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GEOCHEMICAL PROBLEMS IN IRRIGATED SOILS OF CENTRAL FERGANA

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Abstract

The article analyzes the biogeochemical problems of irrigated soils with varying degrees of salinity. In particular, the composition, structure, and geochemical properties of biogeochemical barriers formed as a result of the formation of arable-horny and horny-arable layers in irrigated meadow sedge soils in the Central Fergana region are extensively covered.

Also, in the group of radial barriers, bipolar barriers are distinguished, and the geochemical and physicochemical differences between their upper and lower parts are scientifically described. The results of the study show that the processes and properties occurring in the upper part of the layer differ significantly from those observed in its lower part, which confirms the complex nature of the migration of substances and elements in the soil profile.

Keywords:barrier, arzic-horny, migration, accumulation, pedolite, ecological.

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INTRODUCTION. Today, a comprehensive study of the agrochemical, chemical, physical and biogeochemical properties of irrigated soils, the migration, accumulation, transformation and geoenergetic properties of chemical elements in the soil are among the most pressing scientific problems on a global scale. A thorough analysis of these processes is important for assessing soil fertility, ensuring ecological stability and scientifically assessing anthropogenic impacts.

The distribution of heavy metals and radioactive elements in the soil in different layers of the soil profile is manifested through accumulation or migration processes at different depths, depending on their chemical and physical properties, soil granulometric composition, physico-chemical parameters, and hydrogeological conditions. These processes are interrelated and form a system of biogeochemical problems observed in irrigated soils.

LITERATURE ANALYSIS AND METHODS. The Central Fergana Desert was formed as an accumulative area in the course of historical and geological development, where rivers, streams, and mudflows flowing from the surrounding areas, especially from the mountain slopes, accumulated. The deposition and accumulation of sedimentary rocks brought in during this process took place continuously for many centuries.

Depending on the speed of the currents and the intensity of the floods, the granulometric (mechanical) composition of the deposits changed over time and stratified into layers. Due to the limited possibility of water outflow from the area and the high temperature and dry characteristics of the climate, most of the water was spent on evaporation. As a result, the area served as an erosion base, and clayey rocks, sands, and water-soluble salts accumulated in different quantities and proportions in different layers of the soil profile [3].

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The role of mineralized groundwater located close to the earth's surface in the occurrence of these processes has been scientifically proven, and it has been noted that these waters are under strong pressure [12, 13].

The genetic specificity, chemical and mineralogical composition, and land reclamation properties of the soils of this region were studied by MAPankov (1957), GIOlovyanishnikov (1937), ANRozanovs (1941), and others [8, 9, 12].

The hydromorphic nature of the soils of Central Fergana has been proven (MAPankov, 1957), and among the first to note the presence of densely gypsum-rich, slightly hornblende layers in soil sections at the edges of cone-shaped outcrops.

In his research, M.Umarov studied the impact of various types of agricultural crops on the physical, physical-mechanical properties of Central Fergana soils and noted that there are dense impermeable layers at depths of 70-120 cm, which in turn negatively affect the physical properties of the soil [13].

According to P.N. Besedin (1979, 1981), the soils of the Kuvasoy cone are characterized by salinity, waterlogging, poor permeability, friability, and horniness.

Research methods. As a result of our research based on field observations, it was determined that these types of soils still exist in a number of districts of the region, and soil samples were taken from them. Complex scientific methods were used in the research process.

In particular, geochemical approaches developed by VI Vernadsky and A.Ye. Fersman [1] were used. These methods are based on the study of the migration processes of chemical elements in the earth's crust and its various shells, including the pedosphere. In the analysis of pedogeochemical processes from a geochemical perspective, the methods of the systematic approach proposed by AI Perelman and MA Glazovskaya were also used.

The analysis of the chemical composition of soil and water samples, the content of soil humus, the content of absorbed cations, the determination of gypsum, calcium

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and magnesium carbonates, the amount of nitrogen, phosphorus and potassium in total and mobile forms was carried out on the basis of generally accepted methods. In particular, the methodological instructions of the Uzbek Cotton Research Institute (SoyuzNIXI, 1973) and the "Guide to the Chemical Analysis of Soils" developed by Ye.V. Arinushkina (1970) were used.

RESULTS AND DISCUSSION. It is known that the chemical and physical properties of elements: ionic radius, number of electrons in the outer electron shell, configuration, charge, ionization potential, etc. also play an important role in the processes of accumulation and migration.

Beus et al. [2] have shown that isomorphic changes in elements in primary minerals affect their migration.

A number of geochemical barriers are formed in soils and their genetic horizons under the influence of various factors, and these barriers form the basis of biogeochemical problems.

Soils in Central Fergana are formed on alluvial, alluvial-proluvial, and other deposits, which differ in genesis and composition [6, 7, 10].

Biogeochemical barriers have emerged as a result of the formation of humus-rich and humus-rich layers in the irrigated meadow saz soils of Central Fergana. According to G. Yuldashev, A. Turdaliyev, and others, these layers were formed at different depths of irrigated soils and were called pedolite soils [3].

The concept of geochemical barriers was introduced into science by AI Perelman [4]. Barriers in soil layers, i.e. new formations, salt accumulations, etc., are considered microbarriers.

In studying the processes of migration and accumulation of elements, the geochemical barriers developed by AI Perelman are of great importance, which are understood as a sharp decrease in the migration intensity of chemical elements over a short distance and, as a result, an increase in their concentration [6].

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Some new formations formed in the soil also act as pedogeochemical barriers for a specific group of elements or elements in that area.

The studied soils of the Central Fergana are irrigated meadows, and their genetic layers contain separate dense, cemented layers at different depths. The depth of the dense cemented layer increases from South to North, approaching the surface (Figure 1). The changes in the thickness of this layer also vary [3].

This law is violated in some cases, and the degree of violation depends on the structure of the soil cover and microrelief, as well as the degree of subsidence of the area. These soils are characterized mainly by evaporative, oxygen, gleyic, sorption and double carbonate-gypsum, gypsum-carbonate and other barriers.

According to AI Perelman's theory, a number of water-soluble salts accumulate in evaporative barriers in a certain sequence. Such barriers are typical for the studied soils, in which the amount of salts is concentrated in the sequence MgSO4 > CaSO4 > Na2SO4 > NaCl > Ca(HCO3)2.

In addition to a group of cationic and anionic elements, various amounts of macroelements, microelements, lanthanides, and radionuclides are concentrated in evaporative barriers. This phenomenon has been practically unstudied in irrigated soils and agricultural crops.

From this perspective, a number of properties and characteristics of the soils of Central Fergana were studied in detail. The pedolite, i.e. gypsum-carbonate barriers of the studied soils are located at depths of 18-32 cm, 32-55 cm, 93-111 cm and are characterized by a dense, humus-rich, humus-rich composition (Fig. 2). These layers, although not very thick, can play the role of barriers. We called these barriers (S-Ca) gypsum-carbonate and (Ca-S) carbonate-gypsum barriers [3].

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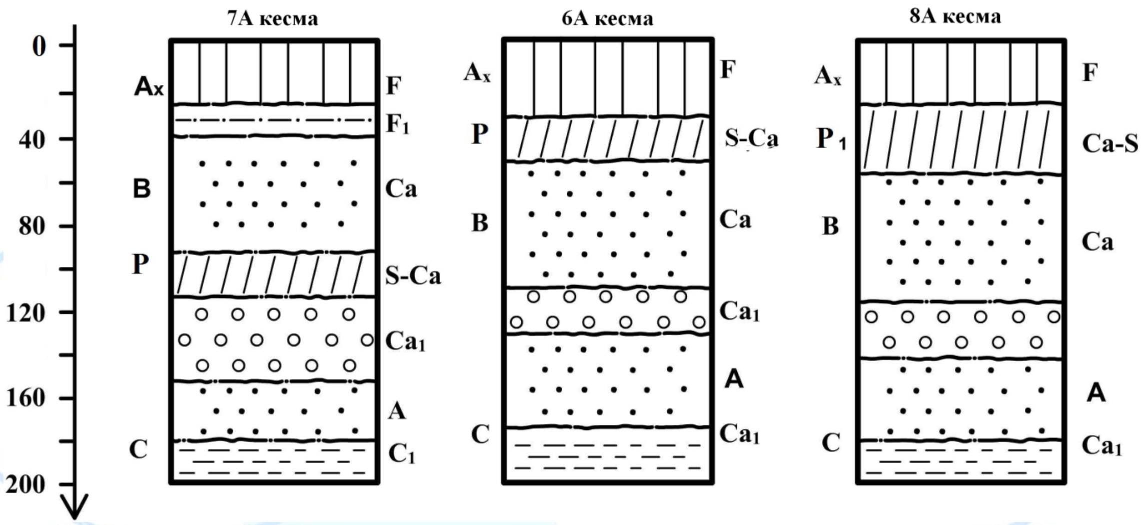

Figure 1. Schematic representation of a pedogeochemical barrier.

Pedogeochemical barriers:	Conditional characters:
F1; F – vapor barriers;	Ah – herd layers;
S-Ca – sparsely branched;	P – pedolite, austere-horny;
Ca-S – horn-bearing;	P1 – pedolite hornblende;
Ca – carbonate;	B – carbonate accumulation layer;

It is known that double barriers were distinguished by AI Perelman, who, among the lateral barriers, called those barriers with an acidic environment on one side, that is, the entrance to the barrier, and an alkaline environment on the other side, and vice versa [3].

In our research, we have distinguished bilateral barriers in the group of radial barriers, which are formed in the inner layers of the soil, that is, during its formation. We also rely on the concept of upper and lower, that is, the properties of the upper parts of the layer differ from the properties of its lower parts (Fig. 2) [11].

We describe radial barriers as follows:

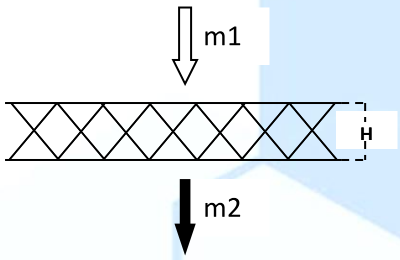

Figure 2. Illustration of radial double barriers.

1. – the direction of chemical elements towards the barrier;

2. – the direction of chemical elements after the barrier;

3. – accumulation of elements in the barrier;

m1 – the state of the environment before the barrier;

m2 – the state of the environment after the barrier;

H is the barrier thickness.

The change in geochemical parameters due to the migration of chemical elements was called the barrier gradient by Perelman. The situation we propose will also remain under the name of the barrier gradient, but instead of L, that is, the barrier length, H – the barrier thickness is adopted, and a small change occurs in the formula, that is, $C_1 = \frac{m_1 - m_2}{H}$; C1 – barrier gradient; H – barrier thickness.

In some cases of the two-way barriers thus formed, we can see a number of changes.

In the conditions of bipolar barriers formed in this way, a number of morphological and geochemical changes are sometimes observed.

The morphological features of these barriers are that they are formed in a radial direction and are located in different depth layers of irrigated meadow sedge soils. In these layers, the migration of elements and substances occurs in two directions - from top to bottom and from bottom to top, which indicates the presence of complex metabolic processes in the soil profile.

In the studied soils, these barriers are characterized by a dense, mineral-rich composition. In addition, IP Gerasimov [5] proposed the use of the term “pedolite” for dense, separate layers of iron, carbonate, and gypsum formations formed during soil

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formation. It is in these barrier layers that carbonate and sulfate salts of calcium and magnesium accumulate in certain quantities.

The obtained data show that irrigated meadow sedge soils are carbonate and gypsum-rich. The carbonate content in them ranges from 6.1-18.8%, $CaCO3$ from 4.5-16.2%, $MgCO3$ from 4.3-16.10%, gypsum from 3.5-44.1%, and epsomite salt from 2.2-27.2%.

It is worth paying special attention to the fact that the high content of carbonate and sulfate salts occurs in the chernozem and chernozem layers (8A: 18-33 cm; 6A: 32-55 cm; 7A: 93-111 cm.). These layers, as a result of the accumulation of carbonate, sulfate salts and some elements, become highly dense, deteriorate water and air permeability, and significantly impede the migration of elements and substances from the upper and lower layers.

In the soils of section 9A, the amounts of gypsum, carbonates, and epsomite are almost evenly distributed, although the amount is slightly higher in the 55-89 cm layer than in the others, which is evidence that it is a remnant of an old layer with poor water permeability, as well as a carbonate illuvial layer. It can be concluded that the soils of section 9A have been developed for a long time, are in a good state of drainage, and under the influence of high agrotechnical conditions, the existing layer is gradually disappearing.

The above-mentioned barriers have some positive aspects in agriculture, and when applying mineral, organic fertilizers and irrigation water to agricultural crops, it is possible to save 20-30% of the total annual rate of fertilizer and water, taking into account the depth of the layer, compared to soils without such barriers.

Conclusion. This situation, i.e., pedolite-rich, i.e. gypsum-carbonate barriers, is also correctly called surface, shallow, and deep pedolite, radial barriers, depending on the depth of their location in the soil layers.

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Systematic monitoring of the content of chemical elements in irrigated soils, their migration processes, accumulation and other geochemical properties is of great importance in assessing and monitoring the agro-ecological state of irrigated areas. These processes serve as a necessary theoretical and practical basis for preventing desertification, salinization, pollution and other negative ecological processes in soils, as well as for determining reclamation measures on a scientific basis.

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