PEDOLOGICAL CHARACTERISTICS OF THE CENTRAL EASTERN AREA OF PLOIEŞTI PLAIN (WESTERN PART OF PLOIEŞTI CITY)

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The aim of this study is to characterize the soils in an area situated at the western edge of Ploieşti city (the central-eastern part of the Ploieşti Plain). In order to map the 58 hectares expected to be turned into a municipal park we performed five soil profiles, which were analyzed both morphologically (color, texture, structure, neoformations, skeleton, gleyzation, pseudo-gleyzation, morphological thickness, consistency in dry state and compactness) and analytically (calcium carbonate, pH, organic carbon and total humus content). Based on our findings, we were able to divide the soils into two ecological groups (chernozems soils and thin soils), which reflect properly their physical, chemical and biological properties, as well as their specific utilization and management (Florea, 2003).

Key words: *pedological study, ecological characteristics of soils, the Ploieşti Plain, Romania.*

Introduction. Methodological Aspects

The present investigation has been accomplished at scale 1:10000, which makes it a large-scale pedological study (Florea *et al.*, 1987). Its purpose was to characterize the soils located in the western part of Ploieşti city, close to Ploieşti West railway station, an area projected to host a 58 ha theme park. The 1:5000 topographic plan was used as a cartographic basis.

The number of soil profiles and borings performed on the field was established depending on the complexity of the terrain and soil cover, as well as on the representative fraction of the base map. Thus, preliminary scouting highlighted a low degree (class I) of land complexity. Class I of land complexity includes smooth natural regions, plains and lowlands, very weekly dissected, with low pedological diversity, lacking forest vegetation or with forests that account for less than 20% of the area (Florea *et al.*, 1987).

According to the *Pedological Studies Elaboration Methodology* (Florea *et al.*, 1987), the minimum number of main and secondary soil profiles per 100 ha for scale 1:10000 and class I of land complexity is 3.7, which means that for the 58 ha area projected for the future municipal park 2.1 profiles are

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necessary. Morphological analyses (color, texture, structure, neoformations, skeleton, gleyzation, pseudogleyzation, morphological thickness, dry consistency, and compaction), the identification of carbonates (using HCl solution) and pH determination (for some of the horizons – using the test paper and 0.5 indicators) were accomplished in the field. At the same time, samples were taken from the A horizons of P1 and P2 soil profiles (at depths of 10-30 cm and 20-40 cm) in order to run laboratory analyses. The aim was to establish the pH values (to compare them with those obtained in the field), as well as to determine the organic carbon content (%) and the total humus content (%), by using the wet-oxidation procedure.

Natural Pedogenetic Conditions, Land Use and Soil Characterization

The pedogenetic conditions of the investigated territory (*Fig. 1*) are given in a synthetic form in the *Table 1*. Five soil profiles were performed in the field, part of them with the pedological probe, with the intention to preserve as much as possible the integrity of the land. These profiles were characterized according to the methodology that is currently used in Romania (Florea *et al.*, 1987; Florea & Munteanu, 2003).

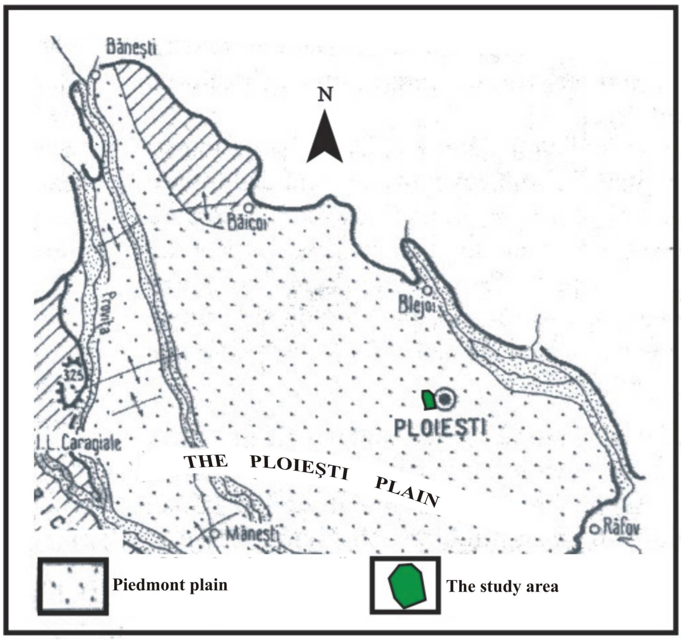

Fig. 1. The Ploiești Plain – Geomorphological map
(Popescu *et al.*, 2005)

Profile number 1 was accomplished on grassland, about 100 m southwest of the cobble road running parallel to the Ploieşti West railway station ($44^{0}55^{'}23$ N; $25^{0}59^{'}38$ E). Following the morphological analysis (*Fig. 2a*, *2b*) the soil was defined as a clay chernozem (showing a Bv horizon) developed on a gravel horizon (Rp) lying at 110 cm. To a certain extent, it is also a rendzinic soil, as much as the Rp horizon is made up of stream gravel predominantly calcareous, with less than 10% of fine materials in the first 150 cm. It is worth noting that carbonate neoformations occur in the first 100 cm of the soil profile. The presence of calcium carbonate, identified through effervescent test, proves the soil is slightly leached. Sometimes, it is meso-calcareous, because effervescence starts at 63 cm deep when tested with HCl. The soil species (defined by the soil structure and skeleton content of two soil horizons – the A horizon and the first part of the B-horizon) are either loamy or loamy-clayey, and are devoid of skeleton or show low amounts of it (skeleton content ± 3-6%; size of skeleton particles 0.2-2 cm).

Table 1

Natural Pedogenetic Conditions and Land Use

Lithology	**Topography**	**Climate**	**Vegetation**	**Land use categories**	**Soil alterations through agricultural use**
Old psefitic stream deposits (aluvio-proluvial) with predominantly limestone rounded gravel	Low and smooth piedmont plain formed at the contact with subsidence areas; the top of the terrace number 2 (Câmpina), lying on the Prahova's alluvial cone (Popescu et al., 2005); about 160 m altitude (altitudinal class – very low, 101-200 m); smooth or slightly rough land (bumps less than 0.5 m amplitude); horizontal or gently inclined areas (gradients less than 2^{0})	(according to the values recorded by Ploieşti station) Mean annual temperature – 10.4^{0}C (*Very high class* of mean annual temperatures); July temperature is 21.9^{0}C; January temperature is – 2.7^{0}C; the mean annual number of freezing days is about 105-110; mean annual precipitation is 608.6 mm (*Medium class* of mean annual precipitation)	Agricultural lands and secondary grasslands with steppe features lying on the latitudinal zone of the forests with *Festuca valesiaca* and *Poa angustifolia*	Arable land with pastures	The appearance of a compacted horizon (plowing foot) as a result of agricultural land use

The sequence of soil horizons starts with Aț (fallow horizon) and extends between 0 and 2 cm. It is followed by a compacted horizon (hardpan – plowing foot), 2 to 6 cm thick, which is explained by the fact that the area has been used as arable land. Down below, between 6 and 40 cm, it lies the mollic horizon (Am), the glomerular structure of which was deteriorated through agricultural use (even though some aggregates with macroscopic pores can still be identified). The present structure is grainy (medium and high) and even polyedric (very small and small); the color is dark (10YR 3/2-10YR 3/3 when dry and 10YR 3/1-10YR3/2 when wet, according to Munsell Soil Color Chart). Based on the color of this horizon and on that of the underlying one (Bv) the soil can be included in the Cernisols class, chernozems type. Bv is a loamy texture horizon, moderately compact, with neutral pH (± 7.0); organic carbon content is 1.73% and total humus content is 2.98%. Between 40 and 60 cm, there is a clayey horizon (Bv) with polyedric structure, of dark color, at least on the faces of the structural aggregates (10YR 3/4 in dry state and 10YR 3/2 in wet state), with loamy or loamy – clayey texture, highly compacted and slightly acid (pH between 6.5 and 6.8). Downwards, it follows the BC transition horizon (between 60 and 70 cm), which is polyedric or sub-angular, loamy-sandy or loamy, moderately compact, slightly acid to neutral (pH = 6.8) and produces a moderate effervescence (which indicates a $CaCO_3$ content ≤ 4%). Last comes the CCa horizon (with carbonate accumulation), which extends between 70 and 110 cm. It is unstructured, loamy-sandy, moderately compact and neutral (pH of approximately 7), showing carbonate neoformations (small veins, filaments or stains) and producing a short and violent effervescence (sizzles), as a result of the very high $CaCO_3$ content (≥ 40%). Below the CCa horizon, at depths higher than 110 cm, it follows the calcareous gravel (producing effervescence) made up of pebbles (0.2-2 cm) and cobbles (2-20 cm).

a *b*

Fig. 2. Clayey chernozem, slightly rendzinic, developed on gravel

Profile number 2 was located on grassland (Fig. 3a, 3b), ± 160 m southwest of the bridge passing over the heating pipe ($44^0 55' 13$ N; $25^0 59' 34$ E). Morphological analyses showed that we were in the presence of a chernozem developed on gravel formations lying at medium to deep levels (Rp at 85 cm). Like its predecessor, this also proved to be a sub-rendzinic and calcium-rich soil. Judging by the presence of calcium carbonate, identified through the application of effervescence test, the soil proved to be calcareous starting from the depth of 45 cm. The soil species (defined by the soil texture and skeleton content of the two specific layers – the A horizon in the first 20 cm and the upper part of the AC horizon) is loamy or loamy-sandy, while skeleton content is ± 3%.

The soil profile begins with the Aț horizon (fallow horizon), slightly compact, which develops between 0 and 2 cm. It is followed by a very compact horizon (hardpan), as in the case of the previous profile. Deeper, is the mollic horizon (Am), the glomerular structure of which has also been deteriorated under the influence of agricultural works. Consequently, the present structure is grainy (medium and high).

a *b*

Fig. 3. Mesolithic and sub-rendzinic chernozems

The dark color of the mollic layer and of the underlying AC horizon (10YR 3/4 when dry and 10YR3/2 when wet), allowed us to include the soil in the Cernisols class, chernozems type. Am horizon has a loamy structure, is moderately compact and has a slightly acid pH (± 6.5). The organic carbon content is 1.86%, while the total humus content is 3.20%. Between 43 and 72 cm it is an AC transition horizon, dark-colored (with values of less than 3.5 in the wet state), at least in its upper part, with a grainy and a polyedric structure, a loamy or a loamy-sandy texture, moderate compaction and slight or neutral acidity (pH = 6.8), which produces moderate effervescence. The CCa horizon follows, lying between 73 and 85 cm. It is unstructured, loamy-sandy, moderately compact and neutral (pH around 7).

It displays neoformations, produces violent and short effervescence, and has a $CaCO_3$ content ≥ 40%. Beyond 85 cm it is the realm of calcareous gravel made up of pebbles (0.2-2 cm) and cobbles (2-20 cm).

Profile number 3 was also located on grassland, ± 20 m south-southeast of the bridge passing over the heating pipe ($44^0 55' 18$ N; $25^0 59' 37$ E). It shows very similar features to profile number 2, as it is also a mesolithic chernozem (Rp is found at 80 cm) and a sub-rendzinic and calcium-rich soil. From the point of view of the presence of calcium carbonate, revealed by the effervescence test, it is a calcareous soil producing effervescence starting from the depth of 40 cm. Soil texture is loamy or loamy-sandy and the skeleton is around 3%. As shown previously, this soil contains calcareous gravel starting from a depth of about 80 cm.

Profile number 4 was located on grassland, ± 270 m west-northwest of Ploieşti West railway station, half distance between the heating pipe and the cobbled road running parallel to the railway. This soil shows a mollic grainy and loamy horizon (Am) followed in the first 25-30 cm by calcareous gravel. Such soils are presently described as rendzinas, whereas in older works they are called chernozems of "*branciog*" type (formed on alluvio-proluvial deposits with rounded gravel, usually calcareous, lying at small depths of 20 to 40 cm).

Profile 5 was performed on plowed field, ± 320 m west of the second expanding portion of the heating pipe lying south of the natural gas station ($44^0 54' 53$ N; $25^0 59' 37$ E). Morphological analyses showed that this soil was a clayey chernozem (because of the Bv horizon). Although the digging did not reach the calcareous gravel, its existence at the bottom of the soil profile is certain, as long as pebbles and cobbles (2-20 cm) were seen in the furrows. By correlating this situation with that encountered at profile number 1 we can conclude that calcareous gravel shows up at ± 150 cm. This suggests that the soil is on the limit between very deep (gravel occurs in the first 150 cm) and extremely deep soils, and also on the limit of the sub-rendzinic variety.

These features do not alter the previously mentioned general qualities of chernozemic soils. Textural species points at a loamy to loamy-clayey soil. In comparison with profile number 1 this soil produces effervescence when tested with HCl at depths between 101 and 117 cm, which makes it a bati-calcareous soil (moderately leached). Other differences are the absence of the fallow horizon (Aț) and the existence of a plowed horizon (Ap), approximately 20 cm thick, at the top of the soil surface.

The Ecologic Characteristics of Soils and Their Importance for the Planning of an Urban Park

Starting from the sub-types, varieties and textural soil species, the soils of Romania have been included in several ecological groups (Florea, 2003). The criteria supporting this classification are the following: soil type and sub-type, soil texture (parent material), hydric and saline regimes, edaphic volume and weathering degree.

These criteria are mirrored not only by the composition of the soil profile, but also by its physical, chemical and biological properties. At the same time, this classification has an ameliorative importance as well, as it mirrors the land use and management techniques.

The ecological group of chernozemic soils includes the mesolithic and batilithic chernozems. On the whole, these are deep soils (excepting the mesolithic sub-type) with an array of favorable physical, physico-chemical and biological properties, which are given by the moderate clay content and the relatively high humus content (medium content of organic matter in the upper horizon: 2-4%). In addition, these soils have a stable grainy structure, good porosity, slightly acid reaction (sometimes even slightly alkaline), high base saturation (> 76%), good water-holding capacity, good aeration capacity and proper nutrient content. All these encourage an intense biological activity, which explains their good fertility. In the case of the moderately deep soils (with calcareous gravel between 76 and 100 cm), represented by the mesolithic chernozems, the properties mentioned previously are also good, but water-holding capacity is relatively low. Anyway, the presence of calcareous material on the bottom of the profile encourages both the exchange of the bases and the quality of the humus. The total drainage of chernozemic soils is good, for which they are not affected by pseudo-gleyzation. On the other hand, phreatic level is very deep and therefore gleyzation processes are also absent.

The shortcomings are connected to several factors. Thus, the climatic water deficit recorded during the dry periods is also experienced by the soil cover (hence the necessity of irrigations). Given the pluvial and thermal characteristics of the investigated territory, the thermal regime of the soil is *mesic* (mean annual temperatures are greater than or equal to 8^0C, but less than 15^0C), while the humidity one is *udic* (during the "normal" years, the moisture control section, which for the analyzed soils lies between 20 and 60 cm, stays wet for a cumulated period of 90 days). At the same time, during "normal" years the moisture control section gets completely dry for less than 45 days in a row in the four months that follow the summer solstice.

The use of these soils as arable lands has generated other negative consequences as well. One of them is the existence of hardpan horizon (the plowing foot). Often it lies in the first 6-7 cm of the soil profile and is very compact. The resistance to penetration tested with the Cole-Parmer portable penetrometer was 4.5 kg/cm^2, while the consistency assessed in dry state was very high (the soil could not be broken with bare hands). The negative consequences of these properties are the following: water percolation and aeration are difficult, water-holding capacity drops, aero-hydrical regime gets worse, the resistance to penetration increases and hinders the development of root system, and the glomerular or grainy structure of the topsoil degrades over time. Moreover these problems have been further enhanced by the practice of overgrazing. The compacted horizon can be destroyed by appropriate agricultural works, meant to loosen the fallow horizon (Aț) of the pasturelands. On the other hand, agricultural works will also seek to remove the rounded gravel from the mollic horizon, which hinder them to a certain extent, although this generally accounts for less than 5%.

The group of soils with low edaphic volume (in which gravel lies at less than 50 cm deep or which usually contain more than 40% rock fragments/gravel) includes a dark, intrazonal soil called rendzina. The low edaphic volume explains the low water reserve and the low amounts of nutrients. Consequently, this soil has a low to moderate fertility, even though the mollic horizon is rich in good quality humus (alkaline mull), and the degree of base saturation is high (more than 76%).

From the standpoint of their bearing capacity, all these soils fall into the category of the mineral soils, physically mature, which can easily support the load of agricultural machinery.

The lands that are supposed to be turned into a municipal park lie at the contact between the silvosteppe and the forest belt. In the past, the area was covered by patches of forest made up of Pedunculate oak (*Quercus pedunculiflora*) and Pubescent oak (*Quercus pubescens*), which are less resistant to drought, oak (*Quercus robur*), Turkey oak (*Quercus cerris*), lime (*Tilia tomentosa*), Field Maple (*Acer campestre*), Field Elm (*Ulmus minor*) etc. At that time, the shrub layer was composed mostly of European Cornel (*Cornus mas*), Common Dogwood (*Cornus sanguinea*), Common hawthorn (*Crataegus monogyna*), Wild Private (*Ligustrum vulgare*), blackthorn (*Prunus spinosa*) etc.

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