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GROSS CHEMICAL COMPOSITION TRANSFORMATION
OF RENDZINAS IN MALYI POLISSYA UNDER THE
INFLUENCE OF DEFLATION

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Abstract. Investigation results of the gross chemical composition of Malyi Polissya Rendzinas (Rendzic Leptosols) and its transformation under the influence of deflation have been revealed. The oxides percentage in soils, their distribution in the profile have been described, and differentiation soil profile indices have been calculated. The changes in Rendzinas gross chemical composition due to the detection process of deflation have been analyzed.

Keywords: Rendzic Leptosols, Malyi Polissya, gross chemical composition, molar ratios, leaching factor, constitutional water content

INTRODUCTION

The gross chemical composition is one of the most important characteristics of soils. The results of the analysis of gross chemical composition can provide information on the elemental soil composition, trace changes in chemical elements content within the soil profile compared to unmodified soil-forming rock, resolve the question of genesis, find out what changes have occurred in the chemical composition during the soil forming processes, reclamation, long-

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term economic utilization and the development of degradation processes. Data analysis of the gross chemical composition of genetic horizons and bedrock enables to understand and explain both the past and modern elementary soil processes and the features of soil formation in general.

Malyi Polissya Rendzinas have undergone a complicated way of evolution, from initial soil formation on the products of eluviogenesis of upper chalk deposits to the full profile soils in the process of forest and grassland vegetation change, strong anthropogenic pressure and the development of intensified degradation processes.

Undoubtedly, anthropogenic impact and degradation processes are reflected in morphological features of soil physical and physicochemical properties as well as their gross composition. However, the information, concerning the transformation of Rendzinas gross chemical composition under the influence of degradation processes, is not obtainable in the scientific literature.

The chemical composition of Malyi Polissya Rendzinas was formed in the soil under the influence of some factors, the leading role of which play soil forming rocks and anthropogenic activities, which often result in the development of degradation processes. The study of Rendzinas gross chemical composition transformation under the influence of wind erosion has been firstly conducted to define the relevance of these studies. Obtained results are of theoretical and practical significance, necessary for an understanding of the genesis and geography of soils, developing of farming practices in order to increase soils fertility and their protection.

Study results of Rendzinas gross chemical composition in Malyi Polissya and western Ukraine were highlighted in detail in the works of A.A. Kyrylchuk, S.P. Poznyak, V.G. Haskevych, R.B. Semaschuk, V.V. Harbar, and others (Kyrylchuk 2003, 2004, 2013, Kyrylchuk and Poznyak 2004, Kyrylchuk and Semaschuk 2012, Haskevych 2009, 2015, Semaschuk 2015, Harbar 2017).

At the same time, the transformation of Rendzinas gross chemical composition in Malyi Polissya due to degradation processes, particularly related to wind erosion, remains unexplored which determined the issues and topicality of the upcoming article.

The purpose of the research is to analyse Rendzinas gross chemical composition in Malyi Polissya. To achieve this goal, the following objectives are highlighted: to establish the correlation of element composition in Rendzinas and determine its change in deflation process. The object of the research is not eroded full profile Rendzinas and Rendzinas of different deflation degree. The subject of the research is the content and profile distribution of SiO_2 , Al_2O_3 , Fe_2O_3 , FeO , CaO , MgO , MnO , K_2O , Na_2O , P_2O_5 , TiO_2 , SO_3 oxides, differentiation indices of the soil profile, constitutional water content and modified silica of non-deflated and deflated Rendzinas.

STUDY AREA

According to the physic-geographical regionalization of Ukraine, Malyi Polissya area is located within the mixed forests zone of Poliss'k province (Fig. 1). Malyi Polissya is located between the Volyn' Highlands in the north, Roztochia in the southwest and Podil'sk hills in the south-east. In the east, it stretches through Ostroh-Slavutsk lowered plain to Zhytomyr Polissya. The length of Malyi Polissya is more than 300 km, the average width is 20–25 km, the total area exceeds 8,000 km². The average altitude of Malyi Polissya is about 220–230 m, and the maximum absolute height of this territory – 276 m – is observed on the Bug-Stir section of the Main European watershed. The most characteristic features of the natural conditions of Malyi Polissya are: the flatness of the territory and a slight variation of the relative heights (10–20 m); the absence of Paleogene and Neogene deposits; significant spread of fluvioglacial sands in surface deposits; the dominance of the Polisk type of forests – pine and broadleaf-pine (mainly oak-pine) and meadow vegetation; predominance of turf-podzolic, Rendzinas, meadow, and gray forest soils in the soil cover; high degree of the territory development.

As a result of Rendzinas' long-term agricultural use, predominantly quantitative changes of their properties occur. The structural and aggregate state deteriorates, an essential compaction of the upper genetic horizons is observed, the humus content is significantly reduced, and the cation exchange capacity significantly decreases, which generally leads to deterioration of soil-ecological conditions of these soils and to the development of deflation process in arable soils (Kyrylchuk and Poznyak 2004).



Fig. 1. Study area and location of modal plots

MATERIALS AND METHODS

The problem of the study of soils gross chemical composition changes and its transformation under the influence of erosion has been described in a number of scientific publications (Dobrzanski *et al.* 1987, Revel and Guiesse 1995, Zagorski 2003, Ramezanpour *et al.* 2010, Gregory *et al.* 2015, Lucyshyn and Haskevych 2016).

Soil and geographic studies were carried out in the north-eastern part of Malyi Polissya area within modal plots “Radekhiv” and “Pavliv” (Fig. 1). The symbols of Rendzinas genetic horizons, according to World Reference Base for Soil Resources (2014), are presented in the article. Analytical studies of Rendzinas gross chemical composition in Malyi Polissya were conducted according to Arynushkina method (Arynushkina 1970). The studies were conducted in the chemical laboratory of the Institute of Geology and Geochemistry of Combustible Minerals.

The results of gross chemical analysis of studied soils were evaluated according to Poluzerov, Myakyna and Arynushkina methodology (Poluzerov 1970, Myakyna and Arynushkina 1979). The balance of higher oxides in the genetic profiles of soils was calculated according to methodical elaborations of Rode (1971).

An integral indicator in estimation the degree of the development of erosion degradation processes in the soils, as Rode notes, is the balance of substances, which can be applied to the chemical, granulometric and mineralogical composition. Calculation of the initial stock of each oxide in each genetic horizon of the investigated soil is carried out according to the formula:

$$A_1 = A_0 \frac{Q_1}{Q_0},$$

where: A_1 is the initial oxide stock in the horizon; A_0 – its stock in the layer of soil-forming rock of arbitrary thickness; Q_0 – the stock of “stable witness” in the same layer of soil-forming rock; Q_1 – the stock of “stable witness” in the horizon where the calculation is conducted.

As a rule, the gross chemical stock of SiO_2 performs the role of “stable witness”. Subtracting the oxide stock actually determined in the horizon, from the value of A_1 we calculate its accumulation (+) or loss (-) (Rode 1971). According to a molar ratio of $(\text{K}_2\text{O} + \text{Na}_2\text{O}) : \text{SiO}_2$ and $(\text{CaO} + \text{MgO}) : \text{SiO}_2$ oxides, the leaching factor proposed by Jenny is calculated. The leaching factor (β) is the ratio of oxides content in any soil horizon to the oxides of the same elements in parent rock. If the leaching factor is 1, then oxides loss does not occur, less than 1 – oxides loss occurs, more than 1 – their accumulation takes place (Jenny 1961).

Analysis of the published works of Rendzinas’ total chemical composition data indicates that most researchers do not calculate and, therefore, do not

provide data on constitutional water content of these soils. According to Rode, identifying chemically bound water based on the total chemical analysis of soils should be mandatory. Constitutional water content was calculated as the difference between the ignition loss and the percentage of humus and CO₂ carbonates. Afterwards, the results were counted in a molar amount. The rate of silicate change was calculated by constitutional water content in a particular soil horizon to its content in the soil-forming rock (Rode 1984).

This allows assessing the nature and direction of elementary soil forming processes directly related to the absolute and relative change of chemical composition of soil mineral part in terms of their ontogenesis, agricultural use and manifestations of erosion degradation.

RESULTS AND DISCUSSION

Rendzinas (Rendzic Leptosols, WRB 2007) of Malyi Polissya are formed on the surface exits of eluvium carbonate rocks of the Upper Cretaceous – marl, limestone, chalk, which was crucial for the formation of their profile structure, morphological characteristics, properties and nature of use.

Rendzinas deflation often occurs in spring and autumn, when the soil surface is bare of vegetation. Deflation also occurs in winter, which is especially evident in the current conditions through the manifestation of global warming, when winters are not snowy and dry and Rendzinas surface is not covered with snow for a long time. Rendzinas surface layer not covered with vegetation or snow is subjected to moisture dehydration, it quickly dries, becomes loose and susceptible to deflation. Deflationary processes affect Rendzinas morphological features, physical and physicochemical properties and gross chemical composition of the soils.

The bulk of the mineral soil consists of silicon, titanium, aluminum, iron, calcium, magnesium, manganese, sodium, phosphorus and sulphur oxides. The data analysis results of Malyi Polissya Rendzinas gross chemical composition prove the high content of silicon oxide. In the humus-accumulative horizon, A_{Ca} of non-deflated full profile Rendzinas SiO₂ content is 65.93–66.56% and is the highest of all oxides (Table 1). The relative content of SiO₂ decreases rather sharply down the profile and in the upper part of the intact soil-forming rock C_{Ca} is 11.62%. Significant SiO₂ reduction towards soil-forming rock caused by the increase of relative and absolute CaO content in the same direction, the second concerning oxides content, consisting of calcium carbonate from 22.76% in A_{Ca} horizon to a maximum of soil-forming rock C_{Ca} – 81.53%.

The relative accumulation of SiO₂ in the upper part of the profile of studied Rendzinas is the result of the physical disintegration of carbonate rocks.

Because of weathering, carbonate cement is destroyed and washed away, while resistant to weathering SiO_2 remains *in situ*.

Al_2O_3 dominates among sesquioxides in Rendzinas profile, the content of which in the horizon A_{Ca} is 4.58–5.00%, while Fe_2O_3 content is 2.03–2.07%. With the depth, oxides content gradually decreases, in the soil-forming rock, Al_2O_3 content is 2.66% and Fe_2O_3 is 1.30% (Table 1). Therefore, the peculiarity of sesquioxides distribution in the profile is their maximum accumulation in the upper part of the profile.

Table 1. Rendzinas gross chemical composition on “Radekhiv” and “Pavliv” modal plots in Malyi Polissya

Horizon	Depth [cm]	Loss on ignition [%]	Oxides content, % by weight of ignited soil											
			SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	MnO	K_2O	Na_2O	P_2O_5	SO_3
Non-deflated full profile														
A_{Ca}	0–22	21.17	66.56	0.17	5.00	2.07	-	22.76	1.18	-	0.81	0.28	-	1.28
A_{Ca}	23–33	21.49	65.93	0.14	4.58	2.03	-	24.82	0.98	-	0.69	0.28	-	0.27
AC_{Ca}	35–45	29.41	48.95	0.13	3.69	1.83	-	43.55	0.51	-	0.48	0.30	-	0.80
A/C_{Ca}	50–60	31.87	28.31	0.12	3.81	1.37	-	64.24	0.60	-	0.43	0.21	-	1.15
C_{Ca}	65–75	39.46	11.62	0.15	2.66	1.30	-	81.53	0.58	-	0.35	0.18	-	1.53
Weakly deflated full profile														
$A_{Ca}+AC_{Ca}$	0–21	18.12	53.58	0.20	5.17	1.51	0.22	19.83	0.68	0.05	0.80	0.35	0.21	0.15
Medium deflated short profile														
$A_{Ca}+AC_{Ca}$	0–27	24.28	41.67	0.13	4.58	1.67	0.14	26.76	0.87	0.05	0.74	0.49	0.21	0.15
Strongly deflated short profile														
$AC_{Ca}+A/C_{Ca}$	0–29	24.31	39.99	0.12	4.75	1.97	0.15	27.35	0.65	0.04	0.70	0.40	0.23	0.15

Non-deflated Rendzinas of Malyi Polissya contain a small amount of MgO and SO_3 oxides. Their contents, in the upper part of humus horizon A_{Ca} , are respectively 1.18% and 1.21%. The gross content of titanium, potassium and sodium oxides does not exceed 1.0%.

In deflated Rendzinas of Malyi Polissya, the changes of gross chemical content are revealed. In particular, in the arable layer of deflated soils, the SiO_2 content significantly decreases up to 53.58% in weakly deflated, 41.67% in medium deflated and to 39.99% in strongly deflated Rendzinas (Table 1).

At the same time, there is a tendency for the increase of CaO content in the upper horizons of deflated Rendzinas, particularly in the medium and strong deflated soils up to 26.76–27.35% or 14.9–16.9% compared to non-deflated Rendzinas. In weakly deflated Rendzinas, CaO oxide content is slightly smaller and is 19.83% (Table 1).

With the increase of soil deflation, the Al_2O_3 and Fe_2O_3 sesquioxides content tend to increase and to reduce in small ranges of values. Similar changes were found in the contents of other oxides. The reasons for the transformation of the gross chemical composition of deflated Rendzinas are their difficult and complex character: mechanical mixing of genetic horizons with different oxides content; blowing of fine soil material or its bringing from neighbouring areas; change of leaching and intra soil weathering processes during agricultural use.

For more information about the heterogeneity or monogeneity of the gross chemical composition of studied Rendzinas and their profile differentiation, the molar ratio of various oxides has been calculated. The molar ratio calculated for genetic horizons of non-deflated and deflated Rendzinas of different level indicates the loss or accumulation of elements, that is important to assess the direction of modern soil formation.

The molar ratios of $\text{SiO}_2 : \text{Al}_2\text{O}_3$, $\text{SiO}_2 : \text{Fe}_2\text{O}_3$, $\text{SiO}_2 : \text{R}_2\text{O}_3$, $\text{Al}_2\text{O}_3 : \text{Fe}_2\text{O}_3$, on the one hand, reflect the distribution of SiO_2 and sesquioxides in the soil profile, and on the other hand, reveal the relative loss or accumulation of aluminum and iron oxides. According to the research, full profile Rendzinas are characterised by enhanced performance of molar ratios in the profile, when compared to unchanged rock. In particular, the ratio $\text{SiO}_2 : \text{Al}_2\text{O}_3$ in the arable horizon A_{Ca} of Rendzinas is 22.63, $\text{SiO}_2 : \text{Fe}_2\text{O}_3 - 85.31$, $\text{SiO}_2 : \text{R}_2\text{O}_3 - 17.89$, more than three times as much as the ratio of these oxides in soil forming rock (Table 2). This indicates the accumulation of silicon oxide on the upper horizons of full profile Rendzinas and the relative of aluminum loss and iron oxides. However, the molar ratio of $\text{Al}_2\text{O}_3 : \text{Fe}_2\text{O}_3$ testifies aluminum quantitative superiority over iron within the whole profile.

In the arable horizons of deflated Rendzinas of Malyi Polissya $\text{SiO}_2 : \text{Al}_2\text{O}_3$, $\text{SiO}_2 : \text{Fe}_2\text{O}_3$, $\text{SiO}_2 : \text{R}_2\text{O}_3$, $\text{Al}_2\text{O}_3 : \text{Fe}_2\text{O}_3$ ratios are narrowing in the direction from weakly deflated full profile to strongly deflated short profile soils. Only the ratio $\text{SiO}_2 : \text{Fe}_2\text{O}_3$ in weakly deflated soil is slightly higher than the values in non-deflated ones (Table 2). Thus, a clear trend is traced in deflated Rendzinas: with the increasing degree of deflation, the ratios between $\text{SiO}_2 : \text{Al}_2\text{O}_3$ and $\text{SiO}_2 : \text{Fe}_2\text{O}_3$ narrow, reaching minimum indexes in strongly deflated soils.

The results show that SiO_2 accumulation weakens in the arable horizon and accumulation of Al_2O_3 and Fe_2O_3 increases in deflated soils. At the same time, predominance of aluminum over iron oxides increases (Table 2).

Narrowing of SiO_2 , Al_2O_3 and Fe_2O_3 molar ratios and their relative accumulation in deflated soils compared to non-deflated ones is observed mainly in weakly developed Rendzinas. One can assume that deflationary processes are of clearly degrading nature, transfer full profile Rendzinas into weakly developed soils, and the soil formation process itself is like the initial one.

Equally important for carbonate soils, besides Al_2O_3 and Fe_2O_3 molar ratios, are $\text{SiO}_2 : \text{CaO}$ and $\text{CaO} : \text{SiO}_2$ molar ratios, which form the basis of the gross

chemical composition of Rendzina. The values of SiO_2 : CaO and CaO: SiO_2 molar ratios indirectly indicate the relative content of silicon and calcium oxides in soils. The magnification of SiO_2 : CaO ratio in the upper part of the profile in non-deflated Rendzinas compared to the parent rock is traced (Table 2). In deflated soils alongside with the increase of soil deflation degree, the SiO_2 : CaO ratio has a tendency to narrow compared to the arable horizon.

This indicates that the process of carbonates dissolution and leaching does not occur in deflated soils. This is because while calcium carbonate winding takes place, their stocks in the arable layer rapidly replenish by ploughing carbonate horizons that lie deeper.

According to the results of studies, the ratio of oxides content ($\text{K}_2\text{O} + \text{Na}_2\text{O}$): SiO_2 in genetic horizons of non-deflated Rendzinas soil profile varies within a narrow range – from 0.01 to 0.04 (Table 2). The leaching factor (β_1) is 0.25–0.50. As for $(\text{CaO} + \text{MgO})$: SiO_2 , it varies widely – from 0.39 in the arable layer to 7.58 in the parent rock. The leaching factor (β_2) is 0.05–0.32. The leaching factor values testify the oxides ($\text{K}_2\text{O} + \text{Na}_2\text{O}$) and $(\text{MgO}$ and $\text{CaO})$ loss in the upper part of full profile Rendzinas compared to SiO_2 .

In deflated soils, the leaching factor values of Ca^{2+} and Mg^{2+} extends, the same occurs in alkaline earth metals for SiO_2 , indicating the weakening of the leaching process in the arable layer of soil.

Molar ratios of calcium, magnesium, potassium and sodium oxides are also calculated to the relatively sedentary Al_2O_3 during weathering and soil forming processes. In particular, $(\text{CaO} + \text{MgO})$: Al_2O_3 ratio within non-deflated Rendzinas soil profile varies in a wide range – 8.89–56.56. The leaching factor (β_4) within the profile is 0.16–0.56, indicating leaching of CaO and MgO to Al_2O_3 . The ratio of the $(\text{K}_2\text{O} + \text{Na}_2\text{O})$: Al_2O_3 oxides in the profile are 0.21–0.29 and the leaching factor (β_3) to Al_2O_3 fluctuates within 0.78–1.07. This indicates the accumulation of alkaline earth metals oxides in the profile upper part (Table 2).

Deflated Rendzinas are characterized both by narrowing and expanding leaching factor values of calcium and magnesium oxides in the arable layer to Al_2O_3 , indicating a slight enhancement in the leaching process of weak deflated soils and the decline of leaching rate in Rendzinas of the medium and strong degree of deflation. As for the K_2O and Na_2O , the process of accumulation takes place in the arable layer of deflated Rendzinas.

The analysis of gross chemical composition includes constitutional water content as well (Table 3). The constitutional water content the non-deflated full profile Rendzinas of Malyi Polissya is 4.09–5.28%. In the upper part of the profile, it is slightly smaller compared to the transitional horizon. The lowest values of constitutional water content are found in the transitional horizon A/C_{Ca}. The coefficient of changes in the silicate part of the soil profile is an identical distribution trend and ranges from 0.98 in humus A_{Ca} to 1.13 in the horizon AC_{Ca}.

Table 2. Differentiation profile indexes of Rendzinas on “Radekhiv” and “Pavliv” modal plots in Malyi Polissya

Horizon	Depth [cm]	Molar ratios											
		$\frac{\text{SiO}_2}{\text{Al}_2\text{O}_3}$	$\frac{\text{SiO}_2}{\text{Fe}_2\text{O}_3}$	$\frac{\text{SiO}_2}{\text{R}_2\text{O}_3}$	$\frac{\text{SiO}_2}{\text{Fe}_2\text{O}_3}$	$\frac{\text{SiO}_2}{\text{CaO}}$	$\frac{\text{Al}_2\text{O}_3}{\text{Fe}_2\text{O}_3}$	$\frac{\text{SiO}_2}{\text{CaO}}$	$\frac{\text{CaO}}{\text{SiO}_2}$	$\frac{\text{CaO}+\text{MgO}+\text{Na}_2\text{O}+\text{K}_2\text{O}}{\text{SiO}_2}$	$\frac{\text{K}_2\text{O}+\text{Na}_2\text{O}}{\text{SiO}_2}$	β_1	β_2
		Non-deflated full profile											
A _{Ca}	0-22	22.63	85.31	17.89	3.77	2.92	0.34	0.34	0.41	0.01	0.01	0.25	0.39
A _{Ca}	23-33	24.42	84.54	18.95	3.46	2.66	0.38	0.38	0.44	0.01	0.01	0.25	0.43
AC _{Ca}	35-45	22.67	74.18	17.36	3.27	1.12	0.89	0.98	0.98	0.01	0.01	0.25	0.97
A/C _{Ca}	50-60	12.76	52.44	10.26	4.11	0.44	2.27	2.48	2.48	0.02	0.02	0.50	2.46
C _{Ca}	65-75	7.46	24.25	5.71	3.25	0.14	7.02	7.62	7.62	0.04	0.04	—	7.58
		Weakly deflated full profile											
A _{Ca} +AC _{Ca}	0-21	17.58	94.82	14.83	5.39	2.70	0.37	0.37	0.43	0.02	0.02	0.50	0.42
		Medium deflated short profile											
A _{Ca} +AC _{Ca}	0-27	15.47	66.78	12.56	4.32	1.56	0.64	0.74	0.74	0.02	0.02	0.50	0.72
		Strongly deflated short profile											
AC _{Ca} +A/C _{Ca}	0-29	14.30	54.81	11.31	3.79	1.46	0.43	0.78	0.78	0.02	0.02	0.50	0.76
		Molar ratios											
Horizon	Depth [cm]	$\frac{\text{CaO}+\text{MgO}+\text{Na}_2\text{O}+\text{K}_2\text{O}}{\text{Al}_2\text{O}_3}$	$\frac{\text{K}_2\text{O}+\text{Na}_2\text{O}}{\text{Al}_2\text{O}_3}$	β_3	$\frac{\text{CaO}+\text{MgO}}{\text{Al}_2\text{O}_3}$	β_4							
		Non-deflated full profile											
A _{Ca}	0-22	9.17	0.29	1.07	8.89	0.16							
A _{Ca}	23-33	10.64	0.26	0.96	10.39	0.18							
AC _{Ca}	35-45	22.24	0.28	1.04	21.97	0.39							
A/C _{Ca}	50-60	31.61	0.21	0.78	31.41	0.56							
C _{Ca}	65-75	56.83	0.27	—	56.56	—							
		Weakly deflated full profile											
A _{Ca} +AC _{Ca}	0-21	7.60	0.28	1.04	7.32	0.13							
		Medium deflated short profile											
A _{Ca} +AC _{Ca}	0-27	11.48	0.35	1.30	11.13	0.20							
		Strongly deflated short profile											
AC _{Ca} +A/C _{Ca}	0-29	11.13	0.30	1.11	10.83	0.19							

Note: β_1 , β_2 , β_3 , β_4 – leaching factor.

This indicates an intensification of intra soil weathering processes in the medium part of the profile (Table 3).

There is no unanimity concerning constitutional water content and coefficient of changes in the silicate part of the soil in deflated soils. Constitutional water content increases in the arable layer of soil from weakly to strongly deflated, indicating the intensification of intra soil weathering. However, in weakly and medium deflated soils, the intra soil weathering processes are slower comparing to non-deflated soils. This can be proved by the coefficient of changes in the silicate part of soil, which is 0.13–0.61.

Table 3. Rendzinas constitutional water content on “Radekhiv” and “Pavliv” modal plots in Malyi Polissya

Horizon	Depth [cm]	Loss on ignition [%]	Humus [%]	CO ₂ carbonate [%]	Constitutional water [%]	Molar quantity H ₂ O	Coefficient silicate part change
Non-deflated full profile							
A _{Ca}	0–22	21.17	4.80	11.81	4.56	253.00	0.98
A _{Ca}	23–33	21.49	4.28	12.06	5.15	286.00	1.11
AC _{Ca}	35–45	19.41	2.82	21.31	5.28	293.00	1.13
A/C _{Ca}	50–60	31.87	1.70	26.08	4.09	227.00	0.88
C _{Ca}	65–75	39.46	0.36	34.46	4.64	258.00	1.00
Weakly deflated full profile							
A _{Ca} +AC _{Ca}	0–21	18.12	4.20	13.34	0.58	32.22	0.13
Medium deflated short profile							
A _{Ca} +AC _{Ca} agr	0–27	24.28	3.67	17.77	2.84	157.77	0.61
Strongly deflated short profile							
AC _{Ca} +A/C _{Ca}	0–29	24.31	2.70	17.04	4.57	253.89	0.98

The cause of this may be the use of agricultural lands and the introduction of material blown from the outside that changes the gross chemical composition of Rendzinas similar to non-deflated ones. Constitutional water content and coefficient of changes in the silicate part of soil increase in strong deflated Rendzinas indicating the activation process of intra soil weathering.

The results of gross chemical composition balance of Rendzinas in Malyi Polissya are shown in Table 4. As the evidence of oxides balance calculation, SiO₂ is used, but even this material is not fully sustainable, as its smallest particles can be mechanically carried away, particularly by the wind (Rode 1984, Kyrylchuk 2003).

Table 4. The gross oxides reserves balance of Rendzinas on “Radekhiv” and “Pavliv” modal plots in Malyi Polissya

Horizon	Depth [cm]	Loss (-) or accumulation (+) component quantity, S [kg·m ⁻²]								
		S _{SiO₂}	S _{TiO₂}	S _{Al₂O₃}	S _{Fe₂O₃}	S _{CaO}	S _{MgO}	S _{K₂O}	S _{Na₂O}	S _{SO₃}
Non-deflated full profile										
A _{Ca}	0–22	0	-1.88	+1.49	-16.99	-1495.07	-28.37	-5.21	-3.20	+3.85
A _{Ca}	23–33	0	-0.88	+0.11	-7.58	-660.80	-12.88	-2.48	-1.42	+0.23
AC _{Ca}	35–45	0	-0.59	+0.50	-4.98	-438.11	-9.55	-1.82	-0.89	+1.02
A/C _{Ca}	50–60	0	-0.25	+2.44	-2.21	-179.58	-4.63	-0.76	-0.42	+0.43
Weakly deflated full profile										
A _{Ca} +AC _{Ca}	0–21	0	-0.13	-1.97	-1.25	-97.83	-0.55	-0.24	-0.13	-1.91
Medium deflated short profile										
A _{Ca} +AC _{Ca}	0–27	0	-0.15	-1.89	-1.17	-102.43	-0.53	-0.18	-0.09	-2.07
Strongly deflated short profile										
AC _{Ca} +A/C _{Ca}	0–29	0	-0.20	-2.02	-1.15	-116.81	-0.63	-0.23	-0.11	-2.37

According to the investigation results, only aluminum and sulphur oxides in non-deflated Rendzinas are characterised by a positive balance and accumulated in the profile, all other components are of a negative balance, among which calcium oxide is of the highest one. All oxides in deflated soils are of a negative balance, that is, the oxides loss, which can be explained by the influence of deflationary processes.

CONCLUSIONS

1. The analysis of the gross chemical composition of both deflated and non-deflated Rendzinas of various degree proved that SiO₂ oxide dominates in the element composition of the soil in the upper horizons. The second component is calcium oxide, the content of which increases down the profile, with substantial SiO₂ decrease alongside. In the arable horizon of deflated soils, the component distribution is similar, however, with the increase of deflation degree, silicon oxide content decreases and the calcium oxide content increases.

2. Molar ratios analysis of non-deflated full profile Rendzinas indicates the SiO₂ accumulation in upper part of the profile and development of sialitization processes. In deflated Rendzinas, we can notify the tendency of sialitization decline and growth of Al₂O₃ and Fe₂O₃ accumulation: with the increase of deflation degree, the ratio between SiO₂: Al₂O₃ and SiO₂: Fe₂O₃ narrows, reaching minimum values in strong deflated soils. Narrowing of SiO₂, Al₂O₃ and Fe₂O₃ molar ratios and relative accumulation of Al₂O₃ and Fe₂O₃ in deflated soils occur similarly to weakly developed Rendzinas. One can assume that deflation pro-

cesses, being of degrading nature, make full profile Rendzinas similar to weakly developed, and the soil formation process to the initial stage.

3. The constitutional water content in the arable layer of deflated soils increases from weakly deflated to strongly deflated, indicating the intensification of intra soil weathering.

4. Oxides content in deflated soils is characterised by the negative balance, which can be explained by the influence of deflationary processes.

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