# MIGRATION AND DISTRIBUTION OF LEAD AND CADMIUM IN THE PROFILES OF THE TWO MAIN SOIL RECLAMATION GROUPS IN AKDALA IRRIGATION AREA

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**Abstract:** Negative influence of heavy metals on individual element of agrocenoses located on arable soils depends on soil features. The investigations of heavy metal migration have great pure and ap-plied importance. Former investigations in Akdala region have outlined four reclamation groups of soils. The division of soils into reclamation groups is based on their main genetic features – hypsometric position, lythologic structure, mechanical content and water-physical properties that define a homogeneous feature of reclamation activities in the operational period. Only two of these group have real practical importance. The first group includes mainly weak saline soils of light mechanical content located on river bed banks of the dead river beds of the Ili river and its ducts, suitable for growing all zoned crops without conducting prior reclamation activities. The second group includes saline soils with various degrees of salinity and heavy mechanical structure located on the negative elements of the relief – depression between channels and their slides and slopes, suitable for development in irrigation and conducting special land improvements under all zoned crops, especially for rice. In the area of soils belonging to the above groups the representative locations have been chosen. 32 soil profiles were selected, from which 148 soil samples were collected. In all the samples the concentrations of lead and cadmium were determined using ASA method. In the profile of both arable and virgin soils of the first reclamation group lead is distributed by the eluvial-illuvial type. Eluvial horizon, from which lead is removed is arable horizon, and illuvial where lead is accumulated is sub-arable horizon. A sub-arable illuvial horizon constitutes a geochemical barrier to lead migration in the profile of these soils. In the profile of the second reclamation group of soils, lead is distributed by the accumulative type, subtype – regressive-accumulative. The horizon of lead accumulation and geochemical barrier have heavy mechanical structure and the arable horizon is relatively rich in humus. In the profile of all the studied soils cadmium is distributed by accumulative type. There is also the horizon of cadmium accumulation, and the geochemical barrier is arable horizon relatively enriched with humus. In addition arable soils of both reclamation groups contain higher amounts of the studied metals than their virgin analogues.

**Key words:** soil, heavy metals migration, lead, cadmium.
***Słowa kluczowe***: *gleba, migracja metali ciężkich, ołów, kadm.*

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## 1. Introduction

The process of soil formation in rice growing areas occurs in exceptional specific conditions which include periodical flooding of soils during the whole growing season and subsequent intensive drying in arid climate conditions. Under such conditions, among soil-forming processes a group of basic anthropogenic soil forming processes begins to dominate. Their direction depends mainly on how the soils are used and the intensity of soil cultivation activities.

Downward water flow which prevails in conditions of constant flooding leads to redistribution of substances in the soil profile – (humus, silt particles, nutrients, including heavy metals), i.e. the differentiation of the soil profile takes place (Otarov et al., 2007; Otarov, Ibrayeva, 2000; Karajjanov, 1973; Karajanov, 1983). The character of redistribution depends mainly on the com-bination of the major factors of soil formation and set of soil properties of certain horizons. Depending on this, particular soil horizons may act as geochemical barriers and media for transport-ing incoming heavy metals.

Belitsyna and Pachepskaya (1980) who studied the distribution of lead in the soils of the Valdai Hills, noted the existence of several geochemical barriers such as sorption, alkali, gley barriers related to the multilevel structure of parent rocks. At the contact of rocks with different mechanical composition in conditions of temporary excessive moisture, the gley horizons are enriched with lead which contain more than 100 mg*kg$^{-1}$. Rozanov (2004) showed bright profiled eluvial-illuvial differentiation of lead in typical strongly podzolic soils. In the podzolic eluvial horizon the lead supply is only 20–30% of the total content of this metal, and the accumulation of transferred lead occurs in the illuvial horizon. Acidic soils absorb less heavy metals from solutions than neutral or carbonate soils. Acidic soils have a smaller number of active centers occupied by protons and aluminum ions, which reduce the possibility of adsorption of $Cu^{2+}$ and $Cd^{2+}$. Carbonate soils rich in calcium are more able to absorb heavy metals. The acid-alkaline conditions often play the leading role in the processes of absorption of cadmium by soils (Prokhorov, Gromova, 1971; Zyrin Sadovnikova, 1985; Cabrera et al., 1994) found a similar regulation, increasing the accumulation of metals in conditions of alkaline reaction of soil solution in terms of lead. Varshal et al. (2001) determined that the mobility of lead and cadmium compounds increased in the presence of fulvic acids and decreased in humic acids with formation of stable metal-organic compounds. Maximum stimulating capacity and minimum toxicity of applied cadmium doses occurred in soils with high humus content and heavier mechanical content in black and dark brown soils, and maximum – in light and low humus light brown soils (Malikov et al., 2002).

In our study we found that the accumulation of Pb and Cd in the major reclamation soil groups in Akdala area depended primarily on soil properties. The soils of the second reclamation group accumulated these metals more than the soils of the first group. The soils of the second reclamation group were characterized by a heavier mechanical structure, relatively high content of humus, greater sorption capacity, reduced filtration ability compare to the soils of the first reclamation group, i.e. they were capable to accumulate heavy metals along with other elements.

The value of the negative impact of heavy-metals on soils and other components of irrigated agro-landscape depends largely on soil properties. Those soil properties which influence the mobility and migration capacity of heavy metals are very important. The higher the capacity of the soil to transfer the heavy metals into insoluble compounds, the more restrictive is the migration along the trophic chain, and vice versa, the lower the ability to transfer heavy metals in soluble compounds, the more it contributes to their removal out of the soil profile and irrigated agro-landscape by drainage water.

Therefore, the study and identification of regulations of migrations of heavy metals on the profile of irrigated soils is one of the topical areas of soil science, having both scientific and practical importance.

## 2. Material and methods

In the territory of ancient Akdala-Bakanass delta scientists from the Institute of Soil Science have outlined four reclamation groups of soils (Belitsyna, Pachepskaya, 1980). The division of soils into reclamation groups is based on their main genetic features – hypsometric position, lythologic structure, mechanical content and water-physical properties that define a homogeneous feature of reclamation activities in the operational period. The first group includes mainly weak saline soils of light mechanical content located on river bed banks of the dead river beds of the Ili river and its ducts, suitable for growing all zoned crops without conducting prior reclamation activities. The second group includes saline soils with various degrees of salinity and heavy mechanical structure located on the negative elements of the relief – depression between channels and their slides and slopes, suitable for development in irrigation and conducting special land improvements under all zoned crops, especially for rice. The last two groups: hilly-ridge and hilly sand with spots of takyr type soils and purely hilly-ridge and hilly sands in the area are almost never used in land cultivation. These lands are pasture lands.

In the territory of Akdala irrigation plot mainly soils of the first two groups have been used. They differ sharply in a set of reclamation measures, both in reclamation and maintenance periods. Therefore, to consider the influence of genetic characteristics of the soils and reclamation activities on the background content of heavy metals, soils of these two reclamation groups were selected as the object of research.

In the present study we used conventional and sufficiently proven methodological approaches and research methods used for ecological and biogeochemical investigations of the main components of natural and cultural landscapes. In particular, we used the method of soil keys (pads). These methods allow us, on the basis of a detailed environmental and biogeochemical analysis of small representative sections, – to find the keys to characterize large areas with a homogeneous structure of soil surface. Morphological and profile methods for studying soil were used, which are the main basic methods of field research and soil diagnosis.

For estimating the background levels of lead and cadmium contents in soils, the soil profiles were studied in the main reclamation groups of soil. In selecting profiles we took into account, and partly considered the sites of previously conducted soil-reclamation works (Belitsyna and Pachepskaya (1980). Within the frame of the main reclamation soil groups, we selected representative sites, where the main soil sections were taken. Soil profiles and sampling were done several times, depending on the expected variability associated with soil-reclamation conditions. In total 32 profiles were taken, of which 148 soil samples were taken for identification of heavy metals and basic soil properties. For comparison with arable analogues and determination of possible anthropogenic effect on heavy metals the representative sites were also allocated in virgin soils.

We used official guidelines and instructions in conducting soil survey work on key sites (Rozanov, 2004; Prokhorov, Gromova, 1971). The determination of the ecological status of soils was done in accordance with the requirements of GOST-s and methodological guidelines regulating the work on the study of soils in general and local pollution (Zyrin, Sadovnikova, 1985; Cabrera et al., 1994; Varshal et al., 2001; Malikov et al., 2002). Heavy metals were identified by atomic absorption spectrometry AA-6200 produced by the company «Shimadzu» (Japan). Statistical data processing was performed by using standard methods of mathematical statistics as described formerly (Kornienko et al., 1977; Dmitriev 1995) using the software analysis package «Excel».

### 3. Results and discussion

In soil science the majority of the studied variables are occasional variables and it is not always possible to predict results in advance. They are subject to laws of randomness. Therefore, when studying the content features and spatial variability of soil properties or the average content of some elements in certain horizons, the application of methods of statistical analysis is very important. Furthermore, the use of statistical analysis also increases the interpretive possibility of the data. It should be noted that all conclusions on the absolute values of soil properties made in one or several typical sections without statistical processing, can often be inaccurate and may lead to wrong interpretation of the obtained data (Dmitriev, 1995).

Therefore, to identify the regulation of migration and distribution patterns of lead and cadmium on the profile of the major soil reclamation groups in the area, the obtained analytical data were calculated by means of variation-statistical indicators of the content of their mobile forms in soil horizons (Table 1).

The calculated values of Student's t-criteria showed that for all the studied soils, except for only two lower horizons of virgin soils of the first reclamation group, the value tfact. was significantly higher than $t_{0,05}$, i.e., the calculated values of the average lead content in soil horizons were statistically significant. This was also confirmed by the rather narrow limits of a reliable interval of the average lead content in all the horizons of the investigated soil groups.

The analysis of the degree of variability of lead content in the horizons of the main reclamation soil groups showed that the determined average statistical values were statistically sustainable, and were evidenced by the values of their variation coefficients, which with some exceptions on a scale of gradations corresponded to the limit from small to medium. A high degree of variation (> 40%) was detected in the soil horizons of the same first reclamation group in which the average lead content in the horizons was statistically incorrect ($t_{факт} < t_{0,05}$). If we consider the fact that the soils of the first reclamation group generally have a light mechanical texture and related to this relatively high rate

Tab. 1. Statistical indices of content of mobile form of lead in the horizons of two groups of reclamated soils in Akdala area
*Tab. 1. Wskaźniki statystyczne zawartości mobilnych form ołowiu w poziomach glebowych dwóch grup rekultywowanych gleb w rejonie Akdala*

| **Reclamation group** *Grupa rekultywacyjna* | **Soil use** *Wykorzystanie gleby* | **Depth** [cm] ***Głębokość*** [cm] | **Statistical indices *Wskaźniki statystyczne*** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | n | M±m | t-criteria | | ± $t_{0,05}$ * m | V [%] |
| | | | | | $t_{факт.}$ | $t_{0,05}$ | | |
| First *Pierwsza* | Arable *Grunty orne* | 0–20 | 8 | 6,5±0,6 | 11,4 | 2,3 | 1,35 | 11,4 |
| | | 20–50 | 9 | 7,0±0,71 | 9,9 | 2,3 | 1,64 | 9,9 |
| | | 50–100 | 11 | 6,9±0,74 | 9,4 | 2,2 | 1,64 | 9,4 |
| | | 100–150 | 7 | 4,8±0,60 | 8,0 | 2,4 | 1,46 | 8,0 |
| Second *Druga* | Arable *Grunty orne* | 0–20 | 8 | 10,8±1,39 | 7,8 | 2,3 | 3,23 | 36,3 |
| | | 20–50 | 14 | 9,1±0,93 | 9,8 | 2,15 | 2,00 | 38,2 |
| | | 50–100 | 9 | 8,5±1,1 | 7,8 | 2,3 | 2,53 | 38,7 |
| | | 100–150 | 9 | 8,3±1,1 | 7,6 | 2,3 | 2,53 | 39,6 |
| First *Pierwsza* | Virgin *Gleby nieużytkowane* | 0–8 | 5 | 4,6±0,55 | 8,4 | 2,6 | 1,53 | 26,7 |
| | | 8–38 | 3 | 4,0±1,26 | 3,2 | 3,2 | 5,43 | 54,5 |
| | | 38–100 | 3 | 5,0±1,97 | 2,6 | 3,2 | 8,46 | 67,5 |
| | | 100–145 | 3 | 3,4±1,89 | 1,8 | 3,2 | 8,14 | 96,8 |
| Second *Druga* | Virgin *Gleby nieużytkowane* | 0–4 | 3 | 8,7±0,74 | 11,7 | 3,2 | 3,19 | 14,8 |
| | | 4–15 | 3 | 7,5±0,93 | 8,0 | 3,2 | 4,02 | 21,7 |
| | | 15–65 | 3 | 6,7±0,41 | 16,4 | 3,2 | 1,74 | 10,5 |
| | | 65–110 | 3 | 6,1±0,64 | 9,5 | 3,2 | 2,74 | 18,2 |

of filtration, their high coefficients of variation become quite natural.

The values of statistical constants of content of mobile form of cadmium in the horizons of the main reclamation soil groups of the area were similar to the constants of lead. The estimation of the average cadmium content in the soil horizons of the studied groups, except for the lower soil horizons of the first reclamation group of soils indicated at their statistical authenticity, tfact is higher than $t_{0,05}$. The reliable intervals of the average content of cadmium on the horizons of the virgin soils were also quite narrow. The reliable intervals of the average content of cadmium on the horizons of the virgin soils were quite broad. In our view this is related to the small number of samples which equals to three.

In the majority of the horizons the coefficients of variation of the average content of cadmium as in the case of lead did not exceed the average value (> 40%). The exception were the lower soil horizons of the first soil reclamation group-related to their light texture and high rates of filtration speed.

The results of statistical data processing, showed that the calculated average contents of lead and cadmium in the horizons of the main reclamation soil groups in Akdala area, possessed statistical sustainability and there was 95% probability that they could be used for the migration and distribution of the investigated metals in the soil profile.

Typically, the soil profile is classified by the type of profile structure and distribution of substances in the profile (Rozanov, 2004). Each soil has its typical soil profile with a specific set of genetic horizons. Its formation is subject to zonal factors of soil formation. According to the ratio of various genetic horizons the types of soil profile structure are identified. The second classification is based on the regulations of migration of substances in the soil profile depending on the factors of soil formation. Regularities on which both classifications are based, are interrelated and interdependent and serve as an instrument for a detailed soil genetic analysis.

In investigations of soil contamination by various pollutants, including heavy metals, the study of their migration in the soil profile is of particular interest, determination of geochemical barriers, types of distribution in soil profile, i.e. their biogeochemical life in the landscapes.

In this regard using the obtained analytical data, the types of distribution of lead and cadmium were identified on the profile of the major soil reclamation groups in Akdala irrigation area and their virgin analogues.

As it is seen in Figure 1, lead in the profile of the first soil reclamation group is distributed by eluvial-illuvial type, i.e. the removal of lead from the upper plow layer to the lower illuvial horizons is typical for them (Figure 1). In our view this can be explained by the fact that the soil of the first reclamation group differ mainly in light-texture, relatively high permeability, low content of organic matter, low absorption capacity and as a consequence has low sorption capacity with respect to heavy metals.

The distribution pattern of lead in the profile of the second reclamation group is different than in the profile of the first reclamation group of soils. Lead has a regressive-accumulative type of distribution. Maximum lead is contained in the upper plow horizon and it sharply decreased with depth, i.e. soils of the second reclamation group have high sorption capacity with respect to heavy metals due to the heavy mechanical structure, low permeability, relatively high content of organic matter. These differences between the reclamation soil groups in the accumulation of lead can be clearly seen when compared to the content of absolute quantities of mobile forms of lead. If the soils of the first reclamation group contain only 6,5 ± 0,6 mg/kg of soil, then the soils of the second reclamation group contain 10,8 ± 1,39 mg/kg of lead.

In contrast to lead mobile forms of cadmium in the soil profile of both reclamation groups are distributed according to the progressive-accumulative type (Figure 2).

Maximum of cadmium accumulation occurs in the upper arable horizon of the soil, whereas the accumulations of cadmium in the sub-arable and the average 50–100 cm horizons were observed in less extend. A minimum content of cadmium was found in the bottom of the profile. The difference between the soil reclamation groups is only in the absolute content of cadmium. The soils of the second reclamation group contain cadmium in the amount of 0,51 ± 0,050 mg•kg$^{-1}$ of soil, whereas soils of the first group contain only 0,3 ± 0,040 mg of cadmium per 1 kg of soil.

Tab. 2. Statistical indices of the mobile form of cadmium content in the horizons of two groups of reclamated soils in Akdala area
*Tab. 2. Wskaźniki statystyczne zawartości mobilnych form kadmu w poziomach glebowych dwóch grup rekultywowanych gleb w rejonie Akdala*

| **Reclamation groups** *Grupa rekultywacyjna* | **Soil use** *Wykorzystanie gleby* | **Depth** [cm] *Głębokość* [cm] | **Statistical indices** *Wskaźniki statystyczne* | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | n | M±m | t-criteria | | $t_{0,05}$ | V [%] |
| | | | | | $t_{факт.}$ | ± $t_{0,05}$ * m | | |
| First *Pierwsza* | Arable *Grunty orne* | 0–20 | 8 | 0,34±0,040 | 9,0 | 2,3 | 0,09 | 31,4 |
| | | 20–50 | 9 | 0,30±0,030 | 10,1 | 2,3 | 0,07 | 29,8 |
| | | 50–100 | 11 | 0,30±0,040 | 7,0 | 2,2 | 0,09 | 47,3 |
| | | 100–150 | 7 | 0,20±0,040 | 5,7 | 2,4 | 0,1 | 46,7 |
| Second *Druga* | Arable *Grunty orne* | 0–20 | 8 | 0,51±0,050 | 9,9 | 2,3 | 0,12 | 28,4 |
| | | 20–50 | 14 | 0,52±0,040 | 14,9 | 2,15 | 0,08 | 25,2 |
| | | 50–100 | 9 | 0,52±0,030 | 16,1 | 2,3 | 0,07 | 18,6 |
| | | 100–150 | 9 | 0,49±0,030 | 18,8 | 2,3 | 0,06 | 16,0 |
| First *Pierwsza* | Virgin *Gleby nieużytkowane* | 0–8 | 3 | 0,32±0,020 | 16,0 | 2,6 | 0,06 | 14,0 |
| | | 8–38 | 3 | 0,23±0,033 | 7,0 | 3,2 | 0,014 | 24,7 |
| | | 38–100 | 3 | 0,17±0,033 | 5,2 | 3,2 | 0,061 | 33,5 |
| | | 100–145 | 3 | 0,13±0,033 | 4,0 | 3,2 | 0,014 | 43,3 |
| Second *Druga* | Virgin *Gleby nieużytkowane* | 0–4 | 3 | 0,53±0,033 | 16,0 | 3,2 | 0,143 | 10,8 |
| | | 4–15 | 3 | 0,43±0,033 | 13,0 | 3,2 | 0,143 | 13,3 |
| | | 15–65 | 3 | 0,37±0,033 | 11,0 | 3,2 | 0,143 | 15,7 |
| | | 65–110 | 3 | 0,43±0,088 | 4,9 | 3,2 | 0,379 | 35,3 |

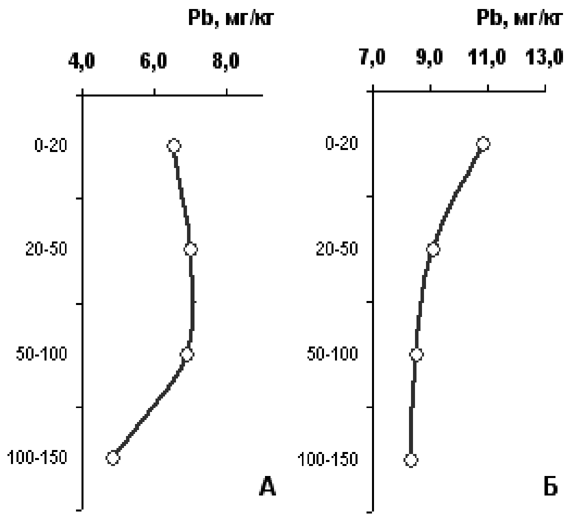


Fig. 1. Distribution of lead in the profile of the first (A) and second (B) reclamation groups of arable soils
*Ryc. 1. Rozkład poziomu ołowiu w profilach gleb użytkowanych rolniczo grupy pierwszej (A) i drugiej (B)*

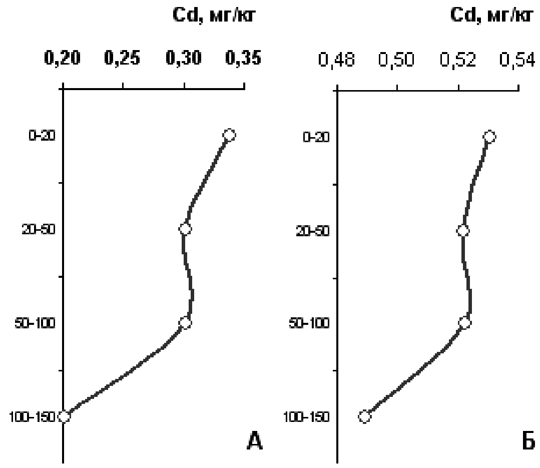


Fig. 2. Distribution of cadmium in the profile of the first (A) and second (B) reclamation groups of arable soils
*Ryc. 2. Rozkład poziomu kadmu w profilach gleb użytkowanych rolniczo grupy pierwszej (A) i drugiej (B)*

Thus, on the basis of the obtained data, we can conclude that the arable soil horizons of the first group were eluvial soils, from where lead is removed with downward current of water, and due to this the horizon is less subjected to contamination. In the subsurface illuvial horizon lead which is taken from the upper horizon is accumulated, i.e. this horizon is a kind of geochemical barrier on the way of lead migration. A geochemical barrier in soils of the second reclamation group is the arable horizon which is relatively rich in humus.

In order to identify the influence of a long-term irrigation on the distribution of heavy metals in the profile of rice-marsh soils of the area, the character of distribution of lead and cadmium in the profile of their virgin analogues was also analyzed.

In the distribution of lead in the profile of virgin soils of the first reclamation group, a similar pattern as in the arable options is observed (Figure 3). In the profile of these soils, lead is distributed as the eluvial-illuvial type, which is described above in detail.

In the soil profile of the second reclamation group lead is distributed in uniform-accumulation type, which differs from the other types in uniform gradual reduction of lead content in depth. In our view, this type of distribution can be explained, in contrast to the arable analogues, by the lack of intensive long-term downward water flow.

Virgin soils in both groups also differ from the arable analogues in relatively low content of lead. Virgin soil versions of the first group contain lead less than 1.9 mg•kg$^{-1}$ of soil, the second group – 2.1 mg•kg$^{-1}$ of soil.

To conclude, we can say that in the virgin soils, lead is relatively more mobile than cadmium and it forms noticeable eluvial and illuvial horizons. Virgin soils contain relatively less lead than their arable analogues, i.e. due to constant flooding in long-term irrigation enhances the accumulation of lead in the arable soil layer.

The distribution of cadmium in the profile of the virgin soils differs quite clearly from the type of distribution in the profile of the arable analogues. In the soils of the first group cadmium is distributed according to even-accumulation type (Figure 4). In the soils of the second reclamation group there is a rather complex mixed-type distribution, up to a depth of 1 meter distribution of cadmium is of uniform-accumulative type, and is similar to the progressive – ground-accumulative type. Such a mixed genetic profile type is almost always linked with groundwater and movement of elements in the upper layers of the profile. For a clear exact definition of such complex type of distribution of substances other approaches and methods, as well as special genetic investigations are needed including the identification of the depth of groundwaters and content of heavy metals in their composition. The upper root part of the profile of both arable and virgin soils of both reclamation groups differs in higher sorption capacity with regard to cadmium.

In the case of absolute content of cadmium in the upper root layer of the soil profile, virgin and arable soils are almost identical. The difference is only a hundredth of a milligram per kilogram of soil.

## 4. Conclusions

In the profile of both arable and virgin soils of the first reclamation group lead is distributed by the eluvial-illuvial type. Eluvial horizon, from which lead is removed is arable horizon, and illuvial where lead is accumulated is sub-arable horizon. We can say that eluvial arable horizon is less subject to contamination. A sub-arable illuvial horizon constitutes a geochemical barrier to lead migration in the profile of these soils. In the profile of the second reclamation group of soils, lead is distributed by the accumulative type, subtype – regressive-accumulative. The horizon of lead accumulation and geochemical barrier have heavy mechanical structure and the arable horizon is relatively rich in humus.

In the profile of all the studied soils cadmium is distributed by accumulative type with subtypes – progressive and uniform-accumulative. There is also the horizon of cadmium accumulation, and the geochemical barrier is arable horizon relatively enriched with humus.

Soils of the second reclamation group are characterized by a relatively higher content of lead than the soils of the first group. In addition arable soils of both reclamation groups contain higher amounts of the studied metals than their virgin analogues.

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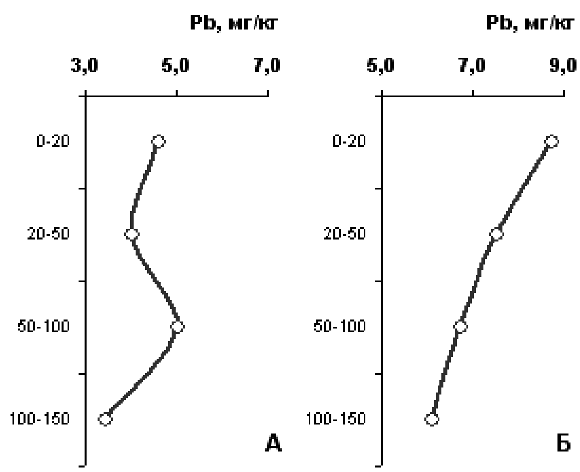


Fig. 3. Distribution of lead in the profile of first (A) and second (B) reclamation groups of virgin soils
*Ryc. 3. Rozkład poziomu ołowiu w profilach gleb nieużytkowanych grupy pierwszej (A) i drugiej (B)*

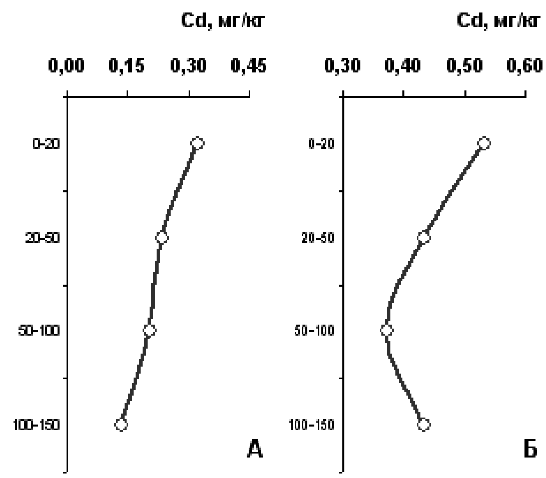


Fig. 4. Distribution of cadmium in the profile of first (A) and second (B) reclamation groups of virgin soils
*Ryc. 4. Rozkład poziomu kadmu w profilach gleb nieużytkowanych grupy pierwszej (A) i drugiej (B)*

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## MIGRACJA I ROZPRZESTRZENIENIE OŁOWIU I KADMU W PROFILACH DWÓCH ZASADNICZYCH GRUP REKULTYWOWANYCH GLEB Z NAWADNIANYCH TERENÓW OBSZARU AKDALA

*Streszczenie*

Negatywny wpływ metali ciężkich na poszczególne elementy agrocenoz na terenach rolniczych zależy głównie od właściwości gleb, szczególnie tych, które wpływają na mobilność i zdolność migracji tych pierwiastków. Badanie i zależności kierujące migracją metali ciężkich mają duże znaczenie poznawcze i praktyczne. Poprzednie badania gleb w rejonie Akdala określiły cztery grupy rekultywacyjne gleb, spośród których dwie mają istotne znaczenie. Grupę pierwszą stanowią gleby słabo zasolone o lekkim składzie mechanicznym, położone w korycie i starorzeczach rzeki Ili, na których możliwe jest prowadzenie upraw bez uprzedniego przeprowadzenia zabiegów rekultywacyjnych. Druga grupa obejmuje silniej zasolone gleby o ciężkim składzie mechanicznym położone w depresjach między kanałami, które wymagają nawadniania i polepszenia struktury przed rozpoczęciem upraw. W obrębie gleb należących do tych dwóch grup wybrano reprezentatywne powierzchnie badawcze, na których wykonano 32 profile glebowe, z których pobrano 148 prób w celu identyfikacji poziomu kadmu i ołowiu i określenia podstawowych cech glebowych. Dla celów porównawczych i ewentualnego określenia wpływu antropogenicznego badano analogiczne próby gleb użytkowanych rolniczo i nieużytkowanych. Metale ciężkie oznaczano metodą absorpcyjnej spektrometrii atomowej. W profilach gleb z pierwszej grupy zarówno użytkowanych rolniczo, jak i nieużytkowanych, poziom ołowiu wykazywał cechy rozkładu eluwialno-iluwialnego, co oznaczało usuwanie tego pierwiastka z poziomu eluwialnego (warstwy ornej) i akumulowanie w warstwie niższej – iluwialnej. Warstwa ta stanowi barierę do dalszej migracji ołowiu. W profilach gleb drugiej grupy zaobserwowano akumulacyjny typ rozkładu poziomu ołowiu. W profilach wszystkich badanych gleb kadm lokuje się zgodnie z akumulacyjnym typem dystrybucji, w którym obserwuje się poziom nagromadzania się tego pierwiastka, a geochemiczna bariera migracji charakteryzuje się stosunkowo wysoką zawartością humusu. Zauważono również, że gleby obu grup użytkowane rolniczo zawierają wyższe stężenia obu badanych metali niż ich nieużytkowane analogi.