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THE PHYSICAL AND BIOCHEMICAL PECULIARITIES OF REPRESENTATIVE SOILS IN GIURGEU MOUNTAINS

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Abstract: The analyses for the description of physic-chemical and humus fractional characteristics have been determined for two soil subtypes, respectively four soil profiles, that are representative for the lower altitudes area of Giurgeu Mountains. The analysis has been based on: one Andi-Eutric Cambisols (EC an- 920 m alt.) and three Cambic Andosols (AN ca) situated at different altitudes: 1120-1140 m, 1197 m and 1310 m. The purpose of the research is to indentify some quantitative and qualitative differences in regards to some organic and inorganic components from the soil. Have come into prominence the sum of exchangeable bases, the total acidity exchange, the degree of base saturation and other aspects related to organic accumulation (the highest in Cambic Andosols: 1120-1140 m alt.), degree of humification (higher for the same Andosol and variable for the one from 1310 m alt.), the distribution curve on the profile of chemical and biochemical humic components. In terms of quality, there are differences in regard to the humification degree of organic matter, the dynamic on the profile of the main humus fractions (humic acids, fulvic acids, non-extractable material) forming the horizons of accumulation for some of the fractions.

Introduction

Giurgeu Mountains occupy a median position both in the central group of the Eastern Carpathians and in the crystalline longitudinal axis, the mentioned massif being limited in north by the Borsec Depression – Vinului valley, Bistricioarei valley, at east by the Putna and Putna Întunecoasã valleys that separate them by the Bicaz Mts., to south by Belcina valley– Pângăraţi Pass, and towards east by Giurgeu Depression.

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Andic soils (Andosols and andic subtypes) well represented in Giurgeu Mountains are forming on parental emanant from the disintegration and alteration of volcanic rocks with occurrences at altitudes higher than 800-1000 m (Vasu, 1986). The climate conditions with relatively low temperatures and high rainfall during all four seasons are in favor of gradual acidification of soil and maintaining it in a wet condition on the entire profile, which accelerates the alteration of vitric minerals. The soils have been identified and diagnosed by a soil experts lead by Prof. Dr. Constantin Rusu (”Alexandru Ioan Cuza” University of Iaşi, Romanian Aacademy, Department of Iaşi, Geography Group) whom we thank this way.

Methods and materials

The analyses for the description of physic-chemical and humus fractional characteristics have been determined for one Andi-Eutric Cambisols (EC an – 920 m alt.) and three Cambic Andosols (AN ca) situated at different altitudes: 1120-1140 m, 1197 m and 1310 m.

For each soil profile has been analysed 5 samples and tested depending on the horizons. It has been determined for every soil sample the pH of aqueous suspension, the total organic carbon (TOC) by wet oxidation method and dosage titration by Walkley-Black method of changing Doughnut and the humus (total organic C x 1.724). Also, it has been determined the sum of exchangeable bases (S_B – me/100 g sol), the total acidity exchange (S_H – me/100 g sol) and, by calculation, the cation exchange capacity (T – me\100 g sol) and the degree of base saturation (V %).

The humus components have been determined with the method elaborated by Kononova M. M. and Belcikova N. P. (1961) in which the soil sample it is divided into many other subsamples and extractions are made with solution mixed with sodium pyrophosphate ($Na_4P_2O_7$ x 10H2O) 0.1 m and sodium hydroxide (NaOH) 0.1 n, pH of about 13. The solution based on sodium pyrophosphate is considered to be the best extractant for humic fractions. The extract ensued it is used in determining the total extractable carbon (TEC) and the carbon from humic acids (HA), after first washing the fulvic acids (FA). The total fulvic acids are determined by calculation. From the resulted values were calculated some indices for characterizing the humification degree of organic matter and the polymerization degree of humic compounds. The data is in the form of tables and diagrams as it follows: total organic carbon (TOC) % from the soil; total extractable carbon (TEC): % from the soil, % from the TOC.; humic acids carbon (HA) and fulvic acids carbon (FA): % from the soil, % from the TOC and % from TEC; residual carbon consisting of the carbon from partially decomposed residue and humic carbon (CH) is represented in % from the soil and % from the TOC.

Results and discussions

Andi-Eutric Cambisols (EC an – 920 m alt.) was sampled from a slope in Topliţa locality and belongs to a natural grassland vegetal cover. The thickness of the profile is of 75 cm (Table 1.). The chemical reaction of the soil is a slightly acidic reaction on the entire profile (5.74-6.38 pH). The organic accumulation is high and represented on a curve that shows its decrease directly proportional with the depth (4.96-0.74 % tot.org.C.). The sum of exchangeable bases (S_B) around 25me/ 100 g soil indicates a good fertility; the acidity exchange (S_H) shows a lower reserve of acidic ions (H^+, Al^{3+}) and the degree of base saturation (V%) with high values on the entire profile emphasize the eubasic character (Table 1.).

The humification degree can be represented as a sinuous curve with values of 35.08 in Aou and 77.2 in Bv3. The humifiable material is mainly consisting of fulvic acids which exceed 8.15-2.35 times the humic acids (Tabel 2.); the humification is unqualitative (Figure 1.).

Table 1. The physico-chemical properties of Andi-Eutric Cambisols – Topliţa area (920 m alt.)

Horizon	***Aou***	***A/Bv***	***Bv1***	***Bv2***	***Bv3***
depth (cm)	*3-20*	*20-30*	*30-45*	*45-60*	*60-75*
pH	*5.74*	*6.16*	*6.23*	*6.46*	*6.38*
TOC (%)	*4.96*	*2.40*	*1.33*	*1.02*	*0.74*
Humus (%)	*8.54*	*4.14*	*2.29*	*1.76*	*1.28*
S_B (me/100 g soil)	*23.18*	*21.58*	*15.95*	*17.38*	*20.18*
S_H (me/100 g soil)	*8.61*	*4.19*	*3.75*	*2.87*	*2.65*
T (me/100 g soil)	*31.79*	*25.77*	*19.7*	*20.25*	*22.83*
V (%)	*72.92*	*83.74*	*80.96*	*85.83*	*88.39*

TOC – total organic carbon (% from soil mass); **Humus** (% from soil mass); **S_B** - the sum of exchangeable bases (me/100g soil); **S_H** - total acidity exchange (me/100g soil); **T** - cation exchange capacity (me/100g soil); **V** - degree of base saturation (me/100g soil).

Tab. 2. The distribution of humic fractions in Andi-Eutric Cambisols – Topliţa area (920 m alt.)

Horizon depth (cm)	**pH**	**TOC**	**Humus**	**TEC**	**HA**	**FA**	**Residual C**	**HA/ FA**	**FA/ HA**
Aou 3-20	5.74	4.96	8.54	1.74/35.08	0.19/3.83/10.91	1.55/31.25/89.09	3.22/64.92	0.12	8.15
A/Bv 20-30	6.16	2.40	4.14	0.89/37.25	0.18/7.5/20.22	0.71/29.75/79.77	1.69/62.75	0.25	3.94
Bv1 30-45	6.23	1.33	2.29	0.52/39.09	0.16/12.03/30.76	0.36/27.06/69.24	0.81/60.91	0.44	2.25
Bv2 45-60	6.46	1.02	1.76	0.38/37.25	0.10/9.80/26.31	0.28/27.45/73.69	0.64/62.75	0.35	2.8
Bv3 60-75	6.38	0.74	1.28	0.57/77.02	0.17/22.97/29.82	0.40/54.05/70.18	0.17	0.42	2.35

TOC – total organic carbon (% from soil mass); **Humus** (% from soil mass); **TEC** – total extractible carbon (% from soil mass / % from TOC); **HA** – carbon from huminic acids (% from soil mass / % from TOC / % from TEC); **FA** – carbon from fulvic acids (% from soil mass / % from TOC / % from TEC); **residual C** – non-extractible carbon and humines (% from soil mass / % from TOC).

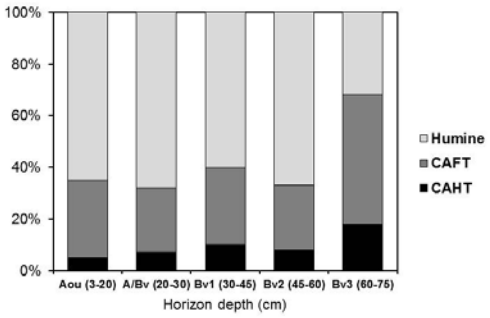

Figure 1. Humic fractions in Andi-Eutric Cambisols related to TOC (920 m alt.)

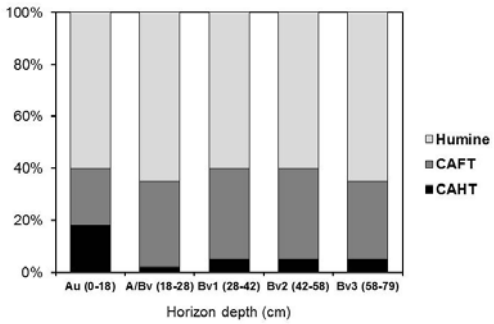

Figure 2. Humic fractions in Cambic Andosol related to TOC (1120-1140 m alt.)

The Andosols (Andosols category) are the soils whose characteristics are related to parental material nature, respectively to the nature of volcanic rocks (andesites and pyroclastic) and the andosalization conditions, with permsnently repercussive changes of mineral associations and paragenesis representative for each mountain or eruption cycle (Rusu et al., 2008). The analysis has been made on 3 Cambic Andosols profile from diferren altitudes and have been compared with Cambic Andosols from Igniș-Oaș Mountains (Lupaşcu et al., 1998).

The Cambic Andosol (ANca) (1120-1140 m alt.) was sampled from a slope located at north from Borsec Pass, under the main high in Borsec locality from a mixed forest of *Picea abies, Abies alba, Fagus silvatica*. The thickness of the profile is of 110 cm. The chemical reaction of the soil is acidic, respectively slightly-acidic on the entire profile (4.97-6.42 pH)(Table 3.).

The organic accumulation is high and it is represented on a curve that shows its decrease directly proportional with the depth (13.78-2.41 %TOC). The physic-chemical analyses (Table 3.) emphasis a high cation exchange capacity in Au horizon (T - 42.2%) and much lower on the profile as a result of high bioaccumulation under the forest litter and which comes with the process of andosalization. S_B is high, also related to the high values of TOC, indicating a good fertility. The S_H is variable on the profile (20.5-3.2 me/100 g soil) and contributes to an eumesobasic soil differentiation.

The humification degree of the organic matter can be represented as a curve slightly sinuous with values of 46.95 in *Au* and 39.00 in *Bv3* (Table 4.). The humifiable material mostly consist of fulvic acids which exceed the humic acids all over the profile (Figure 2.); the humification is unqualitative (Perepeliță, 1986).

Table 3. The physico-chemical properties of Cambic Andosol – Borsec area (1120-1140 m alt.)

Horizon	Au	Au/Bv	Bv1	Bv2	Bv3	Bv4	Bv5
depth (cm)	0-18	18-28	28-42	42-58	58-76	76-90	90-100
pH	4.97	5.48	5.74	5.93	6.10	6.42	6.57
TOC (%)	13.78	8.78	5.27	0.90	2.41	0.80	0.66
Humus (%)	23.76	15.14	9.09	1.55	4.15	1.38	1.14
S_B (me/100 g soil)	21.63	16.86	17.98	20.86	26.77	19.16	20.7
S_H (me/100 g soil)	20.58	13.90	11.15	9.30	7.36	4.20	3.20
T (me/100 g soil)	42.21	30.76	29.13	30.16	34.13	23.36	23.90
V (%)	51.24	54.81	61.72	69.16	78.44	82.02	86.61

TOC – total organic carbon (% from soil mass); **Humus** (% from soil mass); **S_B** - the sum of exchangeable bases (me/100g soil); **S_H** - total acidity exchange (me/100g soil); **T** - cation exchange capacity (me/100g soil); **V** - degree of base saturation (me/100g soil).

Table 4. The distribution of humic fractions in Cambic Andosol – Borsec area (1120-1140 m alt.)

Horizon depth (cm)	pH	TOC	Humus	TEC	HA	FA	Residual C	HA/ FA	FA/ HA
Au 0-18	4.97	13.78	23.76	6.47/46.95	3.09/22.42/47.75	3.38/24.53/52.25	7.31/53.25	0.91	1.09
Au/Bv 18-28	5.48	8.78	15.14	3.31/37.69	0.22/2.50/6.64	3.09/35.19/93.36	5.47/62.31	0.07	14.04
Bv1 28-42	5.74	5.27	9.09	2.29/43.45	0.36/6.83/15.72	1.93/36.62/84.28	2.98/56.55	0.18	5.36
Bv2 42-58	5.93	3.49	6.02	1.54/44.13	0.28/8.03/18.19	1.26/36.10/8.81	1.95/55.87	0.25	4.50
Bv3 58-76	4.61	2.41	4.15	0.94/39.00	0.21/8.71/22.34	0.73/30.29/77.66	1.47/61.00	0.28	3.47

TOC – total organic carbon (% from soil mass); **Humus** (% from soil mass); **TEC** – total extractible carbon (% from soil mass / % from TOC); **HA** – carbon from huminic acids (% from soil mass / % from TOC / % from TEC); **FA** – carbon from fulvic acids (% from soil mass / % from TOC / % from TEC); **residual C** – non-extractible carbon and humines (% from soil mass / % from TOC).

The Cambic Andosol (ANca) (1197 m alt.) was sampled from an andesitic plateau from Culmea Neagră, Sărmaș locality, under natural grassland with *Festuca rubra, Nardus stricta, Alchemilla vulgaris* etc. The thickness of the profile is of 110 cm.

The chemical reaction of the soil is slightly acidic on the entire profile (5.87-6.61 pH). The organic acummulation (Table 5.) is humiferous moderate in the superior horizons and represented as a curve that shows its decrease directly with the depth (2.45-0.59% tot.org.C.); the data indicates a good mineralization (Table 6.). The absorptive complex of the soil is eubasic (V- 73.9-90.5%). The values higher than 25 me/100 g soil of S_B and lower of S_H (7.7-3.3 me/100 g soil) determines an increase of the degree of base saturation.

The humification degree (Table 6.) can be represented as a slightly sinuous curve with values among 49.79 in *Au/Bv* and 62.85 in *Bv3.* The humifiable material is mainly consisting of fulvic acids that exceed (4.8-1.2 time, values much more lower values than in the Andosol from 1310 m alt.) on the entire profile the humic acids (except the last horizon) (Figure 3.). This Andosol is more similar with the

ones indentified in Igniş-Oaş Mountains, not only as bioacummulation, but also as proportion and profile distribution of the humic acids (Lupaşcu et al., 1998).

Table 5. The physico-chemical properties of Cambic Andosol – Sărmaş area (1197 m alt.)

Horizon	At	Au	Au/Bv	Bv1	Bv2	Bv3	B/C+R
depth (cm)	0-6	6-21	21-35	35-50	50-63	63-80	80-100
pH	5.18	5.59	5.87	6.03	6.21	6.61	6.06
TOC (%)	11.22	4.64	2.45	1.13	0.72	0.35	0.59
Humus (%)	19.35	7.99	4.22	1.95	1.24	0.59	1.02
S_B (me/100 g soil)	28.37	21.93	25.17	25.97	31.57	31.57	33.97
S_H (me/100 g soil)	15.02	7.73	7.51	7.06	5.74	3.31	4.64
T (me/100 g soil)	43.39	29.66	32.68	33.03	37.31	34.88	38.61
V (%)	65.38	73.94	77.02	78.63	84.62	90.51	87.98

TOC – total organic carbon (% from soil mass); **Humus** (% from soil mass); **S_B** - the sum of exchangeable bases (me/100g soil); **S_H** - total acidity exchange (me/100g soil); **T** - cation exchange capacity (me/100g soil); **V** - degree of base saturation (me/100g soil).

Table 6. The distribution of humic fractions in Cambic Andosol – Sărmaş area (1197 m alt.)

Horizon depth (cm)	pH	TOC	Humus	TEC	HA	FA	Rezidual C	HA/FA	FA/HA
Au/Bv 21-35	5.87	2.45	4.22	1.22/49.79	0.21/8.57/17.21	1.01/41.22/82.79	1.23/50.21	0.20	4.80
Bv1 35-50	6.03	1.13	1.95	0.63/55.75	0.16/14.15/25.39	0.47/41.6/74.61	0.5/44.25	0.34	2.93
Bv2 50-63	6.21	0.72	1.24	0.38/52.77	0.10/13.88/26.31	0.28/38.89/73.69	0.34/47.23	0.35	2.8
Bv3 63-80	6.61	0.35	0.59	0.22/62.85	0.10/28.57/45.45	0.12/34.28/54.55	0.13/37.15	0.83	1.2
B/C+R 80-100	6.06	0.59	1.02	0.27/45.76	0.19/32.20/70.37	0.08/13.56/29.63	0.32/54.24	2.37	0.42

TOC – total organic carbon (% from soil mass); **Humus** (% from soil mass); **TEC** – total extractible carbon (% from soil mass / % from TOC); **HA** – carbon from huminic acids (% from soil mass / % from TOC / % from TEC); **FA** – carbon from fulvic acids (% from soil mass / % from TOC / % from TEC); **residual C** – non-extractible carbon and humines (% from soil mass / % from TOC).

The Cambic Andosol (ANca) (1310 m alt.) was sampled near Runcului Peak (Jolotca locality), respectively from the superior area of a mountain high, under a natural grassland with *Festuca rubra, Nardus stricta, Deschampsia caespitosa, Agrostis tenuis, Trifolium repens, Alchemilla vulgaris* etc. The parental material is represented by pyroclastic and pyroclastic with andesitic lava. The thickness of the profile is of 75 cm.

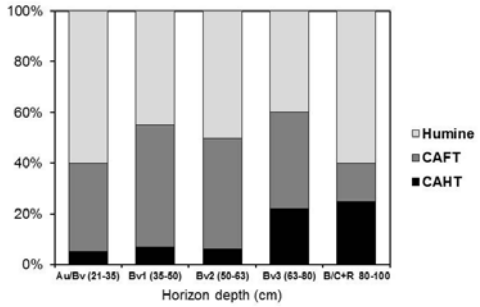

Figure 3. Humic fractions in Cambic Andosol related to TOC (1197 m alt.)

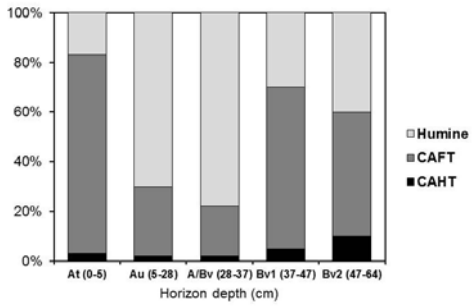

Figure 4. Humic fractions in Cambic Andosol related to TOC (1310 m alt.)

The chemical reaction of the soil is acidic, respectively slightly-acidic on the entire profile (4.99-5.94 pH). The organic acummulation is highly humiferous by the half of the profile and represented on a curve that shows the acummulation in *Au* and *A/Bv* horizons (14.3-10.29 % TOC); the data indicates a deferred mineralization due to severe ecologic conditions (Păunescu, 1973).

Table 7. The physico-chemical properties of Cambic Andosol – Jolotca area (1310 m alt.)

Horizon	**At**	**Au**	**A/Bv**	**Bv1**	**Bv2**	**Bv/C+R**	**C+R**
depth (cm)	0-5	5-28	28-37	37-47	47-64	64-75	>75
pH	4.99	5.04	5.33	5.52	5.94	6.02	6.06
TOC (%)	8.36	14.30	10.29	3.49	2.89	2.37	2.28
Humus (%)	14.41	24.65	17.73	6.01	4.98	4.09	3.93
S_B (me/100 g soil)	9.99	7.59	9.19	12.39	15.58	17.98	21.98
S_H (me/100 g soil)	40.63	44.38	33.56	29.59	16.34	12.81	13.47
T (me/100 g soil)	50.62	51.97	42.75	41.98	31.92	30.79	35.45
V (%)	19.74	14.60	21.49	29.51	48.81	58.39	62.00

TOC – total organic carbon (% from soil mass); **Humus** (% from soil mass); **S_B** - the sum of exchangeable bases (me/100g soil); **S_H** - total acidity exchange (me/100g soil); **T** - cation exchange capacity (me/100g soil); **V** - degree of base saturation (me/100g soil).

The absorbtive complex of the soil is oligobasis in the first 50 cm and mesobasic for the other part of the profile. S_B is variable which indicates a low fertility. The values of S_H are between 44.6 and 12.8 me/100 g soil, which determines the degree of base saturation to decrease (Table 7.). The humification degree can be represented as a sinuous curve with values among 88.63 and 27.89. The humifiable material is mainly consisting of fulvic acids that exceed (17.52-3.05 time) the humic acids all over the profile (Table 8., Figure 4.). This quantitative extreme difference between the two humic fractions indicates an unqualitative humification.

Table 8. The distribution of humic fractions in Cambic Andosol – Jolotca area (1310 m alt.)

Horizon depth (cm)	pH	TOC	Humus	TEC	HA	FA	Rezidual C	HA/FA	FA/HA
At 0-5	4.99	8.36	14.41	7.41/88.63	0.4/4.78/5.39	7.01/83.85/94.61	0.95/11.37	0.05	17.52
Au 5-28	5.04	14.30	24.65	5.07/35.45	0.43/3.00/8.48	4.64/32.45/91.52	9.23/64.55	0.09	10.79
A/Bv 28-37	5.33	10.29	17.73	2.87/27.89	0.28/2.72/9.75	2.59/25.17/90.25	7.42/72.11	0.10	9.25
Bv1 37-47	5.52	3.49	6.01	2.63/75.35	0.28/8.02/10.64	2.35/67.33/89.36	0.86/24.65	0.11	8.39
Bv2 47-64	5.94	2.89	4.98	1.74/60.21	0.43/14.87/24.72	1.31/45.33/75.28	1.15/39.79	0.33	3.05

TOC – total organic carbon (% from soil mass); **Humus** (% from soil mass); **TEC** – total extractible carbon (% from soil mass / % from TOC); **HA** – carbon from huminic acids (% from soil mass / % from TOC / % from TEC); **FA** – carbon from fulvic acids (% from soil mass / % from TOC / % from TEC); **residual C** – non-extractible carbon and humines (% from soil mass / % from TOC).

Conclusions

The determinations concerning physic-chemical peculiarities and the analysis of the organic matter in the 4 soil profiles are relevant for the following aspects:

- the chemical reaction of the soil in aqueous suspension is variable on the profile between 5.74 and 6.38 pH in the Andi-Eutric Cambisols and with slightly lower values, on the entire profile, for the Andosols;
- the organic accumulation indicates high mineralization processes in Andi-Eutric Cambisols (920 m alt.) and a much slowly mineralization in the three Andosols as a consequence of a cold and wet climate that slows down the microbial activity;
- the sum of exchangeable bases is variable on the profile (high values in the superior horizons and at their base and lower values on the profile), but also from one profile to another (maximum values in the Andosol from 1197 m alt. and minimum values in the Andosol from1310 m alt.);
- the total acidity exchange is variable on the profile and directly proportional with the decreasing of the depth, but also from one profile to another: the Eutric Cambisol shows the lowest values and the Cambic Andosol (1310 m alt.) the highest values;
- the degree of base saturation is different for each profile: the Eutric Cambisol is eubasic, the Cambic Andosols: mesobasic (at 1120 m alt.), eubasic (at 1197 m alt.) and oligobasic (at 1320 m alt.).

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