MINERALOGICAL AND MICROBIOLOGICAL DIAGNOSTICS OF PRIMARY SOIL FORMATION IN THE CONDITIONS OF GRAY-EARTH SOILS OF THE SEMIDESERT ZONE OF THE MIDDLE PART OF THE NAKHICHEVAN AUTONOMOUS REPUBLIC

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Abstract: *the results of studies of micromorphological and microbiological methods of primary soil formation on exposed carbonate gypsum-containing medium loams in semidesert positions of gray-alluvial and dark-gray-earth soils were presented. In the specific, ancient conditions of soil formation (medium moisture with a dense wall cover), the profile of primary soils with certain horizons was formed, which have macro-signs associated with the high activity of soil groups of microorganisms. The results obtained confirm that in this soil, the processes are associated with the intake of organic matter in the form of leaf litter, steppe dying of the roots of herbaceous plants.*

Keywords: *clay semi-desert, soil-forming rock, micro-signs of horizons, humic acids, differentiation of ecological-semi-desert groups of microorganisms.*

Introduction

The geochemical formation of the micromorphological layer in the steppe zones was mainly studied at the Institute of Soil Science and Agrochemistry of the National Academy of Sciences of Azerbaijan on the initiative of I. Sh. Iskenerov back in 1969. In the former Soviet Union, more attention was paid to this problem by M. A. Glazovskaya [10] when studying desert tanning in arid conditions.She experimentally proved that the desert tan is formed as a result of several stages of weathering of minerals with the active participation of micro-organisms from the film of living microorganisms on the surface of stones to the ferruginous-manganese crust, including green and blue-iron algae. The study of the initial stages of soil formation by micromorphological and mineralogical methods mainly concerned the issue of weathering of solid erupted rocks. Studies of primary soil formation on loose loam deposits are few [1; 23; 31]. At present, the first results have appeared showing changes in fine fractions (silt and dusty fractions) in different coenoses, including on cover loams, using the example of Large lysimeters [4;37].

Continuing this goal, E. V. Abakunov [1] when studying primary soil formation in different natural zones came to the conclusion that the main process in primary soil formation is the accumulation of organic matter. The power of the organ-mineral horizons, their macro-and micromorphological features depend on a large number of factors of the duration and nature of moisture, pH of the environment, the content of nutrients, as well as the activity of soil fauna and microorganisms [9, 12, 14, 22].

In our work, the results of the study of primary soil formation on medium-heavy carbonate loams are a continuation of the studies of one of the previously studied sections located in the territories of the South-Eastern and South-Western parts of the steppe of the Nakhichevan Autonomous Republic. As a result of the study of ancient soils in a half-meter layer (1.5 m), a low-power soil with a differentiated profile, a humus horizon with a thickness of 1.5-2 cm, was formed.

To this end, we had to study the features of microstructure and micromorphology in the profile of the studied soil with the identification of the main trends of elementary soil-forming processes (EPP) that form this profile. To determine the intensity and nature of their processing, including biological processing, to identify the trends in the transformation of organic matter within the profile and its relationship with the mineral base of the soil to describe the microforms, composition and features of micro-organisms of fine matter.

Objects methods and research

The direct objects of micromorphological studies are the characteristic horizons of primary soils samples (Fig. 1). On the sections from the upper part of the centimeter, comparative analyses of the main elements of microstructure were determined in order to divide them into stable and dynamic ones related to the features of the elementary soil processes. The study of microstructure was carried out on large oriented sections with a size of 2x2 cm made on micromonolith with an undisturbed structure with impregnation of synthetic layers without heating, which allows us to preserve elementary soil formation without destruction [19]. Exposure of soil samples undisturbed during the day when moistened with sterile water. Generalizations of the visual characteristics of six agarized glasses are presented.

Over many years of research, low-power soils with a distinctly differentiated profile have been identified. In addition to these soils, the micromorphological properties of meadow-gray-earth soils of the Shirvan steppe in the Kura-Araks lowland (k-1) were studied.

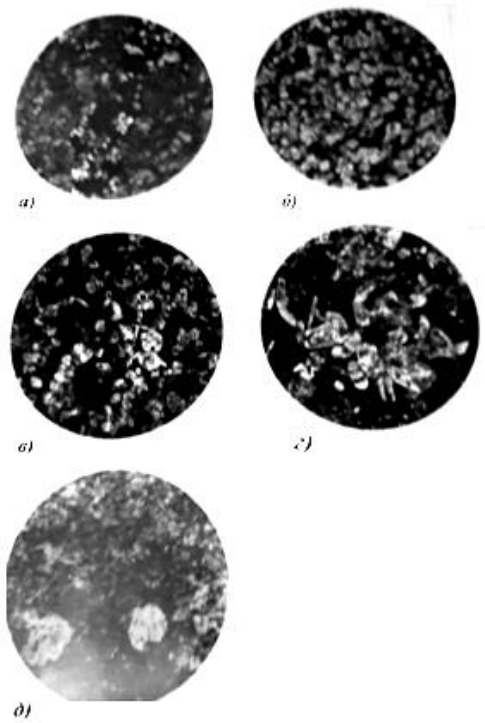

Fig. 1. Micromorphology of meadow-gray-earth soil (section k-1). Uv. 8x8.
a) 0-10 cm; b) 10-24 cm; c) 34-54 cm
d) 54-83 cm; picoli x, e) 83-100 cm; picoli

Meadow-gray-earth soil formed on alluvial and deluvial loamy sediments of the Shirvan steppe. It is characterized by the following micromorphological features.

0-10 cm. The color is light gray with brownish plant composition, large microaggregates are traced, the pores are tremulous and there are oval-shaped pores. There are plant remains in the form of living root hairs that are half-decomposed and charred, even the browned roots of the plant are at various stages of decomposition. The minerals of the soil skeleton are distributed more or less evenly, and differ in their roundness. Large minerals of the soil skeleton are distributed either in groups or in layers. It's as if the minerals of the soil skeleton are being offered through the cracks. In some areas, the fine part is mixed with minerals. No movement of the silt fraction was detected. It is also somewhat dispersed. There is also volcanic glass in some sections of the mostly altered section.

34-54 cm color, light gray, dense build there are some large pores, agrogirovannost expressed unevenly. The organic part of the soil is represented by decomposed charred evenly distributed plant residues. The finely dispersed part of the soil is characterized by the uniformity of the soil skeleton. In the finely dispersed part of the soil, fine-grained carbonates are found, which makes it possible to assume that once solutions of high-concentration bicarbonates circulated in the soil droplets. Of the minerals of the soil skeleton, there are single iron hydroxides, feldspar, quartz, and the minerals of the schliffe are as if immersed in a finely dispersed part.

54-83 cm. The color is light gray with dispersion, the addition is relatively loose. Microaggregates are clearly visible, separated from each other by capillaries or microcracks among the microaggregates of pores of various shapes. Organic matter is represented by charred plant remains. In comparison with the previous one, these horizons are layered. There are areas consisting mainly of fine-grained particles, and in some areas there are layers that make up groups of broken materials that protect adjacent transition zones, from minerals, feldspars, volcanic glass, etc.

83-100 cm differ quite clearly the color is gray with a brownish tint the addition is loose, the agrogation is not clearly expressed. Organic residues in very little. The minerals of the soil skeleton are represented by rolled fragments of various rocks. This horizon is also characterized by a layered formation. One layer is rearranged by fine particles, and the other by coarse clastic materials.

A characteristic feature of this section is that the layered structure of the soil is observed especially in important layers. The meadow process, as shown by the micromorphological description, died out so long ago that traces of it are not clearly preserved. To get an idea of the general petrographic composition of the soils of the Shirvan steppe, fractions with a size of 0.1-0.01 mm were studied. By characterizing the soil skeleton, it is possible to study the individual edematous fractions of each mechanical analysis, which makes it possible to

establish some regularity of the distributed individual minerals or mineral groups of different fractions of the mechanical analysis.

The studied fractions of 0.1-0.01 mm in size contain most of the minerals that make up the group part of the soil. The data (Table 1) shows the mineralogical composition of these fractions of meadow-gray-earth soils of the Shirvan steppe of the Kura-Araks lowland.

From these points of view, the serozems of the alluvial soils of the South-western region of the Sadarak plain were studied. Time 1.

The studied fractions of 0.1-0.01 mm in size contain most of the minerals that make up a significant part of the soil. The data (Table 1) shows the mineralogical composition of this fraction of the meadow gray-earth (time 1) soils of the Shirvan steppe show that the minerals are represented mainly from the light fraction, which accounts for about 99%. The composition of the light fraction is mainly dominated by aggregates of clay minerals. Feldspars are more common in the upper 0-27 cm horizon (up to 7%), quartz is almost absent.

A characteristic feature of the soils of the Shirvan steppe is the predominance of the heavy fraction, along with hornblende, chlorite and biotite (Fig. 2). If the amount of hornblende is assigned in the range of 15-85%, then chlorite is 18-52%. Moreover, the content of chlorite in the upper horizon is less, which was facilitated by the intensive transformation of chlorite in comparison with soil-forming rocks. In the horizon of 98-124 cm, its content reaches 52%. Interestingly, the content of chlorite in the highly dispersed part of these soils is also large . Of the ore minerals, brown ironstone predominates, its amount in the upper horizon reaching up to 15%. The presence of a small amount of barite in the upper horizon indicates that the water extracts of these soils may contain a small amount of salts.

Table 1. Mineralogical composition of the Shirvan steppe soils, (fraction size 0.1-0.01 mm)

	On the cut	**P-7**		**Sediments of the Gechnaya river**
	Minerals	0-27	98-124	
	Heavy fractions in %	0,14	0,29	0,93
Ore deposits	Brown ironstone	13,00	4,0	12,0
	magnetite, ilmenite	4,0	3,0	5,0
	zircon	+	0,5	-
Sustainable	Granite	-	-	-
	Rutile	-	-	+
	Tourmaline	0,5	0,5	+
	Hematite	0,5	0,5	18,0
Amphibolus	Cornea exchange	35,0	15,0	0,5
	Corneal exchange basaltic	0,5	+	-
	Glaucophene	-	-	3,0
	Avgit	0,5	+	
Pyroxenes	Diopsit	-	-	30,0
	Biotite	1,5	+	-
	Chlorite	18,0	32,0	+
	Glauconitis	-	-	30,0
	Epidod	1,0	1,0	5,0

0-20 cm color is boreal field, the addition is loose spongy, the aggregation is uneven on some burned clearly. The pores and basically rounded phoria, humus substances distribute evenly. Sometimes organic residues permeate the mineral mass. The plasma is carbonate - clay,. There is no accumulation of carbonates. There is a weak iron content of minerals of a large fraction, feldspar, quartz are distributed evenly. Rolled fragments of carbonate rocks are rarely found. 20-38 cm color is dark brown with respect to porosity, aggregation is almost absent, ornanic substances are provided in the form of finely dispersed humus. There is more organic matter in this horizon than in the higher sections of the shelf that are saturated with organic matter. The plasma is clay-carbonate. Minerals in the form of a large-block part, rolled. Feldspars, hornblende, and quartz are well distinguished. Chlorite is sharply released. Fine-grained carbonates permeate the clay mass.

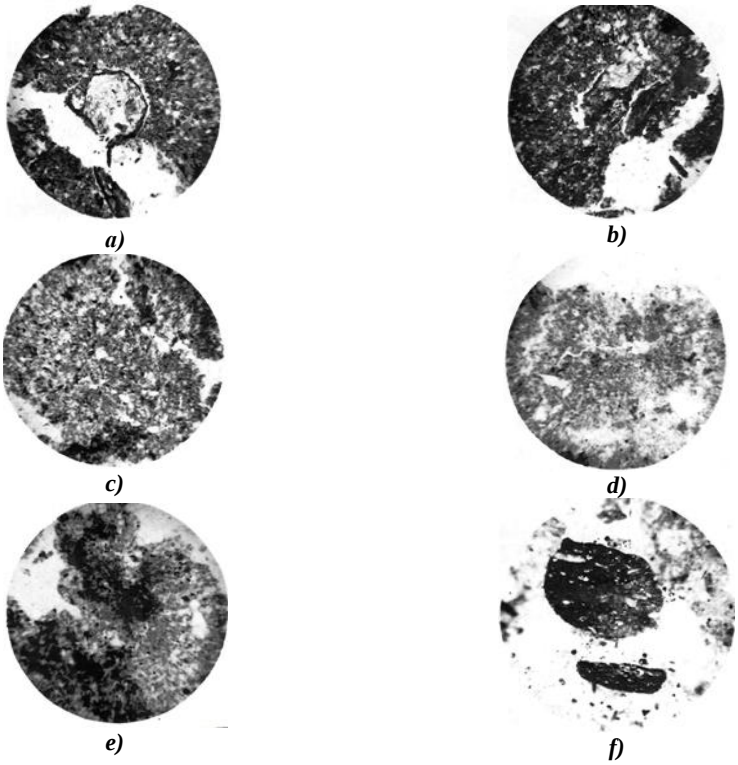

Fig. 2. Микроморфология сероземно - аллювиальной почв (разр 1). Uv. The 47-the.
(a) the 0-20 cm; (b), 22-41 cm; (c) 41-70 cm; (d) 70-97 cm; (e) 97-130 a; pikoli

38-59 cm Color light brown, field porosity, porosity is well expressed, the voids between the particles and aggregates are mostly rounded, but there are also elongated, connected by channels. Organic matter in the form of a slightly noticeable chlepoid form, evenly dispersed in the plasma. Rarely observed microcongretions in the plasma of indeterminate outlines sometimes in the form of clots of iron hydroxide. Obizvestkovannye crumbs are well distinguished. A lot of highly dispersed calcite. The plasma is clay-carbonate. Due to the high degree of carbonation in crossed picoles, high apizotronicity is characteristic. The minerals are charaterized by rolling and strongly destroyed, there are feldspar, quartz, etc.

59-88 cm color light gray, porous, slightly aggregated uniform, the mass is relatively dispersed. The pores are large, of various configurations. Organic matter is represented by humus particles. The soil plasma is clay-carbonate. There are many primary minerals of varying degrees of roundness.

88-126 cm color light gray, porous. The pores are of a fractured nature. Against the background of the soil mass with parallel picoles, black dots of vozemozhno magnetite are distinguished. The most common primary minerals are quartz and plagioclase. In some plagioclases, the bands are also wider. Among the anfibols there are hornblende, elongated prismatic shape. Fragments of calcite rocks are rarely observed. Even rarer are the pseudomorphoses of small fishhedral gypsum.

126-160 cm color of the soil-forming rock and various primary minerals are subject to destruction. Micro-morphological characteristics of this soil show that the profile is characterized by a high filtration capacity. At the same time, an increase in the round-block material is observed down the profile. The plasma is mainly clay-carbonate. According to the distribution, the micromorphological description of dark gray soils in the South-Eastern part of the Sharur plain of the Nakhichevan Autonomous Republic (section 4) is characterized by the following features.

0-22 cm grayish brown, loose, aggregates of the first and second order. The pores are interaggregate, the organic matter is represented by semi-decomposed, the plant residues are carbonated, the clay mass aggregates are impregnated with a dispersed mass of organic matter. There are many destroyed primary minerals of quartz, feldspars and other series of minerals, traces of weak chloritazation.

22-41 cm light brown, loose aggregates of the first order are characterized by fine-grained. Single small particles of humus substances. Clay-carbonate plasma, large grains of primary minerals. Figure 3.

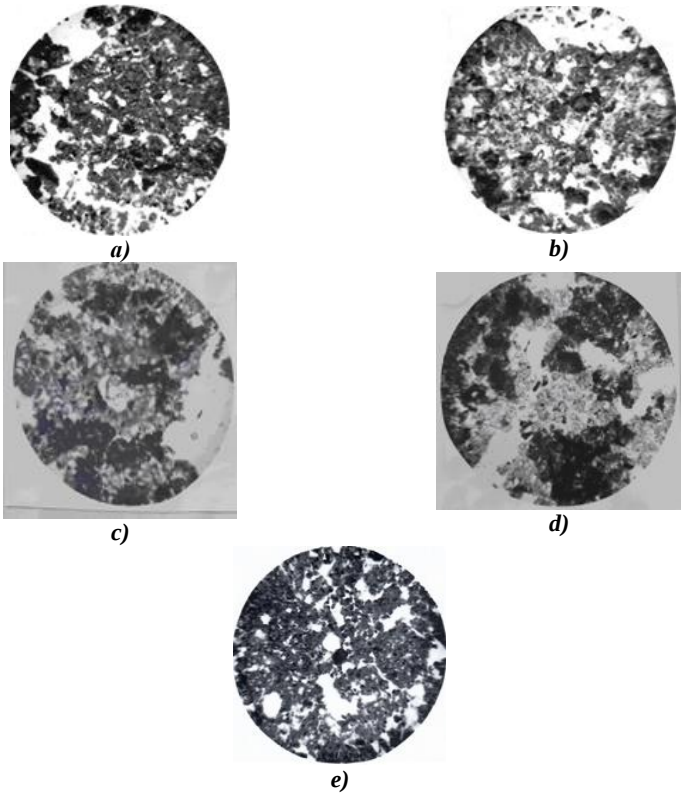

Fig. 3. Micromorphology of dark gray-earth soil (section 4). Uv. 47 times.
a) 0-22 cm; b) 22-41 cm; c) 41-70 cm; e) 97-130 cm; picoli

41-40 cm light brown, loose build, poorly expressed aggregativeness, interaggregate pores of different cofiguration, connection with each other by fractured capillaries. Clay-carbonate plasma there are obosovlenye allocation of fragments of carbonate rocks, subject to the process of soil formation to varying degrees. The primary minerals are quartz feldspar and hornblende.

70-97 cm light brown field compound loose, weakly aggregated mass. The pores are round and mole-shaped. The plasma is clay-carbonate. The clay mass is impregnated with carbonate formations. At reduced picoles, due to the presence of a highly dispersed mineral mass, anisotropy is observed. Among the clay mass, large fragments of carbonate rocks are distinguished.

97-130 cm differ from the overlying horizon in dispersion. There is an accumulation of psedomorphic clay clumps. Rare rock fragments. The soil mass is slightly chloroformed.

The micromorphological description shows that despite the features of anthropogonicity, porosity is observed evenly throughout the profile. The primary minerals underwent a strong change. Carbonation is observed in all genetic horizons. At the same time, their content fits in the lower horizons due to the presence of large fragments of carbonate rocks. The presence of fine crystalline carbonate precipitates throughout the profile indicates that solutions of high-carbonate waters circulate in the soil profile.

In general, the morphological image of this profile corresponds to the type of humus polozems from the department of underdeveloped soils in the trunk of the pevichny soil formation [20]. The litter and humus-undeveloped horizon are most clearly formed in the profile.

The humus profile is characterized by a sharp decrease in the total humus. At a depth of 0-22 cm, it is contained in an amount of 1.33% below at a depth of 20-38 cm , 1.20%, and in the lower reaches it decreases to 0.30%, and in the South-Eastern part of dark gray soils, humus changes from the upper horizons of 0-22 cm, 1.26%, to the lower ones, where it often decreases and is 97-130 cm, 0.94%.

The granulometric composition in all horizons is defined as too heavy .

Carbonate crystals and drusac can be characterized by their shape as both dissolvable and well-preserved. The study of the chemical properties of the laid sections showed that the soil-ground tol.up to a depth of >80 cm in most of its parts is leached of easily soluble salts in which calcium sulfates predominate the content of toxic salts does not exceed 0.3%, the presence of Cl - ion is insignificant the content of exchangeable Na+ exceeds 1 mol (7 kv) kg and under it there are fresh ground waters of calcium sulfate composition.

These characteristics, combined with additional moisture from poorly mineralized meltwater, provide favorable conditions for the spontaneous growth and development of herbaceous plant culture. The micromorphological properties of the soil are presented in Table 2.

Let's list the general properties for all the formed horizontal lines.

1. Throughout the studied profile, the main internal mass is provided by a contrasting elementary microstructure with a nesting distribution, a fine-grained microstructure with a nesting distribution among a thin material of fine-grained particles. These features of the ratio of large particles and fine-dispersed material at the micro level were described earlier for the soil-forming material of semi-desert gray-earth soils in the central part of the Nakhichevan Autonomous Republic.

2. The absence of any sharply carbonate neoplasms in the form of modules, constriction in the intra-torpedo mass and the studied profile. Cryptomicrograin carbonates are evenly dispersed in the thin-clay material. At large magnifications under the microscope, it is seen that many medium-grained particles of primary calcite grains differ in internal recrystallization. Grains of minerals of large fractions are mainly represented by sharp-angled grains of quartz and feldspars, relatively many light micas and partially glauconite grains of amphiboles and ore minerals are rare.

Results and discussion

Medium-heavy carbonate loam, which is the source material for the formation of the South-Eastern and South-Western regions of the Nakhichevan Autonomous Republic, has all the macro-characteristics of this rock. The study area is characterized by dense microgrowth, large - plate structure, carbonate-clay composition of fine-dispersed matter, nest distribution of fine-grained grains of the skeleton [17].

For this purpose, it can be noted that active biogenic structuring covers the upper 0-20 cm layers. Such a deep penetration of soil biota is probably due to their seasonal migration to horizons with increased moisture when the upper 20 cm of the soil dries up in the summer. This and also have environments of plant residues at a depth of 30 cm, that is, the biogenic processing of plant residues penetrates deeply through biogenic pores-channels into the soil-forming material. Among the microforms of humus, brown amorphous humus predominates, which permeates only individual clay-carbonate layers of soils.

Using as a basis for the development of Kubiena [30] and drawing on numerous literature data on the micromorphological diagnosis of humus formation in different types of soils, we believe that for many years there was an accumulation of coarse and poorly decomposed plant remains, which at the time of study are characterized by high biogenic destruction with the formation of coprolites of micro and meso fauna.

This allows you to talk about the formation of humus microforms (type model) it is most pronounced in the upper 0-20 cm layers of these soils.

Formed by this type of humus occurs under specific conditions of decomposition of plant residues. In the spring, the mineralization of the litter is hindered by the prolonged stagnation of water in the pond digging, and the high biological and microbiological activity occurs apparently immediately after the snow melts in a short period before the sharp thickening of the soil in the summer period. Despite the vastness of the plant litter with dense ground vegetation, the formation of a soft type of humus () is not frictionless here. In general, within the upper 0-20 cm layers of poorly developed humus soil, we can note a trend in the vertical zonal tenacity of the soil fauna and, as a consequence of this difference, in the nature of decomposition of plant residues.

The features of the studied profile are finely dispersed silicate-thin-carbonate inlays in the pores of the channels, mainly root residues. This allows us to say that the eluvial illuvial suspension transfer of a finely dispersed substance takes place. The formation of elements of carbonate soil formation in the form of pore-like dense pieces of coarse-grained thin crystals was not observed in the intra-soil mass of carbonate neoplasms and is apparently associated exclusively with the process of biogenic carbonation. Which is most clearly expressed in the upper horizons. They are always located in the pores in which there are plant residues, roots of different sizes. When comparing the sections of samples from different selection years, it is possible to note quantitative and not qualitative differences in the formation of carbonate biogenic accretions in the pores of the passages in plant residues.

It is interesting that in the studies on primary soil formation by E. I. Gagarin and V. P. Tsyplenkov [7], micro-aggregates of coarse-grained carbonates were also noted in some microparticles of the poorly developed humus horizon of aggregates of the initial rocks. This local decarbonation was already evident in the tenth year of their observations.

Gypsum neoplasms and features of their microgeneration. Gypsum nests and others for the lower horizons of gray-earth soils were described by microscopic methods earlier. Their genesis is associated with the inheritance of their properties of soil-forming rocks [18, 32].

On the basis of micromorphological studies, it can be noted that the elements of microstructure inherited from the original soil-forming material have undergone changes due to both frontal and local elementary soil-forming processes.

Frontal macro-signs are associated both with humus-acumlative rounding of organic matter of the moder type and with active zoogenic structuring of mineral matter in the upper three centimeters.

In the depth of the upper horizon, there is observed (0-30 cm) a) the uplifting of rock cryptograin carbonates; b) the transformation of clay minerals or their browning of individual aggregates, which is diagnosed by the decrease in the two-direction of clay domes and the fragmentation of clay kutans on the grains of minerals of large fractions.

At a depth of 3-5 cm, a) relatively active illuvial accumulation of fine-grained silicate-carbonate particles with the formation of insriggings and a very weak accumulation of humus-ferruginous-clay matter with the formation of thin iron-clayey kutans were noted. b) biogenic accumulation and micro-accumulation of elongated calcite crystals both in the pores with plant residues and inside the tissues themselves. d) zoogenic aggregation, etc.

In general, it can be noted that at the time of the study, humus - accumulative and metamorphic processes are most active (due to biogenic and cryogenic structuring).

Conclusions

1. With many years of soil formation on exposed carbonate loams in the conditions of gray - earth and semi-desert pond-digging of herbaceous vegetation, the primary soil with horizons characterized by a special set of micro features and various manifestations of the perenniality of the soil meso-microfauna was formed.

2. Gypsum rock formations in the form of accretions of large gypsum crystals underwent weaker dissolution, as a result of which new formations were formed in the vicinity of them in the form of accretions of idiomorphic small rhombedral micrite crystals.

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