The Social Sciences 11 (18): 4348-4351, 2016
ISSN: 1818-5800

The Provision of Development Conversion Perspectives into Undeground One for Russian Iron Ore Deposits Development

[1]Golik Vladimir Ivanovich, [1]Gabaraev Oleg Znaurovich, [2]Maslennikov Stanislav Alexandrovich, [3]Khasheva Zarema Muratovna and [3]Shulgaty Leonid Petrovich
[1]North Caucasus State Technological University, Nikolaeva Str., 44, 362021 Vladikavkaz, Russia
[2]The Institute of Entrepreneurship and Service Sector, Don State Technical University, Shevchenko Str., 147, 346500 Shakhty, Russia
Southern Institute of Management, Stavropolskaya Str., 216, 350040 Krasnodar, Russia

Abstarct: The place of Russia in the global iron ore production is determined. The practice of the underground method for iron ore deposit development in Russia and the CMA is described. The shortcomings of the existing concept for non-waste mining and processing production based on the use of concentrator tailings as a slurry to fill the depleted cells. It is proposed to use the technology mechanical activation in disintegrator type plants for the extraction of metals and residual the revealing of mine refuse viscosity properties.

Key words: Iron ore, underground mining, wastelessness, enrichment, hydromixture, chamber, mechanical chemistry, activation, disintegrator

INTRODUCTION

Russia is one of the world leaders in terms of metal ore reserves, production and processing. Up to 26% of world reserves is located on its territory. According to estimations the world reserves of iron ore make over 800 billion of crude ore containing >230 billion tons of iron. The explored reserves make about 160 billion of tons which contain up to 80 billion tons of pure iron. Russian stocks make 18% in terms of iron content, enabling it to share the 1st and the 2nd place with Brazil.

According to iron ore exports Russia is greatly inferior to other countries at the world exports of about 1,000 million tons and the production of about 3,000 million tons.

In terms of production, Russia is behind China, Brazil, Australia and India. If at the beginning of the millennium, the share of Russia in world production was >8% by the end of the first decade of the 21st century it dropped to 4%. Russian mining industry is concentrated in the hands of private companies (Golik and Hasheva, 2015; Golik *et al*., 2015a, b).

In the short term iron ore market development depends on the overcoming of the global crisis consequences. In the medium-and in the long-term the increase of demand and iron ore prices is expected (Dubinski, 2013).

The Russian market of iron ore is focused mainly on domestic demand and supply in the countries which support the strong demand for raw materials: China, Slovakia, the Netherlands, Italy, Czech Republic, Kazakhstan, Hungary, Poland, Turkey and the United States (Liu *et al*., 2012; Singh *et al*., 2010).

The open way of development which produces about 90% of RF iron ore is the dominant one. This is due to the extensive version of the iron ore industry development they produce in the first place the minerals which are closer to the surface. When the pit depth becomes a critical one, they proceed to the mining method or combine an open pit and underground mining.

MATERIALS AND METHODS

Main part: All-Russian Research Institute of Mineral Resources (ARRIMS) has developed the hydraulic borehole mining for KMA conditions. This method did not provide the erosion of kimberlite rocks on the diamondiferous areas of the Lomonosov deposit in the Arkhangelsk region.

The Belgorod MPP began to mine ore by SGD means from Gostischevsky deposit and can not solve the same problem, even by using a state support for a number of years in the form of tax breaks. For the CMA is currently the variant of iron ore mining by underground method requires some reflection and substantiation (Cavalcante and Caraiba, 2013).

Corresponding Author: Golik Vladimir Ivanovich, North Caucasus State Technological University, Nikolaeva Str., 44, 362021 Vladikavkaz, Russia

Now a days, Russia mines only 8% of iron ore by underground method. The underground way of iron ore deposit development is the main one at the operating companies of the Altai-Sayan area.

Abakan, Kazsky, Tashtagol and Sheregesh mines recover more than half of Russian underground iron ores from large deposits at the depths of 500-800 m with the ore strength coefficient of 10-14 according to Prof. Protodyakonov's scale. The issue of Tashtagol deposit development under the Condoma river is being solved by the development system with a hardening filling.

This technology was studied for Lebedinsky MPP conditions. The results of metal extraction and curing increase are obtained by hardening mixtures manufactured with the mechanic-chemical activation of components.

Korobkovskoye deposit (KMA) is developed by an underground method. This is the mine named after Gubkin (OJSC "KMAruda plant" of Belgorod region) and Yakovlevskoye deposit-Yakovlevsky mine (LLC "Metal Group", Belgorod Region).

The field of the mine Gubkina was opened by six trunks. Mining operations are conducted within a single storey the height of which makes 60 m. A storey-chamber development system with permanent interchamber pillars is applied at the maintaining of a ceiling pillar from unoxidized quartzites at the capacity of 70-100 m.

Mining operations are conducted in the floor with an absolute mark: -65 m (-71 m) and-125 m. There is no large abundance of water within this floor and a weak watering is dedicated to quartzite contacts with non-metallic arrays and tectonic zones. The water inflow into a mine makes 300 m^3h^{-1}.

The stopes of the system basic variant with the dimensions of 55×30 m are oriented by a long side transversely across the extension of deposits and are separated by pillars with the width of 20 m (interchamber ones) and 25 m (intersectional ones).

Rock refuses are the original material for underground cavity filling at OJSC "KMA Ruda plant" and mine drainage water replenishes the circulating waters of the processing factory. At that the concentration of concentrator wastes is provided from 4-70%, solid by weight. The annual production of crude ore makes 4.8 million tons (the content of iron makes 32.11%).

Manufacturing is a closed cycle: the extraction of ore the production of iron ore concentrate-the laying of tails. A stowing complex allows to separate a sandy product from a pulp and store it in the processed chambers of a mine and feed purified water into the technological process of a CCP. A complex is capable to process 4,636 m^3 of pulp per hour to produce 4517 m^3 of clarified water and 340 tons of waste per hour.

The further development of Korobkovsky deposit by an underground method assumes a two-stage excavation of deposit reserves with the layer processing of support pillar reserves during the second stage.

The implementation of an official concept concerning non-waste mining and processing production is performed on the use of beneficiation plant tailings as a slurry to fill the depleted underground mine chambers with the use of a closed system for technological circulation of water.

Yakovlevsky mine produces 1 million tons of iron ore with and plans to increase it up to 4.5 million tons per year. For this purpose, the company planned to increase the crushing and sorting plant capacity, the commissioning of a new filling complex and the increase of miner staff by 40%.

From the point of technology application with the filling by hardening mixtures-high population density, the availability of agricultural lands on the surface, the localization of mineralization at greater depths within complex mining and hydro-geological conditions-KMA mines are the most promising ones.

Now a days the predominant focus for the filling of voids by rock refuses without the extraction of valuable metal components from them has a significant drawback. Rock refuses contain the ingredients in the form of rare earth and precious metals, the value of which can be compared with the value of the extracted components (Packey *et al*., 2012; Reck and Graedel, 2012). The ferruginous quartzites, composing large and unique deposits contain precious metal mineralization which provides about 25% of annual gold production overseas.

The areas of iron ore localization have the industrial content of gold, platinum and platinum group metals, copper, nickel, cobalt, chromium, rare and radioactive elements. The precious metal mineralization is presented by a high-grade native gold with a dash of copper and silver ligature. A native bismuth and minerals as well as scheelite, barite and pitchblende with the admixture of radiogenic lead are found in relation with it. These rocks have platinum group minerals. Gold-platinum metal mineralization is characterized as by the independent minerals of noble metals so as by their attendant native metals and their alloys (Fig. 1).

The economic effect of technology is defined as the excess of the valuation results over the valuation of the total cost:

$$? = \sum_{t=1}^{T} P_t - \sum_{t=1}^{T} ?_t + \sum_{t=1}^{T} \Pi_t$$

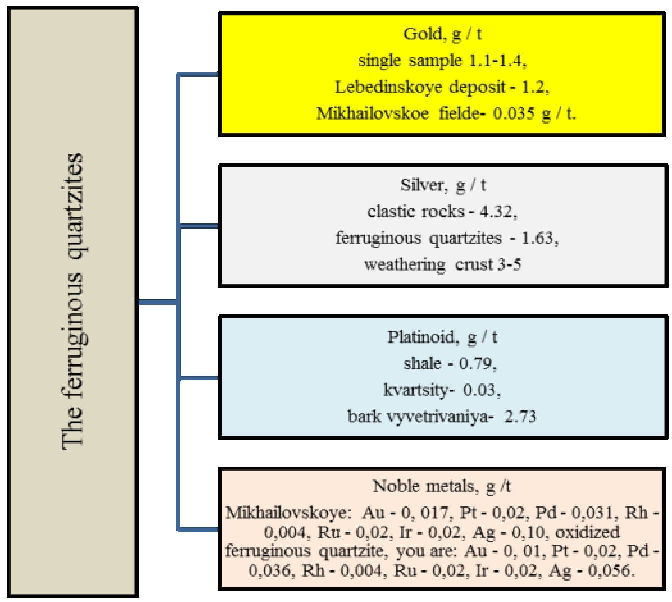

Fig. 1: The content of variable metals in ferruteroüs quartzites

Where:

P_t = The main product cost in the t-th year
$Э_t$ = The production costs of the main product in the t-th year
$П_t$ = The value of by-products in the t-th year
T = The calculation period duration

Under the appropriate conditions, the use of additional profit can make the technologies with the filling of voids by hardening mixtures economically attractive ones.

The activation of tails in disintegrators solves 2 problems: the removal of residual metals and the disclosure of mine refuse binding properties. The effectiveness of such a solution may be obvious only with a full consideration of all dead refuse accumulation consequences on the earth surface, including the entire spectrum of the negative impact on flora, fauna and people.

The concept of metal extraction technology humanization concept from KMA deposits includes the following elements (Golik and Hasheva, 2015; Golik *et al*., 2015a, b):

- The extraction of commodity ore to the surface for factory processing with minimum losses and the dilution by filling the voids with hardening mixtures
- The extraction of metals from the sorting products recovered on the surface of ores by heap leaching

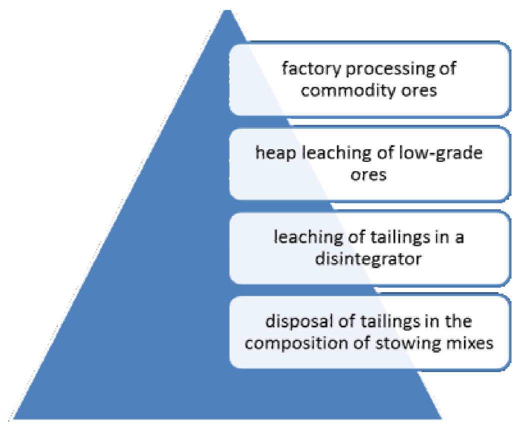

Fig. 2: Elements of resource sving concept during the extration of iron ores

- The extraction of metals from mine refuses and metallurgy by the combined technologies with the mechanic-chemical activation of the leaching processes in a disintegrator
- The recycling of secondary leaching tailings using an activated fine fraction as a binder and a large fraction as an inert aggregate (Fig. 2)

The benefits of the proposed concept are confirmed by the SWOT-analysis of the subject: the entering and the promotion of recycling technology on the market ore mine refuse recycling technology with the obtaining of metals, binders and inert components for the preparation of hardening mixtures (Table 1).

Table 1: SWOT-analysis matrix

Positive influence	Negative influence
External environment	
Opportunities: trend on introduction of ecologically safe technologies; priority of the direction of rational environmental management; increase in demand for iron ore in the long term; possibilities of an entry into the international market; absence of direct competitors	Threats: influence of consequences of crisis; instability of demand and the prices in the short term; limitation of a sales market of production; lack of effective tax incentives of introduction of ecologically focused technologies
Internal environment	
Strengths: advantages in costs; performed the study process; availability of technological and technical documentation; focus on environmental safety, a global trend; focus on the conservation of resources; no close analogs;perform R&D; opportunities to promote products or results	Weak sides: the need for significant capital investments; the need for additional research in the non-basic conditions; uncertainty of business processes and sales; limited opportunities for advertising and promotion of products; limited financial resources

"The performed volume of R and D" is the priority factor among strengths. "The need for substantial capital investment" is the priority factor among weaknesses. The factor "the lack of direct competitors" is the priority one among the possibilities. The factor "the complexity of environmentally-oriented innovation implementation in the mining industry" is the main one among the threats.

The most effective strategy is "the creation of a broad sales network" which implies an active marketing, the search for partners in Russia and abroad, the access to international markets, the focusing on the knowledge-based part of project implementation and the transfer of technical work performance on the basis of outsourcing.

The restoration of land capacity lost due to mining is the duty of future generations. The assessment criteria of technology impact on the environment should be the degree of its loyalty towards nature. In accordance with the nature preservation principles the society will declare the moratorium on the technology implementation, if it is incompatible with the nature conservation concept (Ivashchuk and Ivashchuk, 2013).

CONCLUSION

Summary: The problem of iron ore mining conversion into underground method with the filling of voids by hardening mixtures include the issue of raw material provision for their manufacture which can be solved within the framework of non-waste recycling of ore mine refuses. A promising area of real recovery of metals from tailings is the combination of chemical enrichment and mineral activation methods in disintegrators, providing the extraction of metals to a safe level. The feature of this new technology is the use of mine refuses in the mixture not only as inert fillers but also as binders.

ACKNOWLEDGEMENTS

The reported study was supported by the Russian Foundation for Basic research (RFBR), research project No 15-07-08300\16 and grant of the President of the Russian Federation for the young scientists No MK-6986.2015.8.

REFERENCES

Cavalcante, P.R.B. and S.A.M. Caraiba, 2013. Paste fill: A safety solution for pillar mining. Frank Palkovits, KOVIT Engineering Limited, Brazil, pp:443.

Dubinski, J., 2013. Sustainable development of mining mineral resources. J. Sustain. Min., 12: 1-6.

Golik V.I. and Z.M. Hasheva, 2015. Economical efficiency of utilization of allied mining enterprises waste. Social Sci., 10: 682-686.

Golik, V., A. Doolin, M. Komissarova and R. Doolin, 2015a. Evaluating the effectiveness of utilization of mining waste. Int. Bus. Manage., 9: 1993-5250.

Golik, V.I., S.G. Stradanchenko and S.A. Maslennikov, 2015b. Experimental study of non-waste recycling tailings ferruginous quartzite. Res. India Public., 15: 35410-35416.

Ivashchuk, O.A. and O.D. Ivashchuk, 2013. Automation and intellectualization to control the ecological situation in the urbanized territories. Proceedings of the 2013 IEEE 7th International Conference on Intelligent Data Acquisition and Advanced Computing Systems, Volume 2, September 12-14, 2013, Berlin, pp: 814-820.

Liu, J., Y. Han, Y. Li and S. Zhang, 2012. Study on mechanism and technology of deep reduction for lingyang iron ore. Proceedings of the 26th International Mineral Processing Congress, IMPC 2012: Innovative Processing for Sustainable Growth, September 24-28, 2012, New Delhi india, pp: 2335-2343.

Packey, D.J., 2012. Multiproduct mine output and the case of mining waste utilization. Resour. Policy, 37: 104-108.

Reck, B.K. and T.E. Graedel, 2012. Challenges in metal recycling. Science, 337: 690-695.

Singh, R., R. Rath, B. Nayak and K. Bhattacharyya, 2010. Development of process for beneficiation of low-grade iron ore samples from orissa india. Proceedings of the XXV International Mineral Processing Congress, September 6-10, 2010, Brisbane, Australia, pp: 1235-1241.