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PHYSICO-CHEMICAL STUDIES OF DIABASES OF KARAKALPAKSTAN IN THE PRODUCTION OF SILICATE CONSTRUCTION MATERIALS

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Abstract
The article presents the results of experimental studies of diabases from the Keklitau and Sheikhzheli deposits of Karakalpakstan using chemical-mineralogical, X-ray diffraction, analyses. The results of physico-chemical analysis confirmed that diabase from the Keklitau deposit in Karakalpakstan can be used instead of the feldspar component to develop the composition of ceramic products as a grog agent, depending on the final temperature of the fired material.

Keywords Ceramics, magmatic rock, diabase, physical and mechanical properties, chemical analysis, X-ray diffraction, mineral, melting point, sintering.

INTRODUCTION

Currently, it is very relevant to involve local raw materials in ceramic production, in particular in Karakalpakstan, instead of those imported or imported from distant regions of the Republic in order to more fully use the raw materials of developed deposits, as well as the development of waste-free technologies for producing ceramic materials for construction purposes [1, 2].

It is known that in order to improve the quality of ceramic materials and provide them with high performance characteristics, it is necessary to solve problems associated with the development of the most effective methods for intensifying the sintering process of raw material compositions. From the literature it is known about the possibility of practical use of rocks of magmatic origin in ceramic raw materials masses to intensify the sintering process when producing ceramic products with high physical and mechanical properties. It has also been established that at a temperature range of 1160–1230℃, these rocks form a ceramic material with a practically low water absorption rate [3, 4].

Magmatic rocks are products of solidification of fiery liquid silicate melts (magma), entering the upper floors of the lithosphere or into its surface from the deepest parts of the earth. Magmatic rocks, in the form of diabases, gabbrodiabases and porphyrites diabases, are the most common rocks. Diabase is an effusive rock of volcanic origin, formed in the form of lavas. They are usually dark gray, black or greenish-black rocks with a glassy or porphyritic texture. In terms of mineralogical composition, the bulk of the diabase is composed of microlites, clinopyroxene, magnetite or titanomagnetite, as well as volcanic glass, olivine, clinopyroxene, plagioclase, and rarely orthopyroxene or hornblende . The most common mineral in diabase a is apatite [5]. This rock is used as a raw material for crushed stone, the production of diabase fiber, stone casting and acid-resistant powder, as well as a filler for concrete and other various industries in the production of building materials [6].

The purpose of this study is to assess the possibility of using diabase rocks of Karakalpakstan in the production of building ceramic products for internal wall cladding , as well as to establish criteria for intensifying the processes of sintering raw material compositions.

As the initial component for conducting experimental studies, we used samples of diabase from the Keklitau and Sheikhzheli deposits of the Republic of Karakalpakstan, where there are the necessary reserves for their industrial processing.

RESEARCH METHODS AND MATERIALS

Experimental studies on the development of compositions and production technology, determination of the main characteristics of ceramic materials based on clayey and diabase rocks were carried out using modern as well as generally accepted classical methods of physical and chemical analysis and physical and mechanical testing.

In this work, chemical-analytical and X-ray diffraction analyzes were used.

The material composition of samples of diabase raw materials was determined by silicate rational chemical analysis using the accelerated method [7]. The mineralogical composition of diabase samples was determined by X-ray phase analysis, which was carried out by the powder method on an X-ray diffractometer Shimadzu LABX XRD-6100 with CuKα - radiation. Radiographs were taken in increments of 0.02, the tube current and voltage mode was 30 mA, 30 kV. Identification of mineral phases and analysis of the results was carried out using reference books and generally accepted databases ICDD PDF -2 [8].

RESULTS AND ITS DISCUSSION

The results of the analysis of the chemical composition and determination of the physical and mechanical properties of diabase samples from the Keklitau (KD) and Sheykhzheli (ShD) deposits are presented in Table 1, Table 2.

According to the analysis results presented in Table 1, it is shown that the chemical composition of the diabase samples of the Keklitau and Sheikhzheli deposits differs from other magmatic rocks of this type in the high amount of Na2O content, which corresponds to GOST 23034-78 [10] - “Feldspar and quartz-feldspar materials”

used in the raw material composition for the production of ceramic wall materials. Therefore, when using diabase rocks for ceramic materials, this circumstance should be taken into account.

Table 1

Chemical composition of diabase samples from the Keklitau and Sheikhzheli deposits

name of raw materials	Oxides content, wt. %								LOI, wt.%
	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	Na_2O	
KD -1	55.71	17.53	6.62	0.94	4.10	0.52	1.73	10.01	2.84
KD -2	54.52	17.20	6.91	0.83	3.84	0.72	2.10	10.65	3.22
KD -3	56.90	16.91	6.33	0.96	3.55	0.62	1.94	9.80	2.93
$KD_{avg.}$	55.71	17.21	6.62	0.91	3.83	0.62	1.92	10.15	3.00
ShD -1	55.07	17.14	8.18	0.53	4.58	3.68	2.34	2.34	5.62
ShD -2	56.71	17.21	7.67	0.65	4.94	3.56	2.46	2.11	4.99
ShD -3	54.82	16.84	8.01	0.49	3.95	3.05	1.99	2.00	5.28
$ShD_{avg.}$	55.53	17.06	7.95	0.56	4.49	3.43	2.26	2.15	5.31

Table 2

Physico-mechanical properties of diabase samples from the Keklitau and Sheikhzheli deposits

Name of raw materials	Porosity, %	Density, g/cm^3	Water absorption, %	Strength compression, MPa	Melting point, T ^oC	
					Start	End
Keklitau Diabase	0.68	3.02	0.11	135	1160	1205
Sheikhzheli Diabase	0.79	2.95	0.23	130	1185	1220

According to the technological properties of the studied diabases, it was established that they are rocky rocks (Table 2), having a fairly dense and durable structure, as well as low water absorption. However, in terms of the melting point value, they are significantly low-melting magmatic rocks.

The mineralogical composition of the studied samples of diabase samples from the Keklitau and Sheikhzheli deposits was determined by X-ray phase analysis, the results of which are shown in Fig. 1 and Fig. 2 respectively.

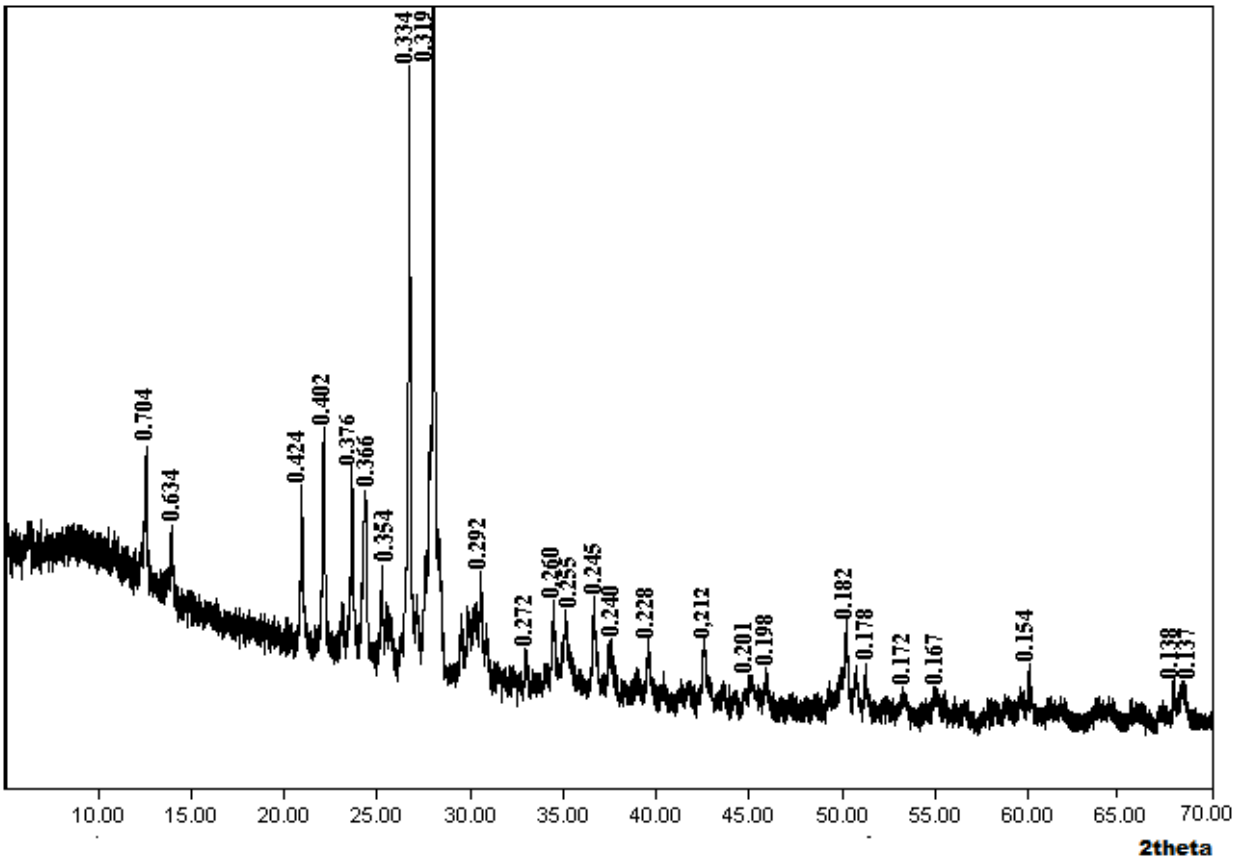

Fig.1. X-ray diffraction pattern of a sample of diabase rock from the Keklitau deposit

The X-ray diffraction patterns of the Keklitau diabase (Fig. 1) show the presence of diffraction maxima corresponding to the following minerals: quartz (d = 0.424; 0.334; 0.245; 0.228; 0.212; 0.181; 0.138; 0.137 nm), albite (d = 0.634; 0.402; 0.376; 0.366; 0.319; 0.292 ; 0.285; 0.272; nm), hematite (d = 0.366, 0.272, 0.255, 0.167 nm) and there are diffraction lines with low intensity of the chlorite mineral (d = 0.704; 0.424; 0.260 nm).

On the obtained X-ray diffraction patterns of the Sheikhzheli diabase sample (Fig. 2), the presence of diffraction maxima is also observed, corresponding to the minerals: quartz (d = 0.424; 0.333; 0.245; 0.228; 0.223; 0.212; 0.197; 0.181; 0.166; 0.153; 0.137 nm), chlorite (d = 0.713; 0.496; 0.424; 0.365; 0.352; 0.296; 0.255; 0.228; 0.197 nm), albite (d = 0.636; 0.352; 0.318; 0.310; 0.259; 0.212 nm) and a small amount of calcite (d = 0.302; 0.228; 0.223 нм).

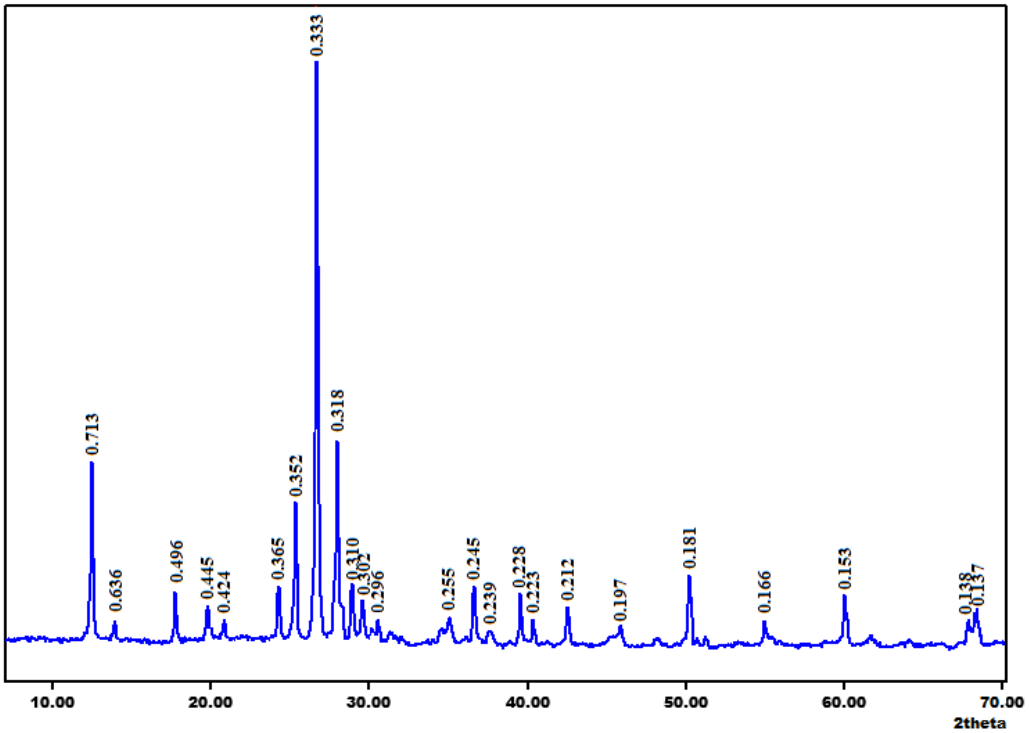

Fig.2. X-ray diffraction pattern of a sample of diabase rock from the Sheikhzheli deposit

It should be noted that the number of diffraction maxima and intensities corresponding to the minerals of albite in the Keklitaus diabase is much greater, and calcite is not observed in comparison with the Sheikhzheli diabase.

X-ray phase analysis of the studied samples of diabase samples from Karakalpakstan showed that the phase composition of these diabases consists mainly of quartz minerals, sodium and potassium-sodium feldspar, magnesium aluminum hydrosilicate and aluminosilicates, which are closer to the material composition of feldspars [10] .

The results obtained on the basis of comprehensive physicochemical studies show that in terms of chemical and mineralogical composition and content of main oxides, Keklitau diabase is similar to the composition of feldspathic minerals.

CONCLUSION

Thus, on the basis of experimental studies carried out using chemical-analytical and X-ray phase analysis methods, it has been established that basalt rocks from the Keklitau deposit in Karakalpakstan can be used instead of the feldspar component to develop the composition of ceramic products as a grog agent, depending on the final temperature of the fired material.

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