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THE STUDY ON THE ENVIRONMENTAL SIGNIFICANCE OF GLAUCONITE DEPOSITS OF THE SOUTH KAZAKHSTAN REGION WITH THEIR FURTHER APPLICATION IN AGRICULTURE

Abstract. In connection with market relations in the agricultural production, it is possible to abandon the use of high doses of expensive chemical fertilizers and introduce them in smaller amounts under different crops jointly with natural mineral glauconite, which is characterized by a whole set of chemical compounds and micro elements necessary for the mineral nutrition of plants. This work is aimed at identifying common geological and environmental characteristics of glauconite deposits in order to conduct a study on the use of glauconites in agriculture. In the course of the study, stimulatory effects of glauconites on the development of useful soil microflora determining their fertility and sides of glauconites possessing high adsorption and cation exchanging properties which can be used as the adsorbent of contaminants were studied. With the help of an areal application of glauconite in the cultivation of agricultural crops and the creation of geochemical barriers, rehabilitation of soil properties having a high technogenic load as a result of industrial enterprises activities were identified.

Keywords: glaukonit, minerals, technogenic loading, the soil, adsorption, montmorillonite, a forage, culture.

Introduction. In the modern seas, glauconite deposits are formed in the shelf fields and upper part of a continental slope. There are no glauconite deposits in the abyssal area. The average depth of the formation of modern glauconite is from 20 to 150 m, in average is about 70-80 m, but the formation of glauconite at shallower depths is likely to be from 10 to 20 m. The presence of glauconite at the depths of 200-400 m was also identified. Standing out as the finest sediment, sometimes it penetrates into the cavity of foraminifera and radiolarians, filling them and forming glauconite cores. Such cores are found in the modern bathyal silts.

A shallow-marine origin is widely expanded in sedimentary rocks and the modern marine sediments. Glauconite contains bathyal green silt, glauconite sandstone, light green glauconite cretaceous sands, green glauconite ordovician limestone and many other rocks. But it does not form large monomineral clusters in nature and occurs exclusively in a mixture with other minerals of clayey or sand strata; its content in the rock seldom exceeds 50%. Celadon in small quantities is common in the tonsils and cracks of effusive rocks. Among glauconite facies, sands and aleurites, which sometimes included in the composition of phosphorite conglomerate, dominate; glauconite clays are more rare, although they are quite common. Sometimes glauconite silts are enriched by calcite and represent glauconite limestone, usually more or less clayey, by themselves in the form of fossils. Glauconite is formed only in the sea basins, but its seeds are resistant to weathering and is therefore in the secondary occurrence they are found in freshwater and even terrestrial sediments. As a result, by the presence of only grains of glauconite in those or other deposits, their marine origin cannot be judged. In the form of large grains, it is contained in the coarse-grained sands and mall pebble conglomerates,often phosphorite.

In recent years, the study of geological systems of glauconite deposits in the developed countries has become increasingly deep since glauconites are significant mineral objects in the broad sense. Ongoing

researches in this field are conducted in many countries around the world, especially in European countries. Over the past century, the scope of glauconite use is more and more expanded. The reason is a valuable mineral composition and chemical properties of different glauconite. The study of glauconite rocks from the upper cretaceous sediments in the Southern Priaralie was carried out over a number of years by taking layered samples from outcrops and cores of drilled wells in the areas [1]. All selected samples were integrated to a complex modern laboratory investigation to determine the glauconite composition in them and study its application prospects in various areas of agriculture.

The studied areas of glauconite deposits of the Southern region require a detailed study of structural and crystal-chemical characteristics of minerals with a complex and changeable structure, which allows to identify new criteria for evaluating their quality and manufacturability to produce competitive products. The relevance is determined by the need to expand the mineral resource base of our country, including, by means of the development of new scientific and methodological foundations of mineralogy studies.

Owing to the comprehensive studies, the possibility of widespread use of glauconite in agriculture was revealed contemporaneously providing solutions to environmental problems. The estimated reserves and resources of deposits and occurrences of glauconite, identified through conducting the studies within the glauconite deposits of South Kazakhstan region will be able to provide business enterprises, commercial farms and other facilities with activities operating in a number of the mentioned spheres of our economy. In particular, as glauconites are easily enriched, they can be used in natural form as a fertilizer since their high agrochemical properties have been proved.

A high absorption capacity of glauconite can be used to solve problems of geo-ecology engineering to protect the environment from the effects of various eco toxicants that can rapidly migrate to the hydro and geosphere and thereby disrupt the normal course of biochemical processes.

The study purpose is to investigate the mineral composition of glauconite rocks of Southern Kazakhstan, investigate various properties in the agricultural sector, as well as carrying out experimental work with the help of modern technologies for the use of glauconites in the various fields of activity.

Research methods. In the study of the glauconite concentrate (hereinafter simply "glauconite"), the complex physical and chemical methods were used: photocolorimeters, differential thermal, X-ray structural, X-ray phase analyses. In the course of the study, the investigation was carried out on the technological properties and the quality assessment of glauconite deposits, expediency of application (in various fields of activities) of various forms of a glauconite material – a natural rock, concentrate, extract, mixture with other ingredients, etc. The workability of glauconite raw materials was determined primarily by the adsorption characteristics and the amount of glauconite granular in the rock. In this regard, recommendations on the limits of the content of critical components – glauconite, quartz, clay (<0.01 mm) and glauconite rocks oxides (K2O, P2O5), essential in the evaluation of their quality for specific areas of use, especially for the needs of agriculture and environment at the improvement of the environment from polluting toxic substances were developed.

Results and discussion. Glauconite relates to a class of clayey minerals, a family of phyllosilicates containing continuous tetrahedral layers of the structure TgS (T -81, A1, Fe, etc.). They are characterized by the same type of structure with aluminosilicate layers of 2: 1, separated by interlayers of different varieties consisting of K + cations, as in micas, water molecules and exchangeable cations as in montmorillonites. An important fact is that there are often significant quantities of minerals (Mn, Cu, Co, Ni, B et al.) in glauconite, and many reservoir of glauconite rocks contain high impurity of P2O5 and even include phosphate horizons. All this gives grounds to consider glauconites as natural fertilizers, which allow us not only to enrich the soil with potassium, but also to improve its structure, retain moisture, stimulate growth and reduce the incidence of plants. Glauconite of the southern region has the following average chemical composition.

Due to rather high content of potassium dioxide (7.6%) and phosphorus pentoxide (up to 3%), glauconite can be used to produce potash fertilizer or as a natural fertilizer without processing. In particular, the introduction of glauconite flour into soil increases the yield of a number of crops and potatoes by 10-20%, significantly increases the yield of fruit trees.

Taking into account the limited edition of industrial forms of fertilizers containing macro and micro elements in its composition, we attached particular importance to the glauconite, capable to fill their deficiency in soils and plants.

Table 1 – Results of chemical (silica) analysis on the glauconite rocks of the south-central part of the Central Karatau

#	Places of occurrence	SiO_2	Fe_2O_3	CaO	MgO	K_2O	P_2O_5	Al_2O_3	Na_2O	MnO	FeO	TiO_2	SO_3
1	Bala-Burgem	79,57	3,6	2,54	1,25	4,40	0,49	3,42	1,49	0.45	2,50	0,02	0,27
2	Burgem	78,69	3,20	2,40	1,28	4,29	0,36	3,68	1,96	1,21	2,58	0,03	0,32
3	Krash-tobe	84,36	2,10	0,76	0,86	3,89	0,56	3,59	1,26	0,49	1,86	0,01	0,26
4	Kainar	86,77	1,13	0,83	0,76	4,18	0,59	2,23	1,12	0,56	1,69	0,01	0,13
5	Kainarbulak	82,58	2,78	1,05	0,97	3,23	0,86	3,67	1,89	0,86	1,78	0,02	0,31
6	Kos Uyenki	83,69	2,22	0,80	0,99	3,56	0,48	3,39	1,92	0,84	1,72	0,01	0,38

The results of two years of observation (2014-2016) indicate that glauconite has had a significant positive impact on the food ration of the soil. Under its influence in determining both terms, not only the content of soluble forms of potassium, phosphorus and micro elements, but also nitrogen that is associated apparently with increasing soil, microbiological activities were increased (Table 2).

Table 2 – Effect of glauconite on the nutrient content of the southern calcareous in Black Earth at the cultivation of irrigated potato

Years of research	Term of determinations	Experience options	NO_3	P_2O_5	K_2O	B	Mn
			mg per 100 g of soil			mg per 1 kg of soil	
2014-2015	Seedlings	Control	24,0	4,9	94,0	0,6	0,8
		Glauconite 10 t / ha	31,0	6,5	125,0	0,8	16,4
	Blooming	Control	32,0	trace	5,0	0,2	36,0
		Glauconite 10 t / ha	50,0	2,5	22,5	0,4	40,0
2015-2016	Seedlings	Control	33,0	5,8	94,0	0,6	16,0
		Glauconite 10 t / ha	41,0	6,5	94,0	0,7	32,4
	Blooming	Control	52,0	2,5	15,0	0,3	36,2
		Glauconite 10 t / ha	68,0	3,2	29,0	0,5	48,0

The plants that grow in areas with the introduction of glauconite were different from the control plants with greater height; powerful leaf-shaped apparatus and intense dark green color, indicating a high content of nitrogen and chlorophyll in them. The difference between the experimental and control plants was particularly noticeable in the second half of the growing season. The potatoes reacted to the glauconite most strongly. The total collection of tubers on average increased by 68 centners per 1 ha from this fertilizer in two years, which amounts to 32% of the control plants.

The use of glauconite was effective, particularly good results were obtained from growing barley in the village "Shaga" of Turkestan district of South Kazakhstan region (Table 3).

In the fall of 2014, 30 t/a of manure was applied in the experimental field and corn was planted on the green fodder in the spring of 2015. After its harvesting, 20 t/ha of glauconite sand containing glauconite from 36% to 40% and was introduced under deep autumn plowing on the area of 29 ha. An equal-area was left for the control (Table 3).

The harvest of alfalfa hay, green mass of corn, fruits of cucumbers and tomatoes were increased by 12-20% by using glauconite. The effect of glauconite was not limited by only one year. Subsequently, the tuber potato crop was increased by 18.6% and green mass of corn to 13.2%. The glauconite in grain barley increased the content of the cheese protein by 1.3% (control – 8.7%, glauconite – 10.0%). Under its influence, carbohydrate biosynthesis and vitamin C were improved in the areas of vegetable crop (Table 4).

Table 3 – Efficiency of glauconite on the southern calcareous black earth under the irrigation term

Crop	Sort, hybrid	Options	The harvest centners per 1 ha			increment	
			2013	2014	aver.	c	%
Corn, green mass	VIR42	Control	394	325	360	–	–
		Glauconite 10 t / ha	446	388	417	57	15,8
Potatoes, the tubers	Volzhanin	Control	251	173	212	–	–
		Glauconite 10 t / ha	342	218	280	68	32,0
Tomatoes, fruitage	Volgogradskiy 5 /95	Control	505	440	473	–	–
		Glauconite 10 t / ha	582	490	537	64	13,5
Cucumbers, fruitage	Urozhainy 86	Control	420	305	363	–	–
		Glauconite 10 t / ha	474	344	409	46	12,6

Table 4 – Effect of glauconite on the quality of vegetable crops yield under the irrigation, the average for 2014-2016

Crop	Control	Dry substance	Sugars, %	Vitamin C	Acidity in %
Tomatoes	Glauconite 10 t / ha	6,9	2,25	15,2	0,67
	Control	6,9	2,55	25,5	0,39
Cucumbers	Glauconite 10 t / ha	4,0	1,80	4,9	0,13
	Control	5,0	2,15	5,9	0,13

The use of glauconite on the background of the aftereffect of manure increased the actual yield of barley grain at 8.9 kg/ha or 37.7%. The yield increase was ensured mainly due to the increase in the coefficient of productive tillering (from 2.2 to 2.6) and weight of 100 seeds (from 41.5 to 47.0 g).

It is characteristical that 12.7 t/ha of barley grain was gathered from the array production (29 ha). The combined use of manure (aftereffect) and 20 tonnes of glauconite sand on the backdrop of high agricultural technology increased the barley grain yield by 2.6 times, indicating the prospect of joint use of local, organic and mineral fertilizers.

Good potato responsiveness on glauconite obtained in our field experiments served as the basis for its implemention into the production in the state farm "Shaga" of Turkestan district of South Kazakhstan region, where the areas reach 120-130 hectares under this crop.

Glauconite was introduced in 2015 under the spring plowing of the soil on an area of 35 hectares. For this reason, and also due to the lack of timely watering in the experimental field, the optimum density of plant standing could not been obtained. Glauconite interaction with the soil was less prolonged compared with the autumn term of the introduction. But even in these conditions, 22 centners of potatoes were obtained from each hectare from glauconite additionally, which were 17.4% of the control.

In 2016, glauconite aftereffects were studied in the same state farm. When accounting the actual potato crop from the area of 35 ha, its increment of 10.3 centners per 1 hectare or 16 was obtained, in relation to the control, where the yield was 64.1 centners per 1 hectare. The glauconite aftereffect was studied at the state farm “Icahn” of Turkestan district of South Kazakhstan region. In 2014, we took into account the yield of green mass of sunflowers from whole the experimental field (29 ha), which was equal to 77.2, and 70.3 per 1 hectare in the control. The yield increase on the experimental area was 6.9 centners per 1 ha or 9.8%. In 2016, the largest yield increase in the pea-barley mixture for hay (18.6 centners per

1 ha or 26.2%) was obtained in the variant with the introduction of 10 tons of glauconite. In addition, glauconite has not only a direct effect, but also a significant aftereffect when introducing 15-20 t/ha. The study with glauconite and especially under the irrigation terms should be continued.

Conclusions and offers. The conducted studies suggest the appropriateness of using the cretaceous and paleogene glauconite as a fertilizer containing essential micro and macro elements necessary for plants. Under its influence, the food regime of the soil is improved, the quantity and quality of seedling of sowing material are improved (significantly) and the incidence of plants, especially in the initial period of the growing season is reduced; all this improves germination capacity of indicators and provides high-quality development of plants during the complete growing season, improves fruit formation in a hot and dry summer period in the southern region in comparison with the control samples. Glauconite introduction into soil separately and jointly with mineral fertilizers contributes to the enrichment of basal layer of agricultural crops with mineral elements, improvement of aeration and moisture retention in the soil. The use of this technological technique is relevant since it allows to solve a number of problems to improve the efficiency of using mineral fertilizers, increase crop yields and the quality of potatoes and other agricultural crops. The options have been identified where through the use of glauconite and fertilizers there is a significant increase in the content of starch in tubers of potato, dry substance, crude protein and vitamin C.

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ОҢТҮСТІК ҚАЗАҚСТАН АЙМАҒЫНДАҒЫ ГЛАУКОНИТТІ КЕННІҢ ЭКОЛОГИЯЛЫҚ МАҢЫЗДЫЛЫҒЫН ЖӘНЕ ОЛАРДЫ АУЫЛШАРУАШЫЛЫҒЫНДА ҚОЛДАНЫЛУЫН ЗЕРТТЕУ

Аннотация. Бүгінгі таңда ауылшаруашылық өндірісіндегі орныққан нарықтық қарым-қатынасындағы жағдайға байланысты, әр түрлі егін өсімдіктеріне қымбат минералды тыңайтқыштардың жоғары мөлшерінің орнына олардың аз ғана мөлшерімен қатар табиғи минерал глауконитті пайдалану әлдеқайда ұтымды болып келеді, себебі, глаукониттің құрамында өсімдіктердің минералды қоректенуіне қажетті бірқатар химиялық

қосылыстар және микроэлементтер кездеседі. Бұл жұмыс, ауылшаруашылықта глауконитті қолдану үшін глауконитті кендердің жалпы геологиялық-экологиялық сипаттамаларын анықтауға бағытталған зерттеу жұмыстарын жүргізуге бағытталған. Зерттеу барысында глауконитердің топырақ микрофлорасына қажетті қалпына келтіруші, өнімді жоғарлатушы, зиянды заттарды сіңіретін жоғары адсорбциялық және катион-алмастырушы қасиеттері бар екендігі айқындалған. Глауконитті ауылшаруашылық астықты өсіру және өндірістік орындарының техногендік жүктеменің нәтижесінде зақымданған топырақ жүйесіне геохимиялық кедергілерді жасау үшін оларды аудан бойынша ендіріп, топырақ үшін реабилитациялық қасиеті қарастырылған.

Түйін сөздер: глауконит, микроэлементтер, техногенді жүктеме, топырақ, адсорбция, монтмориллонит, жем, мәдени өсімдік.

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ИЗУЧЕНИЕ ЭКОЛОГИЧЕСКОЙ ЗНАЧИМОСТИ ГЛАУКОНИТОВЫХ МЕСТОРОЖДЕНИЙ ЮЖНО-КАЗАХСТАНСКОГО РЕГИОНА С ДАЛЬНЕЙШИМ ИХ ПРИМЕНЕНИЕМ В СЕЛЬСКОМ ХОЗЯЙСТВЕ

Аннотация. В связи со сложившимися в сельскохозяйственном производстве рыночными отношениями, можно отказаться от использования высоких доз дорогостоящих минеральных удобрений и вносить их в меньших количествах под различные культуры совместно с природным минералом глауконитом, который характеризуется целым набором химических соединений и микроэлементов, необходимых для минерального питания растений. Данная работа направлена на выявление общей геолого-экологической характеристики глауконитовых месторождений с целью проведения научных исследований по применению глауконитов в сельском хозяйстве. В ходе исследований выявлено стимулирующее действие глауконитов на развитие полезной микрофлоры почв, определяющих их плодородие, изучены стороны глауконитов обладающих высокими адсорбционными и катионообменными свойствами, которые могут использоваться в качестве адсорбента загрязняющих веществ. С помощью площадного внесения глауконита при выращивании сельскохозяйственных культур и создания геохимических барьеров, выявлено реабилитационное свойство почвы, имеющую высокую техногенную нагрузку в результате деятельности промышленных предприятий.

Ключевые слова: глауконит, микроэлементы, техногенная нагрузка, почва, адсорбция, монтмориллонит, корм, культура.