Afyon Kocatepe Üniversitesi Uluslararası Mühendislik Teknolojileri ve Uygulamalı Bilimler Dergisi

Afyon Kocatepe University International Journal of Engineering Technology and Applied Sciences

AKÜ IJETAS Vol **2**(2) (2019) Aralık (117-124s) AKU J.Eng.App.Sci. **Vol 2** (2) (2019) December (117-124p)

Araştırma Makalesi / Research Article

e-ISSN 2667-4165 (https://dergipark.org.tr/akuumubd)

Lisakovski Katmanı Of Demir Cevheri Özellikleri

Karlygash Shynbergenova[1], Tatyana Kryazheva[1]

[1] *Zhezkazgan baikonurov University, Mining engineering, Zhezkazgan/Kazakistan.*

e-posta: karligash_jez@mail.ru, ORCID ID: https://orcid.org/0000-0001-7653-4955
e-posta: kryazheva_t@mail.ru , ORCID ID: http://orcid.org/0000-0003-2804-020X

Geliş Tarihi: 30.04.2019 ; Kabul Tarihi:16.10.2019

Anahtar kelimeler
İnce taneli yapı; Oolit; Demir konsantresi: Hidrogetit ; manyetit; Klorit

Öz

Makalede, Lisakovski birikintisinin oolitik cevherlerinin manyetik ayırma yöntemiyle zenginleştirilmesine yönelik laboratuvar çalışmalarının sonuçlarını sunmaktadır. Morfometrik analiz sonuçları ve üç çeşit cevher ve konsantre kalitesinin incelenmesi, zenginleştirme parametreleri değiştirilerek elde edilmiştir.

Specific Features Of Iron Ore Of Lisakovski Deposit

Keywords
Fine-grained structure; Oolite; Iron concentrate; Hydrogetite; magnetite; Chlorite.

Abstract

The article presents the results of laboratory studies of the enrichment of oolitic ores of the Lisakovski deposit by the method of magnetic separation.The results of morphometric analysis and the study of the quality of three types of ore and concentrates, obtained by changing the enrichment parameters, are presented.

1. Introduction

The authors conducted laboratory researches of iron ore at the Lisakovskiy deposit. Scientific research was carried out on the Grant of Commercialization, funded by JSC "NATD" on the topic "Assessment of the distribution of non-ferrous, rare and dispersed elements in technogenic waste of JSC “ArcelorMittalTemirtau”.

MPP	Inventory stocks on 01.01.2013		Ore production		The content of iron in the concentrate, %
	Category	Stocks (millions of tonnes)	Size, mm	Costs, tenge/tonne	
Lisakovskiy	A+B+C	1111,2	0-2	355	54*
Atasu	A+B+C	480,6	0-80	1527	54
Kentobe	B+C	239,2	0-80	2859	53
Atansor	C	44,8	0-80	1789	54

*Note: * The iron content in the Lysakovkiy concentrate of ore is indicated by the calcined weight.*
Table 1 Technical and economic indicators of MPP in LLP “Orken”

The iron ore component of the metallurgical raw materials of JSC “ArcelorMittal Temirtau”, supplied by LLP “Orken”, which is not rich in iron content, ore concentrates of the Central Kazakhstan deposits and concentrates from the Lisakovskiy ore, ore concentrate of SSMPPA with high iron content.

2. Ore delivery

LLP "Orken", which is a subsidiary of JSC "ArcelorMittalTemirtau", includes mining and processing plants that process ore from the Karazhal, Kentobe, Atansor and Lisakovskiy deposits. Technical and economic indicators of MPP in LLP “Orken” are represented in Table 1.

Iron ores involved in the metallurgical redistribution at JSC "ArcelorMittalTemirtau" are characterized by reduced iron content by 12-14% compared to concentrates of the world's leading metallurgical companies. The reason for this is that iron ores have a fine-grained structure, and when grinding to size, which was provided by grinding-crushing stations of the last century, the grain is not opened, and as a consequence, the ore is not effectively concentrated and removed during preparation process.

The most promising way to reduce the production costs of JSC “ArcelorMittalTemirtau” is to increase the efficiency’s enrichment of iron ore deposits of its own.

After the devaluation of tenge in 2014, the metallurgical processing of Lisakovskiy concentrates with iron content of 54.0-55.0% and during 2015 became economically unprofitable. JSC “ArcelorMittalTemirtau” the Lisakovskiy gravitational-magnetic concentrate is practically not used in the stock of “ArcelorMittalTemirtau” and Lisakovskiy Mining and Processing Plant (LMPP) stores a significant part of its output on the site of the plant.

Lisakovskiy ore lies at a shallow depth, extraction requires stripping 5-15 m. Mining is conducted without the production of explosions by excavators, which ensures production costs at the level of $ 1 per ton. The ore mainly consists of oolithes of 0.2-0.6 mm in size bound by clayey constituents. Oolithes have low strength and are easily crushed in a ball mill to a particle size of less than 0.044 mm for 12 minutes. In the ore base of Lisakovskiy MPP there are 4 groups of deposits: Main, South, Steppe and East. The main reserves (75%) are concentrated in the Main Deposit, which is currently being processed. Areas 1, 2, 3 are developed with the average mass fraction of iron 38.2% [1].

Geological and technological classification of ores of the Lisakovskiy deposit is shown in Table 2.

3. Mineral composition and ore characteristics of the Lisakovskoye deposit.

The main ore mineral is hydrogelite, nonmetallic is quartz. According to texture-structural genetic characteristics and physical properties, oolithic ores are divided into two types: loose oolithic and massive. Three structural species are distinguished in the ores: thick-oolithic ore composed mainly of ore oolithes (50-80%) with a subordinate amount of cement and quartz; rare-oolithic ores, consisting of ore oolithes (less than 50%) with predominance of cement and free quartz and fine-oolithic cemented ores. A component of the oolithes is the hydrogenerite of two generations with a finely dispersed admixture of ferrochlorite clay substance. The sizes of oolithes range from 0.05 to 0.60 mm, 0.2-0.6 mm predominate.

The main ore mineral is hydrogelite, nonmetallic is quartz. According to texture-structural genetic characteristics and physical properties, oolithic ores are divided into two types: loose oolithic and massive.

Characteristics of ore			Mass fraction, %		Grain-size class, mm						Concentrate	
					1,6		-0,6+0,3		-0,3+0,15			
Type of ore	Grade of Ore	Structural, textural and mineralogical	Fe	Oolithes	Ore outcrop %	m.f. Fe,%	Ore outcrop %	m.f. Fe,%	Ore outcrop %	m.f. Fe %	Ore outcrop %	m.f. Fe,%
1	1-1	Bondless stiff Oolithic	42-49	60-85	0-7	27-46	35-65	44-49	4-24	38-47	-	-
	1-2	Large – Medium Oolithic	40-42	55-75	0-10	25-44	33-60	42-48	4-24	35-46	65-85	49-51
2	2-3	Bondless stiff Oolithic, medium and Fine Oolithic	38-40	50-70	0-10	23-44	29-57	33-47	6-31	33-45	60-75	48-50
	2-4	Bondless Rare Oolithic	34-38	40-65	0-15	21-42	24-52	32-46	7-38	27-44	53-70	47-49
	2-7	Mediumfine-Oolithic	30-34	25-60	0-10	19-42	11-50	20-43	8-48	20-42	40-65	44-47
3	3-5	Rare Oolithic	34-38	40-65	10-45	24-47	19-15	38-46	3-20	30-46	45-70	47-50
	3-6	Fine Oolithic	34-38	30-60	10-45	22-46	12-47	21-45	3-35	25-45	45-60	44-47
	3-8	Rare and Fine Oolithic	30-34	25-60	10-45	19-45	9-44	17-45	3-35	15-43	30-60	42-47

Table 2. Geological and technological classification of the Lisakovski deposit

Three structural species are distinguished in the ores: thick-oolithic ore, composed mainly of ore oolithes (50-80%) with a subordinate amount of cement and quartz; rare-oolithic ores, consisting of ore oolithes (less than 50%) with predominance of cement and free quartz and fine-oolithic cemented ores. A component of the oolithes is the hydrogenerite of two generations with a finely dispersed admixture of ferrochlorite clay substance. The sizes of oolithes range from 0.05 to 0.60 mm, 0.2-0.6 mm predominate.

Layered natured ores are often of the oolithic structure, often deformed, consists mainly of hydrogite, chlorite and calcium phosphate. Oolithes are fissured, so they resist weakly to grinding. Magnetite is represented by thin crystalline particles smaller than 0.005 mm. The ore can be slightly oxidized (martitized). Chlorite belongs to the chamoisite type, it contains magnesium and ferrous iron. Calcium phosphate belongs to the apatite group, its molecule can contain one or more OH groups and, possibly, a little SiO_2 instead of PO4 (Muhammed M., Zhang Yu. 2011). Its morphology can be different - amorphous and pseudohexagonal. A theory is known that phosphate anions absorb and grow on the surface of the gel ferrohydrate and phosphorus is excluded from the iron ore lattice inside the crystals of liquid cement dehydrate and recrystallized. Limited phosphorus removal is achieved by grinding and magnetic separation, which is partly technically feasible, so this technology of removing phosphorus from iron ores is used.

Part of the phosphorous is part of the cement mass, which connects finely-dispersed grains of magnetite. Therefore, it is impossible to remove it mechanically to contents that meet the requirements of the metallurgical processing.

4. Laboratory Results.

The phosphorus content of various types of Lisakovskiy ore varies from 0.6 to 0.8% according to many studies and is explained by the presence of stilpnosiderite (iron hydroxides enriched in phosphorous) and single apatite grains.

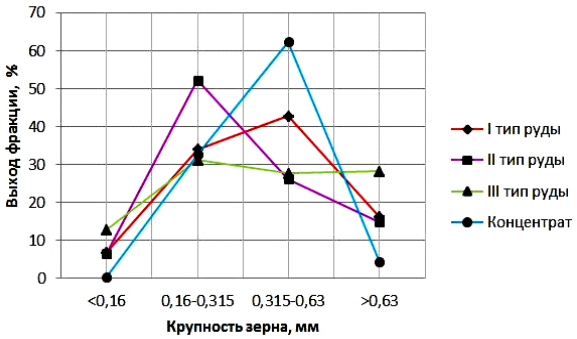
The phosphate found in the ore is represented by a white, loose mass of microspherolitic structure. Spherolithes, forming phosphate, closely adjoin each other. The size of the spherolithes varies from 0.004 to 0.018 mm. Phosphate of calcium is not the main carrier of phosphorous in concentrates, i.e. it is an insignificant part. Along with calcium phosphate, the presence of aluminophosphate was first detected in the hydroghetite, which in its parameters of the crystal lattice corresponds to the wavellite with iron ions.

Quality of I, II and III types of Lisakovski ore and concentrate is shown in picture 1, grain-size composition of iron-ore materials is shown in picture 2

Based on the iron content, type II ore of all fractions contains less than 30% and it cannot be enriched, leaving it in the deposit or moving it to the tailings pond. In fractions of more than 0.63 mm I, III types of ores, less than 30% of iron is contained.

5. Characteristics of the technological properties of ore.

Sorting allows you to remove 17% of the ore type I, 28% of the ore type III. Taking into account the



fact that type II ore can be excluded from the enrichment process, the total reduction of ores larger than 1.0 mm excluded from enrichment will be 40.5%.

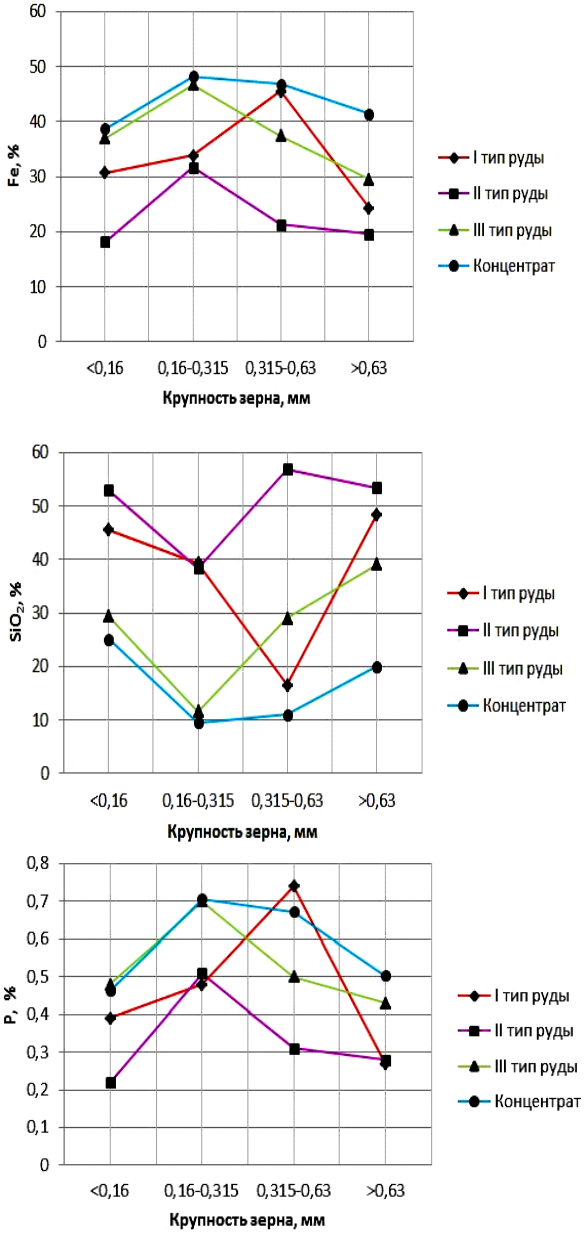


Figure 1. Quality of I, II and III types of Lisakovskiy ore and concentrate

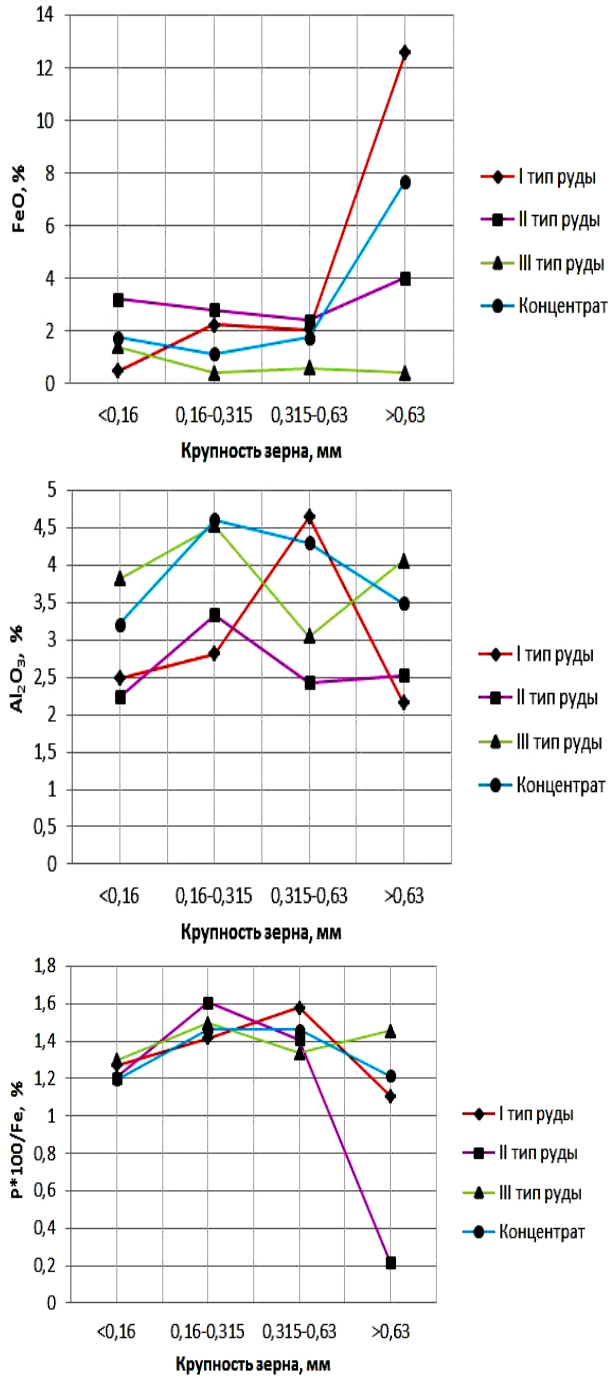


Figure 2. Grain-size composition of iron-ore materials

In ores I, II, III, types contain respectively 8.7 and 12% of the fraction less than 0.16 mm. The total amount of fines in the initial ore will be 10%.

The removal of these fractions of ore will significantly improve the efficiency of the enrichment process.

The structure of fractions of types I, II and III is shown in Fig. 3, 4, 5, where it is seen that oolithes are iron-containing nuclei and complex iron-containing iron-containing shell. The photographs shown in Fig. 4 and 5 indicate that the oolite grains have a complex structure: some grains have a shell structure, some of the oolithes are represented by a mixture of grains of various minerals less than 50 microns, so that grinding to a fineness of less than 0.044 mm is necessary to separate the iron-containing minerals. Studies carried out at LLP “Centrgeolanalit” found that the grinding time of the original Lisakovskiy ore and concentrate is 27 and 12 minutes.

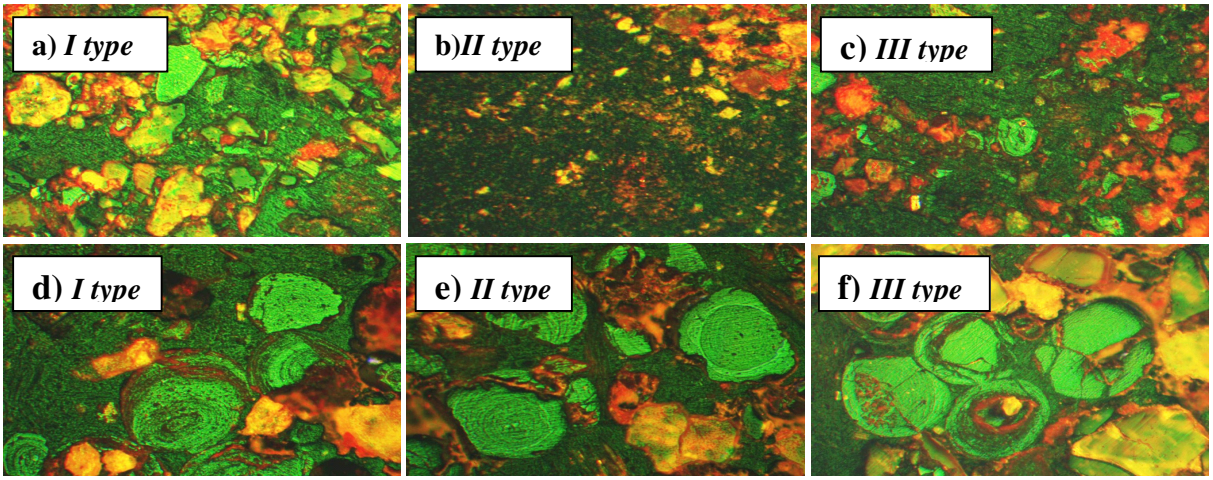


Figure 3. Structure of fractions: a, b, c - 0÷0,2 mm and d, e, f - 0,4÷0,2 mm I, II and III types of Lisakovskiy ores. Reflected light; zoom 10x

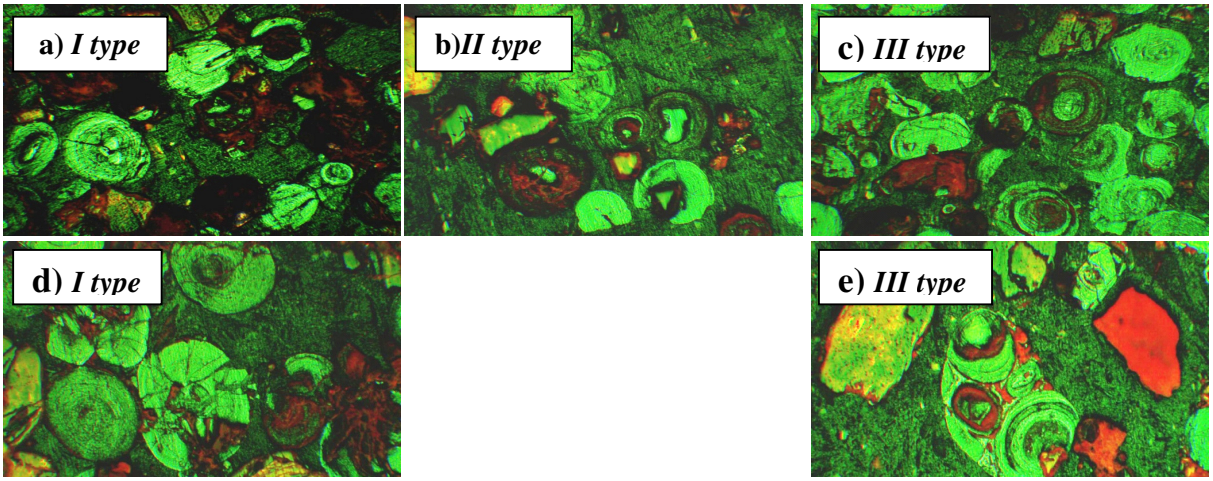


Figure 4. Structure of fractions: a, b, c – 0,63÷0,4 mm I, II and III types of Lisakovskiy ores; d, e – 1,25÷0,63 mm I and III types of Lisakovskiy ores. Reflected light; a, c - zoom 10x, b, d, e - zoom 5x

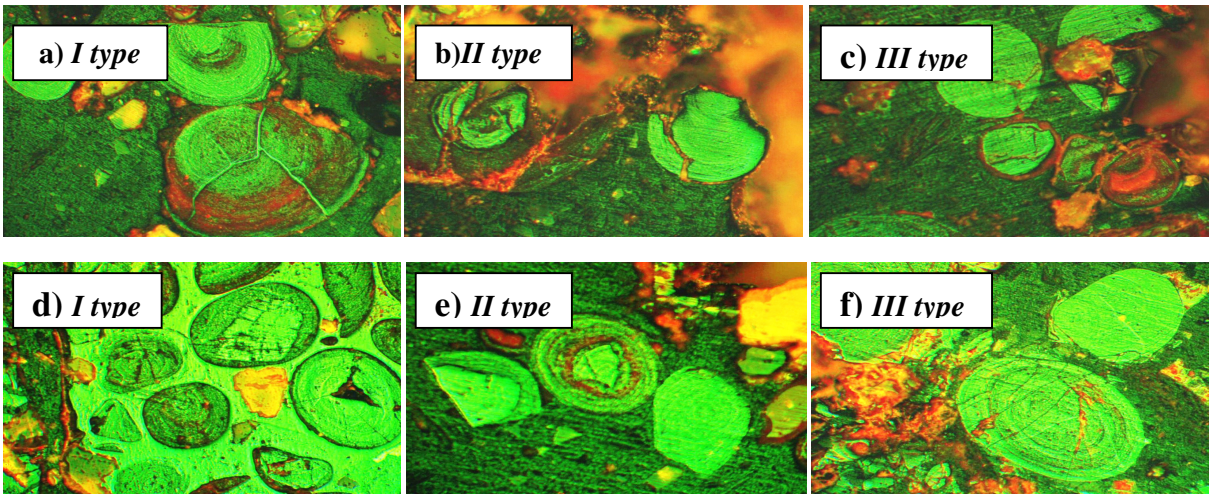


Figure 5. Structure of fractions:a, b, c – 3÷1,25 and d, e, f - 5÷3 mm I, II and III types of Lisakovskiy ores. Reflected light, zoom 10x

6. Conclusion

• High-phosphorus ores of the Lisakovskoye deposit with reserves of 1.11 billion tons are the main components of the sinter blend of ArcelorMittal Temirtau. The advantages of ore are the minimum costs in the extraction and grinding of ores, the lower cost of iron ore concentrate compared to concentrates of other mining and processing plants of Orken LLP.

• The relevance of this work lies in the fact that in Kazakhstan there are also the largest deposits of oolitic iron ore, which include: Ayatskoye with reserves of up to 7 billion tons and the Aral Sea deposit with reserves of up to 2 billion tons.

• The concentrate produced by the mining and processing plants of Orken LLP contains 54-56% of iron, which is 12-14% lower than in the leading enterprises of the near and far abroad. Production of high-quality iron ore concentrates from Orken LLP is possible with the enrichment of products crushed to a particle size of less than 0.074 mm or 0.044 mm.

• Lisakovskaya ore is currently being enriched using the method of jigging with the cleaning of middlings using wet magnetic separation without grinding the oolites.

7.References

Iron deposits of Kazakhstan, 2013. a reference book. - Almaty. 163 .

Muhammed M., Zhang Yu. 2011. Phosphorus removal from iron ores by hydrometallurgy process. Metallurgy, **12,** 619-624.

Isanova B.Kh., Tsybulko S.V. 2010. Hydrometallurgical methods for the dephosphorization of the Lisakovsk concentrate. *Republican scientific journal* "*Technology of production of metals and recycled materials* 2 (18) 87-91.

Isanova B.Kh., Arbuzov V.A., Gavva NF, Tsybulko S.V. 2010. Acid and alkaline methods for the dephosphorisation of the Lisakovsky concentrate. *Republican scientific journal Technology of production of metals and recycled materials*,(2 (18) 25-29.

Maxyutin L.A. Isanova B.Kh., Zvizhinskaya N.I., Gavva N.F. 2008.Determination of the degree of dephosphorization of iron ores during chemical enrichment, *Republican scientific journal "Technology of production of metals and secondary materials* **2** (14) 79-81.

Kryazheva T.V., K.T. Shynbergenova, L.A. Maksyutin 2016. Estimation of the distribution of non-ferrous and rare metals by industrial waste of JSC" Arcelormittaltemirtau "/ *Scientific journal Vestnik, -ZHEU:* №1, 125.

Kryazheva T. V., Shynbergenova K. T., Tanatova A. O 2018. Methodology for conducting production monitoring of the environment. *Compilation of materials of the XVIII International Baikonur Readings*, Human capital is the fundamental basis for the development of society and the driving force of the fourth industrial revolution; Zhezkazgan, 215 p.

Kryazheva T. V., Shynbergenova K. T. 2018. Problems of technogenic waste in industrial regions of the Karaganda region *Collection of materials of the International XVIII Baikonur Readings*, Human capital is the fundamental basis for the development of society and the driving force of the fourth industrial revolution, Zhezkazgan, 218.

Maksyutin LA, Kryazheva T.V., Shynbergenova K.T. 2016. Assessment of technogenic waste of JSC" ArcelorMittalTemirtau "from the point of view of the content and distribution of rare metals and trace elements" - *Scientific journal Vestnik, -ZHESU*. 81 p.

Sarkenov, B. B., Tusupbekova, T.Sh. 2011. The possibility of leaching Sayak ore. *Proceedings of the scientific conference* "Science and Education - the leading factor of the strategy" Kazakhstan 2030 , Saginovskiereadings № 3, Karaganda, KSTU, 22, p. 375-376.

Sarkenov B.B., Malyshev V.P., Turdykozhaeva A.M., Ospanov E.A. 2010. Evaporation and boiling of simple substances. Monograph, *Moscow, Scientific World*, - 304 p.

Takishov A.A., Kapsalyamov B.A., Shynbergenova K.T. 2015. Man-made waste as a reserve of the mineral resource complex *Materials of the XII International Baikonur Readings* "Academician O. A. Baikonurov and his contribution to the development of mining, science and education in Kazakhstan 378-383 p.

Contacts of authors

Карлыгаш Shynbergenova, PhD of engineering sciences, associate professor , Zhezkazgan baikonurov University,phone:+77773138017,+77058748187, email:*karligash_jez@mail.ru*

Tatyana Kryazheva, PhD of mining engineering, associate professor , Zhezkazgan baikonurov University, phone:+787057655736, email:kryazheva_t@mail.ru