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OBTAINING COMPLEX FERTILIZERS BASED ON GLAUCONITE, PHOSPHORITE, SAPROPEL OF KARAKALPAKSTAN IN THE PRESENCE OF UREA

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Abstract

The article shows possible ways of using the mineral glauconite, phosphorite, sapropel of Karakalpakstan and their role in the agricultural sector. The process of obtaining complex fertilizers based on glauconite, phosphorite and sapropel of Karakalpakstan with the addition of carbamide was investigated. The possibility of producing complex fertilisers based on raw materials with carbamide, which content of N_2 ranges from 9,2–9,6; K_2O 1,5–3,1; P_2O_5 3,51–8,3%, respectively. Diffractograms and EDR analysis of these minerals are also provided. The results of existing experience in the use of glauconite, phosphorite and saprolpel in agriculture show that these mineral raw materials have the property of restoring soil fertility due to the content of various trace elements that increase soil fertility. Along with this, the water-retaining property of these minerals will allow more rational use of water.

Keywords: *Karakalpakstan, Krantau, glauconite, Kushkanatau, sapropel, phosphorite, fertilizers, meliorant, trace elements, agriculture*

Introduction

Cotton, rice, wheat, maize produced and cultivated in Karakalpakstan noticeably respond to changes in the diet, the composition of nutrients contained in fertilizers of nitrogen, phosphorus, potassium and trace elements. Therefore, this time the most urgent task is to develop new methods for producing and using effective mineral fertilizers. In this regard, great attention is paid to the problem of the development and use in Uzbekistan and Karakalpakstan of mineral fertilizers obtained on the basis of local, natural raw materials, which include a highly dispersed variety of bentonite clays, glauconites, phosphorites, sapropel and others, which contain up to 15 different trace elements and organic matter. The use of glauconite sands, phosphorite flour and sapropel directly as fertilizer, or the preparation of complex microelements containing fertilizers on their basis, is of great economic importance for our region, since it leads to a decrease in the cost of mineral fertilizers by replacing some of the imported fertilizers with cheap, local fertilizers, which leads to a decrease in the cost of their use. The presence of large areas of glauconite containing sands of phosphorite deposits and sapropel in the territory of Karakalpakstan, their availability, dictate the need for their more detailed study and development of technology for obtaining complex fertilizers based on them (Artyushin A. M., Derzhavin L. M., 1984; Environmental problems of Uzbekistan. (2011); Allaniyazov D. O., 2019; Allaniyazov D. O., Erkaev A. U., 2021; Allaniyazov D. O., Erkayev A. U., Tajibayev T. A., Ochilov S. U., 2023).

Carbamide is the main source of nitrogen as a fertilizer and, in combination with phosphorus and potassium, enhances the synergistic effect of nutrients needed for plants in the soil. The combined use of carbamide and phosphorite leads to a decrease in the pH level, which increases the rate of absorption of phosphorus in the form of P_2O_5 (phosphorus oxide) and improves its solubility in water.

Research objects and methods

The object of research in this work is the glauconite sands of Krantau, phosphorite flour, sapropel of the Kushkanatau field of Karakalpakstan and standard mineral fertilizers produced from plants of Uzbekistan urea.

Research material and methodology

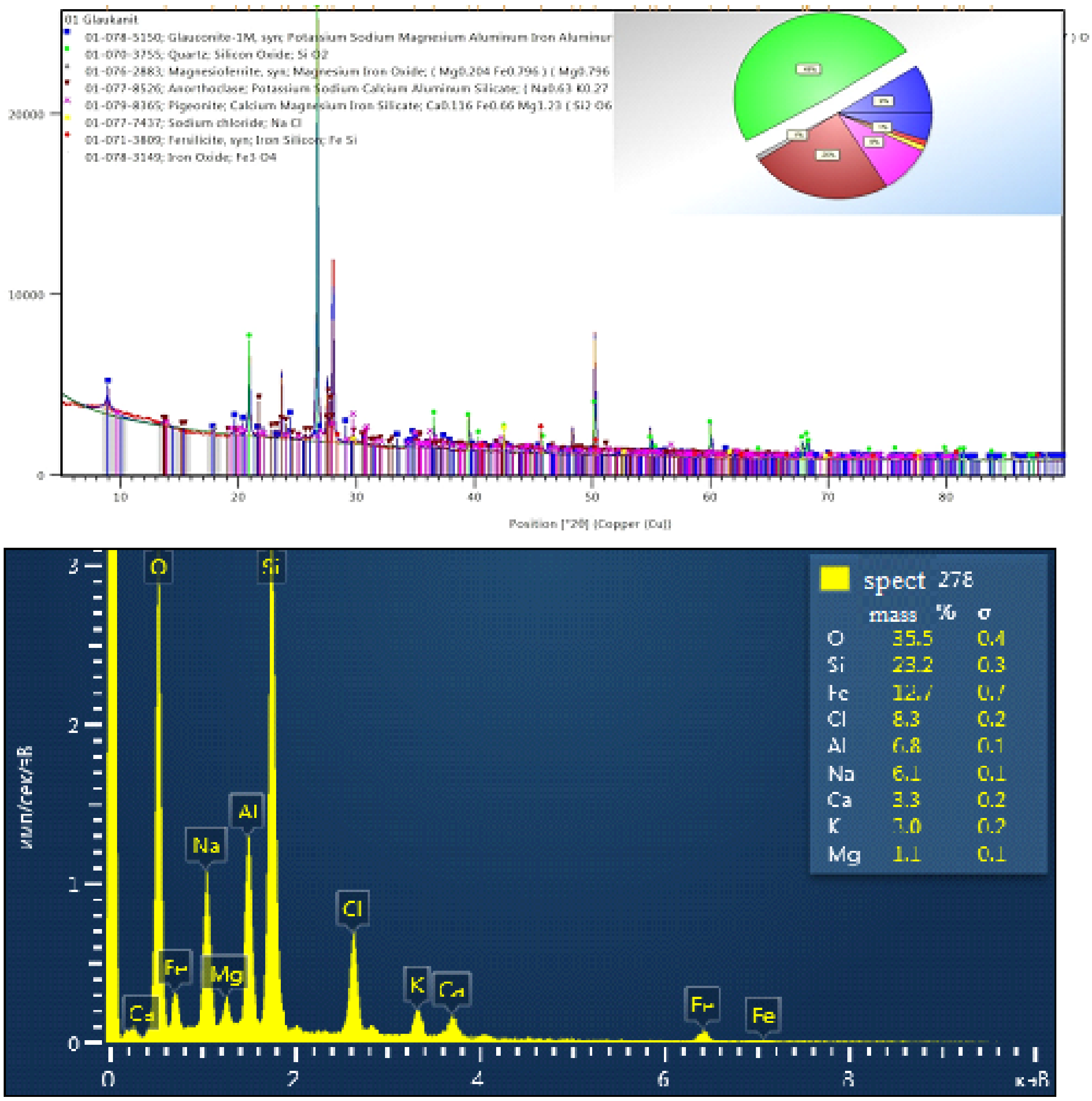
The samples were identified on the basis of diffractograms taken on a computer-controlled XRD-6100 apparatus (Shimadzu, Japan). Radiation-CuKa (β-filter, Ni, 1,54178 current and tube voltage mode 30 mA, kV) and a constant detector speed of 4 degrees per minute, in increments of 0.02 degrees, (ω/20 adhesion) were used, and the scanning angle varied from 4 to 800. The scanning angle in diffractometric studies varied from 2 to 80°. Qualitative and quantitative identification of the phases of the presented samples was carried out using the MATCH! ® Phase identification from Powder Diffraction program (Crystal Impact, GbR, Bonn, Germany, 2015) (MATCH!® 2015; Döbelin, N., Kleeberg, R., 2015). In laboratory conditions, the effect of carbamide on the process of producing complex fertilizers from components of the sapropel, phosphorite, and glauconite system was studied.

Research results:

The production of complex mineral fertilizers based on glauconite, phosphorite and sapropel continued to be widely used in agriculture. Figure 1–3 shows diffractograms and EDS analysis of glauconite sands, phosphorites and sapropel. When taking diffractograms, the same modes were observed, and sample weights were approximately equal.

The following chemical elements were recorded in the energy dispersion spectrum of these raw materials with the following percentage correspondences; (Glauconite) oxygen 35,5; silicon 23,2; iron 12,7; chlorine 8,3; aluminium 6,8; sodium 6,1; calcium 3,3; potassium 3,0; magnesium 1,1. (Phosphorite) oxygen 39,0; calcium 36,2; phosphorus 6,7; carbon 6,2; silicon 4,6; sulphur 2,5; fluorine 1,8; aluminium 1,4; sodium 0,8; magnesium 0,8. (Sapropel) oxygen 45,2; silicon 24,2; aluminium 9,0; iron 7,6; calcium 6,4; potassium 3,5; magnesium 2,1; sodium 1,1 and chlorine 0,8. Processing these materials has the potential to increase agricultural yields.

Figure 1. *Diffractogram EDR Analysis of Glauconite in the Krantau Field*



The results show that as the carbamide content of the mixture increases, the strength of the formed granules also increases. If the standard strength of carbamide granules is 1,5 MPa, then when the ratio of mixture to carbamide changes from (100:0) to (63:37), this indicator increases from 0,68 to 3,6 MPa. The maximum pellet strength – 4,15 MPa – is achieved with a mixture to carbamide ratio of 50:50. In addition, as the urea content of the fertilizer increases, the digestibility of P_2O_5 plants improves. The highest digestibility of phosphorus was observed at the ratios of the mixture to carbamide (80:20) and (63:37). It can also be noted that as the carbamide content in the mixture increases, the amount of nutrients increases. At a mixture to carbamide ratio of (100:0), the N, P_2O_5 and K_2O content was 7%, while the maximum nutrient content was observed at ratios of (50:50) and (63:37). The relative composition of sapropel, phosphorite and glauconite components was compiled using ternar diagrams. The results are shown in (Fig. 4).

Figure 2. *Diffractogram and EDR analysis of phosphorite of the Central Kyzylkum*

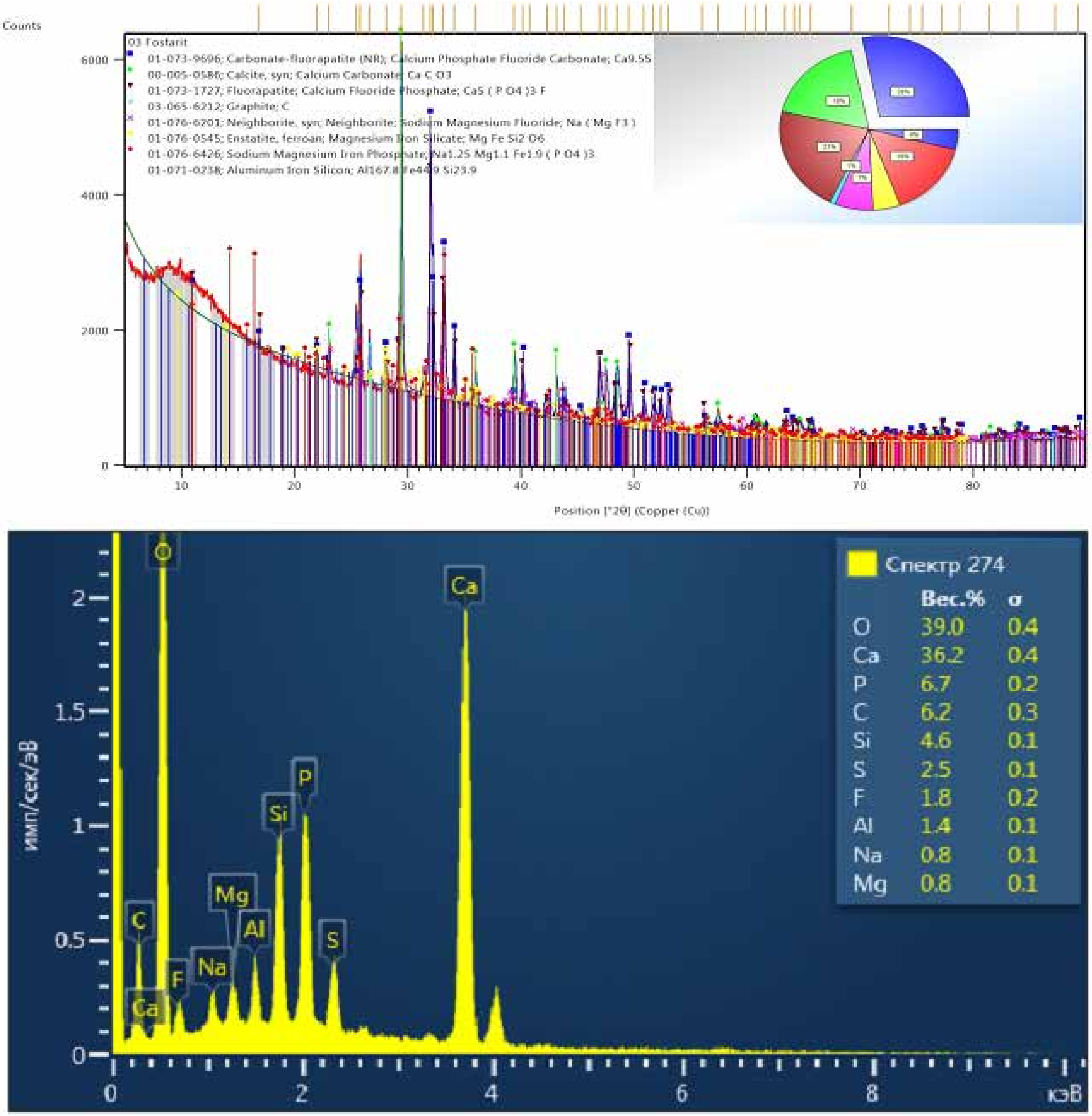
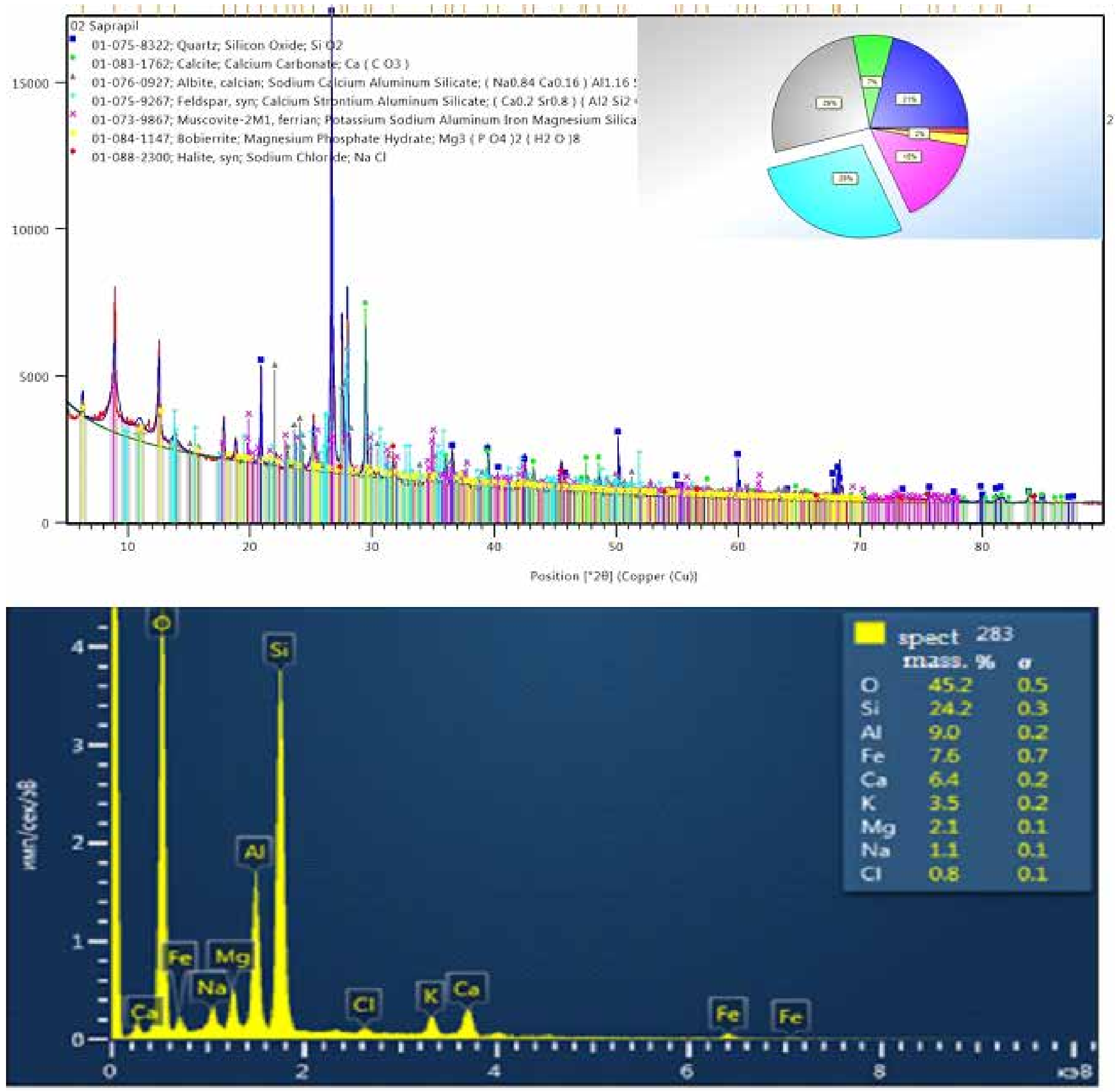


Figure 3. *Diffractogram of EDR analysis of sapropel in the Kushkanatau field*



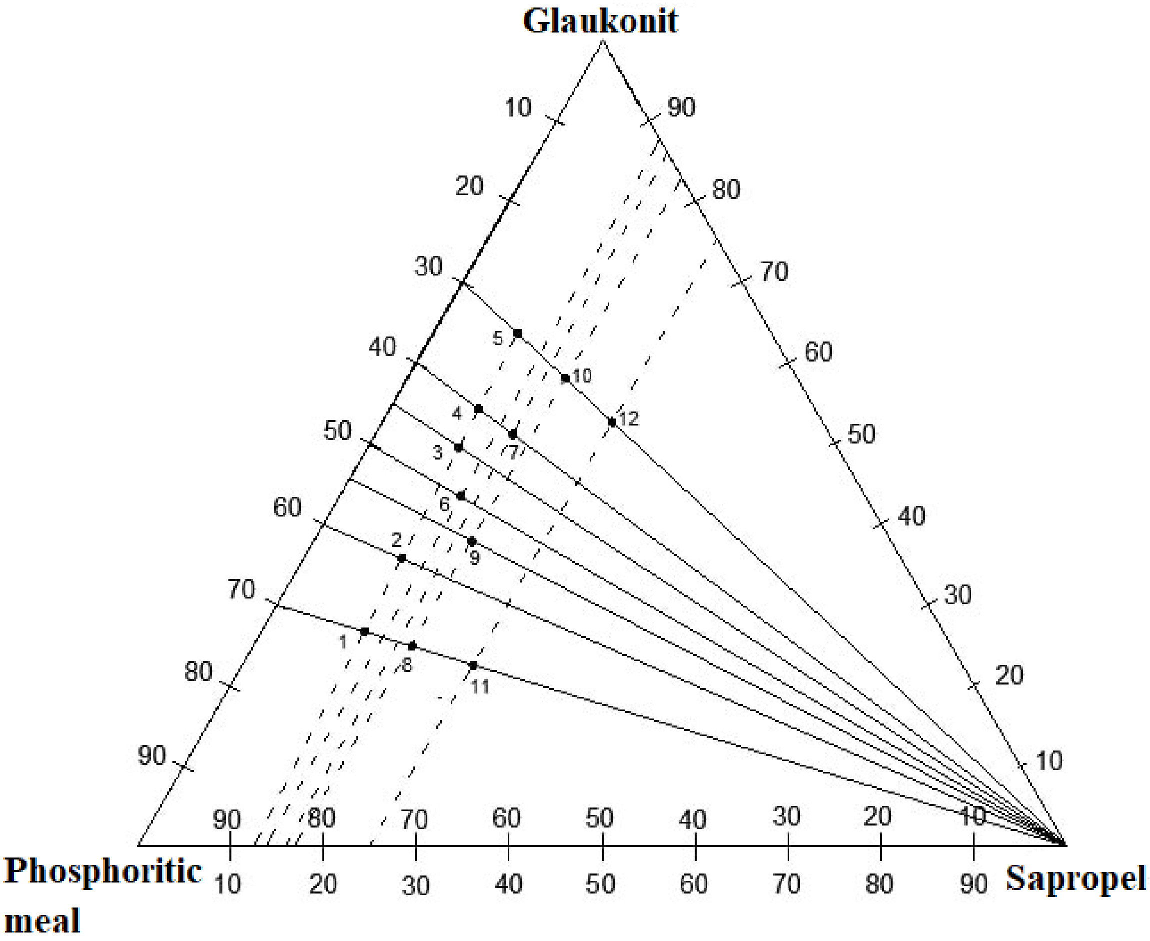
Laboratory tests were performed based on the selected ratios. From the obtained research results, mixtures were prepared in ratios of 5:10:12, and studies with the addition of carbamide in ratios of 100:0, 80:20, 63:37, 50:50 were continued. First of all, sapropel, phosphorite, glauconite and carbamide were crushed to the same particle size, thoroughly mixed to a homogeneous mass and granulated in a plate granulator. A 10% ammonium sulfate solution was used as the coupling reagent.

As a result, granules containing organic groups and trace elements were obtained, the appearance of which was similar to standard fertilizer granules produced in factories. The obtained products were analyzed for the content of N, P_2O_5, K_2O, CaO, Mg according to conventional methods. The strength of the pellets was also measured. The results are shown in Table 2.

The sum of the nutrient components, depending on the ratio of Glauconite+Fosmuca+Sapropel, varies within; 16,3–33,5; 16,11–31,5% and 16,2–31,5% with carbamide, respectively.

Further, the elemental composition of the resulting meliorants was studied. From (Fig. 5) it can be seen that the composition of meliorants contains the highest content of elements O_2, Ca, C, Si, N_2, K, P, Al, Fe, etc.

Figure 4. *Relative content of sapropel, phosphorite and glauconite components (triangular diagram)*



Based on the ternar diagram (Fig. 4), the material and granulometric composition of the meliorant is determined. The results are shown in Table 1.

Table 1. *Material and particle size distribution of meliorant*

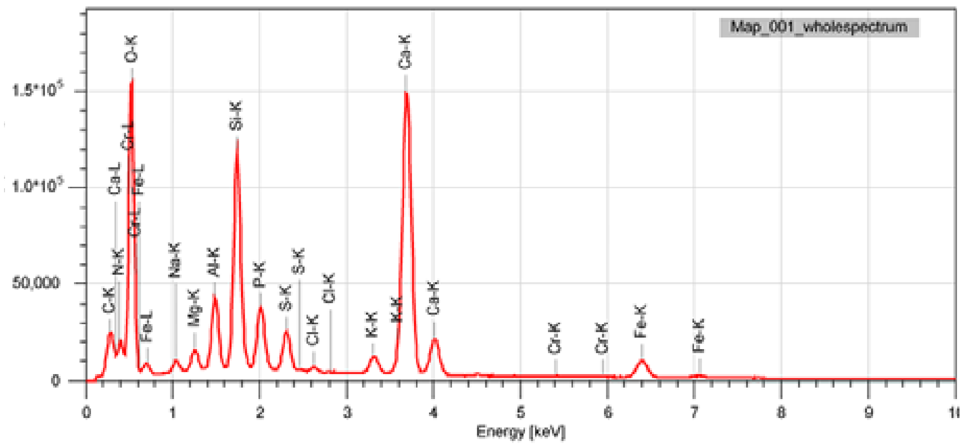
Sample numbers correspond to nomogram numbers, (Fig. 1)	Material composition, gr					Particle size distribution of meliorant grain-size mass, %				
	Enriched glauconite	Fosmuka C.K.	Sapropel	Carbamide	$(NH_4)_2SO_4$ 10%	4	-4+3	-3+2	-2+1	0–001
1.	19.6	50.4	10	20	8	3	25	54	9	9
2.	48.4	21.6	10	20	11	4	23	52	12	9
3.	19	46	15	20	14	6	24.2	49.8	14	6
4.	45.4	19.6	15	20	9	6	30	51	10.5	2.5
5.	18	42	20	20	14	5.4	25	57	8.6	4
6.	39.8	20.2	20	20	11	3	30	59	13	5

From table 1 it can be seen that the main granulometric mass of the fraction content is –4+3; 23,0–30,0 and –3+2 are 49,8–59%, respectively

Table 2. *Chemical composition of meliorant treated with carbamide*

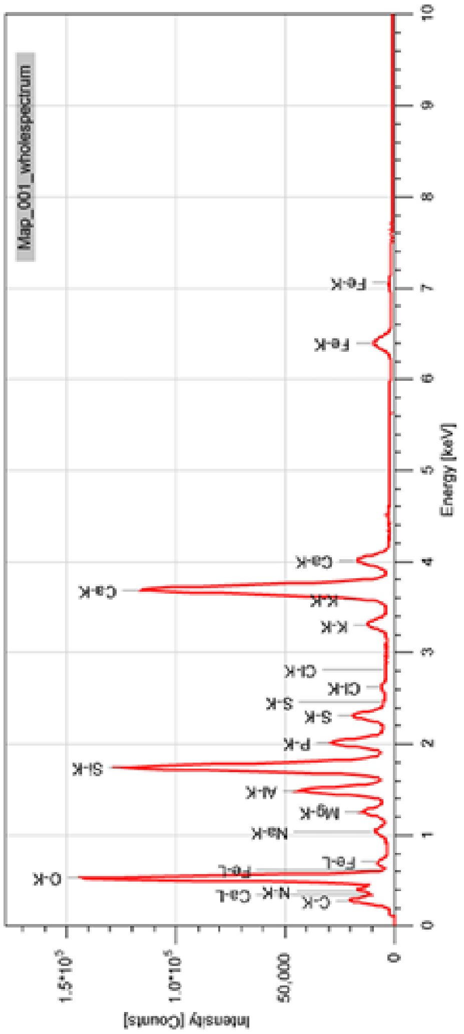
Sample numbers correspond to (Table 1)	Content of components,%									Sum of nutrients,%		Pellet strength MPa
	N %	K_2O %	$P_2O_{5\,total.}$ %	CaO	S	$P_2O_{5\,digestible}$ 2%-each – citric acid %	$P_2O_{5water,}$ %	$\frac{P_2O_{5digestible}}{P_2O_{5total}}$, 2%–each –citric acid, %	$\frac{P_2O_{5water}}{P_2O_{5total}}$ %	$N+P_2O_5+K_2O$, %	$N+P_2O_5+K_2O+S+$ $+CaO+MgO$ %	
1.	9.4	1.5	8.3	22.5	4.65	3.73	1.91	45.0	23.0	19.2	48	3.5
2.	9.2	3.05	4.01	14.68	2.4	3.2	2.41	80	61	16.3	33.5	2.6
3.	9.5	1.66	7.4	23.3	4.3	4.66	2.1	63.0	28.4	18.54	47.65	3.5
4.	9.5	3.1	3.51	10.8	2.12	2.73	1.37	78	39.2	16.11	31.5	2.9
5.	9.6	1.82	6.95	21.5	3.9	4.2	1.89	60.4	27.2	18.32	45.54	3.5
6.	9.6	3.02	3.55	12.9	1.9	3.1	2.21	87.5	62.3	16.2	31.5	3.3

Figure 5. *Elemental analysis results for meliorant, table 1–2, sample-2,4,6, treated with carbamide.* **Sample 2.**



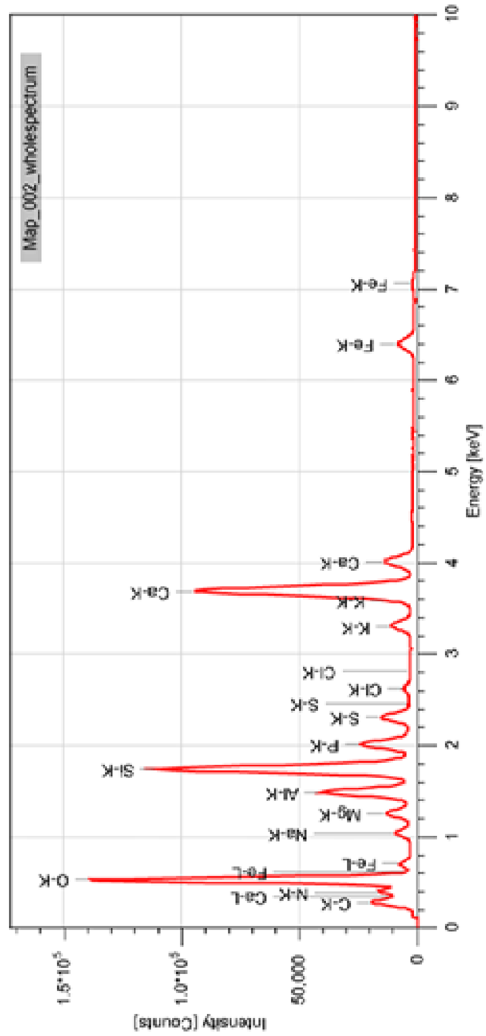
Element	Line	Mass%	Atom%
C	K	11.70±0.02	18.52±0.03
N	K	7.74±0.03	10.51±0.04
O	K	41.72±0.05	49.58±0.05
Na	K	0.71±0.01	0.58±0.00
Mg	K	0.84±0.00	0.66±0.00
Al	K	2.60±0.01	1.83±0.01
Si	K	7.51±0.01	5.08±0.01
P	K	3.24±0.01	1.99±0.00
S	K	1.94±0.01	1.15±0.00
Cl	K	0.26±0.00	0.14±0.00
K	K	0.98±0.00	0.47±0.00
Ca	K	18.07±0.02	8.57±0.01
Cr	K	0.08±0.00	0.03±0.00
Fe	K	2.63±0.01	0.89±0.00
Total		100.00	100.00

Sample 4.



Element	Line	Mass%	Atom%
C	K	11.70±0.02	18.56±0.03
N	K	5.73±0.03	7.79±0.04
O	K	43.34±0.05	51.61±0.06
Na	K	0.74±0.01	0.62±0.01
Mg	K	0.89±0.01	0.70±0.00
Al	K	3.12±0.01	2.21±0.01
Si	K	9.23±0.01	6.26±0.01
P	K	2.89±0.01	1.78±0.00
S	K	1.66±0.01	0.99±0.00
Cl	K	0.23±0.00	0.12±0.00
K	K	1.19±0.01	0.58±0.00
Ca	K	16.45±0.02	7.82±0.01
Fe	K	2.83±0.01	0.97±0.00
Total		100.00	100.00

Sample 6.



Element	Line	Mass%	Atom%
C	K	12.20±0.02	19.04±0.03
N	K	5.85±0.03	7.84±0.04
O	K	44.63±0.05	52.30±0.06
Na	K	0.86±0.01	0.70±0.01
Mg	K	0.91±0.01	0.70±0.00
Al	K	3.26±0.01	2.26±0.01
Si	K	9.20±0.01	6.14±0.01
P	K	2.67±0.01	1.62±0.00
S	K	1.46±0.01	0.86±0.00
Cl	K	0.32±0.00	0.17±0.00
K	K	1.15±0.01	0.55±0.00
Ca	K	14.77±0.02	6.91±0.01
Fe	K	2.71±0.01	0.91±0.00
Total		100.00	100.00

Conclusions

The interaction of the components: glauconite, phosphorite, sapropel and carbamide was studied, while their elemental composition was determined using modern physicochemical methods of analysis.

The process of obtaining complex fertilizers based on mineral raw materials of Karakalpakstan was studied. The sum of the nutrient components, depending on the ratio of Glauconite+Fosmuca+Sapropel, varies within; 16,3–33,5; 16,11–31,5% and 16,2–31,5% with carbamide, respectively. Urea remains neutral in these fertilizers. When making complex fertilizers, these interactions should be taken into account.

It has been determined that in complex fertilizers, the introduced components may be crystalline or amorphous due to interaction with water, glauconite and other components.

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