

# With Regard to the Chromic Luvisols in Romania

Anca-Luiza Stănilă (Corresponding author)

Department research in soil science, agrochemical and environmental protection, Laboratory of soil sciences and sustainable development

National Research Institute for Soil Science, Agrochemistry and Environment, 61 Mărăști Blvd, District 1, 011464, Bucharest, Romania

Tel: 021/3184458/214, Fax: + 021/3184348

Received: February 1, 2016    Accepted: February 21, 2016    Published: March 3, 2016

doi:10.5296/jas.v4i2.9135

URL: <http://dx.doi.org/10.5296/jas.v4i2.9135>

## Abstract

There are many written reports concerning the formation and the distribution of chromic luvisols of Romania. In many cases it has been appreciated the fact that their presence would be due to some specific condition, the stress being focused on the Mediterranean nuance of climate.

Newer pedological studies show that these soils have a distribution area more restrained. In fact they appear within some narrow interfluvies or marginal stripes of some well drained interfluvies formed at their surface of loess or loess-like deposits.

A major role in their formation is that soil climate expressed by a definitive hydric regime, probably an alternotranspercolative one.

The colour intensity seems to be influenced both by the hydration state of iron and of iron content of parent material. Iron hydroxide suffers a rapid dehydration under prolonged drought condition of soil; they turn into rusty sesquioxides of goethite type, hydrohematite type, inducing to the soil the reddish brown colour.

In a more recent work N. Florea and M. Cicotti (1976) stated that chromic luvisols should not be regarded as a zonal soil formed in the current area, but as a largely inherited, developed under different climates.

**Keywords:** clay migration, chromic luvisols, parent material, genesis, hydric regime, the reddish brown colour

## 1. Introduction

Many authors referred to formation and spread area of chromic luvisols in our country (Gh. Murgoci, 1924; N. Cernescu, 1934; M. Popovăț, 1937, 1945; C. Chiriță, 1955, 1958). In most cases their presence was attributed to specific conditions, with the emphasis on

Mediterranean climate influence. Also, there have been allegations that the formation of these soils in Romania could be explained by the contribution of at least three factors, namely: the parental material, vegetation and, of course, the temperate climate with mediterranean shade.

After C. Chiriță, chromic luvisols could be considered a late developmental stage of luvisols and by other authors would come from the processing luvisols, following deforestation, while E. Ehwald, in the same year, estimated that the red color of these soils is not due in any case to the parent material, since this has a yellowish color. According to him, chromic luvisols seems to be just another variety of haplic luvisols.

Regarding the color of these soils, M. Popovăț stated in 1937 that this is due, at least in Oltenia, to the parental material. In fact, westwards of Olt River chromic luvisols formed on a reddish, claylike deposit, the thickness of which is between 12-15 m, and borders the southern margin of the Getic Piedmont. In all likelihood, this may represent an alteration crust translocated to the high mountain area, dating from the Lower Pleistocene.

## **2. Materials and Methods**

The field studies consisted of mapping and spatial reambulating the studied area on maps at 1:10.000 and 1:25.000 scales, with collection of numerous soil and groundwater samples, with observations on relief, micro-relief and parent material.

The basic research and mapping unit of the areas with chromic luvisols was the soil profile, thus allowing the study of morphological characteristics of the soils. As a result, soils were classified based on intrinsic properties, namely the soil profile, taking into account diagnostic horizons and characteristics.

Soil profiles were located on the ground so that to form a network of studied points. The method of parallel routes, located almost at equal distances has been used, to cover more or less uniformly the whole working area.

The morphological description of soil profiles was done according to the Romanian System of Soil Taxonomy (SRTS, 2003, 2012).ICPA, Bucharest.

In order to establish the soils diagnosis, their morphological features have been taken into account, namely the thickness of morphological horizons, color, texture, structure, composition, adhesion, etc.

Soil samples were taken from genetic horizons both in modified and unchanged settings.

In modified settings, soil samples of 20 cm thickness were taken in bags, for the chemical characterization to be carried.

In natural (unchanged) settings, soil samples were taken using a metal cylinder of known volume (200 cm<sup>3</sup>).to characterize the physical and hydro-physical features, as well as the momentary soil moisture.

The following methods have been used for the physical and hydro-physical features:

**Particle size analysis** (granulometry):

- pipette method for fractions <0.002 mm, including;
- wet sieving method for fractions from 0.002 to 0.2 mm and dried sieving method for fractions > 0.2 mm

For the the **textural classes and subclasses**, we used the Romanian system, according to the Methodology developed for soil studies, ICPA, 1987.

**Apparent density (AD)** method: metal cylinder of known volume (200 cm<sup>3</sup>) for the momentary soil moisture.

**Total porosity (TP)**: by computing  $PT = (1 - AD / D) * 100$

**Fadind coefficient (CO)** was estimated based on the content of clay (<0.002 mm).using the relationship:

$CO (\%) = 0,05 + 0,35 A$ , where:

A = clay content < 0,002 mm.

The chemical characteristics were determined using the following methods:

**Total nitrogen (Nt)**: Kjeldahl method, decomposition of H<sub>2</sub>SO<sub>4</sub> at 350 °C, catalysts: potassium sulphate and copper sulphate.

**pH**: potentiometrically, with glass and calomel combined electrode, in aqueous suspension, at the ratio of 1/2, 5.

**Humus**: wet oxidation (Walkley-Black method, modified) and results expressed in percentage.

**The degree of base saturation (V%)** and **total cation exchange capacity (T me/100 g soil)**, by calculation.

**Sum of bases (SB)**: extraction using 0.05 n hydrochloric acid (Kappen-Schofield- Chiriță method).

**Available phosphorus (mobile)**: Egner-Riehm-Domingod method and colorimetric dosed with blue molybdenum, according to Murphy-Riley method (ascorbic acid reduction).

**Available potassium (mobile)**: extraction according to Egner-Riehm-Domingo method and dosing by flame photometry.

### 3. Results and Discussion

More recent pedological studies undertaken in the Vlășia Plain (Maia Plain, Snagov Plain, Ilfov Plain, Călnăului Plain), as well as in other geographical areas in our country where chromic luvisols have been best studied, have demonstrated that these soils occupy more reduced surfaces, even if their distribution area remains the same. There are totally out of the question those in Oltenia, Banat, the northwestern part of Romania and the Ploiești Plain, the

colour of which is actually inherited from the parental material, an alluvial-proluvial Pleistocene deposit, itself of red colour (Figure 1).

In the cases we studied it resulted that chromic luvisols characterize either very narrow interfluves or marginal, relatively well-drained strips of the interfluves, formed on loess or silty-loess sediments, such as those north and south of Bucharest, respectively Călnăului Plain, Burnas Plain, the terminal piedmontan Snagov Plain, or areas of slightly sloping marginal fields, or terraces, as observed in Neajlov Plain, Călniștei, Burdea and Iminogului Plains.



Figure 1. Chromic luvisols in Romania. 1 – Chromic luvisols, developed on loamy clays, on alluvio-proluvial deposits of Pleistocene age; 2 – Chromic luvisols, developed on loess-like deposits, loamy clays and alluvio-proluvial deposits.

Since the relief is a cvasihorizontal plain, with fine-grained, clayly sediments at the surface, internal soil drainage is significantly hampered, so that stagnation of the rain warts at the surface is imminent. In this case, chromic luvisols do not appear so strongly pigmented with iron hydroxides, but get a yellowish-brown hue that closes them to haplic phaeozems.

Levigating process manifested primarily by deep-washing the  $\text{CaCO}_3$  at depths of 150-200 cm. The greater the depth to which leaching produces, the adsorption complex debasement usually reaches the eubasic stage. It is possible that bioaccumulation and wind deposition to contribute to it, ensuring a calcium intake for the complex exchange relations of the adsorption complex. Since soil textural differentiation is not too big, the levigation of the clay fraction is relatively low.

Under the action of water and weak acid forest humus, the weathering of minerals may continue up to turning silicates into clay; preceded by the heavy removal of colloidal iron silicates as colloidal hydroxide, which precipitates in situ. The phenomenon is present even starting from the upper horizon of the soil profile. This hydroxide undergoes subsequent partial dehydration and turns into less hydrated sesquioxides of rusty colors, such as goethite ( $\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$ ) and even hematite ( $\text{Fe}_2\text{O}_3$ ) that accumulate in horizons A and B, thus giving the reddish-brown colour of the soil. Color intensity is conditioned both by the hydration state of iron and by the iron content in the parent material.

Analytical data on total iron content does not allow differentiations between chromic luvisols, haplic luvisols and not even to luvisols.

Chromic luvisols are characterized by a profile of type *Ao-AB-Bt-C*, relatively deeply developed, and carbonate horizon frequently situated at depths over 150-160 cm (Table 1, 2, 3, 4).

Table 1. Physical and chemical data on chromic luvisols (Ciofliceni - Snagovului Plain)

| Hori<br>zon | Depth<br>(cm) | 0,002<br>mm | 0,002-<br>0,02<br>mm | 0,02-<br>0,2<br>mm | 0,2-<br>2,0<br>mm | Humus<br>% | pH  | V%   | Total<br>N % | Mobile<br>P ppm | Mobile<br>K ppm |
|-------------|---------------|-------------|----------------------|--------------------|-------------------|------------|-----|------|--------------|-----------------|-----------------|
| Ap          | 0-15          | 28,7        | 36,3                 | 34,3               | 0,7               | 2,57       | 6,1 | 78,2 | 0,119        | 11,0            | 122             |
| Ao          | 25-35         | 31,3        | 34,6                 | 33,1               | 1,0               | 2,45       | 6,9 | 79,0 | 0,111        | 22,5            | 144             |
| AB          | 40-55         | 31,2        | 35,7                 | 31,9               | 1,2               | 1,85       | 6,8 | 86,4 | -            | -               | -               |
| Bt1         | 65-80         | 35,2        | 34,0                 | 29,5               | 1,3               | 0,92       | 6,8 | 83,4 | -            | -               | -               |
| Bt2         | 90-105        | 37,5        | 32,2                 | 29,8               | 0,5               | -          | 6,6 | 83,4 | -            | -               | -               |
| Bt3         | 130-145       | 40,0        | 30,2                 | 29,3               | 0,5               | -          | 6,6 | 85,0 | -            | -               | -               |
| Bt4         | 170-185       | 38,5        | 32,2                 | 28,9               | 0,4               | -          | 6,7 | 87,0 | 26           | -               | -               |
| Bt5         | 200-215       | 38,5        | 34,4                 | 27,0               | 0,1               | -          | 7,0 | 89,3 | -            | -               | -               |
| Cca         | 240-250       | 37,1        | 29,1                 | 33,0               | 0,8               | -          | 8,4 | -    | -            | -               | -               |

The thickness of the upper horizon varies between 32 and 50 cm (frequently between 32 and 35 cm), while the argic *Bt* horizon may exceed 110 cm (65-150 cm). The *Bt* soil horizon differentiate by color, clay content and structure in at least two sub-horizons. It appears somehow richer in clay as compared with the *Ao* horizon.

Table 2. Physical and chemical data on chromic luvisols (Dumbrăveni - Snagovului Plain)

| Hori<br>zon    | Depth<br>(cm) | 0,002<br>mm | 0,002-<br>0,02<br>mm | 0,02-<br>0,2<br>mm | 0,2-<br>2,0<br>mm | Humus<br>% | pH  | V%   | Total<br>N % | Mobile<br>P ppm | Mobile<br>K ppm |
|----------------|---------------|-------------|----------------------|--------------------|-------------------|------------|-----|------|--------------|-----------------|-----------------|
| Ap             | 0-27          | 31,2        | 35,6                 | 33,0               | 0,2               | 2,04       | 5,5 | 75,8 | 0,115        | 12,2            | 134             |
| A <sub>1</sub> | 27-38         | 29,0        | 34,3                 | 36,6               | 0,1               | 1,98       | 6,0 | 80,9 | 0,106        | 1,5             | 104             |
| Ao             | 38-50         | 36,7        | 33,1                 | 29,9               | 0,3               | 1,62       | 6,4 | 83,2 | 0,096        | 0,5             | 104             |
| AB             | 50-65         | 37,4        | 30,9                 | 31,2               | 0,5               | 1,08       | 6,8 | 86,3 | 0,075        | -               | -               |
| Bt1            | 65-85         | 39,7        | 25,8                 | 30,9               | 0,6               | 0,96       | 6,8 | 86,3 | 0,060        | -               | -               |
| Bt2            | 85-110        | 36,6        | 30,5                 | 32,5               | 0,4               | -          | 7,1 | 88,7 | -            | -               | -               |
| Bt3            | 110-150       | 36,5        | 32,0                 | 31,4               | 0,1               | -          | -   | -    | -            | -               | -               |

|     |         |      |      |      |     |   |     |      |   |   |   |
|-----|---------|------|------|------|-----|---|-----|------|---|---|---|
| Bt4 | 150-180 | 35,4 | 31,9 | 32,7 | 0,0 | - | 7,2 | 90,4 | - | - | - |
| Cca | 180-200 | 36,1 | 27,5 | 36,3 | 0,1 | - | 7,2 | 90,4 | - | - | - |

**Table 3. Physical and chemical data on chromic luvisols (Lipia - Snagovului Plain)**

| Hori<br>zon    | Depth<br>(cm) | 0,002<br>mm | 0,002-<br>0,02<br>mm | 0,02 -<br>0,2<br>mm | 0,2-<br>2,0<br>mm | Humus<br>% | pH  | V%   | Total<br>N % | Mobile<br>P ppm | Mobile<br>K ppm |
|----------------|---------------|-------------|----------------------|---------------------|-------------------|------------|-----|------|--------------|-----------------|-----------------|
| Ap             | 0-22          | 29,2        | 35,8                 | 34,6                | 0,4               | 3,07       | 5,4 | 69,6 | 0,163        | 11              | 120             |
| A <sub>1</sub> | 22-33         | 29,9        | 34,8                 | 35,0                | 0,3               | 3,15       | 5,6 | 72,0 | 0,157        | 15              | 150             |
| A <sub>0</sub> | 33-48         | 35,8        | 32,9                 | 31,1                | 0,2               | 1,76       | 5,8 | 76,9 | 0,100        | -               | -               |
| AB             | 48-70         | 37,8        | 32,3                 | 29,5                | 0,4               | 1,15       | 6,5 | 89,3 | -            | -               | -               |
| Bt1            | 70-100        | 39,7        | 31,0                 | 28,8                | 0,5               | -          | 6,4 | 84,4 | -            | -               | -               |
| Bt2            | 100-131       | 36,0        | 29,1                 | 34,4                | 0,5               | -          | 6,5 | -    | -            | -               | -               |
| Bt3            | 131-162       | 25,5        | 28,5                 | 35,8                | 0,2               | -          | 6,8 | 90,5 | -            | -               | -               |
| Cca            | 193-245       | 34,9        | 28,1                 | 38,8                | 0,1               | -          | 8,5 | 100  | -            | -               | -               |

In all the analyzed cases the *C* horizon distinguishes by its yellowish color and appearance of calcium carbonate as spottings, at depths exceeding 150 cm (150-220 cm).

Physical, hydro-physical and chemical features strongly detach chromic luvisols from haplic phaeozems or even luvisols. The parental material on which they formed contains 25-35% clay (grains smaller than 0.002 mm) and up to 32% dust. The clay is unevenly distributed along the soil profile. This increases from 28-30% at the surface to about 40-45% in the *Bt* horizon, which shows an index of textural differentiation between 1.2 to 1.4.

**Table 4. Physical and chemical data on chromic luvisols (Bălăceanca – Călnăului Plain)**

| Hori<br>zon    | Depth<br>(cm) | 0,002<br>mm | 0,002-<br>0,02<br>mm | 0,02 -<br>0,2<br>mm | 0,2-<br>2,0<br>mm | Humus<br>% | pH   | V%   | Total<br>N % | Mobile<br>P ppm | Mobile<br>K ppm |
|----------------|---------------|-------------|----------------------|---------------------|-------------------|------------|------|------|--------------|-----------------|-----------------|
| A <sub>0</sub> | 0-14          | 28,2        | 30,7                 | 41,1                | 0,0               | 5,00       | 4,90 | 56,1 | 0,192        | 16              | 146             |
| A <sub>0</sub> | 14-24         | 29,4        | 33,2                 | 37,4                | 0,0               | 5,05       | 2,67 | 57,8 | 0,119        | 11              | 100             |
| A <sub>0</sub> | 24-38         | 30,0        | 32,4                 | 37,6                | 0,0               | 5,60       | 2,46 | 74,5 | 0,102        | 9               | 124             |
| AB             | 38-53         | 38,0        | 28,4                 | 33,4                | 0,0               | 5,90       | 1,45 | 78,2 | -            | -               | -               |
| Bt1            | 55-75         | 41,0        | 27,1                 | 31,9                | 0,0               | 6,00       | 2,85 | 85,0 | -            | -               | -               |
| Bt2            | 80-100        | 39,0        | 28,7                 | 31,4                | 0,0               | 6,20       | -    | 86,4 | -            | -               | -               |
| Bt3            | 100-120       | 35,2        | 31,2                 | 33,6                | 0,0               | 6,30       | -    | 85,0 | -            | -               | -               |

In all the analyzed cases the *C* horizon distinguishes by its yellowish color and appearance of calcium carbonate as spottings, at depths exceeding 150 cm (150-220 cm).

Bulk density of these soils is medium at the surface (1.28 to 1.37 g/cm<sup>3</sup>), large and very large along the soil profile (1.50 to 1.66 g/cm<sup>3</sup>), while total porosity, as well as permeability decrease with depth. Only field water capacity remains constant but presents medium values (23-26%).

Soil reaction along the profile ranges from slightly acid (pH 5.7 to 6.5) to slightly alkaline (pH 8.2 to 8.3) due to the presence of carbonates (Table 1, 2, 3, 4, Figure 2, 3, 4, 5).

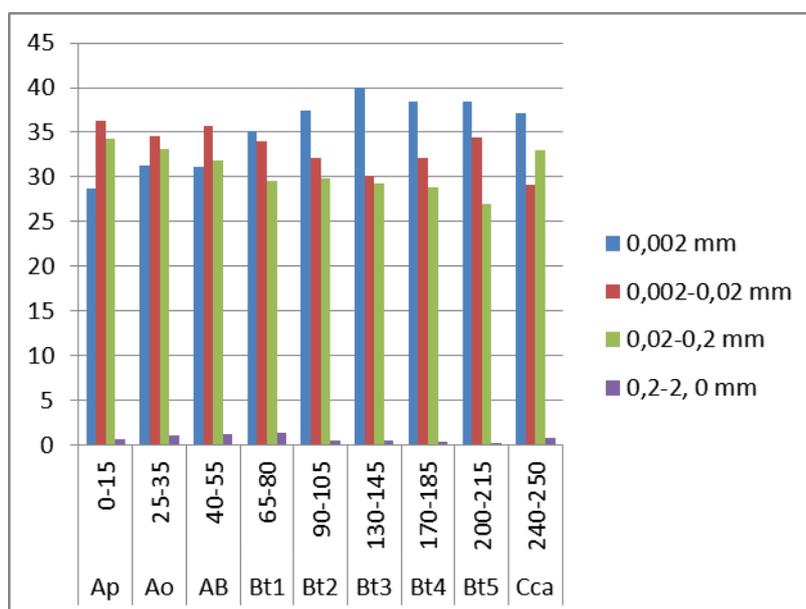


Figure 2. Granulometric composition of chromic luvisols (Ciofliceni – Snagovului Plain)

Humus content in the *Ap* horizon is generally small, between 1.7 and 3.0%. Humus composition is characterized by the ratio AH:AF higher than 1 one the surface, but subunit values for the rest of the profile.

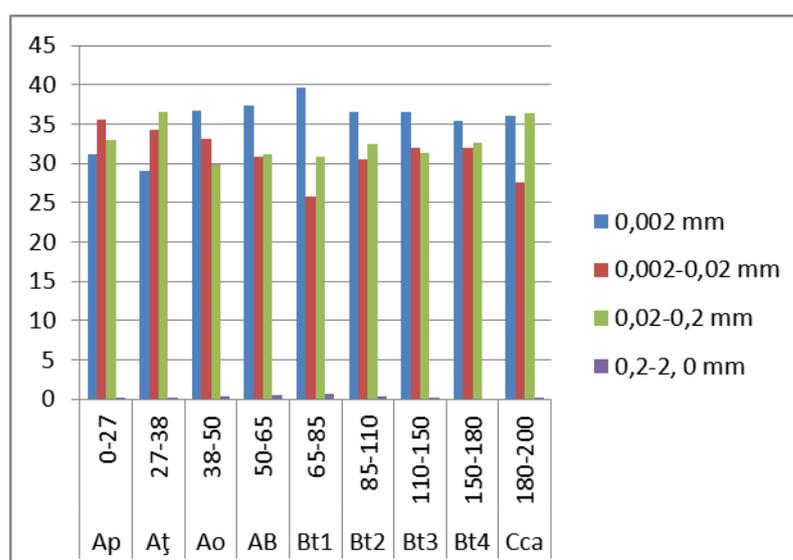


Figure 3. Granulometric composition of chromic luvisols (Dumbrăveni – Snagovului Plain)

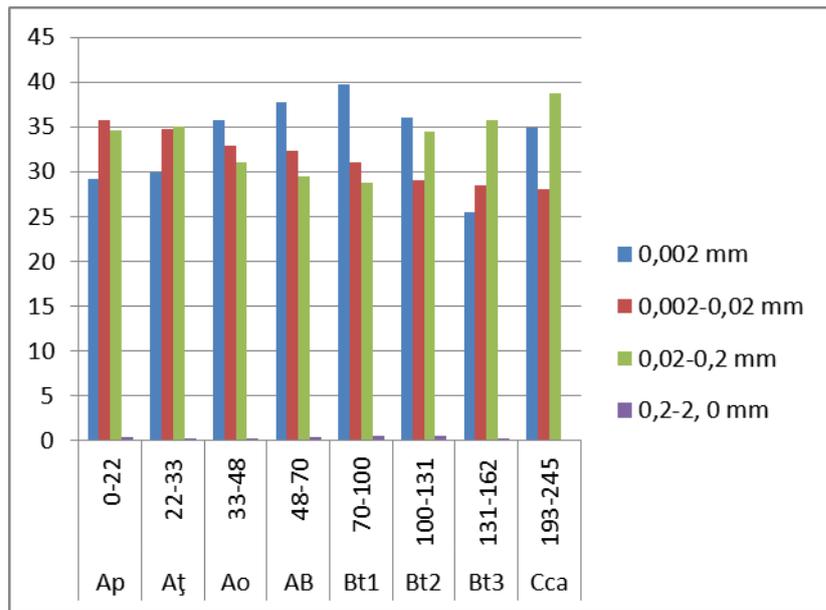


Figure 4. Granulometric composition of chromic luvisols (Lipia – Snagovului Plain)

The proportion of free humic acid and free, aggressive fulvic acids is similar with the composition of forest soils humus. The proportion of humic acids in connexion to calcium is similar to that of steppe soils.

The degree of saturation is variable, often around 80%, sometimes less, so most chromic luvisols are eubasic soils.



Figure 5. Granulometric composition of chromic luvisols (Bălăceanca – Călnăului Plain)

Total nitrogen content is low to middle (0.119 to 0.165%) in the *Ap* horizon, most commonly about 0.120% and the C:N ratio has values around 13 at the surface. Phosphorus and potassium contents are characterized by low and medium values, that distinguishes the chromic luvisols from the steppe soils (Table 1, 2, 3, 4, Figure 6, 7, 8, 9).

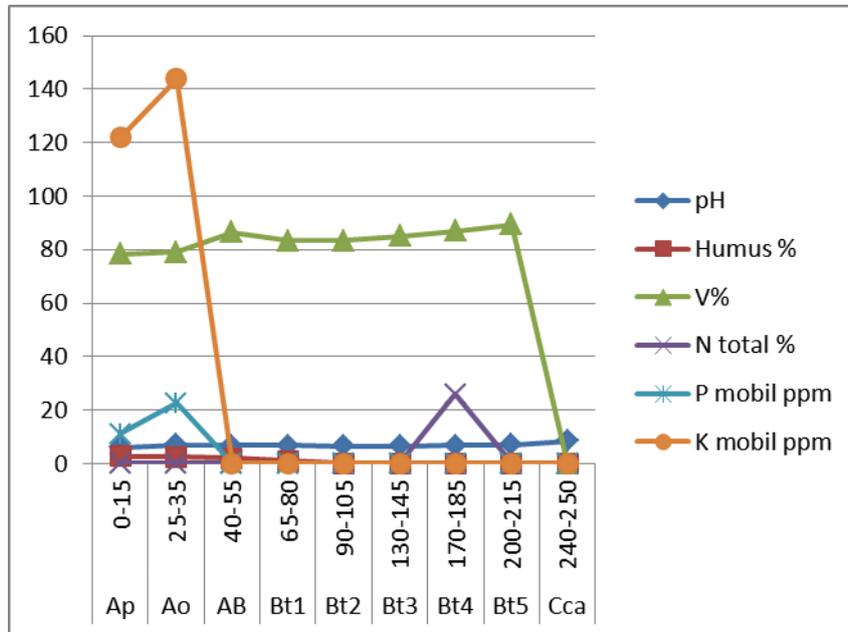


Figure 6. Chemical features of chromic luvisols (Ciofliceni – Snagovului Plain)

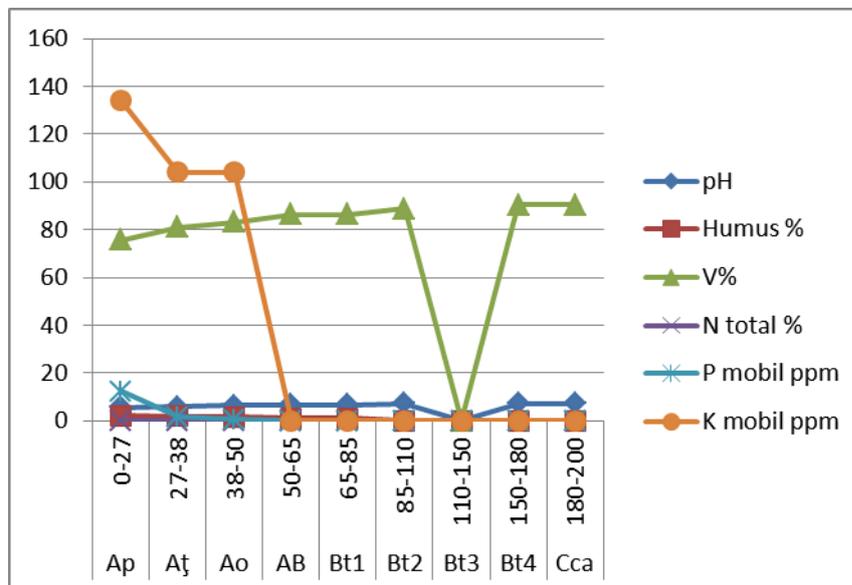


Figure 7. Chemical features of chromic luvisols (Dumbrăveni – Snagovului Plain)

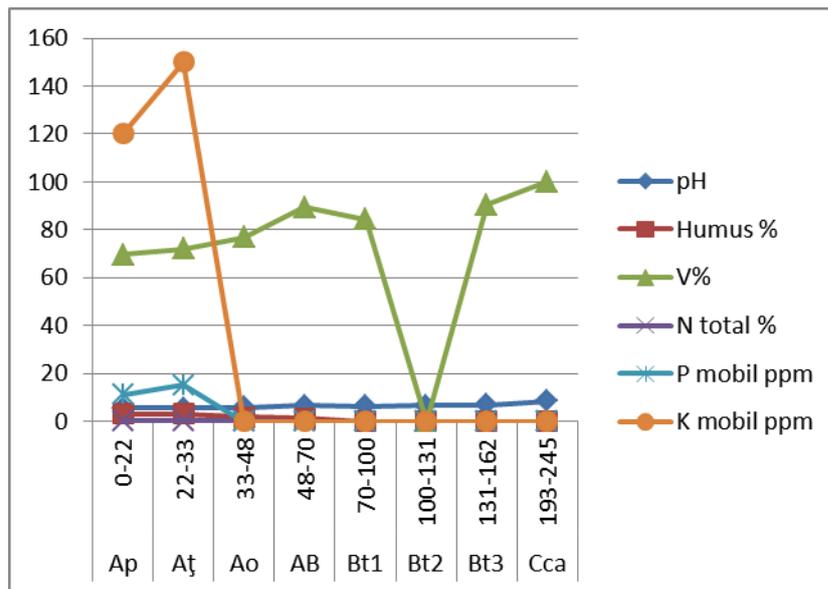


Figure 8. Chemical features of chromic luvisols (Lipia – Snagovului Plain)

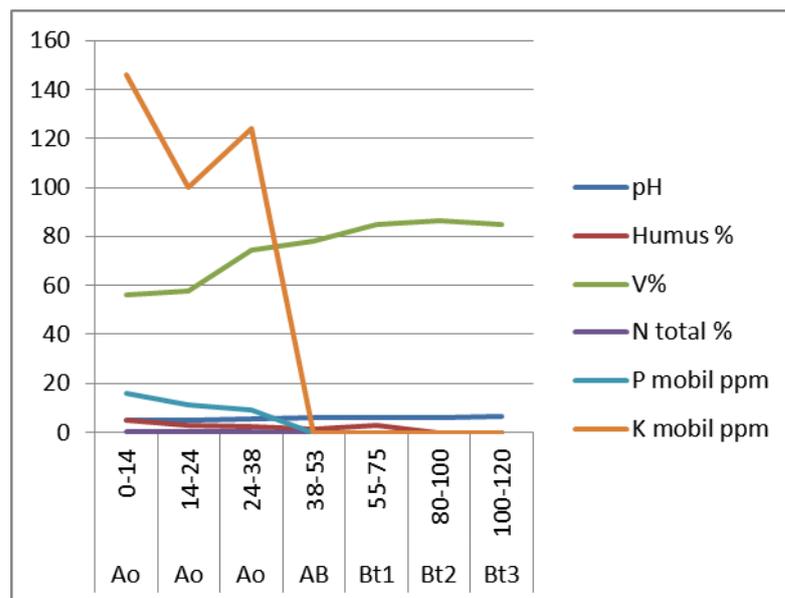


Figure 9. Chemical features of chromic luvisols (Bălăceanca – Călnăului Plain)

#### 4. Conclusion

Chromic luvisols formed in Romania both on loess and loess-like deposits (Wallachia) and also on red clayey deposits (Oltenia, Banat, north west of the country). Between Ialomița and Olt rivers they are stable only on the interfluvies, forming strips of 1-2 km wide, then quickly make place to another types of soils (usually, weakly luvisc phaeozem). Therefore, it is possible that the area occupied by these soils in our country be much smaller than that recorded on current maps of soils, even if their distribution area remains about the same.

An important role in the formation of these soils had soil climate expressed by the hydric

regime, probably alternatively trans-percolation.

Iron hydroxide undergoes rapid dehydration because of prolonged dry conditions, passing into rusty-colored sesquioxides such as goethite, hematite and even hydro-hematite, giving a reddish brown colour to these soils.

Fertility chromic luvisols is generally good. They are biologically active soil with humus bioaccumulation (in the forest) with medium or hard texture, compact and hard permeable argic Bt horizon.

Are considered forest soils with high fertility for lowland forests plainly, and agricultural crops. They require an adequate agrotechnic and increased amounts of mineral and organic fertilizers.

In order to achieve good production results, these soils require measures agropedameliorative and surface drainage (scarification, modification depth plowing, leveling operation).

## References

- \_\_\_\_\_ (1987). Methodology developed for soil studies, ICPA, Bucharest.
- Cernescu N. (1934). Facteurs de climat et zones de sol en Roumanie. Technical and Economical Studies, *Geological Institute of Romania, C Series, 2*, Bucharest.
- Cernescu N. (1945). Contributions to the two knowledge of genetic soil chemism with clay accumulation horizon. I. Reddish brown Forest Soil. Bulletin of the Faculty of Agronomy, No. 2/1945, Bucharest.
- Florea, N., & Munteanu, I. (2012). Romanian System of Soil Taxonomy. Sitech Publishing House, Bucharest.
- Ispas, Șt., Stănilă, Anca-Luiza (2015). Soils of Romania. Publisher Wallachia University Press, Targoviste
- Parichi M., Stănilă Anca-Luiza, Bănică S. (1999). Data on soils in the surroundings of the city of Bucharest. Annals of the Spiru Haret University, Geography Series, No. 2, Bucharest.
- Parichi M., Taină Ioana, Stănilă Anca-Luiza, Costache R., & Bănică S. (1998). On some soils of the Cănaului Plain (southern area of the municipality of Bucharest) and their pedogenetic conditions. Annals of the Spiru Haret University, Geography Series, No. 1, Bucharest.
- Parichi, M. (1996). Review of soil map for the Bucharest area. ICPA Archives, Bucharest.
- Stănilă Anca-Luiza (2003). The Snagov Plain – Pedogeographical Study. Carol Davila University Publishing, Bucharest.
- Stănilă Anca-Luiza, Parichi M. (1998). Pedogeographical observations in the western part of the Snagov Plain. Annals of the Spiru Haret University, Geography Series, No. 1, Bucharest.
- Stănilă Anca-Luiza, Parichi M. (2001). Loesses and fossil soils in the Snagov Plain. Annals of

the Spiru Haret University, *Geography Series*, 3, Bucharest.

Stănilă Anca-Luiza, Parichi M. (2001). Soil mapping. Romania for Tomorrow Publishing House, Bucharest.

### **Copyright Disclaimer**

Copyright for this article is retained by the author(s).with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/3.0/>).