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# Qualitative and Quantitative Determination of the Mineral Composition of Glauconite Sands of the Krantaus Deposit

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**Abstract:** In the work, glauconite sands of Karakalpakstan, including those from the Krantausskoe deposit, were studied. The physical and chemical properties and compositions of glauconite sand were studied with the aim of their processing into local fertilizers. These samples were studied by powder diffractometry using modern programs for quantitative analysis. Studies have shown that glauconite containing rocks is the most valuable agronomic ore that can be used as complex fertilizers.
**Keywords:** Krantau, mineral, glauconite sand, qualitative X-ray diffraction analysis quantitative phase analysis

## Introduction

The role of mineral fertilizers in raising crops is well known. Mineral and organomineral fertilizers play a decisive role in obtaining high yields of raw cotton and other crops. In many countries, the need for mineral fertilizers is very high, and is growing every day. Therefore, along with the main mineral fertilizers produced by industry, it is necessary to use local resources. In this regard, special attention should be paid to the mineral raw material glauconite. We in the Republic have huge reserves of glauconite sandstone in the area of Krantau. Glauconite is widely used in agriculture as a soil fertilizer in Russia, the USA, Canada, Japan, England, Belgium, Italy, India and in many countries of the world. Of interest is not only the nutritional components of glauconite, but also its structure, a very high cation exchange capacity. In addition, glauconite is widely distributed in nature. Research aimed at developing a technology for enrichment of glauconite sands of Karakalpakstan, in particular, the Krantau deposit, with the simultaneous production of glauconite-containing complex fertilizers, is very relevant, which is one of the main tasks of this work [1].

## Methods and materials

Qualitative determination of the mineral composition of glauconite sands of the Krantaus deposit; the mineral composition of glauconite sands was determined by X-ray phase analysis. The samples were first studied by the method of qualitative X-ray phase analysis using the MDI JADE 5.0 program. To determine the quantitative composition of the minerals of glauconite sands of different fractions, the method of quantitative X-ray diffraction analysis was chosen. These calculations were carried out with the computer program Profex-3.9.2 [2-5] developed by the employees of Nicola Doebelin of the Geological Institute (University of Bern, Switzerland) and Reinhard Kleeberg of the Institute of Mineralogy (TU of the Mining Academy, Freiberg, Germany).

## Results and discussion

On the basis of physicochemical, X-ray phase analysis methods, the mineralogical composition of glauconite from the Krantaus deposit of Karakalpakstan has been established. In addition to quartz (SiO2), the samples contain kaolinite, muscovite, illite, montmorillonite, halite (common salt), feldspar varieties anorthite, albite, microcline, and trace amounts of phosphorites and chlorites. Kaolinite is a clay mineral from the hydrous aluminum silicate group. Chemical composition of $Al_4[Si_4O_{10}](OH)_8$; contains 39.5% $Al_2O_3$, 46.5% $SiO_2$ and 14% $H_2O$. The diagnostic reflections of kaolinite are its basal reflections - 001, 002, 003 (0.712-0.714; 0.355-0.357; 0.237-0.238 nm). There are also some polytypes 1M, 2M1 (dikit) and 2M2 (nakrit).

Muscovite is a potassium and aluminum aluminosilicate with hydroxyl, belonging to dioctahedral micas, a rock-forming mineral. The composition is determined by the formula $KAl_2(AlSi_3O_{10})(OH)^2$. Muscovite's diagnostic reflexes are its basal reflex - 001 -1.001nm (Fig. 1). There are also some polytypes of fuchsite, phengite, sericite, etc.

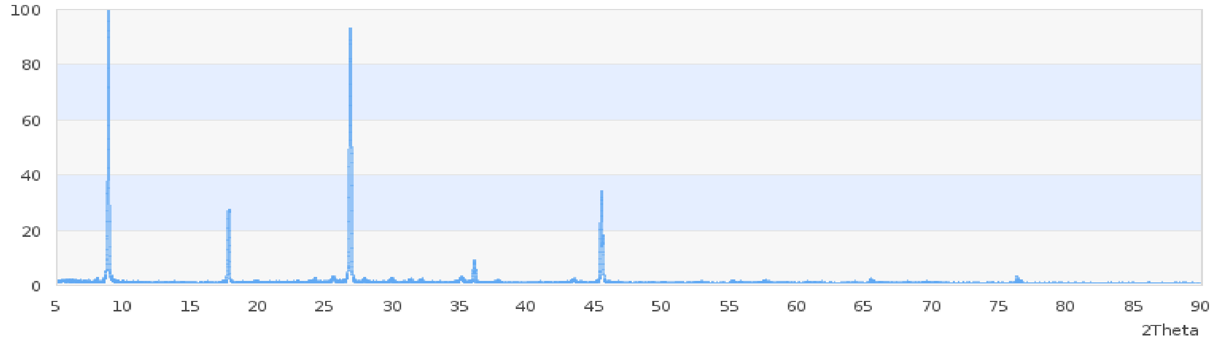


**Fig.1. Diffractogram of muscovite**

Illite $K_{0.65}Al_{2.0}[Al_{0.65}Si_{3.35}O_{10}](OH)_2$ (synonyms: hydromuscovite, monothermite, grundite, geschwitzite) is a mineral from the group of hydromicas of the structural type sheet silicates of the class Silicates. The name is given by the place of discovery in Illinois (USA). In most cases, illite is a product of partial hydrolysis of muscovite, in some cases mixed-layer illite-muscovite formations appear, to which in most cases the name hydromuscovite is applied, in some cases it is a product of alteration during the transformation of feldspars into kaolinite. Montmorillonite $(Na,Ca)_{0.33}(Al,Mg)_2(Si_4O_{10})(OH)_2 \cdot nH_2O$ clay mineral belonging to the subclass of layered silicates, the main component is bentonite. This mineral has the ability to strongly swell due to its structure and has pronounced sorption properties. The main diagnostic reflex for montmorillonites is 001, other basal reflexes are less pronounced. The position of the 001 reflection in montmorillonite is not constant; it essentially depends on the type of exchangeable cations, the amount and figuration of interlayer water. The interplanar distance of the first basal reflection (d001) of montmorillonite containing sodium as an exchange cation, with which one molecular layer of interlayer water is bound, is 1.24 nm, in the case of calcium d001 = 1.54 nm, and magnesium - 1.43 nm. Another type of minerals present in glauconite sands are different modifications of feldspar.

Microcline (from other Greek Μικρός - small and κλίνω - I tilt) is a widespread rock-forming mineral of the silicate class of the feldspar group, potash-sodium feldspar (Fig. 2), potassium aluminum silicate of the frame structure. The name is due to the fact that the angle between the cleavage planes of this mineral is only 20' different from the right angle. Compound (%): $K_2O$ - 16,93; $Al_2O_3$ - 18,35; $SiO_2$ - 64,72. The microcline usually contains ingrowths of albite (so-called perthite). Forms white, brown, pink, sometimes green (amazonite) crystals, crystalline aggregates. Rock-forming mineral of many rich igneous and metamorphic rocks, pegmatites

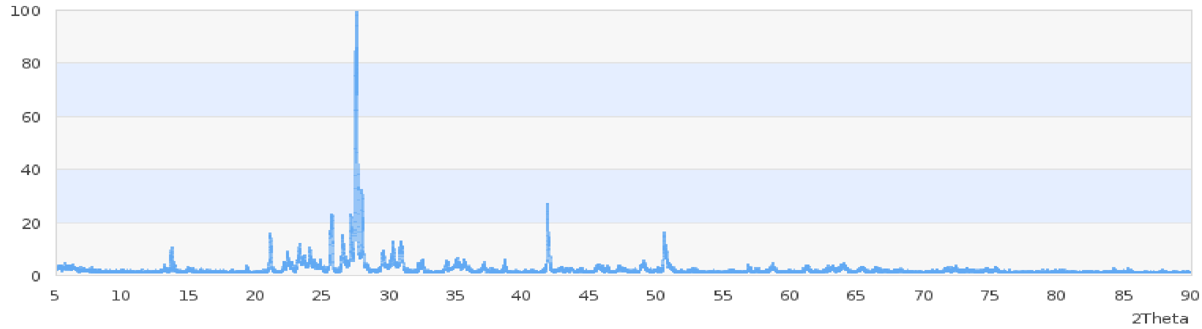


**Fig.2. Microcline diffractogram**

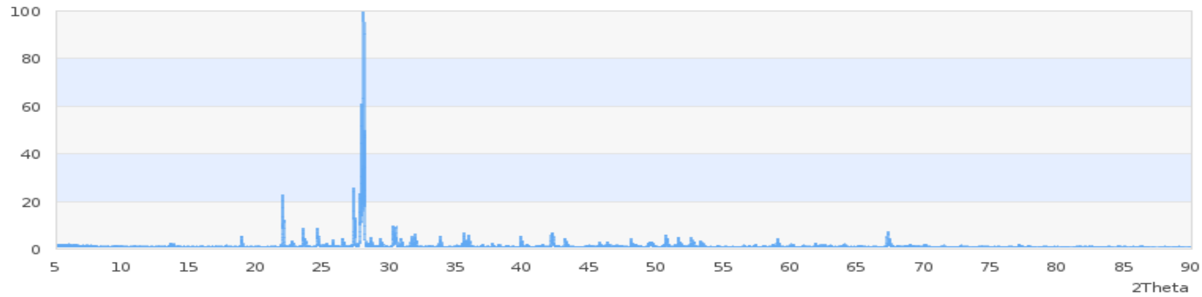


**Fig.3. Diffractogram of anorthite**

Anorthite (ancient Greek ἄνορθος - oblique) is a mineral from the group of feldspars (plagioclases) (Fig. 3). In terms of composition, it belongs to aluminosilicates with a framework type structure. Chemical formula of pure anorthite: $CaAl_2Si_2O_8$, where CaO - 20,1 %, $Al_2O_3$-36, 7 %, $SiO_2$ - 43,2 %. Qualitative X-ray diffraction analysis showed (Fig. 4) that in glauconite sands there are varieties of feldspar, where the peak maxima are at 2θ=27,49$^0$ (d/n=3,24 Å) и 2θ=27,92$^0$ (d/n=3,19 Å). These peaks are the main peaks of microcline and anorthite (analbite). The strongest peak belongs to quartz with corresponding values 2θ=26,64$^0$ (d/n=3,342 Å). Weak peak at 2θ=12,29$^0$ (d/n=7,19 Å) corresponds to basal reflections of kaolinite. A pronounced reflection of muscovite in this diffraction pattern is not noticeable, which should have corresponded to 2θ=8,81$^0$ (d/n=10,03 Å). The presence of the mineral illite shows a basal peak at 2θ=20,70$^0$ (d/n=4,29 Å). The presence of halite is not always noticeable even in samples from the same point with different sifted sieves, the peak position is 2θ=31,73$^0$ (d/n=2,82 Å). Amorphous-crystalline glauconite does not show strong reflections, but its presence with montmorillonite is visible due to the tubercle 2θ=5-8°.

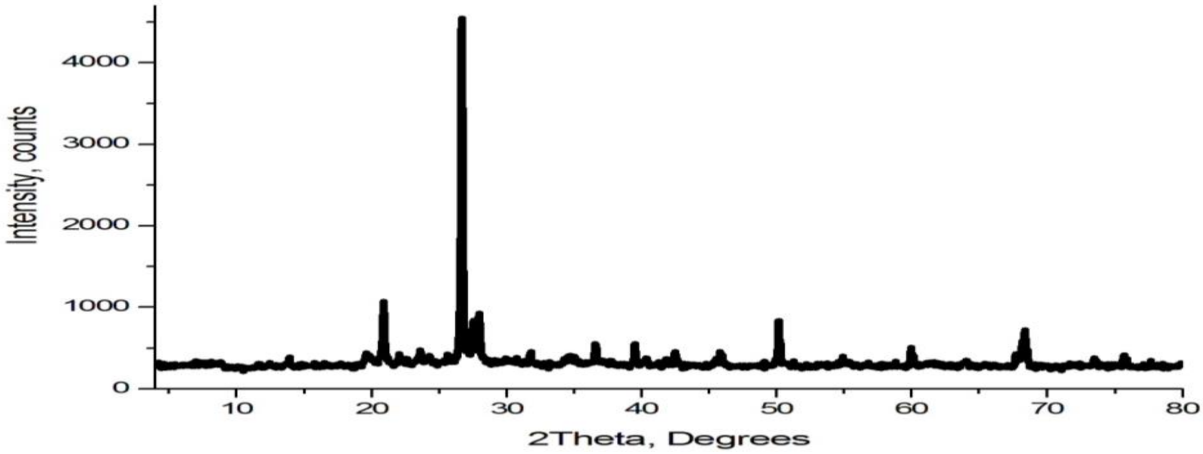


**Fig. 4. X-ray diffraction pattern of glauconite sand from the Krantausskoe deposit**

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Thus, in addition to glauconite and quartz, samples of glauconite sands contain feldspar minerals (microcline, orthoclase, albite, anorthite), hydromicas (illite, muscovite), kaolinite, montmorillonite, halite, and traces of chlorites and phosphorites.

**Quantitative determination of minerals in the composition of glauconite sands of the Krantausskoye deposit.** The calculations take into account only the crystalline phases in the samples under consideration. When taking into account, in samples, the content of glauconite ranges from 30-35%, the content of quartz ranges from 20 to 35%, quite a lot of hydromica (muscovite and illite) is contained from 5 to 25% and different types of feldspar (anorthite, microcline, albite) in some places more than the content of quartz (Table). As we noted above, the content of halite (NaCl) (about 1%), and sometimes other minerals, was determined in the samples.

**Quantitative phase analysis for glauconite sands taking into account the amorphous component.** It was determined that after a sieve with a size of 1 mm, the samples contain glauconite from 30 to 39%, quartz content ranges from 18-28%, anorthite feldspar - 15-16%, potassium-containing feldspar imicroint 5-11%, clay mineral illite 7-11%, they also contain muscovite (0% - 10%) and halite (NaCl) up to 2%.

**Table 1.**
**The mineral composition of glauconite sands of the Krantausskoye deposit enriched through a sieve of different sizes**

**Glauconite sample 3, point 1, sieve 1**

| Mineral | % |
|---|---|
| Quartz | 26,01 |
| anorthite | 15,17 |
| Feldspar (K) | 5,46 |
| Illit | 11,10 |
| hydrotalcite | 0,23 |
| NaCl | 2,00 |
| Calcium ultraphosphate | 0,18 |
| Glauconite | 39,81 |

**Glauconite sample 3, point 1, sieve 0.16**

| Mineral | % |
|---|---|
| Quartz | 25,01 |
| anorthite | 6,24 |
| Feldspar (K) | 4,50 |
| Illit | 8,79 |
| Muscovite | 5,40 |
| hydrotalcite | 0,64 |
| NaCl | 2,18 |
| Fluellite | 0,29 |
| Butlerite | 0,15 |
| Glauconite | 46,80 |

**Glauconite sample 3, point 1, sieve - ≥016**

| Mineral | % |
|---|---|
| Quartz | 20,01 |
| anorthite | 13,40 |
| Feldspar (K) | 3,07 |
| Illit | 7,66 |
| Muscovite | 10,00 |
| hydrotalcite | 0,24 |
| NaCl | 2,00 |
| Fluellite | 0,34 |
| Glauconite | 43,28 |

**Glauconite sample 8, point 3, sieve 1**

| Mineral | % |
|---|---|
| Quartz | 27,99 |
| anorthite | 15,29 |
| Feldspar (K) | 10,87 |
| Illit | 12,56 |
| hydrotalcite | 0,24 |
| NaCl | 1,22 |
| Fluellite | 0,34 |
| gillebrandite | 0,80 |
| Lopezit | 1,41 |
| Glauconite | 29,52 |

**Glauconite sample 8, point 3, sieve 0.16**

| Mineral | % |
|---|---|
| Quartz | 24,01 |
| anorthite | 10,72 |
| Feldspar (K) | 4,15 |
| Illit | 7,37 |
| Muscovite | 5,21 |
| Iriginite | 0,49 |
| NaCl | 0,78 |
| Glauconite | 47,27 |

**Glauconite sample 8, point 3, sieve - ≥016**

| Mineral | % |
|---|---|
| Quartz | 32,01 |
| anorthite | 15,02 |
| Feldspar (K) | 9,24 |
| Illit | 8,30 |
| Muscovite | 6,80 |
| NaCl | 1,85 |
| Butlerite | 0,94 |
| Iriginite | 0,93 |
| Glauconite | 25,02 |

**Glauconite sample 12, point 5, sieve 1**

| Mineral | % |
|---|---|
| Quartz | 18,51 |
| anorthite | 15,36 |
| Feldspar (K) | 4,85 |
| Illit | 6,86 |
| Muscovite | 8,20 |
| Kaolinite | 5,01 |

**Glauconite sample 12, point 5, sieve 0.16**

| Mineral | % |
|---|---|
| Quartz | 18,01 |
| anorthite | 3,30 |
| Feldspar (K) | 2,25 |
| Illit | 8,33 |
| Muscovite | 5,95 |
| hydrotalcite | 0,78 |

**Glauconite sample 12, point 5, sieve - ≥016**

| Mineral | % |
|---|---|
| Quartz | 23,01 |
| anorthite | 11,88 |
| Feldspar (K) | 2,82 |
| Illit | 5,93 |
| Muscovite | 6,02 |
| NaCl | 1,95 |

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|---|---|---|---|---|---|
| hydrotalcite | 0,97 | NaCl | 1,56 | Iriginite | 0,39 |
| NaCl | 1,79 | Iriginite | 0,29 | Glauconite | 47,97 |
| Butlerite | 0,27 | Glauconite | 59,52 | | |
| Iriginite | 0,36 | | | | |
| Glauconite | 37,82 | | | | |

In addition to the above minerals, the samples contain minerals - fluellite, gillebrandite, lopezite, hydrotalcite, calcium ultraphosphate, butlerite and iriginite in the range of 0.10-1%, and the presence of these minerals was noticed depending on the size of the sieve [6].

In samples passed through a sieve with a hole size of 0.16 mm, the content of glauconite increases and reaches 47-60%, while the content of other dominant minerals decreases - quartz, anorthite, potassium feldspar, illite (Table 1). The smallest fraction (-16 mm) of the amorphous phase can increase due to the amorphous phase of other minerals and therefore we cannot consider the entire amorphous phase to be glauconite, although the content of the amorphous phase also dominates in them compared to the sieve fraction with a size of 1 mm.

**Conclusions**

Based on qualitative X-ray phase analysis methods for determining the mineral composition of glauconite sands, the mineralogical composition of glauconite from the Krantausskoe deposit of Karakalpakstan has been established. In addition to quartz ($SiO_2$), the samples contain kaolinite, muscovite, illite, montmorillonite, halite (common salt), feldspar varieties anorthite, albite, microcline, and trace amounts of phosphorites and chlorites.

And according to the Quantitative phase analysis for glauconite sands, taking into account the amorphous component, it was determined that after a sieve with a size of 1 mm, the samples contain glauconite from 30 to 39%, the quartz content ranges from 18-28%, anorthite feldspar - 15-16 %, potassium-containing feldspar and microint 5-11%, clay mineral illite 7-11%, they also contain muscovite (0% - 10%) and halite (NaCl) up to 2%. In addition to the above minerals, the samples contain minerals - fluellite, gillebrandite, lopezite, hydrotalcite, calcium ultraphosphate, butlerite and iriginite in the range of 0.10-1%, and the presence of these minerals was noticed depending on the size of the sieve.

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