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BULK CHEMICAL COMPOSITION OF THE MOUNTAINOUS MEADOWY BROWN SOILS OF THE UKRAINIAN CARPATHIANS AND PROCESSES OF ITS TRANSFORMATION

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The features of the bulk chemical composition of mountainous meadowy brown soils and anthropogenically-modified soils of the Svydovets and Chornogora arrays of the Ukrainian Carpathians are investigated. The ratio of the oxides content of the most important chemical elements of the mineral part of mountainous meadowy brown soils and parent material is determined. The basic transformation processes of the mineral part of the studied soils and parent material are established. The peculiarity of the bulk chemical composition of meadow brown soils is the high content of silicon oxides, and the high content of aluminum oxides and iron oxides. Their total content is within 94 %. This indirectly indicates a significant chemical homogeneity of the soil with the parent material. The relative accumulation of SiO_2 in the upper genetic horizons of the soil profile is due to the physical disintegration of silicate rocks. Its relative bulk content is gradually reduced from 76,10–77,43 % to 72,28–76,93 % in the transition to a parent material. It was established, that the removal of sesquioxides beyond the boundary of the soil profile leads to the formation of a depleted soil profile on aluminum oxides and iron oxides, as we compare with unchanged parent material. Absolute values of the indicators of leakage factor of alkaline earth metals grow in the direction towards to the parent material. This indicates about intensive development of erosion processes in the upper part of the soil profile. This is due to the physical and chemical disintegration of aluminosilicates and the removal of compounds of disintegration into the lower soil genetic horizons. The analysis of the results of balance of bulk reserves of oxides testified, that during the formation of the mountainous meadowy brown soils of the Ukrainian Carpathians, oxides of trivalent metals (aluminum and iron) and compounds of alkaline earth metals are subjected to removal from the genetic horizons of the soil profile. Quantitative bulk chemical analysis didn't show any significant differences in the material composition between the mountainous meadowy brown soils and the mountainous meadowy brown anthropogenically altered soil.

Key words: mountainous meadow brown soils, bulk chemical composition, Svydovets and Chornogora arrays, Ukrainians Carpathians.

The modern process-genetic approach allows us to trace the tendencies of the development of elementary soil processes occurring in the soil profile. It exists on the basis of the interpretation of the results of the bulk chemical analysis of the solid phase of the soil.

Most researchers recommend using the data on the distribution of oxides in the soil profile, calculating their molar ratios, leaching rates, the balance of substances and the general degree of differentiation of the profile. The authors point out that an important aspect of the objective characterization of the distribution of oxides in the soil profile is the conversion into a scorching non-carbonate soil weight. Since the quantity of each oxide is influenced by the content of carbonates, humus and chemically bound water [1; 3; 7; 10; 11].

The theoretical basis of the chemical composition of the soils is based on the generally accepted statement about the considerable conservatism of the mineral part of the soil. Various calculations and coefficients, which are used for the assessment of the soil processes, related to the change in the chemical composition of the mineral part of the soil, while ignoring its external introduction.

A few scientific works are devoted to the study of the chemical composition of the mountainous meadowy brown soils of the Ukrainian Carpathians. Some details about the chemical composition of these soils are contained in the works of I. Gogolev [4], G. Andrushchenko [1], P. Pasternak [8], V. Kanivets [5], S. Pozniak [9] and others. The results of researches testify to the similarity of the bulk chemical composition of mountainous meadowy and mountainous forest soils. Even Cambisols (burozems), formed on different parent materials, have a similar chemical composition of the soil. Bulk analyzes of Cambisols in all climatic zones have shown, that the soil profile of Cambislos is depleted on Calcium and Magnesium and eluvoved for sesquioxides, first of all iron.

Studying the bulk chemical composition of the mountainous meadowy brown soils of the Svydovets and Chornohora array, we compared the content and relations, which we obtained as a result of analytical calculations, the chemical elements of the parent material and the genetic horizons of the soils. The results show, that the studied soils have a high content of SiO_2 and an increased content of Al_2O_3 and Fe_2O_3 (table 1). Their total share is within 94%. This indicates a significant chemical homogeneity of the source material in the formation of mountainous meadowy brown soils of the study area.

The relative accumulation of SiO_2 in the upper genetic horizons of the soil profile is mainly due to the physical disintegration of silicate rocks and the resistance of quartz to weathering. Its relative gross content is gradually reduced from 76,10–77,43 % to 72,28–76,93 % in the transition to a parent material.

Among sesquioxides (R_2O_3), Al_2O_3 predominates with a percentage content of 11,57–13,47 % in the upper humus-accumulative horizon. Its content are gradually increasing down the genetic profile to the parent material – 12,24–15,16 %. In parent material the bulk content of Al_2O_3 is 16,31–18,06 %.

Among alkaline earth elements, potassium oxide (K_2O) and sodium (Na_2O) are characterized by higher relative content. This is due to the biological processes of plant life. The amount of potassium (K_2O), sulfur (SO_3) and titanium (TiO_2) oxides in the studied soils is insignificant.

The differences in the content of the chemical elements of the soils of the Svydovets and Chornohora arrays are due to differences in the chemical composition of the parent material. The composition of lolynska formation of the Svydovets array are characterized by a more intensive alternation of clay shale (siltstones and argillites), than the composition of the burkutska formation of the Chornogora array.This causes an increased concentration of aluminum oxides (Al_2O_3) and iron oxides (Fe_2O_3), and lower silicon oxide (SiO_2) content. Accordingly, the mountainous meadowy brown soils of the Svydovets array are characterized by a lower content of silicon oxides (SiO_2) – 76,10 %, and a higher content of aluminum oxides (Al_2O_3) – 13,47 %.

Table 1

Bulk chemical composition of the mountainous meadowy brown soils of the Ukrainian Carpathians

Валовий хімічний склад гірсько-лучно-буроземних ґрунтів Українських Карпат

Horizon	Depth of sampling, sm	%									
		SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	SO_3	K_2O	Na_2O	Losses
Mountainous meadowy brownsoils, Chornogora array (cut – ChSh–1)											
H	8–20	77,43	11,57	5,67	0,69	0,33	1,19	0,13	1,75	1,24	12,55
Hp	21–36	77,69	11,61	5,52	0,72	0,32	1,08	0,10	1,78	1,18	8,97
Ph	37–54	76,93	12,24	5,52	0,76	0,39	1,17	0,03	1,75	1,21	7,26
P	70–80	70,13	16,31	6,21	0,98	0,67	2,20	0,07	2,28	1,21	–
Mountainous meadowy brown anthropogenically altered soil, Chornogora array (cut – ChSh–3)											
H	0–20	76,29	12,24	5,56	0,67	0,32	1,75	0,17	1,69	1,31	10,15
Hp	21–45	75,89	12,85	5,42	0,63	0,46	1,75	0,03	1,68	1,29	5,91
P	70–80	70,13	16,31	6,21	0,98	0,67	2,20	0,07	2,28	1,21	–
Mountainous meadowy brown soils, Svydovets array (cut – SvB–1)											
H	5–20	76,10	13,47	4,86	0,72	0,87	0,92	0,11	1,70	1,25	18,40
Hp	21–36	74,46	14,22	4,99	0,73	0,87	1,43	0,05	1,78	1,47	12,23
Ph	37–54	72,28	15,16	5,02	0,73	0,88	2,02	0,01	1,89	2,01	8,54
P	60–70	66,13	18,06	7,27	0,61	0,98	2,55	0,01	3,11	1,36	0,56
Mountainous meadowy brown anthropogenically altered soil, Svydovets array (cut – SvB–3)											
H	0–23	76,85	12,63	4,91	0,77	0,41	1,36	0,01	1,76	1,29	11,60
Hp	23–48	75,15	13,76	5,17	0,80	0,53	1,47	0,01	1,80	1,31	9,49
Ph	49–67	73,98	14,27	5,55	0,82	0,62	1,57	0,01	1,84	1,34	8,24
P	70–80	68,25	17,14	6,89	0,88	0,97	2,33	0,03	2,31	1,30	0,54

Analysis of the values of molar ratios testifies, that the studied soils are characterized as expanded (SiO_2:Al_2O_3, SiO_2:Fe_2O_3 and SiO_2:R_2O_3) and narrowed (Al_2O_3:Fe_2O_3) parameters of the molar ratio of sesquioxides in the soil profile, compared with the parent material. This indicates that aluminum and iron oxides are washed away from the soil profile.

Especially the soil profile loses sesquioxides, in relation to the parent material: molar ratio SiO_2:R_2O_3 in the upper humus-accumulative horizon is 7,81–8,67 and decreases to the parent material to 6,69–8,30. The molar ratio SiO_2:R_2O_3 is 4,95–5,39 in the parent material, which is due to a decrease in the intensity of leaching processes. Iron is most likely to be washed out of the soil profile (molar ratio SiO_2:Fe_2O_3 – 36,49–41,84), slightly less aluminum (molar ratio SiO_2:Al_2O_3 – 9,60–11,38) in the upper genetic horizons with a gradual narrowing of the indicator down the profile. The washing of sesquioxides beyond the boundaries of the soil profile determines the formation of a depleted soil profile on aluminum oxide and iron oxide as compared to unchanged parent material (table 2).

Table 2

Profile differentiation indicators of the mountainous meadowy brown soils of the Ukrainian Carpathians

Показники диференціації профілю гірсько-лучно-буроземних ґрунтів Українських Карпат

Horizon	Depth of sampling, sm	Molar ratio				
		SiO_2 : Al_2O_3	SiO_2 : Fe_2O_3	SiO_2 : R_2O_3	Al_2O_3 : Fe_2O_3	CaO : SiO_2
Mountainous meadowy brown soils, Chornogora array (cut – ChSh–1)						
H	8–20	11,38	36,49	8,67	3,20	0,005
Hp	21–36	11,38	37,61	8,73	3,30	0,004
Ph	37–54	10,69	37,23	8,30	3,48	0,005
P	70–80	7,31	30,15	5,88	4,12	0,010
Mountainous meadowy brown anthropogenically altered soil, Chornogora array (cut – ChSh–3)						
H	0–20	10,60	36,64	8,22	3,45	0,004
Hp	21–45	10,04	37,38	7,91	3,72	0,006
P	70–80	7,31	30,15	5,88	4,12	0,010
Mountainous meadowy brown soils, Svydovets array (cut – SvB–1)						
H	5–20	9,60	41,84	7,81	4,35	0,012
Hp	21–36	8,90	39,84	7,27	4,47	0,013
Ph	37–54	8,11	38,46	6,69	4,74	0,013
P	60–70	6,22	24,29	4,95	3,90	0,016
Mountainous meadowy brown anthropogenically altered soil, Svydovets array (cut – SvB–3)						
H	0–23	10,35	41,76	8,29	4,03	0,006
Hp	23–48	9,28	38,81	7,49	4,17	0,008
Ph	49–67	8,81	35,57	7,06	4,03	0,009
P	70–80	6,77	26,45	5,39	3,90	0,015

Evenly-accumulative character of the profile distribution of alkaline earth metals caused by biological interception during the vegetation period of plants, which compensates their climatogenic withdrawal. Number of calcium oxide (CaO) and titanium (TiO_2) is small – less than 1%. Percentage content is lower than in the composition of parent material. In the process of burozem formation, the reduction of the bulk content of magnesium oxide (MgO) and potassium oxide (K_2O) in the mountainous meadowy brown soils of the Chornohora and Svydovets array was observed in comparison with the parent material. The narrowing of the molar ratio CaO:SiO_2 from 0,014–0,004 to in the upper humus-accumulative horizon to 0,010–0,016 in the parent material indicates that the intensity of leaching processes and the removal of products of dissolution of divalent alkaline earth metals (Ca and Mg) outside the soil profile.

We calculated the degree of differentiation of the weathering crust and soil according to the molar ratio between mobile (K_2O, Na_2O, CaO, MgO) and stable (SiO_2) components for a more detailed description of the loss/accumulation of substances in the soil horizons compared to the parent material. This method was first proposed by Harasovitz. He recommended using Al_2O_3 as a stable component for lateritic soils [6]. Considering the features of the chemical composition of the mountainous meadowy brown soils, we also consider it necessary to calculate where SiO_2 is taken as a stable component, as the least mobile component during the formation of burozems.

The results of the research indicate for leaching Ca^{2+} and Mg^{2+} relative to SiO_2 within the soil profile of the mountainous meadowy brown soils (table 3). The factor of leaching fluctuates between 0,410–0,680 in the upper humus-accumulative horizon and increases to the parent material – 0,493–0,747. The relative accumulation of Na^+ and K^+ occurs in the soil stratum relative to Al_2O_3.This is due to the fact that aluminum, as the most moving element during the formations of burozems, migrates beyond the boundaries of the soil profile. Potassium and sodium, and their organo-mineral compounds are less mobile and are constantly renewed as a result of biological circle. Therefore, the leakage factor relative to Al_2O_3 is 1,193–1,247.

Absolute values of the indicators of leakage factor of alkaline earth metals grow in the direction towards to the parent material. This testifies to the more intensive development of weathering processes in the upper part of the soil profile. This is due to the physical and chemical disintegration of aluminosilicates and the removal of compounds of disintegration into the lower genetic horizons.

Rode A., proposed a method of eluvial-accumulative coefficients (EAC), which includes: E*Ar* - EAC for a specific oxide; E*At* - the total EAC of all oxides; E*Am* - EAC of all oxides, except oxide of the witness [2, 11, 12]. Negative value means the transfer of oxides from the *n*-horizon, positive – their accumulation.

Table 3

Factor of leaching of the mountainous meadowy brown soils of the Ukrainian Carpathians
Фактор вилуговування гірсько-лучно-буроземних ґрунтів Українських Карпат

Horizon	Depth of sampling, sm	Molar ratio											
		$\frac{MgO+CaO+Na_2O+K_2O}{Al_2O_3}$	β	$\frac{MgO+CaO+Na_2O+K_2O}{SiO_2}$	β	$\frac{Na_2O+K_2O}{Al_2O_3}$	β	$\frac{Na_2O+K_2O}{SiO_2}$	β	$\frac{MgO+CaO}{Al_2O_3}$	β	$\frac{MgO+CaO}{SiO_2}$	β
Mountainous meadowy brown soils, Chornogora array (cut – ChSh–1)													
H	8–20	0,660	0,945	0,058	0,607	0,337	1,247	0,030	0,801	0,322	0,754	0,028	0,484
Hp	21–36	0,625	0,895	0,055	0,575	0,331	1,223	0,029	0,786	0,294	0,687	0,026	0,441
Ph	37–54	0,622	0,890	0,058	0,609	0,314	1,159	0,029	0,793	0,308	0,720	0,029	0,493
P	70–80	0,698	–	0,096	–	0,271	–	0,037	–	0,428	–	0,058	–
Mountainous meadowy brown anthropogenically altered soil, Chornogora array (cut – ChSh–3)													
H	0–20	0,744	1,066	0,070	0,735	0,323	1,193	0,030	0,823	0,422	0,986	0,040	0,680
Hp	21–45	0,725	1,039	0,072	0,756	0,304	1,124	0,030	0,818	0,421	0,985	0,042	0,717
P	70–80	0,698	–	0,096	–	0,271	–	0,037	–	0,428	–	0,058	–
Mountainous meadowy brown soils, Svydovets array (cut – SvB–1)													
H	5–20	0,582	0,751	0,061	0,487	0,286	0,932	0,030	0,604	0,296	0,632	0,031	0,410
Hp	21–36	0,678	0,874	0,076	0,611	0,303	0,988	0,034	0,691	0,374	0,800	0,042	0,559
Ph	37–54	0,806	1,040	0,099	0,798	0,351	1,143	0,043	0,877	0,455	0,973	0,056	0,747
P	60–70	0,775	–	0,124	–	0,307	–	0,049	–	0,468	–	0,075	–
Mountainous meadowy brown anthropogenically altered soil, Svydovets array (cut – SvB–3)													
H	0–23	0,657	0,904	0,063	0,592	0,316	1,179	0,031	0,772	0,341	0,743	0,033	0,486
Hp	23–48	0,645	0,888	0,069	0,647	0,296	1,103	0,032	0,804	0,350	0,762	0,038	0,556
Ph	49–67	0,658	0,906	0,075	0,695	0,291	1,085	0,033	0,833	0,367	0,801	0,042	0,615

N o t e : β is the factor of leaching by Ienney.

The analysis of the results of eluvial-accumulative coefficients indicate to the intensive processes of the total transfer of oxides from the genetic horizons of soils (table 4): E*at* reaches values -0,08 – -0,13. The obtained coefficients testify to the differences in the differentiation of the soil profile of the mountainous meadowy brown soils. The values of the removal of E*Ar* are due to differences in the composition of the parent material, and facial features (biogeocentric changes and degree of human activity), and have the following character:

- Cut ChSh–1: most amenable to removal CaO (*EAr* – -55,23 %) → MgO (E*Ar* – -50,82 %) → TiO_2 (E*Ar* – -36,77 %) → Al_2O_3 (E*Ar* – -35,77 %);
- Cut ChSh–3: most amenable to removal CaO (E*Ar* – -56,10 %) → TiO_2 (E*Ar* – -37,15 %) → K_2O (E*Ar* – -31,86 %) → Al_2O_3 (E*Ar* – -31,01 %);
- Cut SvB–1: most amenable to removal MgO (E*Ar* – -68,75 %) → K_2O (E*ar* – -52,55 %) → Fe_2O_3 (E*Ar* – -41,95 %) → Al_2O_3 (E*Ar* – 35,18 %);
- Cut SvB–4: most amenable to removal CaO (E*Ar* – -62,43 %) → MgO (E*Ar* – -48,16 %) → Fe_2O_3 (E*Ar* – -36,67 %) → Al_2O_3 (E*Ar* – 34,57 %).

The sulfur oxides are characterized a positive values of E*Ar* in the soil profile of the mountainous meadowy brown soils of the Svydovets and Chornogora arrays (cutChSh–1, ChSh–3 та SvB–1).

Intensive washings outside the profile of the studied soils Al_2O*3* and Fe_2O_3 indicates about the absence of brunification process in the lower transient soil genetic horizons.

Table 4

Eluvial-accumulative indicates of the mountainous meadowy brown soils
of the Ukrainian Carpathians
Елювіально-акумулятивні показники у гірсько-лучно-буроземних ґрунтах
Українських Карпат

Horizon	E*Ar* , %									E*At* , %	E*Am* %
	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	SO_3	K_2O	Na_2O		
Mountainous meadowy brown soils, Chornogora array (cut – ChSh–1)											
H	–	-35,77	-17,38	-36,60	-55,23	-50,82	+68,33	-30,47	-7,05	-0,09	-0,32
Hp	–	-35,76	-19,83	-33,51	-57,45	-55,57	+30,90	-29,44	-11,65	-0,10	-0,33
Ph	–	-31,59	-19,01	-29,04	-47,35	-51,44	-56,80	-30,15	-9,21	-0,09	-0,30
Mountainous meadowy brown anthropogenically altered soil, Chornogora array (cut – ChSh–3)											
H	–	-31,01	-17,70	-37,15	-56,10	-26,88	+123,25	-31,86	-0,48	-0,08	-0,27
Hp	–	-27,19	-19,35	-40,59	-36,55	-26,49	-60,40	-31,91	-1,48	-0,08	-0,25
Mountainous meadowy brown soils, Svydovets array (cut – SvB–1)											
H	–	-35,18	-41,95	+3,22	-22,70	-68,75	+883,78	-52,55	-20,43	-0,13	-0,39
Hp	–	-30,07	-39,04	+6,28	-21,16	-50,20	+344,06	-49,17	-4,00	-0,11	-0,33
Ph	–	-23,22	-36,85	+9,41	-17,81	-27,35	+15,07	-44,50	35,37	-0,09	-0,25
Mountainous meadowy brown anthropogenically altered soil, Svydovets array (cut – SvB–3)											
H	–	-34,57	-36,67	-21,90	-62,43	-48,16	-65,29	-32,38	-11,89	-0,11	-0,35
Hp	–	-27,09	-31,85	-17,44	-50,38	-42,70	-69,73	-29,23	-8,48	-0,09	-0,29
Ph	–	-23,20	-25,64	-13,66	-40,72	-37,86	-65,77	-26,66	-5,22	-0,08	-0,24

The analysis of the results of balance of bulk reserves of oxides testified, that during the formation of the mountainous meadowy brown soils of the Ukrainian Carpathians that oxides of trivalent metals (aluminum and iron) and compounds of alkaline earth metals are subjected to removal from the genetic horizons of the soil profile. The general tendency to decrease the content of the soil profile on oxides in order of decreasing intensity can be represented as follows: $K_2O \rightarrow MgO \rightarrow Na_2O \rightarrow Al_2O_3 \rightarrow Fe_2O_3$. The general trend is due to the peculiarities of the formation of Cambisols in the alpine and subalpine zones of the Ukrainian Carpathians. The soil profile is impoverished with iron and aluminum oxides after complete leakage of the soil layers on two- and monovalent alkaline earth metals.

Quantitative bulk chemical analysis didn't show any significant differences in the material composition between the mountainous meadowy brown soils and the mountainous meadowy brown anthropogenically altered soil. This is due to the fact that the determining factor in the formation of the chemical composition of mountainous meadowy brown soils is the composition of parent material, and does not anthropogenic factor. But the anthropogenic factor changed the direction of soil-forming processes: the mountainous meadowy brown anthropogenically altered soil (cuts ChSh–3 and SvB–4) are characterized by more intensive removal of oxides Al_2O_3, Fe_2O_3, MgO i CaO in comparison with virgin soils. This is due to more intensive processes of destruction of the mineral part of the soil, under the influence of the acidic environment of the soil solution, and more intensive processes of removal, as a result of flushing water regime of the unsoded (without sod) soil surface.

Conclusions

1. The peculiarity of the bulk chemical composition of the mountainous meadowy brown soil is the high content of silicon oxides and the high content of aluminum and iron oxides. Their total content is within 94 %. This indirectly indicates a significant chemical homogeneity of the soil with the parent material.

2. Relative accumulation of SiO_2 in the upper genetic horizons of the soil profile is due to the physical disintegration of silicate rocks. Its relative bulk content is gradually reduced from 76,10–77,43 % to 72,28–76,93 % during the transition to the parent material.

3. It was established, that the removal of sesquioxides beyond the boundary of the soil profile leads to the formation of a depleted soil profile on aluminum oxides and iron oxides, as we compare with unchanged parent material. Absolute values of the indicators of leakage factor of alkaline earth metals grow in the direction towards to the parent material. This indicates about intensive development of erosion processes in the upper part of the soil profile. This is due to the physical and chemical disintegration of aluminosilicates and the removal of compounds of disintegration into the lower soil horizons.

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СПИСОК ВИКОРИСТАНОЇ ЛІТЕРАТУРИ

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РЕЧОВИННИЙ СКЛАД ГІРСЬКО-ЛУЧНО-БУРОЗЕМНИХ ҐРУНТІВ УКРАЇНСЬКИХ КАРПАТ ТА ПРОЦЕСИ ЙОГО ТРАНСФОРМАЦІЇ

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Досліджено особливості валового хімічного складу гірсько-лучно-буроземних та антропогенно змінених ґрунтів Свидовецького масиву Українських Карпат. Визначено співвідношення вмісту оксидів найважливіших хімічних елементів мінеральної частини гірсько-лучно-буроземних ґрунтів та ґрунтотворних порід. Встановлено основні трансформаційні процеси мінеральної частини досліджуваних ґрунтів та ґрунтотворних порід. Особливістю валового хімічного складу гірсько-лучно-буроземних ґрунтів є високий вміст оксидів Силіцію, підвищений вміст оксидів Алюмінію та Феруму. Сумарний їхній вміст знаходиться в межах 94 %, що опосередковано засвідчує значну хімічну однорідність ґрунтової товщі з материнською породою. Відносне накопичення SiO_2 у верхніх генетичних горизонтах ґрунтового профілю зумовлене фізичною дезінтеграцією силікатних порід. Його відносний валовий вміст поступово зменшується від 76,10–77,43 % до 72,28–76,93 % з переходом до ґрунтотворної породи. З'ясовано, що винесення сесквіоксидів за межі ґрунтового профілю обумовлює формування збідненого ґрунтового профілю на оксид Алюмінію та оксид Феруму, порівняно з незміненою ґрунтотворною породою. Абсолютні величини показників фактора вилуговування лужноземельних металів зростають у напрямі до ґрунтотворної породи, що засвідчує інтенсивніший розвиток процесів внутрішньоґрунтового вивітрювання у верхній частині ґрунтового профілю, обумовлених фізичною і хімічною дезінтеграцією алюмосилікатів і винесенням сполук розпаду у нижчі генетичні горизонти. Аналіз результатів щодо балансу валових запасів оксидів засвідчив, що під час формування гірсько-лучно-буроземних ґрунтів Свидовецького і Чорногірського масивів з генетичних горизонтів ґрунтового профілю піддаються виносу як оксиди тривалентних металів (Алюміній та Ферум), так і сполуки лужноземельних металів. Кількісний валовий хімічний аналіз не показав істотних відмінностей у речовинному складі гірсько-лучно-буроземних цілинних та антропогенно змінених ґрунтів.

Ключові слова: гірсько-лучно-буроземні ґрунти, валовий хімічний склад, Свидовецький масив, Українські Карпати.