FORUM GEOGRAFIC

Forum geografic. Studii și cercetări de geografie și protecția mediului
Volume **XIX**, Issue **1** (**June** 2020), pp. **29-36**
http://dx.doi.org/**10.5775/fg.2020.034.i**

Gross chemical analysis of the turf and podzolic soils on glacial deposits, laid by dense carbonate rocks

Mariana SALIUK[1], Mykhailo MYKYTA[1], Vasyl LETA[1,*]

[1] Faculty of GEOGRAPHY, Department of Physical Geography and Environmental Management, Uzhhorod National University, Universytets'ka street, 14, Uzhhorod, Ukraine

* *Corresponding author*: vasyl.leta@uzhnu.edu.ua

Received on 25-12-2019, reviewed on 20-03-2020, accepted on 15-06-2020

Abstract

Gross analysis allows us to reveal issues concerning the genesis of soils and to identify the peculiarities of elementary soil processes. The article summarizes the results of the study of gross chemical analysis of the turf and podzolic soils on alluvial and glacial deposits, laid by dense carbonate rocks. Features and relationships of oxides content in soils and soil-forming rocks are considered, that will make possible to justify important issues of the nature of these soils and to study the dependence of their natural properties with dense carbonate rocks.

It is established that oxides of silicon, ferum, aluminum and calcium form the basis of gross chemical composition of the turf and podzolic soils on alluvial and glacial deposits, laid by dense carbonate rocks. The maximum content of the first component is observed in the upper humus-eluvial horizon (90–94%), aluminum and ferum oxides – in iluvial accumulative horizons, where their content in total is 7–15%. Calcium oxide content in soil profile of studied soils, naturally increases from 0.36% in the upper horizons to 0.95% in the transitional, and in the laid carbonate rocks its content can reach up to 35%. This confirms the fact that laid carbonate rocks have a significant influence on the flow of all soil elementary processes, and gross analysis confirmed the presence of carbonates in the entire soil profile, which could not be determined during field or macromorphological studies. Oxides of alkaline-earth metals are mainly accumulated in the upper humus horizons of all soils, their content decreases down the profile. Potassium and phosphorus oxides, although pliable to washing, however are delayed in the soil and included in the biological cycle and partially fixed in secondary minerals. The content of biologically important components such as P_2O_5, MnO, S, N in the upper horizons of the studied soils is closely related to the accumulation of humus.

Keywords: *gross chemical analysis, gross chemical composition, oxides, chemical elements, soil formation, turf and podzolic soils on glacial deposits, laid by dense carbonate rocks*

Rezumat. Analiza chimică brută a solurilor podzolice dezvoltate pe depozite glaciare, depuse pe roci carbonatice dense

Analiza brută ne permite să dezvăluim probleme referitoare la geneza solurilor și să identificăm particularitățile proceselor pedogenetice. Articolul rezumă rezultatele studiului analizei chimice brute a solurilor podzolice pe depozite aluviale și glaciare, formate pe roci carbonatice dense. Sunt luate în considerare caracteristicile și relațiile conținutului de oxizi din soluri și rocile din substrat, ceea ce va face posibilă justificarea problemelor importante ale naturii acestor soluri și studierea dependenței caracteristicilor lor naturale de stratului de roci carbonatice.

S-a stabilit că oxizii de siliciu, fer, aluminiu și calciu se află la baza compoziției chimice brute a solurilor podzolice dezvoltate pe depozitele glaciare, deasupra rocilor carbonatice dense. Conținutul maxim al primei componente este observat în humusul orizontului eluvial superior (90-94%), aluminiu și oxizi de fier în orizonturile de acumulare iluviale, unde conținutul lor total este de 7-15%. Conținutul de oxid de calciu în profilele solurilor studiate crește în mod natural de la 0,36% în orizonturile superioare la 0,95% în cele de tranziție, iar în rocile carbonatice, conținutul său poate ajunge până la 35%. Acest lucru confirmă faptul că rocile carbonatice parentale au o influență semnificativă asupra fluxului tuturor proceselor elementare ale solului, iar analiza brută a confirmat prezența carbonaților pe întregul profil al solului, ceea ce nu a putut fi determinat în timpul studiilor de teren sau a celor macromorfologice. Oxizii metalelor alcalino-pământoase sunt acumulați în principal în humusul din orizonturile superioare ale tuturor tipurilor de sol, conținutul acestora scăzând pe profil. Oxizii de potasiu și fosfor, deși pot fi spălați, cu toate acestea sunt reținuți în sol și incluși în ciclul biologic și fixați parțial în minerale secundare. Conținutul de componente biologice importante precum P_2O_5, MnO, S, N, în orizonturile superioare ale solurilor studiate este strâns legat de acumularea de humus.

Cuvinte-cheie: *analiza chimică brută, compoziția chimică brută, oxizii, elementele chimice, formarea solului, solurile podzolice pe depozite glaciare, depuse peroci carbonatice dense*

Introduction

Soil is an arena of continuous chemical, physical and biological processes, an active participant in the cycle of substances in nature. Its physical, chemical, morphological properties reflect those complex processes and phenomena that took place during the long process of soil formation. Gross chemical analysis reveals issues related to soil genesis and to identify the peculiarities of elementary soil processes.

As Miakina and Arinushkina (1979) note, in the 1920's, soil scientists actively studied the gross content of each element in each soil horizon, in terms of the availability of elements for plant nutrition. Until the 1930's, scientists used gross chemical analysis extensively to investigate the elemental composition of soils, which was essential to assess the direction of the soil formation process. In the 1940's, scientists paid considerable attention to the definition of molecular relations. Modern soil scientists use significantly less of so-called "old-fashioned materials" of gross analysis. But it must be noted that both gross analysis and molecular relations are extremely important and useful. After all, in 1944 Polynov noted that gross chemical analysis was the necessary initial stage of all researches and determined the direction of the following analyses and definitions. The further development of analytical technology in world science has led to a change in the ways in which the quality composition of soils is assessed, therefore, many laboratories, making extensive use of the new technique, have paid much less attention to gross analysis. Even now, for genetic purposes, gross analysis is only partially used in various modifications. The results of studies of gross chemical analysis of soils we find in quite recent works (Krasnov et.al., 2017; Melkerud et.al, 2000; Olsson et.al., 2000; Sanborn et.al., 2011).

The question of the genesis of the turf and podzolic soils on alluvial and glacial deposits, laid by dense carbonate rocks, is poorly addressed by the literature, which is due to insufficient information base about their properties. Some information about these soils can be found in the works of Andrushchenko (1970); Friedland (1986); Polupan et.al. (1988); Vernander et.al. (1986). Therefore, gross chemical analysis will allow to substantiate important issues about the nature of these soils; to study the dependence of their natural properties from the depth of the laid carbonate rocks; to establish classification accessory.

The purpose of the research is to study the gross chemical composition of the turf and podzolic soils on alluvial and glacial deposits, laid by dense carbonate rocks, to investigate changes in their chemical composition, to justify the dependence of this composition on soil-forming rocks, to identify the influence of laid rocks on the overall soil formation process.

Tasks to be solved: to estimate the gross chemical composition of soils; to interpret the data and to trace their changes depending on soil-forming and laid rocks; to justify the removal or accumulation of chemical elements according to the soil profile; to provide an analysis of the soil leaching factor.

The practical significance of the results. Gross analysis data will make it possible to trace changes in the content of chemical elements by soil profile, to identify the direction of soil-forming processes (or soil genesis). The obtained results allow to trace the chemical composition of the mineral part of the soil and their functional dependence on the soil-forming and laid rock and the depth of its occurrence, which in the future will allow to apply the obtained results to clarify the criteria of classification of the studied soils.

Materials and Methods

Maly Polissya is located in the most western part of Ukraine (Fig. 1). It borders the Volyn Upland in the north, Roztocze in the northwest, Opillia in the south and southwest. The territory stretches in a latitudinal direction for 220 km, from the town of Rava-Ruska, Lviv region, to the outskirts of Ostrog, Rivne region. The average width of Maly Polissya is 20–25 km, and the widest part is 75 km. The melting waters of the lower Quaternary glacier (Oka glaciation) played an important role in the formation of the territory of Maly Polissya. Wide valleys are filled with sandy water-glacial deposits, which lie on water-resistant Cretaceous deposits, which in some places come to the surface.

The dominant type of relief is flat-undulating accumulative aluvial-glacial plains, which alternate with alluvial and swampy plains along the main rivers Rata, Solokia and Bolotna - left tributaries of the Western Bug. Dominant absolute heights - 210-240 m, maximum height - 274 m. The background soils on the territory of Maly Polissya are sod-podzolic soils on water-glacial deposits and sod-carbonate soils. Less common are sod-podzolic soils on water-glacial deposits, lined with dense carbonate rocks, which occupy more than 30 thousand hectares (4.3% of the total area of Maly Polissya) and are located as relatively large areas (up to 10-15 hectares), and insignificant areas (within 0.1–0.2 hectares) among the background soils.

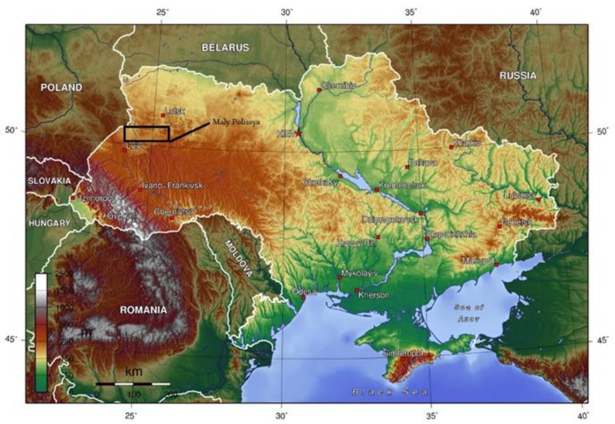

Fig. 1: Location Map of the Study Area

The object of the current research is the least studied in the region of Maly Polissia (Fig. 1), i.e. turf and podzolic soils on alluvial and glacial deposits, laid by dense carbonate rocks. The gross chemical composition was determined for such soils: turf and slightly podzolic soils on alluvial and glacial deposits, laid by dense carbonate rocks from the depth of 1–1.5 m (soil cut 3R and 5B); turf and slightly podzolic (soil cut 4B) and turf and podzolic secondary-carbonized slightly deflated soil (soil cut 7B) on alluvial and glacial deposits, laid by dense carbonate

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rocks from the depth of 0.5–1 m. The gross composition of the soil-forming and laid rocks on which these soils were formed was also studied (Tab. 1–2).

The gross analysis includes the determination of hygroscopic moisture, losses from calcination, organic carbon and nitrogen content and element content, which are part of the mineral part of the soil, and the determination of CO_2 carbonates in carbonate soils. The results of the determination of SiO_2, Al_2O_3, Fe_2O_3, MnO, CaO, MgO, SO_3, P_2O_5, K_2O, Na_2O, TiO_2 are expressed by the content of oxides (Arinushkina, 1970).

During the research were performed complete gross chemical analysis and determination in percentage by weight of air-dry soil oxides: SiO_2, Al_2O_3, Fe_2O_3, FeO, TiO_2, MnO, CaO, MgO, SO_3, P_2O_5, K_2O, Na_2O, H_2O, CO_2, and losses from calcinations. A complete silicate analysis was done for 15 elements. SiO_2 was determined by weight method after the decomposition of sample weight by fusion with sodium carbonates. The main soil-forming components: Al_2O_3, Fe_2O_3, CaO, MgO were determined by volumetric complexometric method at appropriate pH values of titration was carried out by trilon B. The content of oxides MnO, P_2O_5, TiO_2 – by photometric method on a photocolorimeter, alkaline oxide content – by the method of atomic absorption spectrophotometry.

The obtained results were transferred on dry, calcareous carbonate-free soil. The content of oxides is converted to the content of chemical elements, the molar ratios of these oxides are calculated. Data processing of the GCA was carried out according to the generally accepted method concluded in the manual of Arinushkina (Arinushkina, 1970).

According to Bowl et.al. (1977) the dominant issue of genetic study of the mineral part of the soil is the elucidation of changes in its chemical composition under the action of soil-forming processes, and comparison of data, expressed as a percentage of dry soil weight does not give a correct understanding of changes in the mineral part of the soil, because the amount of each oxide is affected by the content of humus and chemically bound water. Therefore, methodically correct will be the recalculation of the results, expressed as a percentage from dry soil weight to a percentage of mineral part weight, that is, it is necessary to exclude from calculations the content of humus and chemically bound water.

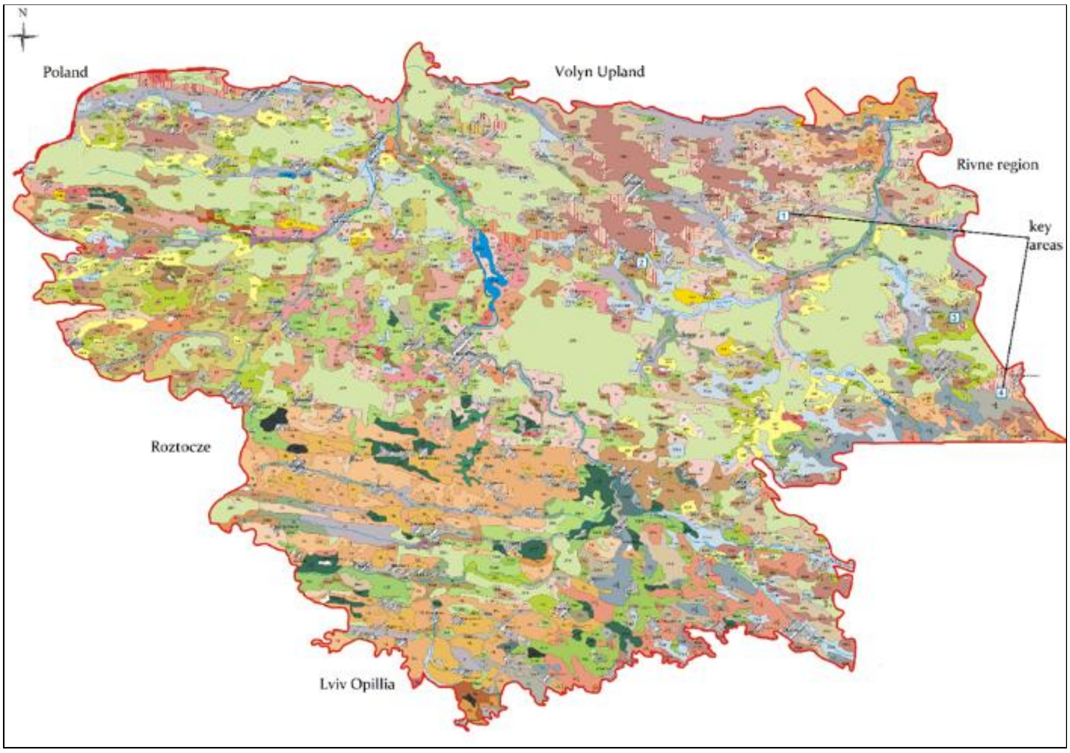

Fig. 2: Soils of Maly Polissya

Results and Discussion

The results of the gross analysis of turf and podzolic soils on glacial deposits, laid by dense carbonate rocks are presented in Tables 1-2. According to the obtained results, we will be able to establish the peculiarities of flow of elementary soil processes and identify changes that have occurred during the process of soil formation. Obligatory to detect changes as part of soil profile is necessary to carry out the analysis of maternal rock (or laid rock, if it is at a slight depth within the profile). As Vynohradov (1949) noted, from a geochemical point of view, a type of soil-forming process can be characterized first of all by the depth of destruction of the mineral substance of soil-forming rock and the final composition of this type of soil. The gross chemical composition of the rocks is crucial in identifying changes in the chemical composition of soils that have occurred during the process of soil formation. Comparison of these data, according to Samoilova (1983), is possible only if the soil is formed from homogeneous rock. From this point of view, it is difficult to characterize the studied soils, because they were formed on alluvial and glacial deposits, which at different depths lie on dense carbonate rocks (cuts 3R,4B,5B). The studied soils in the lower part of the profile are carbonate, and in the cut 7B carbonate is observed in all horizons. According to Fridland (1986), presence of free carbonates in soil, by virtue of existing laws, slows down the destruction of primary minerals, because silicates do not break down until free calcium is removed, which is in the rock.

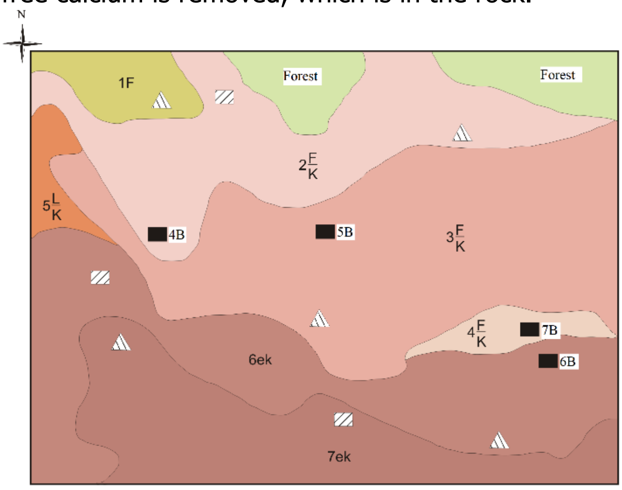

Fig. 3: Investigated soil cuts (4B, 5B, 7B)

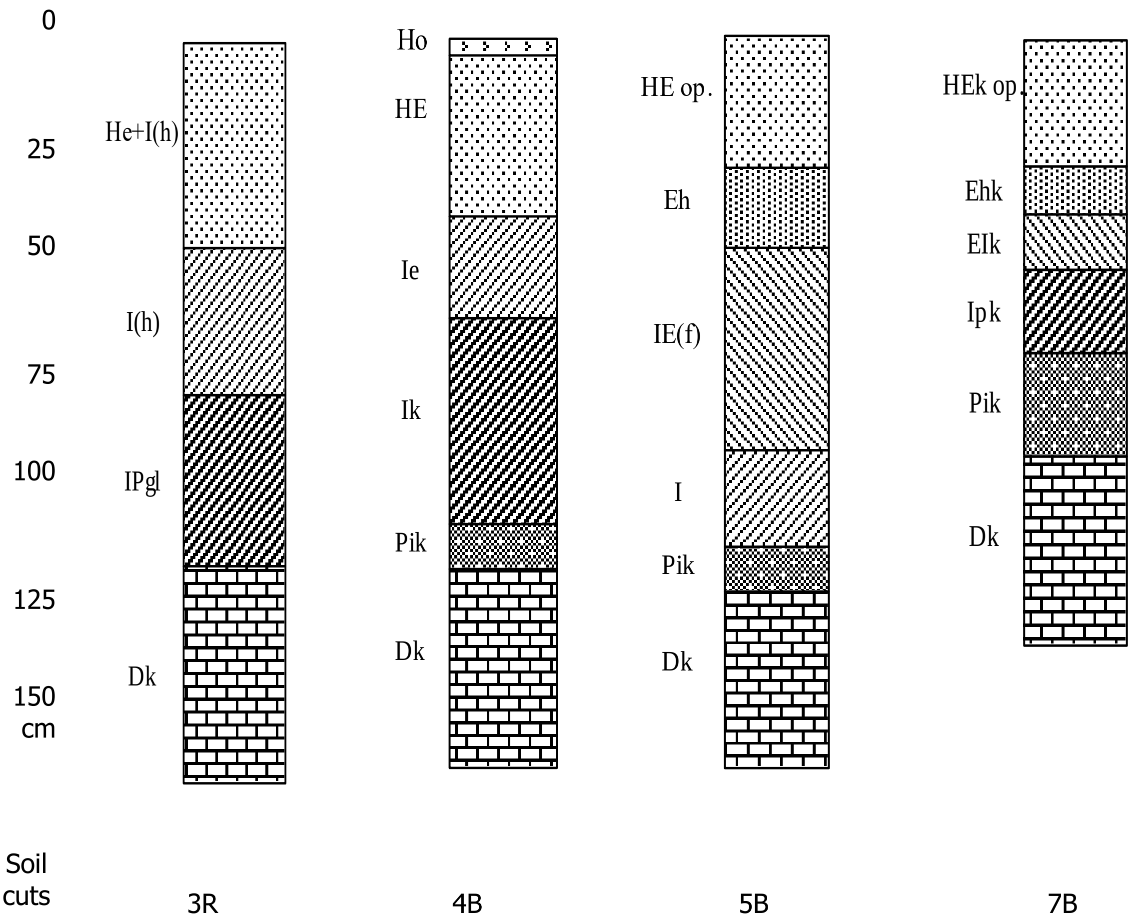

Fig. 4: Structure of soil profiles of sod-podzolic soils on water-glacial deposits lined with dense carbonate rocks

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The question of the evolution of soils formed on dense carbonate rocks was posed for the first time by K. Glinka in his work "Soil formers and soil formation". As noted by the author at the initial stage of soil formation, due to the excess of carbonates in the rock, there will be a delay in the decomposition of organic residues, resulting in the accumulation of humus. At the same time, on the overlying horizon, there is water, which is enriched with carbonic acid, and here there is a brown or yellow loam. And when the moment comes that the humus horizon will be separated from the parent rock by a layer of carbonate-free loam, then the conditions due to which humus accumulated in the soil will disappear (Semashchuk, 2014).

Soil cuts 4B, 5B and 7B are laid within Brodiv alluvial-water-glacial plain when approaching to the Holohoro-Kremenets hills. The relative heights of the territory are 244–263 m. The cuts are laid at a short distance from each other, but, having analyzed the gross analysis data, one can see a sharp difference in the gross chemical composition of the laid rocks of these soils. The laid rocks of the soil cuts 5B and 7B have the same content of silicon oxide (5.61–5.21%) and calcium oxide (50.98-51.10%). The content of one and a half-oxides is also almost the same, and is 1,20–1,56% (Al_2O_3) and 0,58–0,60% (Fe_2O_3) (Tab. 1). The laid rock of the cut 4 B differs sharply – it has a relatively high content of SiO_2 and one and a half oxides due to possible intensive leaching; as a result, there is a residual accumulation of the silicate portion (sand) and the removal of carbonates, which was confirmed by physical and chemical analyzes. In addition, a decrease in calcium and CO_2 oxides was observed (Tab. 1).

Table 1: Gross chemical composition of soils, % by weight of dry soil

№ Soil cuts	Genetic horizons, sampling depth, cm	Loss on ignition, %	Hygroscopic moisture, %	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	MnO	K_2O	Na_2O	P_2O_5	Sзar.	TiO_2	CO_2
3R	He+I(h)(0-40)	3,89	1,62	86,97	5,12	0,91	0,02	0,85	0,10	0,07	1,11	0,27	0,08	0,22	0,38	-
	I(h) (59-69)	5,85	5,68	74,12	13,50	2,44	0,01	0,89	0,10	0,05	1,69	0,33	0,06	0,13	0,63	-
	PIgl (92-102)	4,92	3,78	68,27	14,59	4,45	0,02	0,26	0,20	0,04	1,12	0,30	0,06	0,18	0,55	-
	Dk (137-147)	2,80	0,90	31,91	3,98	1,55	0,04	33,26	0,40	0,03	0,66	0,24	0,07	0,26	0,19	24,26
4B	HE (5-40)	1,80	0,59	90,33	4,16	1,14	0,07	0,42	0,10	0,04	1,14	0,52	0,04	0,23	0,27	-
	Ik (85-95)	1,83	1,57	86,45	5,97	2,37	0,05	0,43	0,10	0,02	1,20	0,46	0,04	0,41	0,22	-
	Pik (110-120)	1,14	0,76	77,26	4,85	2,83	0,05	1,94	0,20	0,02	1,15	0,37	0,04	0,40	0,17	
	Dk (120-140)	0,78	0,25	50,12	2,04	1,06	0,03	25,06	0,40	0,02	0,43	0,25	0,04	0,33	0,11	18,93
5B	HE (0-30)	1,75	0,25	92,40	2,74	0,96	0,04	0,35	0,05	0,03	0,86	0,40	0,04	0,27	0,18	-
	IE(f) (55-65)	1,92	2,46	86,25	4,85	3,58	0,03	0,28	0,10	0,03	1,52	0,33	0,05	0,32	0,15	-
	Pik (115-125)	1,28	0,30	81,43	6,23	2,94	0,03	4,48	0,30	0,02	0,40	0,21	0,07	0,35	0,11	-
	Dk (125-150)	0,84	0,35	5,61	1,20	0,58	0,02	50,98	0,61	0,02	0,19	0,12	0,11	0,44	0,07	38,85
7B	Hek op (0-30)	3,03	1,09	87,65	4,53	1,21	0,13	0,85	0,24	0,04	1,11	0,39	0,07	0,22	0,26	-
	Ipk (60-70)	2,60	2,75	82,85	7,87	2,90	0,10	0,58	0,50	0,04	1,31	0,35	0,07	0,29	0,27	-
	Pk(i) (75-85)	3,11	1,87	80,64	6,77	2,12	0,10	1,45	0,50	0,04	1,02	0,27	0,08	0,26	0,15	-
	Dk (100-110)	3,70	0,60	5,21	1,56	0,60	0,60	51,10	0,51	0,03	0,22	0,09	0,08	0,25	0,07	36,52

Table 2: Gross chemical composition of soils,% by weight of calcined carbonate-free soil

№ Soil cuts	Genetic horizons, sampling depth, cm	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	MnO	K_2O	Na_2O	P_2O_5	Sзar.	TiO_2	Silicate CaO
3R	He+I(h)(0-40)	90,49	5,33	0,95	0,02	0,89	0,11	0,07	1,15	0,29	0,08	0,23	0,39	-
	I(h) (59-69)	78,73	14,34	2,59	0,01	0,95	0,11	0,06	1,79	0,35	0,07	0,14	0,66	-
	PIgl (92-102)	76,25	13,63	3,25	0,07	2,15	0,24	0,06	1,62	0,45	0,11	0,61	0,57	-
	Dk (137-147)	75,89	9,46	3,70	0,10	5,60	0,96	0,07	1,56	0,58	0,17	0,62	0,46	2,35
4B	HE (5-40)	91,99	4,24	1,16	0,07	0,43	0,10	0,04	1,16	0,53	0,04	0,24	0,28	-
	Ik (85-95)	88,06	6,09	2,41	0,05	0,43	0,10	0,02	1,22	0,47	0,04	0,41	0,23	-
	Pik (110-120)	87,02	5,92	2,95	0,05	1,25	0,50	0,03	0,80	0,46	0,06	0,50	0,22	-
	Dk (120-140)	89,21	3,62	1,89	0,05	1,69	0,71	0,04	0,77	0,45	0,07	0,59	0,20	0,95
5B	HE (0-30)	94,05	2,79	0,98	0,04	0,36	0,05	0,03	0,88	0,41	0,04	0,28	0,18	-
	IE(f) (55-65)	87,48	5,42	4,03	0,03	0,30	0,10	0,03	1,42	0,33	0,04	0,33	0,15	-
	Pik (115-125)	82,85	7,97	3,85	0,03	0,82	0,35	0,26	1,89	0,30	0,05	0,48	0,27	-
	Dk (125-150)	51,84	11,13	5,38	0,19	13,76	5,66	0,19	1,76	1,11	1,02	4,08	0,65	1,49
7B	Hek op (0-30)	90,39	4,67	1,25	0,14	0,88	0,25	0,04	1,15	0,41	0,07	0,23	0,27	0,85
	Ipk (60-70)	85,06	8,08	2,98	0,01	0,59	0,52	0,04	1,34	0,36	0,07	0,30	0,27	0,58
	Pk(i) (75-85)	82,59	7,96	3,25	0,10	3,15	0,77	0,03	1,16	0,30	0,08	0,28	0,30	1,25
	Dk (100-110)	39,32	11,77	4,55	4,55	34,49	3,87	0,23	1,67	0,68	0,61	1,90	0,53	4,57

Table 3: Content of chemical elements,% by weight of calcined carbonate soil

№ Soil cuts	Genetic horizons, sampling depth, cm	Si	Al	Fe	Ca	Mg	Mn	K	Na	P	S	Ti
3R	He+I(h)(0-40)	42,35	2,82	0,35	0,64	0,06	0,06	0,96	0,21	0,04	0,09	0,23
	I(h) (59-69)	36,84	7,58	0,86	0,68	0,06	0,04	1,49	0,26	0,03	0,05	0,40
	PIgl(92-102)	36,12	6,48	0,69	1,41	0,11	0,04	1,33	0,30	0,05	0,03	0,31
	Dk (137-147)	35,52	5,00	0,46	4,00	0,58	0,06	1,29	0,43	0,07	0,25	0,27
4B	HE (5-40)	43,05	2,24	1,41	0,31	0,06	0,03	0,96	0,40	0,02	0,09	0,17
	I (85-95)	41,21	3,22	2,00	0,31	0,06	0,02	1,01	0,35	0,02	0,17	0,14
	Pik(110-120)	41,62	2,47	1,87	1,02	0,12	0,02	0,99	0,34	0,02	0,21	0,13
	Dk (120-140)	41,75	1,92	1,35	1,21	0,43	0,03	0,64	0,33	0,03	0,24	0,12
5B	HE (0-30)	44,02	1,47	1,29	0,26	0,03	0,02	0,73	0,30	0,02	0,11	0,11
	IE(f) (55-65)	42,58	2,54	2,01	0,32	0,07	0,02	1,22	0,27	0,02	0,19	0,11
	Pik(115-125)	41,69	4,02	1,78	1,47	0,31	0,10	1,57	0,45	0,22	0,27	0,21
	Dk (125-150)	24,26	5,89	1,32	9,84	3,41	0,14	1,46	0,83	0,44	1,63	0,39
7B	Hek op (0-30)	42,30	2,47	2,81	0,63	0,15	0,03	0,95	0,30	0,03	0,09	0,16
	Ipk (60-70)	39,81	4,27	2,81	0,42	0,31	0,03	1,11	0,27	0,03	0,12	0,16
	Pk(i)(75-85)	38,48	3,54	2,81	1,56	0,32	0,04	1,28	0,35	0,08	0,44	0,24
	Dk (80-90)	18,40	6,22	2,81	24,66	2,33	0,18	1,39	0,51	0,26	0,76	0,32

3R – turf and slightly podzolic sand and light loam soil on water and glacial deposits, laid by dense carbonate rocks from the depth of 1–1.5 m (under the virgin soil)
4B – turf and slightly podzolic sandy soil on water and glacial deposits, laid by dense carbonate rocks from the depth of 0,5–1 m (under the forest)
5B – turf and slightly podzolic sandy soil on water and glacial deposits, laid by dense carbonate rocks from the depth of 1–1.5 m (under the arable land)
7B – turf and slightly podzolic secondary-carbonized slightly deflated soil on water and glacial deposits, laid by dense carbonate rocks from the depth of 0.5–1 m (under the arable land)

Having observed the results of the gross soil analysis (Tab. 1-2), more destruction of the silicate portion in the cut 4B can be observed, which characterizes turf and slightly podzolic soils on water and glacial deposits, laid from the depth of 0,5–1m by dense carbonate rocks. According to Fridland (1986) the destruction of the mineral part of the soil is more active in acidic conditions where the solutions are not rich in bases. The value of the pH of this soil is 4.7–5.1, which causes more active destruction of the mineral part. This cut is laid under the forest, where forest vegetation determines the concentration of hydrogen ions in the soil solution, that cause an acid reaction of the environment, and calcium is a component of the potential part of the soil and does not normally accumulate in the humid conditions of forest zones, which results in faster destruction of silicates and aluminosilicates.

The turf and podzolic soils on alluvial and glacial deposits, laid by dense carbonate rocks are characterized by an increase of calcium oxides in the lower part of the profile. The upper humus-eluvial horizons of the cuts 4B, 5B and 7B are characterized by high content of SiO_2 (90,39–94,05%) and one and a half oxides, among which aluminum oxide prevails, with its maximum amount found in the illuvial horizons (Tab. 1-2). In general, as Andrushchenko (1970) noted, the gross composition of the iluvial horizons is very variable, due to the presence of pseudofibers that have formed at the boundaries between rock layers. In addition, a decrease of SiO_2 content and an increase of alkaline earth oxides have been recorded in the iluvial horizons. The increase of the content of K_2O and Na_2O in the illuvial horizons is due to the decay of primary minerals – feldspar on plagioclase and kalischpat, the basis of which are elements K+ and Na+, which was also noted at the micromorphological level of research. Such division of chemical elements by profile of the turf and podzolic soils on water and glacial deposits, laid by dense carbonate rocks, is characteristic for podzolic soil formation, when, as Karpachevskyi points out, in the upper horizons there is destruction of minerals, except silicon, and the products of destruction (usually Al_2O_3 and Fe_2O_3) are brought into the lower horizons. The accumulation of one and a half oxides in the lower horizons is mainly due to the increase in the content of the sludge fraction (Karpachevskyi, 1960). At the same time, the large amount of silicon which is released during the primary soil-forming process from the aluminosilicate minerals is brought by surface, ground and underground water (Parfenova and Yarylova, 1956).

Having studied the average chemical composition of the main soil types of the European part of the USSR, Kudrin (1963) came to the conclusion that the average 'maternal rock' in its aluminosilicate part is very close to the 'middle soil', and this indicates that losses of individual chemical elements from the soil profile are not observed or are expressed very weakly; it concerns mainly of calcium oxide, judging that its content in "middle soil" is lower than that of "middle maternal rock," then this is due to the processes of soil formation. The conclusions drawn by S.A. Kudrin can also be applied to the soils under consideration.

The content of calcium oxides in the turf and podzolic soils, laid by dense carbonate rocks naturally increases downward to the soil-forming and laid rock. The highest content of this oxide is characterized by the laid rocks of the cuts 7B (51,1%) and 5 B (50,98%). Accordingly, the highest content of silicate calcium has the cut rock 7B (Tab. 2). The content of silicate CaO and CO_2 directly correlates with the carbonate content ($CaCO_3$).

Forum geografic. Studii și cercetări de geografie și protecția mediului
Volume **XIX**, Issue **1** (**June 2020**), pp.**29-36**
http://dx.doi.org/**10.5775/fg.2020.034.i**

Oxides of alkaline earth metals are mainly accumulated in the upper humus horizons of all soils, their content decreases down the profile and in some cases increases in soil-forming and laid rocks (Tab. 1-2). According to Parfenova (1956), potassium and phosphorus oxides, although pliable to washing, however, are delayed in the soil and "trapped" in biological circulation, but still partially fixed in the secondary minerals. Sodium and sulfur compounds are typical biological additives, transiting through the tissues of organisms, carried outside the profile. However, changes of these components in the soil profile are not major in soil formation. The content of biologically important components such as P_2O_5, MnO, S, N in the upper horizons of the studied soils is closely related to the accumulation of humus, and is modified under the influence of life activity of microorganisms. So, the nature of alkaline earth metals is mainly biogenic, because soil organic matter is the main source of nitrogen and a reserve of such elements as phosphorus and sulfur. One of the main reasons for the accumulation of a significant amount of humus in soils is the slowing down of the decomposition of organic matter due to excess carbon dioxide and alkaline soil solution (Semaschuk, 2014).

Turf and slightly podzolic soils, laid from the depth of 1–1,5 m by dense carbonate rocks (3R), differs from the soils described above. Note that it was laid within Buho-Styrskoi alluvial-water-glacial plain, the relative heights of which are 238–243 m. In the gross chemical composition of the laid carbonate rock, the content of the SiO_2 is higher, and is 31.91%, which is related to the deeper occurrence of the laid carbonate rock (Table 1). Soil-forming and laid carbonate rocks of Buho-Styrskoi alluvial-water-glacial plain have a significant increase in this oxide with simultaneous relative loss of calcium and magnesium oxides. These results are also consistent with the researches of Kyrylchuk and Pozniak (2004). One and a half oxides in the profile of this soil are divided in the eluvial-illuvial type with a clear expression of the washing horizon in which their number is increased in 2–3 times, compared with the upper horizon. A similar type of division is characterized by the content of calcium, magnesium, potassium, sodium, sulfur and titanium (Table 1-2).

Thus, the gross content of chemical elements in the turf and podzolic soils on water and glacial deposits, laid by dense carbonate rocks, is characterized by the depletion of humus horizons with aluminum and ferum and the enrichment of silicon.

Another important approach of researching the content of chemical elements in soils and soil-forming rocks is the recalculation of the content of oxides to the content of chemical elements. The results of the corresponding recalculation are shown in Table 3. The gross content of chemical elements is characterized by the depletion of humus horizons Al^{3+} and Fe^{2+} and the enrichment of Si^{+}. The results of the gross analysis of the cut 4B, which was laid under the forest, are interesting. Accordingly, these soils with forest bedding gets about twice as many ash elements, among which significant percentage belongs to K, Na, Ca i Mg. This may be the main cause of the turf process in these soils.

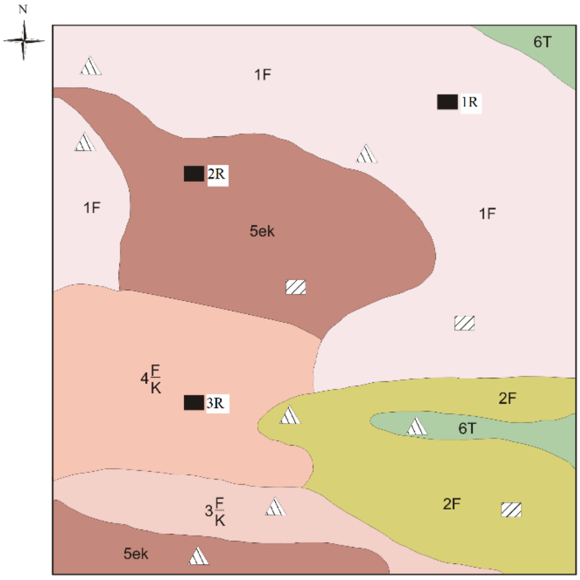

Fig. 4: Investigated soil cut (3R)

It should not be ignored the change of the content of elements of the turf and podzolic soils on water and glacial deposits, laid by dense carbonate rocks, under the influence of agricultural activity. Thus, with the increase of soil cultivation, the aluminum and ferum content decreases, which is especially sharply noticeable when comparing their numbers on arable land (cuts 5B, 7B), under the forest (cut 4B) and on the fallow (old abandoned arable land – cut 3R). In the lower part of the profile (iluvial horizons) aluminum is more, which is due to the lower degree of cultivation of this horizon. The decrease in aluminum and ferum below the iluvial horizon is associated with a decrease in acidity and an increase in the amount of absorbed bases in the carbonate rock.

Conclusion

The data of the gross chemical analysis allowed to establish regularities of the gross composition of the profile of soils, soil-forming and laid rocks and the changes that took place in the process of soil formation. Research has established that the turf and podzolic soils on alluvial and glacial deposits, laid by dense carbonate rocks and their soil-forming rocks are practically two-component: they consist of silica (SiO_2) and one and a half oxides (Al_2O_3 and Fe_2O_3), such division of chemical elements indicates the process of ashes (accumulation of SiO_2 in upper horizons and removal of destruction products down the profile). In the lower genetic horizons, the content of calcium oxides increases. According to the results of the research, the content of oxides in soils can be arranged in such a sequence (in the descending direction): $SiO_2 \rightarrow Al_2O_3 \rightarrow Fe_2O_3 \rightarrow CaO \rightarrow K_2O \rightarrow MgO \rightarrow TiO_2 \rightarrow MnO \rightarrow P_2O_5$. The most modified part of the soil profile is the upper layers; maximum accumulation of one and a half oxides is noted in the illuvial horizon and coincides with the maximum accumulation of silt and clay particles. The gross chemical analysis confirms lithological heterogeneity of soil-forming rocks and their influence on soil-forming processes. Underlayment of sod-podzolic soils with carbonate rocks affects the increase of humus content in humus-eluvial horizons (1.5–3%) and growth to 80–90% of the degree of base saturation. This in turn affects all agrochemical parameters of these soils. In the territory of Maly Polissya, the studied soils in terms of natural fertility are in second place after sod-carbonate soils (rendzin), so they are actively used in agriculture. There is a change in the gross chemical composition of soils in intensive agricultural activities, at which content of aluminum and ferum in profile is reduced, processes of internal soil leaching are faster.

The practical significance of the study. Gross chemical analysis confirmed the lithological heterogeneity of soil-forming and laid rocks and their influence on the chemical composition of genetic horizons. The results of the gross analysis allowed to trace the chemical composition of the mineral part of the soil. It has been established that the study of the gross composition of soils (in particular, the process of decomposition of aluminosilicates and silicates) should be in one line with the study of such important soil formation processes as turf, podzolic, gley etc.

Given the large areas of distribution areas of sod-podzolic soils, underlain by dense carbonate rocks, within the Ukrainian Polissya (approximately 210 thousand hectares), the results of our research can be used to further study their genesis, evolution and properties. Also our research is important in terms of analysis of agricultural land. In addition, the results of comprehensive research will improve agricultural production, help calculate the value of these soils.

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