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THE USE OF GROUP COMPOSITION OF IRON COMPOUNDS FOR DIAGNOSTICS OF MOUNTAIN SOILS IN THE MIDDLE URALS.

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The content and the ratio between the iron forms have been thoroughly studied in mountain soils of the Middle Urals (Northern Baseg). Under consideration are the ratio of iron forms and distribution types of iron compounds along the soil profile. It has been established that in the major soil profiles studied within the mountain-forest belt under the thin forest the content of iron silicate forms in the fine earth is higher by 2 times as compared to non-silicate ones. In soils developed within the mountain-tundra belt under the small mountain forest the above ratio of iron forms seems to be narrow to a considerable extent. The group composition of iron compounds in soils of the studied territory reflects the dependence of changes in their content on the vertical zonality, slope exposition and elevation. The profile distribution pattern and the ratio between the iron forms serve as evidence of physical weathering and such a soil-forming process as the burozem formation; the features of podzolization haven’t been identified. The diagnostics of mountain soils and the definition of their subtypes are given according to the group composition of iron compounds including illuvial-humus, ferruginous, metamorphizeed and eluviated ones. The dry peat podpurs with the ochric subtype (TJ–BH–BFan–CLM) and the ferruginous litho-soddy eluvizem (O–ay–EL–CLMf) have been diagnosed for the first time under conditions of mountain tundra on western macroslop of the Middle Urals.

Keywords: mountain soils, diagnostics, form of iron compounds, soil classification.

INTRODUCTION

In studying the soil genesis it is traditional to pay special attention to iron compounds, their content and distribution throughout the soil profile. This information is required to diagnose and classify the soils and to determine the development degree of soil formation processes [2, 3, 14, 15, 37, 38, 40, 41, 42, 52, 69, 72, 75].

Iron is referred to typomorphic chemical elements in soils of humid landscapes [12]. Many researchers indicated that the ratio between different forms of iron compounds along the soil profile and even within a horizon plays a diagnostic role in identifying the elementary soil-forming processes that can be manifested in their accumulation or redistribution [18, 19, 23, 24, 29–31, 36, 40, 42, 43, 45, 49, 51, 59, 62]. The iron compounds are the most sensitive indicators to show changes in the conditions reflecting the varying intensity of such processes as weathering and soil formation, moistening and aeration that are responsible for the development of the soil profile [5, 7, 14, 24, 25]. The ratio between the forms of iron compounds detects the physical-chemical properties of soils, their sorption and has the influence on the mobility of many acceptor elements [1–11, 14–18, 21–24, 28, 30, 31, 36, 38, 42–44, 47, 48].

In spite of numerous publications concerning the iron content and forms in soils and their interactions with genetic soil properties the problem under consideration is a matter of some difficulty because there is a great diversity of iron forms in soil and boundaries between them are rather conditional. The rare and expensive physical methods are required to identify the real content and distribution of different iron forms in soils. The literature sources contain only the data about the total content of non-silicate, crystalline and amorphous iron forms however the data about their distribution along the soil profile to diagnose a genetic character of soils are practically absent.

The very few publications devoted to the diagnostics of mountain soils in the Urals according to the group composition of iron compounds appeared in the 1960-70s of the 20th century. The soils in the mountain part of the Urals started to be thoroughly studied only some years ago and their classification was open to discussion for a long period of time. At first, these soils were considered as podzolic [39] and acid non-podzolized ones [4, 5, 26, 27]. Later on, the idea of the Urals as a zone of podzolic soils has been revised and the brown forest soils were recognized [21, 44, 45, 50, 64, 65]. In the substantive-genetic soil classification published in 2004 it is possible to determine the position of soils using the field morphologic-genetic and analytical diagnostics of soils [35]. However, in spite of similar soil physical and chemical properties there are no grounds to judge about identical differentiation processes of the solid phase in comparable soils [17] and the field diagnostics is insufficient to determine their genesis. The detailed diagnostics must be conducted as based upon the totality of indices for the chemical composition of genetic horizons in the soil profile [1, 2, 6–9, 14, 15, 18, 21–28, 30–32, 40, 44, 58, 63].

The present studies are aimed at specifying the diagnostics of the mountain soils in the Middle Urals (Northern Baseg mountain) by means of the content and forms of iron compounds and types of their distribution along the soil profile.

OBJECTS OF RESEARCH AND METHODS

The objects of research are soils of mountain landscapes at the territory of State natural reservation “Basegi” in the Perm region. This reservation embraces Basegi ridge situated to the west from the watershed part in the Urals between 58°50’ and 60’N. This is a meridiaonally stretched ridge consisting of three mountains: Northern Baseg (951.9 m), Middle Baseg (994.7 m) and Southern Baseg (851 m). The territory is represented by metamorphic rocks being referred to the region of low mountains in the Middle Urals. The soil-forming bedrocks are chlorite, chlorite-sericite, mica shales and products of their weathering. The climate is cold and moist like as continental. The mountain-forest, subalpine and mountain-tundra (bald mountain) belts are distinguished according to the vegetation zonality.

The field studies have been carried out at the territory of this reservation in the main relief elements of Northern Baseg mountain with account of vertical zonality from 950 m (bald mountain belt) to 315 m (mountain-forest belt). (Fig. 1). Analytical data were obtained in the chair of soil science in State Agricultural Academy in Perm. The detailed characteristics have been earlier described [54, 55, 58, 68]. The morphological features of mountain soils are the shallow profile, indistinct boundaries between the horizons, brownish color, the absence of podzolization morphological features. According to the soil classification of 2004 the studied soils are regarded to trunk of postlithogenic soils including 5 orders, 6 types and 7 subtypes. Within the bald mountain belt the soils are medium-loamy in humus horizons, in the mid-profile their texture becomes heavy loamy being decreased to medium-loamy close to the parent material. In soils of the mountain-forest belt it is heavy loamy. The carbon content (C_{total}) in humus horizons varies from 3.2 to 4.1%. The soil $pH_{(KCl)}$ is 3.01 to 3.97. The content of exchangeable bases is rather low (0.5–22.3 cmol(+)kg^{-1}), the hydrolytical acidity is high (8.8–25.2 cmol(+) kg^{-1} in topsoils.

These studies should be considered as a continuance of research in mountain soils in the Middle Urals with the view of studying the group composition of iron compounds. In the laboratory of soil physico-chemistry of the V.V. Dokuchaev Soil Science Institute the soil samples taken in 12 pits were analyzed to detect the iron content by X-ray fluorescence analyzer ReSpect, the content of non-silicate and amorphous iron was measured following the Mehra and Jackson procedure with subsequent atomic absorption method.

A detailed review of shortcomings in the method of iron chemical extraction has been presented in publications of Vodyanitskiy [10–15]. In the WRB system the analyses are recommended to determine free iron compounds following the Mehra and Jackson procedure and the amorphous iron compounds in acid oxalate (Tamm) extraction.

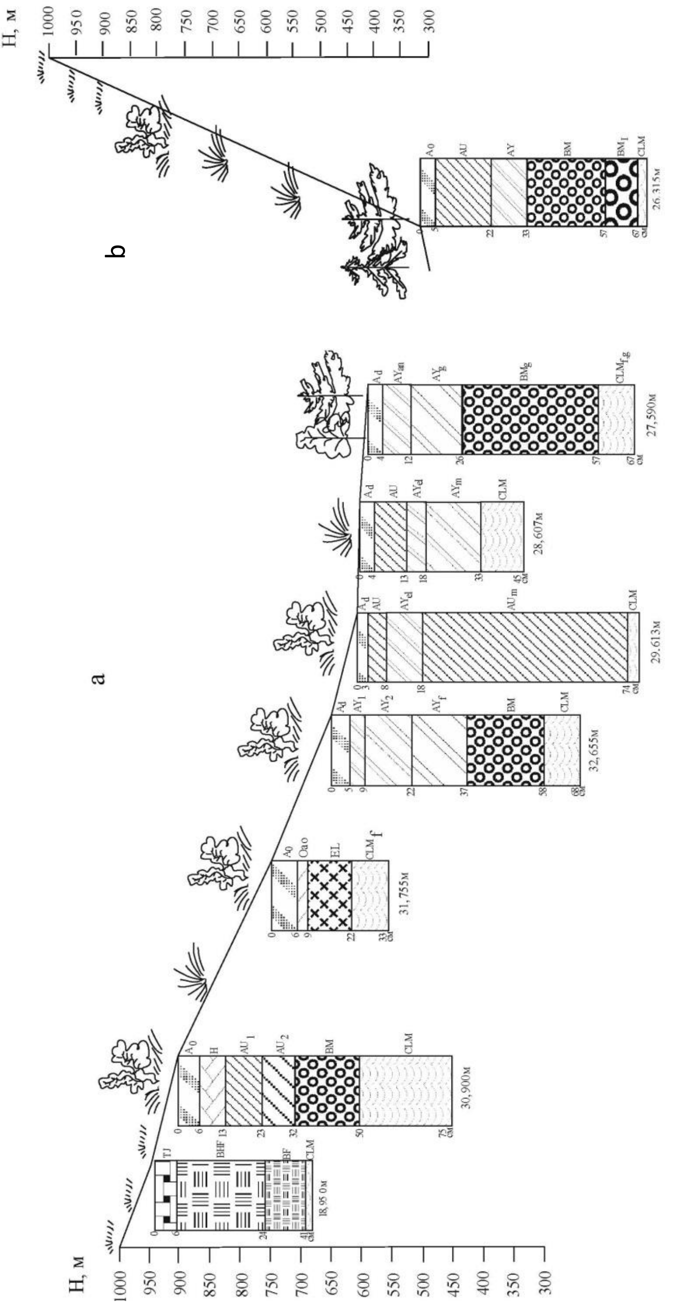
In the course of our studies the analyses have been made to determine the content of iron silicate compounds (Fe_{si}), crystalline compounds (Fe_{cr}), Schwertman coefficient (Fe_{cr}: Fe_{non} ratio) widely applied in practice to study the soil genesis [36, 51, 69, 70, 75, 76] and the coefficient of oxidogenesis [10–14]. To identify the distribution types of iron compounds in the soil profile, the soil classification published in 2004 and Rozanov’s publication “Soil Morphology” were applied. Under use were also the comparative-profile, comparative-geographical, statistical and analytical methods. Statistical processing of the obtained data was in Microsoft Excel and Statistica 6.0.

RESULTS AND DISCUSSION

The total content of iron (Fe_{tot}) is characteristic of the amount of all the iron forms. Its average content in the studied soils makes up 6%. According to Vinogradov it is higher than the klark of soils and the lithosphere. In Vodyanitskiy scale (2002) this is the category with the moderately high content except soil pits 18, 30 (average) and 31 (moderately low). On the whole, these soils are medium ferruginous. The total content of iron is highly varied in topsoils (from 3.3 to 7.3%), with depth it becomes increased (Fig. 1). According to peculiar distribution of Fe_{tot} in the soil profile three groups are distinguished: (1) differentiation of its distribution in the profile is absent (pits 18, 19, 29, 32), (2) eluvial-illuvial type of distribution (pits 17, 26, 30) and (3) eluvial type of distribution with varying intensity in different soil types (pits 15, 24, 28, 27, 31) (Table 1). The types of Fe_{tot} profile distribution serve as evidence of different correlation between the processes of physical weathering, physico-chemical transformation of the soil mass and the substance transfer in the course of the soil formation (Fig. 2).

Besides the total iron it is traditional to distinguish two groups of iron compounds including silicate (Fe_{si}) and free or non-silicate (Fe_{fr}). Fe_{si} in the studied soils varies from 1 to 7% averaged 4% and makes up more than a half from Fe_{tot} – 65% reaching sometimes 85%, it permits to regard these soils to the siallitic group. Such iron content can indicate that there is a considerable amount of its crystalline oxides. The Fe_{si} content prevails over its non-silicate forms in the soils under study, thus evidencing the process of burozem formation and possible manifestation of subsoil claying. The main process is always accompanied by the other soil-forming processes. Due to this fact Fe_{si} can be present in different soils. In burozems and gleyzems within the mountain-forest belt (pits 15, 17, 19, 26, 27, 24) and in organo-accumulative soils of the bald mountain belt (pits 28, 29) the iron is represented by its silicate compounds (58.2–84.2%). Fe_{si} being dominated over Fe_{fr} speaks about the physical disintegration and possible mineralogical transformation of the soil mineral mass resulted in the fact that the intensity of iron removal from minerals is rather low. In soils of the bald mountain belt (pits 18, 30) the Fe_{si} content is lower as compared to that in soils of the mountain-forest belt and accounts for 22.7–61.0%. It is evident that in soils developed at the height of 700 m about the sea level the processes of physico-chemical weathering are dominant.

The Fe_{si} distribution along the profile is quite different in soil types in dependence on the height: podbur (pit 18 at the height of 950 m), dark humus soil (pit 29 at the height of 613 m) reveal a weakly expressed or undifferentiated iron distribution. In dark humus burozems (pits 15, 17, 19) and gray humus soil (pit 28) developed at the height of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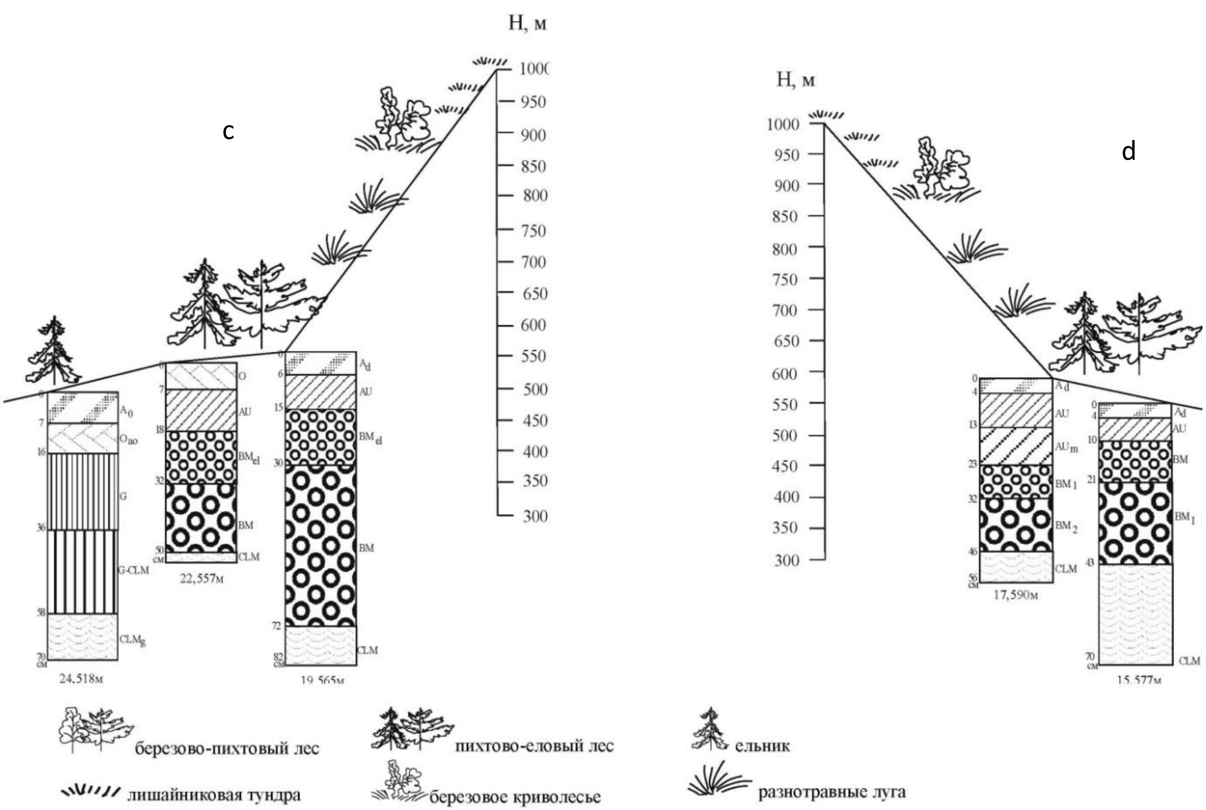

Fig. 1. Distribution of soils within the environment-topographic profile on slopes of the Northern Baseg mountain (a – southern, b – northern, c – western, d – eastern)l the number and the height are indicated under the pit scheme.

Table 1. Iron compounds in the soils of the Northern Based mountain

Pit, height a.l.s.	Horizon	Fe_{tot} %	$Fe_{ns.}$			Fe_{car}	$Fe_{ns}:Fe_{tot}$	$Fe_{car}:Fe_{ns}$	$Fe_{am}:Fe_{ns}$
			Fe_{am}	Fe_{cr}	Sum				
			% from the total						
Pit 18,	BHF	4.69	14.07	29.64	43.71	56.29	0.44	1.29	0.32
955 м	BF	4.52	10.18	28.76	38.94	61.06	0.39	1.57	0.26
Pit 30,	AU_1	3.40	18.24	26.47	44.71	55.29	0.45	1.24	0.41
900 m	AU_2	5.09	38.90	11.39	50.29	49.71	0.50	0.99	0.77
	BM	4.11	17.03	24.57	41.61	58.39	0.42	1.40	0.41
	CLM	3.84	14.58	26.04	40.63	59.38	0.41	1.46	0.36
Pit31,	Oao	0.93	4.30	40.86	45.16	54.84	0.45	1.21	0.10
755 m	EL	1.64	3.05	61.59	64.63	35.37	0.65	0.55	0.05
	CLM f	3.39	11.21	66.08	77.29	22.71	0.77	0.29	0.15
Pit 32,	AY_1	8.02	23.57	21.07	44.64	55.36	0.45	1.24	0.53
655 m	AY_2	8.23	21.14	26.97	48.12	51.88	0.48	1.08	0.44
	AYf	8.53	20.75	30.25	51.00	49.00	0.51	0.96	0.41
	BM	8.19	16.00	32.36	48.35	51.65	0.48	1.07	0.33
	CLM	8.01	8.86	35.71	44.57	55.43	0.45	1.24	0.20
Pit 29,	AU	7.14	8.12	19.75	27.87	72.13	0.28	2.59	0.29
613 m	AJel	7.35	8.03	18.23	26.26	73.74	0.26	2.81	0.31
	AUm	7.72	9.07	17.62	26.69	73.31	0.27	2.75	0.34
Pit27,	AYan	6.14	13.19	9.93	23.12	76.88	0.23	3.32	0.57
590 m	AYg	6.66	23.44	7.51	30.95	69.05	0.31	2.23	0.76
	BMg	7.13	5.75	14.44	20.19	79.81	0.20	3.95	0.28
	CLMf.g	7.60	5.27	17.12	22.38	77.62	0.22	3.47	0.24
Pit 15	AU	5.02	15.93	23.89	39.82	60.18	0.40	1.51	0.40
577 m	BM	5.98	12.71	24.25	36.96	63.04	0.37	1.71	0.34
	BMi	6.39	9.39	19.08	28.47	71.53	0.28	2.51	0.33
	CLM	6.14	8.48	25.10	33.58	66.42	0.34	1.98	0.25
Pit 19,	AU	7.81	16.89	15.49	32.38	67.62	0.32	2.09	0.52
565 m	BMel	7.64	10.74	16.37	27.11	72.89	0.27	2.69	0.40
	BM	7.32	7.10	11.61	18.71	81.29	0.19	4.34	0.38
	CLM	7.59	6.19	9.61	15.80	84.20	0.16	5.33	0.39
Pit 24,	G	3.56	19.41	6.19	25.60	74.40	0.26	2.91	0.76
518 m	G(CLM)	6.79	15.91	20.63	36.54	63.46	0.37	1.74	0.44
	CLM	6.71	6.56	23.39	29.95	70.05	0.30	2.34	0.22
Pit 26,	AY	5.60	15.18	15.01	30.19	69.81	0.30	2.31	0.50
315 m	BM_1	5.88	20.93	14.46	35.39	64.61	0.35	1.83	0.59
	BM_2	5.59	21.45	13.94	35.40	64.60	0.35	1.83	0.61
	BMi	5.45	17.61	15.96	33.57	66.43	0.34	1.98	0.52
Pit28,	AU	6.33	8.38	13.75	22.12	77.88	0.22	3.52	0.38
607 m	AYel	7.36	6.25	12.78	19.03	80.97	0.19	4.25	0.33
	AYm	8.23	6.81	10.58	17.39	82.61	0.17	4.75	0.39
	CLM	7.96	4.02	15.20	19.22	80.78	0.19	4.20	0.21
Pit17,	AU	5.82	18.37	23.35	41.72	58.28	0.42	1.40	0.44
590 m	AUm	6.40	17.51	23.29	40.79	59.21	0.41	1.45	0.43
	BM_1	5.69	14.06	24.42	38.48	61.52	0.38	1.60	0.37
	BM_2	5.41	9.98	24.95	34.93	65.07	0.35	1.86	0.29
	CLM	5.62	11.91	23.29	35.21	64.79	0.35	1.84	0.34

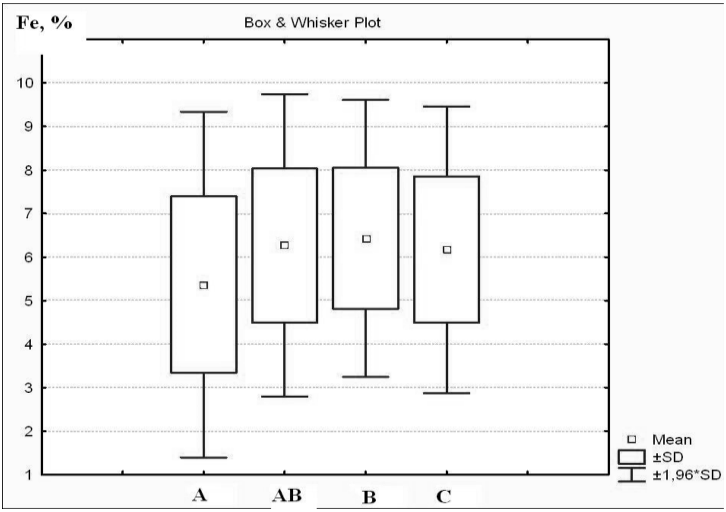

Fig. 2. Changes in the content of total iron in horizons of mountain soils (*n*=12).

570-610 m the distribution type is evenly-eluvial. The accumulative-eluvial-illuvial distribution characterized by increasing the Fe_{si} content with depth to the weathered bedrock is observed in burozems (pits 26, 27, 30, 32) and gleyzem (pit 24). And only the pit 31 displays the evenly-accumulative Fe_{si} distribution along the soil profile.

The Fe_{nsi} accumulation is the most important diagnostic feature to judge about the soil formation [14, 19, 21, 22, 24, 25, 60], peculiarities of the subsoil weathering [11, 17, 30, 31, 32, 66] and the relative age of soils [36, 37, 67]. According to Fe_{nsi} content the studied soils are regarded to the group of soils with the low content of the non-silicate iron, its content makes up 2% and only the AY horizon in pit 32 reveals 4%. The accumulation of no-silicate iron in the mid-profile (pits 27, 30, 32) as compared to over-and underlying horizons can serve as evidence that the soil is polygenetic, in which the horizons of accumulation are marked as boundaries between the upper humus horizons and the lower part of the soil profile. The humus-acidic hydrolysis of the primary minerals is weakly manifested and the iron removed due to ferrallitization is capable to connect the acid organic matter into stable complexes. The share of Fe_{nsi} enables to assess the development degree of oxidogenesis in soils that is always uneven at different stages of weathering and soil formation. It is known that at the initial stages of weathering the iron is removed as isolated one, the further oxidogenesis takes place together with humatogenesis thus forming disperse and weakly crystalline forms of iron compounds [14, 72, 75, 76].The relative Fe_{nsi} content averages 35%. According to Vodyanitskiy's scale the studied soils are referred to categories from those with the low Fe_{nsi} content (pits 27, 28] to moderately low [pits 18, 32, 31, 30m 15, 17] and average content [pits 26, 24, 19, 29]. The Fe_{nsi}:Fe_{tot} ratio is varying from 0.17 to 0.45 indicating the weakly expressed degree of oxidogenesis. Only the pits 30 and 31 located in the upper part of the bald mountain belt and the pit 32 at the lower boundary of this belt reveal the Fe_{nsi}:Fe_{tot} equaled to 0.5 in the lower part of the profile what is characteristic of ferrallitic or allitic processes. Thus, the oxidogenesis is manifested in these soils to a more considerable extent as compared to the soils situated at the height lower than 700 m about the sea level.

The analysis of Fe_{nsi} distribution throughout the soil profiles showed that the undifferentiated type is characteristic of soils located within the subalpine belt (pits 28, 29), burozems and gleyzems in the mountain-forest belt reveal an eluvial-illuvial type (pits 15, 24, 27, 30, 32) indicating the presence of metamorphic claying as a process of the profile development. The increased content of non-silicate iron in metamorphic horizons speaks about the process of burozem formation. The burozems occupied the lower part of the mountain-forest belt (315 m) display the progressive-eluvial distribution of iron (pit 26). The lithozem (pit 31 at the height of 755 m) shows the increase in the Fe_{nsi} content close to the bedrock and the regressive-eluvial type of its distribution, on the contrary, in pits 18 (955 m), 17 (590 m) and 19 (565 m) the Fe_{nsi} is accumulated in topsoils and decreased towards the bedrock that is typical for the evenly-accumulative type of iron distribution. The content of non-silicate iron compounds can reach the values identical to the content of total iron in highly weathered soils, however this phenomenon is not observed in the studied soils what speaks about the young age of these soils.

The crystalline iron compounds (Fe_{cr}) make up 1%, their maximum is 3%. The distribution along the soil profile is identical to that of non-silicate iron being accumulated in the mid-profile, thus testifying the claying process in the subsoil horizons.

In a number of publications the mechanisms responsible for the formation and accumulation of oxalate-soluble oxides in soils are described [3, 60]. It can be the *in situ* claying of amorphous oxides resulted from the rock destruction and removal of mobile elements (weathering) or the input of elements from the bedrocks into the soil solution in the course of biological turnover with consequent precipitation of amorphous compounds (illuvial accumulation). The formation of “amorphous” (oxalate-soluble) compounds following Tamm procedure is associated with the conditions under which Fe(III) is reduced to Fe(II) and subject to oxidation accompanying by the $Fe(OH)_3$ formation.

The Fe_{am} accumulation occurs in organo-mineral horizons of burozems, in organo-accumulative soil, gleyzems (pits 15, 17, 18, 19, 28, 24, 32) and in the mid-profile of burozems (pits 26, 27, 30). The weakly expressed differentiation according to amorphous and crystalline iron forms is attributed to lessive process. In pits 29 and 31 the regressive-eluvial type of distribution is observed. The distribution types indicate different oxidation-reduction conditions that lead to increasing the mobility of this iron compound. Downwards the profile the Fe_{am} content is decreased, its mobility becomes declined as well, the maximum of which is marked only in horizons that are excessively moistened and reveal the features of gleying.

The content of amorphous iron can serve as a diagnostic feature of seasonal wetting by surface waters [36]. With increasing the hydromorphism degree the Fe_{am} content is also increased. In soils with acid reaction the mobility of this element is augmenting. The organic acids destroy the minerals being conductive to the formation of mobile complex iron compounds. Due to changing the oxidation degree at the expense of excessive moisture and insufficient aeration the iron compounds become mobile to a considerable extent that can lead to the formation of concretions, bleaching of the soil mass (pit 31) and removal of iron compounds by vertical and lateral runoff (pit 30).

The iron oxidogenesis is becoming a progressive soil-ecological process [15] when the dispersed weakly crystalline iron compounds being chemically connected with the organic matter are accumulated in topsoils. The most favorable conditions for the Fe_{am} accumulation are observed in soils within the subalpine belt at a height of 900 m. Its content is rather high throughout the profile being maximal in the AU_2 horizon. The increase of the Fe_{am} content in humus horizons serves as evidence that the intensive biological turnover occurs under thin spruce-fir forests and the grass vegetation. In the soil humus horizons the Fe_{am} and Fe_{cr} distribution seems close to each other but downwards the profile the Fe_{am} content is sharply decreased whereas the amount of Fe_{cr} becomes increased. According to S.V. Zonn this iron behavior is explained by dissolution of residual ferruginous films and some iron accumulation resulted from the soil weathering.

The ratio between the silicate and non-silicate iron was used as an independent index for the weathering degree of the soil mass. The lesser is the value of this ratio the higher is the soil weathering degree. In the bald mountain belt the soils on the slope of southern exposition (pits 27–29) reveal the soil formation processes to a greater extent than the weathering process. (Fig. 3). In burozems on the western slope of the Northern Baseg mountain the soil-forming process is highly manifested as compared to the soil on the eastern slope. In soils developed at the height of more than 650 m the weathering processes become activated.

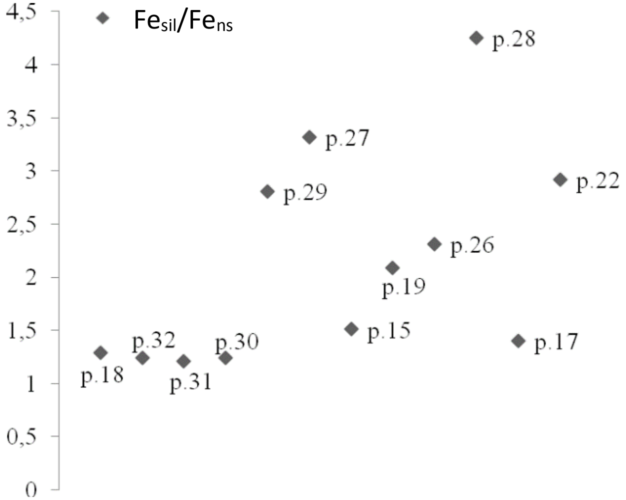

Fig. 3. The weathering degree in mountain soils (p. – pit).

Schwertman's criterion (K_{sch}) permits to judge about the crystallization of free iron oxides and hydroxides. It is increasing with increasing the soil hydromorphism degree [73, 74]. The sensitivity of this criterion to excessive moistening has different explanation. Schwertman doesn't consider it as a criterion of hydromorphism because it reflects the gleying degree but it has been established that this criterion allows adequately diagnosing the excessive hydromorphism only in soils subjected to the surface moistening [16, 36, 37, 74].The percolative water regime is characteristic of mountain soils. In the studied soils K_{sch} is < 1. There is an opinion that the low values of this criterion (0.00–0.06) are inherent to the inherited gley [16]. Such a low K_{sch} value is observed in the EL horizon (0.05) of the soil (pit 31) that is gray in color without features of excessive moistening.

According to K_{sch} the soils are grouped in the following way (Fig. 4).For the soils developed at the height of more than 700 m the K_{sch} value is rather high due to hydromorphism under severe conditions of mountain landscapes. The soils developed at the height of 600–700 m are subject to hydromorphism to a lesser extent owing to the lateral runoff in soils on steep slopes. In soils at the height of less than 600 m

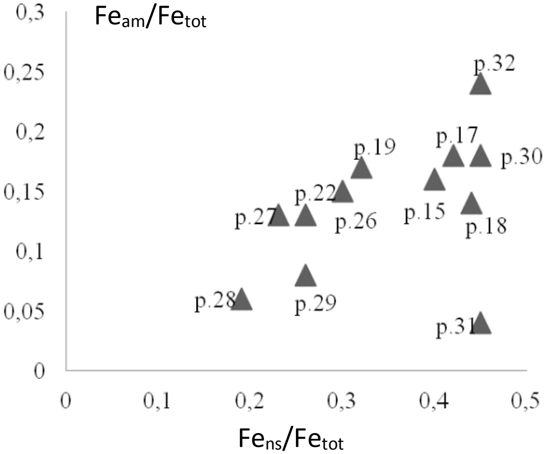

Fig. 4. The soil grouping in space according to Schwertman's criterion (Fe_{am} Fe_{ns}).

(pits 17, 15, 19, 24, 27) the hydromorphism degree is somewhat increased at the expense of the forest litter in the fir-spruce forest within the mountain-forest belt.

The results of the group composition of iron compounds make it possible to specify the field diagnostics of soils. It was complicated to determine the classification position of soils developed within the bald mountain belt (pit 18). There exists the idea that the severe conditions in this belt of the Middle Urals are suitable only for the development of primitive soils (petrozems, dry peaty lithozems) represented by the humus-weakly developed and dry peaty horizons overlying the bedrock. Really, the soil profile 41 cm thick with genetic TJ, BH and BF horizons was found at the height of 950 m. The analysis of the group composition of iron compounds testified the absence of claying process characteristic of burozems and eluvial-illuvial redistribution of iron compounds typical for soils of podzolic type. At this height the most typical cryogenic coagulation of weathering products, fissure formation and freezing promote the formation of BH and BF horizons. The presence of these horizons speaks about the Al-Fe-humus illuviation that is characteristic of podburs [60]. Thus, nder onditions of mountain tundra within the bald mountain belt on the western slope of the Middle Urals the dry peaty podburs have been first diagnosed and namely the ochric subtype TJ–BH–BFan–CLM.

The classification position of the soil (pit 31 at the height of 755 m) under the birth thin forest within the subalpine belt was debatable. It is known that in this belt the mountain-meadow soils (Soil classification of 1977) or organo-accumulative soils and lithozems (Soil classification of 2004) are widely spread. In course of our field soil survey under study was a shallow soil 22 cm thick with the well expressed grayish-whitish horizon underlying the dark-humus one like as the profile of the mountain-podzolic soil. The presence of the bleached horizon doesn’t permit to classify this soil as an organo-accumulative one because initially it was regarded to lithozems but this question remained debatable as well. According to the profile thickness and ecological conditions for the formation this soil can be diagnosed as lithozem but the profile form doesn’t permit to do it. The data of the group composition of iron compounds in soil showed the absence of elluvial-illuvial differentiation in the profile and helped establish that the existing redox-Al-Fe-humus differentiation provokes the transition of iron oxides into the mobile form, their migration and partial accumulation at the oxidating barrier [61]. The chemogenic iron redistribution in soil is possible at the expense of seasonal surface moistening due to terracing of slopes, microrelief, etc. The subalpine meadows are confined to stone-fields promoting the peculiar catchment and accumulation of rain water. Bearing in mind the data about the content of iron forms, ecological conditions for the soil formation, morphological features of horizons in this soil (pit 31), it seemed reasonable to diagnose the bleached horizon as eluvial (EL) but not podzolic (E); the soil was referred to the order of eluvial soils, to the type of soddy-eluvozem and ferruginous subtype. In view of the shallow profile the soil was classified as litho-soddy-ferruginous eluvozem (O–ay–EL–CLMf).

CONCLUSION

The field diagnostics of mountain soils doesn’t permit to study in detail their genesis and position in soil classification due to the similarity of some morphological features. The group composition of iron compounds provides additional information on dominant soil-forming processes and allows diagnosing these soils in accordance with the present-day approaches of the soil classification.

The group composition of iron compounds in mountain soils of the Middle Urals made it feasible to diagnose the crystalline iron forms in the soil profile, their predominance and increasing with depth whereas the content of amorphous iron forms becomes decreased (burozem formation). Thanks to the group composition of iron compounds it was also possible to determine the biological iron fixation, oxidogenesis, gleying process, Al-Fe-humus illuviation, redox-Al-humus differentiation reflected in the names of the studied soils at the level of types and subtypes. The features of podzolization haven’t been identified in these soils because the content of free iron compounds is rather low in the topsoil.

The changes in conditions for the soil formation are accompanied by redistribution of the ratio between different iron forms along the soil profiles. The character of their profile distribution allows diagnosing the correlation between the processes of soil formation and physical weathering.

In mountain soils the ratio between the groups of iron compounds reflects the dependence of changes in their content on the conditions of vertical-elevated belts, slope exposition and the height of the area. The decline in the content of silicate iron and the increase of the amount of free iron compounds are observed depending on the absolute height and vegetation alteration.

According to the group composition of iron compounds it became possible to determine the classification position of the studied soils as illuvial-humus, clayey-illvial, ferruginous, metamorphized, elluvial ones. Thus, the group composition of iron compounds permitted to improve the field diagnostics of soils and to define their genetic name in accordance with the soil classification system of 2004.

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