ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 8 , August 2022

Studies of the Chemical and Mineral Composition of Serpentinite of the Karakalpak Deposit

Saparova G., Dzhandullaeva M., Erkaev A. U. Kucharov B. Kh

Karakalpak Research Institute of Natural Sciences, Karakalpak branch of the Academy of Sciences of the Republic of Uzbekistan
Tashkent institute of chemical technology
Tashkent institute of chemical technology
Institute of general and inorganic chemistry of the academy of sciences of the Republic of Uzbekistan

ABSTRACT: The paper presents data on the study of chemical and mineral serpentinite of the Karakalpak deposit. According to chemical analysis, the composition of raw materials containing 33-35% MgO was determined. According to the derivatogram data, it was found that the first endothermic effect, associated with the removal of adsorbed water, was obtained at a temperature of 170°C, the second, associated with the destruction of the structure at 680°C (mass loss in this region is 10%).

KEYWORDS: serpentinite, X-ray phase analysis, DTA measurements, magnesium, energy-dispersed analysis, temperature, endothermic effect, exothermic effect, magnesium nitrate, processing, fertilizer.

I. INTRODUCTION

It is known that magnesium is an essential component of chlorophyll, and in the case of a lack of this chemical element, a slowdown in the growth and development of plants is observed, expressed in a change in the color of the leaf mass, a deterioration in immunity and an increased incidence of plants, and the volume and quality of the harvested crop also decreases [1]. Magnesium nitrate has found wide application in many branches of the chemical industry. Therefore, magnesium nitrate, due to its properties, is an indispensable component of many technological processes in various fields of production.

There are many technological ways of processing serpentinite. But all these technologies are based on the same chemical processes: leaching of acid-soluble components from raw materials into the water-salt phase with solutions of mineral acids (hydrochloric, sulfuric, nitric) or sintering them with salts of mineral acids [2]. Each deposit of natural serpentinite is unique in its own way (due to the variability of the mineralogical composition and properties), therefore, known technologies cannot be transferred to the processing of Karakalapak serpentinite. Based on the characteristics of any raw material, separate scientific and technological research is required to select the optimal conditions for their processing.

Chemical processing of substandard magnesium-containing materials (dolomite, talc, serpentinite, etc.), in our opinion, is also of practical interest, given the current meager state of provision of the country's agriculture with magnesium-containing fertilizers.

In the Republic there are silicate magnesium-containing rocks, consisting mainly of minerals of the serpentinite group, such as lizardite, chrysotile, antigorite and others. To obtain magnesium compounds from local raw materials, there is a need for their complex processing, which will allow extracting all useful components from them and obtaining finished commercial products.

The most acceptable source for obtaining magnesium compounds can be considered serpentinite, the natural reserves of which, like dolomite, are huge. In addition, during the enrichment of chrysotile asbestos, waste is formed - serpentine, which occupies large areas [3]. It is a cheap raw material for the production of magnesium hydroxide and oxide, sulfates, chlorides and magnesium nitrates. Serpentinite, in addition to lizardite $Mg_6[(Si_4O_{10}](OH)_8$, contains minerals of the serpentine group (antigorite, forsterite, magnetite, diopside, chrysotile), which have the same formula

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 8 , August 2022

$Mg_3[Si_2O_5](OH)_8$. It contains 30-45% MgO, which indicates the prospects of its synthesis on an industrial scale. Theoretically, it consists of 43,0% MgO, 44,1% SiO_2 and 12,9% H_2O. The main impurities are oxides of iron, aluminum and calcium.

In recent years, many technological schemes for the processing of serpentinite raw materials have appeared. But, all these schemes are based on the same chemical processes: leaching or sintering [4]. Thus, the work [5] shows the possibility of hydrochloric acid processing of serpentinite to obtain such products as magnesium oxide, silicon dioxide, and heavy metal hydroxide concentrates. The following were found as significant shortcomings: the aggressive effect of HCl on equipment; air pollution with chlorine and difficulty in separating impurity components from $MgCl_2$ solution.

Based on this, studies aimed at developing a technology for processing serpentinite from the Karakalpak deposit into magnesium nitrate with the simultaneous production of nitrogen fertilizers are very relevant, which is one of the main tasks of this work.

II. METHODS AND MATERIALS.

The determination of the elemental composition and morphological studies were carried out using a scanning electron microscope SEM - EVO MA 10 (Zeiss, Germany) by the method of energy-dispersive X-ray spectroscopy (EDS), in which they were determined using energy-dispersive elemental analyzers brand - Oxford Instrument - Aztec Energy Advanced X-act SDD. Obtaining data on the elemental composition was represented by electronic photographs with selected local areas, a table of composition, as well as a graphical spectrum. Measurements of the phase characteristics of the test sample were carried out on a powder x-ray diffractometer "Panalytical Empyrean" [6] All control over the operation of the equipment is carried out by means of a computer using the Data Collector program, and the analysis of X-ray patterns was carried out using the High Score program with a PDF 2013 database. "Panalytical Empyrean" fitted with a Cu tube ($K_\alpha 1$= 1,5406 Ǻ). The measurements were carried out at room temperature in the range of 2θ angles, in the range from 5° to 90°, in the step-by-step scanning mode with a step of 0.013 degrees and a signal accumulation time at a point of 5 s. DTA and TG measurements were carried out on a STAPT 1600 synchronous thermal analyzer manufactured by the German company Linsseys; measurements were carried out in an oxidizing environment at a speed of 20 s/min [7].

III. RESULTS AND DISCUSSION

Analysis of the chemical and mineral composition of raw materials allows you to determine:

– the required amount of HNO_3 and the possibility of chemical interaction with it of the contained components;

- the degree of influence of pre-treatment of raw materials on increasing the yield of products.

Serpentinite from the Karakalpak deposit was used for the study. Analysis of the feedstock was carried out using chemical, X-ray phase (XR), thermogravimetric methods of analysis.

Table 1
Chemical analysis of the original serpentinite

MgO	FeO	Fe_2O_3	Al_2O_3	CaO	Na_2O	SiO_2
33.06%	1.62%	6.63%	2.47%	1.82%	1.56%	41.42%

As shown by chemical analysis, the serpentinite of the Karakalpak deposit contains MgO - 33-34% and SiO_2 - 41-42%.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 8 , August 2022

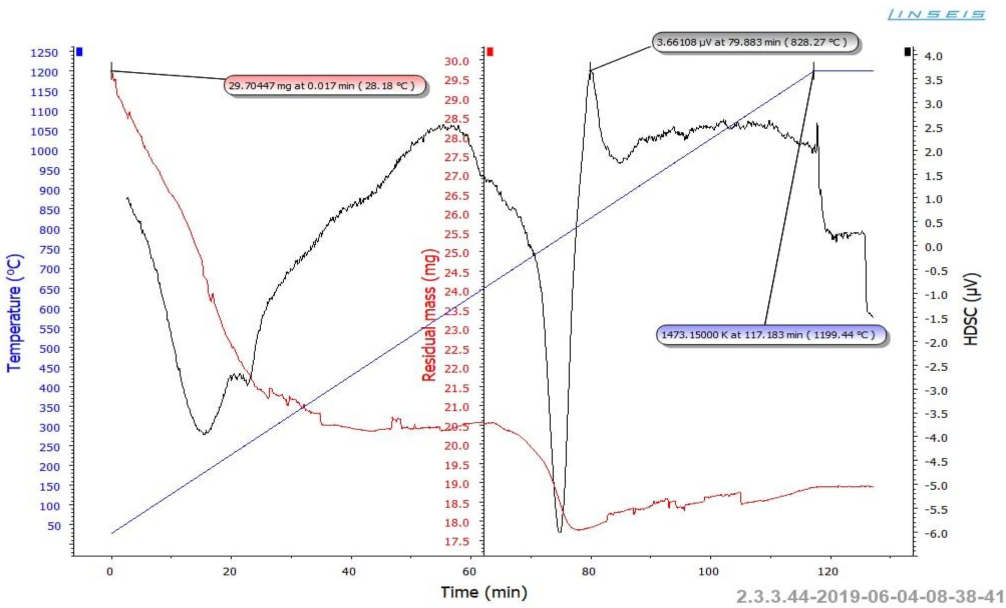

Figure 1. Derivatogram of serpentinite

According to the data of the derivatogram (according to the behavior of the DTA and TG curves), clear peaks are distinguished associated with the endothermic effect caused by the dehydration of the mineral (Fig. 1). The first endothermic effect associated with the removal of adsorbed water was obtained in the temperature range of 170°C, the second, associated with the destruction of the structure, at 680°C (mass loss in this region is 10%). At a temperature of 818,7°C, an exothermic effect appears due to the ordering of the forsterite structure formed during their dehydration.

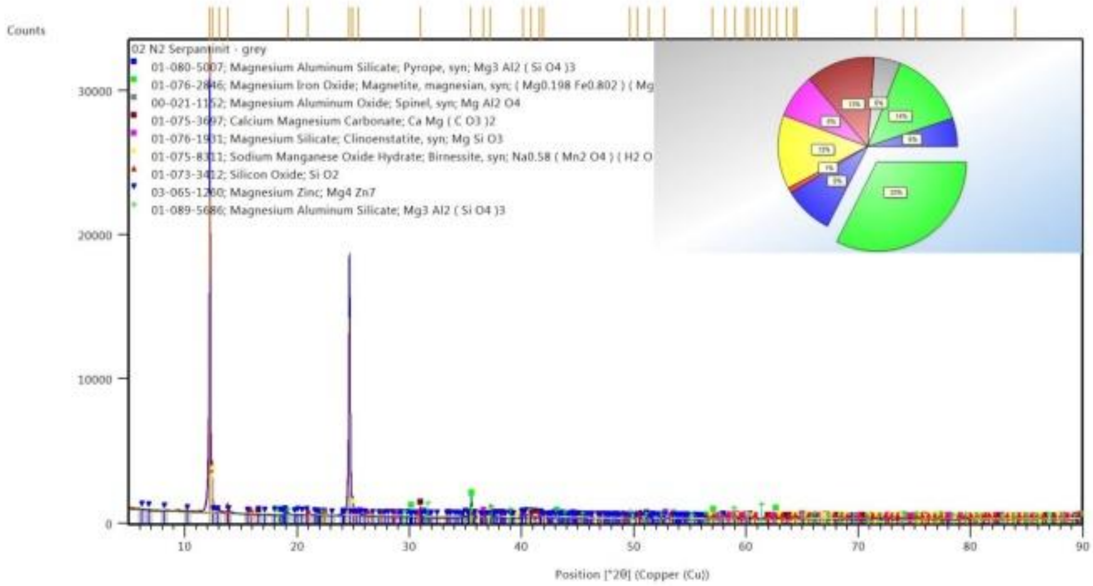

Figure 2. X-ray of the original serpentinite.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 8 , August 2022

X-ray phase analysis showed that the starting material (serpentinite) is a mixture of magnesium silicates containing OH groups and water molecules. The presence of inclusions of magnetite, magnesite, spinel, clinoenstatite, birnessite, and pyrope is also noted.

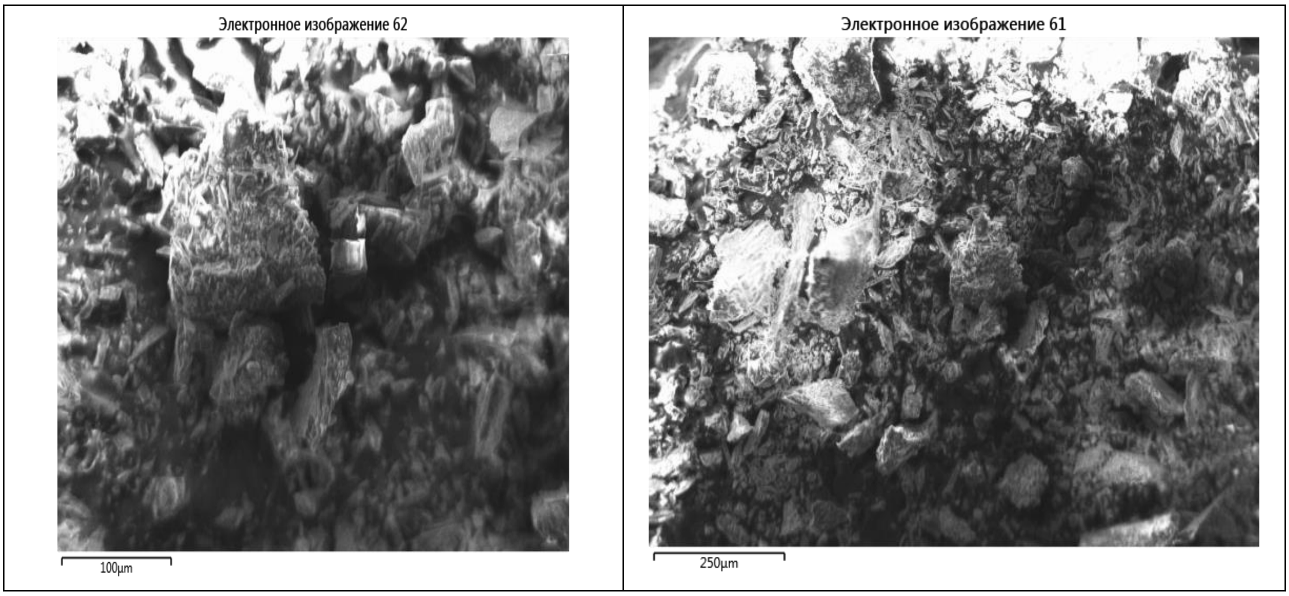

Figure 3. SEM images of the original serpentinite

Serpentinite of the Karakalpakskoye deposit is heterogeneous in structure. Figure 2 shows several different-shaped particles belonging to different minerals.

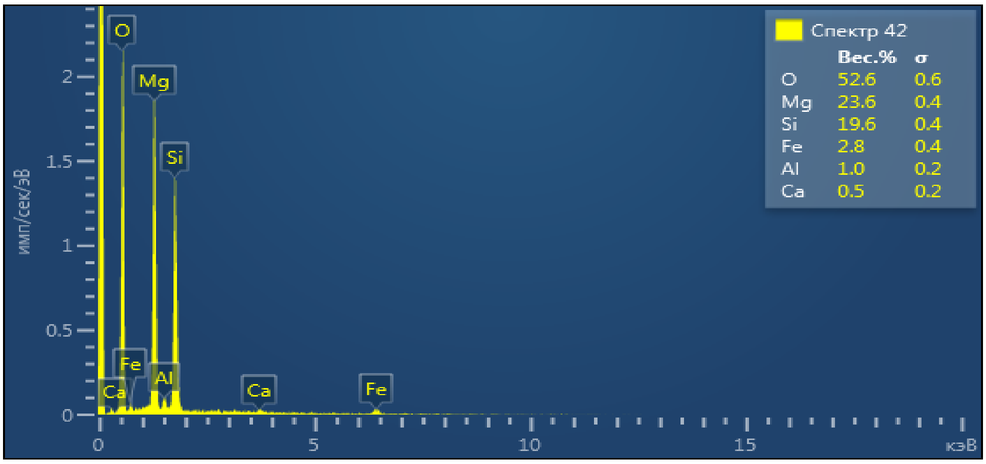

Figure 4. Energy dispersive spectrum of the sample.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 9, Issue 8 , August 2022

Table 2

Elemental composition of initial and heat-treated serpentinite by energy-dispersive X-ray spectroscopy.

Element	Content weight. %		
	original	Heat treated	
		178°C	800°C
O	52,6	47,18	42,69
Mg	23,6	23,77	25,89
Al	1.0	1,09	1,07
Si	19,6	20,78	22,20
Ca	0,45	0,47	0,67
Fe	2,72	6,71	6,92

As Fig. 4 shows, the content of Mg, Ca, and Si in the original serpentinite is 23,6; 0,5 and 19,6%, while the content of Al and Fe sesquioxides is 1,0 and 2,8%, respectively.

IV.CONCLUSION

Thus, in order to obtain magnesium compounds by acid processing of serpentinite from the Karakalpak deposit, the physicochemical properties of this mineral were studied. According to the derivatogram data, there are clear peaks associated with endothermic effects caused by the dehydration of the mineral. X-ray phase analysis showed that the original serpentinite is a mixture of magnesium silicates containing OH groups and water molecules in its composition. The presence of inclusions of magnetite, magnesite, spinel, clinoenstatite, birnessite, and pyrope is also noted.

REFERENCES

1.http://www.maxam-chirchiq.uz/ru/catalog/mineralnye-udobreniya/magniy-azotnokislyy.html

2.Peredin Yu.V., Usoltseva I.O., Krasnoshchekova D.A. The main technologies for obtaining magnesium oxide from serpentinite. // Polzunovskiy Bulletin. -2019.-№2. -p.123-127.

3.Methodological recommendations on the application of the classification of reserves to asbestos deposits. / Ministry of Natural Resources of the Russian Federation. -M., 2005. -40p.

4. Peredin Yu.V., Usoltseva I.O., Krasnoshchekova D.A. The main technologies for obtaining magnesium oxide from serpentinite. // Polzunovskiy Bulletin. -2019. -#2. -p.123-127.

5. Sagarunyan S.A., Arustamyan A.G., Agamyan E.S., Nazaryan E.M., Sagarunyan A.S. Study of the processes of complex processing of serpentinites. // Proceedings of the Kola Scientific Center. -1/2018 (9), part 1. Chemistry and materials science. -Issue. 2. -pp.187-191.

6. Patrick Echlin. Handbook of Sample Preparation for Scanning Electron Microscopy and X-Ray Microanalysis.//Cambridge Analytical Microscopy. -UK, Springer. -2009. -330p.

7. Makoto Otsuka and Hajime Kinoshita. Quantitative Determination of Hydrate Content of Theophylline Powder by Chemometric X-ray Powder Diffraction Analysis. // AAPS Pharm Sci. Tech. -2010 March; 11 (1): 204–211.

8. Brown M.E. Introduction to Thermal Analysis. //Techniques and Applications 2nd ed. – Kluwer. -2010. – 310 p.