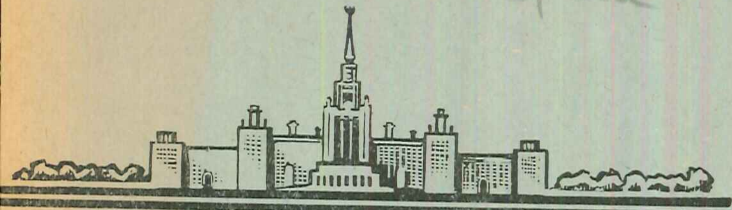

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«SOIL CLASSIFICATION AND NOMENCLATURE USED IN SOVIET PEDOLOGY, AGRICULTURE AND FORESTRY»

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SOIL CLASSIFICATION AND NOMENCLATURE USED IN SOVIET PEDOLOGIE, AGRICULTURE AND FORESTRY

First data concerning soils of the european part of the USSR were obtained in the forties of the last century. Basing on them K.S. Veselovsky ten years later compiled a soil map of the European Russia, where for the first time he designated areals of chernozemic soils.

Further investigators, such as I.I. Wilson, and especially V.I. Chaslavski made this map more detailed. They have taken into account peasants' experience and peasants knowledge on soils that were summarized with the help of statistics.

In the eighties V.V. Dokuchaev and N.M. Sibirtzev worked out the principles of natural historic soil theory and layed down the foundation of genetical soil science. Their ideas about the essence of pedology, connection of soils and geographical surroundings are well known.

Old knowledge were not entirely rejected. They were assimilated in new classification system and general soil map of V.V. Dokuchaev and N.M. Sibirtzev.

Pedologists of Dokuchaev soil school consider soil properties together with all processes and phenomena in the solum in a close connection with their causes. This point of view, known as ecologic-genetical approach is taken as a basis for the classificational system.

The ecologic-genetical approach, as Dokuchaev used to emphasize, is based on morphological, physico-chemical and other soil properties studied in a genetical aspect. Thatswhy investigation of each soil profile comprises a large complex of phenomena, consisting of 3 ingredients : soil properties-soil-forming processes - agents of soil-formation.

Such a general approach to the analysis of soil phenomena requires much labour, but prevents us better from errors, as if each ingredient were studied separately.

Genetical soil types theory and its approbation

Soil classification used in the Soviet Union is based on the genetical soil types theory elaborated by V.V.Dokuchaev, N.M. Sibirtzev and supplemented by K.D. Glinka and L.I.Prasolov. The latter gave the shortest and in the same time the most precise definition of a soil type. According to Prasolov the genetic soil type is characterized by unity of origin, substance transformation, migration and accumulation. Term "unity" is understood here in a general sense and is replaced by some scientists by terms : "similiarity" and "uniformity".

Genetic soil types are not the superior classificational units, but are the most essential ones. Beginning with them the whole system develops on higher and lower taxonomic levels (soil classification in "sensu strictu" and soil systematic). The taxonomical system below the type level is thoroughly elaborated and comprises subtypes, genera, species, subspecies and categories. It is approved by Soil Science Society Classificational Commission.

The taxonomical system above the type level is less elaborated. It comprises soil classes, subclasses, ranges;

soil associations and families are suggested too.

Genetical soil type theory as a classificational basis was approbated by further investigations successfully in its main part. In the time of its creation there was not as much material as now, but owing to the geographical approach used many type groups and separate soil types were defined correctly.

New discoverings in pedology enriched this system and made more precise. We mean the following important moments in the development of pedology :

1) Soil absorption complex theory and composition of exchangeable cations (K.K. Gedroitz);
2) Theory of weathering tendences and crusts of weathering (B.B. Polinov);
3) Humus composition theory (I.V. Tiurin and oth.);
4) Water regime theory (G.N. Visozki, A.A. Rode).

Main results of these fundamental investigations confirmed the existed classificational limits.

Agrochemical characteristic of the soils of the USSR being published in the last time is based on the genetical soil type system too.

The vitality of the classification accepted in the Soviet Union is proved by its wide application in agriculture and forestry.

Of great importance is the soil terminology elaborated on the basis of this system and taking into account many popular terms.

Classificational system above the type level

This part of the classificational scheme is not quite ready. Several approaches are suggested / 1) physico-chemical groups or type ranges (K.K. Gedroitz), 2) bio-chemical groups or ranges (L.V. Tiurin), 3) soil groupings according to water regime types (A.A. Rode, 4) soil grouping on the basis of types of organo-mineral reactions (V.R. Volobuev), 5) geochemical associations (M.A. Glasovskaya), 6) ecologic-genetical classes and subclasses (E.N. Ivanova, N.N. Rozov), 7) energetical classes and historic-genetical ranges (V.A. Kovda). All these approaches are competent and none of them may be rejected while elaborating the superior classificational ranges. Thatswhy the classificational system above the type level must be complex. Possible ways of the solvation of this problem are discussed in other communications at our Symposium,

The main task of the present report is a detailed information about the soil systematic used in the Soviet Union.

Systematic of the soils of the USSR

In the last few years (1962-1966) the Dokuchaev Soil Institute on the Ministry of Agriculture initiative carried out a work of compiling a systematical list of the soils of the whole country.

The tasks of such a work were : 1) to detalize the existing classification, introducing additional subtypes and genera for a more complete estimation of hydro-thermical soil regimes, important in agronomical and melioration practice.

2) Tables, illustrating the systematical subdivision of each soil type,

3) diagnostic criteria.

In the present communication we may discuss only a part of these materials, exactly :

table I - Complete systematical list of soils of the USSR

table II - General diagnostic characteristic of the main soil types of the USSR

table III - Systematical subdivision of the Chernozem type (as an example of soil systematic below the type level)

table IV - Diagnostic of Chernozem subtypes.

The systematical list of genetic soil types

Among the soils of our country having such a vast territory from arctic deserts to subtropics 110 soil types may be distinguished. The system of soil grouping at lower classificational levels is founded on 3 coordinate axes.

The first of these axes allows to combine genetical types in ecologic-genetical classificational groups (classes) according to soil essential properties. Among the latters we have taken into account such properties that are most closely connected with natural surroundings and are to the least extent subjected to alterations under the melioration influence. We mean at the first place the thermical regime of soils and energetical balance of soil-formation, that the mankind with all its powerful technique can't yet govern. We mean also certain peculiarities of hydrological regime depending on

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athmospheric moistening. For their alteration additional quantities of fresh water are required, while among other natural resources, fresh water supply is rather scarce.

With those fundamental features of soil formation other ones are connected, exactly :

1) seasonal biological rhythms, of soil processes, conditioned mainly by soil temperature and soil humidity; 2) general tendency, intensity of weathering; 3) general aspect of substance migrations; 4) main peculiarities of biological turn=over of nitrogen and ash-elements.

Ecologic-genetic soil groups correlate with the types of agriculture and forestry.

The second coordinate corresponds to genetical soil ranges indicated by S.S. Neustruev in connection with oro-hydrological peculiarities of soil formation. Later on they were elaborated by I.P. Gerasimov, A.A. Zavalishin, E.N. Ivanova.

Genetical soil types in the systematical list are grouped in 4 genetical ranges : 1) automorphic, 2) weakly hydromorphic-alluvial, 3) semihydromorphic, 4) hydromorphic.

Hydromorphic-alluvial soils are placed in corresponding nonalluvial ranges because of superficial alluvial accumulation combined with other forms of hydrogenic accumulation.

In each ecologic genetic group (class) hydrogeological processes, determining range definition coincide with many other processes (salinization, gley, humification, peat-accumulation etc.). Such combinations account for the peculiarity of soil formation.

The idea of soil subdivision according to orohydrological peculiarities had long ago received a practical use. It reflects the character of substance migrations and accumulation in soils. It serves as a basis for the theory of complexes and combinations and theory of soil survey. It is considered in cadastral work, by typisation of natural pasture resources and in forest taxation. At last it becomes of greatest value in working out drainage projects, especially in cases where irrigation may bring about secondary salinization.

Third coordinate - biophysic-chemical soil ranges. According to K.K. Gedroitz and I.V. Tiurin 5 bio-physico-chemical soil ranges may exist : they are displayed according to 1) peculiarities of organic-matter decomposition, 2) saturation of absorption complex and cation composition, 3) general structure of soil profile and presence of carbonates, gypsum and soluble salts.

These ranges are accepted by science and practice. They serve as a basis for the theory of chalking, gypsum-melioration and fertilization. But it is a well-known fact, that soils of different classes, different genetical ranges, but of the same bio-physic-chemical range react differently to agrochemical and meliorative applications and require special complex of measures.

Trying not to overload the systematical list we omissed 2 important coordinates - lithological and historic-genetic soil ranges.

Lithologic ranges were included formely in our previous schemes as "lithogenic subclasses" in each ecologic-genetical group. As for historical ranges, they must be sought in historical links between alluvial, hydromorphic and automorphic soils. Historical connections may be discovered also between some automorphic soils, f.i. between Chernozems, Grey Forest and Podzolic soils.

Soil type characteristic

Definition and diagnostic of soil types in present systematic is based on a broad complex of soil properties, including : 1) profile morphology, 2) mineral and chemical composition together with the composition of organic matter, liquid and gaseous phases of the soil, 3) physico-chemical properties, 4) hydro-thermical, gaseous and biological regimes.

All soil properties may be divided into 2 great groups : a) those determined directly in the field and by a system of trivial soil analyses (diagnostic signs properly), exactly : profile morphology, distribution of humus, exchangeable cations, textural fractions in the solum etc.; b) determined with the help of special investigations (diagnostic signs of classificational importance) such as water, thermical gaseous, biological regimes, dynamic of nutritive elements and seasonal variations of substances; subtle peculiarities of chemical composition of organic and mineral soil parts etc.

Both groups of properties being in the close relation, it is possible to consider all of them while elaborating the systematic, and to use mainly the first group in soil survey.

As there is no possibility to discuss in the present report the whole complex of signs of both kinds we give in table II only the main systematic and diagnostic criteria for 15 main soil types that were disclosed through leading processes and most important phenomena, determining genetical and agronomical soil properties.

In the table II, in the second column main data characterizing water regime type, its seasonal variations and depth of moistening are found. They show essential differences between genetical soil types in substance migrations and water supply for chemical and biological soil processes. The 3 and 4 column present approximate figures for 2 important characteristics of thermical regime : 1)of temperature root-containing layer in July and 2) t° gradient between the upper soil layer and subsoil for the same month. The temperature of subsoil corresponds approximately to the calculated temperature of isothermal layer.

The fifth column contains a list of main soil-forming processes determining type definition and data about the depth of soil formation.

The soil forming process theory comprises two main approaches to the study of soils closely related. One of the approaches considers soil properties, the second - agents of soil formation.

Each genetical soil type possesses a lot of different properties and signs.

Relations between these properties may be understood only from the point of view of predominant soil processes. The process notion allows to bind some properties in genetic complexes. In the soil system we now consider the prevailing importance is reserved for modern soil processes, meaning by them processes corresponding to present hydro-thermical soil regime. The latter accounts for the prevailing tendency in the agricultural use of soils.

All soil processes, and essential at the first place are in some way reflected in the soil profile. Under the term "genetic profile" we imply not only morphological profile, but also a physico-chemical and hydrothermical profile stated by analyses and stationary observations. We support B.B.Polinov's idea about the soil profile as a complex of particular profiles each one according to elementary processes and phenomena. Its further development this idea received in I.P.Gerasimov works.

The 6 column of the same table contains schemes of soil profiles for main types. The system of horizons is ABC, the most popular in the USSR, with small additional letters and figures.

Additional letters signify : humus composition (f - fulvic, f-g - fulvic-humic, g - humic), exchangeable cation composition (Ca, Na), gley (g), presence of cryogen (m) and always cold (h) soil horizons; argilification (og), calcium carbonate (k) and salt (s) accumulation.

In each concrete soil profile besides the main horizons shown in the table, additional horizons are always present, and they allow to name the soil according to its subtype and generic attitude.

All soil horizons are mutually related in the same degree as soil processes are.

Separation and characteristic of soil subtypes

A genetical subtype is the next taxonomical unit in soil systematic. It reflects gradual changes of soil properties between soil types. Transitions between authomorphic soil types are displayed in hydrothermical regime alterations, and between authomorphic and hydromorphic - in hydrological regime alterations. Alongside processes of accumulation and transformation of organic matter are changed together with processes of migrations of mobile substances in the solum.

Genetical criteria (processes, phenomena) for subtypes definition are given in the 7th column. Among them of great importance are : intensity of humus - and organic matter accumulation, tendency and forms of migrations of carbonates, gypsum, soluble salts and other substances, depth of winter cooling and summer heating, etc.

Many soil processes are seen clearly in genetic profiles of subtypes, hence their quantitative expression might be found.

As an example we should like to consider chernozemic subtypes.

The subdivision of chernozem type to subtypes is shown in the table II. Geographically each subtype is characterized by its distribution in a certain subzone and a certain facies of the whole zone in the same time.

Examples of quantitative characteristics for loamy and clay subtypes are given in the table IV. It illustrates, first, diagnostic indications of soil definition properly (humus content, depth of humus horizon, humus supply in the solum, pH, depth of effervescense) and, secondly, diagnostic signs of classificational value, giving a quantitative characteristic for hydrothermal regime of various subtypes and their biological productivity. Among them it seems necessary to cite : stock of productive moisture in the soil in a certain time, depth of winter freezing and summer heating, agricultural productivity according to different land-use scales, etc.

It is interesting to pursue the alteration of those signs in main ranges of chernozemic subtypes.

From podzolized chernozems to the southern in each facies the first changes concern the water regime. They are revealed through decrease in humus content and intensity of leaching. Moving from warm facies to cold ones in the limits of chernozem zone we see first some alterations in the thermical regime, especially in that of profound horizons, then a certain decrease of humidity follows, the chernozems become less deep, but frequently more humic. Carbonate individualizations and depth of salic horizons also change due to other kind of seasonal moistening variations.

Despite all the alterations considered the biogenic essence of the soils remains. The soils are chernozemic although with different natural and agricultural productivity. In each subtype specific chernozemic processes develop, and the humus content in the profile range in certain limits.

In the same way other soil types are subdivided. From northern to southern boundaries of taiga zone the following groups of podzolic subtypes replace each other : 1) gley-podzolic, with a climatic superficial gleying, transitional to tundra soils; 2) typical podzolic; 3) sod-podzolic soils, transitional to grey forest soils. In the podzolic zone from west to east among the groups cited we can distinguish various subtypes, exactly : 1) warm, 2) moderately-warm, 3) cold, 4) long-frozen. The first ones are genetically close to brown forest soils; and are called sod-pale-podzolic, the latter - to cryogen-taiga soils.

Investigations of last few years revealed great differences between all the subtypes of podzolic soils. They are not less than those of chernozems and concern morphological features, forms of organic matter accumulations, various soil regimes. They may also account for essential differences of podzolic soils in agricultural and forestry respect.

Soil genera

Soil genera are very important soil units within the subtypes. They were suggested by N.M. Sibirtzev.

Nowadays genera are defined according to a complex of genetical properties explained by peculiarities of parent rock, composition of ground waters or some relic features. Generic indications in soil morphology are revealed in certain alterations of properties of main genetic horizons, or in their displacement, or in the appearance of additional horizons in the typical structure of soil profile.

Among the above-mentioned Chernozemic subtypes the following genera are distinguished :

usual - possessing all properties of subtypes developed on clays and loams;

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with a weak profile differentiation - formed on sands and loamy sands, poor in humus, with a weakly structured humus horizon and undistinct carbonate-illuvial horizon;

noncalcic - without carbonate-illuvial horizon on noncalcareous rocks;

with a deep effervescense - with a lowered carbonate horizon. In comparison with "usual" they are restricted to loamy parent material with a higher water permeability;

calcic - on hard calcareous rocks and calcareous clays with residual calcium carbonate on the surface;

solonetzic - with a solonetzic horizon and other signs of alkalinization, due either to original salinity of the parent rock either to its secondary salinization in the previous phase of hydromorphic soil formation;

solodized - having a solodized horizon or other signs of solodization for the same reason as in case of solonetzic horizons;

vertisolic - with compact humus horizon, sometimes with a special "vertisolic" horizon usually inherited from the previous phases;

lithogenetically-acid, found on shales or sandstones with acid reaction;

contact-meadowish - developped on lithogenically discontinuous parent materials and having indications of extra-moistening and gley on contacts between layers.

Among the subtypes of podzolic soils the following genera may be distinguished :

iron-illuvial - mainly on light-textured sediments with a distinct iron sesquioxides - enriched illuvial horizon;

humus-illuvial - also on light-textured rocks, having a dark humus enriched B horizon with a relatively high proportion of fulvic acids (in comparison with A_1);

secondary podzolic - conserving a relic humus colouring under the A_2 horizon. The humus composition in this relic "secondary" humus horizon is more humic, than in A_1 horizon;

residual hydromorphic - inheriting some signs of former hydromorphic soil-formation, etc.

As seen from the table II, column 8, soils of each ecologic-genetical group have their own specific generic properties, but few genera are common for any groups.

Generic subdivision reflects the influence of parent rock on soil formation and properties. It is very important in agriculture and forestry, determining the choice of agrotechnical measures. It should be taken into account by elaboration of meliorative projects.

Soil species

Soil species are defined within genera on the basis of quantitative indications displaying the intensity of main soil-forming processes. Usually 3 types of signs are used :

1) depth of a certain horizon in cm;

2) quantity of a certain substance or group of substances in one of soil horizons, expressed in %;

3) supply of a certain substance or group of substances in the solum in t/ha, or kg/m^2.

In soil survey the intensity of process is measured visually and after gathering analytical data is replaced by more precise figures.

Having a rather developped system of field-stationary and laboratory investigations, we receive many qualitative characteristics. Among them the most important are chosen.

For chernozems such are always figures of the depth of humus horizon and intensity of humus accumulation, then - depth of leaching and degree of alkalinization.

The most important species criteria for podzolic soils concern the depth of podzolic horizon and intensity of podzolization, then - degree of humus-accumulation or development of humus-illuvial process, etc.

Soil type, subtype and genus determining choice of agrotechnical, forestry and meliorative applications, soil species helps to establish necessary intensity of those measures.

Soil varieties, categories and phases according to erosion and deflation

Soil varieties, categories and phases, being in the second part of the taxonomical system are extremely important both for soil characteristic and for its agronomical and forestry evaluation. These taxonomical units form a special part of soil systematic, closely connected with geological phenomena.

Soil variety separation is based on textural analysis data. The latter is done by a pipette method in Kachinski modification applied to Stoks rapidities.

Two scales for textural subdivision of rocks and soils. The first one is based on the quantity of particles smaller than 0,01 mm (fine earth). The second scale deals with mutual relation of sand (1-0,05 mm), silt (0,05-0,001 mm) and clay ($\not<$ 0,001 mm) fractions. The notion of prevailing fraction is admitted and soil texture receives one more characteristic.

Soil categories are defined according to petrographical peculiarities of rocks, meaning their origin, fabric and lithological composition.

In soil nomenclature the category separation is made with help of rock name (f.i. a moderately podzolic humus-illuvial loamy sandy soil on old alluvial sand). Such a parent-rock definition often implies soil age and previous stages of evolution.

In distinguishing soil phases changes due to erosion and deflation are considered. Soil phases reflect the influence of destructive geological phenomena on soil cover, sometimes accelerated by human activities.

4 grades of soil erosion and deflation are suggested :

1) weak - only the upper part of A horizon is removed;
2) moderate - the lower part of A horizon (A_2 in podzolic soils) is truncated;
3) stony - the B horizon is partly truncated;
4) very stony - a greater part of B horizon is absent.

This general system is controlled for each soil type by some additional criteria. The depth of eroded horizon by the same erosional grade may be different in various soil types and depends on profile structure and depth of upper horizons.

Presently some additional criteria for deflated light-textured soils are applied. The reason for it is the fact of blowing out fine fractions from the humus horizon. Hence the decrease in soil fertility even without any shortage of the solum All the kinds of erosional processes influence the soil formation greatly. Besides erosional and deflation phases, phases according to deluvial and eolian burial are distinguished.

Cultural soil formation and grades of soil alterations under cultivation

Usual measures applied to soils in the process of reclamation concern mainly water and nutritive regimes and, to a certain extent, thermical and gaseos regimes. Alongside some alteration in cation composition, degree of saturation, soil reaction, and aggregate state of the soil take place. This changes, being rather irreversible may store in the profile from one rotation to the other. Still more deep alterations are brought about by melioration. Thatswhy it is suggested that the cultural and cultivated soils should be divided into "agrogenic" and "meliogenic".

Nowadays much attention is paid in our country to the processes in cultivated soils and their systematic. Comparison of cultivated and virgin soils helped to draw several alteration grades : 1) strongly cultivated soils; 2) moderately sultivated; 3) weakly cultivated; 4) newly reclaimed; 5) outplowed soils. In different soil types criteria are different.

For how long properties due to cultivation may conserve in the soil?

Experience confirms their stability only by periodical repetition of agrotechnical and meliorative measures. In the opposite case the cultivated soils begin to regress to their primary state, corresponding to natural regime. Hence the great attention paid in cultivated soil systematic to the primary soil features determination. Consequently, the cultivated soil name comprises the virgin soil name and the grade of cultivation.

The accepted approach to cultivated soil systematic allows to estimate easier results of some changes in agrotechnical and meliorative measures.

Soil nomenclature

Soil nomenclature accepted in the Systematical List is based on soil terminology widely used both in scientifical work and in practice. It originates from popular soil names and is now applied according to certain rules. Its substitution by any artificial system is considered useless.

In the soil name the type name, as the most important, is given at the first place.

For soil type designation the colour principle is used. The colour of the upper horizon is combined with suffix "zem" (land) - chernozem, serozem, krasnozem, geltozem, or with a word "soil" : chestnut soil, cinnamonic soil etc.

Besides colour names, some terms reflecting main soil type properties are used - solonetz, solonchak, sod-grey soil.

It became evident owing to much knowledge about soils gained, that soils of different genetic types have the same colour of the upper horizon. Thatswhy the necessity of adding essential factor characteristic appeared : brown forest soils, brown semidesertic soils.

In certain cases ecological characteristic, closely connected with soil properties prevail in the type name, f.e. tundra soil, meadow-bog soil, etc.

The subtype nomenclature is based either on some terms devising soil properties (podzolized, leached, sod, etc.) or on words showing subtypes location (northern, southern) or differences in thermical regimes within the type (warm, cold).

All these terms together with the type name disclose clearly genetical transitional grades between soil types. The central subtype in such a range is called "typical".

Generic nomenclature is formulated independently and is entirely based on terms, reflecting soil properties (carbonatic, solonetzic, saline, contact-gley, iron-hardpan etc.) or some relic features (residual-meadowish, residual-hydromorphic etc.). Soil genera on clays and loams without any additional marks are ordinarily called "usual".

Species nomenclature takes into account terms displaying quantitative grades of processes and phenomena. They may be used independently (deep, moderately-deep, shallow, rich, with a low humus content) or combind with subtype (sod weakly podzolic, sod-podzolic, sod strongly podzolic) or generic nomenclature (strong, moderately, weakly solonatzic).

Variety, category, phase and cultivation grades nomenclature is discussed in the foregoing pages.

The whole nomenclature system embraces several hundreds of soil subdivisions considering varieties, categories and phases. Their recognition requires about 150 main terms, used independently and in combinations.

The convenience of this nomenclature consists in reflecting soil properties in taxonomical definitions, also in easy memorizing without special learning.

The main failure, to our notion, - soil names are too complicated.

In practical use many soil names are abbreviated; in legends they are given only in titles, and in colloqual speech are simply implied.

In cartography a system of figures and letters is widely spread. It was founded by L.I. Prasolov. Type, subtype and generic subdivision are shown on the map by letters, all the others - by figures.

We have discussed briefly the soil classification and nomenclature elaborated by pedologists of the Soviet Union and accepted both in scientifical institutes and in practice. Main ideas of this schema have much in common with classifications and nomenclatures existing in other countries.

GENERAL DIAGNOSTIC CHARACTERISTIC OF MAIN SOIL TYPES OF THE USSR

Genetic soil types (examples)	Water regime	Thermical regime (approximate data): Main July t° (in A hor)	t° of isothermal layer	Main soil type determining processes
1	2	3	4	5
Arctic soils	Cryogenic with a slight extramoisteening	+2° +6°	-8° -5°	Weak accumulation of weakly unsaturated humic-fulvic humus Weak gley process in the active layer Distinct cryogen phenomena and microrelief formation of polygonal profile type depth 30-40 cm
Tundra soils	Cryogenic with a long period of moistening	+6° +10°	-8° 0	Superficial dry peat-formation (knobs) Unsaturated fulvic mobile humus formation Suberficial and over-cryogenic gley Cryogen phenomena and microrelief-formation of knobby and polygonal types with cracky thermocarst. Profile depth 30-100 cm
Cryogenic taiga soils (without pale soils)	Cryogenic percolated with a seasonal surface-water on the perma frost	+10° +14°	-10 0	Accumulation of unsaturated and weakly saturated fulvic and brown-humic fulvic, often mobile humus Weak gley process and humus retinization in the supercryogen layer Salt and carbonate leaching cryogen phenomena with local microrelief-formation of cracky and partly knobby types with thermocarst Profile depth 50-150 cm

Table II

Main genetic horizons	Subtypes are subdivided according to : (processes and phenomena)	Genera are subdivided according to : (phenomena and properties)
6	7	8
A_f humic B(g) transitional, weakly gleyed Cm - cryogenic	Development and forms of humification and depth of active layer (Desert-arctic, typical, arctic)	Worked out Not studied
A_f(g) humus gleyic Bg transitional gleyic	Forms of humification Balance of superficial and overcryogenic gley Existance of podzolization	Distinctness of gley process dependently on texture Existance of humic-illuvial horizon
Af humic B(g) transitional	Existance of : Superficial (climatic) gley Podzolization	Depth of summer thawing depending on rock properties. Existance of residual carbonatic horizon Existance of residual signes of hydromorphic soil formation

1	2	3	4	5
Podzolic soils	Permacide	$+10^0$ $+8^0$	-1^0 $+5^0$	Formation and partial accumulation of mobile fulvic and humic-fulvic humus Podzol-forming process (podzolization and partial lessivage) salt and carbonate leaching Profile depth - 100-200 cm
Bog-Podzolic soils (superficial moistening)	Periodical alteration of permacide and stagnant water regimes	-	-	Superficial accumulation of organic matter Mobile fulvic and humic-fulvic humus formation with its partial accumulation Gley-podzol-forming process Gleying of the solum
Grey forest soils	Periodically permacide	$+16^0$ $+20^0$	$+1^0$ $+8^0$	Accumulation of weakly saturated fulvic-humic and humic-fulvic humus Podzolization (lessivage and partly podzol-forming process) Formation of illuvial-carbonate horizon at a certain depth Salt-leaching Profile depth 150-200 cm
Brown forest soils	Permacide	$+16^0$ $+22^0$	$+4^0$ $+40^0$	Formation with partial accumulation brown-humic-fulvic unsaturated humus Argillification throughout the profile (of hydromicaillite-type) Leaching of salts and carbonates out of the solum and the crust of weathering

6	7	8
Af-h humus A_2 podzolic B illuvial or transitional C - leached	Existance of superficial (climatic) gley Forms of humification (typical, sod) Depth and intensity of winter freezing and summer warming	Presence of : Iron - illuvial horizon humus-illuvial horizon Contact-gley horizon Residual carbonate horizon Relic "second" humic hor. etc.
o A_{fg} organic A_{fg} humic A_{2g} podzolic Bg illuvial Cg gleyed C not gleyed, leached	Development and forms of humification Type of moistening (superficially and ground-water gleyish and gleyed) Intensity of winter freezing and summer warming	Presence of : humus-illuvial horizon iron hardpan Contact-gley horizon Relic "second" humus horizon etc.
Afh humus AB - transisional B illuvial C leached Ck calcic	Development of humus accumulation (light grey, grey, dark grey soils) Character and intensity of podzolization Intensity and depth of winter freezing and summer warming	Presence of : Relic "second" humus hor. Contact-gley horizon Vertisolic horizon Residual lithogenic-calcic horizon etc.
A fh humus $B^{\alpha g}$ transitional C -leached	Existance of podzolization, lessivage and pseudogleyification Degree of saturation (acid, weakly unsaturated) Intensity and depth of winter cooling and summer warming	Presence of : Residual carbonate hor. Ancient ferrallitic hor. etc.

1	2	3	4	5
Chernozems	Impermacide with a profound moistening in wet years			Humic. Ca-saturated humus accumulation in a deep root-containing layer Carbonate migrations in the solum together with their general leaching and formation of carbonate-illuvial horizon Salt leaching or formation of deep salt illuvial horizons Profile depth-150-300 cm
Meadow-chernozemic soils (ground-water moistening)	Periodical alteration of water stagnant and weakly exsudative regimes			Humic Ca-saturated humus accumulation in the root-containing layer Secondary carbonate and salt migration against background of total leaching Gleying of the lower part of the solum up to the ground-water
Chestnut soils	Impermacide			Accumulation of humic and fulvic-humic Ca-saturated humus Carbonate migrations in the profile in certain cases of weak salt solutions Formation of salt- and carbonate-illuvial horizons Profile depth 100-200 cm

6	7	8
A_h^{Ca} humus $AB_{(k)}$ transitional with humus Bk carbonate-illuvial Ck carbonate	General humus accumulation in the profile (humus reserves) Existance of podzolization and leaching Type of carbonate migration in the profile and forms of their individualization (pseudomycelium, farinaceous carbonates) Depth of salt-leaching Depth and intensity of winter cooling and summer warming	Place in the profile of the carbonate-illuvial horizon depending on the rock composition Presence of : solonetzic horizon vertisolic horizon lithogenic-carbonate hor. contact-gley horizon etc.
A_h^{Ca} humus AB transitional with humus $B_{k(g)}$ carbonate illuvial gleyed Cg carbonatic gleyed, below-ground-water	Type of moistening (superficial, ground-water) Distinctness of meadow process (meadowish or meadow-chernozemic) Intensity of winter cooling and summer warming	Presence of : Podzolized horizon solodized horizon solonetzic horizon solonchak horizon vertisolic horizon etc.
A_h^{Ca} humus $B_{(k)}$ transitional B_{ks} carbonate salt-illuvial C_s carbonate - saline	Total humus accumulation (dark chestnut, chestnut, light chestnut) Forms of migrations and individualization of carbonates in the profile and degree of salt leaching Intensity and depth of winter cooling and summer warming	Place in the profile of the carbonate-illuvial horizon depending on the rock composition Existance of solonetzic horizon solodized horizon solonchak horizon relic humus horizon on river terraces, etc.

1	2	3	4	5
Meadow-step chestnut solonetz (ground-water Moistening)	Impermacide with a periodical capillary ascention			Accumulation of humic fulvic Na, Mg and Ca-saturated humus solonetz process Salt migrations against the background of their gradual leaching Gleying of the lower part of the profile up to the ground-water
Brown semi-desertic soils	Impermacide with a shallow spring-summer moistening	$+22^{0}$ $+28^{0}$ and more		Formation and small accumulation of humic-fulvic Ca-saturated humus Carbonate and weak salt-solution migrations in the profile Profile depth 80-100 cm
Grey-brown desertic soils	Impermacide	$+26^{0}$ $+32^{0}$ and more		A very small accumulation of humic-fulvic Ca-saturated humus Carbonate migrations with surface enrichment Salt migrations with accumulation in the sub-humus horizon Iron oxides dehydratation Profile depth about 50 cm
Geltozem	Permacide	$+20^{0}$ $+26^{0}$		Formation and accumulation of unsaturated mobile fulvic humus Argillification throughout the profile (of kaolinite and halloysite type) Salt and carbonate leaching out of the solum and crust of weathering Profile depth about 200cm

6	7	8
A_{fh}^{Na-Ca} humus B_{sol}^{Na-Ca} solonetzic B(g) transitional C_{ksg} carbonate-saline-gleyed below - groundwater	Forms of solonetz process development ("solonetz-solonchaks", typical, solodized, "nonnatric") Distinetness of meadow process (meadowish- and meadow-step) Intensity of winter cooling and summer warming	Salt composition (sodic, compound, chloride, sulphate) Depth of dypsum
A_{fh}^{Ca} with a low humus content $B_{(sol)}$ transitional B_k carbonate-illuvial C_{ks} carbonate-saline	Not worked out	Presence of : solonetzic horizon leached horizon depending upon rock composition Anciently saline horiz. Residual gypsum hor. etc.
A_{fh}^{Ca} with a low humus content carbonatic B_{ks} transitional carbonate-saline C_{ks} carbonate-saline with gypsum	Degree of superficial carbonate enrichment (carbonatic, poor in carbonates)	Presence of : solonetzic horizon residual gypsum horizon
A_f humus B transitional C leached	Saturation degree (not saturated, weakly unsaturated) Existance of podzolization (lessivage and pseudogleyification) Possibility of winter cooling	Presence of residual-carbonatic horizon

1	2	3	4	5
Cinnamonic soils	Hot percolated or weakly percolated with a profouned winter moistening	+22° +27°		Considerable accumulation of mainly humic Ca-saturated humus (in neutral alkaline medium) Formation of carbonate-illuvial horizons Salt leaching out of the profile Profile depth more than 200cm
Grey-Cinnamonic soils	Hot percolated with winter moistening	+23° +28°		Accumulation of Ca-saturated humic and humic-fulvic humus Weak in neutral medium Carbonate migrations locally to the surface and formation of carbonate-illuvial horizon Profile depth surpasses 200cm
Serozems	Hot percolated with a slight winter moistening	+24° +30° and more		Small accumulation of humic-fulvic Ca-saturated humus crypto (in neutral alkaline medium) Carbonate migrations with ascendant movements, accumulation throughout the profile and certain leaching of humus horizon Soluble salts are present in small quantities in the lower part of the solum Profile depth about 200 cm

6	7	8
A_h^{Ca} humus B^{ag} textural-metamorphic C_k carbonatic	Degree of carbonate-leaching and depth of carbonate-illuvial horizon (leached, typical, carbonatic)	Presence of : lithogenic-carbonate hor. Residual solonetzic hor. Ancient saline horizon Residual meadow process indications etc.
A_h^{Ca} humus B^{ag} textural-metomorphic carbonatic C_k carbonatic	Development of humus accumulations (dark, usual, light)	Presence of : solonetzic horizon ancient saline horizon ancient gypsum horizon Residual signes of meadow process Pebble layers etc.
A_{fh}^{Ca} with a low humus content B_k transitional cryptotextural carbonatic Ck/s/ carbonatic, salts are possible	Degree of superficial humus accumula tion (light, typical, dark) Intensity of carbonate migrations in the solum (rich or poor in carbonates) Distinctness of	Presence of : Ancient saline horizon Solonetzic horizon Pebble layers etc.

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