medium-sized companies are the greatest economic powerhouse. Business development of a company depends not only on the availability of corresponding resources, but also on the capability of attracting necessary resources and using them to gain competitive advantages. One aspect of competitive advantages of a mining enterprise and of attracting investors is the cost of crude minerals in the subsoil, i. e. complete record of all types of crude minerals – non-commercial reserves, hard rock and other rock in dumps, valuable components in tailings, etc. Besides, valuation is necessary to optimize the solutions on stock management, substantiate the development of new areas, and geological exploration planning. There are different techniques of such valuation (market, net assets, performance assessment, net assets and input, reproduction, rent, alternative cost, etc.), calculation data differing dramatically. To valuate crude minerals in the subsoil the authors propose the income approach which represents a set of objects valuation techniques based on the determination of expected return of valuation objects use. Future return is valuated and summed with the account of the time of its creation. In foreign practice the income approach of valuating mineral assets is usually applied at the deposits with a high level of development, while at the stage of development other techniques are applied [6, 7].

Aggregated valuation of the item subject to valuation is carried out by the formula:

$$V = (B - C)O / K_c, \quad (1)$$

V – the value of the item subject to valuation, rub.; B – exercise price of an item of natural resource or the product of processing, rub.; C – extraction and processing cost for one item, rub.; O – anticipated annual output, item; K_c – capitalization ratio, unit fraction.

Capitalization ratio must provide the investor with not only the manageable level of investment return, but also the investment recovery. The capitalization ratio is not essential at the stage of the preliminary estimation of the object's investment attractiveness due to insufficient reliability of valuation at the early stages of decision making by the investor. Detailed simulation of monetary flows is also not necessary, i. e. there is no need in labor intensive calculation with the involvement and processing of large volume of input information because the reliability of the projected values is too low.

In order to determine the competitiveness of the revived Peshchernoe gold field (P) in the Sverdlovsk region, the value indicators of the field under consideration are compared with three newly developed fields: Altyntashskoe gold ore field in the Chelyabinsk region (A), Shilovskoe gold ore field in the Sverdlovsk region (Sh), and Iagodnoe gold ore field in the Sverdlovsk region (Ia). All the enterprises are situated relatively close to each other. The region of Peshchernoe field is economically developed and is provided with local manpower resources. The territory refers to the regions of the mining Middle Ural, where mineral exploration and geological investigation have been carried out and dozens of deposit have been developed throughout the centuries. Leading industries within Krasnoturyinsk Urban District are represented by non-ferrous metallurgy (Bogoslovsk aluminium smelter), iron ore mining enterprises (Bogovlovsk mine administration (rus. Bogoslovskoe rudoupravlenie), placer (Iuzhno-Zaozersky mine), lode gold (Zoloto Severnogo Urala), and construction materials. Table 1 contains the indicators of fields development, table 2 contains the results of the aggregated valuation of all types of crude minerals for the fields under consideration.

Table 1. Basic indicators of the compared gold fields development
Таблица 1. Основные показатели отработки сравниваемых золоторудных месторождений

Field	Average grade, g/t	Ore reserves, thousand ton	The volume of hard rock overburden, thousand ton [1]	The volume of tailings, thousand ton [2]	Non-commercial reserves, thousand ton, (grade, g/t)	Cost of marketable products, million rub.[3]	Operating cost, million rub.
A (gold)	2.19	1734	3700	1700	–	8201	6024.8
(silver)	1.26	–	–	–	–	66.1	–
P (gold)	6.09	1164.5	3200	1100	–	15312	11337
(silver)	1.73	–	–	–	–	48.2	–
Sh	2.79	836	4440	830	740 (1.2)	5037	3090
Ia	2.3	981.2	2300	950	650 (1.7)	4875	3273

References: [1] Strength R_c = 70.8–85.4 MPa. Suitable for "Crushed stone and gravel of solid rocks for construction works" according to GOST 8267-93; [2] Gold content in tailings 0.8–1.4 g/t, silver – 1 g/t; [3] Cost with the account of losses. Price of gold – 2700 rub/t, silver – 30 rub/t (average price in 5 years).

In order to estimate the competitiveness of the gold mining enterprise, the functional approach is reasonable [8] as the most fact-based and embracing important valuations of business activity of a mining enterprise. The main indicator of the effective use of the resources and maximum return of expenses is the value for money. Rate of return by the types of economic activity is estimated by the Federal Tax Service of Russia on the basis of the order (*RF FTS Order of 30 May 2007 N MM-3-06/333@ (revised 10 May 2012) "On the validation of the Concept of for field tax inspections planning system". For 2018. Available from: http://www.consultant.ru/document/cons_doc_LAW_55729*). In case the rate of return is lower than the normative, FS is to test the enterprise for expenses overstatement or other indicators misstatement. As of 2018, the value for money for metal ore mining is 57.3%, which is a considerably high normative rate of return because there are high risks for mining activities. The vast majority of the enterprises under consideration are competitive, firstly, because of the natural conditions (surroundings) and the established high price on precious metals (the prices have kept on growing since 2018). Peshchernoe field, possessing the highest content of metal, has adverse mining and geological conditions and high mining cost. In case metal prices

are reduced by 20–25%, the field will be unprofitable (if only gold is mined), but with the development of hard rock and tailings the field will retain stable financial indicators. Diversification by means of expanding the range of products will enlarge the value of the enterprise, improve techno-economic indicators and competitiveness [9]. It is possible to produce construction materials (gravel, screening, concrete and asphalt concrete filler, abrasive materials, cast stone material, brick (mudrock from loose overburden), agricultural meliorant, etc. from hard rock, tailings and loose overburden [10, 11]. Primary ore development (current production) and simultaneous processing of technogenic raw material will reduce the prime cost of production and dressing (i. e. reduce operating costs per a ton of ore), because the plant capacity will increase.

Table 2. Cost of crude minerals
Таблица 2. Стоимость минерального сырья

Fields, product	Product from tailings[1], kg	Cost, million rub.	Processing costs[2], million rub.	Products made of non-commercial reserves, kg	Cost, million rub.	Processing costs[3], million rub.	Construction materials made of hard rock[4], million m^3
A (gold)	1224	3305	1275	–	–	–	1.877
(silver)	1360	40.8	–	–	–	–	–
P (gold)	792	2138	825	–	–	–	1.623
(silver)	880	26,4	–	–	–	–	–
Sh	598	1614	622.5	888	2397.6	455.77	2.232
Ia	684	1846.8	712.5	884	2386.8	1022.0	1.167

Fields, product	Cost, million rub.	Expenditures, million rub.	Cost summary, million rub.	Expenditures summary, million rub.	Total cost, million rub.	Total expenditures, million rub.	Value for money, %
A (gold)	844.6	244	4190.4	1519.0	12457.5	7543.8	65.1
(silver)	–	–	–	–	–	–	–
P (gold)	730.3	211	2894.7	1036.0	18254.9	12373	47.5
(silver)	–	–	–	–	–	–	–
Sh	1004	290	5015.6	2122.3	10052.6	5212.3	92.8
Ia	525.1	152	4758.7	1886.5	9633.7	5159.5	86.7

References: [1] Extraction of metals from tailings with more promising techniques (for example, chloridizing roasting) accepted 80% (in practice can reach 95%); [2] The prime cost of processing 1 t of sand from the tailings storage 750 rub. (by analogy with processing) [13]; [3] Development and processing costs for non-commercial reserves due to the low content of metal and correspondingly heavy processing are 30% higher; [4] Processing is possible in amounts of 70% of hard rock overburden volume, bulk weight 1380 t/m^3, price 450 rub/m^3, self haul.

Mining complex has always been the greatest source of destruction and pollution for the environment. The total area of disturbed areas in Russia exceeds 2 million ha, the rate of revegetation are behind the rate of land disturbance. In order to quickly return the lands and reinstate their availability to national economy, revegetation is required which is impossible without considerable capital investment. Reclamation or revegetation is required which is impossible without considerable capital investment. According to MSMU scientists' estimates [12], specific costs of dump surface planning vary from 123 to 1000 dollars/ha. Cost of applying a 15–30 cm layer of soil, which was removed and stored earlier in bulk, is 970–1450 dollars/ha; cost of biological stage of

revegetation, which includes grass sowing, shrubs or trees planting varies from 80 to 320 dollars/ha. Apart from that, costs include regular and one-time payments which depend on the area of the subsurface site. Dumps and tailing storages mining reduces expenditures for reclamation and revegetation and cuts down various payments.

Conclusion. From the results of the conducted analysis the following observations have been made:

– gradual deterioration of the quality of the crude mineral base of gold, which manifests in the growth of the share of minor objects, reduction of valuable components content, and the complication of mining–technological conditions of mining, etc.;

– the presence of institutional (structural and financial) barriers which prevent from involving the fields from the unallocated and allocated subsoil reserve funds in operation;

– continued growth of already huge cumulative waste of mining and metallurgical industries.

The conditions which will provide the growth of competitiveness and investment attractiveness for the projects of small and medium-sized business (junior companies) must be created by means of:

– introduction and development of land provision declarative principle for geological exploration;

– simplified procedures of timberland registration for subsoil use;

– introduction of tax benefits and simplification of subsoil usage procedures as for the technogenic objects;

– creation of favorable investment environment;

– improved mechanisms aimed at integrated cluster development.

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Конкурентоспособность золоторудных месторождений

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Реферат

Актуальность. *Россия занимает третье место в мире по добыче и производству золота. При этом Урал считается колыбелью российской золотодобычи. В современных условиях обеспеченность предприятий Урала запасами золота при подземной добыче составляет 20–30 лет, при открытой – 30–40 лет. Прирост запасов в России наблюдается в основном на базе коренных месторождений. Из россыпных же месторождений добыча постоянно снижается. В то же время повышение цен на золото создает предпосылки по вовлечению в эксплуатацию резервных золотоносных месторождений. Непреодолимым барьером для освоения новых месторождений зачастую выступает нехватка финансовых средств, и для потенциальных инвесторов первоочередной задачей становится доступ к наиболее перспективным проектам, к золоторудным месторождениям, отличающимся высокой конкурентоспособностью.*

Цель исследования *– разработка методического подхода к оценке конкурентоспособных золоторудных месторождений на этапе прединвестиционных исследований и его апробация в условиях конкретных месторождений.*

Методы исследования: *метод сопоставлений, аналогий, технико-экономический анализ.*

Результаты. *В процессе исследований выявлены основные причины, тормозящие процесс освоения новых золотоносных месторождений. Доказано, что важнейшим аспектом конкурентных преимуществ горных предприятий является стоимость минерального сырья с учетом балансовых, забалансовых запасов, используемых скальных и других пород в отвалах, полезных компонентов в хвостах обогащения и др. Предлагается формула расчета укрупненной стоимости объекта и производится сопоставление конкурентоспособности вновь вводимого в эксплуатацию золоторудного месторождения Пещерное и трех вновь осваиваемых месторождений: Алтынташского, Шиловского и Ягодного. Исходя из основных показателей отработки месторождений выполнен расчет стоимости минерального сырья, который позволил проранжировать сравниваемые месторождения по уровню конкурентоспособности.*

Выводы. *Выполненный анализ показал, что наблюдается постепенное ухудшение качественных характеристик золоторудных месторождений при накоплении массы отходов. Вовлечению в отработку новых месторождений препятствуют институциональные барьеры и недостаток финансовых средств у недропользователей. Повышение конкурентоспособности малого и среднего горного бизнеса требует: внедрения и развития заявительного принципа предоставления участков недр для целей геологического изучения; упрощения процедуры оформления лесных участков для целей недропользования; внедрения налоговых льгот и упрощения порядка недропользования по техногенным объектам; создания благоприятного инвестиционного климата; развития механизмов, направленных на комплексное кустовое освоение объектов недропользования.*

Ключевые слова: *золоторудные месторождения; оценка; конкурентоспособность; стоимость минерального сырья; сопоставление.*

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