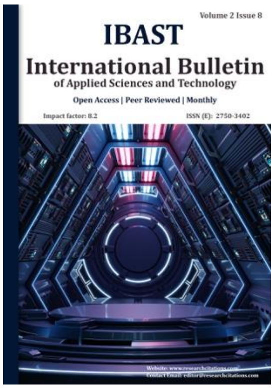

COMPREHENSIVE STUDY OF THE MATERIAL COMPOSITION AND STRUCTURAL FEATURES OF THE MINERAL DOLOMITE OF THE JAMANSAY DEPOSIT OF THE REPUBLIC OF KARAKALPAKSTAN

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Abstract

The article presents research on the chemical-mineralogical composition of magnesian rocks of the dolomite mineral of the Jamansay deposit in Karakalpakstan. The results of studying the chemical and chemical-mineralogical properties of the dolomite mineral are presented. The results of chemical, thermogravimetric, X-ray fluorescence, electron microscopic, and IR spectroscopic analyses of the dolomite mineral containing natural magnesium are presented. These analysis methods are universal and, to date, more modern methods for studying the compositions of solid materials. Based on the research results, it was noted that the samples of the studied minerals are sufficiently pure and suitable for use in the production of binding building materials.

Keywords: magnesium binders, dolomite, binding substances, magnesite, caustic dolomite, mineral, raw materials, carbonate, derivatogram.

Introduction. In science, there are various methods for extracting magnesium compounds from dolomite and using raw materials and semi-finished products for various chemical industries. Today, dolomite is widely used in cement production, construction industry, and ceramics industry. Considering the localization of imported raw materials, semi-finished products, and the use of natural resources within the Republic, dolomite is of great interest. [1,2].

Dolomite is a rock that is more than 90% (depending on the deposit) composed of the mineral dolomite, belonging to the carbonate class, and according to the entire chemical formula represents $CaMg(CO_3)_2$. The optimal composition of dolomite is $MgCO_3$ - 45.8%, $CaCO_3$-54.2%. The hardness of dolomite on the Mohs scale is 3.5-4, and the density of dolomite is 2.8-2.9 g/cm. Dolomite, as a natural non-metallic rock, is usually found in yellow and brownish colors due to impurities of iron compounds, clays, and other substances. Dolomite can also be in the form of a yellowish-floury crumbly mass called dolomite flour or dolomite sand. For the production of caustic dolomite, it is advisable to use raw materials with a high content of magnesium oxide. However, dolomite can also be used in industries such as oil production, construction, and the production of refractories [3,4].

The development of an industrial sector is interconnected, primarily in terms of providing high-quality raw materials with high commodity indicators. In construction, magnesium binder is used to obtain products of wide application: fibrolite, xylolite, heavy concretes, magnesium concretes, putties, etc., which are used as binding agents.

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Dolomites in the territory of Uzbekistan are confined to Paleozoic and Mesocainozoic deposits. The mineral resource base of dolomites is represented by numerous deposits and occurrences in the Central Kyzylkum, Malguzar, Pachkamar, Karakiya, Dehkanabad, Farhad cliffs, and the Nuratin Mountains. Among them, only one dolomite deposit - the "Farhad Rock" - has been explored as a refractory raw material [5,6]. The main consumer of dolomite is metallurgy, which uses dolomite refractories in large quantities. The corresponding quality requirements of the refractory industry are of particular industrial interest, as by firing them, periclase can be obtained as the main component of magnesia refractory products [7]. The focus on the leading role of dolomite application is substantiated by the presence of a significant number of deposits and manifestations of this type of mineral in the republic. Uzbekistan possesses practically several dozen promising dolomite resources containing more than 20% magnesium oxide.

Objects and methods of research. The purpose of this work is to study the chemical-mineralogical composition of dolomite from the Jamansay deposit for obtaining binding building materials in production.

The Jamansay dolomite deposit is located in the Karauzyak district of the Republic of Karakalpakstan, 110 km southeast of the district center Karauzyak and 12 km east of the settlement of Karatau. The center of the Republic of Karakalpakstan, Nukus city, is located 85 km northwest of the deposit.

The study of the mineralogical composition of dolomite minerals was carried out by chemical, physicochemical, IR spectroscopic, and X-ray fluorescence analyses. These analyses are universal and, to date, more modern methods for studying the compositions of solid materials.

Results and discussion. Chemical, X-ray fluorescence, IR spectroscopic, scanning electron microscopic, and thermogravimetric analyses of the dolomite mineral were conducted. Laboratory chemical studies of natural dolomite minerals were conducted according to GOST 5331-63 [8]. The results of the chemical analysis are presented in Table 1.

Table 1.

Chemical composition of dolomite of the Jamansay deposit according to elemental composition data

Name	Content %								
	CaO	MgO	SiO_2	MnO	Al_2O_3	SO_3	Fe_2O_3	P.p..p	Too toxic
Dolomite	25.7	24.1	2.18	0.12	1.03	0.428	2.14.	43.98	99.678

As can be seen from the data in Table 1, the dolomite content in the sample is 99%, which indicates an increased content of carbonate compounds. Dolomite components can include oxides such as SiO_2, Fe_2O_3, Al_2O_3, MnO, organic compounds, and others.

A quantitative analysis of the elemental composition of dolomite was performed on a Rigaku NEX DE X-ray fluorescence analyzer, a EDXRF table energy-dispersive X-ray fluorescence device, which measures the energy and intensity of secondary fluorescence study, determining the elements and quantitative content in the sample (Figure 1).

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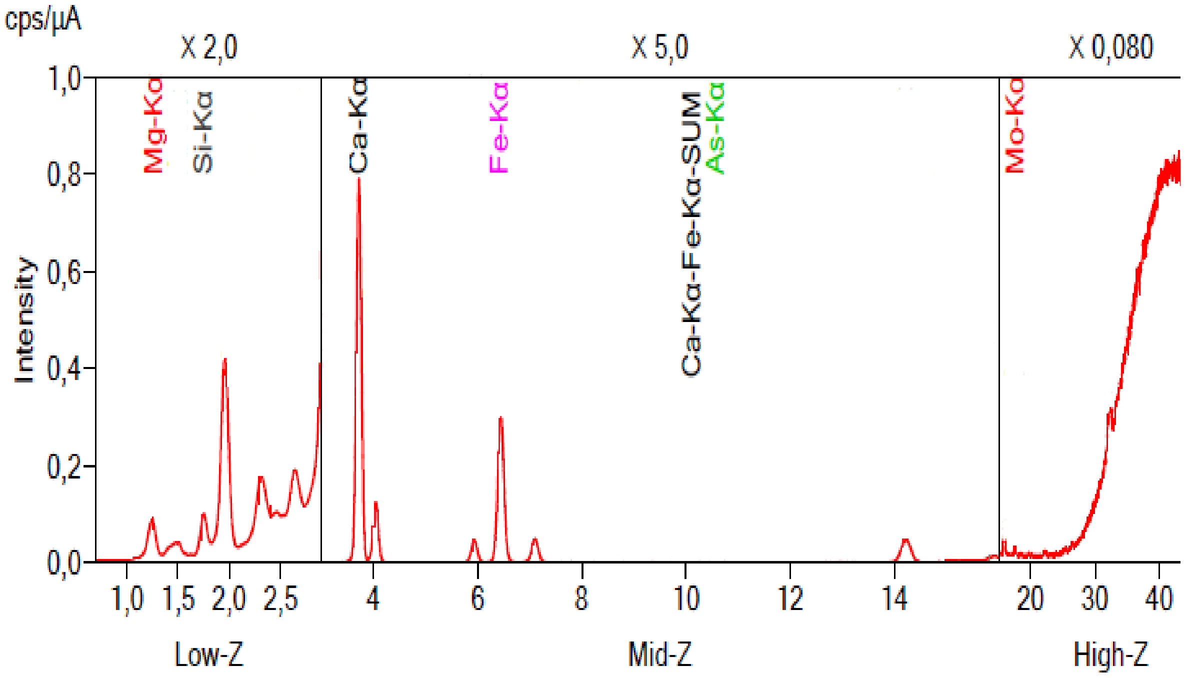

Fig.1. X-ray fluorescence analysis of dolomite mineral.

The IR absorption spectra were recorded on spectrophotometers, which confirms the data obtained during the chemical analysis. IR spectroscopic analysis (Figure 2) showed that the spectra of dolomite minerals are characterized by a set of absorption lines of the vibrational spectrum in the region of 3400-3600 $^{cm-1,}$ x characteristic for deformation and valence vibrations of water, and *OH* groups. In the 1455-1300 $^{cm-1}$ frequency region, absorption bands characteristic of the $_{CO3}$ group appear.

The thermal dissociation process of dolomites has been studied by many authors. Thus, according to [9-12] data, the decomposition of $MgCO_3$ occurs in the range of 700-870°C, and $CaCO_3$ - at 820-1000°C. The decomposition process of calcium and magnesium double carbonates strongly depends on the crystalline structure of the rock, the content of magnesium carbonate in it, and the presence and quantity of impurities. However, some researchers of dolomite dissociation kinetics indicate that the decomposition process begins with its decomposition into individual carbonates at approximately 400°C, then at 500°C, $MgCO_3$ decomposes into MgO, and at 700°C, $CaCO_3$[13-15]. From the above information, it follows that the nature of thermochemical transformations significantly depends on its physicochemical properties. Therefore, due to the lack of data on the thermochemistry of dolomite dissociation from the "Jamansay" deposit, a derivatographic analysis was conducted.

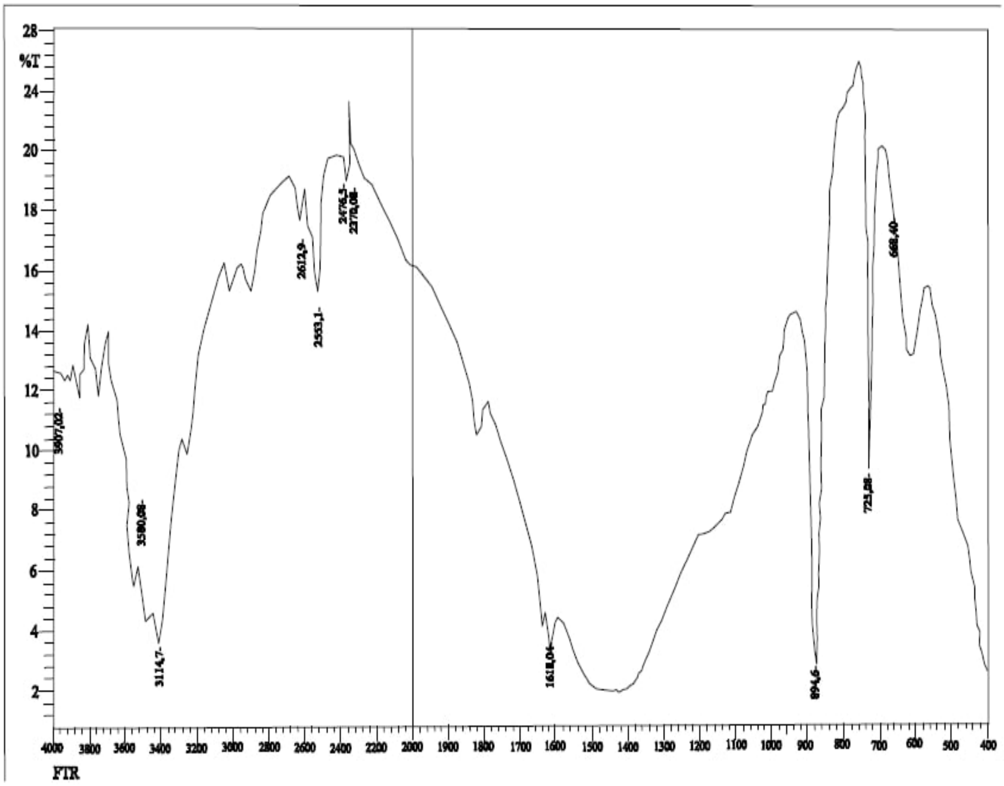

Fig.2. IR spectroscopic image of dolomite from the Jamansay deposit

Differential-thermal analysis of dolomite mineral samples was carried out on a DTG-60 SHUMADZU derivatograph in the temperature range of 30-1000°C at a rate of 10°C/min, in a nitrogen medium.

By thermogravimetric analysis of the dolomite powder sample, three endothermic effects are observed (see Figure 3).

The first exposure occurs in the range of 33.45-556.75°C (2.0%) with a slight weight loss, which may be associated with the release of moisture or adsorbed substances.

The second stage, at 556.75-816.18°C (42.8%), is associated with the decomposition of dolomite into individual carbonates and the dissociation of $MgCO_3$, which begins at 500°C. The endothermic effect is associated with the thermal dissociation of calcium carbonate.

Small losses at high temperatures are associated with the complete and final decomposition of the remaining third-stage substances at a temperature of 816.18-1001.88°C (0.6%). After 1000°C, no changes are observed. The mass remains constant.

Endothermic heat effects begin at 702.88 °C and end at 771.72 °C. Here, the highest endothermic decomposition process of $MgCO_3$ reaches its maximum at 742°C.

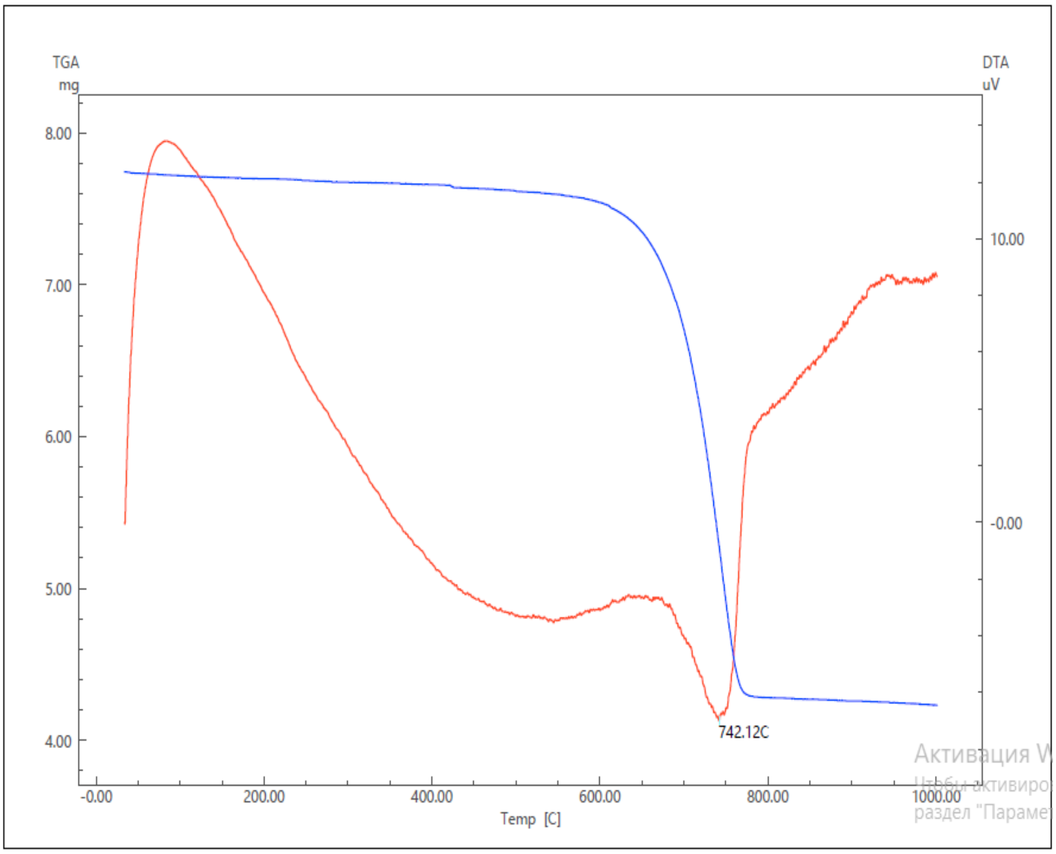

Figure 3. Thermogram of dolomite from the Jamansay deposit

In this work, the microstructure of the dolomite sample was analyzed using a JEOL JSM-T210 type scanning electron microscope (SEM) of various sizes (6 μm and 2 μm scales). The sample was prepared under vacuum conditions and scanned with high precision.

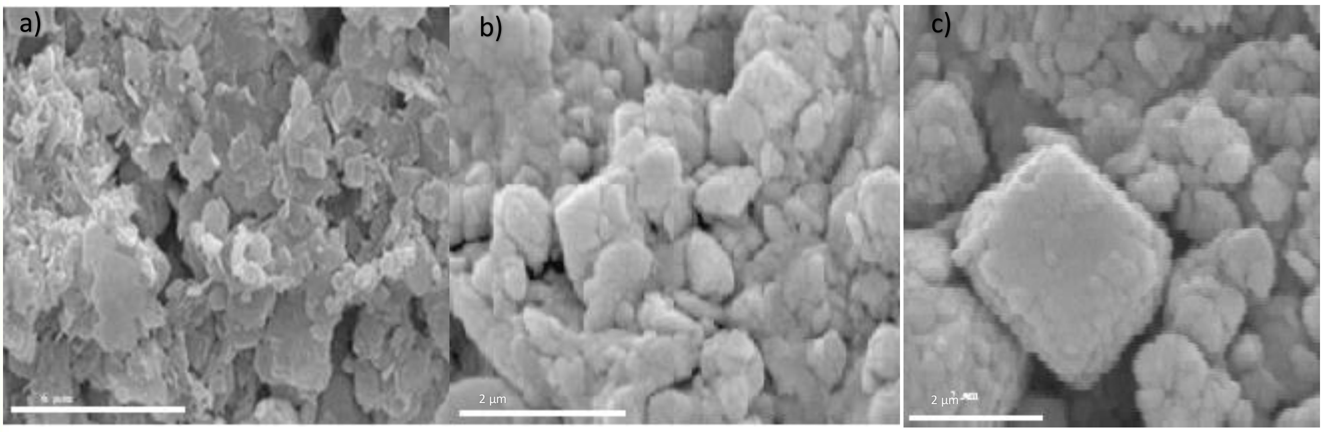

Figure 4. Jamansay dolomite of various sizes microscopic images in size

Fig. 5 SEM images of dolomite-rich samples from Stage 2 (a) and Stage 3 (b), and a magnesite-rich sample from Stage 3 (c). The crystals generally have a size less than 2 lm and are rhombohedral. habits. Some knurled surfaces are identified in Stage 3 dolomite and magnesite, while the 2nd stage dolomite crystals show smooth faces (perhaps due to a higher degree of aging)

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Analysis of scanning microscopy data shows that in Figure 4 (a), dolomite particles are tightly packed, have uneven morphology, and aggregate with each other, manifesting as lamellar and small grains. In Figure 4 (b), it was observed that particles of even smaller sizes are joined together to form an aggregate, their surface is relatively rough and in some cases is limited by cracks. Figure 4 (c) shows that dolomite crystals are clearly formed, with some particles developing into a cubic or rhomboid morphology.

These SEM observations show that the crystalline structure of dolomite has a specific heterogeneity in the micron range, the particles are strongly bound to each other, and its morphology can undergo significant changes during thermal or mechanical processing.

Thus, the production of binders based on dolomite raw materials is the most promising, including in our region, which allows for the production of binders based on local raw materials. Based on the data presented, it can be concluded that the dolomite content indicates an increased content of carbonate compounds. The results of IR spectroscopy, thermogravimetric, scanning electron microscopy, and X-ray fluorescence analyses show that the studied dolomite consists of magnesium and calcium carbonates and is suitable for use in the production of binding building materials.

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