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Assessment of Financial Opportunities for Implementation of Innovation Potential by Mining Enterprises of Non-Ferrous Metallurgy of the North and the Arctic *

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Abstract. The analysis of methods for assessing the financial opportunities for increasing the economic efficiency of industrial enterprises using absolute and relative indicators and coefficients was carried out. A mechanism for determining financial possibilities for realizing innovative potential of northern mining enterprises of non-ferrous metallurgy, based on the method of assessing the three-component coefficient, which allows choosing the most rational strategy of scientific and technological development, taking into account financial resources and features of production functioning in the northern regions of the Russian Federation, was developed. It is shown that the proposed methodology can be used with limited information in the accounting statements provided in public access. On the basis of objective indicators, the research of innovation activity of twenty industrial enterprises of non-ferrous metallurgy directly operating in the North and the Arctic and included as subsidiaries and branches of seven largest corporations — PJSC MMC “Norilsk Nickel”, JSC “Mine Karalveem”, PJSC “Acron”, JSC “Mining company “Berelekh”, PJSC “Seligdar”, OJSC “Susumanzoloto”, JSC “Polymetal” for the period 2013–2019 was carried out. Studies showed the dependence of the innovation activity of northern enterprises of non-ferrous metallurgy on the level of financial security revealed by the method of assessing the three-component coefficient. Scientifically substantiated possibility of developing and implementing a strategy of innovation development of enterprises for the medium and long term periods based on the level of financial security is shown. Enterprises with high financial security or in special cases (with additional investments with normal financial security) are able to generate innovation technologies. As the analysis has shown, the majority of northern enterprises have low financial security, which does not allow them to count on effective innovative development without attracting a significant amount of targeted investments.

Keywords: *northern enterprise, non-ferrous metallurgy, methodology, assessment, financial capability, innovation potential.*

Introduction

The mining industry, including nonferrous metallurgy enterprises, is a determining sector in the economies of the North and Arctic regions and the Russian Federation, which will retain a raw material orientation with a high share of exports and significant potential for innovative development of the mining industry, the greatest importance of which is characterized by copper-nickel, gold, apatite-nepheline and rare metals [1]. The gross value of industrial production of nonferrous metallurgy enterprises, which are essentially city-forming, is about 7% of Russia's GDP and 14% of

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the country's export potential [2]. The raw material base of nonferrous metallurgy in the North and the Arctic of Russia allows ensuring growth of nonferrous metals production for domestic consumption and export. In this regard, the “raw material” orientation of nonferrous metals production and, most importantly, the innovative technologies implementation, are fully correlated with the strategy of transition of the Russian economy to an innovative development path.

Among the key problems and risks that characterize the current state of nonferrous metallurgy is the low level of advancement and implementation of innovative projects for the development and processing in the conditions of the North and the Arctic, the specific features of which are, first of all, high costs. In this regard, it is necessary to develop a modern paradigm of a balanced mining mechanism¹ [3–5].

The aim of the work is to study the financial possibilities of realizing the innovative potential of nonferrous metal mining enterprises of the North and the Arctic to increase the economic development of the macroregion and the Russian Federation.

Materials and methods

A review was carried out showing the developed methods for assessing the financial capabilities of industrial enterprises for making managerial decisions to improve the modernization of economic efficiency using absolute and relative indicators and coefficients [6, 7]. As a result of the analysis and taking into account the limited indicators of financial statements publicly available, a method for assessing the three-component coefficient was chosen. Its calculation methodology was proposed in the works of A.A. Trifilova [8], A.D. Sheremet [9], N.V. Sobchenko [10], Zh.A. Sokolova [11], E.V. Shvarova, J.A. Tkach [12] and other authors. The use of a three-component coefficient allows the enterprise to choose the most rational strategy for the implementation of innovative development, taking into account financial resources and the peculiarities of functioning in the northern regions of the Russian Federation. To determine financial stability, the proposed methodology provides for the calculation of the following indicators:

Lack (surplus) of own current assets C_{COC} :

$$\pm C_{coc} = CK - BA - 3 \quad (1),$$

where CK — own assets (reserves and capital),

BA — non-current assets,

3 — inventories

Lack (surplus) of own sources and long-term borrowed assets C_{cA} :

$$\pm C_{ca} = C_{COC} + \overline{DK} - 3 \quad (2),$$

¹ Elie D. An Analysis of Global Safety Trends in the Oil and Gas Industry — Impacts and Challenges in the Years Ahead // SPE/IATMI Asia Pacific Oil & Gas Conference and Exhibition, 20-22 October, Nusa Dua, Bali, Indonesia. Society of Petroleum Engineers, 2015. DOI: <https://doi.org/10.2118/176502-MS>. URL: <https://www.onepetro.org/conference-paper/SPE-176502-MS> (accessed 10 May 2020).

where C_{COC} — lack (surplus) of own current assets,

ΔK — long-term loans and credits,

$З$ — inventories.

Lack (surplus) of the main sources of cost formation O :

$$\pm O = C_{co} + KK - З \quad (3),$$

where C_{cd} — lack (surplus) of own sources and long-term borrowed assets,

KK — short-term loans and credits,

$З$ — inventories.

On the basis of the above indicators, a three-component coefficient of financial stability is determined. In the case of the coefficient size greater than 0, the situation is denoted by 1, in the case of the coefficient size less than 0 — 0.

In accordance with the three-component coefficient of financial stability, enterprises are ranked into four groups:

1. High level of own financial resources is characterized by a three-component coefficient “1; 1; 1”.
2. Normal financial solvency with necessary resources is characterized by a three-component coefficient “0; 1; 1”.
3. Satisfactory financial support for operating costs and inventories is characterized by a three-component coefficient “0; 0; 1”.
4. Deficit or absence of financial resources for the implementation of innovative activities is characterized by a three-component coefficient “0; 0; 0”.

Enterprises of the first group, characterized by a high level of financial security, do not require external borrowing for innovative development.

Enterprises of the second group require additional borrowing to develop and implement innovative technologies.

Industrial enterprises of the third and fourth groups lack the basis for developing an innovative development strategy without attracting a significant amount of external financial resources.

Research results of innovative activity of nonferrous metallurgy enterprises in the North and the Arctic of Russia

On the basis of publicly available official reports, analysis of scientific publications in the journals “Gornyi Zhurnal”, “Tsvetnye Metally”, “Obogashchenie Rud”, “Mining Informational and Analytical Bulletin”, “Izvestiya Vuzov. Tsvetnaya Metallurgiya”, “Zoloto i Tekhnologii”, “Zolotodobycha”, as well as expert assessments, the level of innovative activity of 7 largest corporations of nonferrous metallurgy and 17 of their subsidiaries and branches operating directly in the northern territories was determined for the period 2013–2019:

1. PJSC “Mining and Metallurgical Company “Norilsk Nickel” is located in the city of Norilsk. The company produces technical sulfur, technical selenium, cathode copper, precious metal concentrates, nickel matte, primary nickel, nickel carbonyl shot, nickel carbonyl powder, nickel concentrate, electrolyte cobalt, cobalt concentrate, technical sulfuric acid, sodium chloride, sodium sulfate, copper matte, nickel matte ².
2. JSC “Kola Mining and Metallurgical Company” is a subsidiary of PJSC “MMC “Norilsk Nickel”. The company is located in the city of Monchegorsk, Murmansk region. It produces nickel carbonyl shot, primary nickel, nickel carbonyl powder, cathode copper, nickel concentrate, cobalt concentrate, precious metal concentrates, technical sulfuric acid, electrolyte cobalt, sodium chloride, sodium sulfate, nickel matte, nickel matte, copper matte ³.
3. JSC “Mine Karalveem” is located in the city of Bilibino, Chukotka Autonomous Okrug. The company produces gold concentrate ⁴.
4. JSC “North-Western Phosphorous Company” is a subsidiary of PJSC “Acron”. The company is located in the village of Koashva, Murmansk region. It produces apatite concentrate ⁵.
5. JSC “Mining company “Berelekh” with subsidiaries ⁶:
 - LLC “Udarnik-2000”, located in the village of Udarnik, Magadan Region, produces gold concentrate;
 - LLC “Maldyak”, located in the city of Susuman, Magadan region, produces gold concentrate;
 - LLC “Elita”, located in the village of Maldyak, Magadan Region, produces gold concentrate;
 - LLC “Monolit”, located in the village of Shirokoye, Magadan Region, produces gold concentrate;
 - LLC “Palladium”, located in the city of Magadan, produces gold concentrate;
 - LLC “Iridium”, located in the city of Magadan, produces gold concentrate.
6. PJSC “Seligdar” with subsidiaries ⁷:

² Annual Report of PJSC MMC Norilsk Nickel for 2018, p. 73. URL: <https://www.nornickel.ru/investors/reports-and-results/#2018> (accessed 30 June 2020).

³ Manufactured Products and Sales. URL: <https://www.kolagmk.ru/pages/779-produkciya-i-sbyt.html> (accessed 15 June 2020).

⁴ Constituent Documents of the Company. Annual Report for 2017, p. 6. URL: <https://www.goldpro.ru/rudnik-karalveem/> (accessed 25 June 2020).

⁵ Financial Statements. Annual Reports. PJSC Acron's 2019 Annual Report, p. 38. URL: <https://www.acron.ru/investors/financial-statements/?brand=1988&type=178&year=2020> (accessed 05 July 2020).

⁶ JSC “GDK” Berelekh. Annual Report, p. 8. URL: <https://www.e-disclosure.ru/portal/files.aspx?id=16501&type=2> (accessed 30 June 2020).

⁷ Activity Map. Gold Division. URL: <https://seligdar.ru/geography/gold-division/grk-nizneyakokitski> (accessed 17 June 2020).

- JSC “Zoloto Seligdara”, located in the city of Aldan, Republic of Sakha (Yakutia), produces gold concentrate;
 - LLC “Ryabinovoe”, located in the city of Aldan, Republic of Sakha (Yakutia), produces gold concentrate;
 - JSC “Lunnoe”, located in the city of Aldan, Republic of Sakha (Yakutia), produces gold concentrate;
 - LLC “Samolazovskoe”, located in the city of Aldan, Republic of Sakha (Yakutia), produces gold and silver concentrates.
7. OJSC “Susumanzoloto” with subsidiaries⁸:
- LLC “Electrum Plus”, located in the city of Magadan, produces gold concentrate;
 - LLC “Rudnik Shturmovskoy”, located in the city of Magadan, produces gold concentrate.
 - JSC “Polymetal” with subsidiaries:
 - JSC “Serebro Magadana”, located in the urban-type settlement Omsukchan, Magadan Region, produces gold and silver concentrates⁹;
 - LLC “Mayskoe” Gold Ore Company”, located in the town of Pevek, Chukotka Autonomous Okrug, produces gold concentrate¹⁰;
 - LLC “Primorskoe”, located in the city of Magadan, produces gold concentrate¹¹;
 - LLC “Omolon” Gold Ore Company”, located in the city of Magadan, produces gold concentrate¹².

It should be noted that, despite the direct connection of JSC “Kola MMC” with PJSC “MMC “Norilsk Nickel”, the enterprise was studied separately, taking into account the scale and export significance of products not only for the Murmansk region, but for Russia as a whole.

Fig. 1 shows the assessment of financial possibilities for the innovative projects implementation of nonferrous metallurgy corporations in the North and the Arctic, for which accounting reports are presented, including subsidiaries and branches, for 2013, 2015 and 2019.

⁸ PJSC “Susumanzoloto”. Annual Report, 2019, p. 11, 16. URL: <http://www.e-disclosure.ru/portal/files.aspx?id=6323&type=2> (accessed 03 July 2020).

⁹ Annual Reports, 2019, p. 37. URL: <https://www.polymetalinternational.com/ru/investors-and-media/disclosure-center/annual-reports> (accessed 02 July 2020).

¹⁰ Organizational Structure. URL: <https://www.polymetalinternational.com/ru/about/at-a-glance/group-structure> (accessed 01 July 2020).

¹¹ Organizational Structure. URL: <https://www.polymetalinternational.com/ru/assets/where-we-operate/dukat-hub> (accessed 01 July 2020).

¹² Bashlykova T.V. Sposob izvlecheniya blagorodnykh metallov iz otrabotannykh shtabeley kuchnogo vyshchelachivaniya [Method for Extracting Precious Metals from Waste Heap Leaching Piles]. URL: <https://patents.google.com/patent/RU2622534C2/ru> (accessed 15 July 2020).

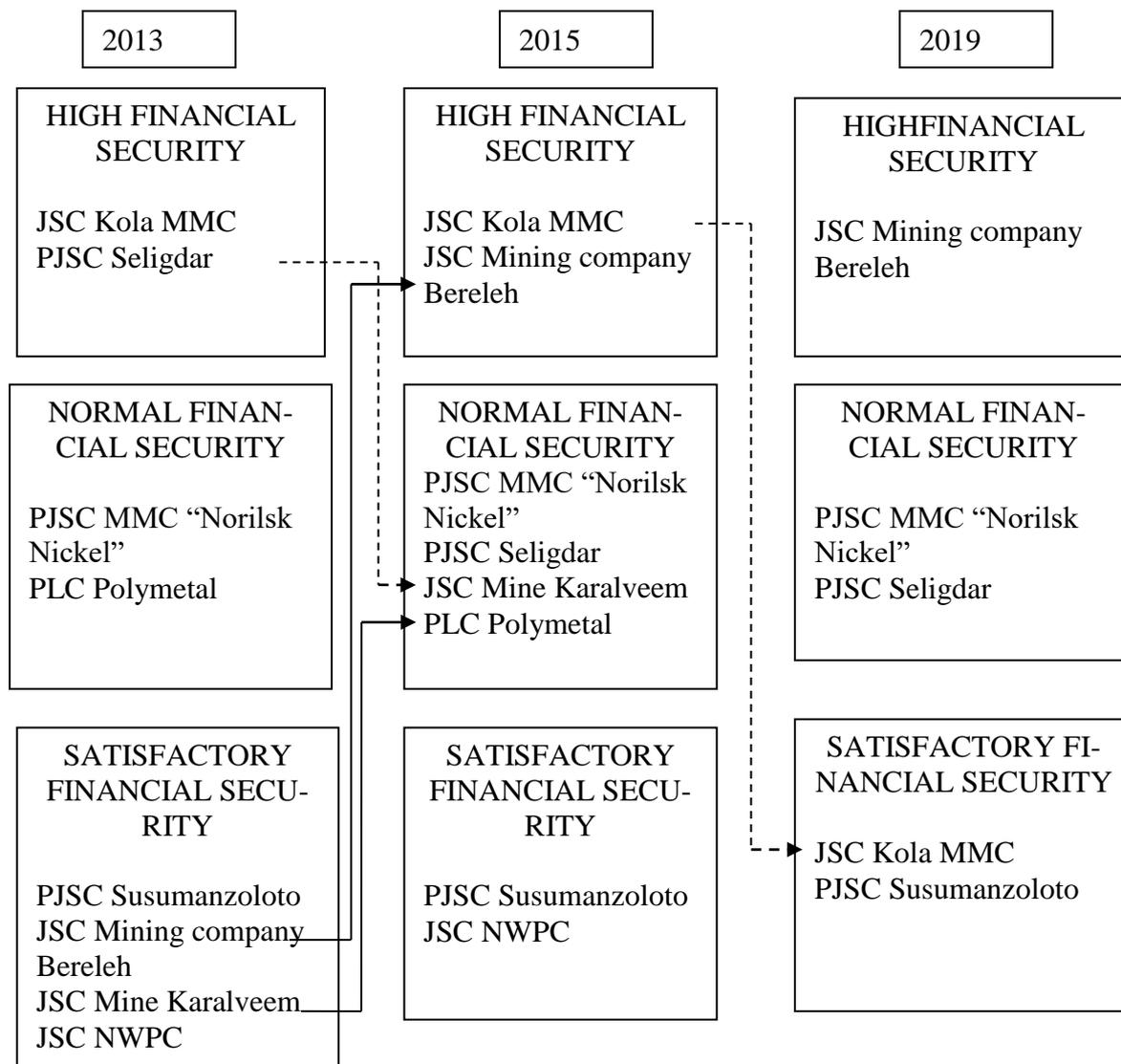


Fig. 1. Assessment of financial possibilities for the innovative projects implementation of nonferrous metallurgy corporations in the North and the Arctic¹³.

The analysis made it possible to determine that the financial possibilities for realizing the innovative potential of northern mining enterprises are not sustainable and, consequently, innovative activity is mainly associated with the availability of the necessary financial resources.

PJSC "MMC "Norilsk Nickel" is included in a group with normal financial solvency, which characterizes the possibility of implementing an innovative development strategy with the attraction of additional funds. Practice has shown that the company has implemented projects. So, in 2017, together with JSC "Mekhanobr Engineering" at the Talnakh Enriching Plant, a technology for charge enrichment of bucking and cuprous ores was introduced, which allows processing low-nickel pyrrhotine [13].

JSC "Polymetal" is also included in the group with normal financial security, which characterizes the possibility of implementing an innovative development strategy with the attraction of

¹³ Note: due to the fact that there are no accounting data for 2019 for JSC Karalveem Mine and JSC Polymetal, the analysis was carried out for 2013 and 2015.

additional funds. Innovative projects have been implemented at subsidiaries. JSC “Serebro Magadana” has developed and implemented the following innovative projects:

- in 2018, the Omsukchan Gold Recovery Plant introduced a concentrate condensation technology, which makes it possible to control the composition of nonferrous metals in the finished product¹⁴;
- in 2019, the Omsukchan Gold Recovery Plant together with LLC PC “Spirit” introduced a screw separation technology, which allows increasing gold recovery into concentrate¹⁵.

In 2018, LLC “Mayskoe” Gold Ore Company”, together with SGS Company (Russia), introduced a combined oxidized ore processing technology, which makes it possible to increase the share of gold in concentrate by 24%¹⁶.

Two enterprises (JSC “Mining company “Berelekh” and JSC “Mine Karalveem”) improved their positions in terms of innovation potential in 2015–2019 comparing to 2013 and moved from the group with a satisfactory level of financial security to the group with high and normal level, respectively. It should be noted that enterprises do not fully use financial opportunities to realize their innovative potential.

PJSC “Seligdar” worsened its financial position. In 2013, it was characterized by a high level of financial security, in 2015 it moved to a group with normal financial security. In 2017, together with the Russian research and innovation company “RIC Center-ESTAgeo”, the technology of heap bioleaching of gold was introduced, which makes it possible to increase gold recovery from refractory ores from 30% to 80%¹⁷. A patent for an invention was received¹⁸. However, in 2019 PJSC “Seligdar” had a satisfactory level of financial support.

JSC “Kola MMC” was part of a group with high security of its own financial resources in 2013–2015. The innovation strategy could be justified without attracting external investment. Thus, the company has implemented the following projects:

¹⁴ Production results for 3 quarter of 2018. URL: <https://www.polymetalinternational.com/ru/investors-and-media/reports-and-results/result-centre/#26-2018> (accessed 07 July 2020).

¹⁵ Rashin A.G., Prokopyev E.S., Patrin S.A. Rezul'taty opytno-promyshlennoy pererabotki lezhalykh khvostov ZIF rudnika «Dzhulyetta» s primeneniem tekhnologii vintovoy separatsii [Results of Experimental-Industrial Processing of Stale Tailings of the Mill of the Juliet Mine Using the Technology of Screw Separation]. URL: <https://zolotodb.ru/article/12242> (accessed 15 July 2020).

¹⁶ Annual Reports, 2019, p. 39. URL: <https://www.polymetalinternational.com/ru/investors-and-media/disclosure-center/annual-reports> (accessed 02 July 2020).

¹⁷ «Seligdar» zapustil opytnoe proizvodstvo po kuchnomu biovyshchelachivaniyu zolota iz upornykh rud [Seligdar Launched a Pilot Plant for Heap Bioleaching of Gold from Refractory Ores]. URL: <https://seligdar.ru/post/8206> (accessed 01 July 2020).

¹⁸ Bashlykova T.V. Sposob izvlecheniya blagorodnykh metallov iz otrabotannykh shtabeley kuchnogo vyshchelachivaniya [Method for Extracting Precious Metals from Waste Heap Leaching Piles]. URL: <https://patents.google.com/patent/RU2622534C2/ru> (accessed 15 July 2020).

- in 2017, together with LLC “Gipronickel” (St. Petersburg), a technology for briquetting of copper-nickel concentrate was introduced, which makes it possible to reduce emissions of pollutants into the atmosphere by 35-40 thousand tons¹⁹;
- in 2018, a technology to control finished products in the briquetting area using artificial intelligence and machine vision was introduced, which makes it possible to improve product quality control²⁰;
- in 2019, together with LLC “Gipronickel”, a technology for electro-extraction of nickel from solutions of chlorine dissipation of nickel powder in tube furnaces was introduced, which makes it possible to increase the production capacity from 120 thousand to 145 thousand tons of electrolytic nickel per year and to increase the level of nickel extraction into concentrate by 1%²¹.

In 2019, JSC “Kola MMC” moved to a group with satisfactory financial security, which affected the decrease in innovative activity.

OJSC “Susumanzoloto” retained its positions in the rating and in the period under review belongs to the group with satisfactory financial security, which affected the low innovation activity (there are no implementations). Without attracting a significant amount of external financial resources, which is currently difficult, it is practically impossible to plan the implementation of the innovative development strategy for long-term and short-term periods.

Studies have shown mainly low innovative activity of nonferrous metallurgy enterprises in the North and the Arctic over the past 8 years.

Conclusion

An assessment of the financial possibilities for the implementation of innovative potential by mining enterprises of nonferrous metallurgy of the North and the Arctic has been carried out.

On the basis of objective indicators, research on innovation activity of twenty industrial enterprises of nonferrous metallurgy for the period 2013–2019 has been carried out. The organizations operate directly in the North and in the Arctic and are included as subsidiaries and branches of the seven largest corporations.

The studies have shown the dependence of innovative activity of northern nonferrous metallurgy enterprises on the level of financial security, revealed by the method of assessing the three-component coefficient. Enterprises with high financial solvency or, in special cases, with additional investments and normal financial security, are able to generate innovative technologies.

¹⁹ Reports and Results. 2017. Annual Report, p. 71. URL: <https://www.nornickel.ru/investors/reports-and-results/#2018> (accessed 30 June 2020).

²⁰ Reports and Results. 2018. Annual Report, p. 101. URL: <https://www.nornickel.ru/investors/reports-and-results/#2018> (accessed 30 June 2020).

²¹ Reports and Results. 2019. Annual Report, p. 73, 82. URL: <https://www.nornickel.ru/investors/reports-and-results/#2018> (accessed 30 June 2020).

As the analysis has shown, most enterprises in the North and the Arctic have low financial security, which does not allow them to have effective innovative development without attracting a significant amount of targeted investments.

The methodology used has shown the possibility of assessing the financial capabilities of enterprises to develop a strategy for innovative development with limited information in the accounting reports publicly available.

Further scientific research and ways to increase innovative activity are required in order to improve the main technological and economic indicators of mining enterprises of nonferrous metallurgy in the North and the Arctic.

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