



CHEMICAL AND MINERALOGICAL RESEARCH BASALT "AYDARKUL"

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Abstract

In the article, researches on structural, chemical mineralogical properties of Aydarkul basalts and their content are carried out, and the results are described. The mineralogical composition of Aydarkol basalts is studied and the results are highlighted. The results of the research were analyzed and compared with the physico-chemical composition and properties of basalt rock from other deposits. On the basis of the obtained results, opinions and conclusions were made about the possible application of Aydarkul mine basalts in the fields of production.

Keywords: Basalt, structure, mineralogical composition, texture, geological structure, crystal structure, metabasalt, diabase.

Introduction

Vision

Demand for basalt products has recently increased, leading to a growing range of applications. Studies of the chemical and physical-mechanical properties of these rocks have revealed that, by improving existing technology, scientifically substantiating the development of integrated basalt processing methods and organizing the production of basalt products, this represents a promising area for developing local mineral resources.

Complex research methods were studied and used, including scientific generalizations, the electromagnetic method, thermal analysis, chemical analysis method, semi-quantitative spectral analysis, radiometric and gamma-spectrometric method for determining naturally active isotopes, mineralogical method for studying the composition of basalts, laboratory and semi-industrial tests on basalt enrichment, mathematical and statistical method; computer technology for information processing.



Thus, studying the properties and composition of basalts increases the efficiency of using local basalt raw materials, their enrichment and the organization of production of new, high-quality and environmentally friendly products.

Research Results and their Essence

Experience from other countries shows that basalts are a unique and promising raw material source for Uzbekistan. Therefore, chemical and mineralogical studies of basalts are of practical interest, the results of which allow for the adjustment of the diverse applications of basalts in our country. Currently, the country's known total processed basalt reserves amount to over 1 billion tons, which can be integrated into industrial production for various applications. This will enable this gift of nature to be transformed into a unique raw material for the construction of houses, bridges, and fortifications.

The physical and technical properties of basalt rock make it possible to establish enterprises producing highly efficient construction, technical, heat and sound insulation, and composite materials and products for various industries [3,4]. To achieve this, it is necessary to conduct a series of studies examining the inherent and material properties of basalt rock. Therefore, the materials in this article are devoted to studying the mineralogical and chemical properties of this rock, using the Aydarkul basalts as an example. Spectral analysis of the Aydarkul rock revealed the following characteristics related to its mineralogical composition.

mineralogical analysis was carried out . A semi-quantitative analysis of the rock was carried out to determine and clarify the mineralogical properties of the Aydarkul basalts. The studies revealed that the Aydarkul basalts contain olivine in the range of $13.7 \div 18.7\%$, pyroxene in the range of $19.3 \div 23\%$ and plagioclase - $34.6 \div 54\%$. The following chemical elements were not found in the studied samples of the Aydarkul basalts : Zn , Cd , Ag , Bi , Ge , Ti , Sb , W , Sn , In , As and P. While in the composition of basalts of Uzbekistan, for example, in the Asmansay basalts , the listed elements are present in significant percentages .

It has been revealed that the multi- oxidation composition of basalts is due to the bonding forces between oxygen and the chemical elements of metal-containing oxides, which form a rigid crystal lattice. Particularly prominent are the bonds between oxygen and Al , Fe , Mg , K , N , Ti , and Si .



Basalts of the Aidarkulskoye deposit A finely porphyritic rock with an aphyric , allotriomorphic granular structure. It consists of equal amounts of completely irregular grains of plagioclase and pyroxene, similar in optical properties to diopside-augite. $C : Ng = 30-43^\circ$. The grain sizes of plagioclase do not exceed 0.01 mm in the groundmass and 0.5-0.7 mm in the In very rare porphyroblasts . The crystals are elongated, with unclear faceting, forming sinuous, jagged, bay-like boundaries. The crystals are twisted, forming felt-like structures together with similar xeromorphic augite grains, the grain sizes of which in the groundmass are somewhat smaller than the plagioclase laths . The content of the anorthite component cannot be determined due to the curvature of the polysynthetic twins. Judging by the width of the twin individuals, these are plagioclases of labradorite composition, possibly descending in places to andesine and rising to bytownite . Augite crystals are more isometric than the elongated grains of plagioclase silicate, which form small tabular crystals, where most sizes reach maximum dimensions in the bulk of the rock, not exceeding 0.01 mm . However, individual sites within the silicate rock may be occupied by larger augite crystals, forming small porphyritic segregations up to 0.5–0.7 mm in size .

High relief, a relatively high refractive index compared to adjacent plagioclase crystals, and fairly bright light yellowish-brownish interference colors, along with a large extinction angle, ranging from 36 to 43 ^{degrees} , suggest that the pyroxene composition is transitional between diopside and augite. In crossed nicolites, this is easily identified by its interference color. In addition to these two mineral phases, the rock contains approximately 30% of its volume of vitreous material of microgranular and implicational structure.

The rock described apparently underwent the flow of extruded magma down the slope of a volcano. This is evidenced by the banded distribution of the glassy material, oriented in a single direction. The glass wrapping around individual augite and plagioclase crystals creates a pattern of ociliary structure in the groundmass. The dark gray and almost black color of the glassy material indicates its complex structure.

The twisting of plagioclase crystals and the felt-like orientation of groundmass crystals possibly indicate that the rock formed under conditions of lava flow. This rock also has a certain number of pores. The pores here are oriented along the



direction of flow or bands, which differ in the ratio of glass to crystalline phases. Some bands contain more glass than bands whose structure is dominated by crystalline grains.

Reaching 2.0 mm in length, corresponding to the direction of banding, with a width 2–3 times smaller than the pore length. Sometimes the pores are interconnected by narrow, cord-like cracks. Almost all the large pores here are hollow, filled with Canadian balsam. However, in some areas of the rock, smaller, relatively isometric pores filled with chalcedony-like quartz are found. Along with the quartz, pseudorocks are found in these pores. non-aggregated amorphous chlorite in very small segregations, the development of which occurs through which minerals is difficult to determine. Such finely porphyritic aphyric basalts, located north of the North The Nurata Mountains were studied by L.V. Shpotova and V.N. Ushakov. They consider them to be a product of the Belta basalt eruption Kuraminsky structural-formational zone.

was conducted at the Central Research Laboratory of the Novosibirsk Mining and Metallurgical Combine. Ten samples were selected for chemical analysis.

The results of the study of all samples are presented in Table 1.

Study The chemical composition of basalts was analyzed in laboratory conditions. The goal was to determine the content of oxides : silicon, aluminum, titanium, calcium, iron, magnesium, potassium, sodium, total sulfur, and sulfate sulfur .

By chemical analysis method taking into account moisture and loss of weight on ignition Data characterizing the chemical composition of basalts were obtained. Analyses showed that in the basalts of the Aydarkul deposit, the silicon oxide content in some samples reaches 62.9%, compared to 47.0–53% in other basalt deposits around the world and in Uzbekistan.



Table 1 . Chemical composition of basalts from the Aydarkul deposit

No. about would	SiO ₂	TiO ₂	Al ₂ O ₃	CaO	MgO	FeO	Fe ₂ O ₃	K ₂ O	Na ₂ O	MnO ₂	P ₂ O ₅	H ₂ O	Others	
													Content desire. < 1%	sludge
1	49.7	1.9	9.05	9.67	3.8	5.6	3.4	0.11	4.23	0.05	0.08	1.01	3.1	8.3
2	50.3	2.5	11.2	7.8	2.8	4.9	4.0	0.11	3.3	0.09	0.05	1.1	2.9	8.6
3	52.9	2.1	10.2	10.8	2.65	5.9	3.9	0.14	4, 11	0.011	0.021	1.09	1.11	4.88
4	47.7	1.98	7.2	8.89	2.75	4.6	3.87	0.11	2.3	0.05	0.08	1.04	8.17	11.26
5	57.1	1.9	9.67	11.1	2.53	5.6	3.9	0.14	3.11	0.16	0.05	1.02	0.87	2.77
6	56.8	1.77	10.9	7.95	2.69	6.9	3.87	0, 11	4.133	0.03	0.02	1.03	0.73	3.07
7	55.9	2.5	8.27	10:45	3.44	6.55	3.9	0.17	4.53	0.05	0.01	1.01	0.53	2.69
8	54.44	2.44	9.43	9.9	2.81	6.6	4.9	0.14	3.31	0.00	0.02	1.01	0.71	4.19
9	53.9	1.79	7.2	9.87	3.0	4.6	2.9	0.14	3.3	0.03	0.08	1.1	2.12	9.97
10	47.7	2.2	11.1	10.12	3.2	4.65	2,3,0	0.13	3.13	0.06	0.04	0.98	6.63	10.06

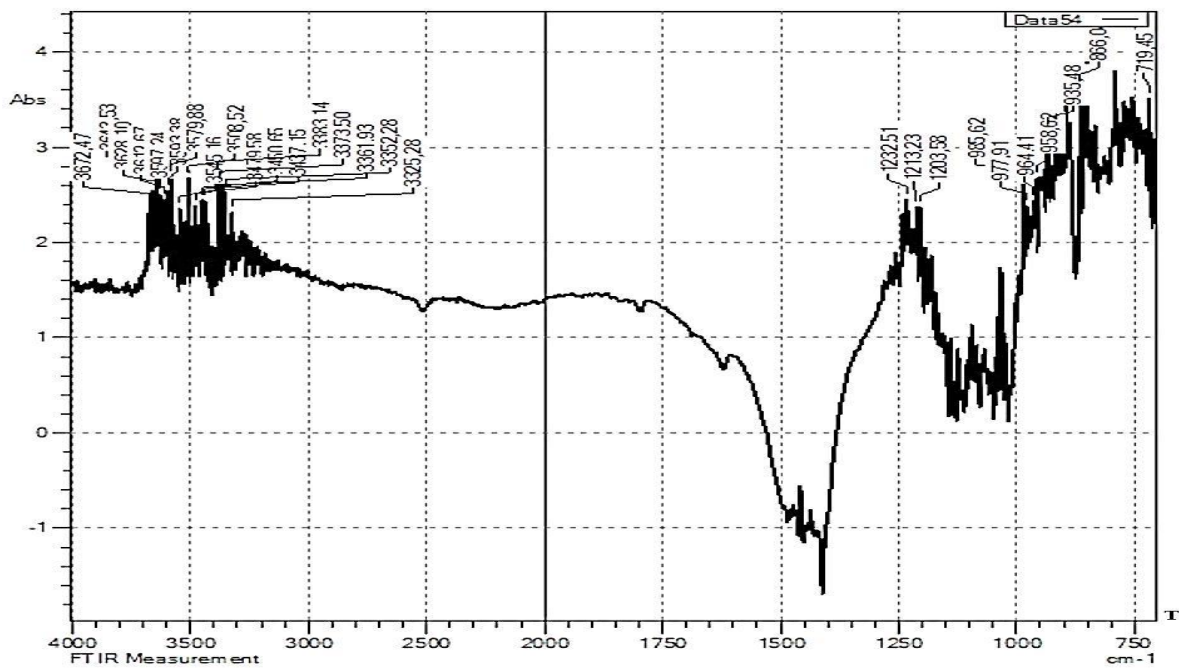
MgO 5% versus 10%, CaO 15% versus 3%, Na₂O 3.6% versus 3%, Fe₂O₃ 12%, versus 15%, etc. A significant content of chemical compounds such as SiO₂, CaO, Al₂O₃ was noted in the composition of the basalt rock of both deposits. Components such as MnO, Fe₂O₃, FeO in percentage terms are contained in smaller quantities in the basalt of the Aydarkul deposit than, for example, those found at a close distance in the Asmansay basalts.

It should be noted that the melting temperatures of the basalts from the studied deposits differ from each other by approximately 100 - 200 °C. In the composition of the basalts studied, the SiO₂ content is in the range of 58.7 ÷ 62.9%, in the Asmansay basalts it is in the range of 45.7 ÷ 53.3%.

Experiments have shown that the Aydarkul basalts are composed of 24 chemical elements. The main rock-forming elements are magnesium, sodium, silicon, iron, aluminum, and calcium. The remaining chemical components, numbering up to 43, are found to be related to changes in the dipole moment of a molecule during rotation or vibration of its constituent atoms, isotopic substitution within the molecule, its symmetry, and the number of electrons in its outer shells. Figure 1 presents these results for the studied basalts at the deposit.

The absorption band at 737.0 cm⁻¹ is due to deformation vibrations of the Si - O - Si bond, and 474.1 cm⁻¹ to vibrations of the silicon-oxygen tetrahedron. Analysis of the spectra of the basalt melting product allows us to conclude that Al₂O₃ completes the polymer tetrahedral network of the silicon-oxygen polyanion

and is represented as $[AlO_4]^{5-}$. In the material under study, iron oxide, like aluminum, tries to complete the silicon-oxygen framework due to a lack of silicon oxide; in this case, iron oxide is to a greater extent in the tetrahedral coordination $[Fe_2 + O_{4/2}]$. [6,7]



Rice. 1. IR spectra of “Aydarkul” basalts

Thus, it was discovered that the bond between oxygen and metallic elements leads to the formation of corresponding oxides, which form the basis of silicate basalt as a whole. In such a solid structure, silicon-oxygen bonding plays an important role, as the bulk of basalt consists of the oxide SiO_2 . Research on the transformation of basaltic rock is expressed through derivatograms.

It has been found that basalts consist of three silicate compounds, which are: olivine, pyroxenes and plagioclases, which consist mainly of metal-containing oxides.

Analysis of the DTGA curve shows that the curve consists mainly of two sigmoids, which occur in two stages. The first stage occurs in the temperature range from $150^\circ C$ to $700^\circ C$, while the mass loss is 11.46%, the second stage occurs in the temperature range from $750^\circ C$ to $1200^\circ C$, while the mass loss is



23.7%. When heated to $600 \div 900$ °C in an oxidizing environment, iron monoxide contained in olivine is oxidized to iron oxide, and olivine is converted into forsterite (2 MgOSiO_2) and clinoenstatite (2 MgOSiO_2). At temperatures above 1200 °C Fe_2O_3 , FeO, reacts with forsterite to form magnesium metasilicate. Magnesium metasilicate has four modifications, so their presence in refractories is impractical. Study and analysis of the TGP curve shows that the decomposition rate of the carbon-containing material in the temperature range of $600\text{-}1080$ °C is maximal and amounts to 2.88 mg / min , and the amount of energy expended, correspondingly, is 8.430 mV s / mg .

The study of the process of thermal impact on basalts is expressed through derivatograms developed by the authors.

An analysis of the DTGA curve shows that it consists primarily of two sigmoid functions, which occur in two stages. The first stage occurs in the temperature range from 150 °C to 700 °C, with a mass loss of 11.46%. The second stage occurs in the temperature range from 750 °C to 1200 °C, with a mass loss of 23.7%.

When the heating temperature reaches $600 \div 900$ °C in an oxidizing environment of Fe_2O_3 , FeO contained in olivine is oxidized to iron oxide, and olivine is converted into forsterite (2 MgOSiO_2) and clinoenstatite (2 MgOSiO_2). At temperatures above 1200 °C Fe_2O_3 , FeO reacts with forsterite to form magnesium metasilicate. Magnesium metasilicate has four modifications, so Its special presence in refractories is impractical.

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Temperature increases during crystallization of amorphous products of the initial raw materials. Due to destruction of the crystalline structure of natural basalt during heat treatment, an exothermic effect is observed in the temperature range of $820\text{-}840$ °C. This phenomenon can be explained by the discovery of three endothermic effects (at temperatures of $120\text{-}160$ °C, $335\text{-}375$ °C, $580\text{-}590$ °C, respectively) and two exothermic effects (at temperatures of $300\text{-}450$ °C and $700\text{-}720$ °C). It was established that the shape of the thermal curves is related to the



thermal insulation properties of the raw materials and the characteristics of the basalts from the Aydarkul deposits .

The results of X-ray studies of basalt showed that the mineralogical composition of the crystalline phase is represented (in mass%) by the minerals calcite CaCO_3 - 29.8; albite $\text{NaAlSi}_3\text{O}_8$ - 27.7 ; silicon oxide SiO_2 -35.9; alkaline basalt (Mg, Fe , Al , Ti), (Ca , Na , Mgm Fe) (SiAl) $_2\text{O}_6$ -6.6. The results are presented in Table 3.

The X-ray diffraction pattern of basalt rock shows diffraction maxima of quartz ($d = 0.474$; 0.367 ; 0.182 Nm). Along with them, studies have revealed the presence of aluminosilicate compounds ($d = 0.323$; 0.296 Nm) and pyroxenes ($d = 0.253$; 0.2015 Nm). [7,8] .

Conclusion

Multiple The results of the conducted studies show that the Aydarkul basalts are quite suitable for the production of modern basalt-containing products new generation materials and products.

According to TSh -64-15562057-03:2002, the basalts studied are environmentally friendly, have positive physical and mechanical properties, are resistant to both acidic and alkaline environments, and have low thermal conductivity. Furthermore, they have a wide range of applications compared to other similar materials.

These properties of basalts have determined the relevance of the problem of further development and creation of highly effective technologies for the integration of this gift of nature into industry.

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