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PROSPECTS OF OBTAINING QUARTZ FLOUR FROM IRON ORE ENRICHMENT WASTE STORAGE

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Abstract. Tailings storage facilities of iron ore beneficiation in the Kryvbas region currently contain more than 6 billion tons of mineral raw material. These waste deposits could become a source for obtaining iron concentrate and a silicate product, primarily finely ground quartz sand. However, to date, no economically feasible solution has been found for processing the waste to extract iron. Less attention has been paid to the issue of obtaining silicate material (mostly quartz) from the waste. Quartz mining in Ukraine is carried out at only one deposit in Zhytomyr region, and while there are many deposits of quartz sand, their quality (purity) is insufficient. Fine grinding is required to improve quality. In this regard, the material from iron ore tailings is competitive because it does not require energy-intensive grinding processes. The purpose of this work was to analyze iron ore beneficiation waste to determine the prospects for obtaining quartz flour. To achieve this, the following tasks were solved: establishing the annual volumes of waste that fill the tailings facilities of mining plants; studying the mechanism of waste formation and grain size; determining the quantity of fractions ready for beneficiation with particle size less than 50 μm contained in the tailings; and, based on an analysis of the degree of mineral liberation, forecasting the parameters of the silicate material that can be obtained from tailings finer than 50 μm. The study notes a significant resource of raw materials for obtaining quartz flour, and provides the annual volume of waste from five mining-beneficiation plants in Ukraine. The mechanism of waste generation by beneficiation operations in the traditional magnetic scheme is investigated, and it is found that in the coarsest waste from the first stage of magnetic separation, the content of < 50 μm size classes averages 23.7%. It is determined that in the tailing material, the amount of <50 μm size classes represented by liberated ore minerals averages 45%. This fraction is suitable for further processing without energy-intensive crushing and grinding operations. A microscopic analysis of mineral liberation was performed and a forecast is made for the characteristics of the silicate material that can be obtained from tailings <50 μm. The prospect of obtaining a silicate product in the form of quartz flour with a yield of 20–30% of the processed volume and iron content of 4–5% is established. The obtained quartz product is technologically competitive with sands of other origin; it has prospects as a raw material for the needs of radio electronics, the manufacture of optical instruments, fiberglass, filtration systems, metallurgy, construction, and other industries.

Keywords: iron ore, enrichment, waste, quartz, iron content.

1. Introduction

In Ukraine, about 6 billion tons of material have accumulated in the tailings storage facilities of magnetite quartzite iron ore beneficiation at the mining and beneficiation plants (MPP) of Kryvbas. These waste products could serve as a source for obtaining iron concentrate and a silicate product, predominantly quartz sand, for use in construction. However, at present no practical solution has yet been found for processing iron ore beneficiation waste in an economically feasible way [1, 2].

Currently, a small amount of iron ore waste is used in road construction, for reinforcing tailings dam embankments, manufacturing paving tiles, etc. The obstacle to broader use of the waste is the high residual iron content, up to 13–17%. Over time the iron undergoes chemical transformations and oxidizes. This makes the waste material friable, which negatively affects the strength of building products if used as an aggregate.

At present, a significant base of theoretical and practical research on the processing of fine mineral raw materials has been accumulated [4–9]. This includes studies of fine vibratory classification [4], hydraulic processing [5–7], and mechanical treatment methods [8, 9]. These developments can be applied to processing the material in iron ore tailings storage with the aim of extracting both iron and valuable silicate mass, which is represented mainly by fine quartz fractions.

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Extraction of iron from magnetite quartzite beneficiation waste is complicated by the fact that the iron is present mostly in oxidized form. In this case, ordinary magnetic separation is not effective; flotation, high-gradient magnetic separation, as well as hydraulic and combined methods are recommended [3]

The tailings material is promising for obtaining silicate raw material. Magnetite iron ore contains approximately 40% quartz (SiO_2). After beneficiation of the ore, the quartz content in the waste is 70–75%, in the form of a finely ground product. Thus, iron ore tailings can be a source for obtaining quartz flour. It is known that Ukraine has a single deposit where quartz is extracted – the Volodarsk-Volynskyi deposit in Zhytomyr region. Many deposits of quartz sand exist in Western Ukraine, Kharkiv and other regions, but the quartz flour obtained from them contains too many harmful impurities. It requires purification for use in optical and radioelectronic devices, for manufacturing glass for rockets and submarines, etc. To increase the purity of quartz flour, flotation (as in China, India) and chemical methods are used. Recovering quartz from iron ore tailings, compared to processing natural sands, is a promising direction of research.

The material in iron ore tailings is also attractive for processing because it does not require energy-intensive crushing and grinding to liberate the minerals (Ostapenko P. Ye., Olevskyi V. A. et al.). These operations were already performed earlier at the beneficiation plant. Nevertheless, iron ore tailings do contain coarse fractions that must either be removed or ground before further beneficiation. It is known that the liberation of minerals in iron quartzites occurs below a particle size of 50 μm (L.A. Lomovtsev, V.V. Karmazin et al.). By separating from the waste the fraction <50 μm, one can obtain a product with almost no intergrown particles, which makes it suitable for further efficient processing.

The concept of this work is to isolate from the entire mass of waste only the fine fraction with particle size less than 50 μm, which is suitable for further processing without additional grinding.

The aim of the work is to determine the quantity of the fine fraction <50 μm contained in the tailings and to establish the prospects of processing it to obtain a silicate material with minimal iron content.

2. Methods and methodology

The study applied methods of analysis of iron ore beneficiation indicators at the mining and beneficiation plants, as well as experimental tests on the waste from iron ore tailings storage facilities.

The methodology of the work consists in solving the following tasks:

1. Establish the annual volumes of waste from the iron ore mining plants.
2. Investigate the mechanism of formation and the grain size composition of beneficiation waste.
3. Identify the amount of fractions ready for beneficiation with particle size less than 50 μm contained in the tailings.
4. Perform an analysis of mineral liberation and forecast the parameters of the silicate material that can be obtained from the <50 μm fraction of the tailings.

3. Results and Discussion

Task 1. Annual volumes of waste from iron ore plants in Kryvbas.

Typical magnetite quartzite ores processed industrially have an iron content of about 33% (ranging 31–35%). The rest is gangue that must be removed to tailings. This does not mean that about 70% of the ore goes to waste and all the iron reports completely to concentrate. In practice, the tailings yield is lower, and the concentrate output is more than 33% due to some gangue being carried into the concentrate. Typical production figures are: concentrate yield up to 40% of ore, waste (tailings) yield up to 60%. Given this, and considering the concentrate production capacities of various plants (from open sources), the volume of waste annually reporting to the tailings storage of each mining plant was calculated (Table 1).

Table 1 – Volume of waste from Kryvbas mining and beneficiation plants depending on product output by design (at commissioning) vs. actual in 2021

Name of plant (product, Fe content in product)	Production volume (concentrate/pellets), million t/year		Waste volume, million t /year 2021
	by design	in 2021	
Southern – concentrate 63–65 %	11.0 / 5.0 (sinter)	13.5 / 0	20.25
Northern – concentrate up to 66 %	14.2 / 9.5	13.4 / 6.35	20.1
Poltavskyi – concentrate 62–64%, flotation concentrate up to 68%	13.0 / 12.0	12.0 / 11.2	18
Inhuletskyi – concentrate 63.7–64.8%, flotation conc. 67.0–67.5%	14.0	11.8	17.7
Tsentralnyi (Central) – concentrate 65.0–68.2%	6.0 / 2.2	4.8 / 2.26	7.2

*Note: For Poltavskyi MPP in 2024: concentrate production 6.9 million t at 67% Fe, pellets 4.98 million t. For other plants, information is not available in open sources.

From Table 1 it is evident that each plant annually generates waste on the order of millions of tons. These wastes are stored in a wet state in the tailings storage facilities of the respective mining-beneficiation plants.

Task 2 Mechanism of formation and fine fraction content in beneficiation waste

The traditional magnetic concentration scheme at these plants includes three, sometimes two, stages of ore grinding. After each stage, classification is performed and the overflow is processed by wet magnetic separation (WMS) on drum separators of type PBM, and on deslimers of type MD-5 or MD-9. The performance of the waste streams from these operations for two plants is given in Table 2.

The mechanism of waste formation is as follows. In the first-stage mills, the ore is ground and fed to a spiral classifier from which the fine fraction is removed as overflow and goes to the first stage of magnetic separation (MMS-1). From Table 2, it is seen that MMS-1 directs about 40–45% of the ground ore to waste. In practice it is known that, regardless of stage, during wet magnetic separation the concentrate is coarser than the tailings. In the second and third grinding stages, the hydrocyclone overflows (which are finer than the spiral classifier overflow) are processed, yielding finer tailings in the subsequent separators. For example, the content of <50 µm fines in the tailings of Deslimers 1 and 2 is 90% and 95%, and in the tailings of magnetic separators MMS-3 and MMS-4 it reaches 85% and 95–97%, respectively.

Table 2 – Yield and iron content in waste from operations of the traditional wet magnetic beneficiation of magnetite quartzite iron ores

Beneficiation operation	Northern MPP		Inhuletskyi MPP**	
	Yield, %	Fe_total, %	Yield, %	Fe_total/Fe_magnetic, %
MMS-1 (1st stage wet magnetic sep.)	43.16	12.4	44.7	12.9 /0.7
Desliming-1 (after MMS-1)	4.17	11.75	4.6	13.4 / 2.5
MMS-2 (underflow of 2nd stage mill)	3.35	14.81	(4.42*)	11.15 /0.4
MMS-3 (overflow of Desliming-1)	1.85	16.04	3.2	15.4 /2.0
Desliming-2 (after MMS-3)	2.62	12.79	0.04	12.9 / 5.0
MMS-4 (overflow of Desliming-2)	1.45	18.3	0.5	17.5 /4.0
Waste excluding MMS-1	13.44	14.01	17.16	12.74
Total (all stages) – Fe_total/Fe_magnetic	56.59	12.78/2.2	61.84	12.85/1.0

Notes: *Three grinding stages at Northern MPP; *Two grinding stages at Inhuletskyi MPP, where the second-stage hydrocyclone overflows of two subsections are combined and processed together.

The data in Table 2 show that the overall tailings yield is about 60% of the ore (56.59% and 61.84% for the two cases). It is also seen that with each successive operation the waste yield decreases, but the iron content in the waste increases, reaching 18.3% and 17.5% at the last MMS stage. The largest portion of the waste is produced at the first stage of magnetic separation (MMS-1). These tailings are the coarsest; moreover, the majority of the oxidized ore is rejected in MMS-1, because oxidized iron is weakly magnetic and is not captured by PBM-type magnetic separators.

Not only oxidized iron ends up in the waste, but also magnetic iron. This is evident from the last column of Table 2, which shows the losses of magnetic iron across the operations. According to the regulations for the operation of beneficiation plants at mining and processing plants (MPP), the content of magnetic iron in the total waste should not exceed 2.5%, but in practice, it can reach 3–3.5%. However, the major portion of the waste consists of oxidized iron - 83–85% of the total iron is in the form of oxidized varieties such as hematite, martite, etc. The total iron content in the waste ranges from 10–11% at the Lebedyn MPP, to 12–15% at the Kryvbas MPP, and 20–21% at the Mykhailovskyi MPP, where mixed ores are processed. Due to the presence of oxidized iron, conventional magnetic separation is ineffective for waste processing, requiring flotation or combined processing schemes [3].

The content of coarse fractions in the waste is determined by the specifics of MMS-I waste. They are the largest in quantity and size among the wastes from other operations. Approximately 60% of the ore ends up as waste, of which 40–45% comes from MMS-I; the remaining 15–20% are other wastes with an iron content ranging from 13–14% to 17%. The relatively large particle size of MMS-I waste is confirmed by the data in Table 3.

Table 3 – Content of <50 μm fraction in MMS-1 products (feed, concentrate, tailings)

Indicator/MPP	Poltava	Inhuletskyi	Northern	Stoilenskyi	Mykhailovskyi	Average
Feed (Classifier Overflow)	45	43.30	43.5	46.6	41.97	**44.1**
Concentrate MMS-1	19	16.15	23.88	22.89	18.87	**20.2**
Waste from MMS-1	25	27.15	19.62	23.71	23.1	**23.7**

The data in Table 3 confirm the typical pattern of magnetic separation: the concentrate is coarser than the tailings. Overall, MMS-1 tailings are relatively coarse, containing on average only 23.7% fine fraction <50 μm

All the tailings, from MMS-1 and other stages (Table 2), are discharged together into the tailings pond, because the tailings handling system at the beneficiation plants is designed such that all waste streams are combined and transported via special sluices lined with stone. However, for example, at Poltava MPP the MMS-1 tailings are removed separately, dewatered, stockpiled, and used for road and dam construction, etc. Yet the 12% iron content in MMS-1 tailings (Table 2) makes this material unstable. Oxidized ore varieties break down easily under weathering, so the direct use of MMS-1 waste is problematic. It has been noted by researchers that MMS-1 tailings require additional grinding to liberate interlocked grains for further processing [1–4]. We propose that it would be more economical to isolate the fine fraction from MMS-1 tailings that can be effectively processed further. For this purpose, a wet vibro-classification of MMS-1 tailings at 50 μm is suggested [5].

Task 3. Determining the quantity of <50 μm fraction in tailings ready for beneficiation

We determine the quantity of the <50 μm fraction in the aged tailings of a storage facility, for example at Inhuletskyi MPP, assuming we plan to process this material. From Table 2, for Inhuletskyi MPP the total tailings yield is 61.84%, of which MMS-1 contributes 44.7%. Expressed as a percentage of the total tailings mass, MMS-1 accounts for:

$$44.7 \cdot 100 / 61.84 = 72.3\%$$

From Table 3 it is seen that within the MMS-1 tailings themselves, 27.15% consists of fine <50 μm particles. Relative to the total mass of ore processed, this constitutes:

$$72.3 \cdot 27.15 / 100 = 19.63\%.$$

Apart from MMS-1 tailings, the tailings storage also contains the material from the other beneficiation operations, in the amount of:

$$100-72.3=27.7\%.$$

This portion represents the tailings from the other operations, and is composed entirely of liberated fine fractions.

Thus, in the total mass of aged tailings, the proportion of fine fraction <50 μm is:

$$27.7+19.63=\ 47.3\%.$$

Similar calculations were performed for the Poltava and Northern MPPs.

At Poltava MPP, the final tailings yield is 61.17%, of which MMS-1 tailings constitute 43.67%. From Table 3, the <50 μm fraction in MMS-1 tailings is 25%. In total, the proportion of <50 μm fraction ready for beneficiation in the overall tailings mass is:

$$\left(43.67\cdot 100/61.17\cdot 25/100\right)+\left(100-\left(43.67\cdot 100/61.17\ \right)\right)=\ 46.46\%.$$

For Northern MPP, from Table 2 the final tailings yield is 56.59%, including 43.1% from MMS-1. Assuming an average fine fraction content in MMS-1 tailings of 23.7% (Table 3), the proportion of <50 μm fraction in the total tailings is:

$$\left(43.1\cdot 100/56.59\cdot 23.7/100\right)+\left(100-\left(43.1\cdot 100/56.59\ \right)\right)=\ 41.9\%.$$

On average for the three plants:

$$\left(47.3+46.46+41.9\right)/3=45.22\%.$$

Therefore, by classifying the tailings material by any method, it is possible to obtain about 45% of material with particle size <50 μm that is ready for beneficiation, out of the total mas. Beneficiation of this fine fraction is possible, for example, by hydraulic methods, high-gradient magnetic separation, or flotation.

Task 4. Analysis of mineral liberation and forecast of silicate product parameters from <50 μm tailings

For the technological parameter forecast, a set of studies was carried out on the distribution of liberated grains and intergrowths in the concentrate and tailings of Inhuletskyi MPP. Both products had particle size <50 μm (screened at 50 μm). Grain counting was performed under a microscope following standard methodology. The calculated iron content in individual grains and in products assumed magnetite contains 72.36% Fe. The chemical analysis showed the overall Fe content in the initial samples was 64% for the concentrate and 14.5% for the tailings. Table 4 presents the yields of liberated particles and intergrown particles by category.

The data in Table 4 allow us to forecast the parameters of the silicate material that can be recovered from the tailings as follow.

Suppose that all particles have the same size and that we manage to recover only the pure gangue particles. Let us denote this product as “silica product grade 1.” It would have a yield of 41% (of the fine fraction) and an iron content of 3.6% Fe

This product can be obtained only from the <50 μm classes, where mineral grains are liberated. As shown above, the content of such classes in the tailings is 47.3%. It follows that extracting the “purest” silica mass from the tailings would yield:

$$47.3 \cdot 41 / 100 = \ 19.3\%.$$

Table 4 – Particle composition of concentrate and tailings from beneficiation by the traditional magnetic scheme (Inhuletskyi MPP, fraction <50 μm)

Particle type	Magnetite share in particle (fraction)	Fe content in particle, %	Particle yield,%	
			concentrate	tailings
Ore (liberated ore grain)	0.98	71	87	3
Ore–gangue intergrowth (ore-rich)	0.75	54.3	3	9
Gangue–ore intergrowth (gangue-rich)	0.25	18.1	1.6	23
Disseminated ore in gangue	0.1	7.2	2.4	24
Gangue (liberated non-ore grain)	0.05	3.6	6	41
Total yield of particles, %			100	100
Overall Fe content in product, %			64.0	14.3

Under hydraulic separation, most likely the disseminated ore particles will be recovered along with the gangue grains. Let us call this product “silica mass grade 2.” The yield of this silica mass (among the fine fraction) would be 41+24=65%, which relative to the entire tailings material is: 47.3·65/100= 30.75%. The iron content in this material would be: (24·7.2+41·3.6)/65=4.93%. The parameters of the potential silica products that can be recovered without additional grinding are given in Table 5.

Table 5 – Forecasted parameters of silica products obtainable from tailings

Silica product (grade)	Yield ,%		Fe content, %
	fraction (% of <50 μm)	relative to total tailings	
Type 1. Extraction of gangue minerals	41.0	19.3	3.6
Type 2. Extraction of disseminated and gangue grains	65	30.7	5.0

5. Conclusions

The quartz content in magnetite-rich ferruginous quartzites subjected to beneficiation at Ukrainian mining and processing plants is approximately 40%, while the quartz content in the beneficiation waste is about 70–75%. The aim of this study was to analyze the waste accumulated in tailings storage facilities to assess the prospects of obtaining quartz flour with minimal iron content.

The following tasks were addressed in this work.

1. The volume of waste annually added to the tailings of five Ukrainian MPPs was determined. At the same time, the production of concentrate according to design and as of 2021 was presented. It was shown that millions of tons of waste are added to the tailings annually.

2. The mechanism of waste formation and the amount of fine fraction below 50 μm by beneficiation operations using the traditional magnetic separation scheme were studied. It was found that the content of particles smaller than 50 μm in the coarsest waste from the first stage of magnetic separation averages 23.7%

3. It was determined that the amount of material in the tailings of iron ore MPPs suitable for further processing without energy-intensive crushing and grinding operations averages 45%. These are size fractions below 50 μm, consisting of liberated minerals from ferruginous quartzites.

4. A microscopic analysis of mineral liberation was conducted, and projections were made for the silicate mass that could be obtained from tailings material smaller than 50 μm. The study revealed the potential to obtain a silicate product in the form of quartz flour with a yield of 20–30% of the processed volume and iron content of 4–5%.

The resulting quartz product is technologically competitive with sands of other origins due to the absence of additional grinding and the need for washing out clay impurities. It has potential applications as a raw material for the radio electronics industry, optical device manufacturing, fiberglass production, filtration systems, and more.

Conflict of interest

Authors state no conflict of interest.

REFERENCES

1. Sokolova, V.P. and Uchitel, A.D. (2017), "Slurry processing of iron ore beneficiation", *Zbahachennya korysnykh kopalyn,* no. 66(107), pp. 1–9. available at: http://zzkk.nmu.org.ua/pdf/2017-66-107/01.pdf (Accessed 25 February 2025).

2. Medvedieva, O., Kyrychko, S., Nykyforova, N., and Koval, N. (2019), "Substantiation of the boundary of the tailings storage core during the storing of the cleaning rejects by hydraulic method", *E3S Web of Conferences*, vol. 109, 00056. *International Conference Essays of Mining Science and Practice*, https://doi. org/10.1051/e3sconf/201910900056

3. Oleynik, T.A. (2013), "Modern trends in the development of hematite ore enrichment technologies in Ukraine", *Zbahachennya korysnykh kopalyn,* no. 56(97), available at: http://zzkk.nmu.org.ua/ pdf/2014-56-97/02.pdf (Accessed 12 February 2025).

4. Bulat, A.F., Shevchenko, V.G., and Shevchenko, G.A. (2016), "Technology of classification of fine fractions of crushed iron ore to improve the quality of concentrates", *Bulletin of the Academy of Mining Sciences of Ukraine*, no. 7, pp. 35–39.

5. Bondarenko, A.O., Maliarenko, P.O., Zapara, У.E. and Bliskun, S.P. (2020), "Testing of the complex for gravitational washing of sand", *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, no.5, https://doi.org/10.33271/nvngu/20205/026

6. Nadutyi, V.P., Kurilov, V. S, Chelyshkina, O.G., and Hankevych, V. F. (2021), "Analytical studies on constrained particle settling velocity in a water suspension of fly ash from thermal power plants", *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, no. 1, pp.32–38, https://doi.org/10.33271/nvngu/2021-1/032

7. Semenenko, Ye., Kril, S., Nykyforova, N., Tatarko, L., and Medvedieva, O. (2019), "Calculation of pressure loss and critical velocity for slurry flows with additive agents in vertical polyethylene pipelines", *E3S Web of Conferences, International Conference Essays of Mining Science and Practice*, vol. 109, 00083, https://doi.org/10.1051/e3sconf/201910900083

8. Tytov, O., Haddad, J. and Sukhariev, V. (2019), "Modelling of mined rock thin layer disintegration taking into consideration its properties changing during compaction", *E3S Web of Conferences, International Conferences Essays of Mining Science and Practice*, vol. 109, 00105, https://doi.org/10.1051/e3sconf/201910900105

9. Nadutyi, V., Chelyshkina, O., Sukhariev, V. and Haddad, J. (2020), "Energy estimation of the interaction of a roller vibratory classifier's blade with crushed rock mass for solving design problems", *E3S Web of Conferences, II International Conference Essays of Mining Science and Practice*, vol. 168, 00058, https://doi.org/10.1051/e3sconf/202016800058

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ПЕРСПЕКТИВИ ОТРИМАННЯ КВАРЦОВОЇ МУКИ З ЩЛАМОСХОВИЩ ВІДХОДІВ ЗБАГАЧЕННЯ ЗАЛІЗНИХ РУД

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Анотація. Шламосховища відходів збагачення залізних руд Кривбасу на теперішній час містять понад 6 млн тонн мінеральної сировини. Відходи мали б стати джерелом для отримання залізного концентрату і силікатного продукту, переважно тонко змеленого кварцового піску. Але наразі практичного вирішення питання переробки відходів для вилучення заліза, яке було б економічно доцільне, поки що не знайдено. Менша увага приділялась питанню отримання з відходів силікатної маси представленою переважно кварцом. Видобуток кварцу в Україні здійснюється лише на одному родовищі в Житомирській області, хоча покладів кварцового піску багато, але їх якість (чистота) недостатня. Щоб підвищити якість, в першу чергу, потрібно застосовувати тонке змелення. В цьому плані сировина залізорудних шламосховищ є конкурентоспроможною, бо не потребує енергоємних процесів змелення. Метою роботи є аналіз відходів збагачення залізних руд для визначення перспектив отримання кварцової муки. Для цього вирішені наступні задачі: встановлені щорічні обсяги відходів, які поповнюють шламосховища залізорудних комбінатів; досліджений механізм формування і крупність відходів; визначена кількість готових до збагачення класів крупністю менше 50 мкм, що містяться в шламосховищі; на підставі аналізу ступеню розкриття мінералів виконано прогноз показників силікатної маси, яку можна отримати з сировини шламосховищ крупністю менше 50 мкм. В роботі відзначено значний ресурс сировини для отримання кварцової муки, приведений щорічний обсяг відходів п'яти ГЗК України. Досліджено механізм отримання відходів за операціями збагачення по традиційній магнітній схемі і встановлено, що в найбільш крупних відходах першої стадії магнітної сепарації вміст класів менше 50 мкм становить в середньому 23,7%. Встановлено, що в матеріалі шламосховищ кількість класів крупністю менше 50 мкм, які представлені розкритими мінералами руди, становить в середньому 45 %. Цей продукт придатний для подальшої переробки без використання енергоємних операцій дроблення та змелення. Виконано мікроскопічний аналіз розкриття мінералів і зроблено прогноз показників силікатної маси, яку можна отримати з сировини шламосховищ крупністю менше 50 мкм. Встановлена перспектива отримання силікатного продукту у вигляді кварцової муки при виході 20-30% від об'єму переробки і вмісті заліза 4-5%. Отриманий кварцовий продукт технологічно конкурентоспроможний із пісками іншого походження, він має перспективи як сировина для потреб радіоелектроніки, виготовлення оптичних приладів, скловолокна, систем фільтрації, використання в металургії, будівництві та інших галузях.

Ключові слова: залізна руда, збагачення, відходи, кварц, вміст заліза.