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Finding of New Opportunities for Target Use of Phosphate Ores' Deposits of Kazakhstan

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Abstract:

The aim of the research is to study the mineralogical composition and properties of phosphate ores of various deposits of Kazakhstan in order to produce nitrogen-, phosphorus- containing fertilizers with increased agrochemical value. The chemical composition of ground phosphate from various places was studied; IR spectroscopic, scanning – electron microscopic and DTA analyses of the ore were carried out. The carried out experiments enable to select composition additives to ammonium nitrate in order to improve its consumer properties. It has been found that the phosphorites of various deposits differ both in content of P2O5 total and P2O5 utal. Presence of fluorine, magnesium, quartz and other substances in them can improve/worsen the technological mode of production of fertilizers. The results of the study of the mineralogical composition and microstructure of phosphate rock samples enable to design the technology of producing new products with useful properties, first of all complex nitrogen-, phosphorus- containing fertilizers. In our case the authors try to find a composition additive in order to make ammonium nitrate less explosive and to improve its fertilizing properties.

Keywords - Agrochemical Quality, Ammonium Nitrate Deposits, Chemical Composition, Phosphate Ores.

I. INTRODUCTION

In recent years nitrate contamination of agricultural products in all regions of the world has increased. It should be noted that the level of application of nitrogen fertilizers in economically developed countries is much higher than in the developing countries. Of course, agricultural products without nitrates do not happen, because they are the main source of nitrogen in plant nutrition.

The natural cycle of nitrogen, having a global character, includes formation, transport and accumulation of nitrates in various components of the biosphere, among which a plant organism is the main one. The Russian scientist D.N. Pryanishnikov and his students proved that ammonium (NH^+) and nitrate (NO) forms of nitrogen are equivalent, but their ratio depends on the specificity of the cultivated crop and environmental factors [1]. So, against the background of potassium the nitrates are better utilized by the plants, and ammonium correspondingly against the background of calcium. Nitrates are better taken up in an acidic medium, whereas ammonium- in an alkaline medium.

Unjustified application of high doses of nitrogen fertilizers leads to its accumulation in the soil in large quantities. In addition, nitrogen fertilizers contribute to the mineralization of the organic matter of the soil, and as a consequence, nitrates are supplied from the soil itself. Therefore, to obtain heavy and high quality yields, it is necessary to incorporate into the soil mineral fertilizers of balanced composition, i.e. containing phosphorus, potassium and nitrogen in reasonable proportions.

In addition, constant increase in the number of livestock, use of industrial complexes for reproduction and fattening of animals leads to formation of waste with sufficiently high nitrogen content within a limited area. As a result, the level of nitrates in agricultural landscapes increases, there appears the need for environmentally safe waste utilization. These wastes are mainly wastewater and active excess silt with a high content of total nitrogen (38-1500 mg / l), most of which is represented by organic and ammonium forms [2, 3]. In this connection, production of complex fertilizers with optimal content of N, P, K is an actual problem.

The most common raw materials for production of these fertilizers in Kazakhstan are the phosphate ores. The aim of the authors is to study the mineralogical composition and properties of ores from various deposits to produce nitrogen- , phosphorus- containing fertilizers with increased agrochemical quality on the basis of ammonium nitrate. The work was carried out at the request of "KazAzot" JSC (Aktau, Kazakhstan), which produces ammonium nitrate [4, 5]. Although the company's products are in demand domestically and abroad, the management's desire to find ways to improve the agrochemical quality of ammonium nitrate is a well-thought-out decision in the light of agrarians' aims to apply balanced fertilizers to grow biologically pure products.

Of course, ammonium nitrate among nitrogen fertilizers shows higher yield indices, but meets cyclic changes, leading to granules' destruction, caking, increased dusting and risk of an explosion initiation. Various additives are suggested to prevent these negative moments. So, in 2013 Sandia National Laboratories staff announced the development of a safe and effective composition based on the mixture of ammonium nitrate and ferrous sulphate, which cannot be used to produce explosives. However, the authors refused to protect the fertilizer formula with a patent, because this compound could be rapidly spread in regions with high terroristic danger [6].

Specialists of "KazAzot" JSC independently carried out tests to obtain safe, stabilized ammonium nitrate with nitrogen content of 28% with the use of composition additives [4]. At the same time, to obtain more convincing data and to develop an effective technological mode, scientists of M.Auezov SKSU were involved; they conducted a number of complex physicochemical and analytical laboratory studies, the results of which are shown below.

II. MATERIAL AND METHODS

Samples of fertilizers with total nitrogen content of 28%, namely stabilized ammonium nitrate with addition of ammophos, ground phosphate, chalk and dolomite powder, were obtained in the pilot production of “KazAzot” JSC. Ammophos dissolves perfectly in the pulp of ammonium nitrate; the finished product has high strength. The experiments showed the possibility of obtaining explosion-proof ammonium nitrate with the addition of dolomite, chalk. However, the phenomenon of foam formation was discovered during the dissolution of chalk and dolomite in the fusion of ammonium nitrate. A defoamer is needed, this complicates the process.

Complete impossibility of dissolution and miscibility of ground phosphate from “Kazphosphate” LLP (Taraz, Kazakhstan) in water and fusion of ammonium nitrate of any concentration was found. Ground phosphate completely precipitates, clogging the pipelines. Encouraging results are given by tests with the addition of ground phosphate of the Chilisai deposit.

In order to find new possibilities for increasing the agrochemical quality of ammonium nitrate as composite additives, we have chosen cottrell dust and phosphorus-containing products – ground phosphate from the Chilisai, Karatau, Zhanatas, Akzhar and Cockjohn deposits [7-9] (Fig.1).

Fig. 1. Deposits of phosphate ores of Kazakhstan [7-9]

Ground phosphate is dry, dust-forming powder of gray, brown or yellowish color. It is slightly hygroscopic, does not cake. It has been established by experiments that the solubility of ground phosphate of various deposits in 2% citric acid ranges from 3-27% [10, 11]. In addition to P_2O_5, the ground phosphate contains calcium, sulfur, magnesium and a wide range of microelements: Fe, Cu, B, Mn, Mo, Zn, Co. The chemical analysis, presented below for each deposit, gives a more complete picture.

Cottrell dust is a large-tonnage waste of yellow phosphorus production. The yield of dust is 221 kg per ton of phosphorus. Currently, about 450,000 tons of cottrell dust is stored in the storage tanks of “Kazphosphate” LLP. In terms of its chemical composition, this product is a good phosphorus-potassium containing fertilizer. The average chemical composition of the cottrell dust is: CaO - 6-23%, SiO_2 - 26-38%, P_2O_5 - 17-27%, Fe_2O_3 - 0.6-1.4%, K_2O - 9-28%, Na_2O - 2.5 -5.5%, MgO - 4-23% [12, 13].

As follows from preliminary studies, ground phosphate and cottrell dust can reasonably be used as composition additives to ammonium nitrate, and this will undoubtedly improve its agrochemical performance. Resources of these types of composite additives are in larger excess than the need in them.

To date, there is little reliable information about the composition and properties of selected composition additives. With the use of the latest equipment from the university's laboratories, they were subjected to complex physicochemical and analytical laboratory studies: screen, chemical, infrared spectroscopic (IR), raster-electron microscopic (REM), differential- thermal (DTA) and other analyzes. These studies will allow us to further refine the parameters of the technological mode for ammonium nitrate production with improved physicochemical and consumer properties.

The material composition of phosphate ores of various deposits was determined by the chemical method in accordance with GOSTs [14]. The mineralogical composition and microstructure of the ore samples were studied on JEOL scanning electron microscope JSM6490 LV [15]. It should be noted that these analyzes of samples were carried out repeatedly.

III. RESULTS AND DISCUSSION

III.I The market of phosphorous-containing raw materials in the world

Numerous deposits of phosphate raw materials are known in India, Australia, Brazil, Turkey, Egypt, Algeria, and Tunisia. Apatite reserves are explored in Sri Lanka and India [16-18]. World reserves of phosphate ores are mainly presented by phosphorites, the amount of apatite does not exceed 6% of reliable reserves. About 80% of the total reserves of phosphate raw materials are in the USA, Morocco and the CIS states (Fig. 2) [19].

The quality of the ores is very variable. The granular phosphorites of Morocco, Tunisia, Egypt, Israel, Jordan are of very high quality, they contain up to 35% P_2O_5 and in some cases do not require enrichment. The world's mining of phosphate ores is led by the United States, Morocco and China, Russia is in the fourth place.

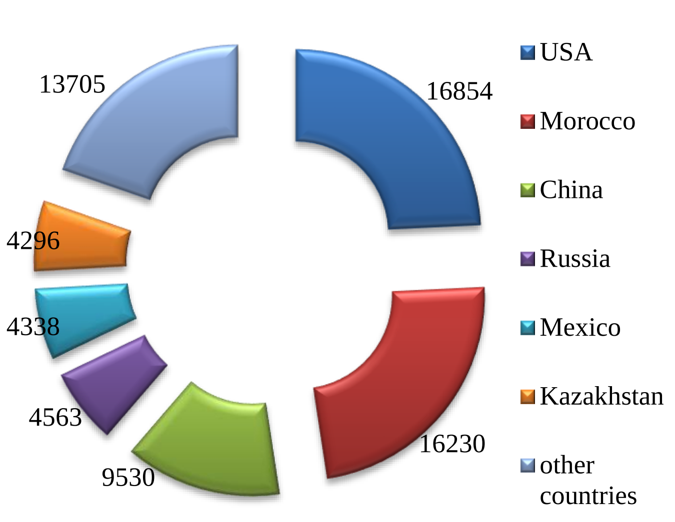


Fig. 2. Distribution of phosphate reserves in the world, mln.t. P_2O_5 [16, 17, 18, 19]. ****Note: data on the reserves differ; the article adopts the average data of later years.*

In the CIS countries there are rich, unique reserves of apatites and phosphorites (Table 1). Deposits of phosphate raw materials of the Khibiny group are the best ones in the world, the largest deposits are in Transbaikalia and Kazakhstan. The problem of ensuring the agriculture of Siberia and the Far East with mineral fertilizers is especially severe. The annual demand for phosphate fertilizers is 900 thousand tons for Western Siberia, 450 thousand tons – for Eastern Siberia, 250 thousand tons – for the Far East [20, 21]. Projects for the development of the fields of Yakutia, Buryatia, other regions of Siberia and the Far East remain still unrealized. In addition, low selling prices for apatite concentrate / phosphorite ($ 60-80 per ton) increase the risk of losses in the extraction of raw materials.

Kazakhstan in terms of reserves of phosphate raw materials is the largest raw material base of Eurasia. At present, about 45 phosphorite deposits have been explored, including the resources of the Karatau field, amounting to more than 15 billion tons of P_2O_5, and the Aktyubinsk massive - over 2.5 billion tons of P_2O_5 [7, 8, 9] A considerable part of the phosphate raw material is processed into ground phosphate, which has fertilizing properties. Ground phosphate in the amount of 200 thousand tons per year is produced at "Temir Service" LLP in Aktyubinsk, it operates on the Chilisisa phosphorites, and at "EuroChem-Karatau" LLP in the amount of 640 thousand tons per year from the Cockjohn deposit ore [22-23].

Table 1. Reserves of phosphate ores of Russia and CIS countries

Deposits	Type of raw materials	Reserves, mn.t. P2O5	
		Explored, by categories A +B +C1	C2 and prognostic data
Russia			
Deposit Khibin (Murmanskaya oblast)	Apatites	533	267
Kovdor and other deposits of the Kola Peninsula	Apatites	153	462
Kingisepp and central regions of the European part	Phosphorites	183	753
Belaya Zima (Irkutstkaya oblast)	Apatites	26	101
Seligdar and regions of Aldan (Yakutia)	Apatites	106	9
Oshurkovo (Buryatia)	Apatites	109	11
Phosphorites of Siberia and Far East	Phosphorites	32	450
Kazakhstan			
Karatau field	Phosphorites	646	2870
Aktyubinski field	Phosphorites	135	625
Ukraine			
Novopoltavskoye ,Stremigorodskoye,	Apatites	66	64
Oskovckoye		7	393
Estonia			
Toopse, Kabala	Phosphorites	157	669
Uzbekistan			
Djeroy-Sardarinskoye and others	Phosphorites	58	72
Source: [7, 24].			

Apatite and phosphorite concentrates are mainly used for acid processing with the help of sulfuric acid into phosphorus-containing fertilizers (ordinary and double superphosphate, ammophos, etc.). For this phosphoric, nitric or hydrochloric acids are sometimes used. In this case, harmful compounds are the compounds of magnesium, aluminum, iron, carbonates, organic substances, etc. In addition, the enrichment and processing of phosphate ores generates a significant amount of waste ("tailings") [25-27]. They contain associated and useful components, in particular, rare-earth elements (fluorine, martite, vermiculite, etc.).

It should be noted that Kazakhstan phosphorites have significant differences in composition and properties. There are ores difficult to enrich: when grinding, enriching some substances are destroyed, new compounds are formed or they interfere with the course of the reaction. Therefore, we conducted a thorough study of ores and a variety of tests.

III.II Analysis of ground phosphate of deposits in Kazakhstan

III.II.I Chemical analysis

The results of the chemical analysis of ground phosphate are given in Table 2. As can be seen, phosphorites' deposits of the Cockjohn and Zhanatas deposits have the highest content of P_2O_5. The high SiO_2 content in the ores of Chilisai, Karatau, and Akzhar deposits averages about 32%. The CaO content in the ores of the Zhanatas and Cockjohn deposits exceeds 30%, and in the phosphate ores of the Chilisai, Akzhar and Karatau - not more than 27%. Phosphate ores of the studied deposits contain about the same quantities of oxides of magnesium, iron, and aluminum. At the same time, the Chislisai and Karatau phosphorites are relatively rich in iron and aluminum oxides, and phosphorites of the Zhanatas, Akzhar and Karatau deposits are distinct by the content of excess amount of magnesium oxides

Table 2. Chemical composition of ground phosphate

№	Ground phosphate of the deposits	SiO_2, %	P_2O_5, %	CaO, %	MgO, %	Fe_2O_3, %	AI_2O_3, %
1	Chilisai	34,38	18,87	25,77	0,65	1,2	2,65
2	Akzhar	26,86	18,12	27,55	1,14	0,40	1,26
3	Zhanatas	15,84	26,34	32,88	1,4	0,71	1,42
4	Karatau	33,92	21,87	27,20	1,14	1,14	1,65
5	Cockjohn	8,94	28,37	37,50	0,9	0,61	1,22
Source: [9, 10, 11].							

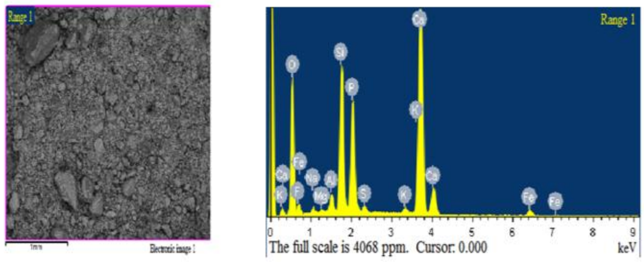
Table 3 presents data on the content of water-soluble, utilizable and citric-soluble P_2O_5 in the considered varieties of ground phosphate. From the table, it follows that phosphorites of the Cockjohn and Zhanatas deposits are mostrich in P_2O_{5total}. However, the content of P_2O_5 in utilizable form in the Cockjohn phosphorites is much higher than in the Zhanatas ores. Among the studied varieties of ground phosphate, despite the relatively average content of P_2O_5 total, ground phosphate from the Chilisai deposit contains practically the entire P_2O_5 in utilizable form.

Table 3. Content of water-soluble, utilizable and citric - soluble P_2O_5 in ground phosphate

№	Ground phosphate of the deposits	P_2O_5 total , %	P_2O_5 water-soluble, %	P_2O_5 utilizable (on trilon solution), %	P_2O_5 citric-soluble, %
1	Chilisai	18,87	0,28	9,0	8,8
2	Akzhar	18,12	0,24	7,0	6,8
3	Zhanatas	26,34	0,26	7,05	7,2
4	Karatau	21,87	0,2	5,0	4,9
5	Cockjohn	28,37	0,3	10,0	9,8
Source: [10, 11, 23].					

III.II.II Raster-electron microscopic (SEM) analysis

Repeated SEM analysis of ground phosphate of all the deposits was carried out. The most interesting results for the Chilisai and Cockjohn deposits are presented in Fig. 3 and Fig. 4.



Element	% by wt.	Weight composition in terms of oxides ,%
O	48.53	
F	2.87	
Na	0.78	1,05
Mg	0.23	0,38
Al	1.20	2,27
Si	9.59	20,51
P	9.61	22,02
S	0.52	1,30
K	0.56	0,67
Ca	24.57	34,37
Fe	1.56	2,23

Fig. 3. SEM data of ground phosphate of the Chilisai deposit

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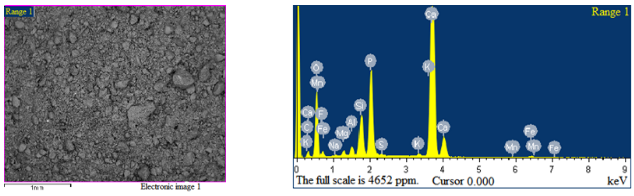


Element	% by wt.	Weight composition in terms of oxides ,%
C	7.81	
O	42.35	
F	4.05	
Na	0.28	0,38
Mg	0.57	0,95
Al	0.94	1,78
Si	4.00	8,56
P	10.76	24,65
S	0.21	0,53
K	0.40	0,48
Ca	27.80	38,89
Mn	0.21	0,27
Fe	0.63	0,91

Fig. 4. Data of SEM of phosphorite flour of Cockjohn deposit

SEM analysis for all the ores' samples, as well as the data of Fig. 3 and Fig. 4, indicate that from the number of the studied samples of ground phosphate the phosphorites of the Cockjohn, Chilisai and Zhanatas are the richest ones in phosphorus**.** In addition, they contain relatively little magnesium. At the same time, the phosphorites of the indicated deposits are characterized by a relatively high content of fluorine. In the studied samples of ground phosphate, the content of aluminum, silicon and calcium is approximately the same.

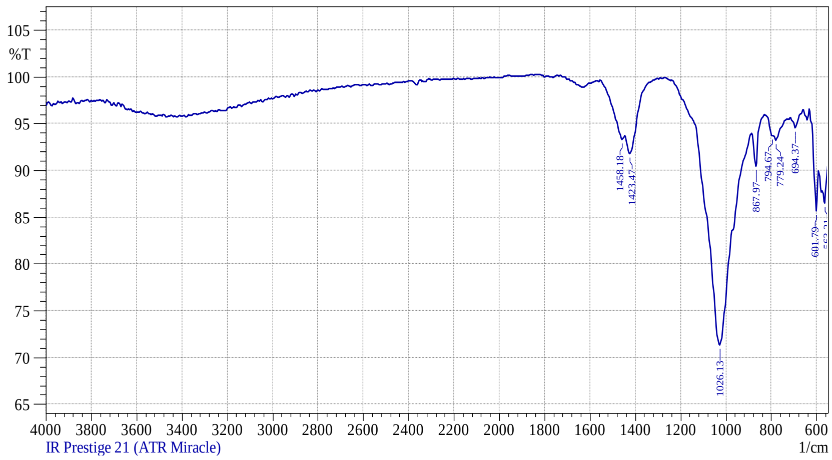
On the basis of these data the researchers tend to offer JSC "KazAzot" the ground phosphate of the Chilisai and Kokjon deposits for mixing with ammonium nitrate in order to produce a complex and explosion-proof fertilizer.

III.II.III Infrared spectroscopic (IR) analysis

The IR analysis of ground phosphate of all the explored deposits was carried out. After the preliminary discussion of the results, the authors decided to demonstrate data on the earlier selected two deposits: the Chilisai and the Cockjohn. The results of infrared spectroscopic analysis of samples of ground phosphate are presented in Fig. 5 and Fig. 6.

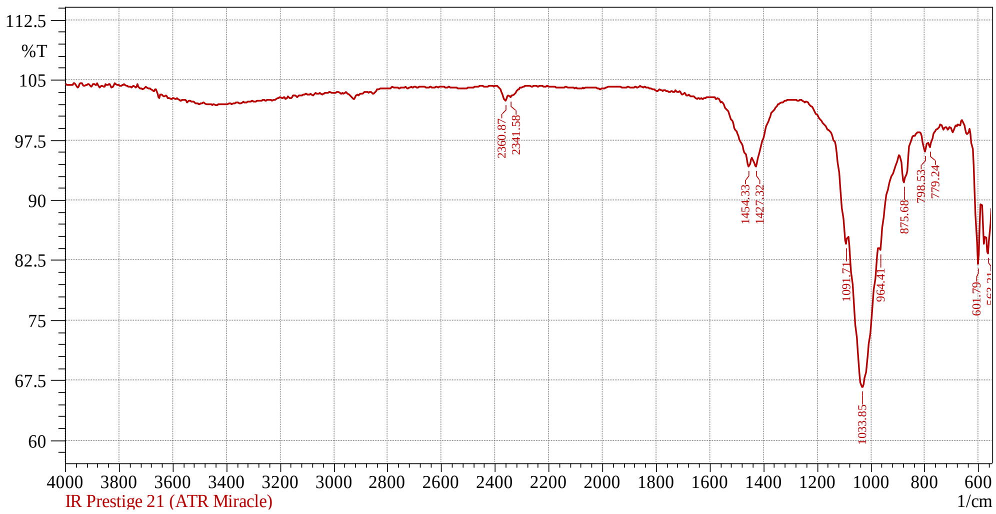
The bands, corresponding to phosphate and quartz, are characterized by high intensity on the spectrum of the sample of the Chilisai ground phosphate. The less intense absorption spectra of 1423-1458 cm^{-1} are characteristic for phosphorus and free compounds P=O. Judging from the doublet 794-867 cm-^{1}, about 15% of quartz are present in phosphorite as well as some clay minerals -563 cm^{-1}.

The IR analysis of the ground phosphate of the Cockjohn deposit differs somewhat (Fig. 6). Analysis of the absorption spectra of infrared radiation shows the presence of the types of bonds: P-O-C; P = O; P-O-P; P-O-Al (bands of 1091 cm^{-1}, 964 cm^{-1}); Fe_2O_3 (883 cm^{-1} band); Si-O-Si (bands 1091-1033 cm^{-1}); CO_3^{2-} (band 1454 cm^{-1}); $CaCO_3$ (875-1427 cm^{-1} bands).



No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	563.21	86.477	2.113	570.93	547.78	1.218	0.095
2	601.79	85.619	6.204	628.79	590.22	1.723	0.457
3	694.37	94.527	1.400	713.66	659.66	1.090	0.152
4	779.24	93.215	2.472	825.53	729.09	2.367	0.513
5	794.67	93.655	0.235	829.39	790.81	0.873	-0.024
6	867.97	90.399	3.988	883.40	829.39	1.514	0.297
7	1026.13	71.278	24.952	1234.44	887.26	20.359	15.330
8	1423.47	91.730	2.729	1442.75	1303.88	2.075	0.419
9	1458.18	93.259	1.076	1550.77	1446.61	1.705	0.133

Fig. 5. IR- spectroscopic data of ground phosphate of the Chilisai deposit



No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	563.21	83.366	3.150	570.93	547.78	1.506	0.167
2	601.79	82.053	9.971	632.65	590.22	1.952	0.746
3	779.24	96.630	0.863	786.96	740.67	0.384	0.027
4	798.53	96.061	1.496	821.68	786.96	0.415	0.076
5	875.68	92.209	3.943	891.11	825.53	1.246	0.401
6	964.41	83.776	1.326	972.12	894.97	3.217	0.049
7	1033.85	66.621	18.150	1083.99	972.12	14.396	6.308
8	1091.71	84.477	1.807	1238.30	1083.99	2.295	-2.230
9	1427.32	94.217	1.513	1438.90	1303.88	0.227	0.109
10	1454.33	94.208	1.771	1566.20	1442.75	0.789	0.203
11	2341.58	102.806	0.362	2349.30	2279.86	-1.073	0.008
12	2360.87	102.429	0.904	2395.59	2349.30	-0.661	0.056

Fig. 6. IR spectroscopic data of ground phosphate of the Cockjohn deposit

Hence it follows that the composition of ground phosphate of the Cockjohn deposit includes quartz (bands of 1091 cm^{-1}), phosphosiderite (bands of 779-798 cm^{-1}).

If to talk about the spectroscopic data of ground phosphate of other deposits, then in the spectrum of the Akzhar ores there is extended absorption in the region of 3250-3150 cm^{-1} due to the vibrations of the associated hydrogen bonds. Absorption spectra with wavelengths of 1049-1060 cm^{-1} are characteristic for phosphorus compounds P = O (with hydrogen bond). The absorption bands in the 952-906 cm^{-1} region are characteristic for P-F bonds and phosphates. Absorption spectra with wavelengths of 1020-1090 cm^{-1} characterize the presence of silicate compounds with valence linkages Si-O-Si.

In the absorption spectrum of the Zhanatas ground phosphate, the bands 799-1427 cm^{-1} and 1,450 cm^{-1} correspond to the bond C-O (5% of carbonate). Carbon in the sample is apparently not only as a separate phase of carbonate (calcite, dolomite, siderite), but also as isomorphic inclusions of carbonate. The bands 601,694,1037 cm^{-1} correspond to gypsum. The bands of 1091 cm^{-1} are characteristic for organosilicon compounds such as Si-O-C, Si-O-Si.

It should be noted that the Karatau phosphorites differ in heterogeneous and complex mineralogical compositions: bands 798, 563, 883 cm^{-1} indicate presence of quartz and feldspar; bands 729, 964, 1454, 1435 cm^{-1} characterize the C-O bond; bands 601, 679 cm^{-1} correspond to gypsum; organosilicon compounds are characterized by bands of 1091 cm^{-1}; bands of 1031 cm^{-1}, 678 cm^{-1} are characteristic for P_2O_5.

III.II.IV Differential-Thermal Analysis (DTA)

Differential-thermal analysis shows the presence of volatile constituents in the studied product. The results of DTA analyzes of ground phosphate of the fields are as follows: Karatau - 2.5%; Cockjohn - 6,5%; Chilisai - 6.9%; Zhanatas - 7.1%; Akzhar - 14%.

As an example, the Cockjohn deposit data are presented (Fig. 7). Differential-thermal analysis is performed under the following conditions of derivatography: sensitivity of the balance is 500, temperature increase rate is 2.7°C and maximum temperature of heating is 1000 °C.

In the time period of about 85 minutes the initial mass of the sample was constantly decreasing. In this case, as follows from data in Fig. 7, endo- and exo-effects are successively manifested on the DTA curve.

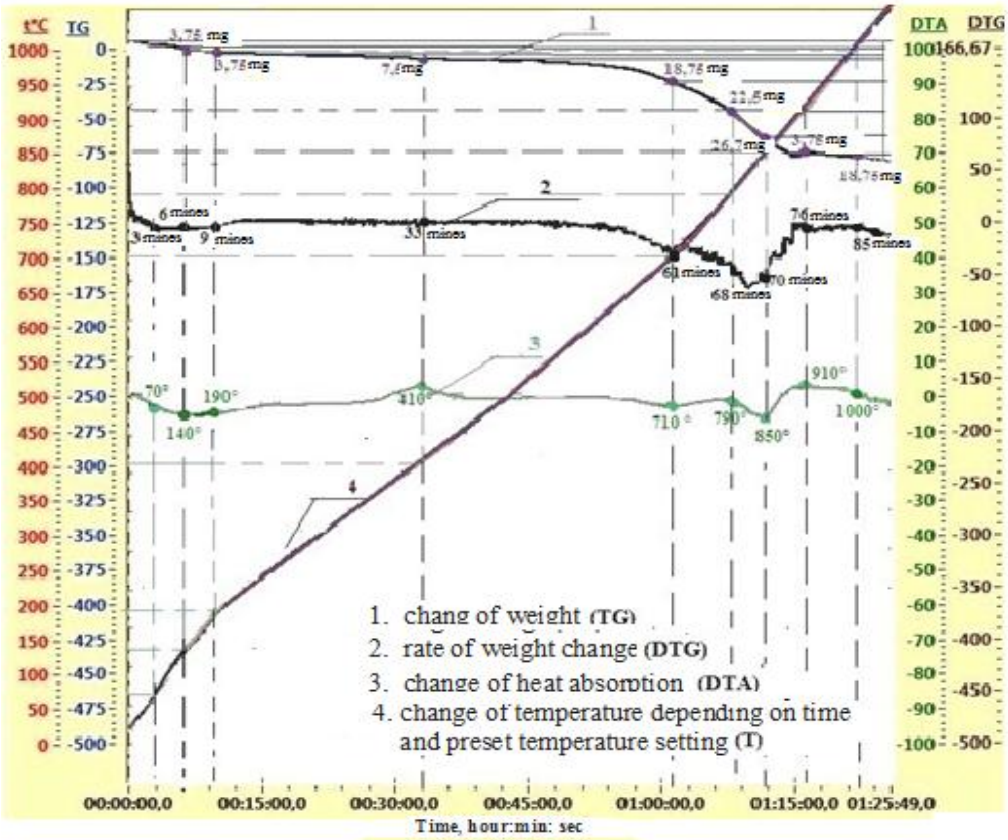


Fig.7. Derivatogram of ground phosphate from the Cockjohn deposit

The endo-effect, observed over a period of 3 to 9 minutes in the temperature range of 70-190ºC, is the result of the removal of adsorption and constitutional waters. The exothermic effect with a maximum at 410 °C is due to the burnout of organic constituents of the ground phosphate. The endo- and exo-effects, observed in the temperature range of 710 °C and 790-910 °C, correspond to the dehydration of the calcium sulfate dihydrate and decomposition of clay minerals and accompanying carbonate minerals, mainly calcite. At temperatures of 910-1000ºC, dehydration of hydro mica occurs. As a result of the decomposition of the sample of the Cockjohn ground phosphate weighting 1610 mg, the total weight loss was 105 mg or 6.5%.

IV. CONCLUSIONS

1. With sufficient mineral resources, the production of fertilizers in Kazakhstan is characterized by a weak level of development against the background of global trends. Thus, fertilizers are applied only to 5% of the acreage (3 kg per 1 ha). In Russia, about 40 kg are used per hectare, while in Europe and the USA it is 130-140 kg, in Latin America less than 90 kg [27, 28]. Out of the total volume of applied fertilizers, 62% are nitrogen ones, mainly ammonium nitrate.

2. Agricultural structures of different forms of ownership (more than 200 thousand units) are in urgent need of complex fertilizers, containing nitrogen, phosphorus and potassium, because of the arid climate and low soil fertility. Ammophos with two nutrients in a soluble form - nitrogen and phosphorus is the most called for. It is assumed that the capacity of the domestic market of fertilizers will grow as the program "Agrobusiness -2020" is being implemented. Already today, there is an increase in the export potential of Kazakhstan's agriculture to the EAEU countries.

3. In connection with the worsening of the food problem in the future, the need for fertilizers in the world will increase 29. At the same time, it is necessary to take into account the change in the structure of world demand in favor of complex fertilizers. For Kazakhstan this is a positive trend, even today the difference in price and cost produces sufficient profit. It is necessary to cover the needs of the expanding agrarian market of the country, to work on improving the quality and range of fertilizers, since large competitors (China, India, Russia) will not only block export to us, but will also supply their products to the Kazakhstan market

4. Kazakhstan has sufficient competitive advantages in terms of cheap raw materials, proven technology of fertilizers production and prospects for sales markets. The availability of

its own raw materials makes it possible to expand the range of nitrogen and complex fertilizers. The being formed transport corridors: the "Western Europe-Western China" highway and the "Nurlyzhol" railway project (a light road) enable to export products practically to almost all the regions of Europe and Asia. The question is how to efficiently process the ore, so that there is less waste and the costs are lower.

5. The authors are convinced that it is necessary to further study the composition of the deposits and the properties of the elements in the composition of ore in order to design the production of new products with useful properties. For example, it is possible to obtain ammonia-lime saltpeter with boron. This product is used for all crops; it is a universal top dressing. The inclusion of boron into the fertilizer composition positively affects the taste of fruits, helps to fight many plant diseases, such as core browning, scab, root hollow, dryness of the tops of fruit trees and spot disease of fruits. In our case, specialists of "KazAzot" JSC set the task for scientists to find a composition additive in order to make ammonium nitrate less explosive and increase its fertilizing properties.

6. Experience shows that a small percentage of useful substances are extracted from the ore, the rest remains outside. Clearly, this is the imperfection of technology. From the said ores and dumps during processing it is possible to obtain a lot of other products, for example, rare-earth elements. This will reduce the dumps, produce more fertilizers and other human-needed products.

V. ACKNOWLEDGEMENT

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