Research on the Presence of Phaeozems in the Suceava Plateau

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Phaeozems are in class cernisols and has a wide spread in the Suceava Plateau. These soils have been the objective of many pedo-geographical studies, being firstly interpreted as exhausted chernozems (Obrejeanu et al., 1958), as exhausted brown forest soils (Bucur, 1967), and then as pratozems or chernozems like soils (Florea and Muica, 1962), presently being known under the name mentioned above. To achieve its purpose were established following objectives have been achieved in the field and laboratory: the study of the natural formation of phaeozems Suceava Plateau; the morphological, chemical and physical phaeozems (for which the characteristic of the space searched areas have been opened in the soil profiles were taken samples); determining the favorability of different crops. Among the pedogenetic factors, the relief played a very important role in the formation and development of the phaeozem type soils from this part of the country. The process of soil formation is manifested as the chernozems by intense accumulation of humus at the top of the soil profile, but at a lower level and having a higher content of fulvic acids than the chernozems. It follows horizon Amolic (Am), dark and quite deep.

Keywords: phaeozems, Suceava Plateau, glacis of slope, accumulation of humus, favourability for different crops

Suceava Plateau is a subdivision of Moldavian Plateau, occupying the northeastern part of it. It is named after the main river that drains through in the middle after the most important urban center in the region - Suceava, the old capital of Moldavia from the XVth century, residence county of the same name. It is bounded west Obcina Mare, south of Moldavian Valley. East Suceava Plateau dominates the Moldavian Plain by a steep erosive marked by localities Dorohoi - Strunga (Saua Ruginoasa) [14]. In northern limit exceeds the border with Ukraine, overlapping watershed basins of Suceava and Siret. From the geological point of view, this plateau is composed of Sarmatian sediment comprising clay, marl, sand, sandstones, limestones oolitic and monoclonal arranged conglomerates.

Dominance coarse west formations in contact with the mountain, betrays torrential regime in which they were submitted.

The relief plateau record altitudes between 190 m (at the confluence of Moldova-Siret) and 692 m in Ciungi Hill. Most of its area (over 54%) is between 300-500 m altitude.

In general, Suceava Plateau has a variety of sharp relief. Monoclinic structure and have determined the presence of hard rocks led to the predominance of the relief structure, for example, cuesta, valleys consequential and the structural surface or glacis of slope.

Parent material of soil are represented by elluvium clay loam, delluvium, colluvium and loess-like deposit results in the alteration of various clays, clay marl, marl, limestone, sandstone, plus recent nature fluvial sediments.

Major valleys (Siret, Suceava, Moldova) has floodplains and terraces whose number varies from one river to another.

Phaeozems occur in association with chernozems become predominant for wet areas of Suceava Plateau. At the upper end continues to luvisols.

Phaeozems identified as soil type with the advent SRTS-2003 include some of cambic chernozems, argic chernozems, argic phaeozems, greyic phaeozems and pseudorendzinas that no horizon Cca or secondary carbon concentration in the first 125 cm.

Experimental part

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 scale, with collection of numerous soil and groundwater samples, with observations on relief, micro-relief, parent material, etc.

The basic research and mapping unit of the areas with phaeozems 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.

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

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 [14].

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^3), to characterize the physical and hydro-physical features, as well as the momentary soil moisture.

The analytical methods used for determination of physical and chemical

Determination of particle size fractions

- pipette method fraction ≤ 0,.002 mm;
- wet sieving method for fractions 0.002 to 0.2 mm and dried fractions > 0.2 mm. The results are expressed as a

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percentage of the remaining material after the pretreatment.

Organic matter (humus) determined by volumetric method Walkley - Black wet oxidation after the change Gogoasa [23].

Total Nitrogen ***(Nt):*** Kjeldahl method disintegration H_2SO_4 at 350^0C, a catalyst of potassium sulfate and copper sulfate.

Phosphorus accessible (P mobile): method-Riehm-Domingo and dosed with colorimetric molybdenum blue method after Murphy-Riley (reduction with ascorbic acid).

Potassium (K mobile) accessible: after extraction method Egner-Riehm-Domingo and determination by flame photometry.

pH: potenþiometric, determined the combined glass electrode and a calomel, in aqueous suspension the soil/ water ratio of 1/2.5.

The base saturation degree (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-Chirita method).

Interpretation of the results has been submitted in accordance with *Methodology developing soil studies*, ICPA Bucharest, 1987, provided for in current legislation on the subject.

Block diagram representing the landscape ahead, constitute a means of rendering landforms.

For its construction, using an isometric projection in which the vertical axis is an axonometric Z, and X and Y axes form between them an angle of 120^0. Making block diagram is obtained based on the interpretation of field and laboratory data.

Economic value of agricultural land under natural conditions is made using synthetic biophysical parameters converted into organic soil characterization indicators or ecopedological indicators. Ecopedological indicators are used to specify the evaluation marks in the paper *Methodology developing soil studies*, ICPA, Bucharest, 1987.

Results and discussions

The relief, main factor in the phaeozems' formation

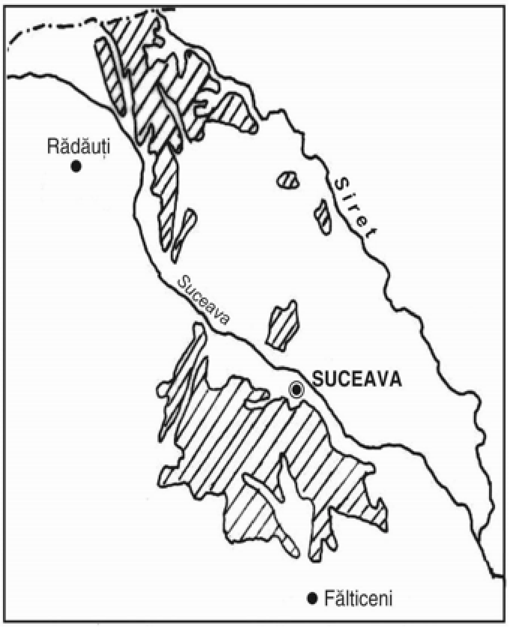

Fig. 1. The spreading of phaeozems (Parichi et al., 2006)

The phaeozems characterise both acclivous lands with glacis of slope aspect and south or south-east display and more evolved, peneplained interfluves (fig. 1).

Their formation in such relief conditions and in a space where the clime acquires a more pronounced continental character in time, with annual average thermic (7.8-7.9 ^0C) and pluvial (576-650 mm) values much more different than those characteristic to the distribution area of the cambic chernozems can be explained only by the ample geomorphological transformations suffered by the entire plateau area.

As from the Volhinian, numerous rivers split the area between the montan area and the Siret River into major compartments (Marginea-Ciungi Piedmont, Dragomirnei Plateau, Falticeni Plateau, Radauti Depression etc.), each compartment having an own local regional evolution. On the territory between Suceava and Siret Rivers, the evolution begins the moment Suceava's water becomes the affluent of Siret Valley, on a line situated with 50 km more to the north than the actual one and disrupts the volhinian sandstone plate.

At the beginning of the Quaternary, under the action of the physical-chemic processes of surface disaggregation and erosion (hydrographical – streaming, stream washings, fragmentations etc.), the sandstone plate mentioned above is almost totally grinded in the area of the former Suceava River stream and other loamy clay sediments are brought nowadays; a relief of anti-climax glacis adapted to structure (Granicesti) or strongly peneplained (Manastireni) (fig. 2) develops, having these new sediments as a basis. Soils, diagnosed as phaeozems because of their morphological, physical and chemical properties, develop in the area where the glacises or the peneplained, slightly wavy relief reaches an equilibrium because of the loamy

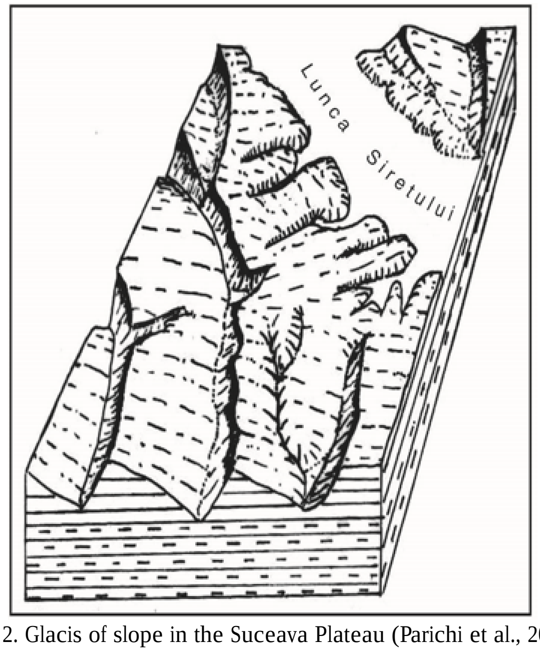

Fig. 2. Glacis of slope in the Suceava Plateau (Parichi et al., 2006)

clay sediments of adobe nature (1-10 m thickness) and under the simultaneous influence of clime and an abundant vegetal carpet.

The predominant vegetation is forest steppe zone, but with a higher proportion of woody vegetation (due to more humid climate). Certain subtypes phaeozems appear in the area deciduous forest (oak forests).

Main morphological characteristics and physic-chemical properties of the phaeozems

The phaeozems are the correspondents of the chernozems, the cambic and illuvial clay chernozems which are present in more humid areas and are more spread in Suceava Plateau.

The main morphological characters of phaeozems are:

- may be particles humic clays horizon B or often hydromorphic character when there Bt horizon.

excludes land formed on the parent material limestone or rocks limestone (including gravel) occurring between 25-75 cm.

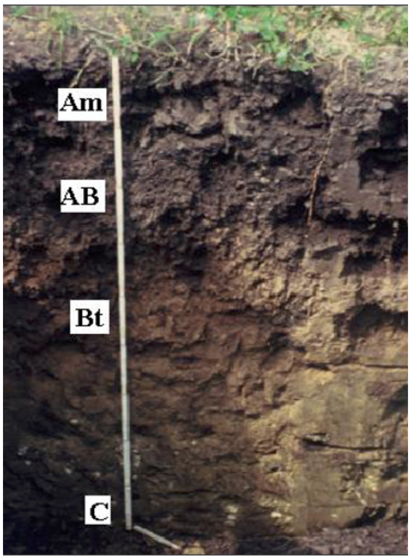

Fig. 3. Argic phaeozem in the Suceava Plateau (Stanila, 2017)

- may have horizon shrinkage properties, gleyic properties (Gr horizon) in 50 cm stagnic properties (w, or less than 50 cm, W) (SRTS, 2012).

Argic phaeozems presents a profile of type *Am-AB-Bt-C* developed (fig. 3, 4).

Am horizon, with a 45-50 cm thickness, is very dark, dark brown - blackish (10YR 2/2-2/1) when humid, low-medium grained, slightly compacted, honeycombed, loose, with high biological activity, and gradual passage.

AB transitional horizon 20-22 cm is characterised by a dark brown-slaty colour (10YR 2/2-2/1) in humid condition, has a high angular polyhedral structure, it becomes flinty when is dry and slightly rotten when is humid, it is sticky, moderately plastic and presents clay layers and rare grass-roots.

Bt horizon frequently exceeds 90 cm in thickness and is divided in two and even three sub-horizons. Their colour changes very little, remaining dark brown even in the Bt_3 sub-horizons, and the transition to the Cca horizon is realized neatly.

C horizon is generally under 160-170 cm thickness and changes colour, becoming dark yellow-brown (10YR 4/4) when is wet, is plastic, slightly rotten and it contains small quantities of $CaCO_3$ veinlets and concretions.

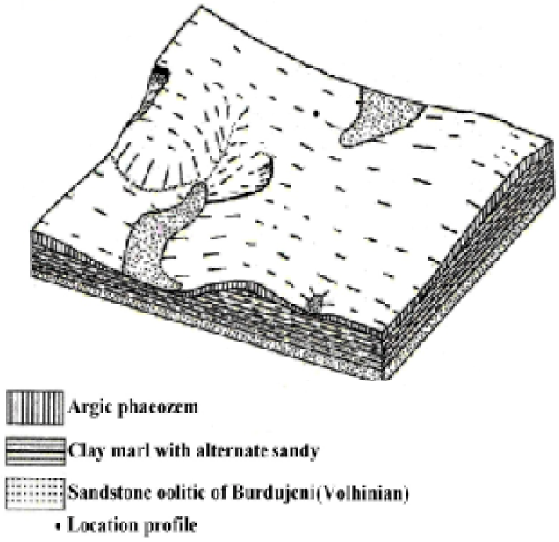

Fig. 4. Block diagram in Suceava Plateau (Parichi et al., 2006)

The analytical data show that these soils are very rich in humus. They contain more than 5% humus in the superior layer and 1% humus under the depth of 100 cm (table 1).

This rich humus content corresponds to high values of nitrogen, phosphorus and potassium (0.240-0.250% Nt, 15 ppm P and 133 ppm K); soil's *p*H reaction is moderately acid (5.6) in the upper horizon and the degree of saturation is lower than in the case of the cambic chernozems (68-88%) (table 2).

We can notice a slight textural differentiation between the Am and Bt horizons, which is determined by clay migration, but also by the irregularity of the parental material. The total capacity of cationic exchange is between 33 and 37 me/100 g soil.

Table 1

GRANULOMETRIC COMPOSITION OF ARGIC PHAEOZEMS FROM SUCEAVA PLATEAU

Horizon	Depth in cm	2-0.2 mm	0.2-0.02 mm	0.02-0.002 mm	< 0.002 mm	0.01 mm
Ap	0-14	0.58	36.2	27.1	36.1	50.5
Am	14-25	0.81	33.3	31.7	34.2	54.5
AB	25-40	0.68	33.6	26.4	39.3	54.3
Bt1	45-65	0.61	30.2	27.2	42.0	58.0
	65-80	0.49	25.1	22.6	51.2	65.0
Bt2	80-100	0.48	25.5	24.2	49.8	64.0
	100-120	0.47	26.4	24.1	48.3	63.0
C	160-175	0.87	28.5	24.0	46.5	59.9

Table 2

CHEMICAL DATA ON ARGIC PHAEOZEMS FROM SUCEAVA PLATEAU

Horizon	Depth in cm	SB me/100 g sol	T me/100 g sol	V %	Total N %	Mobile P ppm	Mobile K ppm
Ap	0-14	22.3	32.8	68.0	0.251	15	133
Am	14-25	22.1	32.8	69.1	0.249	15	119
Bt_1	45-65	28.1	36.8	71.2	0.149	4	126
	65-80	29.1	36.9	75.5	0.112	3	124
Bt_2	100-120	31.3	35.5	88.9	-	-	-
C	160-175	28,2	31,5	94,2	-	-	-

Table 3

PHYSICAL AND HYDRO-PHYSICAL DATA ON GREYIC PHAEOZEMS FROM SUCEAVA PLATEAU

Horizon	Depth (cm)	Granulometric composition				Physical and hydro-physical properties						
		<0,002 mm	0,002-0,02 mm	0,02-0,2 mm	0,2-2 mm	DA g/cm^3	PT %	CO %	CC %	CU %	CT %	K mm/h
Am	0-20	32.8	33.0	34.2	0.0	1.08	59.6	10.8	26	15.2	55.1	20.6
Ame	22-34	34.5	29.8	35.7	0.0	1.28	52.1	8.7	25	16.3	40.7	11.5
AB	34-53	39.6	27.5	32.9	0.0	1.39	48.0	9.6	25	15.4	34.5	12.3
Bt_1	53-100	42.5	27.7	29.8	0.0	1.41	47.5	10.5	25	14.5	33.6	17.9
Bt_2	100-160	41.3	30.1	32.8	0.0	1.50	44.1	11.5	24	12.5	29.4	20.7
Bt_3	160-191	37.1	30.8	32.1	0.0	1.51	43.6	12.1	24	11.9	28.8	0.3
Ck	195-285	35.5	25.1	39.4	0.0	1.45	45.7	10.5	23	12.5	31.5	6.9

Table 4

CHEMICAL DATA ON GREYIC PHAEOZEMS

Horizon	Depth (cm)	pH (H_2O)	Humus %	C/N	T me/100 g sol	V %	Total N %	P ppm	K ppm
Am	0-20	5.80	6.12	15.7	19.2	67.8	0.264	12	130
Ame	22-34	5.52	2.34	15.5	14.55	42.1	0.102	10	111
AB	34-53	5.44	1.86	12.6	16.68	56.3	0.100	4	123
Bt_1	53-100	5.30	1.32	11.5	15.40	64.6	0.078	-	-
Bt_2	100-160	5.20	-	-	14.57	79.4	-	-	-
Bt_3	160-191	5.66	-	-	14.62	88.6	-	-	-
Ck	195-285	7.42	-	-	-	100.0	-	-	-

Greyic phaeozems presents a profile of type Am-Ame-Bt-C or Cca developed.

Greyic phaeozems have a clayey-loamy texture. Clay content is 32-33% in horizon Am and 34-35% in Ame, then slightly increase the profile without exceeding 43% (table 3), index of texture differentiation hovering around 1.2-1.3. There are loose in the upper horizon (-2.9 to 18.3%), moderately compacted in Bt (14-15%). Very low bulk density Am (1.08 to 1.28 g /cm^3) becomes higher in Bt (1.50 to 1.51 g /cm^3), and the porosity of soil has high and very high values on the surface (52- 60%).

Field capacity is large-sized in all cases (25-26%), medium withering coefficient (from 8.7 to 11.5%), water and the available moisture holding capacity is very high (15.2 to 16.3). The permeability is high (11.5 to 20.7 mm / h), except for subhorizon Bt3 and C the values are small-sized (0.3 to 6.4 mm/h).

Greyic phaeozems generally contain 5-12% humus in the upper horizon, when the wood is below 3.5% in the culture. It has a moderate acidic reaction (5.20 to 5.80) (table 4).

Effective cation-exchange capacity is characterized by low values (from 14.57 to 19.82 me /100 g soil), and the degree of saturation mesobasic horizon Am (67.8%), decreases abruptly in Ame (42.1%), and reach the base to fully saturated horizontally C.

For the supply of nutrients, it is in the middle of the upper horizon nitrogen (0.07 to 0.25%) if the soil is cultivated and low profile with respect to phosphorus (10-12 ppm) and potassium (111-130 ppm).

Use and fertility of the phaeozems

Being rich in humus and nutrients, but also having relatively good physical properties, the phaeozems from the Suceava Plateau have a potentially high fertility, a property that generates rich crops, especially if they are properly cultivate. They are used for cultivating grains (wheat, maize, barley), industrial plants (sugar beet, potatoes, flax bundle) and just a small part for fruit farming or fodder plants (fig. 5, 6).

The data obtained from the standard lots have shown that we can cultivate up to 40 tons of potatoes on argic phaeozem, 5-8 tons more that on the greyic phaeozem, and 38-39 tones of sugar beet.

The results decrease in the rainy years (up to 5 t/ha). The richest harvests were obtained from the lots situated in the middle third of the versant glacis, which was better drained.

The estimations regarding the favourability for different crops, compared to other types of soils, show a very high score in natural conditions (table 5).

Fig. 5. Slopes under wheat and maize in Suceava Plateau

Fig. 6. Greyic phaeozems grown barley in Suceava Plateau

Table 5
FAVOURABILITY PHAEOZEMS FOR DIFFERENT CROPS

Type of soil	Wheat		Maize		Potatoes		Barley		Flax bundle		Sugar beet	
	Note of economic value	Soil quality classes	Note of economic value	Soil quality classes	Note of economic value	Soil quality classes	Note of economic value	Soil quality classes	Note of economic value	Soil quality classes	Note of economic value	Soil quality classes
Argic phaeozem	75	II	65	II	80	II	76	II	78	II	77	II
Greyic phaeozem	67	II	54	III	69	II	73	II	73	II	70	II

In general, the degree of suitability for different uses and increase the phaeozems crops with Bt horizon to the horizon Bv. Good results give potato and sugar beet.

Conclusions

The phaeozems from the Suceava Plateau appeared and developed as a result of some ample regional geomorphologic transformations. Because of some morphological characteristics they can be compared to clay chernozems, and given the conditions of a smooth relief, less drained, they evolve to luvisols.

Pedogenetic process dominant is the clay migration, quite intense, process that results in the formation of clay skin organo-mineral the impurities are mainly constituted of organic matter and iron. They have similar compositions from which the material iluvial because all components have migrated together (organic matter-clay-iron).

After their deposition in the form of clay skin organo-mineral held a series of transformations, such as clarification of these clay skin by gradual loss of organic matter under the action of microorganisms (evidence of their presence in the clay skin or in the vicinity) followed by mobilization of Fe and discoloration of clay skin (in wet conditions).

Organic matter is very abundant and occurs in different forms in the profile: vegetable residues in various degrees of grinding and decomposition occur frequently in the upper layers.

Being rich in humus and nutritive substances, but also having relatively good physical properties, they have a potentially high fertility, a property that generates rich crops, especially in potatoes and flax bundles.

Compared to chernozems, is located in the more humid areas, they are well supplied with water, but in this case there is a shortage of moisture for the compensation of which, apart from some specific work is required, irrigation and soil. Obtaining better yields can be achieved through the application of organic and mineral fertilizers.

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