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PALEVYE SOILS ON CARBONATE-FREE DEPOSITS IN CENTRAL SIBERIA AND THEIR TAXONOMIC POSITION IN THE SOIL CLASSIFICATION OF RUSSIA

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Based upon a comprehensive analysis of detailed descriptions of soil profiles and analytical data obtained by I. Sokolov, V. Zol'nikov, L. Yelovskaya and other researchers, as well as upon data on the soil-forming factors, an attempt is made to determine the taxonomic level of "palevye" undifferentiated neutral and weakly acid soils derived from carbonate-free deposits in the new classification system of Russian soils (versions 2004, 2008). The above group of soils is not uniform. According to their diagnostic morphological and physical-chemical properties the loamy permafrost-affected soils with ice-rich permafrost should be placed in the order of cryometamorphic or iron-metamorphic soils. The loamy sandy soils with dry permafrost may be placed in the same order. The soils with a shallow profile (< 30 cm) on hard parent rock should be qualified as members of the order of lithozems. The specific features of these soils make it possible to suggest new elements to the soil classification. A subtype of palevye metamorphized soils is offered to recognize the types of rzhavozems and raw-humus rzhavozems as the soils transitional to the palevye soils. This suggestion is aimed at harmonization of a variety of ideas on the genesis, conditions for the development and nomenclature of soils, which permits us to give a more complete and reliable perception of the soil cover in the Central Siberian plateau.

Keywords: comparative-geographical analysis, soil classification.

HISTORICAL BACKGROUND

In the publication on the paleogeographic peculiarities in the "coldest region of the world" I.P. Gerasimov was the first to show that taiga soils in Yakutian Depression reveal strong differences from usual podzolic soils and have to be recognized as a special soil type. I.P. Gerasimov proposed to distinguish the primary-forest palevye and secondary-forest palevye solodic soils with residual humus [8]. In the system of soil classification of the USSR, palevye soils were defined by Ye.N. Ivanova as a type of typical zonal automorphic soils in the class of boreal frozen-taiga soils with its further subdivision into the subtypes of solodic palevye, typical palevye and podzolized palevye soils [11]. The subtype of typical palevye soils included two genera: residual-carbonate and non-carbonate neutral soils. Following the ideas of Ivanova, the genesis of palevye soils is controlled by the bioclimatic factor rather than by the presence of carbonates in the parent material [12]. This approach was implemented in the legend to the Soil Map of the Russian Federation (1 : 2.5 M scale), in which six variants of the palevye soils were introduced, namely: typical, humus and podzolized soils on carbonate-free deposits and carbonate, solodic and gray palevye soils on carbonate substrates [16].

Taking into account the cryogenic factor, V. Zol'nikov with coauthors placed palevye soils into the type of palevye frozen (permafrost-affected) soils [28]. Following the traditional nomenclature for soil types, I. Sokolov suggested that they should be named palevo-carbonate, palevo-solodic and palevo-gray soils instead of palevye carbonate and palevye solodic soils [24]. In 1986, the Working Program of the State Soil Map (SSM) included the soddy palevye, palevye-gray and palevye-solodic soils on carbonate loams, palevye-cryozemic soils on heavy-textured deposits with the impeded drainage as transitional to cryohydromorphic gley soils (cryozems), palevye raw-humus and palevye podzolized soils on non-carbonate rocks [20]. On small-scale soil maps all the undifferentiated palevye soils are traditionally shown non-differentiated into subtypes [1, 15].

The common diagnostic properties of palevye soils both on carbonate and non-carbonate deposits are the following: the presence of the humus-accumulative A1 horizon and a specific metamorphic horizon without the features of Al–Fe-humus process; neutral and weakly alkaline pH; the upper horizons reveal a rather low base saturation, whereas the lower horizons are saturated to a greater extent; the content of oxalate-soluble iron is rather low being uniformly distributed along the profile; the profile differentiation of total Al and Fe oxides is absent in the clay fraction [21].

Despite similarity in climatic conditions, there are certain differences between the areas of palevye soils on carbonate and non-carbonate deposits. The palevye soils on loess-like carbonate loams are dominant in the most continental and dry part of Central Yakutia: the coefficient of continentality has the highest value there, while the value of moistening coefficient is rather low. At the same time they are better provided with heat in summer. The vegetation is represented by larch and birch-larch grass-shrubby forests, where the mosses are few. The palevye non-carbonate soils are developed under moss-shrub thin larch and pine-larch forests (Table). The difference in bioclimatic factor responsible for soil formation is explained by the fact that the palevye soils on carbonate loams prevail in an old-alluvial plain with absolute altitudes of 100–230 m, while the palevye soils on non-carbonate deposits – in high denudation plains and plateaus composed of sand, shales, tuffaceous-sedimentary and derivates of mafic rocks.

The natural type of palevye soils profile on non-carbonate deposits is: O–(AO)(A1)–A1B–B1m–BC–C[1] , the soils on carbonate loess–like loams reveal some differences in the lower part of the profile: O–(AO)A1–A1B–B1m–Bca–(Bcs)–(Bs)–Cca, i.e. together with the humus and metamorphic horizons they have the horizons, in which carbonates, sometimes gypsum and soluble salts are accumulated. They are also different in physical-chemical properties: the soils confined to carbonate deposits are characterized by higher values of pH and base saturation, the increased content of absorbed Na (3-5% from CEC) and the broader C_{ha}/C_{fa} ratio in upper horizons [5]. Having combined the soils with different profile formulas and varying physical-chemical properties, the authors emphasized that the specific soils in Yakutsk region are confined to a certain soil forming environment, associated with the extremely continental arid and cold climate, the continuous permafrost and xerophytic moss-lichen vegetation in larch taiga.

Comparative ecological, diagnostic and process characteristics of pale soils (according to I. Sokolov, V. Zolnikov, L. Yelovskaya, Yu. Ershov and G. Bystryakov)

Conditions for soil formation, soil properties, soil-forming processes	Soils			
	Pale non-carbonate			Pale carbonate
	on volcanic tuff and its derivates in the interfluves between Nizhnya and Podkamennaya Tunguska	on carbonate-free sedimentary bedrocks within the Viluy basin	on compact eruptive and metamorphic rocks in Anabar plateau	on friable carbonate rocks in central Yakutia
Environmental conditions				
Climate	Cold (∑T> 10°C 500–1200°C), semi-humid (*Kmoist* 0.6–1.0, precipitation 300400 mm/year), highly continental (*Kcont* 52–58)			Moderately cold (∑T>10°C 1200–1400°C), semi-arid (*Kmoist* 0.44–0.55; precipitation 200–250 mm/year); extreme continental (*Kcont* 58–64)
Soil-forming rocks	Slightly stony loams of the basic composition	Slightly stony loams of acid and middle composition	Gravel-stony of different composition	Loess-like carbonate loams
Relief	Terraced surfaces, watersheds and slopes of denuded plateaus	Watersheds and slopes of denuded plains and plateaus	Watersheds and slopes of the plateau	Watersheds and slopes of weakly dissected plain
Vegetation	Middle taiga; larch and pine-larch moss-lichen and shrubby forests		Northern taiga and pre-tundra thin forests thin larch lichen-shrubby forests	Middle taiga (similar to southern); larch and birch-larch moss-lichen and grass-shrubby forests

Conditions for soil formation, soil properties, soil-forming processes	Soils			
	Pale non-carbonate			Pale carbonate
	on volcanic tuff and its derivates in the interfluves between Nizhnya and Podkamennaya Tunguska	on carbonate-free sedimentary bedrocks within the Viluy basin	on compact eruptive and metamorphic rocks in Anabar plateau	on friable carbonate rocks in central Yakutia
Cryological conditions	The thawing depth 100–120 cm, icy permafrost	The thawing depth 80–150 cm, icy permafrost	The thawing depth >150 cm, permafrost of little ice and dry	The thawing depth 100–130 cm, icy permafrost
Accompanying soils	Pale podzolized, podzolic, cryozems, peat boggy soils			Pale solodic, pale gray, solods, soils in alases (meadow-chernozemic, meadow-chernozemic saline, chernozemic-meadow saline, soddy- and peaty-gley)
Morphological and analytical characteristics of soils				
Profile type (according to literature sources)	O–A1O–(A1)–(A1Bm)–Bm–BC–C	O–Ad–AB–B1–BC	Ao–(AoA1)–A1–Bm(fe)–C(caco$_3$)	O–AO–A1–(A1Bm)–Bm–Bca–(BCgs)–Cca
Thickness and structure of the humus horizon A1(A1O)	3–13 cm, crumbly, nutty-crumbly or not expressed; microstructure flocculant-granular or crumbly	3–6 cm, not expressed	5–10 cm, not expressed	5–15 cm, fine-granular-powder-like

Conditions for soil formation, soil properties, soil-forming processes	Soils			
	Pale non-carbonate			Pale carbonate
	on volcanic tuff and its derivates in the interfluves between Nizhnya and Podkamennaya Tunguska	on carbonate-free sedimentary bedrocks within the Viluy basin	on compact eruptive and metamorphic rocks in Anabar plateau	on friable carbonate rocks in central Yakutia
Coloring of metamorphic horizons	Brown, cinnamon-brown, light-brown, yellowish-brown	Light-brown, grayish-brown, grayish-cinnamon	Yellow-brown, pale-brown	Cinnamon-pale, pale
Structure of metamorphic horizons	Crumbly, flocculent; microstructure - granular, ooidic, crumby, coagulated	Powder-like, friable-powder-like, granular-crumby	Not expressed	Powder-like
Overfrozen excessive wetting	Slightly expressed		Absent	Slightly expressed
Buried horizons	Slightly expressed or absent	Absent	Absent	Ansent
Cryogenic wedges and microrelief	Clearly expressed		Absent	Clearly expressed
pH, unsaturation	Weakly acid and neutral, weakly unsaturated and saturated		Acid, unsaturated, weakly acid and neutral, weakly unsaturated	Neutral and alkaline, saturated
Ratio between “amorphous” and crystalline iron	0.6–0.3	No data	0.08–0.3	0.1–0.4
C_h/C_f ratio	1.0–0.6	1–0.5	0.85–0.4	1.5–0.3

Conditions for soil formation, soil properties, soil-forming processes	Soils			
	Pale non-carbonate			Pale carbonate
	on volcanic tuff and its derivates in the interfluves between Nizhnya and Podkamennaya Tunguska	on carbonate-free sedimentary bedrocks within the Viluy basin	on compact eruptive and metamorphic rocks in Anabar plateau	on friable carbonate rocks in central Yakutia
	Soil-forming processes			
Humus accumulation in the form of raw-humus horizons	Clearly expressed			Weakly expressed
Humus accumulation in the form of soddy horizons	Not always expressed			Clearly expressed
Humus illuviation	Not expressed			Not expressed
Accumulative-carbonate	»			Clearly expressed
Cryogenic structure formation	Clearly expressed	One can see	Not expressed	One can see
Solonetzization, solodization	Not expressed			Weakly expressed
Ferritization in situ (metamorphism)	Weakly expressed			Weakly expressed
Profile type in the soil classification of Russia	O–AO–AYAJ–BFMgrpl–BC–C or O–AO–AYAJ–CRMpl–BC–C	O–AO–AYAJ–CRMpl–BC–C or O–AO–AYAJ–BFMpl–BC–C	O–(AO)–AY–BFM(pl)–BC–C	AJ–BPL–BCa–Cca

In the soil cover, the soddy palevye soils on carbonate loams are associated with palevye solodic, palevye gray as well as hydromorphic soils in alases, and with solods, whereas the palevye raw-humus soils on non-carbonate loams – with palevye podzolized, podzolic, cryozems and boggy soils.

Taking into consideration the ecological, morphological and physical-chemical differences in palevye soils derived from carbonate and non-carbonate rocks, they were divided by Yelovskaya at a high taxonomic level, the latter being identified as transitional to taiga raw-humus burozems. The palevye soils on non-carbonate deposits were referred to the order of accumulative-humus in the type of frozen palevye-brown soils, while the palevye soils on carbonate rocks – to the order of accumulative-humus and accumulative-carbonate in the type of frozen palevye soils (it is worthy of note that this type includes such types as frozen chernozem, meadow-chernozem and chernozem-meadow soils) [5]. On the Soil map of Yakutia compiled by L.Teterina., the undifferentiated soils on carbonate loams were named frozen taiga palevye soils but those confined to non-carbonate rocks – frozen taiga soils [2]. Thus, there were two viewpoints to classify palevye soils: all the palevye soils should be combined into one type irrespective of the rocks from which they are derived, or they should be separated at a high taxonomic level.

Central and Western Siberia is a traditional area of palevye soils in Central Siberia as shown on soil maps including the Soil Map, scale 1 : 2.5 M. Thanks to a number of studies carried out by many researchers during the last decades the area of palevye soils on non-carbonate deposits has been considerably expanded to the north and west [3, 6, 14, 19, 21]. The palevye soils were identified as confined to crystalline acid rocks in Anabar as well as in Maimecha-Kotuy, Olenek-Anabar, Olenek-Markhinsk, Viluy, Ilimpea-Nidym, Central-Tungus plateaus, where outcrops of mafic rocks occur. The palevye soils on acidic silicate rocks were recognized as acid unsaturated soils, the values of pH and base saturation in which seemed to be lower as compared to those inherent to the typical non-carbonate soils [21].

STATE OF THE PROBLEM

In the soil classification of Russia, the name “palevye” is used only for neutral and alkaline soils with the following profile: O–AJ–BPL–BCA(BCAcs)–(BCca)[2], i.e. soils developed on carbonate loams and characterized by such diagnostic horizons as light-humus, palevo-metamorphic and accumulative-carbonate ones. The latter can display the features of gypsum and soluble salts accumulation. These soils are included into the order of palevye-metamorphic soils as a type, and divided into subtypes of saline and gypsum-containing soils. In this order, the types of palevye dark-humus soils with the corresponding diagnostic AU horizon are recognized as well [13]. At the same time, in Central Siberia it is possible to find a great group of weakly acid (or acid) and neutral undifferentiated soils, the profile of which comprises raw-humus, peat-litter and gray-humus horizons combined with the metamorphic ones; however, the accumulative-carbonate horizon is absent in these soils. According to their profile formula, they cannot be referred to the order of palevye-metamorphic ones. In view of this, the present paper is aimed to determine the position of these soils in the system of soil classification in Russia.

OBJECTS AND METHODS

To discuss the problem, a traditional method of comparative-geographical analysis was applied including the comparison of ecological parameters of the areas, morphological, physical-chemical soil properties and identification of processes responsible for the profile formation in non-carbonate palevye and geographically and/or genetically close metamorphic soils with the undifferentiated profile.

The objects of research are the palevye soils described in detail by I. Sokolov (1986a) in the interfluve of Nizhnaya and Podkamennaya Tunguska Rivers on the derivates of volcanic tuff, the palevye soils in Lena-Viluy Rivers interfluve on eluvial and colluvial non-carbonate sedimentary deposits [27], and the palevye soils on dolerites in the western part of Anabar Plateau [21]. Additionally, other descriptions of palevye soils were used. The comparative-ecological and comparative-morphological analysis of these soils and soils from the order of ferruginous-metamorphic, cryometamorphic and lithozems was made using the diagnostics and terminology accepted in the soil classification of

Russia. The soils under study are named for convenience “palevye non-carbonate” ones.

RESULTS AND DISCUSSION

The first group of palevye non-carbonate weakly stony loamy soils derived from volcanic tuff in the Nizhnaya and Podkamennaya Tunguska Rivers interfluve has the following set of diagnostic horizons[1]: O–A1Q–(A1)–(A1B)–Bm–BCm–C(D). The litter thickness is varying from 2–3 to 10–12 cm. The humus-accumulative horizon is not always developed being replaced by the transitional A1Bm horizon; the metamorphic Bm horizon displays a gradual transition to stony and loamy icy parent materials. According to some morphological and physical-chemical properties, the diagnostic horizons of these soils in terms of the new Russian classification system are the following. The topsoil is a raw-humus AO horizon with abundant fine plant residues and the content of the organic matter ranging from 10 to 25%. The humus horizon proper is a transitional from the light-humus AJ to the gray-humus AY horizon. According to color, acidity and some other physical-chemical indices it seems identical to the gray-humus horizon. However, due to such parameters as base saturation, C_{ha}/C_{fa} ratio (equal to 1) and the absence of eluviation features in the morphology of mineral grains, this horizon is found to be closer to the AJ horizon. At the same time, the humus horizon in these soils is combined with the raw-humus one, what is characteristic of soddy, or gray-humus horizons. The metamorphic horizon, brown, reddish-brown or pale-brown, has a well expressed crumb-granular structure (coagulated according to Yu. Ershov). The sand particles are covered by light-brown opaque iron-clay autochtonous films. The signs of illuviation either of Al-Fe-humus compounds, or suspensions are absent. The soil profile reveals a low content of oxalate-extractable iron. The soils are not differentiated by the total chemical composition, the particle-size distribution, as well as by mobile compounds of Fe and Al. The acidity is decreasing with the depth from weakly acid to almost neutral values; the base saturation is rather high along the profile.

[1] The authors’ symbols of horizons are used to characterize these soils.

In the soil classification of Russia, the mesomorphic taiga undifferentiated soils of Central and Eastern Siberia are referred to the order of ferruginous-metamorphic soils with the types of organic and raw-humus rzhavozems divided into subtypes of typical and illuvial-humus ones [13]. It means that the humus horizons, the strong structure of the metamorphic BFM horizon, the weak eluvial-illuvial differentiation (according to analytical data) were not taken into consideration to define the Siberian rzhavozems in the soil classification of Russia. At the same time, the loamy soils on the derivates of mafic rocks with the clearly expressed microstructure in the Bm horizon recognized in the type of organo-rzhavozems have a subtype of iron-granulated rzhavozems or granuzems. “Classical” granuzems have been described in detail by I. Sokolov on the Putoran Plateau in the northern taiga of Central Siberia [18].

The soils studied in the Nizhnaya and Podkamennaya Tunguska Rivers interfluve are developed in the middle taiga under the environmental conditions that are similar to those inherent to the area of rzhavozems (loamy derivates of mafic rocks, terraced surfaces, cold continental climate). However, these soils differ from rzhavozems, because they are developed under more warm and less wet conditions and have a humus horizon, a weaker structure in the middle horizon, a low content of oxalate-soluble iron. These soils have been considered by I.Sokolov as palevye due to the following diagnostic properties: the humus horizon with features of the light-humus one, light-colored autochtonous iron-clay films in the metamorphic horizon, the absence of features for podzolization, humus and clay illuviation, predominance of crystallized forms of non-silicate iron, pH close to neutral values, high base saturation, the C_{ha}/C_{fa} ratio equal to 1. Though I.Sokolov indicated that the signs of excessive wetting are absent in the lower part of the profile in these soils, it is easy to assume that the layers overlying the permafrost become wet in the autumn-spring period, what is testified by polygonal cryogenic microrelief, the presence of frozen wedges, indistinct diffuse humus morphons in the profile part overlying the permafrost, as well as the icy pattern of the permafrost and soil thawing at a depth of one meter. The above phenomena serve as evidence that the soil formation is significantly affected by the cryogenic factor. In the pit of typical palevye soil demonstrated as a representative of palevye carbonate soils during the field WRB excursion in 2013, the prominent cryoturbation features in the lower profile part were interpreted as a consequence of temporary excessive wetting in layers overlain the permafrost. At the same time, the structure of middle horizons in cryometamorphic soils and granuzems prove to be similar being described as granular, ooid-like, angular-granular and quirk-like one [4].

Thus, morphological, physical-chemical and regime properties of soils under consideration testify to their transitional character between the palevye iron-granulated rzhavozems (granuzems) and cryometamorphic soils. In the soil classification of Russia, such soils should be defined as new subtypes including the raw-humus rzhavozems and soddy iron-granulated palevye-metamorphized soils or as subtypes already existing in the soil classification: cryometamorphic raw-humus or soddy palevye-metamorphized soils. However, it is worthy emphasizing that some physical-chemical properties of these soils similar to those of palevye soils are highly dependent on the mineralogical composition of soil-forming rocks. There are many publications on the influence of the smectite phase in clay minerals derived of mafic rocks on the properties of these soils [22, 23, 26]. In central and eastern parts of Central Siberian Plateau the area of such soils within the middle taiga subzone is restricted by the distribution of sediments containing mafic rock derivates, annual precipitation characteristic of the semi-arid and semi-humid climate (300-350 mm) and the presence of icy permafrost in the soil profile. In the northern taiga under conditions of more humid and cold climate, these soils on loams are replaced by iron-granulated organo-rzhavozems (granuzems) and cryozems, while the palevye typical soils confined to carbonate loams occur under conditions of drier climate.

A considerable part of palevye non-carbonate soils is developed on eluvium and slope deposits of hard rocks (gneiss, granitold, dolerite, shale) in the northern taiga, in pre-tundra thin forests and mountain tundra. As shown in literature, the total thickness of the soil profile on hard rock doesn’t exceed 20–30 cm. In view of this, such soils may be referred to different lithozem types (in dependence on their topsoil: AY(AJ, AO)–C–M) in the order of lithozems.

The loamy soils with a highly stony and thicker (50-60 cm) profiles, as well as loamy-sandy and sandy soils display the following horizon sequence: O–(AOA1)–A1–Bm(fe)–BC–C; they are yellow, yellowish-gray, palevye-brown in their middle horizons and have the accumulative type of the particle-size distribution of the fine earth, the content of coarse grains is increasing with the depth; the cryogenic structure is absent (the permafrost is dry or somewhat icy, or is beyond the profile). The acidity and base saturation values vary to a considerable extent; the share of dithionite- and oxalate-soluble iron varies in dependence on the parent rock. Such soils may be referred both to typical (soddy) rzhavozems, or raw-humus ones with the profile AO-(AY)-BFM-C (acid unsaturated soils), or to transitional subtypes including typical rzhavozems, or to raw-humus palevye-metamorphized soils (a new subtype proposed to be introduced into the soil classification of Russia), if the physical-chemical diagnostic features are close to those of palevye soils, what is characteristic of soils on mafic rocks. With the increasing climate humidity in the northern taiga these soils are replaced by ochric podburs on mafic effusive rocks and light-colored podburs, and lithozems on hard acid rocks and raw-humus illuvial-humus rzhavozems in the middle taiga.

The last group of palevye non-carbonate loamy soils is related to the carbonate-free sedimentary rocks – eluvium and colluvium-solufluction deposits of the Jurassic and Cretaceous, such as sandstones, aleurolites, shales, argillites that compose the high denudation plains and plateaus in the Viluy River basin [27]. Because of the same diagnostic horizons, the main physical and chemical properties of the given soils are similar to those described above, but they differ from loamy soils on mafic rocks by a weaker structure in the upper and middle parts of their profiles. These soils are also different from the above discussed stony soils: they reveal specific cryological characteristics including the icy continuous permafrost, the thawing depth of which is varying from 0.8 to 1.5 m [5]. In the lower horizons of some soils there is a cryogenic platy texture, it is possible to observe the excessive wetting in the absence of morphologically expressed gley, and also the microrelief is cryogenic. Probably, the palevye non-carbonate soils can be formed either under the influence of cryogenic mechanisms, or without them. The structure in the middle horizon of these soils is friable, powder-like, being sometimes weakly expressed. The “classical” structure of the cryometamorphic horizon is granular, angular fine-blocky, ooid-like [13, 17]. The palevye- metamorphic and ferruginous-metamorphic horizons are structured to a lesser extent. By this reason, owing to structural features, pale brown color and abundant fine iron autochtonous films, the metamorphic horizon of the given soils should be considered as a transitional one combining the features of the palevo-metamorphic BPL and the cryometamorphic CRM horizons, hence it may be named CRMpl horizon (if the profile thawing is not deep), or metamorphic and ferruginous-metamorphic to be defined as BFMpl horizon in case of deep profile thawing. According to physical and chemical properties close to those of palevye soils if the thawing depth is maximum, the studied soils may be referred to typical rzhavozems or raw-humus palevye-metamorphic ones with the profile O–AO–(AYAJ)–BMFpl–$C_{\perp}$. When the thawing depth is about one meter and the bedrocks are enriched with ice, it is advisable to include these soils into the group of cryometamorhic palevye–metamorphized, raw–humus, or soddy ones with the profile O–AO–(AYAJ)–CRMpl–$C_{\perp}$, then, they are intergrades to palevye carbonate soils. Up to now, the cryometamorphic soils have been described only in the north of European Russia under conditions of cold humid climate [9, 25]. However, the mechanisms responsible for the formation of the middle horizon in these soils have been so far examined insufficiently. Probably, they may be different under varying lithologic-cryological and climatic conditions, and the area of such soils should be expanded. It is worthy of note, that the profile of the studied soils displays the double-sided freezing: it is frozen for 8 months but the soil moisture is rather high during its freezing what is evidenced by their cryogenic features. It is possible to assume that the formation of the metamorphic horizon in these soils is associated with dehydration and coagulation of fine mechanical particles during the freezing period. In terms of the soil classification of Russia, in the northern taiga due to the decreasing heat supply and the increasing soil moisture the cryometamorphic soils are replaced by organo-and raw humus cryometamorphic including the gleyic ones, and by gleyic cryozems and gley soils far to the north. As it was mentioned above, in the Working Program of the State Soil Map, the soils have been recognized as transitional from palevye to cryozems and named as palevye-cryozems; being confined to loamy-clayey parent materials they were shown in the northern and middle taiga of the State Soil Map (scale 1 : 1 M).

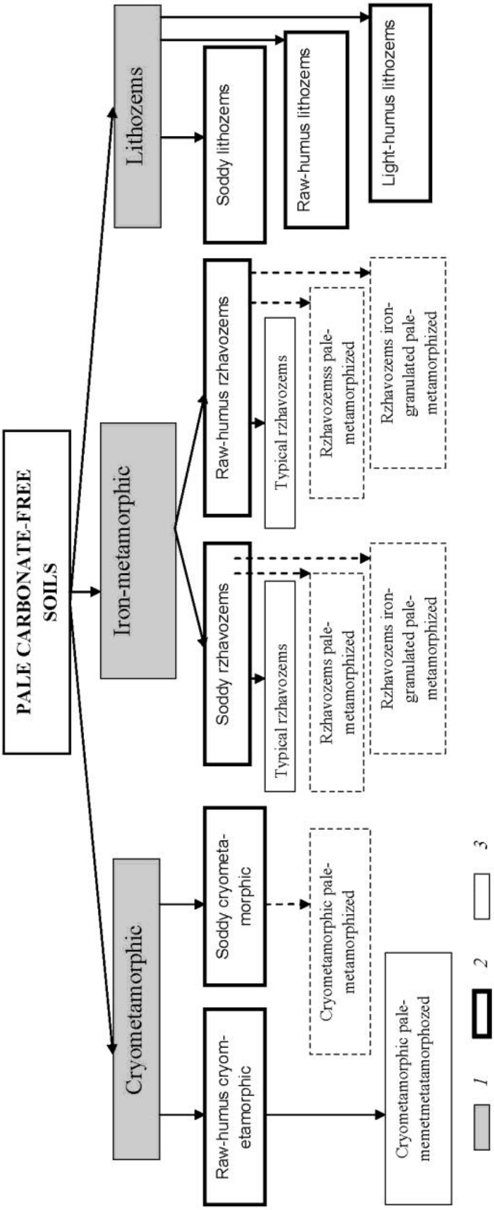
Thus, the undifferentiated soils on loamy, loam-sandy and stony deposits of different mineralogical composition widely spread in the eastern part of Central Siberian Plateau were earlier recognized as palevye soils to be shown on maps; in the Russian system of soil classification they can be qualified for raw-humus rzhavozems and soddy ferruginous-granulated palevye-metamorphized, cryometamorphic soddy or raw-humus palevye-metamorphozed, soddy or raw-humus rzhavozems, soddy or raw-humus palevye-metamorphized rzhavozems, soddy lithozems, raw-humus lithozems, soddy lithozems. There is a part of such soils in the soil classification of Russia; a part of them is proposed to be as additionally introduced (Fig. 1).

The complicated nomenclature construction for the legend of maps can be simplified by using the name “palevye-cryometamorphic” instead of “cryometamorphic palevye-metamorphized” and “soddy granuzems” instead of “soddy ferruginous-granulated rzhavozems”.

CONCLUSIONS

1. A comparative-geographical analysis of the factors responsible for soil formation and the published descriptions of soil profiles allow to introduce some proposals concerning the concept of palevye soils, that are widely spread in Yakutia, and elucidate their position in the soil classification of Russia. The soils with the non-differentiated profile on silicate acid, intermediate and mafic rocks, a part of which has been identified as palevye soils, may be referred to three different orders. The loamy icy-frozen soils with the shallow permafrost on acid and mafic rocks – to the order of cryometamorphic or ferruginous-metamorphic soils; the soils on stony and (loam)-sandy rocks of different chemical and mineralogical composition with the deep permafrost – to the order of ferruginous-metamorphic soils, and the stony soils with the shallow profile (about 30 cm) – to the order of lithozems.

2. This conclusion is possible, but needs further studies. The other solutions can entail considerable changes in the classification system. So, it is possible to identify the order of palevye-metamorphic (non-carbonate) soils and to name it as the order of accumulative-carbonate palevye-metamorphic soils. In the order of palevye-metamorphic soils


PALE CARBONATE-FREE SOILS
Lithozems
Soddy lithozems
Raw-humus lithozems
Light-humus lithozems
Iron-metamorphic
Raw-humus rzhavozems
Typical rzhavozems
Rzhavozemss pale-metamorphized
Rzhavozems iron-granulated pale-metamorphized
Soddy rzhavozems
Typical rzhavozems
Rzhavozems pale-metamorphized
Rzhavozems iron-granulated pale-metamorphized
Cryometamorphic
Soddy cryometa-morphic
Cryometamorphic pale-metamorphized
Raw-humus cryom-etamorphic
Cryometamorphic pale-memetmetatamorphozed
1
2
3

подпись

proper the following types may be distinguished: typical palevye, raw-humus palevye, organo-palevye soils as well as subtypes including podzolized palevye and gleyic palevye.

3. When preserving the order of palevye-metamorphic soils, it seems reasonable to include in it the types or subtypes of soils with the undifferentiated profile: typical or soddy palevye, raw-humus palevye, organo-palevye (non-carbonate), residual-carbonate palevye, dark-humus residual-carbonate palevye (palevye-gray) soils. The accumulation of carbonates and soluble salts corresponds to diagnostic features.

4. To solve the problem relating to advisable changes in the soil classification of Russia, it is necessary to expand geographically the areas occupied by palevye carbonate and non-carbonate soils including their differentiated types.

5. The broad distribution of intergrades permits to divide them into subtypes that are not strongly type-bound. Different subtypes can be recognized in the soil type including the complicated ones to reflect adequately the soil properties and to demonstrate them on the map in view of a great diversity of cryological, lithologic-geomorphological and other conditions. At the level of species it would be advisable to introduce the name of "above-frozen-gleyic" used rather frequently in soil descriptions.

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