

MUHANDISLIK

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ijtimoiy-iqtisodiy, innovatsion texnik,
fan va ta'limga oid ilmiy-amaliy jurnal

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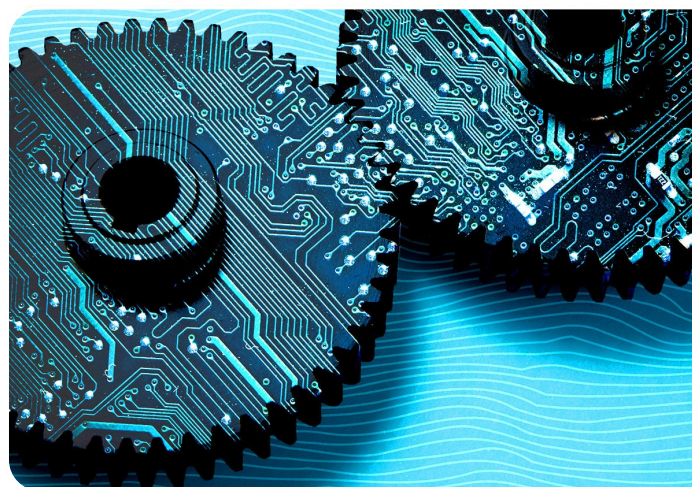
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ТАШКЕНТСКИЙ ФИЛИАЛ



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- 05.01.01 – Muhandislik geometriyasi va kompyuter grafikasi. Audio va video texnologiyalari
- 05.01.02 – Tizimli tahlil, boshqaruv va axborotni qayta ishlash
- 05.01.03 – Informatikaning nazariy asoslari
- 05.01.04 – Hisoblash mashinalari, majmualari va kompyuter tarmoqlarining matematik va dasturiy ta'minoti
- 05.01.05 – Axborotlarni himoyalash usullari va tizimlari. Axborot xavfsizligi
- 05.01.06 – Hisoblash texnikasi va boshqaruv tizimlarining elementlari va qurilmalari
- 05.01.07 – Matematik modellash
- 05.01.11 – Raqamli texnologiyalar va sun'iy intellekt
- 05.02.00 – Mashinasozlik va mashinashunoslik
- 05.02.08 – Yer usti majmualari va uchish apparatlari
- 05.03.02 – Metrologiya va metrologiya ta'minoti
- 05.04.01 – Telekommunikatsiya va kompyuter tizimlari, telekommunikatsiya tarmoqlari va qurilmalari. Axborotlarni taqsimlash
- 05.05.03 – Yorug'lik texnikasi. Maxsus yoritish texnologiyasi
- 05.05.05 – Issiqlik texnikasining nazariy asoslari
- 05.05.06 – Qayta tiklanadigan energiya turlari asosidagi energiya qurilmalari
- 05.06.01 – To'qimachilik va yengil sanoat ishlab chiqarishlari materialshunosligi
- 05.08.03 – Temir yo'l transportini ishlatish
- 05.08.06 – "G'ildirakli va gusenisali mashinalar va ularni ishlatish" (texnika fanlari)
- 05.09.01 – Qurilish konstruksiyalari, bino va inshootlar
- 05.09.04 – Suv ta'minoti. Kanalizatsiya. Suv havzalarini muhofazalovchi qurilish tizimlari
- 10.00.06 – Qiyosiy adabiyotshunoslik, chog'ishtirma tilshunoslik va tarjimashunoslik
- 10.00.04 – Yevropa, Amerika va Avstraliya xalqlari tili va adabiyoti
- 08.00.01 – Iqtisodiyot nazariyasi
- 08.00.02 – Makroiqtisodiyot
- 08.00.03 – Sanoat iqtisodiyoti
- 08.00.04 – Qishloq xo'jaligi iqtisodiyoti
- 08.00.05 – Xizmat ko'rsatish tarmoqlari iqtisodiyoti
- 08.00.06 – Ekonometrika va statistika
- 08.00.07 – Moliya, pul muomalasi va kredit
- 08.00.08 – Buxgalteriya hisobi, iqtisodiy tahlil va audit
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- 08.00.10 – Demografiya. Mehnat iqtisodiyoti
- 08.00.11 – Marketing
- 08.00.12 – Mintaqaviy iqtisodiyot
- 08.00.13 – Menejment
- 08.00.14 – Iqtisodiyotda axborot tizimlari va texnologiyalari
- 08.00.15 – Tadbirkorlik va kichik biznes iqtisodiyoti
- 08.00.16 – Raqamli iqtisodiyot va xalqaro raqamli integratsiya
- 08.00.17 – Turizm va mehmonxona faoliyati

Ma'lumot uchun, OAK
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CHEMICAL-MINERALOGICAL CHARACTERIZATION AND DRY BENEFICIATION TECHNOLOGY OF FELDSPAR FROM THE SULTAN UVAYS DEPOSIT

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Abstract. This article presents a study of the chemical-mineralogical composition, granulometric distribution, and physicochemical properties of feldspar raw material obtained from the Sultan Uvays deposit located in the Republic of Karakalpakstan, Lower Amu Darya region.

According to the results of X-ray diffraction analysis, the sample predominantly consists of microcline (60–65%), albite (21–25%), quartz (7–10%), and calcite (2–3%).

To obtain a concentrate suitable for the glass industry, a four-stage dry beneficiation technology has been developed and experimentally tested. This process includes magnetic separation ($H = 80\text{--}1300\text{ kA/m}$) and electrostatic separation methods.

The beneficiation results demonstrate that the SiO_2 content in the feldspar fraction increased from 68.44 wt.% to 74.60 wt.%, while the total iron content ($\text{Fe}_2\text{O}_3 + \text{FeO}$) decreased from 0.29 wt.% to 0.01 wt.%.

The obtained results confirm that feldspar from the Sultan Uvays deposit meets the requirements of GOST 22557-2019 and can be widely used as an independent raw material in the production of glass and enamel coatings.

Keywords: feldspar, magnetic separation, electrostatic separation, X-ray diffraction analysis, IR spectroscopy, BGMN/Profex Rietveld refinement, glass industry, Lower Amu Darya.

Annotatsiya. Ushbu maqolada Qoraqalpog'iston Respublikasi, Quyi Amudaryo hududida joylashgan Sulton Uvays konidan olingan dala shpati xomashyosining kimyoviy-mineralogik tarkibi, granulometrik taqsimoti hamda fizik-kimyoviy xossalari tadqiq etilgan.

Rentgen difraksiya tahlil natijalariga ko'ra, namuna asosan mikroklin (60–65%), albit (21–25%), kvarts (7–10%) va kalsitdan (2–3%) iboratligi aniqlangan.

Shisha sanoati uchun mos konsentrat olish maqsadida to'rt bosqichli quruq boyitish texnologiyasi ishlab chiqilib, tajriba-sinovdan o'tkazilgan. Ushbu jarayon magnit ajratish ($H = 80\text{--}1300\text{ kA/m}$) va elektrostatik ajratish usullarini o'z ichiga oladi.

Boyitish natijalari dala shpati fraksiyasida SiO_2 miqdori 68,44 og'.% dan 74,60 og'.% gacha oshganini, umumiy temir miqdori ($\text{Fe}_2\text{O}_3 + \text{FeO}$) esa 0,29 og'.% dan 0,01 og'.% gacha kamayganini ko'rsatdi.

Olingan natijalar Sulton Uvays koni dala shpati GOST 22557-2019 talablariga javob berishini hamda shisha va emal qoplamalari ishlab chiqarishda mustaqil xomashyo sifatida keng qo'llanishi mumkinligini tasdiqlaydi.

Kalit so'zlar: dala shpati, magnit ajratish, elektrostatik ajratish, rentgen difraksiya tahlil, IQ spektroskopiya, BGMN/Profex Rietveld tahlili, shisha sanoati, Quyi Amudaryo.

Аннотация. В данной статье представлены результаты исследования химико-минералогического состава, гранулометрического распределения и физико-химических свойств полевошпатового сырья, полученного с месторождения Султан Увайс, расположенного в Республике Каракалпакстан, регионе Нижней Амударьи.

Согласно результатам рентгенодифракционного анализа, образец преимущественно состоит из микроклина (60–65%), альбита (21–25%), кварца (7–10%) и кальцита (2–3%).

Для получения концентрата, пригодного для стекольной промышленности, разработана и экспериментально апробирована четырехстадийная технология сухого обогащения. Данный процесс включает методы магнитной сепарации ($H = 80\text{--}1300\text{ kA/m}$) и электростатической сепарации.



Результаты обогащения показали, что содержание SiO_2 в полевошпатовой фракции увеличилось с 68,44 мас.% до 74,60 мас.%, а общее содержание железа ($\text{Fe}_2\text{O}_3 + \text{FeO}$) снизилось с 0,29 мас.% до 0,01 мас.%.

Полученные результаты подтверждают, что полевоый шпат месторождения Султан Увайс соответствует требованиям ГОСТ 22557-2019 и может широко использоваться в качестве самостоятельного сырья при производстве стекла и эмалевых покрытий.

Ключевые слова: полевоый шпат, магнитная сепарация, электростатическая сепарация, рентгенодифракционный анализ, ИК-спектроскопия, уточнение структуры методом Ритвельда BGMN/Profex, стекольная промышленность, Нижняя Амурдарья.

INTRODUCTION

Feldspar minerals occupy a special place among alkaline aluminosilicate raw materials required for the glass industry. These minerals serve as a balanced source of silica, aluminum, and alkali elements, playing a crucial role in regulating the viscosity of the glass melt and reducing the sintering temperature. For this reason, global demand for feldspar raw materials has been steadily increasing [1-2].

The quality of feldspar raw materials is primarily determined by their chemical composition, mineralogical characteristics, and impurity content. In particular, iron-bearing minerals, titanium compounds, and excessive quartz negatively affect the optical and technological properties of glass products. Therefore, preliminary beneficiation and purification of feldspar ores are considered essential stages before their industrial application [3-4].

Various beneficiation methods, including flotation, magnetic separation, and electrostatic separation, are widely used in international practice to improve the quality of feldspar concentrates. Among them, dry beneficiation technologies are of particular interest due to their lower water consumption, environmental advantages, and economic efficiency, especially in arid regions where water resources are limited [5-6].

The Sultan Uvays deposit, located in the Republic of Karakalpakstan, represents a promising source of feldspar raw materials for the domestic glass and ceramic industries of Uzbekistan. However, the mineralogical composition and technological suitability of this deposit have not been sufficiently studied. Therefore, the present research aims to investigate the chemical–mineralogical properties of feldspar from the Sultan Uvays deposit and to develop an effective dry beneficiation technology for obtaining high-quality concentrate.

LITERATURE REVIEW

Uzbekistan, particularly the Lower Amu Darya basin, represents a highly promising region in this regard. The Sultan Uvays mountain massif, located within the territories of the Khorezm region and the Republic of Karakalpakstan, hosts significant deposits of potassium–sodium feldspar. However, these resources remain insufficiently studied and are still considered underexplored [3]. Although local industry partially utilizes this raw material, systematic scientific data on its mineralogical composition and beneficiation characteristics remain limited in the available literature.

The main challenge lies in the fact that feldspar rarely occurs in a sufficiently pure form suitable for direct industrial application. It must be purified from associated minerals, primarily free quartz and iron oxides. An increased content of iron oxides ($\text{Fe}_2\text{O}_3 + \text{FeO}$) leads to coloration defects in glass and enamel products and reduces their transparency [4]. Therefore, beneficiation has become an essential stage in the technological processing chain.

Two principal approaches are employed for raw material beneficiation: wet processing (flotation) and dry processing (magnetic and electrostatic separation). Although flotation ensures a high degree of purity, it is associated with significant water consumption, high reagent costs, and environmental challenges related to wastewater treatment [5]. In contrast, dry beneficiation technologies generate less waste, simplify the process, and significantly reduce production costs [6].

Previous international studies have shown that magnetic separation is particularly effective for removing iron-bearing minerals such as biotite, magnetite, and hematite, while electrostatic separation allows efficient differentiation between feldspar and quartz based on their surface electrical conductivity [7-8]. The combination of these methods makes it possible to obtain concentrates with improved chemical purity suitable for ceramic and glass applications.

Researchers have also emphasized that the efficiency of beneficiation strongly depends on particle size distribution, mineral liberation degree, and moisture content of the feed material. Proper grinding and classification prior to separation significantly improve concentrate recovery and reduce losses of valuable

feldspar fractions [9]. Therefore, optimization of pretreatment conditions is an important part of feldspar processing technology.

In Central Asia, limited scientific attention has been given to the technological assessment of feldspar deposits compared with other industrial minerals. This creates the need for detailed mineralogical and technological studies aimed at expanding the domestic raw material base and reducing dependence on imported feldspar concentrates for glass and ceramic production [10].

This study presents a comprehensive physicochemical characterization of feldspar from the Sultan Uvays deposit and demonstrates the efficiency of a dry beneficiation technology based on magnetic and electrostatic separation. The results contribute to evaluating the potential of this deposit as a reliable raw material source for the glass industry.

RESEARCH METHODOLOGY

Sampling and Sample Preparation. Samples for the study were collected from three different locations of the Sultan Uvays deposit (DSh-1, DSh-2, DSh-3). The initial samples consisted of lumps weighing 2–5 kg. Under laboratory conditions, primary crushing was performed using a jaw crusher, followed by further size reduction in cone and ball mills to obtain particle sizes in the range of 0.071–1.25 mm. Chemical analyses were carried out in accordance with the requirements of GOST 26423-86.

X-ray Diffraction Analysis (XRD). Quantitative mineralogical composition was determined using X-ray diffraction analysis. The diffraction patterns were processed using the BGMN/Profex software package based on the Rietveld refinement method. Unlike conventional qualitative approaches, this method enables precise quantitative determination of mineral phase proportions [7].

Infrared (IR) Spectroscopy. IR spectra of the samples were recorded in the range of 400–4000 cm^{-1} using a Fourier-transform spectrometer equipped with an ATR accessory. This method allows the identification of Si–O and Al–O bonding groups in silicates, as well as the presence of hydroxyl and carbonate groups. The obtained spectra were comparatively analyzed with the XRD results for validation [8].

Scanning Electron Microscopy (SEM) and Elemental Analysis. The morphology and microstructure of the samples were studied using scanning electron microscopy. Quantitative elemental composition was determined by energy-dispersive X-ray spectroscopy (EDX). The analysis focused on the major elements: Si, Al, K, Na, Fe, and Ca.

Differential Thermogravimetric Analysis (DTG). Thermal properties of the samples were investigated using differential thermal and thermogravimetric analysis. The heating rate was set at 10 $^{\circ}\text{C}/\text{min}$, with the temperature increasing from 20 $^{\circ}\text{C}$ to 1000 $^{\circ}\text{C}$. The results revealed the relationship between temperature and endothermic as well as exothermic effects.

Thermal Treatment Experiments. Samples were subjected to thermal treatment in an electric furnace within the temperature range of 900–1300 $^{\circ}\text{C}$ for 30 minutes. After each temperature stage, changes in crystalline phases were monitored using X-ray diffraction and IR spectroscopy.

Dry Beneficiation Technology. The beneficiation process was carried out in four sequential stages. The first three stages involved magnetic separation at different magnetic field intensities ($H = 80\text{--}100, 1000\text{--}1100,$ and 1300 kA/m) to remove magnetically susceptible minerals. In the fourth stage, electrostatic separation was applied to remove free quartz. This process utilizes the dielectric properties of quartz, characterized by a high electrical resistivity ($10^{16}\text{--}10^{21} \Omega\cdot\text{m}$).

ANALYSIS AND RESULTS

Chemical Composition. In industrial glass production based on feldspar from the Sultan Uvays deposit, particular attention is given to the granulometric composition of the raw material and its compliance with established state standards. This is because the particle size distribution of the batch components significantly influences their mixing behavior, as well as the efficiency of silicate and glass formation processes. For this purpose, three representative samples were selected from the deposit and subjected to chemical analysis (Table 1).



Table 1

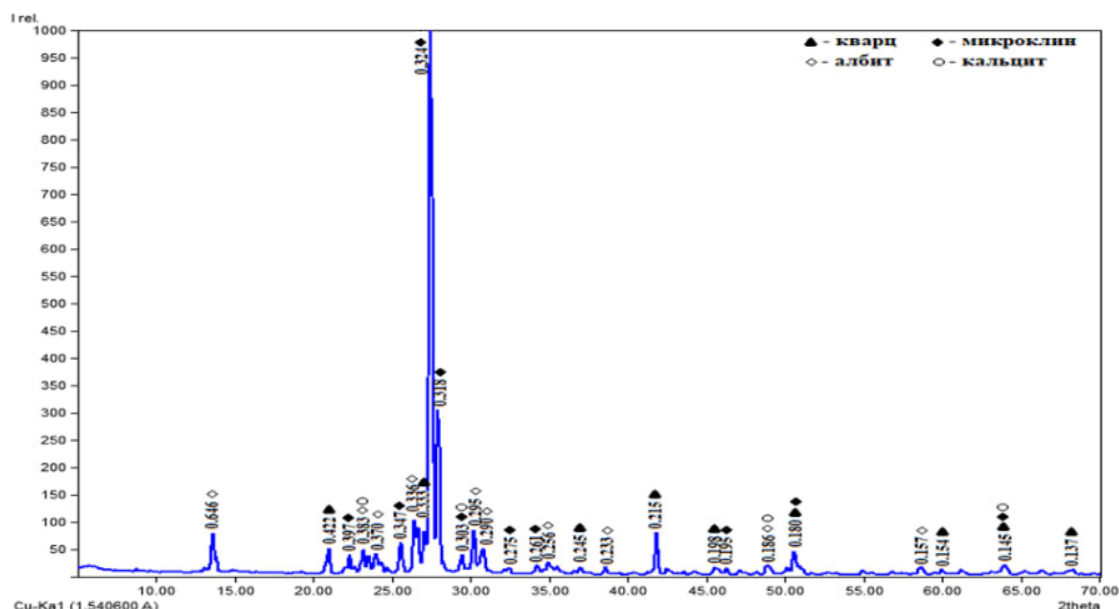
Chemical composition of feldspar samples from the Sultan Uvays deposit (wt. %)¹

Samples	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	K ₂ O	Na ₂ O	TiO ₂	P ₂ O ₅	LOI
DSh-1	68,66	16,53	0,30	0,57	0,31	10,00	2,93	0,04	0,14	0,52
DSh-2	68,16	17,15	0,27	0,53	0,31	9,98	2,88	0,05	0,16	0,51
DSh-3	68,45	16,75	0,31	0,56	0,29	9,96	2,95	0,06	0,16	0,51
Average	68,44	16,81	0,29	0,55	0,30	9,98	2,92	0,05	0,15	0,51

All three samples exhibited similar compositions, with no significant deviations observed. This indicates a relatively homogeneous mineralogical nature of the deposit.

The average SiO₂ content was 68.44 wt.%, which is typical for feldspar materials. The K₂O content of 9.98 wt.% suggests that the sample is potassium-rich and predominantly belongs to the microcline type of feldspar. The Fe₂O₃ content of 0.29 wt.% is slightly higher than the standard requirements, indicating the necessity for beneficiation. The Na₂O content of 2.92 wt.% confirms the presence of an albite fraction [9].

Mineralogical Composition (XRD Results). Processing of the X-ray diffraction patterns using the BGMN/Profex Rietveld refinement method revealed that the sample consists of the following mineral phases: microcline (60–65%), albite (21–25%), quartz (7–10%), and calcite (2–3%). In the initial diffraction pattern, the most intense diffraction peak ($d = 0.324$ nm) corresponds to the microcline mineral phase. Diffraction maxima associated with albite were observed at interplanar spacings of 0.646, 0.370, and 0.336 nm (Figure 1).

Figure 1. X-ray diffraction pattern of the feldspar sample from the Sultan Uvays deposit²

As can be seen from the mineralogical composition, the sample is predominantly composed of potassium–sodium feldspar with the general formula (K,Na)AlSi₃O₈. Although the calcite content is relatively low, its removal during the beneficiation stage is essential. From a thermal standpoint, calcite decomposes at approximately 791 °C with the release of CO₂, which may lead to the formation of gas-related defects during the firing process [10].

IR Spectroscopy Results. The IR spectrum of the sample exhibited characteristic absorption bands typical of natural aluminosilicate minerals (Figure 2).

The analysis revealed absorption bands at 443, 717, 726, 770, 996, and 1131 cm⁻¹, which correspond to Si–O vibrational modes characteristic of quartz. Vibrations observed in the regions of 416, 466, 535, 579, and 647 cm⁻¹ are typical for potassium–sodium feldspar and are associated with K–O and Na–O bonding groups (Figure 2).

¹ author's development² author's development

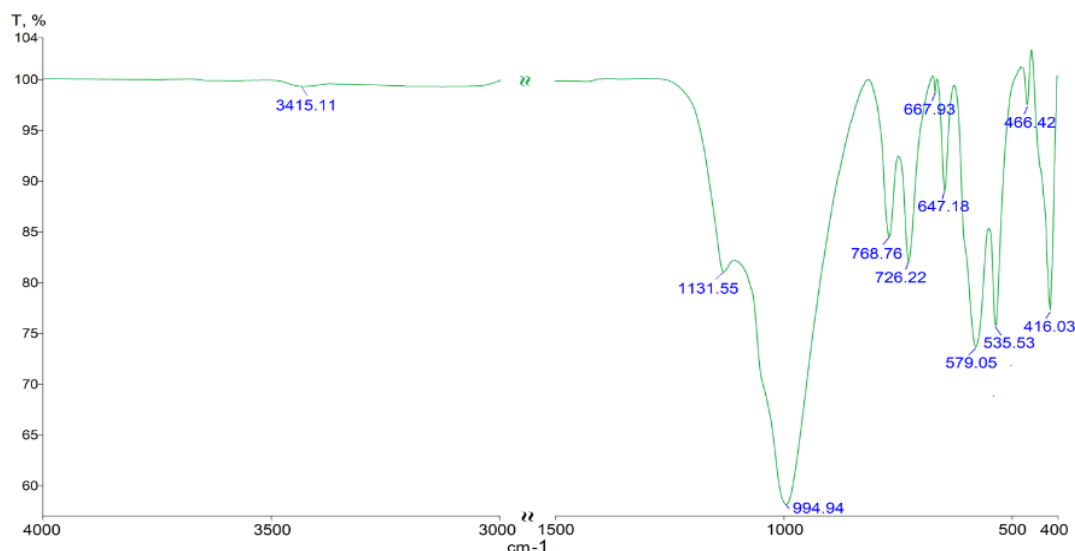


Figure 2. IR spectrum of feldspar from the Sultan Uvays deposit³

The absorption band at 3415 cm⁻¹ corresponds to the stretching vibrations of hydroxyl (–OH) groups, indicating the presence of structurally bound water. The IR spectroscopy results fully confirm the conclusions obtained from the X-ray diffraction analysis [11].

SEM and Elemental Analysis Results. To further validate the above findings, scanning electron microscopy (SEM) coupled with elemental analysis was performed. The quantitative distribution of the major elements in the sample was determined as follows (wt.%): Si – 31.98; Al – 8.89; K – 8.32; Na – 2.16, while other elements constitute the remaining fraction (Figure 3).

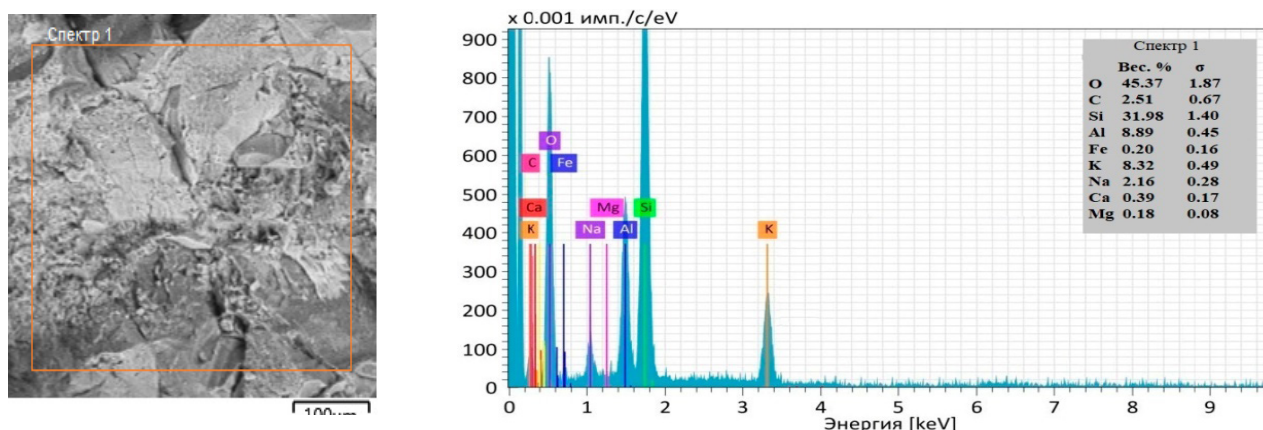


Figure 3. SEM image and corresponding spectrum of feldspar from the Sultan Uvays deposit⁴

These results are in good agreement with the chemical analysis data. The particle morphology is characterized by angular and irregular shapes, indicating that the particles were formed through mechanical crushing. SEM images also revealed the coexistence of different mineral phases within the same particles, which highlights the necessity of their separation through further mechanical processing and beneficiation.

Thermal Analysis Results. The DTG curve exhibited three endothermic and two exothermic effects. The endothermic effects observed at 96 °C and 281 °C correspond to the evaporation of hygroscopic and constitutionally bound water, respectively. The endothermic peak at 791 °C reflects the decomposition of calcite according to the reaction:



The exothermic effects were observed at 562 °C, associated with the phase transformation of β-quartz to α-quartz, and at 843 °C, corresponding to the partial decomposition of microcline and the formation of new crystalline phases [12].

X-ray diffraction analysis of the sample subjected to thermal treatment at 900 °C showed a decrease in the intensity of

³ author's development

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diffraction peaks corresponding to albite and microcline, while the peaks associated with calcite disappeared completely. At 1300 °C, the sample was observed to have largely transformed into a glassy phase. The diffraction pattern exhibited a dominant peak ($d = 0.336$ nm) corresponding to the anorthite mineral phase.

These results confirm the high-temperature mechanisms of glass phase formation [13] (Figure 4).

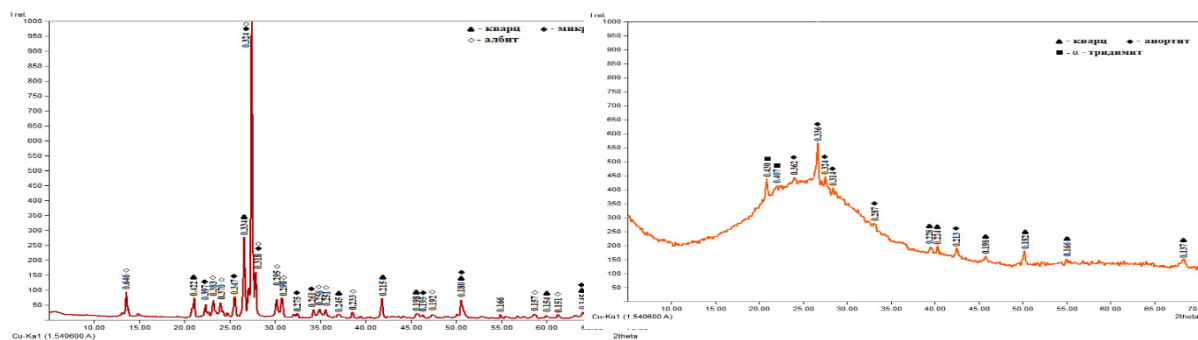


Figure 4. X-ray diffraction patterns of feldspar samples from the Sultan Uvays deposit after thermal treatment at 900 °C and 1300 °C⁵

Physico-Mechanical Properties of Minerals in Feldspar. The selection of an appropriate beneficiation method is largely determined by the differences in the physico-mechanical properties of the constituent minerals. These properties play a decisive role in the separation efficiency (Table 2).

Table 2

Physico-mechanical properties of minerals in feldspar from the Sultan Uvays deposit⁶

Mineral Name	Hardness (Mohs)	Density, g/cm ³	Compressive Strength, MPa	Water Absorption, wt. %
Quartz	7	2.65	250–400	0.1–0.2
Microcline	6	2.54–2.57	100–150	0.2–0.3
Albite	6	2.61–2.63	100–150	0.2–0.3
Calcite	3	2.71	100–150	0.8–0.9

As shown in Table 2, quartz (Mohs hardness = 7) is significantly harder than feldspar (Mohs hardness = 6). Calcite, on the other hand, is the softest mineral (Mohs hardness = 3) and exhibits the highest water absorption capacity (0.8–0.9%).

These differences result in non-uniform fragmentation of minerals during the crushing process, which facilitates selective separation during beneficiation [14].

Results of Dry Beneficiation. The beneficiation process was carried out for particles in the size range of 0.071–1.25 mm. As a result of the four-stage process, the minerals were separated as follows:

First stage ($H = 80$ – 100 kA/m): strongly magnetic minerals, such as magnetite, were removed.

Second stage ($H = 1000$ – 1100 kA/m): weakly magnetic minerals, including hematite, biotite, and muscovite, were separated.

Third stage ($H = 1300$ kA/m): minerals such as muscovite, tourmaline, epidote, and iron-bearing feldspars were primarily removed at this stage.

Fourth stage (electrostatic separation): free quartz was separated from the non-magnetic fraction based on its dielectric properties (Table 3).

Table 3

Chemical composition of separated and beneficiated samples after processing (wt.%)⁷

Mineral Phase	Yield, wt. %	SiO ₂	Al ₂ O ₃	K ₂ O	Na ₂ O	Fe ₂ O ₃ + FeO
Mica	2.82	48.65	20.10	11.35	4.65	0.10
Quartz	18.40	94.60	2.03	1.56	1.39	0.02
Feldspar	70.23	74.60	13.64	9.01	1.08	0.01
Tailings	8.55	38.40	20.45	12.23	3.96	4.56

⁵ author's development

⁶ author's development

⁷ author's development

As shown in Table 3, the feldspar fraction accounts for 70.23% of the total mass. As a result of beneficiation, the SiO_2 content increased from 68.44 wt.% to 74.60 wt.%, while Al_2O_3 decreased from 16.81 wt.% to 13.64 wt.%.

Most importantly, the total iron content ($\text{Fe}_2\text{O}_3 + \text{FeO}$) decreased from 0.29 wt.% to 0.01 wt.%, representing a 29-fold reduction. This result fully meets the color and transparency requirements of the glass industry. The waste fraction constituted only 8.55 wt.%, which is significantly lower than that typically observed in flotation-based beneficiation processes [15].

Description of the Technological Scheme. Based on the obtained experimental results, the following sequential technological scheme is proposed for the dry beneficiation of feldspar from the Sultan Uvays deposit (Figure 5).

Initially, raw material with a particle size of +300 mm is fed through a receiving hopper into a jaw crusher and screened using a grizzly screen. The +25 mm fraction is returned for re-crushing.

The fine fraction is dried in a rotary drum dryer to a moisture content of 0.5%. The dried material is then ground in a cone inertial crusher to a particle size of –1.25 mm. In the next stage, a magnetic separator removes iron-bearing minerals. The beneficiated product is further ground in a vibration mill and classified in an air separator. At this stage, free quartz is separated from the fine fraction using an electrostatic separator based on its dielectric properties. The final feldspar concentrate is collected in a pulse collector and transferred to the product storage bunker [16] (Figure 5).

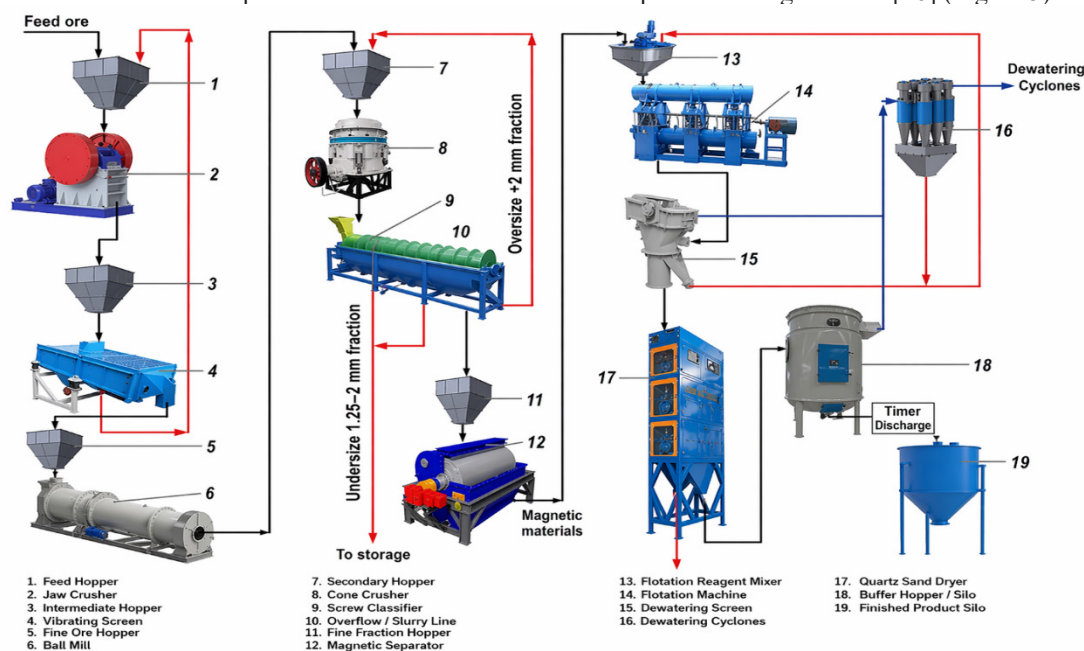


Figure 5. Processing flowsheet of Sultan Uvays feldspar ore⁸

CONCLUSION AND RECOMMENDATIONS

Based on the comprehensive investigations conducted, the following conclusions can be drawn. Feldspar from the Sultan Uvays deposit consists mainly of microcline (60–65%), albite (21–25%), quartz (7–10%), and calcite (2–3%), with an average chemical composition of SiO_2 – 68.44 wt.%, Al_2O_3 – 16.81 wt.%, K_2O – 9.98 wt.%, Na_2O – 2.92 wt.%, and Fe_2O_3 – 0.29 wt.%. These values fall within the acceptable limits defined by GOST 22557-2019.

The results of IR spectroscopy, SEM–EDX, and DTG analyses independently confirmed the findings of X-ray diffraction analysis. Thermal studies showed that the sample undergoes complete transformation into a glassy phase at 1300 °C, indicating its suitability as a raw material for glass and enamel production.

The four-stage dry beneficiation technology based on magnetic separation (three stages, $H = 80$ –1300 kA/m) and electrostatic separation reduced the $\text{Fe}_2\text{O}_3 + \text{FeO}$ content from 0.29 wt.% to 0.01 wt.%, while increasing the SiO_2 content to 74.60 wt.%. The waste fraction was limited to 8.55 wt.%, demonstrating a significant advantage over flotation methods.

The proposed dry beneficiation technology does not require water or chemical reagents, features a simple process flow, and is easy to control. These advantages make it both environmentally and economically favorable, particularly under Central Asian conditions where water conservation is critically important. Future work will focus on pilot-scale testing of the proposed technology, followed by the design of a full-scale industrial processing line. Additionally, it is planned to evaluate the potential use of the separated quartz fraction (SiO_2 – 94.60 wt.%) as an alternative to conventional quartz sand.



REFERENCES

1. Hafner, S. The crystal chemistry of the common rock-forming silicates. // *Mineralogical Magazine*. – 2019. – Vol. 83, No. 4. – P. 571–589.
2. Andreev, A.V., Kostychev, I.A. Ispolzovaniye polevykh shpatov v steklokeramicheskoy promyshlennosti. // *Steklo i keramika*. – 2021. – No. 3. – P. 14–20.
3. Yusupov, O., Xolmatov, B. *O'zbekiston mineral resurslarining sanoatdagi o'rni*. – Toshkent: Fan, 2020. – 312 p.
4. Bolen, W.P. *Feldspar and nepheline syenite: USGS Minerals Yearbook*. – Washington: USGS, 2022. – P. 26.1–26.5.
5. Wills, B.A., Finch, J.A. *Wills' Mineral Processing Technology*. 8th ed. – Oxford: Butterworth-Heinemann, 2016. – 512 p.
6. Ferreira, O.P., Alves, O.L. Dry magnetic separation of feldspar from quartz: effects of particle size and field intensity. // *Minerals Engineering*. – 2018. – Vol. 121. – P. 155–162.
7. Döbelin, N., Kleeberg, R. Profex: a graphical user interface for the Rietveld refinement program BGMN. // *Journal of Applied Crystallography*. – 2015. – Vol. 48. – P. 1573–1580.
8. Buranova, D.B. Main characteristics of quartz-feldspar sands from the Khiva deposit, and the physico-chemical and technological fundamentals of obtaining an enriched concentrate. // *Kompleksnoe Ispolzovanie Mineralnogo Syra*. – 2027. – Vol. 340, No. 1. – P. 37–44.
9. GOST 22557-2019. *Polevye shpaty dlya stekol'noy promyshlennosti*. – Moskva: Standartinform, 2019. – 18 p.
10. Redfern, S.A.T. The thermodynamics of calcite decomposition. // *Contributions to Mineralogy and Petrology*. – 2016. – Vol. 171. – P. 1–12.
11. Sitarz, M., Mozgawa, W., Handke, M. Vibrational spectra of complex ring silicate anions: method of recognition. // *Journal of Molecular Structure*. – 2017. – Vol. 1135. – P. 184–190.
12. Zhang, G., Gao, J. Thermal phase transformations in potassium feldspar studied by differential thermal analysis. // *Journal of the European Ceramic Society*. – 2020. – Vol. 40, No. 3. – P. 772–778.
13. Babayev, Z.K., Masharipova, S.M., Buranova, D.B., & Ataeva, F.A. Improving the stability of restoration inorganic wall materials in the monuments of ancient Khiva. // *Austrian Journal of Technical and Natural Sciences*. – 2021. – No. 1–2. – P. 49–53.
14. Buranova, D.B., Yunusov, M.Y., Babaev, Z.K., Kurambaev, Sh.R., & Atashev, E.A. The physico-chemical analysis of quartz sand of Khiva deposit. // *RA Journal of Applied Research*. – 2023. – Vol. 9, No. 10. – P. 506–509.
15. Dunham, S., Komar, D. Flotation reagent consumption and waste production in silicate mineral processing. // *Minerals*. – 2020. – Vol. 10, No. 7. – P. 621.
16. Karimov, N.X., Toshmatov, E.N. Quruq boyitish texnologiyalari va ularning sanoatda qo'llanilishi. // *O'zbek kimyo jurnali*. – 2022. – No. 2. – P. 44–52.

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