Analysis of the Price Dynamics, Prime Cost and Disproportions in the Subsurface Use

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Abstract. In this article the results of researches of the authors according to the state of the mineral and raw complex of Russia are considered. According to the analysis of different data (standard, statistical and expert evaluations and also the other researches, scientific conferences and production reports, etc.) the authors come to a conclusion about a certain imbalance between the pricing and cost in the mineral and raw sector of economy. Some market mechanisms, such as the stock market, pricing on metals, various principles of pricing on mineral resources and also the cost of works and services when forming the cost of production influence on it. Difference in the price policy leads to the loss of reserves of minerals and strengthens the mineral resources exhaustion. On the basis of the logic-structural and complex analysis the authors come to a conclusion that for the mining industry there is important solution of a question of efficiency of use of the resource potential, and the models of management decisions on effective use of the resources actually remain not investigated. Methods of assessment of a ratio of different factors and their influence on the models of management decisions and the elements of organizational and economic mechanism of management are insufficiently developed.

1. Introduction

1.1. Relevance of research

For the economic relationship in the mining industry characteristic is participation of the state in management. It is connected with the fact that subsoil in Russia and in the most foreign states is the state ownership. Mineral and raw potential causes efficiency of functioning of the other industries and the level of development of the social sphere that demonstrates the value of mining industry in the world and national economies.

Finding of mineral raw material resources in the state ownership (except for the popular minerals) allows consider them the national property, or the mineral source of raw materials of economy. Owing to such high status they need the special relation directed to careful attitude, protection against the inappropriate use.

The relevance of research is determined that for a long time in Russia the main condition of effective use of subsoil isn't implemented. The condition is that timely consecutive studying of subsoil according to the staging of works isn't carried out. Timely and high-quality geological studying is a
duty of the owner, i.e. the authorized public authority. The timeliness is determined by existence on the state balance of explored reserves of mineral in the quantities providing the industry for the term of the period of optimum reproduction.

In the sphere of circulation of mineral raw materials there was a discrepancy of economic mechanisms of production of raw materials and the subjective principles of pricing [1, 2]. Rare researchers spoke about a danger of unbalanced pricing in the subsurface use 20 years ago [3]. However today we observe discrepancy among themselves of the price of mineral and raw products and discrepancy of price characteristics of the cost of production. Such imbalance is a result of the non-use of classical technologies of economic calculations in mining and dependence on the market mechanisms. An example of such dependence is distribution of the prices according to transactions at the exchanges on the production sphere. It is difficult to present such economic circumstances, which would influence the change in price of the mineral raw materials several times a day as it occurs at the exchange. Especially as the price of mineral is important at its studying - deposits, definition of the qualitative characteristics, development of technology of production, enrichment [4].

1.2. The degree of the problem investigation

Many research teams, including under the leadership of A.I. Vladimirov, E.A. Kozlowskii, A.E. Kontorovich, R.M. Ter-Sarkisov were engaged in the research of modern problems of development of the mineral and raw complex of the country, economic assessment and the forecast of development of mineral resources of the mining industry.

Problems of reproduction of mineral resources are considered in S.K. Bezhanov, E.A. Kozlowskii, E.S. Melekhin, V.V. Ovchinikov, N.F. Reymers, P.V. Sadovnik's works and others.

Debatable are the questions of use of the innovative instruments in the management sphere in the mining industry allowing carry out the assessment of mineral resources of the country. Besides, for the mining industry there is important solution of the question of efficiency of use of the resource potential, and the models of management decisions on the effective use of resources actually remain not investigated. Methods of assessment of the ratio of different factors and their influence on the models of management decisions as the problems of scientific research are rather new to the economy of mineral raw materials. Possibility of application of these or those methods of cost and geological and economic assessment of mineral deposits is the most often investigated. But for a long time, the need for strategic management of the economic systems of higher order – the regional economies, industries, industrial complexes, proceeding from the conditions to managements of these systems came. Development of methodology of the complex assessment of mineral resources including both the cost assessment, and geological assessment is for this purpose necessary.

1.3. Novelty of research and practical significance

It is proved that at implementation of analysis of the state of information provision in the system of public administration by the mining industry existence of the separated, not standardized information systems covering only the certain levels of management, or a limited set of management processes is insufficient for creation of the full-fledged control system. As a result of revealed weak interrelations and interdependence of different sections of control system the mineral resources are de-balanced. During the analysis need of its revaluation, need of formulation of new tasks for MR in the changed situation, search of the adequate methods of their decision and a search of new instruments of management of the process of subsurface use and reproduction is revealed and proved.

Correctly certain instruments in the management which are most integrated in the operated (operating) object (mining industry) allow not only develop the optimum innovative model of management, but also to offer the new elements of the mechanism of integration of the industry into this or that economic system.

The practical importance of work consists in development of the basic methodological provisions of the concept of integrated information technological platform in the control system of mining industry.
2. Goals
Research objective is identification of the reasons of an imbalance in the pricing of products of the mineral and raw sector of economy. The solution of such problems is relevant as well because we observe incompleteness of institutional researches in the sphere of subsurface use.

3. Research methodology
In the article some actions which need to be undertaken for elimination of negative impact of a problem of pricing in the subsurface use and cost characteristics of mineral raw materials are offered. Actions are determined on the basis of correlation and regression analysis, the logic-structural analysis of data and the complex analysis of a task. Systematic monitoring gives to the authors necessary data for expeditious entering of amendments into the research.

4. Problem analysis
Mineral raw materials have the unique properties – a part of properties has positive character, and a part of properties of mineral requires systematic attention – as the positive nature of properties in the absence of attention from the state can change on the negative.

Positive properties of mineral raw materials are connected with extraction of the income at the expense of subsoil. Transformation of mineral raw materials into the commodity product submits the rather simple procedure (only - extraction from subsoil and in some cases - enrichment). However, this commodity product forms a considerable part of the budget of Russia.

And here such characteristics as exhaustibility and non-renderability of mineral raw materials level the properties of positive character. It is unambiguously known that mineral raw materials will reach a limit, but it is definitely not known when. But incompleteness of extraction from subsoil, losses at production and processing (including due to the reduction of price) accelerate this process. The order of figures gives in to forecasting. Evaluation of possible exhaustion of resources are known by each type of mineral raw materials across Russia and in general on the world. The Audit Chamber was interested in provision with the explored reserves [5, 6]. According to the Audit Chamber for 2012, from 150 considered types of solid minerals only by 60 types since 2008 provision increased or remained invariable, but production was compensated by a gain only by 19 types, and by 44 types decrease in production is observed. Provision with the explored reserves of oil in Russia - 23 years, at the world provision of 45 years (generally at the expense of the OPEC countries which are provided with the stocks for 85 years). For oil production the world problem is the oil recovery coefficient (ORC), for example, for Russia actually not exceeding 30-35% (about 70% of oil dissipate in subsoil in the course of oil production). For example, the oil recovery coefficient (ORC) on the Russian Arctic Prirazlomnoye field that on the shelf of the Pechersk sea, makes about 26% while on the similar Norwegian fields this indicator reaches 50%, and sometimes more than 60%. According to the Lukoil Oil Company, the industry average CEO in Russia doesn't exceed 25%, CEO on the fields with high degree of clarity in Norway and the USA is in range of 40-50% [7]

Conclusions of different researchers on exhaustion of mineral raw materials in time on the basis of information from various sources are presented in the table 1 [5, 8, 9, 10].
Table 1. Exhaustion of mineral resources over time.

| Mineral resource            | The share of the distributed Fund subsoils', V % | Year of depletion of profitable operating reserves, 2009 | Year of depletion of profitable operating reserves, 2006 | The year of exhaustion of profitable exploited stocks, 2014, (calculation) |
|-----------------------------|-----------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------------------|
| Manganese ore               | 9                                             | 2013                                                     | 2013                                                     | 2058                                                                           |
| Coal                        | 12                                            | 2025*                                                    | 2025*                                                    | 2130                                                                           |
| Molybdenum                  | 52                                            | 2018                                                     | 2018                                                     | 2093                                                                           |
| Tin                         | 27                                            | 2017                                                     | 2017                                                     | 2026                                                                           |
| Uranium                     | 27                                            | 2017                                                     | 2017                                                     | 2077                                                                           |
| Zinc                        | 32                                            | 2014                                                     | 2014                                                     | 2048                                                                           |
| Phosphate salts             | 35                                            | 2025*                                                    | 2025*                                                    | No data                                                                       |
| Sodium salt                 | 40                                            | 2025*                                                    | 2025*                                                    | No data                                                                       |
| Potassium salt              | 44                                            | 2025*                                                    | 2025*                                                    | 2130                                                                           |
| Bauxites                    | 50                                            | 2025*                                                    | 2025*                                                    | 2093                                                                           |
| Manganese ore               | 55                                            | 2018                                                     | 2018                                                     | 2048                                                                           |
| Iron ore                    | 58                                            | 2025*                                                    | 2025*                                                    | No data                                                                       |
| Lead                        | 60                                            | 2013                                                     | 2013                                                     | 2034                                                                           |
| Copper                      | 62                                            | 2018                                                     | 2018                                                     | 2048                                                                           |
| Alluvial gold               | 65                                            | 2014                                                     | 2014                                                     | 2039                                                                           |
| Gold indigenous             | 72                                            | 2017                                                     | 2017                                                     | 2070                                                                           |
| Platinoids                  | 74                                            | 2020                                                     | 2020                                                     | 2055                                                                           |
| Gas                         | 83                                            | 2025*                                                    | 2025*                                                    | 2115                                                                           |
| Magnesite                   | 88                                            | 2018                                                     | 2018                                                     | No data                                                                       |
| Nickel                      | 92                                            | 2018                                                     | 2018                                                     | 2037                                                                           |
| Oil                         | 92                                            | 2022                                                     | 2022                                                     | 2060                                                                           |
| Graphite                    | 92                                            | 2020                                                     | 2020                                                     | No data                                                                       |
| Diamonds                    | 95                                            | 2015                                                     | 2015                                                     | 2035                                                                           |
| Chrome ore                  | 100                                           | 2015                                                     | 2015                                                     | 2064                                                                           |

* Year of completion of the long-Term state program for the study of subsoil and reproduction of mineral resources, approved by the order of the Ministry of natural resources of Russia 2006/05/15 №112.

Analyzing the table, it is easy to notice that a year of exhaustion of the profitable operated stocks on a number of minerals passed long ago, but the stocks didn't end. For example, tin, uranium, manganese, lead. It is connected with the fact that now a considerable part of explored reserves of main types of minerals is already distributed under the license agreements. However, in operation there is only a part (by some types of the raw materials - not really big) the distributed fund of subsoil, and on tin, for example, production actually isn't carried out more than 10 years. Taking into account the available data on the actual production and alleged consumption data on the time of exhaustion of the profitable operated stocks were adjusted.

However, the data on a condition of MR which are available today are separated. Information on consumption, production, stocks [11, 12, 13] is reflected in the state reports submitted to MNR not completely, information isn't structured and by years doesn't coincide. And this information on reproduction of SME not of stocks, and, most often, expected resources. Especially this difference in
assessment of a condition of MNR of Russia is noticeable if to bring together information from the sources of the ministries and departments (MNR, the Audit Chamber) and also information which is available in the territorial departments of the ministry of natural resources of Russia, information of the independent experts. Such assessment is given in the table 2 for one of the federal districts of Russia – the Far-Eastern federal district [14].

**Table 2.** Expert assessments of the state of mineral resources potential of the Far Eastern Federal district.

| Kind of mineral | Share in Russia's proven reserves, % | Share in forecast resources of the Russian Federation, % | Inventory security, years |
|----------------|-------------------------------------|-------------------------------------------------------|--------------------------|
| Gold           | 33,                                 | More than 8,5                                        | Up to 25 (ore); 1,5–5 (placer) |
| Platinum       | Around 0,5                           | P₁ – 2%, P₂ – 5%                                     | Up to 5 (ore Pt)          |
|                |                                     | Around 20                                             | Up to 5 (placer Pt)       |
| Platinoids     | More than 30                         | More than 80                                          | Up to 35                  |
| Silver         | 24,0                                | -                                                     | -                        |
| Rare earth element | Around 81                        | More than 40                                          | 1,5–30                   |
| Diamonds       | 0,8                                 | P₂ – More than 14%                                    | -                        |
| Copper         | Around 92                            | 100                                                   | Around 35                 |
| Tin            | Around 23                            | Around 60                                             | 5–10                     |
| Tungsten       | 8,3                                 | 27,4                                                  | Not more than 15          |
| Lead           | 3,7                                 | 15,9                                                  | Not more than 15          |
| Zinc           | 4,3                                 | -                                                     | -                        |
| Manganese      | 7,9                                 | -                                                     | -                        |
| Iron ore       | Around 11                            | -                                                     | 1,5–150                  |
| Coal           | Around 3,0                           | -                                                     | -                        |
| Oil            | 2,8                                 | -                                                     | -                        |
| Natural gas    | -                                   | -                                                     | More than 200            |
| Oil            | 51,4                                | -                                                     | 11–30                    |
| Fluorspar      | Around 50                            | -                                                     | 10–18                    |
| Antimony       | -                                    | -                                                     | 40–50                    |
| Brucite        | Around 11                            | -                                                     | -                        |

Comparing indicators of the tables 1 and 2 it is possible to see divergences both on the expected stocks, and on the time of exhaustion of stocks in the operated fields. It is possible to draw the only conclusion - there is no uniform information base actually in Russia today. And the situation with the unity of information base about subsoil is aggravated as the last time results of monitoring about the complex assessment of the state of MR by the Ministry of natural resources of Russia are presented in 2006 [10].

One more feature of the mineral raw materials is that depending on its price, there is its quantity, possible for extraction: at the fix price on subsoil it is possible to mark out a certain quantity at the corresponding quality, and by reduction of the price there are the off-balance stocks remaining in subsoil and the quantity of the economically profitable for production stocks decreases. Understanding of this circumstance induces the owner of subsoil, i.e. the states, to hold the price invariable, or even to increase it to stimulate completeness of extraction from subsoil. In table 3 the average prices on some metals widespread in Russia, first of all - are given in the Far East of Russia [15, 16].
### Table 3. Average metal prices during the period 2008-2018.

| Year | Gold, for 1 g | Copper, for 1 ton | Tin, for 1 ton | Lead, for 1 ton | Zinc, for 1 t |
|------|---------------|------------------|----------------|-----------------|--------------|
| 2008 | 28.6          | 7309             | 19713          | 2372            | 2104         |
| 2009 | 31.27         | 5150             | 13562          | 1719            | 1655         |
| 2010 | 39.38         | 7130             | 22156          | 2268            | 2208         |
| 2011 | 50.53         | 7365             | 32654          | 1815            | 2200         |
| 2012 | 53.66         | 9861             | 23698          | 2010            | 2100         |
| 2013 | 45.37         | 8321             | 22654          | 2005            | 1950         |
| 2014 | 40.72         | 6998             | 23754          | 2014            | 2144         |
| 2015 | 36.83         | 5731             | 10100          | 1688            | 1932         |
| 2016 | 37.30         | 4761             | 17638          | 1819            | 2102         |
| 2017 | 39.90         | 5975             | 19990          | 2309            | 2815         |
| 2018 | 40.78         | 6481             | 19941          | 2295            | 2877         |

In the table 4 the cost characteristics of production of one of the most popular metals in the planet - gold with other production expenses are given for comparison [17, 18, 19].

### Table 4. Mining cost of gold including operational expenses.

| Year | Cost of production (Russia, Khabarovsk kr.) | Cost of production (Australia) | Cost of production (South Africa) |
|------|------------------------------------------|-------------------------------|----------------------------------|
|      | 2008                                     | 2010                         | 2013                            |
|      | 21.9                                     | 29.46                        | 34.65                           |
|      | 34.13                                    | 34.13                        | 34.13                           |
|      | 35.50                                    | 31.87                        | 33.20                           |
|      | 26.78                                    | 30.64                        | 34.06                           |

The picture presented in the table 3 doesn't reflect any objective economic processes. It is the sphere of business activity at which implementation interests of MR aren't considered in any way. The mining enterprises make those mineral and raw products, the price for which is formed not taking into account the cost of production, and at the exchanges and therefore the process of pricing infringes on their interests. But the authors pay attention to the other party: all this time the mining enterprises worked on the standards based on the lower price of metals (exchange is 2-5 times lower) [20, 21]. It means, in subsoil the standard at the ore prices specified in the table are left. Material inputs of the process of production are criterion of reference of the reserves of mineral raw materials to the profitable. If the cost of production is higher than the cost of mineral raw materials, the stocks aren't profitable for production. In the table 4 it is possible to see – the cost of gold mining with the other production expenses (transport, tax and so forth) grows. In the table 3 – the gold price formed at the exchange by speculative transactions – falls.

At the expense of difference of the established price of metal and the price put in the project of the mountain enterprise (in standard) we have a loss of ore in subsoil.

But assessment of the mineral raw materials which are available in subsoil is extremely contradictory.

There is the most capacious information. The cost of the explored and previously evaluated stocks of Russia is about 29 trillion dollars with the prospect to remain at this level for decades. The main value is made by the hydrocarbon raw materials (gas, oil and condensate, coals), making together
more than 70% (and it is about 20 trillion dollars), ferrous metals (about 7%), the non-ferrous and rare metals follow further (also about 7%), precious metals and diamonds (about 1%), about 15% falls on the other types of important ore and nonmetallic minerals. Figures are great, but they are presented to us underestimated. In 2013 a number of researchers noted a negative tendency of currency revenue to the growth, specifying that in an annual gross product the mineral raw materials make about 38% of cost and about 80% of the export revenue [22].

There are different approaches to evaluation of the actual specific weight of mining activity. The authors are imposed by the approaches considering formation of industrial complexes both the mining enterprises providing the activity and using their products to a large extent. According to the financial statements it is possible to evaluate integrated influence of the mineral raw complex on the gross product of 70-80%.

According to the Ministry of natural resources, the cost of reserves of oil and gas in Russia exceeds to the few 50 trillion rubles, and the cost of gold and diamonds reaches 1 trillion rubles. Such data contain the documents of MNR of Russia which for the first time evaluated in the value terms the reserves of minerals in the country [23]. Assessment is made as of the end of 2017 and has to be updated annually. MNR evaluated the total value of all mineral and energy resources in subsoil of Russia, including oil and gas, gold and diamonds, copper, iron ore, steam and brown coal at 55.2 trillion rubles.

In 2017 it made 60% of GDP of Russia. Oil reserves in Russia are evaluated in 39.6 trillion rubles. The cost of reserves of gas was 11.3 trillion rubles. Reserves of diamonds are evaluated in 505 billion rubles, and gold — in 480 billion rubles. According to MNR, reserves of the coked coal are evaluated almost in 2 trillion rubles, and iron ore — in 808 billion rubles. The stocks were evaluated on the official statistical methodology of assessment of reserves of minerals, approved in September, 2017 in natural and cost measurements [24]. The stocks in a section of subsoil plots on which licenses for the use of natural resources were granted and on which "there are an engineering design approved in accordance with the established procedure and the other project documentation on performance of work" were evaluated on it. It means that the reserves of minerals evaluated by MNR there are less than the total volume of explored reserves. The ministry estimated the general reserves of oil for the end of 2017 at 9.04 billion t, gas — at 14.47 trillion cube m, gold — at 1407 t, diamonds — at 375 million metric carats (how to compare rubles and tons?).

We see the difference between evaluation of the Audit Chamber and of the ministry of natural resources of Russia. Meanwhile, there are also the other evaluations of mineral resources of Russia. For example, the proved oil reserves in Russia for the end of 2017 made, according to BP (Bee-Pi, till May, 2001 British Petroleum — the multinational oil and gas company with the headquarters in London), 14.5 billion t, natural gas — 35 trillion cube m. According to the United States Geological Survey, the proved gold reserves in subsoil of Russia for the end of 2017 equaled 5500 t [25].

5. The Results of the study

5.1. Reason of different assessment of mineral raw materials

The problem of different assessment consists in distinction of the principles of pricing for the mineral raw materials which is established at the exchange, and the cost of goods, works and services which the mining enterprises use by production of a commodity product. The costs are determined randomly by an example of natural monopolies (more precisely after them - power engineering specialists, transport workers). In this case there are in subsoil "unprofitable" stocks because of higher growth rates of cost of works and services in comparison with the price of metals.

We will consider the influence of two market mechanisms on the state of mineral resources:

1) determination of the price of mineral raw materials at the exchange,
2) ratio of growth rates of the prices of mineral raw materials and the cost of goods, works and services.
It is necessary to prove minimization or a complete elimination of their influence on the mineral resources. It is possible as follows:

a) it is necessary to fix on the basis of detailed geological and economic calculations the cost of mineral raw materials for the terms comparable to duration of a cycle of reproduction of mineral resources (about 10-15 years).

b) to fix for this term the rate of national currency on the level of provision with the liquid mineral raw materials.

The authors realize possible difficulties in realization of similar intentions, but at the same time are convinced of need of their fastest and inevitable permission.

5.2. Resources of growth of profitability from use of a mineral and raw complex

The basis of MR which structure includes the mining industry by the mineral deposits, which are in subsoil of Russia including those which aren't opened yet, and are assumed. Now in Russia the property rights to the resources involved in the mining industry are distributed as follows:

1) the natural resources (subsoil and minerals in them) – property of the state;

2) the capital (investment into the search, investigation, production) – the property of mining operators (subsoil users);

3) the labor (extraction of minerals from subsoil) – the property of hired workers.

To make products (to carry out production), it is necessary to unite all three resources in the course of production. The motive which moves participants of such association - maximizing the net income. Here it must be kept in mind that we don't evaluate the cost of minerals. This motive is defined as follows:

- for the state – difference between the receipts in the budget from the mining industry and the costs of search, protection and metering of the mineral raw materials (in the presence of such expenses);

- for the mining operators - subsoil users – difference between the sales proceeds of got and the costs of mining;

- for hired workers – difference between the salary (including privileges) and the costs of maintenance of the existence.

Benefits for the state are defined here as follows. The state receives taxes from the economic activity in the mining industry and payments regarding the use of natural resources. The less expenses has the state for performance of the functions at the same time, the more the state receives the income.

For businessmen in the mining industry benefits are connected directly with the production process. The less investments are in production and implementation of new technologies of production, the income is more. Thus, the less expenses connected with extraction of the useful component from subsoil the profit at the mining operator - the subsoil user is more.

For the hired workers benefits in a size of salary, compensation of a number of expenses connected with the costs of the existence, a large number of social guarantees. At last, the specifics of production allow get the corresponding professional education and skills at the expense of the enterprise.

It is necessary to notice that each of owners of the resource incurs charges of this resource. Therefore, the income of each owner has to cover his cost from participation in the production process – for ensuring simple reproduction, or to exceed them – for the expanded reproduction. Comparison of the income and expenses of each participant of the process of production, including and the owner, allows determine profitability of use of mineral resources in production.

6. Conclusions

By the results of research it is possible to draw the following conclusions.

1. Extremely negative impact has the process of distribution of operations on the stock exchange directly on the mining production. Free pricing for works and services isn't connected neither with the exchange processes, nor with the so-called inflation. Such pricing has the negative effect on economic relations of production and actually destroys them.
2. The economic system of production in the mineral and raw sector is dis-adjusted, there is no firm, reference indicator. The capital is created and formed not in the sphere of production, but in the sphere of distribution. MR doesn't make personal growth, and is in search of the investors.

3. For elimination of imbalance the pricing not only has to be regulated, but also has to be the subject to the strict state control. Continuous state regulation has to be realized both in the sphere of creation of commodity product, and in the economy services industry.

4. The main minerals in the region are in the distributed fund of subsoil. Reduction of mineral resources of the country is a direct consequence of decrease in financing of the exploration works. In the mining industry there is a gradual replacement of the fields leaving operation put by the rich ores, large, and often huge fields of the poor ores.

As the mineral raw materials are not filled and not renewing the natural resource, it will reach the limit sooner or later. Therefore it is necessary to carry out monitoring of the state of MR. The lack of monitoring influences national security of the state.

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