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The analysis of the problems of mining waste products in the mineral resources sector of the Russian Federation

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Abstract
The functioning of mineral-raw sector of the Russian Federation is accompanied by a significant mining waste formation and accumulation, which in turn is a consequence of the deteriorating quality of mineral resources and the geological work conditions, as well as the problem complex of governance and institutional regulation in the sphere of subsoil use. In this paper the most relevant of these problems were described. The main barriers to effective waste management implementation were identified and divided by authors into three groups: problems associated with the conditions of mineral extraction, problems of subsurface resources management in mineral resource sector, problems of institutional nature.

Keywords: waste, mining, mineral resources, problems, Russian Federation.

INTRODUCTION

Rational use of mineral resources and mining wastes has traditionally been regarded as a factor for increasing the mineral resource base and overcoming the scarcity in natural mineral raw materials, producing more product types, cutting costs on waste disposal, reducing investment in new deposits development, preventing and reducing environmental damage and garnering more social effects. 67% of the overburden of iron ore deposits is usable for production of construction materials (crushed stone, cement, ceramic wall materials) [1, 2].

The evaluated potential of the man-made mineral formations, i.e. tailings, of Ural nonferrous smelters is more than 350 thousand tons of copper, about 210 thousand tons of zinc, 150 tons of silver as well as gold and rare earths [3]. Almost 70% of all placer deposits are man-made mineral formations in the Magadan region [4].

The structure of anthropogenic stocks recorded in the State Reserves Balance (SRB) is also predominantly presented by more than 100 manmade auriferous formations. Apart from them, 18 tin ore, 17 iron ore, 10 muscovite, 7 copper and 6 tungsten formations are recorded [5]. Metallurgical waste has significant potential for rare earth metal extraction [6, 7].

At the same time, waste from mining and processing as well as mining and metallurgical productions is a factor of negative impact on the environment.

Mass of waste accumulated in dumps and tailing ponds covers an area of over 1300 km2 with an average layer thickness of 20 m. The annual increase of safety exclusion areas makes up at least 85-90 km2. Negative impact on the environment occurs in the territory which is 10 times or greater than the waste deposit area [8]. For example, in the Eastern Donbas, waste dumps occupy more than 1.3 thousand hectares of land and the total land area disturbed in connection with coal mining and concentration exceeds 7 thousand hectares [9].

As a result of prolonged storage, under the atmospheric effects useful waste components are “eliminated into surrounding area thereby transforming into pollutants”, which increases the risk of negative impacts from the inert waste placement, land reclamation, vegetation destruction, changes in landscapes [10].

Environmental problems of mining waste are particularly acute in the North-Eastern and Arctic regions where the main mineral resources reserves are concentrated [11]; their peculiarity in socio-economic development is the implementation of business activities focused on the resource sector in a tough environment [12,13,14].

Environmental condition of the Kola Peninsula areas, where the main mining and metallurgical production of the North-West is focused, more than 6 billion tons of solid waste have been accumulated and about 200 million tons are produced annually, is estimated as critical [15,16].

MATERIALS AND METHODS

Official statistic

Mining waste formation and accumulation are not problems of the individual mining and processing industries: official statistics data testify to its national scale (table1).

Table 1: The structure of waste production and consumption (2014-year data)

Indicator	2012	2013	2014	2012	2013	2014
	mln.t.			%		
Total	**5007,9**	**5152,0**	**5168,3**	**100**	**100**	**100**
in mining	**4629,3**	**4701,2**	**4807,3**	**92,4**	**91,2**	**93,0**
fuel and energy minerals	3022,8	3010,5	3187,5	65,3	64,1	66,3
minerals except fuel and energy	1606,5	1690,7	1619,8	34,1	35,9	33,7
Dressing production	**291,0**	**253,7**	**243,1**	**5,8**	**4,9**	**4,7**
including in metallurgic production and production of finished metal products	220,8	172,7	168,3	68,1	69,2	69,2
Wastes in other industries	**87,6**	**114,4**	**117,9**	**1,8**	**3,9**	**2,3**

Source: Compiled by authors based on [17]

More than 90% of all production and consumption waste recorded by national statistics accounts for waste generated during extraction of minerals where 96% are production wastes.

Among all industries, the coal industry is a leader by waste formation and accumulation (more than 60% of production and consumption waste resulting from extraction). For example, in the Kemerovo region, the leading region of coal production in 2014, the volume of waste amounted to more than 2.6 billion tons, or 51% of the total volume throughout Russia. Metallurgical waste accounts for more than 65% of the total volume of production and consumption waste in the processing industry.

National statistics take into account the waste management and disposal by economic activities. Table 2 shows the data received from official sources and on the basis of additional calculations on dynamics of waste formation, management (detoxification) and accumulation (disposal), as well as the increase of production volumes.

Table 2: Dynamics of production, consumption, generation, utilization and accumulation of waste

Indicator	2005	2014		2014/ 2005, %
Production and consumption waste generation by economic activities, million tons				
in mining	2506,2	4807,3		191,8
fuel and energy minerals	1498,6	3187,5		212,6
minerals except fuel and energy	1007,6	1619,8		160,7
metallurgic production and production of finished metal products	180,4	168,3		93,3
Waste management and disposal by economic activities				
in mining	1070,4	2165,7		202,3
fuel and energy minerals	833,1	1433,3		172,0
minerals except fuel and energy	237,3	732,5		308,6
metallurgic production and production of finished metal products	65,4	79,2		121,1
Accumulation (waste placement and disposal)				
in mining	1435,8	2641,6		183,9
fuel and energy minerals	665,5	1754,2		263,6
minerals except fuel and energy	770,3	887,3		115,2
metallurgic production and production of finished metal products	115,0	89,1		77,4
Growth in production volumes, %				
Mineral extraction, including				113,4
fuel and energy minerals				112,8
minerals except fuel and energy				110,5
Metallurgic production and production of finished metal products				118,8

Source: Compiled by authors based on [17]

The results indicate a significant increase in waste generation and accumulation during the period under review exceeding the growth of production volumes in mining. Despite the growth in waste utilization (neutralization) more than two times, less than half of each ton of waste is utilized or neutralized. The situation is much better in manufacturing: metallurgy and production of finished metal products where the growth of waste formation (by 6.9%) and accumulation (by 29.6%) has decreased along with the production volumes growth by 18%.

It should be noted that the official accounting by economic activities does not allow receiving more accurate information about the state of the problem, for example on the mining-metallurgical companies engaged in both mining and metallurgical processing. Therefore, the statistics by activities that are metallurgical production and production of finished products include the parameters for secondary resources processing.

Despite the growth in use of production and consumption waste during mining, there is a upward trend in their accumulations where the growth rate of accumulation exceeds the growth of waste utilization (Fig.1).

According to [18] by 2001, over 80 billion tons of mining waste had been accumulated in the dumps and storages on the territory of Russia, their number increases annually by more than 2 billion tons.

Over 19 billion tons of such waste products were accumulated for the period 2005-2014, i.e. the volume of accumulations has exceeded 100 billion tons by now.

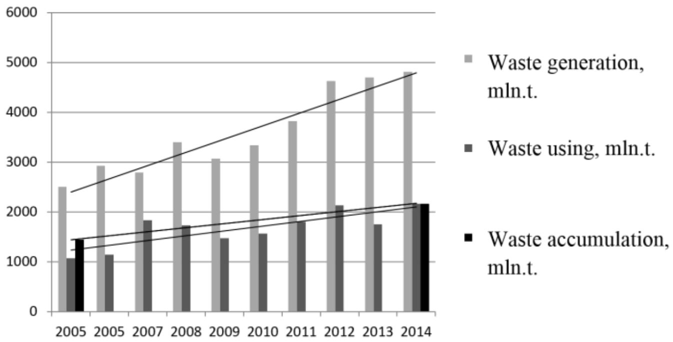

Figure 1: Main trends in generation, using and accumulation of waste in mining
Source: Compiled by authors based on [17]

Analysis of official statistical information has led to the conclusion that, despite the increased waste utilization and disposal, sustainable growth in the volumes of waste generation and accumulation is noted. In comparison with 2005, the growth in waste generation has exceeded 1.62 times the growth in production, and the accumulation 1.77 times. For 9 years, the amount of accumulated waste has doubled, and more than half of this waste falls on the waste from the fuel and energy resources extraction [19,20]. In addition, the mass of waste generated are "accruing" at a faster pace than the volume of their processing and neutralization.

The stability of negative upward trends of mining waste generation and accumulation can be viewed as a manifestation of a number of problems in the mineral sector, the analysis of which allowed to combine them into three groups:

- problems associated with the conditions of mineral extraction;
- problems caused by imperfect control of subsoil use in the mineral resource sector;
- problems of institutional nature.

Problems associated with the conditions of mineral extraction

1. The decline in the quality of the booked reserves and parameter deterioration of the newly discovered deposits is highlighted in the annual national reports [21].
   As a result of lower content of useful components, the same production volume requires extracting a larger volume of rock mass. In recent years the iron content in the ore has decreased from 56-58% to 30-33%; there has been an adoption of ferruginous quartzite extraction. At the end of the XIX century the most part of extracted copper ores contained 5-8% of copper, 0,7 -3% in 1925, 0.4 - 1.5% in the late 70-ies [22].
2. Deterioration of mining and geological work conditions. Long-term practice of developing the most accessible and highly profitable mineral reserves has led to depletion of mineral resources, deterioration of their quality, the need to involve fields with complex environmental conditions in mining. The latter is exacerbated by the decreasing mining depth whereby the volume of recoverable waste rock and low condition mineral resources,which are placed in dumps increases.
3. .Technological conditions of mining operations are characterized by:
   - ineffective resource management along with frequently practiced selective exploitation of rich reserves which leads to deterioration of their structure [23]. For example, in reserves of the unique Oktyabrskoye deposit (Norilsk mining and industrial district) the average content of copper is 1.7%, of nickel is 0.84%, of platinum group metals is 4.7 g/t, and in mined ores they are significantly higher: copper is 4.8%, nickel is 1.9%, platinum group metals are 11.8 g/t. Final tailings obtained in the manufacture of saleable iron ore, copper, zinc and pyrite concentrates contain significant amounts of Copper, Zinc, Sulphur, rare elements [22];
   - high level of mineral losses at the extraction and processing stages. For example, in the implementation of all the new potassium projects it is planned to use only the traditional (mine) extraction method in which up to 60% of ore on average is lost in the depths. In the processing of the Khibiny apatite-nepheline ores, a large number of rare earth elements (REE) is lost every year in the dumps of phosphogypsum, which would be enough to meet all global needs [22];
   - using deposit development technologies and systems leading to a larger waste production. For example, during fuel and energy resources extraction in 2005, the volume of waste amounted to 1496.8 million tons; in 2010 (the year with the highest rate of production growth over the 2005-2014) it was 2204.3 million tons, in 2013 it was 3010.5 million tons. The volumes of coal production were, respectively, 299.0; 322.0; and 351.0 million tons. Given that the waste bulk in the fuel and energy sector falls on the coal mining [24], even by the approximate calculation, the specific indicators of waste generation amounted to, respectively, 5.0; 6.8; 8.6 tons per mining ton. The increase was due to growth of the stripping ratio and coal volumes by open-cut extraction [25].
   - The mining industry is a complex, technologically and organizationally related process. It often happens that the landfilled waste processing is impossible without shutting down the associated production and the technological cycle violations (for example, in the processing of liquid tailings), or building a new tailings storage facility, so the development of such wastes can be conducted only when their dumps are already formed (closed).
4. Quality of the raw materials contained in mining wastes. One of the factors deterring the "stale" waste recycling is worsening of its qualitative and quantitative composition over time, which does not allow or limits its industrial processing. For example, at the Kola MMC, the official losses at beneficiation are up to 30% per year, major losses are refractory flotation tailings and

slags, processing of which is highly energy-intensive. There are quartz-sulfate crusts in stale tails, which makes very low the throughout recovery of nickel from such waste.

Physical and mechanical properties of rocks also change during long-term storage. For example, studies of the overburden rocks from dumps of the Olenegorsk iron ore deposit used in the Murmansk region as construction materials, showed a deterioration of their strength characteristics [25].

Problems of subsurface resources management in mineral resource sector

Activities related to the mining waste management (development) ("waste mining and related processing industries") refer to subsurface use and are not in a separate control area according to the law "On subsurface".

Therefore, for the purposes of this research, the mining waste management means the activities aimed at reducing volumes of formation, accumulation and increasing mining waste utilization and recycling by implementation of the basic management functions (organization, planning, accounting, evaluation, motivation and stimulation).

One of the organizational issues is the current practice for making subsoil plots available for use without considering the possibilities for development of “manmade deposits” previously generated by waste[26], i.e. the constraint mechanism of mineral extraction, at availability of sources of manmade mineral products of this type in the region, does not work.

The most striking example is the situation with granting rights to use subsoil deposits of common minerals. For example, in the Leningrad region, 70 percent of the mineral market is formed by companies that produce crushed stone from the building stone mined from natural deposits under more than 200 licenses, and annual production of common mineral resources in the region is 25,0-30,0 million m3[27]. Every year, on average, 6 to 10 million tons of granite screenings from crushing (dry tailings) are formed in the region, they can be used to obtain additional 4 to 8 million tons of commercial fine crushed stone and sand with similar physical-mechanical and technological properties to natural sand.

Currently, the screening placement in the dumps is requiring 5-7 hectares of land; for this purpose, a common practice is to use natural water bodies.

Another aspect of the problem is the procedure for according permission to develop manmade deposits formed by the waste products which includes the entire complex of activities on examination, geological research, bidding, licensing and registering with the State Reserves Balance (SRB) provided for primary deposits. This procedure increases the duration and cost of all activities for the potential investor which is often small and medium mining business [28].

The reason for the low level of mining waste involvement in the economic turnover is the lack of economic incentives (positive and negative motivation) and commercial interest in processing due to the low land cost, lack of control over waste formation and disposal; in fact, the mechanism of the investment tax credit, preferential loans and taxation does not work in this field.

The state target programs which represent state planning activities and target distribution of budget funds were practically the only way of financial support for activities related to waste including mining until recently.

For example, the Federal Target Program "Processing of manmade mineral formations in Sverdlovsk region" provided: creation of a waste management system based on administrative, legal, economic, information and control regulators; establishment of tax and other benefits to entities processing the manmade mineral formations, application of the concessional lending system and other activities. [29].

The Federal Target Program “Ecology and natural resources of Russia for the period 2002 – 2010” envisaged a number of measures (since 2005) on state regulation of production and consumption waste management: control over the movement and condition of waste disposal facilities, industrial waste conversion into mineral resources, quantitative and qualitative waste assessment, creation of the state regulation system in the sphere of waste management [18].

The main disadvantage of this planning form is a risk of collapse due to lack of financial resources.

For example, tasks assigned in the framework of the Federal Target Program "Waste" (1996-2000) which included about 30 technical measures for the mining waste management, beneficiation and metallurgical conversion were not met in full due to reduced funding, and only 17 out of planned 55 projects of the Programme "Processing of manmade mineral formations in Sverdlovsk region" were implemented [29].

During ten years since the completion of the Federal Program: "Processing of manmade mineral formations in Sverdlovsk region" and the Federal Target Program "Waste" (1996), there have been no instrument for the comprehensive solution of problems of mining and processing industry waste formation, accumulation and disposal.

In this field, a certain breakthrough was development of the Federal Target Program "Elimination of accumulated environmental damage" for 2014 – 2025 in which one of the guidelines is ecological rehabilitation of the territories affected by the negative impact of objects of accumulated environmental damage caused by past economic activity, however, due to the lack of funding in 2015, its activities are actually blocked.

An independent serious problem is the estimation of mining wastes as a secondary resource. First, the mineral resource assessment is dominated by a geological approach based on inherent requirements to particular contents and amounts of useful components and not to the technologies of their extraction and processing. Second, the quality of geological-economic estimation of minerals leads to criticism, reserve categories and the basic requirements to their commercial development are established on its basis. Geological-economic evaluation is probabilistic in nature, for example, in the calculation of solid mineral industrial reserves in indigenous fields, the error in a block can range 25-60% [30]. This error may be even greater when calculating reserves of manmade deposits with the broken structure of minerals.

Administration of waste (information collection, compilation, classification, storage, recording) as any ownership is one of the functional components of waste management at all stages of its life cycle and is performed in order to:

- exchange information to ensure intra- and interagency cooperation of the management bodies in charge of waste (primarily state);
- provide information resources to interested parties (natural and legal);
- create information environment of business.

In our opinion, the main reasons hindering the creation of efficient administration system for mining waste, and, consequently, the information environment ensuring its involvement in economic turnover are:

1. Dual regulation of activities related to mining waste.
2. Lack of comparability for administrated object classifications.
3. Absence of interdepartmental interaction and procedures for information communication on waste mining.
4. Lack of consistency between the mining waste administrating systems.

In 2014, the Russian Federation established a Unified Cadaster System for Waste (State Waste Cadaster) containing more than 80 types of mineral wastes in the Federal Classification Waste Catalogue (FCC).

Dual regulation is that in relation to the user of mineral resources, the mining waste placement (storage and disposal), utilization are regulated by the Federal Law "On production and consumption waste" and defined as the activities related to waste management. At the same time, the Law "On subsoil" qualifies the mining waste utilization as the activity related to subsoil use, which provides for certain procedures in registration of rights to utilize waste. Transporting, storing mining waste in dumps and special facilities also refer to the main activities of the subsoil user.

Mining waste administration is according to various waste classification criteria in terms of environmental and mining legislation. The main parameters characterizing waste from the perspective of environmental legislation are the type, volume, content of harmful components, hazard class, areas designated for waste disposal.

Regulatory framework of mining legislation though uses the term “mining waste and related processing industries", still does not disclose the content of this concept, obviously, due to the fact that the administrated objects are not waste but contained mineral reserves and useful components which are under control of the State Reserves Balance.

The differences are manifested in the administration principles for the mining waste movement: under environmental legislation records are maintained at all stages of the waste life cycle (from waste collection to utilization or disposal).

The mining law provides for a different system based on administration of mineral resource movement (including mining waste and related processing industries) by entering on the balance sheet, reserves conversion from balance to off-balance (and vice versa), write-offs of reserves in the form of loss.

Thus, to date, administration of mining waste and minerals contained in mining waste and related processing industries, are independent, is represented by administration systems actually isolated from each other. This situation complicates the exchange of information and coordination of interdepartmental interests (Ministry of Natural Resources), complicates the activities of subsoil users on the waste use and disposal, restricts access to waste of facilities possessing advanced technologies for its processing that does not contribute to the reduction of waste accumulation.

Comparative description of waste administration systems is presented in table 3.

Table 3: Comparative description of waste administration systems

Comparison criterion	**Waste administration system**	
	Based on provisions of the mining law	**Based on the norms of environmental legislation**
Legislative principles in relation to waste	Mining and processing waste is a potential resource	Waste is a potential danger to the environment
Activity classification	Mining and processing waste utilization is classified as activities related to subsoil use	Collection, transportation, accumulation, storage (disposal), utilization are classified as waste management activities
Administration item	Mineral reserves contained in waste	Mass of weight
Organization principle of administration	Administration during reserves movement in a closed cycle	Administration in the process of waste management (collection, transportation, utilization, storage (disposal), life cycle)
Category contents (waste)	Not defined	Several definitions of the Federal Law "On production and consumption wastes" (FZ-89 dated 24.06.1998); GOST R 53691-2009
Classification criteria	Not defined. The volume of reserves in the waste and the content of useful components are taken into account	Hazard class, type, volumes, placement, physical state, origin
Scope of legislation	Subsoil use	Waste management
Storage period	Unlimited storage in special dumps and a new cycle begins with a commercial interest in waste	Waste storage in specialized facilities for a period of more than eleven months for the purpose of recycling, detoxification, disposal

Institutional problems

The efficiency of the economy and its individual sectors is determined by the institutional environment that is the set of fundamental political, social, legal and economic rules that determine the scope of human behavior and form the basis for production, exchange and distribution.

The institutional environment function with regard to solving the problem of mining wastes lies in "transforming" wastes into real economic resources by involving them in economic turnover. The institutional environment is determined as "the set of institutions and system-forming game rules thereof" [31,32,33]. One of the basic market institutions is the institution of object ownership; therefore, the object must be identified, otherwise it is impossible to observe the owner's rights and obligations, establish legal communications with other entities in respect of this object.

Regarding object as the waste suggests a lack of purpose for thing usage and the owner's desire to dispose of it [34]. These criteria are reflected in the definition of GOST R ISO 14050-2009, article 3.12 – "Waste: substances or objects which the owner wishes or needs to dispose of" that, in particular, corresponds to the definition of "waste" in the EU Waste Directive (Council Directive 91/156/EEC, 1991). The waste owner is the one who produced them or the person who is transferred the rights of ownership.

In the National standard of the Russian Federation waste is defined as "residues of products or complementary products formed during or after certain activities and are not used in direct connection with this activity" (GOST R 53691-2009)".

Regarding the identification of mining wastes, the situation is paradoxical: despite the fact that mining waste processing refers to subsoil use, mining legislation does not allow defining and objectively identifying waste. For example, the applied definition of "mining waste and related processing industries" does not meet the definition used in the state statistical accounting which applies the concept of "production and consumption wastes", which are recorded by economic activities. And the widely used term of "manmade deposit" has no legal definition. In the end, these "flaws" lead to the violation of legal communications, retard the legislative formalization, give rise to contradictions between separate regulations and separate law areas [35].

Subsoil user's waste possession does not mean that the owner is obliged to use them and can dispose of them; waste ownership is limited by right of waste use (utilization) that cannot be transferred to third parties due to the inclusion of waste activities as the kind of subsoil use. Moreover, the law "On subsoil" provides for the regulation obliging subsoil users to store waste if there is no opportunity to use them.

Current mining legislation, in relation to mining waste, defines the "game rules" which abiding does not contribute to the reduction of waste generation and accumulation, and the contradictions with the provisions of the environmental legal acts, primarily the law "On production and consumption waste" often disorient and discourage the subsoil users [36].

The basis for these differences are controversial views on waste as a potential mineral resource that in favourable conditions may be involved in the processing intended for production (extraction) of these useful components, and necessary for the development of the mining industry and a specific company (renewal of its life cycle) and waste as a source of negative impact on the environment.

The legislation of economically developed countries (primarily EU countries) [37] is formed in accordance with the eco-efficiency principles resulting in minimized potential conflicts. (For example, in 2011 Finland, a recognized leader the field of rational use of natural resources, environmental protection and ecology, launched the "Green Mining" program implemented by Tekes Fund which aims by 2020 to make Finland a pioneer in the field of eco-efficient mining industry).

Currently, the mining waste management in EU countries is regulated by the mining code and environmental regulations which envisage the waste generation process at the stages of deposit evaluation and projecting in a form of environmental burden.

Waste and Landfill Framework Directives [Waste Framework Directive (75/442/EEC as amended), Landfill Directive (1999/31/EC)] are the main relevant legal instruments in the field of waste management in the mining industry, and the following are used in addition: IPPC (96/61/EC); Seveso II (96/82/EC, revised by 2003/105/EC); Hazardous waste (91/689/EEC); Water Framework Directive (2000/60/EC); EIA (85/337/EEC, 97/11/EC); Nature (Habitats/birds dir. 92/43/EC, 79/409/EEC) [38]. These directives reflect the payment principles for environmental pollution, mining waste prevention, use, and disposal.

Serious institutional problem in Russia is the high business monopolization in the mineral sector [39], which creates barriers to involve small and medium business entities in sphere of waste treatment. According to official statistics, the share of small and medium entities in mining amounted to one percent in 2014, and the share of employment in this sector is 2.1%, the lowest indicators in the aggregate structure for all types of activities [39].

The small and medium business sectors have a higher innovative potency, the ability to respond more flexibly to changes in the economic environment [40]; the scope of their business interests fall on man-made objects of no value for large companies [41].

The main problems of small and medium mining business participation in the mining waste management are primarily legal restrictions, inconsistency of existing legislation, little interest on part of the state.

CONCLUSION

The growth of mining waste formation and the accumulation extent thereof allow us to consider them as independent management objects and waste management as an independent activity aimed at wastes reduction and (or) involvement in the economic turnover.

The main reasons hindering the development of mining waste management system are: the legal conflict between mining and environmental legislation, inconsistency of accounting systems for waste and minerals, the lack of an effective support system for small and medium mining, undeveloped institutional environment creating conditions for waste involvement in economic turnover.

According to the authors, the main attention should be paid to the legal system and regulatory governance of the mining waste.

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REFERENCES

[1] Komarov M.A., Aliskerov V.A., Kusevich V.I., Zavertkin V.L. Mining wastes – addition source of raw materials. Mineral resources of russia. № 4. 2007. Url: http://www.vipstd.ru/gim/content/view/ 407/204/ (accessed: 11.08.2016)

[2] Peshkova G., Cherepovitsyn A., Tcvetkov P. Prospects of the environmental technologies implementation in the cement industry in russia. Journal of ecological engineering, volume 17, issue 4, 2016.

[3] Bihovskiy L.Z., Sporihina L.V. Anthropogenic wastes as a reserve of the mineral resources base replenishment: status and problems of development. Mineral resources of russia. Economy and management. № 4. 2011. P.19

[4] MAKAROV V.A. Gold of anthropogenic mineral formations – resources and problems of geology-technological assessment. Gold and technology. №3 (13). 2011. Url: http://zolteh.ru/index.php?dn=news &to=art&id=375 (accessed: 11.08.2016)

[5] Kamenev E.A., Kiperman YU.A., Komarov M.A., KOTKIN V.A., Ashirmatov A.B. Anthropogenic mineral resources. Edited by b.k. Mikhailova. Moscow. Science world, 2012. P. 66

[6] Cherepovitsyn A.E., Fedoseev S.V., Teslya A.B., Vyboldina E.Y. Analysis of production and consumption of rare-earth metals in the eu and the brics. Tsvetnye metally, 5, 2015. P. 5–10. Doi: 10.17580/tsm.2015.05.01.

[7] Vyboldina E., Cherepovitsyn A., Fedoseev S. and Tsvetkov p. (2016). Analysis of export restrictions and their impact on metals world markets. Indian journal of science and technology, vol 9 (5), doi: 10.17485/ijst/2016/v9i5/87633

[8] Bokov V.G. Wealth in the dumps (the problem of disposing of mining and industrial wastes in Russia. Center. 1994. № 8-9.

[9] Dushin R.A. Rational use of the natural resource base of man-made deposits at the regional level (with east donbass as an example). Novocherkassk. Norstu (nii). 2009. P.9

[10] Seleznev S.G., Stepanov N.A. Mineral resources wealth on the surface. Features of man-made objects and problems of their development. Sustainable development of mineral rosources. № 6. 2012. P. 15

[11] Teslya A., Cherepovitsyn A., Vyboldina E., Fedoseev S. AND Kozmenko S. (2015) the concept of economic growth of the construction industry in st. Petersburg. Matec web of conferences, 53 () 01005 doi: dx.doi.org/10.1051/matecconf/2016530 1005

[12] Didenko N., Kunze K., Skripnuk D. Russian export strategy and social sector: consequences of resource-oriented exports on population of russia. Mediterranean journal of social sciences. 2015. Part. 6, № 5. Supplement 2. Pp. 473-481

[13] Didenko N.I., Skripnuk D.F. The influence of socio-economic factors on the economic growth of the arctic regions of russia. Arctic in 21 century. Humanities. 2015. № 1 (4). Pp. 53-56.

[14] The development strategy of the Arctic zone of the Russian Federation and national security until 2020. Moscow. 2010. URL: http://narfu.ru/aan/institut_arctic/strategy_AZRF_2010.pdf (accessed: 11.08.2016)

[15] Sokolov YU.I. ARCTIC. The problem of environmental damage accumulation. Arctic: ecology and economy. 2013. № 2 (10).

[16] Kozlov A.V., Fedoseev S.V., Cherepovitsyn A.E., Gutman S.S., Zaichenko I.M., Marinina O.A., Rytova E.V., P.S. Tsvetkov, Tochilo M.V. Integrated development of the economic space of the Russian Arctic. Monograph. 2016. 315 p.

[17] The statistical bulletin "Main indicators of environmental protection". URL: http://www.gks.ru/ (accessed: 11.08.2016)

[18] Russian Federation Government Resolution dated 07.12.2001 N 860 "On the federal target program" Ecology and Natural Resources of Russia (2002 - 2010)" URL: http://docs.procspb.ru/content/part /353846 (accessed: 11.08.2016)

[19] Fedoseev S.V., Cherepovitsyn A.E. Evaluation of overall strategic potential of the Russian Arctic zone basic industries. Vestnik MSTU. 2014. Vol. 17. Iss. 3. pp. 598-605. URL: http://www.vestnik.mstu.edu .ru/v17_3_n58/598_605_fedose.pdf (accessed 11.08.2016)

[20] Nikolaichuk L.A., Tsvetkov P.S. (2016). Prospects of Ecological Technologies Development in the Russian Oil Industry. International Journal of Applied Engineering Research, ISSN 0973-4562, Volume 11, Number 7 (2016) pages 5271-5276.

[21] On the status and use of mineral resources of the Russian Federation in 2011, the State report. Mineral. 2012. URL: http://www.mnr.gov.ru/ (accessed: 11.08.2016)

[22] Gorlova O.S. Man-made mineral deposits. Magnitogorsk: MSTU n.a. N. Nosov. 2001. p.20

[23] Cherepovitsyn A.E., Tsvetkov P.S. (2016). Methodical Approach to Evaluation of the Russian Peat Deposits Exploitation Attractiveness Based on Geology-Technological Criteria. International Journal of Applied Engineering Research, ISSN 0973-4562, Volume 11, Number 7 (2016), pages 5072-5078.

[24] Tcvetkov P., Strizhenok A. Ecological and economic efficiency of peat fast pyrolysis projects as an alternative source of raw energy resources. Journal of Ecological Engineering, Volume 17, Issue 1, 2016, pages 56–62, DOI: 10.12911/22998993/61190

[25] Seleznev S.G. Economic and legal aspects of the Russian legislation in the field of mining waste. The

proceedings of the conference "Problems of use of mining waste facilities". Moscow. 25-26 april. 2013. URL: //www.maxconf.ru (accessed: 11.08.2016)

[26] Trubetskoy K.N. Classification of waste deposits, the main categories and concepts. Mining journal. 1989. № 12. pp. 6-9.

[27] "On the long-term target program" Development and use of mineral resources base of the Leningrad Region in 2011-2015 "Resolution of the Government of the Leningrad region 22.07.2011 № 231. URL: www/consultant.ru (accessed: 11.08.2016)

[28] Seleznev S.G. On the problem of the use of mining and industrial waste. Mineral resources of Russia. Economy and management. 2013. №4. p. 41.

[29] Pahalchik G.Yu. «The Program of Sverdlovsk region technogenic formations processing». Mining journal. 1997. № 11-12.

[30] Chernyahovskiy A.G. Geological and economic evaluation of the solid minerals objects. Mineral resources of Russia. Economy and management. 2013. № 2.

[31] Alchian A.A., Demsetz H. Production, information costs, and economic organization. American Economic Review. 1972. v. 62. N 6.

[32] Coase R. H. The Institutional Structure of Production. The American Economic Review. 1992. vol.82. №4. pp. 713-719.

[33] Kolyushin E.N. The impact of the existing institutional environment for investment relations as the factor of the state economic potential growth. Economic Sciences. 2010. 8(69). pp. 42-45 URL: www.ranepa.ru/docs/dissertation/171-text_diss.pdf (accessed: 11.08.2016)

[34] Pongrácz E. «Re-defining the concepts of waste and waste management». URL: http://herkules.oulu.fi/isbn9514268210/isbn9514268210.pdf (accessed: 11.08.2016)

[35] M.A. Nevskaya, O. A. Marinina Regulatory Aspects of Mining Waste Management in the Russian Federation. Biosciences Biotechnology Res Asia. 2015. 12(3) URL: http://www.biotech-asia.org/ vol12no3/ regulatory-aspects-of-mining-waste-management-in-the-russian-federation (accessed: 11.08.2016)

[36] Nevskaya M, Kabak O. State of regulation of mining and mineral processing waste. Organization and management. Scientific Paper. Gliwice. Poland 2015.№ 81 pp. 37-49

[37] Directive № 2006/21/EU of the European Parliament and of the Council "On waste management mining industry" and amending Directive 2004/35/EU/ Strasbourg, 15 March 2006. URL: base.consultant.ru (accessed: 11.08.2016)

[38] INTOSAI Working Group on Environmental Auditing. Auditing Mining: Guidance for Supreme Audit Institutions. (2010). Retrieved July, 9, 2015. URL: http://www.environmental-auditing.org/Link Click.aspx?fileticket=Ffqb/3zmeZ8=andmid=568andtabid=128 (accessed: 11.08.2016)

[39] Yaremenko Yu.V. The modern economy of Russia: the analysis and development strategy. Forecasting issues. 2015. №5. URL: http://www.ecfor.ru/pdf.php?id=2015/5/01 (accessed: 11.08.2016)

[40] Fedoseev S.V., Tsvetkov P.S. Value added as an indicator of industrial enterprises' economic growth. North and Market: The formation of the economic order. 2015. №4. pp. 128-133.

[41] Small and medium business in Russia – 2014. URL: http://www.gks.ru/bgd/regl/b15_47/Main.htm (accessed: 11.08.2016)