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THE MEADOW-SIEROZEM SOILS CURRENT STATE (GREATER CAUCASUS, AZERBAIJAN)

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СОВРЕМЕННОЕ СОСТОЯНИЕ ЛУГОВО-СЕРОЗЕМНЫХ ПОЧВ (БОЛЬШОЙ КАВКАЗ, АЗЕРБАЙДЖАН)

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Abstract. The aim of the research is obtaining new information about the genesis, the current state, is studying the diagnostic features of the meadow-sierozem soils of the northeastern part of the Greater Caucasus and give the name to these soils in accordance with the International Classification Soils on the Reference Base (WRB) in 2015. The objects of research are meadow-sierozem soils in Shabran district, northeastern part of the Greater Caucasus. Study methods: field studies (relief, vegetation, laying of soil sections, their description, selection of soil samples, establishment of a preliminary classification name of the soils) and physicochemical analyzes of soil samples (humus, gross nitrogen, C:N ratio, reaction of the soil environment, capacity of cation exchange, granulometric composition, composition of complete water extract) were carried out by conventional methods. It has been established that the most characteristic diagnostic indicators of meadow-sierozem soils are the presence of clay signs in horizon B and carbonate formations in the form of mold. Meadow-sierozem soils are low-humus. The reaction of the soil environment is alkaline. According to the granulometric composition, these soils are of medium and heavy clayey or medium and light loamy. Conclusion. The present state of virgin and cultivated meadow-sierozem soils has been studied. For the first time, the diagnostic criteria of the World Reference Base for Soil Resources (WRB) were applied to meadow-sierozem soils, and an attempt was made to give the name of meadow-sierozem soils according to the international classification of soils based on the on the Reference Base (WRB) 2015. With the different principal and supplementary qualifiers, all soils were classified as Calcisols.

Аннотация. Целью исследования является получение новых сведений о генезисе, современном состоянии почв, изучение диагностических признаков лугово-сероземных почв северо-восточной части Большого Кавказа и присвоение этим почвам названия в соответствии с международной классификацией почв по эталонной базе (WRB) 2015 г. Объекты исследования — лугово-сероземные почвы Шабранского района северо-восточной части Большого Кавказа. Методы исследования: полевые исследования (рельеф, растительность, закладка почвенных разрезов, их описание, отбор почвенных проб, установление предварительного классификационного наименования почв) и физико-химический анализ почвенных проб (гумус, валовый азот, соотношение C:N, реакция

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почвенной среды, емкость катионного обмена, гранулометрический состав, состав полной водной вытяжки) проводили общепринятыми методами. Установлено, что наиболее характерными диагностическими признаками лугово-сероземных почв является наличие глинистых признаков в горизонте В и карбонатных образований в виде плесени. Лугово-сероземные почвы малогумусные. Реакция почвенной среды щелочная. По гранулометрическому составу эти почвы относятся к средне- и тяжелоглинистым или средне- и легкосуглинистым. Изучено современное состояние целинных и окультуренных лугово-сероземных почв. Впервые к лугово-сероземным почвам применены диагностические критерии всемирной эталонной базы почвенных ресурсов (WRB) и предпринята попытка дать название лугово-сероземным почвам по международной классификации почв, основанной на эталонной базе (WRB) 2015. С разными основными и дополнительными классификаторами все почвы были отнесены к Calcisols.

Keywords: meadow-sierozem soil, Calcisols, Greater Caucasus, international soil classification, diagnostic horizons, soil genesis, WRB.

Ключевые слова: лугово-сероземная почва, Calcisols, Большой Кавказ, международная классификация почв, диагностические горизонты, почвообразование, WRB.

Introduction

Until now, the ideas and principles of Russian classification, world — WRB, FAO UNESCO schools have been used in the soils classification in Azerbaijan. But in connection with the creation of the WRB (2014) and for integration into the international soil classification, the soil classification of Azerbaijan needs to be improved, that is redefine the names of the classified soils according to the WRB.

The WRB should not replace national classifications; it serves as a unifying system that allows specialists from different countries to communicate. Classification is the language of science, a necessary condition for the exchange of information (Samofalova, 2012).

Meadow-sierozem soils were assigned to the Calcisols reference group. The Calcisols accommodate soils with substantial accumulation of secondary carbonates. Calcisols are widespread in arid and semi-arid environments, often associated with highly calcareous parent materials. Many Calcisols have formerly been called Desert soils. In the United States of America most of them belong to the Calcids, and in Australia to the Calcarosols. In the Soil Map of the World (FAO–UNESCO, 1971–1981) most of them belong to the Xerosols and to a lesser extent to the Yermosols (World Abstracts Database of Soil Resources 2014., 2017).

Meadow-sierozem soils are widespread in all vertical belts of the sierozem zone, but in the virgin state they are currently found only in some regions of Kazakhstan; in other places they are almost completely transformed into irrigated soils (Pochvy SSSR, 1979).

Irrigated sierozem-meadow soils by origin belong to intermediate "transitional" soils. Sierozem-meadow soils, due to a constant rise in the level of groundwater, are capillary moistened to the upper soil horizons, and the lower horizons are dull green, having a gray shade of clay. On sierozem-meadow soils, an evolutionary change continues towards the development of meadow soils (Sobitov et al., 2018).

Meadow-sierozem soils are one of the widespread types of soils in the plains and lowlands of Azerbaijan. More significant tracts of meadow-sierozem soils are concentrated in the Kura-Araz lowland, and are also locally distributed in the Samur-Divichinskaya and Nakhichevan lowlands.

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Meadow-sierozem soils are largely developed for irrigated crops, only in some cases there are small virgin tracts of the state land fund, occupied by winter pastures.

A lot of factual material has been accumulated on the characteristics of the morphological structure and properties of meadow-sierozem soils (Abduyev 2003, Aliyev 1964; Babayev et al., 2011; Salayev 1991, Salayev et al., 2004). Data on meadow-sierozem soils in the northeastern part of the Greater Caucasus are summarized in the monographs "The Soil Cover of the Greater Caucasus" (Babayev et al., 2017).

The zone of distribution of meadow-sierozem soils is characterized by the type of climate of a subtropical semi-desert with warm and frost-free winters and dry hot summers. The average annual air temperature ranges from 12.5-14.6 °C, the sum of active temperatures> 100 is 3907-4600^{0}C. The annual amount of precipitation is 215-310 mm, the moisture coefficient is 0.23–0.33 (Salayev, 1991).

Geomorphologically, meadow-sierozem soils occupy gentle trails, often depression depressions, where conditions of increased ground moisture persist for a significant part of the year. Parent rocks for meadow-serozem soils are deluvial-alluvial loams, often calcareous or young saline alluvial layered loams (Salayev et al., 2004).

The aim of the research is obtaining new information about the genesis, the present state, is studying the diagnostic features of the meadow-sierozem soils of the northeastern part of the Greater Caucasus and give the name to these soils in accordance with the International Classification Soils on the Reference Base (WRB) in 2015 (IUSS Working Group WRB, 2015).

Materials and Methods

The objects of study are meadow-sierozem soils of the Shabran region, the northeastern part of the Greater Caucasus. Meadow-sierozem soils occupy vast areas of the lowland of the Shabran region and a certain part of the Khachmaz region (Figure 1).

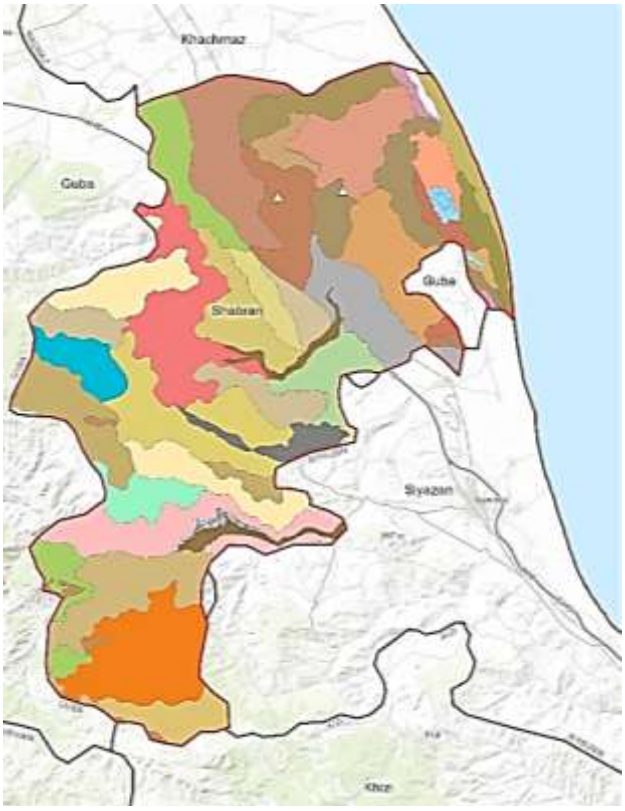

Figure 1. Geographical location of the area and objects of study

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In 1938-1939 A.N. Izyumov studied the geography, genesis and properties of meadow-sierozem soils in the Khachmaz region, and in 1940 M.E. Salayev investigated in Khachmaz (Aliyev, 1964).

Shabran district is located on the territory of the Greater Caucasus Range. The relief of the region is predominantly mountainous. The Caspian low-lying part of the region (Samur-Divichinskaya lowland) is below sea level up to 28 meters, the height of some points in the southwest reaches 2200 m. The lowlands are made up of anthropogenic, and the mountains are made up of Cretaceous, Paleogene and Neogene sediments. The climate in the lowlands and foothills is moderately hot, dry subtropical, in the highlands, it is cold and humid. The average temperature in January ranges from -4 to 1.5° C, in July — from 14 to 25° C. The average annual precipitation is 300-650 mm.

The establishment of soil cuts, the morphological description of the soil profile, and the establishment of a preliminary classification soil names in the field were carried out according to the method adopted in FAO (Guidelines for Soil Description, 2006). Soil samples were taken according to genetic horizons (Rozanov, 1983), physicochemical properties (humus, gross nitrogen, C: N ratio, soil reaction, cation exchange capacity, particle size distribution, composition of complete water extract) (Arinushkina, 1970; Mineev, 1989). Based on the morphological description of soils and their physicochemical properties, the names of meadow-sierozem soils are given according to the International Soil Classification on the Soil Reference Base (WRB) 2015 (IUSS Working Group WRB, 2015).

Results and Discussion

Soil cut No. 39 was laid in the Shabran region, the village of Khalilli. Coordinates: $41^{0}17^{I}31.47^{II}$ N, $48^{0}55^{I}50.45^{II}$ E, at an altitude of 14 m above sea level. It is a pasture area.

Ak1 0-21 light gray (Hue 10 YR 7/1), heavy clay, granular-blocky subangular, dense, roots, biologically processed, wormholes, effervescence visible, moist, clear boundary to;

Adk2 21-32 light gray (Hue 10 YR 7/1), heavy clay, blocky-subangular, dense, roots, biologically processed, wormholes, strong visible effervescence, very moist, clear boundary to;

Bdgkw 32-60 brownish black (Hue 10 YR 3/1), heavy clay, dense, blue-gray rusty spots, strong visible effervescence, pseudomycelia (carbonate infillings in pores, resembling mycelia), very moist, clear boundary to;

B/Cgk 60-110 brownish gray (Hue 10 YR 4/1), heavy clay, structureless, a little dense, blue-gray rusty ocher spots, extremely strong reaction, very moist, smooth boundary to;

Cgk 110-ниже brownish gray (Hue 10 YR 4/1), heavy clay, structureless, a little dense, rusty spots, extremely strong reaction, very moist.

The morphological description of the section shows: clear differentiation of the profile, gradual darkening of the colour of the upper horizons, the thickness of the humus horizon (32 cm) is characterized by a heavy clayey granulometric composition, the upper horizons are biologically well processed. The profile shows signs of weak gleying and the formation of a gleyed horizon (Bg), and blue-gray-rusty ocher spots are well distinguished. Rusty-ocher spots in the B and B/C horizons are characteristic of meadow-sierozem soils. The whole profile is dense or a little dense, the horizon-Bdgkw is very different in color.

In ordinary gleyic meadow-sierozem soils *(Cambic Calcisols (Aridic, Clayic, Gleyic, Stagnic))*, a high humus content is noted in the upper horizon (3.57%), with a rather sharp decrease with depth (to 1.81-0.41%). The content of total nitrogen also decreases down the soil profile (from

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0.26 to 0.06%), the C:N ratio is narrow, 7.9-4.0, which indicates the decomposition of organic matter. The absorption capacity in ordinary gley meadow-sierozem soils ranges from 16.47 to 8.15 cmol (eq)/kg of soil. In the lower horizons, magnesium predominates in the composition of exchangeable cations, the ratio of magnesium to calcium is 5-10. This indicates the magnesium salinity of the parent materials. The reaction of the soil solution is alkaline-7.8-8.1. Carbonate formations in the form of mold appear in the Bdgkw horizon, increasing with depth (from 12.98 to 26.47%) (Table 1). J.C. Dixon (2017) characterizes soils typical for arid conditions, and notes that the progressive increase in the concentration of carbonates and gypsum is accompanied by soil compaction and the formation of layered carbonate (petrocalcic) and gypsum (petrogypsic) horizons (Gorokhova 2019).

Table 1

MAIN PROPERTIES OF MEADOW-SIEROZEMS SOILS

Deep, cm	*Humus %*	*Nitrogen%*	*C:N*	*pH water*	*$CaCO_3$ %*	*Hygroscopic water*	*Exchangable cations cmol (eq)/kg*	
							Ca^{2+}	*Mg^{2+}*
Soil profile No. 39, Shabran region								
0-21	3.57	0.26	7.9	7.8	12.98	4.76	8.26	8.21
21-32	1.81	0.15	7.0	8.1	19.22	4.22	7.60	8.04
32-60	0.98	0.10	5.9	8.0	18.35	9.10	6.41	9.32
60-110	0.88	0.09	5.8	8.1	26.47	3.85	1.54	7.11
110-below	0.41	0.06	4.0	8.1	25.87	5.23	1.27	12.90
Soil profile No. 40, Shabran region								
0-12	4.40	0.31	8.2	7.8	20.06	6.85	0.40	11.50
12-37	1.76	0.14	7.3	8.1	20.07	6.00	5.49	7.57
37-61	1.21	0.11	6.4	8.1	22.01	3.27	28.33	4.24
61-98	0.98	0.10	5.7	8.7	22.45	4.33	-	-
98-134	0.69	0.08	5.0	5.1	22.15	8.76	7.26	13.68
167-below	0.64	0.07	5.3	9.0	21.73	7.98	2.86	8.64

These soils are represented by clayey varieties, since the content of physical clay in the upper horizon is 84.56% and gradually increases to 87.80-90.68%, and sharply decreases in the lower part of the profile (59.80%). The content of the silty fraction is high (38.0-46.0%) (Table 2).

According to the international classification of soils of the world, ordinary gleyic meadow-sierozem soils can be called as follows: *Cambic Calcisols (Aridic, Clayic, Gleyic, Stagnic).*

Soil profile No. 40 was laid in the Shabran region, the village of Khalilli. Coordinates: $41^{0}17^{I}50.29^{II}$ N, $48^{0}59^{I}19.31^{II}$, at an altitude of 3 m above sea level. The relief is a low plain. Fodder crops were sown here.

Ak1 0-12 light gray (Hue 10 YR 7/1), medium loam, crumbly, a little dense, roots, passages of worms and anthills, strong visible effervescence, dry;

Ak2 12-37 brownish gray (Hue 10 YR 4/1), medium loam, lumpy, a little dense, roots, strong visible effervescence, a little moist, clear boundary to;

A/Bk 37-61 brownish gray (Hue 10 YR 6/1), medium loam, lumpy, a little dense, moist, strong visible effervescence, smooth boundary to;

Bgkwyz 61-98 brown (Hue 10 YR 4/4), medium loam, lumpy, a little dense, blue-gray rusty spots, with abundant efflorescence of readily soluble salts, gypsum and the release of carbonates in the form of whitish spots, moist, strong visible effervescence, clear boundary to;

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B/Cgkyz 98-134 brownish gray (Hue 10 YR 5/1), light loam, structureless, a little dense, rusty spots, with abundant efflorescence of readily soluble salts, gypsum and the release of carbonates in the form of whitish spots, moist, strong visible effervescence, smooth boundary to;

Cgk 167-ниже brown (Hue 10 YR 3/4), light loam, structureless, a little dense, rusty spots, glaucous color tint, strong visible effervescence, moist.

Table 2

PARTICLE-SIZE COMPOSITION OF MEADOW-SIEROZEMS SOILS

Deep, cm	*Particle content,%; particle diameter, mm*						
	1-0.25	*0.25-0.05*	*0.05-0.01*	*0.01-0.005*	*0.005-0.001*	*<0.001*	*<0.01*
Soil profile No. 39, Shabran region							
0-21	not	1.80	13.64	22.80	15.76	46.0	84.56
21-32	not	-	11.96	13.48	35.20	42.0	90.68
32-60	not	-	13.08	19.36	31.56	38.0	88.92
60-110	not	-	14.20	21.80	24.00	42.08	87.80
110-below	0.13	14.87	25.20	23.60	18.40	17.80	59.80
Soil profile No. 40, Shabran region							
0-12	not	10.00	15.20	13.00	31.80	30.00	74.80
12-37	not	5.70	16.28	15.58	32.44	30.00	78.02
37-61	0.07	28.73	30.32	10.36	13.64	16.88	40.88
61-98	not	20.64	41.28	13.04	14.64	10.40	38.08
98-134	not	50.08	27.68	3.88	14.76	3.60	22.29
167-below	not	28.79	44.48	13.44	4.89	8.40	26.73

The morphological description of the profile shows: the profile has a clear differentiation of the profile, a gradual darkening of the color of the upper horizons, the thickness of the humus horizon is 61 cm, is characterized by a medium-clayey and medium-loamy granulometric composition, the upper horizons are biologically well processed. A characteristic feature is also the presence of blue-gray and rusty spots in the Bgkwyz horizon. The lower horizons (Bgkwyz and B/Cgkyz) show signs of salinization and gypsum excretion. The entire profile is dense, slightly clayey, the Bgkwyz horizon is very different in color.

In poorly cultivated gleyic, slightly saline meadow-serozem soils, the humus content in the upper horizon is much higher (4.40%), rather sharply decreases with depth (to 1.76-0.64%). The content of total nitrogen also decreases down the soil profile (from 0.31 to 0.07%), the C:N ratio is narrow, 8.2–5.0. The absorption capacity in fluctuates in the range of 32.57–11.90 cmol (eq)/kg of soil. The reaction of the soil environment in the 0-98 cm horizons varies within 7.8-8.7 — alkaline, in the B/C (5.1) horizon, acidic, and in the C (9.0) horizon-strongly alkaline (Table 1).

Poorly cultivated gleyic, slightly saline meadow-sierozem soils are characterized by high carbonate content. The distribution of carbonates along the profile is uniform, the amount of $CaCO_3$ gradually increases down the profile to 20.06-22.45%. The absorption capacity in these soils is low and on average fluctuates between 18-30 cm (eq)/kg of soil. In the A/Bk horizon, calcium prevails in the composition of exchangeable cations with a calcium to magnesium ratio of 6.7, and in the lower horizons, magnesium prevails with a magnesium to calcium ratio of 2-3.

The poorly cultivated gleyic, slightly saline meadow-serozemic soils are represented by clayey varieties, since the content of physical clay in the upper horizon is 84.56% and gradually increases to 87.80-90.68%, and sharply decreases in the lower part of the profile (59.80%). The content of the silt fraction is high (38.0-46.0%). There is a very high content of the 0.005-0.001mm

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fraction (31.80–32.44%) in the upper horizons and the 0.25-0.05 mm (50.08%) fraction in the B/Cgkyz horizon (Table 2). These soils are slightly saline (dense residue is 0.430-0.504 %), sodium cation prevails among the cations (Table 3).

Table 3

COMPLETE WATER EXTRACT OF MEADOW-SIEROZEMS SOILS, %

Deep, cm	*Dense residue*	*Amount of salts*	*HCO^-_3*	*Cl^-*	*SO^{--2}_4*	*Ca^{2+}*	*Mg^{2+}*	*Na+K*
Soil profile No. 40, Shabran region								
0-12	0.430	0.440	0.046	0.041	0.222	0.018	0.018	0.095
12-37	0.460	0.452	0.068	0.061	0.197	0.019	0.015	0.092
37-61	0.450	0.460	0.039	0.035	0.244	0.022	0.010	0.110
61-98	0.504	0.527	0.036	0.043	0.282	0.029	0.005	0.132

According to the international classification of soils of the world, poorly cultivated gleyic, slightly saline meadow-serozem soils can be called as follows: Gypsic Calcisols (Gleyic, Loamic, Stagnic).

Conclusions

The WRB diagnostic criteria were applied to meadow-serozem soils in the northeastern part of the Greater Caucasus. Taking into account their morphological features and analytical data, diagnostic horizons were identified. In all the sections studied, the cambic horizon was identified. The most characteristic diagnostic indicators of meadow-sierozem soils are the presence of clay in horizon B and carbonate formations in the form of mold. On this basis, according to the WRB system, meadow-sierozem soils can be classified as follows: ordinary gleyic meadow-sierozem soils — Cambic Calcisols (Aridic, Clayic, Gleyic, Stagnic). Poorly cultivated gleyic, slightly saline meadow-serozem soils - Gypsic Calcisols (Gleyic, Loamic, Stagnic).

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