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THE ELEMENTS AND OXIDE CONTENT OF THE CHEMICAL COMPOSITION OF THE FELDSPAR

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Abstract: In this article, the results of purifying feldspar from foreign compounds in its composition through the study of its chemical composition are described through the quantitative indicators of oxides and elements in the analysis of its chemical composition. Based on the obtained results, the mineralogical analysis of feldspar was studied, and it was substantiated that the purity level of silicon dioxide is higher in value compared to other elements.

Keywords: feldspar, HCl, SiO_2, dispersity, neutralization, grinding, oxide content, chemical composition.

Introduction. Feldspar contains a group of several minerals and is one of the most widespread silicate minerals in the Earth's crust. They are mainly found in magmatic, metamorphic, and sedimentary rocks, and are considered one of the important raw materials used in various industrial production sectors. Based on the chemical composition analysis of feldspar, it belongs to a group of silicate minerals primarily composed of silicon and aluminum oxides. The main minerals that form rocks, such as feldspar, are the primary minerals that make up the Earth's crust. Additionally, there are various types of feldspar, such as orthoclase, plagioclase, and fluorite. In the chemical composition of feldspar, the main elements found in the literature are aluminum, silicon, oxygen, and depending on the type, potassium, sodium, or calcium. For example, orthoclase has the formula $KAlSi_3O_8$, albite $NaAlSi_3O_8$, and anorthite $CaAl_2Si_2O_8$. Mineralogically, they belong to the silicates, specifically the tectosilicates class [1-3].

Feldspar is composed of quartz, pyroxene, mica, amphibole, clay, olivine, and other minerals (Figure 1). Its total composition is higher than that of quartz (silicon dioxide), and it accounts for about 50% of the total mass of the Earth's crust [4-6].

It is important to study the mineralogical composition of feldspar by studying its chemical composition and isolating important compounds in its composition through chemical activation.

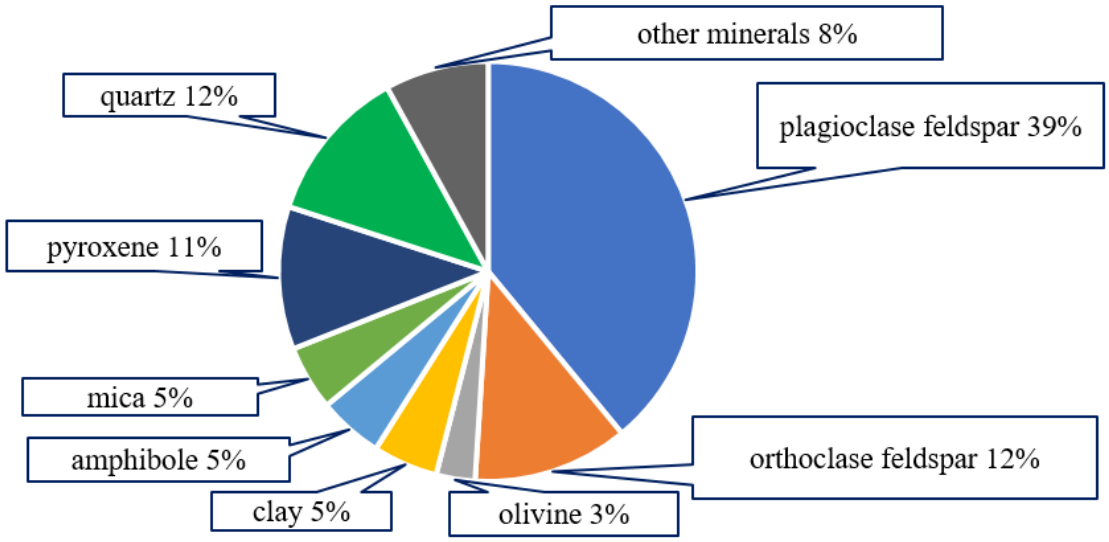
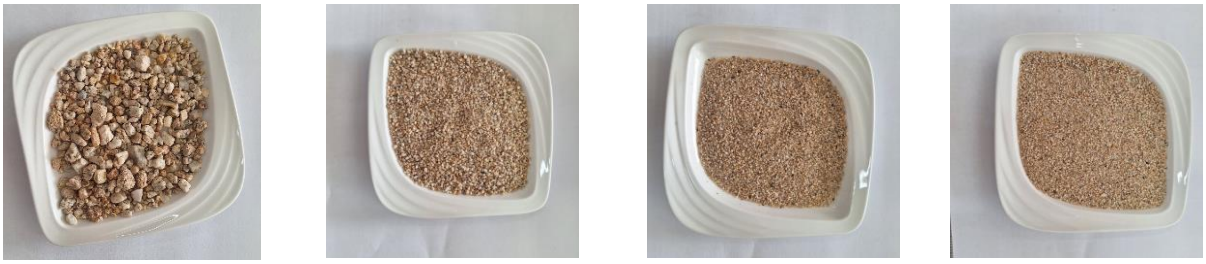


Figure 1. Mineralogical composition of feldspar

Research and results. In the study of the chemical composition of feldspar, the amount of elements and oxides was studied. In this case, a process of purification of mixed compounds in feldspar with different dispersions of different sizes was carried out, namely, it was separated into dispersions of a) 5.00 mm, b) 2.5 mm, c) 1.25 mm, d) 0.63 mm, and the crushed samples were also passed through the same sizes (Figure 2).



a) 5.00 mm b) 2.5 mm c) 1.25 mm d) 0.63 mm

Figure 2. Dispersion indices of feldspar at different sizes

The purified feldspar (VEB – 4600 Wittenberg BT brand) was ground in a ball mill. The feldspar was ground in various sizes according to the samples shown in Figure 2 and passed through sieves with a dispersion of 5.00 ÷0.63 mm. The samples were cleaned of impurities and ground in a ball mill to a particle size of d-0.071 mm, and then studies were conducted using samples with a particle size of 0.071 mm, selected for acid activation using chemical reagents. A solution of 20 g (32%) HCl was prepared for 100 g of the separated feldspar sample. The purpose of washing the samples in HCl is to increase the silicon content of the feldspar by purifying it from various impurities. According to the selected ratio, 100 g of 32% HCl was added to 500 g of feldspar, distilled water was added until it reached the mass of the casting, and the mixture was placed in a muffle furnace until boiling at a temperature of +50°C to +200°C. The boiling process of the sample was continued for 30 minutes to 1 hour from the time of boiling.

The initial sample turned into a thick mass in 30 minutes. After boiling the mass for a total of 1 hour, it was washed with distilled water until the acid content was no longer present and filtered using a vacuum pump. The filtered mass was dried in a drying oven (ShS-80-01 SPU) at a temperature of 105-110°C. During the study, the chemical composition of the first 20 samples was analyzed and conditionally designated by numbers. The chemical composition of the samples was determined in terms of percentage (mass%) of dry matter and the results of the chemical composition are presented in Tables 1-2.

Table 1. Initial feldspar % dry matter analysis result

№	Sample number	Oxide composition, %						
		SiO_2	Fe_2O_3	FeO	TiO_2	MnO	Al_2O_3	CaO
1	**№1**	77,42	2,38	2,16	0,080	0,024	8,50	1,96
2	**№2**	77,20	2,70	2,43	0,10	0,028	8,50	2,24
3	**№3**	77,54	2,46	2,05	0,080	0,032	7,08	2,24
4	**№4**	77,84	2,54	2,09	0,10	0,032	8,03	2,52
5	**№5**	76,82	1,84	1,73	0,040	0,060	10,12	1,96
6	**№6**	76,12	1,71	1,30	0,040	0,028	12,12	1,12
7	**№7**	74,74	1,75	1,69	0,060	0,030	14,17	1,17
8	**№8**	76,46	1,91	1,66	0,060	0,028	13,12	1,12
9	**№9**	77,02	1,91	1,62	0,10	0,032	13,17	1,12
10	**№10**	76,68	1,83	1,43	0,080	0,040	12,12	0,84
№	**Sample number**	**Oxide composition, %**						
		MgO	K_2O	Na_2O	П.П.П	CO_2	S umum.	P_2O_5
1	**№1**	0,80	6,66	2,70	1,37	0,84	0,020	0,09
2	**№2**	0,20	6,05	2,70	1,07	1,06	0,030	0,11
3	**№3**	<0,5	8,25	2,70	1,04	0,88	0,039	0,11
4	**№4**	0,60	6,93	2,63	1,23	0,84	0,060	0,12
5	**№5**	<0,5	6,68	2,08	1,68	1,01	0,016	0,13
6	**№6**	<0,5	5,45	2,30	1,32	1,54	0,040	0,11
7	**№7**	<0,5	5,81	2,23	1,32	1,28	0,030	0,11
8	**№8**	0,40	5,69	1,96	1,19	1,10	0,010	0,12
9	**№9**	<0,5	5,32	1,86	1,48	0,93	0,030	0,11
10	**№10**	0,20	6,35	2,30	1,80	1,15	0,040	0,11

Table 2. Initial feldspar % dry matter analysis result

No.	Sample number	Oxide composition, %						
		SiO_2	Fe_2O_3	FeO	TiO_2	MnO	Al_2O_3	CaO
1	№11	76,56	2,16	1,66	0,14	0,030	13,92	1,12
2	№12	76,18	2,16	1,58	0,20	0,030	13,40	1,40
3	№13	76,98	2,38	1,62	0,050	0,024	11,12	1,12
4	№14	77,36	1,98	1,58	0,12	0,040	12,10	1,12
5	№15	76,46	2,78	1,51	0,14	0,032	9,45	1,96
6	№16	73,88	1,43	1,00	0,12	0,040	14,65	2,52
7	№17	77,56	2,27	1,80	0,12	0,032	8,97	1,40
8	№18	77,78	1,75	1,43	0,30	0,028	9,45	1,68

9	№19	72,14	1,83	1,15	0,12	0,028	6,62	1,68
10	№20	80,56	1,98	1,50	0,36	0,024	11,00	0,84
No.	**Sample number**	**Oxide composition, %**						
		MgO	K_2O	Na_2O	П.П.П	CO_2	S umum.	P_2O_5
1	№11	<0,5	4,66	1,49	1,90	1,23	0,030	0,11
2	№12	<0,5	5,45	1,55	1,69	1,01	0,030	0,11
3	№13	<0,5	5,45	1,96	1,86	1,23	0,016	0,11
4	№14	<0,5	5,32	1,86	1,70	1,06	0,040	0,11
5	№15	0,81	4,66	1,78	1,92	1,10	0,043	0,12
6	№16	<0,5	4,30	1,70	2,11	1,19	0,020	0,11
7	№17	1,41	5,45	1,96	1,37	0,88	0,020	0,11
8	№18	1,01	3,19	2,57	1,42	1,10	0,020	0,11
9	№19	0,81	2,80	1,89	1,64	0,88	0,020	0,10
10	№20	2,02	2,18	1,96	1,42	0,97	0,020	0,10

Based on the results of samples 1-10 taken from the Chiyali site, the amount of silicon dioxide (SiO_2) was determined in the following order, which reflects the trend of variation: SiO_2 №1-77,42>№2-77,20<№3-77,54<№4-77,84>№5-76,82>№6-76,12>№7-74,74>№8-76,46>№9-77,02<№10-76,68. It is clear that the highest amount is observed in sample >№-10. The largest decrease was observed from №6 → №7 (−1.38) and the largest increase was observed from №7 → №8 (+1.72). According to the results, initially the amount of silicon dioxide is observed as the values decrease, then rise again. The large value amount is explained by the indicator 77.84% on plot №4, and the small value by the indicator 74.74% on plot №7. These values were carried out in the range of 0.1 to 3.0%. For example, the amount of silicon dioxide in samples №4 and №7 was 3.10%, and the amount of silicon dioxide (SiO_2) in samples from plots №11 to №20 was determined as follows: №11-76,56>№12-76,18<№13-76,98<№14-77,36>№15-76,46>№16-73,88 <№17-77,56<№18-77,78>№19-72,14<№20-80,56. The samples were determined to have high and low quantitative values ranging from 0.1 to 8.0 g. The largest change is observed in the amount of silicon dioxide in the samples taken from plot №19 and plot №20, which is 8.42%. The value of the SiO_2 content in the samples from the Chiyali site is characterized by the wider occurrence of feldspar in this area. Analysis of tables and scientific conclusions Tables 1 and 2 present quantitative analyses of oxides (SiO_2, Al_2O_3, Fe_2O_3, TiO_2 and other impurities) in feldspar. These results showed that feldspar is suitable for further research and scientific analysis. The analysis showed that the content of SiO_2 (silicon dioxide) is much higher than other components, which provides complete information about the overall chemical quality of the sample. It was also noted that the quantitative indicators of Al_2O_3 and K_2O are also high.

In the chemical analyses of the samples, it was found that the main component in the feldspar composition was the presence of a large amount of SiO_2 oxide, which was distinguished among other samples by its high content. In order to remove excess salts and metal compounds in the composition, chemical treatment was carried out using HCl, and the oxide composition of the samples obtained is presented in Table 3.

Table 3. Quantitative indicators of oxides and elements in feldspar

№	Oxides	Amount%	Elements	Amount%	Unit
1	Cl	0.0187	Cl	0.0208	mass%
2	Na_2O	3.28	Na	2.99	mass%
3	Al_2O_3	13.9	Al	8.07	mass%
4	SiO_2	75.6	Si	38.8	mass%
5	SO_3	0.0296	S	0.0118	mass%
6	K_2O	5.90	K	5.36	mass%
7	CaO	0.584	Ca	0.460	mass%
8	TiO_2	0.102	Ti	0.0682	mass%
9	V_2O_5	(0.0056)	V	0.0032	mass%
10	MnO	0.0090	Mn	0.0073	mass%
11	Fe_2O_3	0.125	Fe	0.103	mass%
12	Co_2O_3	(0.0014)	Co	(0.0015)	mass%
13	NiO	0.0009	Ni	0.0011	mass%
14	CuO	(0.0008)	Cu	0.0009	mass%
15	ZnO	0.0008	Zn	0.0008	mass%
16	Ga_2O_3	0.0013	Ga	0.0014	mass%
17	Rb_2O	0.0285	Rb	0.0287	mass%
18	SrO	0.0140	Sr	0.0128	mass%
19	Y_2O_3	0.0009	Y	0.0010	mass%
20	ZrO_2	0.134	Zr	0.110	mass%
21	SnO_2	0.0018	Sn	0.0015	mass%
22	TeO_2	(0.0007)	Te	(0.0006)	mass%
23	BaO	0.0529	Ba	0.0497	mass%
24	HfO_2	(0.0017)	Hf	0.0016	mass%
25	Ta_2O_5	0.0034	Ta	0.0019	mass%
26	ReO_2	0.0013	Re	0.0012	mass%
27	Ir_2O_3	(0.0010)	Ir	(0.0007)	mass%
28	Tl_2O_3	0.0009	Tl	0.0008	mass%
29	PbO	0.0041	Pb	0.0049	mass%
30	Dy_2O_3	0.0057	Dy	0.0057	mass%
31	U_3O_8	0.0017	U	(0.0005)	mass%

Based on the analysis results, it was determined that the results of the increase in silicon dioxide occur in accordance with the following sequence, namely: SiO_2 – 75.6% > Al_2O_3 – 13.9% > K_2O - 5.90% > Na_2O – 3.28% > CaO – 0.584% > ZrO_2 – 0.134% > Fe_2O_3 – 0.125% > TiO_2 – 0.102%. The content of silicon dioxide is SiO=75.6%, and the highest value indicates that it is effective as a result of treatment with hydrochloric acid, that is, it confirms that the amount of silicon dioxide, which is the main component in the composition of feldspar, is high due to chemical reactions.. Of the remaining compounds in the composition of feldspar, Al_2O_3 was found to be present in an amount of 13.9%, and this component is also considered important. Rare oxides (e.g. TiO_2, MnO, Fe_2O_3) were recorded in relatively low amounts. The results obtained in spectral form are presented in figure 3.

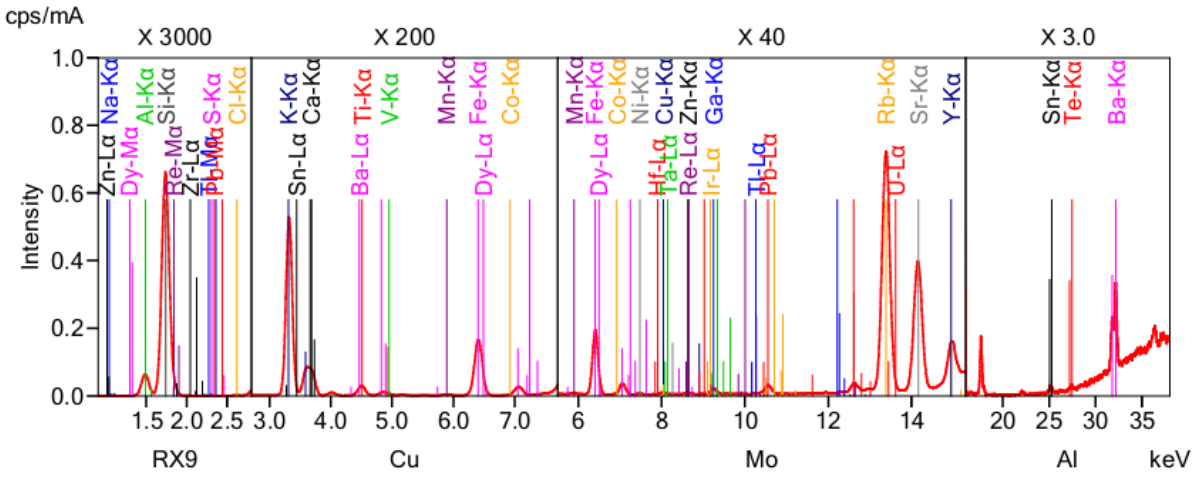


Figure 3. Quantitative indicators of oxides in the composition of a selected sample of feldspar

Based on the quantitative analysis of the oxides, the amount of elements in the feldspar was determined by washing and neutralizing it in HCl. The results are presented in Table 3 below.

Based on experimental analyses, it was determined that the quantitative indicators of the elements in the composition of feldspar, corresponding to the amount of oxides, are in the following order:Si – 38.8% > Al - 8.07% > K - 5.36% > Na - 2.99% > Ca - 0.460% > Zr - 0.110% > Fe - 0.103% was found to be the most common. Among the elements found in small amounts, the presence of Cl, Ti, Mn, Fe, and Zr was determined, as well as the presence of relatively rare elements (e.g., U, Co, Ir) in mass%. The results are presented in Figure 4, which shows the quantitative composition of the elements in spectral form and the obtained analysis results in a diagram.

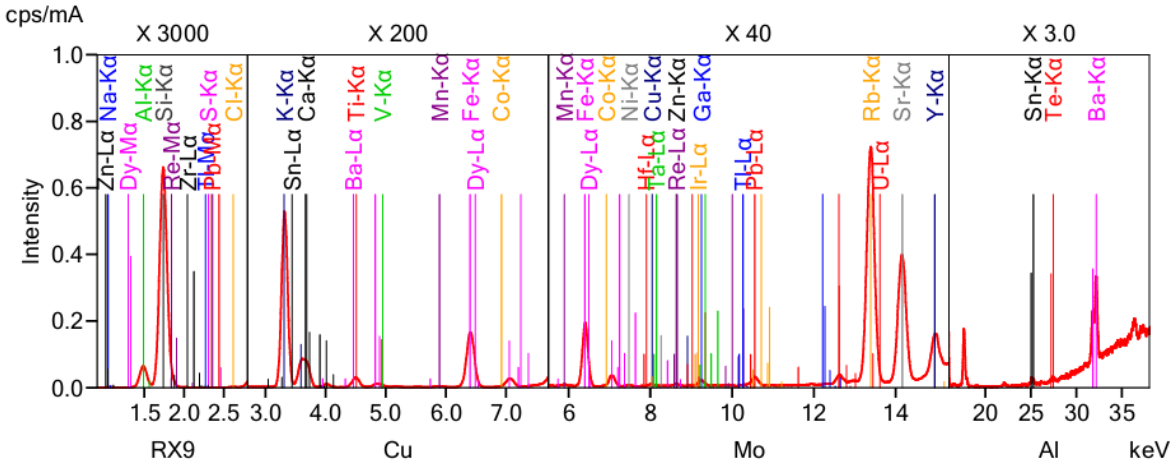


Figure 4. Quantitative indicators of elements in feldspar

The main component of feldspar is SiO_2, and the results obtained from the analysis of its chemical composition confirm the scientific conclusions that the amount of silicon

dioxide in feldspar was increased by removing excess aggregates (such as salts and carbonates, iron oxides) by reacting with hydrochloric acid.

Conclusion. Thus, feldspar was activated in HCl by acid treatment based on the selected compatibility, washed in distilled water until no acid remained in the mass, and the amount of oxides and elements present in its composition was determined. According to the analysis results: SiO_2 – 75.6% > Al_2O_3 – 13.9% > K_2O - 5.90% > Na_2O – 3.28% > CaO – 0.584% > ZrO_2 – 0.134% > Fe_2O_3 – 0.125% > TiO_2 – 0.102% It was found that the content of SiO_2 and Al_2O_3 in the feldspar content of oxides was the highest, while the other oxides were significantly lower. After oxidation, washing and neutralizing in HCl revealed that the most common elements in the feldspar content were Si – 38.8% > Al - 8.07%>K - 5.36%>Na - 2.99%>Ca - 0.460%> Zr - 0.110% > Fe - 0.103%.

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PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY

GROWING, STORAGE, PROCESSING AND AGRICULTURAL PRODUCTS AND FOOD TECHNOLOGIES

CHEMICAL TECHNOLOGIES