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THE INFLUENCE OF GEOLOGICAL AND GEOMORPHOLOGICAL FEATURES OF THE CITY OF BELGOROD ON THE ANOMALOUS PROPERTIES OF SOILS WITHIN ITS TERRITORY

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Abstract:
The morphological properties and distribution of carbonates in the soils of catena of the city of Belgorod were studied. The morphological compliance the soils with the grey typical carbonate-free was ascertained. However, the soil in the upper part of the slope is characterized by abnormal effervescence due to the ingress of carbonate dust from the chalk mining enterprise. The impact of emissions of the enterprise depends on the slope exposure. At present the classification of the studied soils is deficiently developed. Due to the heterogeneity of carbonate dust on the soil surface and the relief features the change in the types of soil combinations is taking place.

Key words: *urban soil, chalky sediments, carbonates dust, soil catena, grey soil, mosaics.*

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INTRODUCTION:

At present, cities, being the centers of population and industry, are characterized by intense impact pollution; they turn into technogenic geochemical provinces. According to [1], one of the basic concepts of ecological study of cities is ecological-geochemical, studying the migration and concentration of chemical elements and their compounds in the main geospheres of the Earth.

In the frame of this concept, the important value belongs to the study of soils, which, unlike air and water environments, quickly absorb pollutants, but very slowly transform them. Ecological aftermaths of anthropogenic changes of soils are often irreversible. In contrast to the homogeneous components of the natural complex (air, water environment), which are characterized by approximately the same level of permissible pollution in different natural zones, the allowable levels of contamination for soils, as noted by [2], can vary for the same indicators up to ten times or more depending on the typical accessories of soils.

Numerous works of Russian and foreign authors [3-6] are devoted to the problem of classification and characteristic of urban soils. Attention to them is increased due to the spread of landscape design on the territory of cities [7].

Currently, there is a number of ecological problems: 1) mainly with the deterioration of living conditions and health status of the population; 2) with the depletion or loss of natural resource potential; 3) with the violation of landscapes as life support systems [8]. This sequence of the enumeration of the ecological problems is not accidental, because anthropocentric anthropocentric point of view in this case is necessary and justified. Apparently, this explains the fact that the main attention of studies of urban soils is paid to their pollution, primarily by heavy metals [9, 10]. At the same time, many researchers note that the common properties of urban soils are artificial layers, deterioration of the structure, the abundance of lithomorphs and anthropomorphs, alkalization of the environment, leading to micronutrient deficiency and phosphorus [3,11].

Still in 1996, we discovered the phenomenon of anomalous distribution of carbonates in the soil profile of Belgorod [12]. Carbonates are non-toxic substances, they do not have the abrupt influence on the health status of the population, but the violation of their distribution in the soil profile leads to the significant change of the soil characteristics and, consequently, to the change of the most important component of the landscape. Such soils are difficult to classify, as the distribution of carbonates is an important classification feature. In this article the level of extension and causes of «anomalous carbonate content» of soils of the city of Belgorod are discussed.

METHODS:

Belgorod oblast is one of the border regions of the Russian Federation. It is located in the south-west of the Russian Federation on the south-western and southern slopes of the Central Russian Upland, it stands out by the powerful development of the mining complex on the basis of Kursk magnetic anomaly (KMA) and agriculture based on the use of fertile chernozems. Figure 1 shows the position of the oblast on the map of the Russian Federation.

The oblast is located on the ancient Russian platform. Important geological and geomorphological features of its territory are widespread in the sedimentary thickness of the deposits of the Cretaceous system of the Mesozoic group and the intensity of erosion processes. This leads to the denudation of chalk deposits on the slopes of river valleys, gullies and ravines, and it also contributes to the development of chalk mining and construction industry. The marked features are characteristic for the territory of Belgorod.

Chernozems and dark grey soils dominate in the soil cover of the oblast. On the territory of the city a variety of surface bodies is added to them. According to the classification [3], they include urbo-soils, urbanozems, technozems, soils of natural and technogenic grounds, ekranozems, sealed grounds. Under the conditions of Belgorod, urbosoils are represented by urbo-grey soils and urbo-cnernozems.

We studied the features of urban soils in the northwestern part of the city. Soil catena including 3 soil sections was laid. Section № 1 was located in the upper part of the slope of the beam of the south-eastern exposure with steeply about 5°, under the ravine forest, grassy cover of which is represented by the sedge - cereals association. Parent rock - cover clay.

Section № 2 was in the middle of the slope with steepness about 5°. The vegetation cover is similar to the one described for section №1.The vegetation cover is similar to that for the section № 1. Parent rock was loess-like loam.

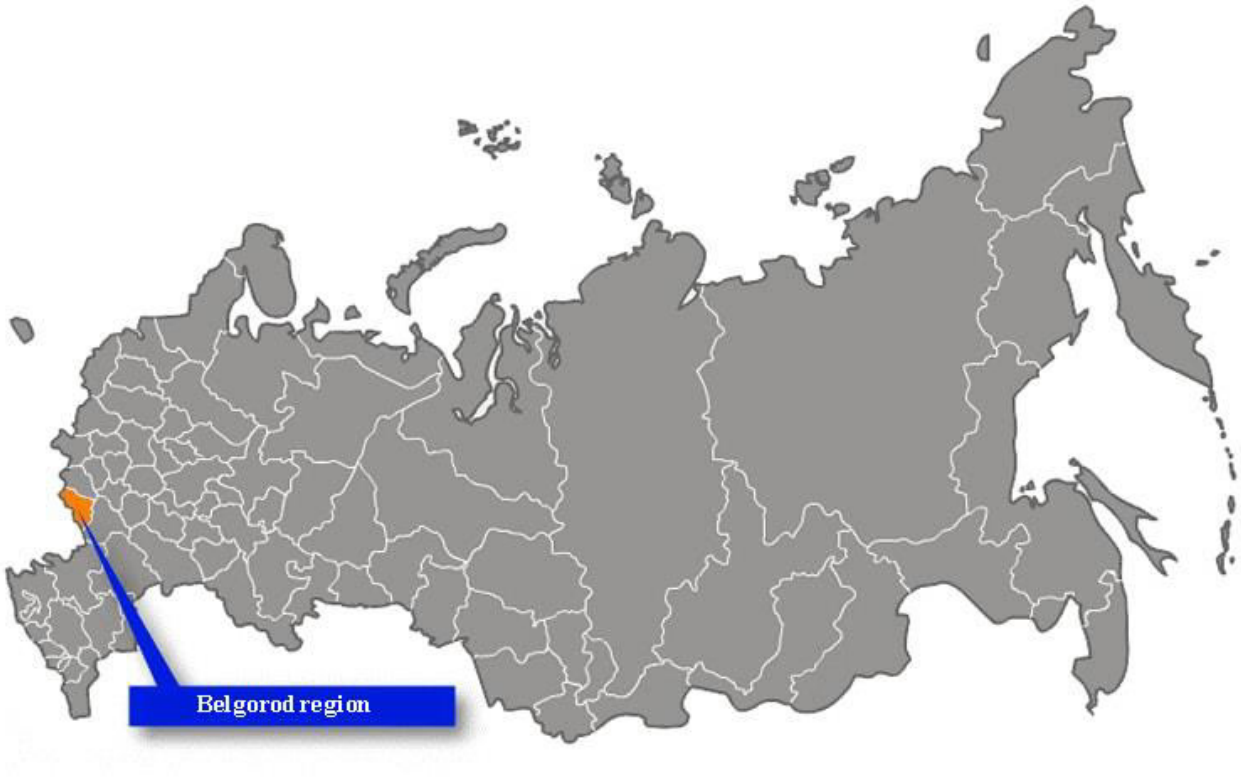

Fig.1. Belgorod oblast on the map of the Russian Federation [https://www.google.ru]

Section № 3 was laid in the lower part of the studied slope of about 15°steepness. Vegetation – sedge-herb association. Parent rock - cover clay, underlying rock- sand.
The results of morphological description of soils are given in tables 1-3.
Table 1

Morphological description of soil section No. 1

Genetic horizons and their power, cm	Characteristic of horizons
Adca 0-5	Sod, dampish, light loam, grey, lumpy-fine-grained structure, friable, inclusions of bimorphs – rare root fragments, edaphon – very numerous roots, tempestuous effervescence, abrupt transition on the number of roots, smooth boundary.
A 5-34	Humus, dampish, medium loam, grey (in the lower is her part – grey-brown), the structure is lumpy-granular, slightly sealing, the biomorphic inclusions – rare root fragments, edaphon – many roots, absence of effervescence, sharp transition in color, wavy border
AE 34-69	Humus-eluvial, dampish, medium loam, light grey, buckshot-lumpy structure, slightly sealing, new forms – rich siliceous powdering, inclusions of biomorphs – single root fragments, edaphon – few roots, absence of effervescence, sharp transition in color, wavy border
B 69-90	Illuvial, wet, clay, dark-brown, structure blocky-nutty-coarse-grained, very solid, inclusions of biomorphs – single root fragments, edaphon – rare roots, absence of effervescence, gradual in color, wavy border
C 90-120↓	Parent rock, wet, clay, inhomogeneously colored: on dark brown background, yellow-brown and light-brown spots, blocky-coarse-grained structure, very solid, edaphon – rare roots, absence of effervescence

Table 2
Morphological description of soil section No. 2

Genetic horizons and their power, cm	Characteristic of horizons
Ad 0-5	Sod, dampish, medium loam, grey, buckshot-grained structure, friable, inclusions of biomorphs – the numerous remains of roots, edaphon – very numerous roots, absence of effervescence, the transition is clear on the number of roots, smooth boundary.
A 5-20	Humus, dampish, medium loam, grey, small-blocked - buckshot-grained structure, friable, edaphon – numerous roots and rare earthworms, absence of effervescence, noticeable transition by color, wavy border
AE 20-40	Humus-eluvial, dampish, medium loam, light grey, buckshot-grained structure, solid, new forms – abundant siliceous powdering, edaphon – numerous roots, absence of effervescence, the transition is clear in color and hardness, wavy border
B1 40-60	Illuvial first, wet, clay, brown, largelynutty-nutty structure, very solid, new forms – clay slicks on brinks of the structural parts, edaphon – numerous roots, absence of effervescence, the transition is clear in color, wavy border
B2 60-105	Illuvial second, wet, clay, yellowish-brown, blocky- largelynutty structure, very solid, new forms – dendrites, edaphon – few roots, absence of effervescence, the transition is clear in color, wavy border
Cca 105-117↓	Parent rock, dampish, medium loam, unevenly colored: yellow background with dark brown spots, blocky-buckshot structure, very solid, the new forms: carbonate in the form of white scurf and streaks, edaphon – rare roots, tempestuous effervescence

Table 3
Morphological description of soil section No.3

Genetic horizons and their power, cm	Characteristic of horizons
Ad 0-10	Sod, dampish, medium loam, grey, lumpy-fine-grained structure, friable, edaphon – very numerous roots, absence of effervescence, sharp transition in the number of roots, smooth boundary
A 10-30	Humus, dampish, medium loam, gray, small-blocked-lumpy-powdery structure, friable, edaphon – numerous roots, absence of effervescence, transition is clear in color, wavy border
AE 30-48	Humus-eluvial, dampish, light loam, light grey, small-blocked –nutty structure, solid, new forms – abundant siliceous powdering, edaphon – numerous roots, absence of effervescence, the transition is clear in color, wavy border
B1 48-76	Illuvial first, wet, medium loam, brown, prism-fine-grained - large-nutty structure structure, solid, in the wall of the incision numerous cracks, inclusions – biomorphs: rare remains of roots, edaphon - rare roots, absence of effervescence, the transition is clear in color, smooth boundary
B2 76-143	Illuvial second, wet, clay, light-brown, blocky-buckshot structure, hard, in the wall of the soil section thin cracks, new forms – clay films on faces of structural separateness, inclusion – biomorphs: rare remains of roots, edaphon – rare roots, absence of effervescence, transition is noticeable by the hardness and granulometric composition, smooth boundary
BC 143-156↓	Transition to the parent rock, wet, inhomogeneous by granulometric composition: from clay to sand, unevenly colored: brown with yellow and dark brown inclusions, blocky- large-nutty structure, very solid, edaphon – unit roots, absence of effervescence

Determination of carbonates was carried out by the technology of alkaline determination.

Main part

The analysis of the presented descriptions of the soil profiles showed that apparently the soils are similar, but the definition of the classification belonging of soil of the section 1 is difficult, as morphological description corresponds to grey typical noncalcareous soil, with the exception of the distribution over profile the nature of the effervescence from 10% HCl.

If one does not take into account the specified fact, it could be argued that, according to the classification of soils in Russia [13], the study soils are grey typical noncalcareous medium-loamy; they differ on the level of species, diversity and rank. So in the section 1 the soil is medium deep light- and medium-loamy with the deeply developed profile on the cover clay, in the section 2 the soil is shallow and medium-loamy with the deeply developed profile on the loess-like loam; in the section 3 the soil is shallow and medium-loamy with the deep profile on the cover clay, underlying by sand.

It was rather difficult to ascertain the rank of the soil in the 3 section, as the modern profile is located on the sandy rock. However in the profile there are no inclusions of sand, it is heavier on the granulometric structure. This fact allows asserting that the soil was developed on low-deep cover clay and at the certain stage the soil formation covered all its thickness so clay parent rock in the profile is not presented in the profile.

The profile distribution of carbonates in the soils of sections 1 and 2 is shown in Fig.2. Data for the soil section 3 is not given, because the carbonates were absent over the profile.

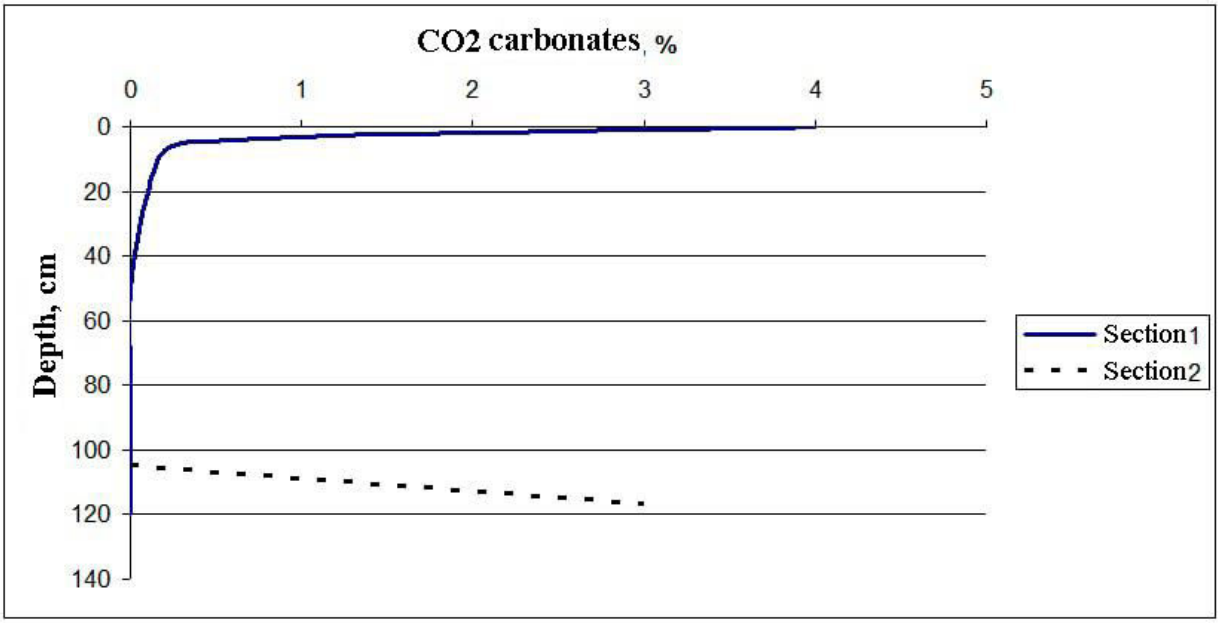

Fig.2. Profile distribution of carbonates in the studied soils

According to the existing ideas about grey soils, they either do not have carbonates in the profile, or carbonates occur, but only at the certain depth, in the parent rock. The distribution of carbonates in sections 2 and 3 corresponds to such ideas: in the soil of the section 3, carbonates are absent, and in the soil of the section 2 they appear in the lower part of the profile, since this soil is developed on the carbonate loess-like loam.

The distribution of carbonates in the soil of the section 1 is completely contrary to the properties of the grey soil. The reason for this event obviously, is the incoming of carbonate dust on the soil surface from chalk quarry which is located just at the distance of about 200 m. The location of the quarry relatively from the studied catena allows us to explain why not all soils effervescence from the surface: the slope faces in the opposite direction from the quarry, so the most intense dust enters on the top of the hill and also on the top of the slope.

When we described these abnormal properties of the soils of the city of Belgorod for the first time, the substantive-genetic soil classification of Russia was still under development, and we proposed in the framework of the then existing soil classification to call such soils «anthropogenic-surface-carbonate» [12]. Currently, according to [13], the identification of such soils also has some difficulties. On the one hand, distinctive features of the soils are diagnosed solely by the chemical characteristic and they are not manifested by the morphological properties that can attribute the studied soil to hemozems. At the same time for hemozems the degree of chemical contamination needs to be assessed as extremely hazardous according to the accepted standards, and for carbonates such parameter for soils has not been

developed yet. Thus, the study soil of the section 1 can be attributed to the carbonate hemozems on the grey soil, but with some degree of conditionality.

The acquisitions by the soil the new properties lead to the change in the structure of the soil covers (SSC). In accordance with the ideas of types of soil combinations [14], the initial state of the soil cover was corresponded to tashets, because in conditions of different parent rocks the soils were similar in their properties, they differed at the level of species, variety and ranks. At change the properties of the soil under the influence of carbonate fallout, its differences with the neighboring soils has become more contrast, just they are observed at the level of the division, that allows to speak about mosaic.

CONCLUSION:

Features of geological and geomorphological structure of the territory of Belgorod are widespread in the sedimentary cover of carbonate rocks and their exposure in the negative forms of relief, so here the mining companies (quarries) and enterprises for the production of building materials are situated, whose activities lead to the incoming of carbonate dust on the soil surface. As a result, grey soils, which are genetically characterized by acidic reaction of the upper part of the profile, effervescence from the surface, which complicates the classification of such soils and leads to the significant change in soil characteristics. Similar patterns have been observed previously in other parts of the city, it testifies that the process of degradation of grey soils in the city of Belgorod is widespread.

FINDINGS:

1. The referring surface- effervescencing grey soils to hemozems not fully reflect their features.
2. The incoming of carbonate dust enhances sinlithogenic trend in the process of formation and transformation of urban soils.
3. Because of to the uneven incoming of carbonate dust due to the relief features there is the change in the structure of the soil cover, which consists in increasing the contrast of soil combinations and also in the change of tashets by mosaics.

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