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METHOD FOR DETERMINING CLAY MINERALS CONTENT IN SOIL

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Abstract

The paper describes a new method for determining clay minerals (hydromica) content in soils. In 100% of total mineral mass, the content of clay minerals estimated by the calculated method is 60.2%; chlorite -11.4%; kaolinite - 7%; montmorillonite - 21.4%. The method described in the paper makes it possible to determine the interzone and intertype distribution of clay minerals in soils, the humus content in soil, etc. It is proposed to determine the clay mineral content in the silty fraction using Fe_2O_3, K_2O, and other silicate oxides. As an example of calculation, brown soils of the mid-mountain belt of the southwest part of the Gissar Ridge are given.

Using this method the calculations were carried out to determine the content of clay minerals and their basic chemical compounds forming oxides, and the molecular ratio $SiO_2:Al_2O_3$, which coincide with the published data (N.I. Gorbunov). The ratios of pure natural minerals, the molecular ratio of $SiO_2:Al_2O_3$, found in the clay minerals in brown soils of the mid-mountain belt are: hydromica 3.3; chlorite - 2; kaolinite - 2; montmorillonite - 4.9, these figures also agree with the data given by N.I. Gorbunov.

Key words: clay minerals, hydromica, chlorite, kaolinite, montmorillonite, soil, potassium, iron, silicate oxides, quantity, particle, reflex, planimeter, roentgenogram.

Introduction. The following methods for determining clay minerals content in soil are widespread: X-ray diffractometry, gradual heating of clay minerals (thermal), electron microscopy, and the method for determining gross chemical elements. Using these methods, data are obtained on the presence of minerals and their forms, their structure in clay soils is indicated. But, none of these methods can show the exact amount of clay minerals in soil and determine the direction of the ongoing processes.

The methods to determine clay minerals content in soil developed in the studies of M. M. Toshkuziev, I. A. Ziyamukhamedov, A. Akhatov, A. Nizamedinova, [1,2], N. I. Gorbunov [3]. T. A. Sokolova, G. M. Solyanik, E. I. Gagarin, E. Yu. Sukhachev [4,5], Robert M., Barshad J. [6] are based on the definition of "semi-quantitative content of minerals".

Using the above methods, researchers V.P. Sosnovskaya, N.P. Chizhikova., I.K. Antipov [7], O.A.Skryabin [8], D.R. Ismatov [9.10], A.Akhatov [11 , 12.13], R. Fayziev [14], M.K. Azimova [15], L.T. Tursunov [16], L. A. Gofurova [17], Yu. N. Vodyanitsky., S. A .Shoba [18], M.D. Maslova., S.L. Belopukhov. E.S. Timokhina, T.V.Shneye, E.E. Nefedieva, I.G. Shaikhiev [19], S.K. Kubashchev [20], V.S. Kryshchenko, R.V. Kuznetsov [21], Barve P., L. Abbadie [22], D. Nazaraliev, L. Samiev, F. Babozhonov, T. Apakhuzhayeva, S. Melikuziev, U. Manzurboev [23] have determined the quantitative mineral composition of virgin and irrigated soils in Uzbekistan.

However, the amount of clay minerals, calculated using these methods, especially the group of montmorillonite minerals, differ greatly when compared with the data in the relevant literature.

The methods developed by N. I. Gorbunov [3] are similar to each other; he recorded the results obtained using an X-ray diffractometer; the surface areas of mineral reflexes and their amount were determined in prepared samples of clay particles of soils saturated with glycerol vapors using a planimeter and X-ray diffraction patterns.

After that, in 1984, T. A. Sokolova and G. M. Solyanik [4] using the recorded X-ray data, measured the amount of clay minerals in soils in prepared samples of clay particles in a natural state and heated to 350 C^0 by the change in the reflex growth. Since the "method of semi-quantitative content of minerals" does not fully reflect the processes occurring in soil, this method did not become the basis for a complete calculation of minerals content in soil.

N. I. Gorbunov [3] believed that there was no good method for determining the amount of clay minerals, and so, it was impossible to determine the change in minerals content in soils and their re-transformation. He noted that if a method for the quantitative determination of humus had been developed, then it would be possible to determine the interzonal and intertype distribution and to show the changes in clay minerals content in soil.

Object of research. The objects of research are brown soils of the mid-mountain zone of the southwest part of the Gissar Ridge (Fig. 1.2)

Research methodology. Soil preparation for analysis and the separation of silt fractions were carried out by N. I. Gorbunov method [3]. General chemical analyzes of soils were carried out by the generally accepted technique. The content of clay minerals was determined by the author's method [11].

Research results. To solve the above problem, it

Figure 1. The Gissar Ridge

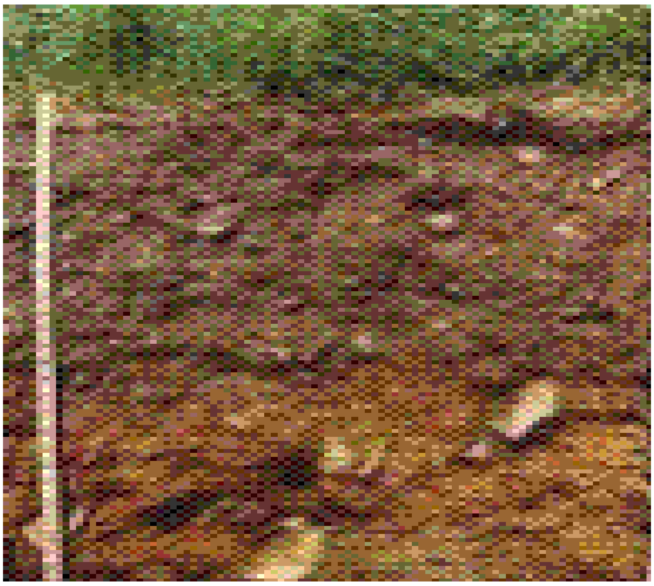

Figure 2. Profile of brown soils

is proposed to determine the amount of minerals in clay particles: potassium, iron, and other oxides in the composition of silicates.

The advantage of this method lies in the fact that only with a general chemical analysis it is possible to determine the silicate part of the oxide and the effect of the change in mineral composition of clay particles on soil formation processes, i.e. when determining crystal-chemical changes the interzonal and interbelt differences are determined. The calculation procedure is given below. Table 1 shows the general chemical composition of clay particles of brown soil in the mid-mountain belt.

Table 1.

General chemical composition of clay particles of brown soil in the mid-mountain belt, %

Forms of xides	SiO_2	Al_2O_3	Fe_2O_3	MgO	K_2O	H_2O
A	52,02	23,94	11,42	4,77	4,95	2,9
B	0,3	0,84	5,01	0,8	1,24	-
C	51,72	23,1	6,41	3,97	3,71	-

Note: A) the general chemical composition of clay particles;

B) oxides in a free state;

C) oxides in a silicate state.

The general chemical composition of clay particles of brown soil in the mid-mountain belt, %.

Table 1 shows the indices of SiO_2, Al_2O_3, Fe_2O_3, MgO, K_2O, since these oxides make up the bulk of the minerals. From literature sources (N.I. Gorbunov) [3] it is known that potassium content is 6% in pure hydromica. From the results of the analyses, it is known that the total potassium content in clay particles is 4.95%. If we subtract the total amount of potassium in a free state from the composition of clay particles, an amount of potassium silicate can be determined 4.95-1.24 = 3.71%. Denoting the amount of silicate potassium in the composition of the pure hydromica mineral as x%, the amount of hydromica minerals is determined, making up the ordinary proportion equal to 60.18%.

Determination of the amount of chlorite and kaolinite minerals in the composition of clay particles is a difficult task because their intense reflexes in the x-ray pattern coincide. In soils of our zone, the kaolinite mineral is found in a very small amount, formed in ancient times. An exception are subtropical and tropical zones (red and yellow laterite), where an amount of this mineral exceeds other minerals. The ratio of kaolinite and chlorite minerals in the x-ray pattern are 7.1; 3.5 and form A^0 reflexes.

Since in the X-ray diffraction pattern, the intense kaolinite reflexes (001-002) coincide with the chlorite reflexes (002,003), their content is determined jointly, then pure chlorite is calculated using silicate iron. To do this, silicate iron in the composition of clay particles is determined, from total amount of iron 11.42% the iron in a free state is subtracted - 5.01% and the amount of silicate iron 6.41% is obtained. Knowing that 100 g of kaolinite and chlorite contains 35% of iron, then making a proportion we have 18.4% of kaolinite plus chlorite minerals in soil.

Now, from 60.18% of hydromica mineral composition, obtained in calculations, determine the amount of iron silicate. It is known that in 100 g of hydromica, there is 4.08% of iron, so in 60.18 g of hydromica, the content of silicate iron is 2.42%.

From the total content of silicate iron, the iron content in the hydromica is subtracted and the amount of silicate iron is determined, in the composition of the pure chlorite mineral it is 6.41-2.42 = 3.99%.

The content of iron silicate in the amount of 3.99% in pure chlorite mineral is determined; according to N. I. Gorbunov [3] in the composition of the chlorite mineral, iron is 35%, which is 11.4%.

Now, from the chlorite plus kaolinite mineral (18.4%) the amount of pure chlorite (11.4%) is subtracted and the amount of kaolinite mineral is determined, which is 18.4-11.4 = 7%. The mineral content (M) of montmorillonite is determined as follows:

$M = 100- (60.2 + 11.4 + 7) = 21.4\%$.

Table 2.

Estimated quantities of minerals and their basic chemical compound forming oxides,%

Name of the mineral	Estimated quantity of mineral, %	SiO_2	Al_2O_3	Fe_2O_3	MgO	K_2O	$SiO_2Al_2O_3$	H_2O
Hydromica	60,2	31,2	15,66	2,42	1,62	3,71	3,3	5,65
Chlorite	11,4	2,84	2,28	3,99	1,14		2	1,15
Kaolinite	7	3,25	2,76	-	-		2	0,99
Montmorillonite	21,4	13,66	4,71	0,87			4,9	1,01

The estimated quantities of minerals and their basic chemical compound forming oxides are given in Table 2.

The amounts of clay minerals and the basic chemical compound of the formed oxides as a percentage and the molecular ratio SiO_2:Al_2O_3 in the clay minerals found in brown soils of the mid-mountain belt, shown in Table 2, are: hydromica 3.3; chlorite-2; kaolinite-2; montmorillonite-4.9; the figures obtained correspond to the data published by N. I. Gorbunov [3], which means that the quantities of clay minerals determined by the proposed method and their distribution in soil are close to the data of the above-mentioned researcher, but the existing method for determining clay minerals is more complicated and time-consuming.

Conclusions. The use of a new method for calculating the amount of clay minerals (humus), makes it possible to study interzonal, intertype distributions and their change in soils. It is proposed to determine the amount of clay minerals in the silt fraction using Fe_2O_3, K_2O, and other silicate oxides, which make it possible to determine the content of clay minerals. The contents of clay minerals obtained in studies are: hydromica - 60.2%, chlorite - 11.4%, kaolinite - 7%, montmorillonite - 21.4%.

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