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CHEMICAL-MINERALOGICAL COMPOSITION AND PROPERTIES OF ANDESIBASALT OF THE KARAKHTAI DEPOSIT

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Abstract
The article presents the results of a comprehensive study of the chemical and mineralogical composition and properties of andesibasalt for the production of fibers. Based on the results obtained, it was determined that the chemical and mineralogical composition of andesibasalt is similar to traditional basaltic rocks and consists mainly of quartz, chlorite, albite, and calcite minerals. It has been established that the studied andesibasalt from the Karakhtai deposit is a promising raw material for the production of basalt-fiber materials for various purposes.

Keywords Magmatic rock, andesibasalt, composition, properties, melting point, X-ray phase analysis, mineralogy.

INTRODUCTION

Currently, the problem of finding ways to rationally use natural raw materials, as well as energy saving, plays an important role in modern construction and production. Saving fuel and energy resources, introducing energy-saving materials, improving the thermal protection of buildings and structures is a priority that contributes to the development and strengthening of the economic potential of the Republic. In the modern conditions of the economy of Uzbekistan, there is an increase in the production of construction and thermal insulation materials, in particular, special attention is paid to basalt-fiber materials based on high-quality magmatic rocks that meet high technical requirements. Igneous rocks are raw materials for the industrial production of basalt fiber, and are also suitable for producing various construction, thermal insulation and ceramic materials [1, 2].

In the Republic, unlike other raw materials, deposits of igneous rocks are extremely widespread and due to this they have reserves of billions of tons, and sometimes have inexhaustible reserves [3 - 5]. Based on this, the problem of developing promising rocky raw materials for the development of an effective composition of silicate materials for various purposes and their innovative production technologies is of current importance for the development of the real sector of the Republic's economy. In this regard, these problems can be solved through the development of new technologies and repurposing of existing production facilities, the development and implementation of effective import-substituting, energy- and resource-saving technologies for producing basalt fiber with high physical and mechanical properties based on local raw materials and secondary resources that will provide domestic market.

MATERIAL AND METHODS

As the initial component for conducting experimental studies, samples of andesibasalt from the Karakhtai deposit, located in the southwestern end of the Chatkal ridge in the Tashkent region, were used. The study of the chemical and mineralogical composition of the sample was carried out using classical methods of physicochemical, in particular spectral, chemical analytical, and X-ray phase studies. It is known from the literature [6, 7] that when assessing the suitability of raw materials for the production of basalt fiber, their chemical composition is first determined, as well as the values of the acidity modulus (Ma) and viscosity (Mv), which directly affect its technological properties.

To determine the material composition of andesibasalt samples, silicate rational chemical analysis was used using the accelerated method [8, 9].

The mineralogical composition of the samples was determined by X-ray phase analysis [10, 11]. X-ray phase analysis was carried out by the powder method on a Shimadzu LABX XRD-6100 X-ray diffractometer using CuKα radiation. Radiographs were taken with a step 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, an international database [12].

RESULTS AND DISCUSSION

As a result of X-ray spectral analysis of samples (Table 1) of Karakhtai andesibasalt, the presence of 19 chemical elements was determined, of which the main rock-forming elements are: silicon, aluminum, iron, magnesium, calcium and sodium, and other chemical elements in the rock are in small quantities.

Table 1

Results of X-ray spectral analysis of andesibasalt from the Karakhtai deposit

Content of chemical elements, mass %									
Si	Al	Ca	Na	K	Fe	Mg	P	Ba	Mn
25,0	8,0	2,0	5,0	0,6	6,0	5,0	0,02	0,01	0,1
Content of chemical elements, mass %									
V	Ti	Cu	Pb	Zn	Ni	Co	Li	Zr	-
0,03	0,1	0,005	0,005	0,004	0,001	0,001	0,002	0,004	-

The results of the study of the material composition of the studied andesibasalt are presented in Table 2.

Table 2

Results of chemical analysis of the studied andesibasalt

Samples	Oxide content per air-dry substance, wt.%								LOI, wt.%
	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	SO_3	
AnB-1	55.67	16.82	5.99	2.98	4.63	6.15	2.04	0.73	6.38
AnB-2	54.11	16.14	5.83	2.96	4.57	6.11	1.98	0.67	6.24
$AnB_{avg.}$	54.89	16.48	5.91	2.97	4.60	6.13	2.01	0.70	6.31

Figure 1 shows the results of X-ray phase analysis of samples of Karakhtai andesibasalt initial and after firing at a temperature of 1000 °C.

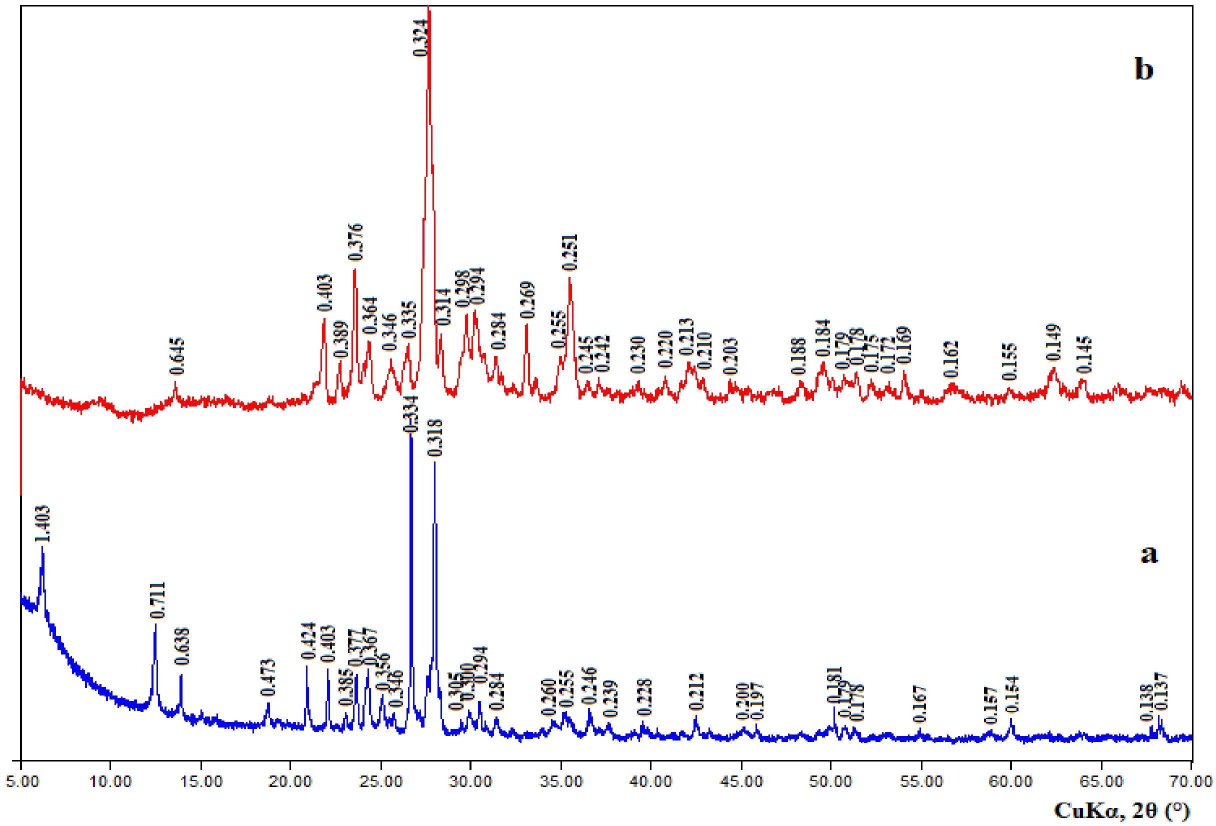

Figure 1. X-ray diffraction of Karakhtai andesibasalt:

a)initial, b)fired at 1000℃

The X-ray diffraction pattern of the Karakhtai andesibasalt (Fig. 1a) shows the presence of diffraction reflections corresponding to the minerals quartz (d = 0.424; 0.334; 0.245; 0.228; 0.223; 0.212; 0.197; 0.181; 0.167; 0.154; 0.137 nm), chlorite (d = 1.421 ; 0.586; .181; 0.167; 0.137 nm), albite (d = 0.636; 0.402; 0.385 ; 0.284; d = 0.385; 0.228; 0.181 nm).

The results of X-ray phase analysis of andesibasalt after firing at a temperature of 1000 °C (Fig. 1b) showed that the presence of diffraction reflections corresponding to the minerals hematite (d = 0.364, 0.269, 0.251, 0.230, 0.220, 0.184, 0.169, 0.145, nm), andesine (d = 0.403, 0.389, 0.376, 0.346, 0.335, 0.324, 0.314, 0.298, 0.294, 0.284, 0.245, 0.210, 0.188, 0.179, 0.178, 0.175, 72, 0.162, 0.155 nm), quartz (d = 0.335; 0.245; 0.213; 0.155 nm) and pyroxene (d = 3.35; 3.24; 0.255; 0.251; 0.242; 0.203 nm).

The results of X-ray phase analysis of the studied samples showed that their chemical and mineralogical composition is similar to traditional basalt rocks and consists mainly of the minerals albite, quartz, chlorite, calcite, as well as other minerals, the content of which is in very small quantities.

The results of determining the indicators of technological properties, in particular the values of the acidity modulus (Mk) and viscosity (Mv), melting point (Tmel.), temperature of the upper limit of crystallization (T.u.l.c.) of samples of andesibasalt samples are given in Table 3.

Table 3

Technological properties of andesibasalt

Samples	Ma	Mv	Melting temperature, °C		Viscosity at temperature, (η, Pa·s)			
			Begin	End	1500	1450	1400	1350
AnB-1	9.53	2.48	1185	1235	8.68	17.67	26.28	41.95
AnB-2	9.33	2.42	1175	1225	8.52	17.49	26.06	41.81
AnB_{avg}.	9.43	2.45	1180	1230	8.60	17.58	26.17	41.88

Based on experimental studies of the technological properties of andesibasalt, it was established that the values of acidity and viscosity moduli, melting point, and viscosity at temperature affect the process of production of basalt fiber.

According to classical technology [1], it can be noted that the properties of products made from igneous, in particular basaltic rocks, are naturally determined, first of all, by the initial chemical composition of raw materials, which are assessed based on the acidity modulus (Mk). It is noted that the higher the acidity modulus value, the more resistant the resulting fiber is to moisture. In the production of mineral wool, the value according to the requirements of GOST 4640-2011 [13] (Mk) of raw materials or raw material composition should not exceed 2.0. However, to obtain fibers, the acidity modulus of one-component charges must be more than 4.0 and up to 5.5-7.0 [14], and sometimes the most optimal for obtaining fibers is considered to be a chemical composition that provides an acidity modulus value ranging from 3.0 -7.0 [6]. According to the calculation results, the acidity modulus of andesibasalt averages is 9.43.

Consequently, there is a direct relationship between the composition of the charge when adding additives, the melting point and the viscosity of the melt. Based on this, for a more accurate assessment of the possibility of using rocks in the production of fibers, it is preferable to use the viscosity modulus, the calculation formula of which includes all the oxides present in the rock in molar proportions. The viscosity modulus indicator influences the entire technological process, from melt homogenization to fiber formation. As can be seen from the data in Table 3, the viscosity modulus of basaltic andesite ranges from 2.42 to 2.48, with an average of 2.45. In terms of the degree of viscosity modulus, this rock belongs to the high-viscosity group.

CONCLUSIONS

In general, the results of chemical and X-ray phase analysis show that the andesibasalt of the Karakhtay deposit consists mainly of quartz, chlorite, albite, calcite minerals, as well as other minerals, the content of which is in very small quantities. Based on the results obtained, it was established that the studied basaltic andesite is a promising raw material for the production of basalt fibrous materials for various purposes.

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