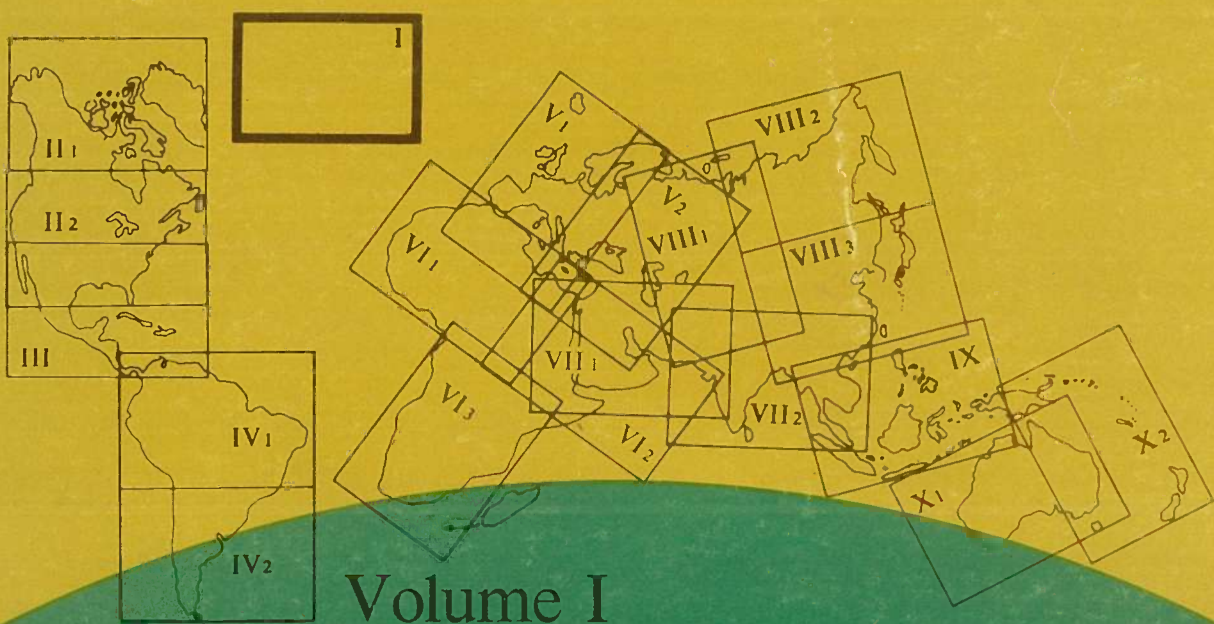
FAO-Unesco

Soil map of the world

1:5 000 000



Volume I
Legend

Unesco

FAO-Unesco

Soil map of the world

1 : 5 000 000

Volume I

Legend

FAO-Unesco

Soil map of the world

Volume I	Legend
Volume II	North America
Volume III	Mexico and Central America
Volume IV	South America
Volume V	Europe
Volume VI	Africa
Volume VII	South Asia
Volume VIII	North and Central Asia
Volume IX	Southeast Asia
Volume X	Australasia

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

FAO - Unesco

Soil map of the world

1 : 5 000 000

Volume I
Legend

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PREFACE

The project for a joint FAO/Unesco Soil Map of the World was undertaken following a recommendation of the International Society of Soil Science. It is the first attempt to prepare, on the basis of international cooperation, a soil map covering all the continents of the world in a uniform legend, thus enabling the correlation of soil units and the comparison of soils on a global scale. The project, which started in 1961, fills a gap in present knowledge of soils and soil potentialities throughout the world, and provides a useful instrument in planning agricultural and economic development.

The project has been carried out under the scientific authority of an international advisory panel, within the framework of FAO and Unesco programmes. The different stages of the work included comparative studies of soil maps, field and laboratory work, and the organization of international expert meetings and study tours. The secretariat of the joint project, located at FAO Headquarters, was vested with the responsibility of compiling the technical information, correlating the studies, and drafting the maps and texts. FAO and Unesco shared the expenses involved in the realization of the project, and Unesco undertook publication of the results.

The present volume is the first of a set of ten which, with maps, make up the complete publication of the Soil Map of the World. This first volume records introductory information and presents the definitions of the elements of the legend which is used uniformly throughout the publication. Each of the nine following volumes contains an explanatory text and soil maps covering one of the main regions of the world.

FAO and Unesco wish to express their gratitude to the government institutions, the International Society of Soil Science, and the many individual soil scientists who have contributed to this international project. Acknowledgement is made in the relevant volumes of the assistance received in each main region.

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1. INTRODUCTION

History of the project

Following consultations which took place on the occasion of the Sixth Congress of the International Society of Soil Science (ISSS) in Paris in 1956, it was decided that Commission V would give special attention to developing the classification and correlation of the soils of great regions of the world. In consequence, soil maps covering Africa, Australia, Asia, Europe, South America and North America — at scales ranging from 1 : 5 000 000 to 1 : 10 000 000 — were presented at the Seventh Congress of the Society held at Madison, Wisconsin, United States, in 1960. This Congress recommended that ways and means be found to publish these maps, which reflected a vast amount of knowledge accumulated in different parts of the world on the properties of soils and on their distribution. However, it was soon apparent that nomenclature, survey methods, legends and systems of classification varied widely and that comparisons were difficult.

In response to the recommendation of the Congress, and recognizing the need for an integrated knowledge of the soils of the world, FAO and Unesco agreed in 1961 to prepare jointly a Soil Map of the World in association with the International Society of Soil Science. This map was planned to be at a scale of 1 : 5 000 000 and based on the compilation of available soil survey material and on field correlation.

The secretariat of the joint project was located at FAO Headquarters in Rome.[1] It was responsible for collecting and compiling the technical information, undertaking the necessary soil correlation, and preparing maps and explanatory texts in cooperation with soil scientists from different countries.

[1] On behalf of FAO and Unesco the coordination of the project was assured by D. Luis Bramão (1961-68), L.D. Swindale (1968-70) and R. Dudal (from 1970). The Unesco secretariat for the project was composed of V.A. Kovda, M. Batisse and S. Evteev. Officers who were closely associated with the work of the FAO and Unesco secretariats were: O. Fränzle and K. Lange in Unesco; K.J. Beek, J. Bennema, M.J. Gardiner, R.B. Miller, A.J. Pécrot, J. Riquier, A.J. Smyth, J.V.H. Van Baren and A.C.S. Wright in FAO. General soil correlation was entrusted to R. Dudal.

Immediately upon the start of the project, FAO and Unesco convened an Advisory Panel, composed of eminent soil scientists from various parts of the world, to study the scientific and methodological problems relative to the preparation of a soil map of the world.[2]

At its first meeting, held in Rome in June 1961, the Advisory Panel laid the basis for the preparation of an international legend, the organization of field correlation, and the selection of the scale of the map and of its topographic base. The Panel met successively at Rome in July 1963, at Paris in January 1964, at Rome in May 1964, at Moscow in August 1966, and at Rome in January 1970. A first draft of definitions of soil units and of a correlation table were presented to the Eighth Congress of the International Society of Soil Science held at Bucharest in 1964. At the Advisory Panel meeting held at Moscow in 1966 a general agreement was reached on the principles for constructing the international legend, on the preparation of the definitions of soil units, and on the adoption of a unified nomenclature. It was on this basis that the first

[2] The participants in this first meeting of the Advisory Panel were: G. Aubert (France), M. Camargo (Brazil), J. D'Hoore (Belgium), E.V. Lobova (U.S.S.R.), S.P. Raychaudhuri (India), G.D. Smith (United States), C.G. Stephens (Australia), R. Tavernier (Belgium), N.H. Taylor (New Zealand), I.V. Tiurin (U.S.S.R.), F.A. Van Baren (Netherlands). V.A. Kovda and M. Batisse represented Unesco; D. Luis Bramão, R. Dudal and F. George participated for FAO.

In addition to those who participated in the first meeting of the Advisory Panel, the following soil scientists took part in successive panel meetings or acted as hosts to regional soil correlation activities: F.H. Altaie (Iraq), L.J. Bartelli (United States), M. Brambila (Mexico), D.A. Cappannini (Argentina), F. Carlisle (United States), N. Cernescu (Romania), J.S. Clayton (Canada), R. Costa Lemos (Brazil), W.A. Ehrlich (Canada), P. Etchevehere (Argentina), G. Flores Mata (Mexico), F. Fournier (France), V.M. Fridland (U.S.S.R.), I.P. Gerasimov (U.S.S.R.), J. K. Gitau (Kenya), S.V. Govinda Rajan (India), E.G. Hallsworth (Australia), W.M. Johnson (United States), Ch. E. Kellogg (United States), A. Leahey (Canada), D. Muljadi (Indonesia), S. Muturi (Kenya), H.B. Obeng (Ghana), M. Ohmasa (Japan), M. Oyama (Japan), R. Pacheco (Ecuador), S. Pereira-Barreto (Senegal), K.A. Quagraine (Ghana), B.G. Rosanov (U.S.S.R.), R.B. Tamhane (India).

Scientists who were associated with the project for most of its duration are listed on the legend sheet as scientific advisors.

draft of the Soil Map of the World was prepared and presented to the Ninth Congress of the International Society of Soil Science held at Adelaide in 1968. This Congress approved the outline of the legend, the definitions of soil units, and the nomenclature. In accordance with the recommendation of this Congress that the Soil Map of the World be published at the earliest possible date, the first sheets were printed in 1970.

Successive drafts of regional soil maps and legends were prepared from a compilation of existing material combined with systematic field correlation, to ensure consistent interpretation of the international legend. Major soil correlation activities were undertaken in South America (1962, 1963, 1964, 1965, 1966), Mexico and Central America (1965, 1967), North America (1965, 1966, 1972), Europe (1962, 1963, 1964, 1965, 1967, 1969, 1971), Africa (1961, 1963, 1970), South and Southeast Asia (1965, 1966, 1972), North and Central Asia (1962, 1964) and Australasia (1962, 1963, 1968). For Europe, the correlation work undertaken by the Working Party on Soil Classification and Survey of the European Commission on Agriculture was closely associated with the work of the Soil Map of the World.

The conclusions of the advisory panel meetings and the results of field correlation in various parts of the world were dealt with in 43 issues of the FAO/Unesco World Soil Resources Reports.

Objectives

The objectives of the Soil Map of the World are to:

- Make a first appraisal of the world's soil resources.
- Supply a scientific basis for the transfer of experience between areas with similar environments.
- Promote the establishment of a generally accepted soil classification and nomenclature.
- Establish a common framework for more detailed investigations in developing areas.
- Serve as a basic document for educational, research, and development activities.
- Strengthen international contacts in the field of soil science.

Quantitative and qualitative appraisals of soil resources on a global basis have engaged the minds of soil scientists from the beginning of the century. Estimates of land reserves have been made in terms of major soil groups, but the figures compiled from different sources varied widely. Such a variation in estimates reflects the problems which arise over the consistent interpretation of available source material, problems which have been given special attention in the preparation of the Soil Map of the World.

With the tremendous amount of knowledge and experience gained in the management and development of different soils throughout the world, the hardship perpetuated in some areas by methods of trial and error is no longer justified. However, the transfer of experience from one area to another has usually been prevented by the seemingly insoluble problem of comparing one soil with another and of describing it in such a way that people in other countries can recognize it.

The Soil Map of the World supplies a common denominator by means of which the correlation of research and experimentation can be made. Its general framework also provides a link between more detailed surveys.

A major obstacle to a comparative study of soil resources is that soils of the same kind have been given a wide variety of names in different parts of the world. This diversity in nomenclature not only reflects differences in vernacular but also varieties of approach to soil classification and dissimilarities among the criteria applied to separate soil units. The legend of the Soil Map of the World is not meant to replace any of the national classification schemes but to serve as a common denominator. Improving understanding between different schools of thought could profitably lead to the adoption of an internationally accepted system of soil classification and nomenclature which would considerably strengthen the status and impact of soil science in the world.

2. THE MAP

Sources of information

From the beginning of the century a number of world soil maps have been published at scales varying from 1 : 20 000 000 to 1 : 100 000 000. These maps were based mainly on concepts of soil formation, rather than on knowledge of the soils themselves. As a result, they varied widely because of different methods of interpreting general data on relief, climate, vegetation and geology in terms of the distribution of major soil groups. The FAO/Unesco Soil Map of the World differs from these previous undertakings; it is based to the maximum extent possible on factual information derived from actual surveys. As this material is compiled from surveys of different intensity it is not of equal precision and reliability. The sources of the material used are therefore indicated on each sheet by means of a small-scale inset map, which specifies whether the information was derived from systematic soil surveys, reconnaissance surveys, or general information.

Where the soil map is based on systematic soil surveys, the boundaries of the mapping units are plotted from field observations, the density of which depends on the scale of the original maps used.

Where the map is compiled from soil reconnaissance, the boundaries are based to a large extent on topographic, geological, vegetational and climatic data. Information regarding the composition of soil associations results from field observations, the density of which, however, is not sufficient to enable the boundaries of the mapping units to be checked systematically.

For those parts of the soil map compiled from general information, both the boundaries of the mapping units and the composition of the soil associations are largely based on the interpretation of data on land forms, geology, vegetation and climate. Only occasional field observations have been made, and these are insufficient to supply detailed information on the distribution of the different soils throughout the area.

Approximately 600 soil maps of different scales and legends have been compiled to form the Soil Map of the World. They were selected from a collection at FAO of 11 000 maps related not only to soils but also to physiography, vegetation, climate, geology and land use. Many of these maps were used for correlation purposes and for filling gaps where direct observations had not been made. Intensive use was also made of first-hand information supplied by FAO field staff engaged in development surveys.

Topographic base

The Soil Map of the World was prepared on the base of the topographic map series of the American Geographical Society of New York at a nominal scale of 1 : 5 000 000. This scale was considered to be the largest possible for presenting a comprehensive picture of the world's soil resources, taking into account the amount of knowledge at present available. Grateful acknowledgement is made of the permission given by the American Geographical Society to use this map.

The Americas are compiled on a bipolar oblique conformal projection. The sheets covering Europe, Africa, Asia and Australasia are based on the Miller oblated stereographic projection, a system consisting of three conformal projections centred on Africa, Central Asia and Australasia, joined together in a continuous fashion by so-called " fill-in " projections. These fill-in areas, mostly covering the oceans, although not conformal have the property of a conformal match at their boundaries with the adjacent strictly conformal projections. As a result there is complete angular continuity between all sheets.

Consideration was given in the early stages to the use of an equal area projection so that the size of the mapping units could be directly measured. An equal area projection has the disadvantage, however, of introducing unnecessarily large distortion. It was felt more important to represent the topographic features and soil patterns in their true shape. The conformal projection, by which parallels and meridians cut each other at right angles, has the additional advantage of facilitating the compilation into one document of large-scale sectional maps and it therefore simplifies considerably the process of reduction. Areas and distances measured directly on the map are subject to variations related to the projection. However, accuracy can be obtained by use of the conversion tables based on the mean-scale departure ratios published by the American Geographical Society.

Sheet distribution

The base map of the American Geographical Society of New York comprises 16 sheets. For the purpose of the Soil Map of the World redistribution has been made over 18 sheets in order to obtain an equal sheet size of 76 × 110 cm frame, and with a view to showing as many countries as possible in full on at least one of the sheets. A nineteenth sheet is devoted to the legend, and is supplied with the present volume.

The map sheets have been grouped into major regions, each of which is described in a separate volume as follows:

I. Legend (1 sheet)
II. North America (2 sheets)
III. Mexico and Central America (1 sheet)
IV. South America (2 sheets)
V. Europe (2 sheets)
VI. Africa (3 sheets)
VII. South Asia (2 sheets)
VIII. North and Central Asia (3 sheets)
IX. Southeast Asia (1 sheet)
X. Australasia (2 sheets)

The distribution of the maps is shown on the sheet index reproduced on the legend sheet and on each map sheet.

Map units

Map units of a world soil map must be sufficiently broad to have universal validity but must contain sufficient elements to reflect as precisely as possible the soil pattern of large regions. The legend of the Soil Map of the World comprises an estimated 5 000 different map units, which consist of soil units or associations of soil units occurring within the limits of a mappable physiographic entity. [1]

When a map unit is not homogeneous — that is, when it does not consist of just one soil unit, which is generally the case on a small-scale map — it is composed of a dominant soil and of associated soils, the latter covering at least 20 percent of the area; important soils which cover less than 20 percent of the area are added as inclusions. The textural class of the dominant soil and the slope class are given for each association. Phases are used where indurated layers or hard rock occur at shallow depth or in order to indicate stoniness, salinity or alkalinity. Climatic variants need to be considered for interpretation purposes.

The different elements of the legend are defined below.

SOILS

The number of soil units which compose the legend of the Soil Map of the World is 106. The legend sheet presents these soil units in an order which reflects the general processes of soil formation. The basic principles which underlie the separation of these soil units and their definitions are discussed in Chapter 3. Areas of " non soil " are shown on the map as miscellaneous land units.

For easy reference the list of soil units is given on pages 12-13, and in order to facilitate retrieval of the symbols the list is also shown on the legend sheet (in English, French, Russian and Spanish) in the alphabetical order of the abbreviations used to represent them on the map.

TEXTURAL CLASSES

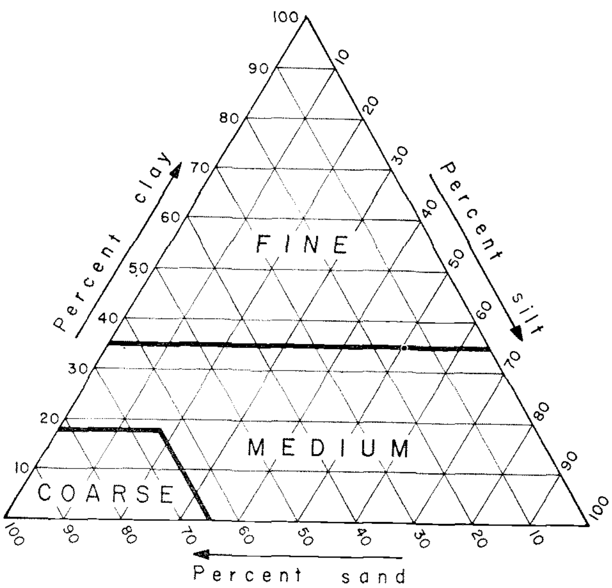
Textural classes reflect the relative proportions of clay (fraction less than 2 microns), silt (2-50 microns) and sand (50-2 000 microns) in the soil. The texture of a soil horizon is one of its most permanent characteristics. It is also a very important one since, in combination with other properties, it is directly related to soil structure, consistence, porosity and cation exchange capacity.

Three textural classes are recognized (marked by the figures 1, 2 and 3 on the map) as shown in the textural triangle on page 5.

[1] At the time the present volume was issued the entire map series was not completed. The number of map units for North America (sheets II 1-2), Mexico and Central America (sheet III), South America (sheets IV 1-2), Africa (sheets VI 1-2-3), South Asia (sheets VII 1-2), North and Central Asia (sheets VIII 1-2-3) and Australasia (sheets X 1-2) was 596, 301, 469, 1 509, 383, 442 and 478 respectively. Certain map units are common to different map sheets. It is estimated that a total of about 5 000 map units cover the whole world.

1. *Coarse textured:* sands, loamy sands and sandy loams with less than 18 percent clay, and more than 65 percent sand.
2. *Medium textured:* sandy loams, loams, sandy clay loams, silt loams, silt, silty clay loams and clay loams with less than 35 percent clay and less than 65 percent sand; the sand fraction may be as high as 82 percent if a minimum of 18 percent clay is present.
3. *Fine textured:* clays, silty clays, sandy clays, clay loams and silty clay loams with more than 35 percent clay.

The textural class is given for the dominant soil of each soil association. It refers to the texture of the upper 30 cm of the soil, which are important for tillage and water retention. Marked changes in texture within the soil resulting from profile development are indicated in the definitions of the soil units (for example, the presence of argillic or natric B horizons or the occurrence of an abrupt textural change).



Because of the scale of the map the textural classes shown are limited to three. It is obvious that for management purposes soil texture has to be defined more precisely.

Slope classes

Slope is an integral part of the land surface. It influences drainage, run-off, erosion, exposure, accessibility. The slope classes referred to here indicate the slope which dominates the area of a soil association.

Three slope classes are distinguished (marked by the symbols a, b and c on the map) :

a. *level to gently undulating:* dominant slopes ranging between 0 and 8 percent ;

b. *rolling to hilly:* dominant slopes ranging between 8 and 30 percent ;

c. *steeply dissected to mountainous:* dominant slopes are over 30 percent.

The effect of slope, for example on run-off and erosion, differs with the soil group and with climate. The separation of the three classes, however, gives a general indication which can be interpreted in relation to the other soil characteristics. The limit of 8 percent is considered significant for purposes of mechanization. Class " a " is obviously too broad — to delimit irrigable areas, for example — but the scale of the map did not allow a more refined subdivision. Nevertheless the slope classes supply an indication of development potential.

Phases

Phases are subdivisions of soil units based on characteristics which are significant to the use or management of the land but are not diagnostic for the separation of soil units themselves. The phases recognized on the Soil Map of the World are: stony lithic, petric, petrocalcic, petrogypsic, petroferric, phreatic, fragipan, duripan, saline, sodic and cerrado.

The definitions of the petrocalcic and petrogypsic horizons, the petroferric contact, the fragipan and the duripan are those formulated in the *Soil taxonomy* of the U.S. Soil Conservation Service (1974). It is to be noted that in this soil classification system the petrocalcic and petrogypsic horizons and the fragipan and duripan are diagnostic for separating different categories of soils. Since the occurrence of these horizons has not been systematically recorded in a number of countries, they are shown as phases on the FAO/Unesco Soil Map of the World where they have been observed.

Stony phase

The stony phase marks areas where the presence of gravel, stones, boulders or rock outcrops in the surface layers or at the surface makes the use of mechanized agricultural equipment impracticable. Hand tools can normally be used and also simple mechanical equipment if other conditions are particularly favourable. Fragments with a diameter up to 7.5 cm are considered as gravel; larger fragments are called stones or boulders. Though it could not be separated on a small-scale map, this difference is obviously important for soil management purposes.

Lithic phase

The lithic phase is used when continuous coherent and hard rock occurs within 50 cm of the surface. For Lithosols the lithic phase is not shown, since the presence of hard rock is already implied in the soil definition.

Petric phase

The petric phase marks soils which show a layer consisting of 40 percent or more, by volume, of oxidic concretions or of hardened plinthite,[2] or ironstone or other coarse fragments with a thickness of at least 25 cm, the upper part of which occurs within 100 cm of the surface. The difference in the petroferric phase is that the concretionary layer of the petric phase is not continuously cemented.

Petrocalcic phase

The petrocalcic phase marks soils in which the upper part of a petrocalcic horizon occurs within 100 cm of the surface.

A petrocalcic horizon is a continuous cemented or indurated calcic horizon,[3] cemented by calcium carbonates and in places by calcium and some magnesium carbonate. Accessory silica may be present. The petrocalcic horizon is continuously cemented to the extent that dry fragments do not slake in water and roots cannot enter. It is massive or platy, extremely hard when dry so that it cannot be penetrated by spade or auger, and very firm to extremely firm when moist. Noncapillary pores are filled; hydraulic conductivity is moderately slow to very slow. It is usually thicker than 10 cm. A laminar capping is commonly present but is not required. If present, the carbonates constitute half or more of the weight of the laminar horizon.

Petrogypsic phase

The petrogypsic phase marks soils in which the upper part of a petrogypsic horizon occurs within 100 cm of the surface. A petrogypsic horizon is a gypsic horizon[4] that is so cemented with gypsum that dry fragments do not slake in water and roots cannot enter. The gypsum content in the petrogypsic horizon is commonly far greater than the minimum requirements for the gypsic horizon and usually exceeds 60 percent.

Petroferric phase

The petroferric phase marks soils in which the upper part of the petroferric horizon occurs within 100 cm of the surface. A petroferric horizon is a continuous layer of indurated material, in which iron is an important cement and organic matter is absent, or present only in traces. The indurated layer must be continuous or, when it is fractured, the average lateral distance between fractures must be 10 cm or more. The petroferric layer is distinguished from a thin iron pan and from an indurated spodic B horizon because it contains little or no organic matter.

Phreatic phase

The phreatic phase marks soils which have a groundwater table between 3 and 5 m from the surface. At this depth the presence of groundwater is not normally reflected in the morphology of the solum; however, its presence is important for the water regime of the soil, especially in arid areas. With irrigation, special attention should be paid to effective water use and drainage in order to avoid salinization as a result of rising groundwater. This phase has been used especially in the U.S.S.R. In other countries, groundwater depth is not consistently recorded during soil surveys.

Fragipan phase

The fragipan phase marks soils which have the upper level of the fragipan occurring within 100 cm of the surface. A fragipan is a loamy (uncommonly a sandy) subsurface horizon which has a high bulk density relative to the horizons above it, is hard or very hard and seemingly cemented when dry, is weakly to moderately brittle when moist; when pressure is applied peds or clods tend to rupture suddenly rather than to undergo slow deformation. Dry fragments slake or fracture when placed in water.

A fragipan is low in organic matter, slowly or very slowly permeable and often shows bleached fracture planes that are faces of coarse or very coarse polyhedrons or prisms. Clayskins may occur as patches

[2] For the definition of plinthite see the section on diagnostic properties in Chapter 3.

[3] For the definition of the calcic horizon see the section on diagnostic horizons in Chapter 3.

[4] For the definition of the gypsic horizon see the section on diagnostic horizons in Chapter 3.

or discontinuous streaks both on the faces and in the interiors of the prisms. A fragipan commonly, but not necessarily, underlies a B horizon. It may be from 15 to 200 cm thick with commonly an abrupt or clear upper boundary, while the lower boundary is mostly gradual or diffuse.

Duripan phase

The duripan phase marks soils in which the upper level of a duripan occurs within 100 cm of the surface. A duripan is a subsurface horizon that is cemented by silica so that dry fragments do not slake during prolonged soaking in water or in hydrochloric acid.

Duripans vary in the degree of cementation by silica and in addition they commonly contain accessory cements, mainly iron oxides and calcium carbonate. As a result, duripans vary in appearance but all of them have a very firm or extremely firm moist consistency, and they are always brittle even after prolonged wetting.

Saline phase

The saline phase marks soils which, in some horizons within 100 cm of the surface, show electric conductivity values of the saturation extract higher than 4 mmhos/cm at 25°C. The saline phase is not shown for Solonchaks [5] because their definition implies a high salt content. Salinity in a soil may show seasonal variations or may fluctuate as a result of irrigation practices.

Though the saline phase indicates present or potential salinization, it should be realized that the effect of salinity varies greatly with the type of salts present, the permeability of the soil, the climatic conditions, and the kind of crops grown.

Subdivision of the degree of salinity was not possible at the scale of the map.

Sodic phase

The sodic phase marks soils which have more than 6 percent saturation with exchangeable sodium in some horizons within 100 cm of the surface. The sodic phase is not shown for Solonetz [6] because the definition implies a high exchangeable sodium saturation in the natric B horizon.

[5] For the definition of a Solonchak see the definitions of soil units in Chapter 3.

[6] For the definition of a Solonetz see the definitions of soil units in Chapter 3.

Cerrado phase

Cerrado is a Brazilian name for level open country of tropical savannas composed of tall grasses and low contorted trees, which is very extensive in central Brazil.[7] This type of vegetation is closely related to the occurrence of strongly depleted soils on old land surfaces. The cerrado phase therefore marks areas where agricultural development meets with great difficulties. In this instance the type of vegetation has been used as an indicator for soil conditions since, in this part of Brazil, the density of soil investigations did not allow a precise separation of the poorer soils.

CLIMATIC VARIANTS

The preparation of soil maps on a regional or continental scale has shown that certain soils occurring in different climatic conditions can have similar morphology and chemical composition. The occurrence of similar soils in different environments may result from:

- Weak soil development on recent sediments which do not yet reflect a marked influence of the climate on soil formation (for example, for Fluvisols).
- The dominant influence of one or more soil-forming factors other than climate (for example, the occurrence in different climatic belts of Podzols on quartz sands, of Andosols on materials rich in volcanic glass or of Vertisols on sediments rich in montmorillonite).
- The effect of previous weathering cycles on soil formation as a result of which soils show marks of climatic conditions which no longer prevail (for example, the occurrence of Ferralsols in subarid conditions or of Chromic Luvisols in humid temperate areas).

Since these soils cannot be distinguished on the basis of characteristics other than soil temperature and soil moisture, climatic data have been used in several major soil classification systems. In the French classification system, the "sols bruns eutrophes de climats tempérés humides" and the "sols bruns eutrophes tropicaux" have similar general characteristics but they are distinguished because of the difference in soil temperature. In *Soil taxonomy* (U.S. Soil Conservation Service, 1974), Xerolls and Udolls have a comparable morphology, but are separated on the basis of a different moisture regime, the Xerolls being mostly dry in summer

[7] This type of vegetation is more precisely described in Volume IV, *Soil map of South America* (FAO/Unesco, 1971).

while the Udolls receive an appreciable amount of rain. In the U.S.S.R., the Alluvial soils are further subdivided into Alluvial soils of arctic, boreal, subboreal, desertic, semidesertic, semidry subtropical and moist subtropical regions, on the basis of the difference in bioclimatic conditions under which they occur.

The Australian soil classification does not use soil moisture and temperature as keying properties, because it is felt that if soils of similar morphology occur under different climatic conditions it is desirable that a classification scheme should not obscure this fact by grouping them on the basis of edaphic considerations. For the same reason the soil units of the Soil Map of the World have not been separated on the basis of differences in soil temperature and soil moisture unless such differences are correlative with other soil characteristics which can be preserved in samples. An exception was made for Yermosols and Xerosols, which were defined in terms of their aridic moisture regime.

Consideration was given to the insertion of "climatic variants" in the Soil Map of the World. However, the separation of such variants would have required a general agreement on a climatological classification, and this appeared to be beyond the scope of the publication. In consequence, only the boundaries of permafrost and intermittent permafrost have been shown on the soil map. However, the climatic maps included in the explanatory texts aim at supplying, in first approximation, necessary data for assessing the agricultural potential of soils in terms of moisture and temperature characteristics as related to their other properties. In recognition of the importance of temperature and moisture as soil properties as well as production factors, similar soils occurring under different climatic conditions should be separated when it comes to interpretation and evaluation for development purposes.

Cartographic representation

Symbols

The soil associations have been noted on the map by the symbol of the dominant soil unit, followed by a figure which refers to the descriptive legend on the back of map in which the full composition of the association is given.

Example:	Lc5	Chromic Luvisols and Chromic Vertisols
	Fo2	Orthic Ferralsols and Ferralic Arenosols

Associations in which Lithosols are dominant are marked by the Lithosol symbol I combined with one or two associated soil units.

Example:	I-Bd	Lithosols and Dystric Cambisols
	I-Lc-To	Lithosols, Chromic Luvisols and Ochric Andosols

Where there are no associated soils or where the associated soils are not known, the symbol I alone is used.

If information on the texture of the surface layers (upper 30 cm) of the dominant soil is available, the textural class figure follows the association symbol, separated from it by a dash.

Example:	Lc5-3	Chromic Luvisols, fine textured, and Chromic Vertisols
	Fo2-2	Orthic Ferralsols, medium textured, and Ferralic Arenosols

Where two groups of textures occur that cannot be delimited on the map, two figures may be used.

Example:	Wm2-2/3	Mollic Planosols, medium and fine textured, and Pellic Vertisols

Where information on relief is available, the slope classes are indicated by a small letter, a, b or c, immediately following the textural notation.

Example:	Lc5-3a	Chromic Luvisols, fine textured, and Chromic Vertisols, level to gently undulating

In complex areas where two types of topography occur that cannot be delimited on the map two letters may be used.

Example:	Fx1-2ab	Xanthic Ferralsols, medium textured, level to rolling

If information on texture is not available, then the small letter indicating the slope class will immediately follow the association symbol.

Example:	I-Be-c	Lithosols and Eutric Cambisols, steeply dissected

Colours

Each of the soil units used for the Soil Map of the World has been assigned a specific colour. The map units have been coloured according to the dominant soil unit. Map units having the same dominant soil unit but which differ in their associated soils are separated on the map by different symbols.

Colour selection has been made by clusters so that soil regions of genetically related soils will show up clearly.

If insufficient information is available to specify the dominant soil unit, the group of units as a whole is marked by the colour of the first unit mentioned in the list. For example, the colour of the Haplic Yermosols is used to show Yermosols in general, the colour of the Orthic Podzols to show Podzols and the colour of the Ochric Andosols to show Andosols.

Associations dominated by Lithosols are shown by a striped pattern of the colours of the associated soils. If no associated soils are recognized, because they occupy less than 20 percent of the area or because specific information is lacking, the colour of the Lithosol unit is applied uniformly with a hatched overprint.

The analytical colour chart of the legend sheet indicates how the different soil colours are composed. Each of the 18 base colours which have been used can be produced in four densities, in full (100 percent), in crossed grid (75 percent), in horizontal grid (50 percent) or in dotted grid (25 percent).

The colour chart shows which combinations of base colours and densities have been used to compose each of the 106 colours representing the soil units. This chart should facilitate the reproduction of these colours and possibly at some stage allow for the standardization of the colour schemes used for representing major soil groups.

OVERPRINTS

Phases which indicate land characteristics not reflected by the soil units or by the composition of the soil associations are shown on the map by overprints. The phases listed on the legend sheet are: stony, lithic, petric, petrocalcic, petrogypsic, petroferric, phreatic, with fragipan, with duripan, saline, sodic and cerrado. Phases are normally shown only when they apply to the whole area covered by a map unit. They may be given for only a part of a map unit when the area to which they apply can be delimited.

Areas of dunes or shifting sands, glaciers and snow caps, salt flats, rock debris or desert detritus are also shown by overprints as miscellaneous land units. Where the extent of the land unit is large enough to be shown separately the sign may be printed over a blank background. When a land unit occurs in combination with a soil association the sign may be printed over the soil colour. Boundaries of permafrost and intermittent permafrost are indicated separately from those of the map units.

Explanatory texts

The map sheets of each of the major regions of the world are accompanied by an explanatory text. Each volume describes the specific development of the Soil Map of the World project for this region, and indicates sources of information and the correlation work carried out.

Environmental conditions, climate, vegetation, physiography and lithology are dealt with in relation to soil distribution. It should be pointed out that the systems used for describing environmental factors are not the same in all volumes. For climate and vegetation no generally accepted classifications are in use, so that the selection of the system to be used was left to the discretion of the authors.

Each volume lists the soil associations which have been separated on the map with indication of associated soils, inclusions, phases, areas of units in 1 000 ha, climate, countries of occurrence, vegetation and lithology of parent materials. In certain regions it has not been possible to collect all the information required, so that only part of it is given.

The distribution of the major soils is discussed in terms of broad soil regions. Special attention is given in each volume to the present land use and the suitability of the land for both traditional and improved farming methods.

For each region a number of site and profile descriptions, with analyses, are given in an appendix.

It should be stressed that the explanatory texts to the Soil Map of the World are not monographs on the soils of a given region but are intended to facilitate the use and interpretation of the map.

3. THE SOIL UNITS

Lack of a generally accepted system of soil classification was a major obstacle to the preparation of the Soil Map of the World. The systems at present in use show profound divergencies resulting from differences in approach to classification as such, varying concepts of soil formation and dissimilarities in the environments to which the systems were to be applied. It was therefore necessary to establish a common denominator between different soil classification systems, and to combine into one outline the major soil units which have been recognized in all parts of the world, both in virgin conditions and under cultivation.

The soil units adopted were selected on the basis of present knowledge of the formation, characteristics and distribution of the soils covering the earth's surface, their importance as resources for production and their significance as factors of the environment. These units do not correspond to equivalent categories in different classification systems, but they are generally comparable to the " great group " level.

To secure reliable identification and correlation in areas far apart, the soil units have been defined in terms of measurable and observable properties. To keep the system " natural, " the differentiating criteria are essential properties of the soil itself. Key properties have been selected on the basis of generally accepted principles of soil formation so as to correlate with as many other characteristics as possible. Such clusters of properties are combined into so-called " diagnostic horizons " which have been adopted for formulating the definitions. Many key properties are relevant to soil use and have a practical value for application. As a result, the units which have been distinguished have prediction value for the use of the soil.

The construction of the legend is based on an international agreement regarding the major soils to be represented on the Soil Map of the World. No consensus could be obtained, however, on the " weight " which each of these units should have within a classification " system ." It is precisely in the concepts on which the subdivisions in categories are based — zonality, evolution, morphology, ecology or geography — that existing soil classification systems differ most. It appeared that, apart from differences in approach, available knowledge of the world's soils would have made it difficult to apply any of these concepts on a global basis.

The list of soil units used here is therefore a monocategorical classification of soils, and not a taxonomic system subdivided into categories at different levels of generalization. However, for the sake of a logical presentation, the soil units of the legend have been grouped on the basis of generally accepted principles of soil formation: Fluvisols, influenced by a floodplain regime; Gleysols, dominated by the hydromorphic soil-forming process; Chernozems, in which organic matter accumulates over great depth in the presence of calcium carbonate; Luvisols and Acrisols, characterized by illuviation of clay under conditions of high and low base saturation respectively; Podzols, in which illuviation of organic matter and/or sesquioxides is determining; Cambisols, characterized by weak weathering of rock without important migration of weathering products within the profile; Planosols, in which strong textural differentiation is caused by a destruction of clay in the surface layers; Ferralsols, in which destruction of the sorptive complex and accumulation of hydrated oxides prevail.

Furthermore, an attempt has been made to present the soil units on the basis of a geographic and evolutionary background, listing first the soils which are not bound to specific climatic conditions and are weakly developed, the Fluvisols, and ending with the strongly weathered soils of the humid tropics, the Ferralsols. The concept of degree of soil profile development cannot, however, be used consistently for classification purposes, since soils in different parts of the world are not members of a continuous sequence of soil formation. For example, one can hardly compare the degree of development of Podzols and Ferralsols, or of Luvisols and Kastanozems, since these soils are products of different environments and of different combinations of soil-forming processes.

The same applies to the concept of zonality, since the influence of climatic factors is often secondary to the effect of parent material or age: for instance, Podzols may occur both under boreal and tropical climates; Planosols are formed under conditions of alternating wetness and dryness which are often bound to specific physiographic conditions rather than to overall climate.

The soil classification used for the Soil Map of the World is not a mere summation of elements but is meant to allow for a creative synthesis and factual inventory of the distribution and characteristics of the world's soils which can be used for both practical and scientific purposes. It is fully realized that the present attempt has many shortcomings, some of which result from the necessity of reaching agreement through compromise. It is hoped that it will be an important step toward the adoption of an internationally accepted soil classification.

This chapter will deal with the nomenclature adopted, the correlation of the soil units with those of existing soil classification systems, the definition of the diagnostic horizons and properties which have been used for defining the soil units, and finally with the definitions of the soil units themselves.

Nomenclature and correlation

For easy reference and communication, the use of soil names is a necessity. Such names are meant to sum up, in an easily remembered term, a set of characteristics which have been found to be representative of a particular soil in different parts of the world.

An attempt has been made to use as many " traditional " names as possible, such as Chernozems, Kastanozems, Podzols, Planosols, Solonetz, Solonchaks, Rendzinas, Regosols and Lithosols. Names which in recent years have acquired a more general acceptance, like Vertisols, Rankers, Andosols, Gleysols and Ferralsols, have also been adopted. Sharpening the definitions of these units by the use of precisely defined terms may have created a narrower concept than that found in the literature for units bearing the same names. It should therefore be stressed that the uniformity aimed at in the preparation of the Soil Map of the World will be reached only if the names are used in accordance with the definitions which have been agreed upon, possibly at the cost of restricting the meaning which they have acquired locally.

A number of terms, such as Podzolized, Podzolic, Brown Forest, Prairie, Mediterranean, Desert, Semi-Arid Brown, Lateritic and Alluvial soils, though firmly established in current soils literature, could not be retained without perpetuating the confusion created by the dissimilar use of these terms in different countries. For a limited number of soils it was imperative to coin new names. Their selection was influenced by the requirement for international work that the names themselves would not change markedly with translation nor have different meanings in different countries.

Throughout the years the terms " podzolized " and " podzolic " have come to be used to indicate illuvial clay accumulation, the formation of a bleached horizon, the penetration of bleached tongues of eluvial material in a B horizon, an abrupt textural change between the eluvial horizon and B horizon, and illuviation of acid organic matter or sesquioxides. In order to avoid the confusion which has arisen from the different uses of these terms, the names Luvisols (from L. *luvi*, perfect tense from *luo*, to wash, " lessiver "), and Acrisols (from L. *acris*, very acid) have been introduced for soils in which the essential characteristic is the illuvial accumulation of clay under conditions of, respectively, high or low base saturation. The term " luvic " is used as an adjective to designate soils showing clay illuviation which is not, however, considered to be the dominant soil-forming process (for example, Luvic Chernozems, Luvic Xerosols, etc.). Soils in which an abrupt textural change is not primarily due to clay illuviation but to a destruction of clay in the surface horizons, are distinguished as Planosols (from L. *planus*, level, flat; connotative of the level or depressed topography in which these soils generally develop). The term Podzols is reserved here for soils which have a B horizon showing a substantial illuvial accumulation of iron or organic matter, or both, but lacking clayskins on ped faces or in pores. Soils showing characteristics both of Luvisols and of Podzols, characterized by an illuvial accumulation of clay, tonguing of the E horizon into the B horizon, and an accumulation of iron and organic matter in addition to the accumulation of clay, have been called Podzoluvisols. [1]

The name " Brown Forest soils " has been used to describe a wide variety of different soils. In its original concept it was a soil developing in subhumid temperate climates, having a " mull " humus, a B horizon with a stronger coloration and a slightly higher clay content than the C horizon, but showing no signs of clay illuviation, and having calcium carbonate in the lower part of the solum. Subsequently this term was used also for acid soils (Acid Brown Forest soils), tropical soils (Sols bruns eutrophes tropicaux) and for soils with

[1] The name Glossisols (from Gr. *glossa*, tongue) was also proposed for these soils on account of the tonguing which is characteristic of them. However, as they are called podzolic in large areas of Europe, it was decided that this precedence should be taken into account in coining the new name.

J FLUVISOLS

Je Eutric Fluvisols
Jc Calcaric Fluvisols
Jd Dystric Fluvisols
Jt Thionic Fluvisols

G GLEYSOLS

Ge Eutric Gleysols
Gc Calcaric Gleysols
Gd Dystric Gleysols
Gm Mollic Gleysols
Gh Humic Gleysols
Gp Plinthic Gleysols
Gx Gelic Gleysols

R REGOSOLS

Re Eutric Regosols
Rc Calcaric Regosols
Rd Dystric Regosols
Rx Gelic Regosols

I LITHOSOLS

Q ARENOSOLS

Qc Cambic Arenosols
Ql Luvic Arenosols
Qf Ferralic Arenosols
Qa Albic Arenosols

E RENDZINAS

U RANKERS

T ANDOSOLS

To Ochric Andosols
Tm Mollic Andosols
Th Humic Andosols
Tv Vitric Andosols

V VERTISOLS

Vp Pellic Vertisols
Vc Chromic Vertisols

Z SOLONCHAKS

Zo Orthic Solonchaks
Zm Mollic Solonchaks
Zt Takyric Solonchaks
Zg Gleyic Solonchaks

S SOLONETZ

So Orthic Solonetz
Sm Mollic Solonetz
Sg Gleyic Solonetz

Y YERMOSOLS

Yh Haplic Yermosols
Yk Calcic Yermosols
Yy Gypsic Yermosols
Yl Luvic Yermosols
Yt Takyric Yermosols

X XEROSOLS

Xh Haplic Xerosols
Xk Calcic Xerosols
Xy Gypsic Xerosols
Xl Luvic Xerosols

K KASTANOZEMS

Kh Haplic Kastanozems
Kk Calcic Kastanozems
Kl Luvic Kastanozems

C CHERNOZEMS

Ch Haplic Chernozems
Ck Calcic Chernozems
Cl Luvic Chernozems
Cg Glossic Chernozems

H PHAEOZEMS

Hh Haplic Phaeozems
Hc Calcaric Phaeozems
Hl Luvic Phaeozems
Hg Gleyic Phaeozems

M GREYZEMS

Mo Orthic Greyzems
Mg Gleyic Greyzems

B CAMBISOLS

Be Eutric Cambisols
Bd Dystric Cambisols
Bh Humic Cambisols
Bg Gleyic Cambisols
Bx Gelic Cambisols

Bk Calcic Cambisols
Bc Chromic Cambisols
Bv Vertic Cambisols

Bf Ferralic Cambisols

L LUVISOLS

Lo Orthic Luvisols
Lc Chromic Luvisols
Lk Calcic Luvisols
Lv Vertic Luvisols
Lf Ferric Luvisols
La Albic Luvisols
Lp Plinthic Luvisols
Lg Gleyic Luvisols

D PODZOLUVISOLS

De Eutric Podzoluvisols
Dd Dystric Podzoluvisols
Dg Gleyic Podzoluvisols

P PODZOLS

Po Orthic Podzols
Pl Leptic Podzols
Pf Ferric Podzols
Ph Humic Podzols
Pp Placic Podzols
Pg Gleyic Podzols

W PLANOSOLS

We Eutric Planosols
Wd Dystric Planosols
Wm Mollic Planosols
Wh Humic Planosols
Ws Solodic Planosols
Wx Gelic Planosols

A ACRISOLS

Ao Orthic Acrisols
Af Ferric Acrisols
Ah Humic Acrisols
Ap Plinthic Acrisols
Ag Gleyic Acrisols

N NITOSOLS

Ne Eutric Nitosols
Nd Dystric Nitosols
Nh Humic Nitosols

F FERRALSOLS

Fo Orthic Ferralsols
Fx Xanthic Ferralsols
Fr Rhodic Ferralsols
Fh Humic Ferralsols
Fa Acric Ferralsols
Fp Plinthic Ferralsols

O HISTOSOLS

Oe Eutric Histosols
Od Dystric Histosols
Ox Gelic Histosols

clay illuviation (Podzolized Brown Forest soils). Further difficulties arise in separating Brown Forest soils from Brown Wooded soils, Burozems, Brunosols or Brown soils, and in justifying how certain Brown Forest soils may be red or yellow or may never have borne any type of forest. For these reasons the name Cambisols was coined as a common denominator (from late L. *cambiare*, change, connotative of changes in colour, consistence and structure which result from weathering in situ).

The term Phaeozems (from Gr. *phaios*, dusky, connotative of the dark colour of the A horizon) has been coined for soils which occur in a transitional belt between Chernozems or Kastanozems and Luvisols. In literature these soils have been known as Prairie soils, Brunizems, Chernozems or degraded Chernozems. None of these terms was suitable for international use because of the restricted meaning resulting from the reference either to different vegetative cover or to colour connotations which are not universally valid.

Compilation of data for international correlation has revealed that the concepts of " desert " and " desert soils " vary rather widely from one continent to another. Subsequently the term " semiarid," as used in Semi-Arid Brown soils, has also acquired a wide range of connotations. For this reason the names Yermosols (from L. *eremus*, desolate, connotative of empty spaces; cf. Sp. *yermo*, desert) and Xerosols (from Gr. *xeros*, dry) have been coined to allow for a better correlation of soils found in different arid and semiarid environments.

The term " Lateritic " was originally restricted to soils, or to weathered material rich in iron which hardens upon exposure. The term was progressively extended to soils with mottled clay, soils with layers of loose concretions, soils with thick iron pans and, even more broadly, to red or yellow soils of tropical regions. A number of alternative names with more specific definitions have been proposed, such as Allitic or Alferritic soils, Ferrallitic, Ferralsols, Krasnozems, Laterized soils, Latosols, Ochrosols, Oxisols, Red earths. The name Ferralsols, which combines brevity, connotation and a fairly wide acceptance, has been retained.

The term Lateritic is particularly inappropriate for the so-called Reddish-Brown Lateritic soils. These show a movement of clay within the profile but have diffuse horizon boundaries and a deeply stretched clay bulge, and generally show a low clay activity. Because of their favourable physical properties and their often higher fertility, especially when derived from basic rock, these soils are separated from the Ferralsols. They have been called Nitosols (from L. *nitidus*, shiny, bright, lustrous, connotative of their characteristic shiny ped faces).

Widely divergent uses have also been made of the term " Alluvial soils. " In its most restricted sense this name has been applied to soils on recent alluvial deposits, enriched at regular intervals by fresh sediments and showing no profile development. In contrast, the broadest connotation of the term includes soils developed from alluvial deposits, regardless of age, in which some profile development may even have taken place. In order to avoid differences of interpretation the name Fluvisols has been introduced and newly defined.

The introduction of the names Histosols (from Gr. *histos*, tissue) for organic soils, and Arenosols (from L. *arena*, sand) for weakly developed sandy soils, needs no explanation. These changes have been made to obtain short names which are easily translated.

The nomenclature of the soil units is reviewed below, indicating the etymology of the name. To facilitate the use of the Soil Map of the World terminology, a comparison is made with names used in some other classification systems.

Since the range of variability allowed for in each system may differ widely, the old and new terms rarely match exactly. The soils grouped under the major headings which follow are similar, although the names they have been given in different countries are seldom synonymous. It should be stressed that the preparation of soil maps on the basis of the international legend cannot be made by a mere conversion of names. The correlation listed below is indicative but cannot replace the use of the original data for placing soils in the uniform legend. To obtain an accurate correlation each classification system would have to be dealt with separately and systematically, and this would be beyond the scope of the present study.

The soil classification systems to which more frequent reference is made in this chapter are those developed in the following countries: Australia (Austral.), Brazil (Br.), Canada (Can.), France (Fr.), Federal Republic of Germany (Germ.), the United States (U.S.A.), the U.S.S.R., and Zaire (Za).

Fluvisols

(From L. *fluvius*, river; connotative of floodplains and alluvial deposits): Alluvial soils pp.[2] (Austral.); Regosols pp. (Can.); Sols tropicaux récents pp. (Za); Sols minéraux bruts d'apport alluvial ou colluvial, Sols peu évolués non climatiques d'apport alluvial ou colluvial (Fr.); Auenböden pp. (Germ.); Fluvents (U.S.A.); Alluvial soils pp. (U.S.S.R.).

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[2] *Pro parte.*

Eutric Fluvisols (from Gr. *eu*, good, eutrophic, fertile).

Calcaric Fluvisols (from L. *calcium*; connotative of an accumulation of calcium carbonate).

Dystric Fluvisols (from Gr. *dys*, ill, dystrophic, infertile).

Thionic Fluvisols (from Gr. *theion*, denoting the presence of sulfur): Brackmarsch pp. (Germ.); Katteklei (Netherlands); Catclays, Acid sulfate soils, Terres alunées (Indonesia, Viet-Nam); Mangrove soils (Guinea, Guyana, U.S.S.R., Venezuela); Sulfaquepts, Sulfic Haplaquepts pp. (U.S.A.).

GLEYSOLS

(From Russian local name *gley*, mucky soil mass; connotative of an excess of water.)

Eutric Gleysols (from Gr. *eu*, good, eutrophic, fertile): Rego Gleysols pp. (Can.); Sols à gley peu profond peu humifères pp. (Fr.); Gley pp. (Germ.); Haplaquents, Psammaquents, Tropaquents, Andaquepts, Fragiaquepts, Haplaquepts, Tropaquepts pp. (U.S.A.), Meadow soils pp. (U.S.S.R.).

Calcaric Gleysols (from L. *calcium*; connotative of the presence of calcium carbonate): Groundwater Rendzina pp. (Austral.); Carbonated Gleysols pp. (Can.); Sols hydromorphes à redistribution du calcaire (Fr.); Borowina pp. (Germ.).

Dystric Gleysols (from Gr. *dys*, ill, dystrophic, infertile): Rego Gleysols pp. (Can.), Sols à gley peu profond peu humifères pp. (Fr.); Gley pp. (Germ.); Haplaquents, Psammaquents, Tropaquents, Andaquepts, Fragiaquepts, Haplaquepts, Tropaquepts pp. (U.S.A.) ; Meadow soils (U.S.S.R.).

Mollic Gleysols (from L. *mollis*, soft; connotative of good surface structure): Wiesenböden pp. (Austral.); Humic Gleysols pp. (Can.); Sols humiques à gley pp. (Fr.); Tschernozem-artige Auenböden pp. (Germ.); Lacovisti (Romania); Haplaquolls (U.S.A.); Meadow soils pp. (U.S.S.R.).

Humic Gleysols (from L. *humus*, earth; rich in organic matter): Humic Gleysols pp. (Can.); Humaquepts (U.S.A.); Meadow soils pp. (U.S.S.R.).

Plinthic Gleysols (from Gr. *plinthos*, brick; connotative of mottled clayey materials which harden irreversibly upon exposure): Plinthaquepts (U.S.A.); Lateritic-Gleysoils (U.S.S.R.).

Gelic Gleysols (from L. *gelu*, frost; connotative of permafrost): Cryic Gleysols (Can.); Pergelic cryaquepts (U.S.A.); Tundra Gleysoils (U.S.S.R.).

REGOSOLS

(From Gr. *rhegos*, blanket; connotative of mantle of loose material overlying the hard core of the earth; soils with weak or no development): Skeletal soils pp. (Austral.); Orthic Regosols pp. (Can.); Sols minéraux bruts d'apport éolien ou volcanique, Sols peu évolués régosoliques d'érosion, Sols peu évolués d'apport éolien ou volcaniques friables (Fr.); Rohböden pp. (Germ.); Orthents, Psamments pp. (U.S.A.).

Eutric Regosols (from Gr. *eu*, good, eutrophic, fertile).

Calcaric Regosols (from L. *calcium*; connotative of the presence of calcium carbonate).

Dystric Regosols (from Gr. *dys*, ill, dystrophic, infertile).

Gelic Regosols (from L. *gelu*, frost; connotative of permafrost): Cryic Regosols (Can.); Pergelic Cryorthents, Pergelic Cryopsamments pp. (U.S.A.).

LITHOSOLS

(From Gr. *lithos*, stone; connotative of soils with hard rock at very shallow depth). Lithosols (Fr.); lithic subgroups (U.S.A.); Shallow mountain soils (U.S.S.R.).

ARENOSOLS

(From L. *arena*, sand; connotative of weakly developed coarse-textured soils): Psamments pp. (U.S.A.).

Cambic Arenosols (from late L. *cambiare*, change; connotative of changes in colour, structure or consistence resulting from weathering in situ).

Luvic Arenosols (from L. *luvi*, from *luo*, to wash, lessiver; connotative of illuvial accumulation of clay): Alfic Psamments (U.S.A.).

Ferralic Arenosols (from L. *ferrum* and *aluminium*; connotative of a high content of sesquioxides): Red and yellow sands (Br.); Arénoferrals (Za.); Oxic Quarzipsamments (U.S.A.).

Albic Arenosols (from L. *albus*, white; connotative of strong bleaching): Spodic Udipsamments (U.S.A.).

RENDZINAS

(From Polish *rzedzic*, noise; connotative of noise made by plough over shallow stony soil): Rendzinas pp. (Austral.); Calcareous Rego Black soils pp. (Can.); Rendzines pp. (Fr.); Rendzina (Germ.); Humuskarbonatböden (Switzerland); Rendolls (U.S.A.); Dern-carbonate soils (U.S.S.R.).

RANKERS

(From Austrian *Rank*, steep slope; connotative of shallow soils from siliceous material): Rankers (Fr.); Ranker (Germ.); Humussilikatböden (Switzerland); Lithic Haplumbrept (U.S.A.).

ANDOSOLS

(From Japanese *An*, dark, and *Do*, soil; connotative of soils formed from materials rich in volcanic glass and commonly having a dark surface horizon): Yellow-brown loams and yellow-brown pumice soils (New Zealand); Humic Allophane soils, Trumao soils (Chile); Acid Brown Forest pp., Acid Brown Wooded soils pp. (Can.); Sols bruns tropicaux sur matériaux volcaniques pp. (Za.); Andosols (Fr.); Andosols (Indonesia); Kuroboku (Japan); Andepts (U.S.A.); Volcanic soils (U.S.S.R.).

Ochric Andosols (from Gr. *ochros*, pale): Dystrandepts pp. (U.S.A.).

Mollic Andosols (from L. *mollis*, soft; connotative of good surface structure): Eutrandepts pp. (U.S.A.).

Humic Andosols (from L. *humus*, earth; rich in organic matter): Dystrandepts, Hydrandepts pp. (U.S.A.).

Vitric Andosols (from L. *vitrum*, glass; connotative of soils rich in vitric material): Vitrandepts (U.S.A.).

VERTISOLS

(From L. *verto*, turn; connotative of turnover of surface soil): Black earths, Grey and Brown soils of Heavy Texture pp. (Austral.) ; Grumusols (Br.); Grumic subgroups (Can.); Argiles noires tropicales (Za.); Vertisols (Fr.); Pelosols (Germ.); Regurs (India); Grumusols, Margalitic soils (Indonesia); Tirs (Morocco); Barros (Portugal); Vertisols (U.S.A.); Black and Gray Tropical soils, Regurs, Vertisols, Compact soils (U.S.S.R.).

Pellic Vertisols (from Gr. *pellos*, dusky, lacking colour; connotative of soils with a low chroma): Black Earths (Austral.); Smolnitza (Bulgaria and Yugoslavia); Vertisols à drainage externe nul ou réduit (Fr.); Barros Pretos (Portugal); Pelluderts, Pellusterts, Pelloxererts (U.S.A.).

Chromic Vertisols (from Gr. *chromos*, colour; connotative of soils with a high chroma) : Brown soils of heavy texture pp. (Austral.); some of the typical Cinnamonic soils (Bulgaria); Vertisols à drainage externe possible (Fr.); Barros Castanho Avermelhados (Portugal); Chromuderts, Chromusterts, Chromoxererts and Torrerts (U.S.A.).

SOLONCHAKS

(From Russian *sol*, salt.)

Orthic Solonchaks (from Gr. *orthos*, true, right; connotative of common occurrence): Solonchaks (Austral.); Saline subgroups pp. (Can.); Sols salins pp. (Fr.); Salorthids (U.S.A.); Solonchaks pp. (U.S.S.R.).

Mollic Solonchaks (from L. *mollis*, soft; connotative of good surface structure): Solonchaks (Austral.); Saline subgroups pp. (Can.); Sols salins pp. (Fr.); Salorthidic Calciustolls and Salorthidic Haplustolls (U.S.A.); Solonchaks pp. (U.S.S.R.).

Takyric Solonchaks (from Uzbek *takyr*, barren plain): Sols bruts xériques organisés d'apport (Fr.); Takyr pp. (U.S.S.R.).

Gleyic Solonchaks (from Russian local name *gley*, mucky soil mass; connotative of an excess of water): Halaquepts pp. (U.S.A.); Meadow Solonchaks (U.S.S.R.).

SOLONETZ

(From Russian *sol*, salt.)

Orthic Solonetz (from Gr. *orthos*, true, right; connotative of common occurrence): Solonetz and Solodized Solonetz pp. (Austral.); Solonetz pp. (Can.); Sols sodiques à horizon B et Solonetz solodisés pp. (Fr.); Natrustalfs, Natrixeralfs, Natrargids, Nadurargids (U.S.A.); Solonetz pp. (U.S.S.R.).

Mollic Solonetz (from L. *mollis*, soft; connotative of good surface structure): Solonetz and Solodized Solonetz pp. (Austral.); Black and Gray Solonetz (Can.); Sols sodiques à horizon B et Solonetz solodisés (Fr.); Natralbolls, Natriborolls, Natrustolls, Natrixerolls (U.S.A.); Solonetz pp. (U.S.S.R.).

Gleyic Solonetz (from Russian local name *gley*, mucky soil mass; connotative of an excess of water): Solonetz pp. (Austral.); Gleyed Solonetz (Can.); Natraqualfs (U.S.A.); Meadow Solonetz (U.S.S.R.).

YERMOSOLS

(From Sp. *yermo*, desert): Desert Sand Plain soils pp., Desert Loams pp. (Austral.); Sols bruts xériques inorganisés pp., Sols peu évolués xériques pp. (Fr.); Typic Aridisols (U.S.A.); Desert soils (U.S.S.R.)

Haplic Yermosols (from Gr. *haplos*, simple; connotative of soils with a simple, normal, horizon sequence): Camborthids and Durorthids (U.S.A.).

Calcic Yermosols (from L. *calxis*, lime; connotative of strong accumulation of calcium carbonate): Calciorthids pp. (U.S.A.).

Gypsic Yermosols (from L. *gypsum*): Sols gypseux pp. (Fr.); Gypsiorthids pp. (U.S.A.).

Luvic Yermosols (from L. *luvi*, from *luo*, to wash, lessiver; connotative of illuvial clay accumulation): Argids (U.S.A.).

Takyric Yermosols (from Uzbek *takyr*, barren plain): Takyr pp. (U.S.S.R.).

Xerosols

(From Gr. *xeros*, dry): Sols bruns isohumiques pp., Sierozems pp., Sols bruns subarides pp. (Fr.); Mollic Aridisols (U.S.A.); Semi-Desert soils, Sierozems (U.S.S.R.).

Haplic Xerosols (from Gr. *haplos*, simple; connotative of soils with a simple, normal horizon sequence): Mollic (xerollic or ustollic) Camborthids and Durorthids (U.S.A.).

Calcic Xerosols (from L. *calxis*, lime; connotative of strong accumulation of calcium carbonate): Mollic (xerollic or ustollic) Calciorthids pp. (U.S.A.).

Gypsic Xerosols (from L. *gypsum*): Sols gypseux pp. (Fr.); Mollic (xerollic or ustollic) Calciorthids pp. (U.S.A.).

Luvic Xerosols (from L. *luvi*, from *luo*, to wash, lessiver; connotative of illuvial clay accumulation): Mollic (xerollic or ustollic) Haplargids and Durargids (U.S.A.).

Kastanozems

(From L. *castaneo*, chestnut, and from Russian *zemlja*, earth, land; connotative of soils rich in organic matter having a brown or chestnut colour): Brown and Dark Brown soils (Can.); Sols châtains pp. (Fr.); Ustolls (U.S.A.); Chestnut soils of the Dry Steppes (U.S.S.R.).

Haplic Kastanozems (from Gr. *haplos*, simple; connotative of soils with a simple, normal horizon sequence): Rego Brown and Orthic Brown soils pp.; Rego Dark Brown and Orthic Dark Brown soils pp. (Can.); Sols châtains modaux (Fr.); Haplustolls, Aridic Haploborolls (U.S.A.).

Calcic Kastanozems (from L. *calxis*, lime; connotative of strong accumulation of calcium carbonate): Calcareous Brown soils pp., Calcareous Dark Brown soils (Can.); Sols châtains encroûtés (Fr.); Calciustolls, Aridic Calciborolls (U.S.A.).

Luvic Kastanozems (from L. *luvi*, from *luo*, to wash, lessiver; connotative of illuvial clay accumulation): Eluviated Brown soils, Eluviated Dark Brown soils (Can.); Argiustolls, Aridic Argiborolls (U.S.A.).

Chernozems

(From Russian *chern*, black, and *zemlja*, earth, land; connotative of soils rich in organic matter having a black colour.)

Haplic Chernozems (from Gr. *haplos*, simple; connotative of soils with a simple, normal horizon sequence): Rego Black and Orthic Black soils pp. (Can.); Chernozem modal (Fr.); Haploborolls, Vermiborolls (U.S.A.); Typic Chernozems (U.S.S.R.).

Calcic Chernozems (from L. *calxis*, lime; connotative of strong accumulation of calcium carbonate): Calcareous Black soils pp. (Can.); Calciborolls pp. (U.S.A.).

Luvic Chernozems (from L. *luvi*, from *luo*, to wash, lessiver; connotative of illuvial clay accumulation): Eluviated Black soils (Can.); Chernozems à B textural (Fr.); Argiborolls pp. (U.S.A.); Podzolized Chernozems (U.S.S.R.).

Glossic Chernozems (from Gr. *glossa*, tongue; connotative of tonguing of the A horizon into the underlying layers): tonguing Chernozems of Siberia (U.S.S.R.).

Phaeozems

(From Gr. *phaios*, dusky, and Russian *zemlja*, earth, land; connotative of soils rich in organic matter having a dark colour.)

Haplic Phaeozems (from Gr. *haplos*, simple; connotative of soils with a simple, normal horizon sequence): Brunizem (Argentina); Rego Dark Gray soils pp. (Can.); Brunizem modal (Fr.); Tschernozem (Germ.); Hapludolls (U.S.A.); Degraded Chernozems pp. (U.S.S.R.).

Calcaric Phaeozems (from L. *calcium*; connotative of the presence of calcium carbonate): Vermudolls pp. (U.S.A.).

Luvic Phaeozems (from L. *luvi*, from *luo*, to wash, lessiver; connotative of illuvial clay accumulation): Brunizem con B textural (Argentina); Orthic Dark Gray soils pp. (Can.); Brunizem à B textural (Fr.); Parabraunerde-Tschernozem (Germ.); Argiudolls (U.S.A.); Podzolized Chernozems pp. (U.S.S.R.).

Gleyic Phaeozems (from Russian local name *gley*; connotative of an excess of water): Gleyed Dark Gray soils pp. (Can.); Gley-Tschernozem pp. (Germ.); Argiaquolls (U.S.A.).

Greyzems

(From Anglo-Saxon *grey*, colour formed by blending of white and black; connotative of white silica powder which is present in layers rich in organic matter, and from Russian *zemlja*, earth, land; connotative of soils rich in organic matter having a grey colour.)

Orthic Greyzems (from Gr. *orthos*, true, right; connotative of common occurrence): Argiborolls pp. (U.S.A.); Gray Forest soils (U.S.S.R.).

Gleyic Greyzems (from Russian local name *gley*; connotative of an excess of water): Aquolls pp. (U.S.A.); Meadow Gray Forest soils (U.S.S.R.).

Cambisols

(From late L. *cambiare*, change; connotative of changes in colour, structure and consistence resulting from weathering in situ.)

Eutric Cambisols (from Gr. *eu*, good, eutrophic, fertile): Orthic Brown Forest soils (Can.); Typische Braunerde (Germ.); Sols bruns modaux, Sols bruns eutrophes tropicaux pp. (Fr.); Eutrochrepts pp., Ustochrepts pp., Xerochrepts pp., Eutropepts (U.S.A.).

Dystric Cambisols (from Gr. *dys*, ill, dystrophic, infertile): Acid Brown Forest soils or Acid Brown Wooded soils (Can.); Saure Braunerde (Germ.); Sols bruns acides (Fr.); Dystrochrepts, Dystropepts (U.S.A.).

Humic Cambisols (from L. *humus*, earth, rich in organic matter): Haplumbrepts, Humitropepts pp. (U.S.A.).

Gleyic Cambisols (from Russian local name *gley*; connotative of an excess of water): Aquic Dystrochrepts, Aquic Eutrochrepts (U.S.A.).

Gelic Cambisols (from L. *gelu*, frost; connotative of permafrost): Cryic Brunisols (Can.); Pergelic Cryochrepts (U.S.A.).

Calcic Cambisols (from L. *calxis*, lime; connotative of strong accumulation of calcium carbonate): Sols bruns calcaires, Sols bruns calciques pp. (Fr.); Kalkbraunerde pp. (Germ.); Eutrochrepts pp., Ustochrepts pp., Xerochrepts pp. (U.S.A.).

Chromic Cambisols (from Gr. *chromos*, colour; connotative of soils with a high chroma): Sols fersiallitiques non lessivés pp. (Fr.); Xerochrepts pp. (U.S.A.); Cinnamonic soils pp. (U.S.S.R.).

Vertic Cambisols (from L. *verto*, turn; connotative of turnover of surface soil): Chocolate soils pp. (Austral.); Sols bruns eutrophes tropicaux pp. (Fr.); Vertic Tropepts (U.S.A.).

Ferralic Cambisols (from L. *ferrum* and *aluminium*; connotative of a high content of sesquioxides): Oxic Tropepts (U.S.A.).

Luvisols

(From L. *luvi*, from *luo*, to wash, lessiver; connotative of illuvial accumulation of clay.)

Orthic Luvisols (from Gr. *orthos*, true, right; connotative of common occurrence): Grey-Brown Podzolic soils (Austral., Can.); Sols lessivés modaux (Fr.); Parabraunerde (Germ.); Hapludalfs; Haploxeralfs pp. (U.S.A.); Podzolized Brown Forest soils (U.S.S.R.).

Chromic Luvisols (from Gr. *chromos*, colour; connotative of soils with a high chroma): Terra Rossa (Austral., Italy); Red Brown Earths pp. (Austral.); Terra Rossa, Terra Fusca pp. (Germ.); Sols fersiallitiques lessivés (Fr.); Solos Mediterraneos Vermelhos o Amarelos (Portugal); Rhodoxeralfs, Haploxeralfs pp. (U.S.A.); Cinnamonic soils pp. (U.S.S.R.).

Calcic Luvisols (from L. *calxis*, lime; connotative of strong accumulation of calcium carbonate): Haplustalfs pp. (U.S.A.).

Vertic Luvisols (from L. *verto*, turn; connotative of turnover of surface soil): Vertic Haploxeralfs (U.S.A.).

Ferric Luvisols (from L. *ferrum*, iron; connotative of " ferruginous " soils): Lateritic Podzolic soils pp. (Austral.); Red-Yellow Podzolic soils of high base status (Br.); Sols ferrugineux tropicaux lessivés (Fr.); Grey Podzolic soils pp. (Thailand, Khmer Rep., Viet-Nam).

Albic Luvisols (from L. *albus*, white; connotative of a bleached horizon): Gray Wooded soils (Can.); Sols podzoliques pp. (Fr.); Eutroboralfs (U.S.A.).

Plinthic Luvisols (from Gr. *plinthos*, brick; connotative of mottled clayey materials which harden irreversibly upon exposure): Lateritic Podzolic soils pp. (Austral.); Groundwaterlaterites pp. (Ghana); Grey Podzolic soils pp. (Thailand, Khmer Rep., Viet-Nam); Plinthustalfs, Plinthoxeralfs (U.S.A.).

Gleyic Luvisols (from Russian local name *gley*, mucky soil mass; connotative of an excess of water). Sols lessivés hydromorphes pp., Sols à gley lessivés pp. (Fr.); Gley-Braunerde (Germ.); Aqualfs (U.S.A.); Podzolic Gley soils pp. (U.S.S.R.).

Podzoluvisols

(From Podzols and Luvisols.)

Eutric Podzoluvisols (from Gr. *eu*, good; eutrophic, fertile): Sols lessivés glossiques (Fr.); Braunerde-Pseudogley pp., Fahlerde pp. (Germ.); Glossudalfs, Glossoboralfs (U.S.A.); Derno-Podzolic soils (U.S.S.R.).

Dystric Podzoluvisols (from Gr. *dys*, ill; dystrophic, infertile): Ortho-Podzolic soils (U.S.S.R.).

Gleyic Podzoluvisols (from Russian local name *gley*, mucky soil mass; connotative of an excess of water): Glossaqualfs, Aquic Glossudalfs, Aquic Glossoboralfs (U.S.A.), Podzolic-Gley soils pp. (U.S.S.R.).

PODZOLS

(From Russian *pod*, under, and *zola*, ash; connotative of soils with a strongly bleached horizon.)

Orthic Podzols (from Gr. *orthos*, right, true; connotative of common occurrence): Podzols humo-ferrugineux (Fr.); Eisenhumuspodsol (Germ); Orthods pp. (U.S.A.); Humic-Ferrous Illuvial Podzols (U.S.S.R.).

Leptic Podzols (from Gr. *leptos*, shallow; connotative of weak development): Brown Podzolic soils pp. (Austral.).

Ferric Podzols (from L. *ferrum*, iron): Podzols ferrugineux (Fr.); Eisenpodsol (Germ.); Ferrods (U.S.A.); Iron-Illuvial Podzols (U.S.S.R.).

Humic Podzols (from L. *humus*, earth; rich in organic matter): Podzols humiques pp. (Fr.); Humus Podsol (Germ.); Humods pp. (U.S.A.); Humus-Illuvial Podzols (U.S.S.R.).

Placic Podzols (from Gr. *plax*, flat stone; connotative of the presence of a thin iron pan): Thin Ironpan Podzols (Ireland, United Kingdom); Placorthods, Placohumods (U.S.A.).

Gleyic Podzols (from Russian local name *gley*, mucky soil mass; connotative of an excess of water): Podzols à gley (Fr.); Gley-Podsol (Germ.); Aquods (U.S.A.); Podzolic Swampy Humic-Illuvial soils (U.S.S.R.).

PLANOSOLS

(From L. *planus*, flat, level; connotative of soils generally developed in level or depressed topography with poor drainage.)

Eutric Planosols (from Gr. *eu*, good; eutrophic, fertile): Planosols pp. (Argentina, Br.); Pseudo-Podzolic soils pp. (Bulgaria); Solos argiluviados para-hidromorficos (Portugal); Albaqualfs, Paleargids pp., Palexeralfs pp., Paleustalfs pp. (U.S.A.); Podbels (U.S.S.R.).

Dystric Planosols (from Gr. *dys*, ill; dystrophic, infertile): Planosols pp. (Br.); Pseudogley, Stagnogley pp. (Germ.) ; Albaquults (U.S.A.).

Mollic Planosols (from L. *mollis*, soft; connotative of good surface structure): Brunizem Planosols (Argentina); Argialbolls, Mollic Albaqualfs (U.S.A.).

Humic Planosols (from L. *humus*, earth; rich in organic matter).

Solodic Planosols (from Russian *sol*, salt): Solodized Solonetz pp., Soloths (Austral.); Solods (Can.); Solods (Fr.); Solods (U.S.S.R.).

Gelic Planosols (from L. *gelu*, frost; connotative of permafrost).

ACRISOLS

(From L. *acris*, very acid; connotative of low base saturation.)

Orthic Acrisols (from Gr. *orthos*, true, right; connotative of common occurrence): Red-Yellow Podzolic soils pp. (Austral.); Red-Yellow Podzolic soils, low base status (Br.); Hapludults, Haplustults, Haploxerults (U.S.A.); Yeltozems pp. (U.S.S.R.).

Ferric Acrisols (from L. *ferrum*, iron; connotative of ferruginous soils) : Palexerults, Paleustults pp. (U.S.A.).

Humic Acrisols (from L. *humus*, earth; rich in organic matter): Rubrozems (Br.); Humults (U.S.A.).

Plinthic Acrisols (from Gr. *plinthos*, brick; connotative of mottled clayey materials which harden irreversibly upon exposure): Hygroferralsols lessivés à plinthite, Hygro-xéroferralsols lessivés à plinthite (Za.); Plinthaquults, Plinthudults, Plinthustults (U.S.A.).

Gleyic Acrisols (from Russian local name *gley*, mucky soil mass; connotative of an excess of water): Aquults pp. (U.S.A.).

NITOSOLS

(From L. *nitidus*, shiny; connotative of shiny ped surfaces.)

Eutric Nitosols (from Gr. *eu*, good; eutrophic, fertile): Krasnozems pp. (Austral.); Terra Roxa estruturada, medium to high base status (Br.); Hygroferrisols pp., Hygroxéroferrisols pp. (Za.); Tropudalfs, Paleudalfs, Rhodustalfs pp. (U.S.A.).

Dystric Nitosols (from Gr. *dys*, ill; dystrophic, infertile): Krasnozems pp. (Austral.); Terra Roxa estruturada, low base status (Br.); Hygroferrisols pp. (Za.); Tropudults, Rhodudults, Rhodustults, Palexerults pp. (U.S.A.); Krasnozems pp. (U.S.S.R.).

Humic Nitosols (from L. *humus*, earth; rich in organic matter): Tropohumults, Palehumults pp. (U.S.A.).

FERRALSOLS

(From L. *ferrum* and *aluminium*; connotative of a high content of sesquioxides): Latosols (Br.); Ferralsols (Za.); Sols ferralitiques pp. (Fr.); Oxisols (U.S.A.); Lateritic soils pp., Ferralitic soils pp. (U.S.S.R.).

Orthic Ferralsols (from Gr. *orthos*, true, right; connotative of common occurrence): Red-Yellow Latosols (Br.); Hygroferralsols pp., Hygro-xéroferralsols pp. (Za.); Sols ferralitiques moyennement à fortement désaturés pp. (Fr.); Red-Yellow Latosols (Indonesia, Viet-Nam); Orthox pp., Torrox pp., Ustox pp. (U.S.A.).

Xanthic Ferralsols (from Gr. *xanthos*, yellow): Pale Yellow Latosols (Br.); Hygroferralsols pp. (Za.); Sols ferralitiques jaunes fortement désaturés pp. (Fr.); Orthox pp. (U.S.A.).

Rhodic Ferralsols (from Gr. *rhodon*, rose): Latosols Roxo (Br.); Hygro-xéroferralsols pp. (Za.); Sols ferralitiques faiblement à moyennement désaturés pp. (Fr.); Orthox pp., Torrox pp., Ustox pp. (U.S.A.).

Humic Ferralsols (from L. *humus*, earth; rich in organic matter): Humic Latosols (Br.); Sols ferralitiques fortement désaturés humiques pp. (Fr.); Humox (U.S.A.).

Acric Ferralsols (from Gr. *akros*, ultimate; connotative of very strong weathering): Acrox (U.S.A.).

Plinthic Ferralsols (from Gr. *plinthos*, brick; connotative of mottled clayey materials which harden irreversibly upon exposure): Plinthaquox pp. (U.S.A.).

HISTOSOLS

(From Gr. *histos*, tissue; connotative of soils rich in fresh or partly decomposed organic matter): Moor peats (Austral.); Organic soils (Can.); Sols hydromorphes organiques (Fr.); Moorböden (Germ.); Histosols (U.S.A.); Bog soils (U.S.S.R.).

Eutric Histosols (from Gr. *eu*, good; eutrophic, fertile).

Dystric Histosols (from Gr. *dys*, ill; dystrophic, infertile).

Gelic Histosols (from L. *gelu*, frost; connotative of permafrost).

Soil horizon designations

A soil horizon may be defined as a layer of soil, approximately parallel to the soil surface, with characteristics produced by soil-forming processes (U.S. Soil Conservation Service, 1951). A soil horizon is commonly differentiated from the one adjacent by characteristics that can be seen or measured in the field — such as colour, texture, structure, consistence — and sometimes also in laboratory tests. In addition to genetic soil horizons many soils show stratification due to variations in parent material or lithological discontinuities. Strictly speaking, a succession of different materials should not be differentiated as "horizons" but as "layers." The distinction is not always very clear, however, since soil-forming processes are often active throughout stratified materials.

A soil is usually characterized by describing and defining the properties of its horizons. Abbreviated horizon designations, which have a genetic connotation, are used for showing the relationships among horizons within a profile and for comparing horizons among different soils.

Horizon designations are therefore an element in the definition of soil units and in the description of representative profiles. Horizon designations are defined in broad qualitative terms, and of course do not substitute for clear and complete descriptions of the morphological characteristics of each horizon.

Though the ABC horizon nomenclature is used by the great majority of soil scientists, the definition of these designations and their qualification with suffixes or figures vary widely. Within the framework of the Soil Map of the World project, the International Society of Soil Science (ISSS) convened a panel of experts[3] to work out a system of soil horizon designations which could be recommended for international use. A first draft was published in Bulletin No. 31 of ISSS in 1967 and discussed at the Ninth Congress of the Society held at Adelaide, Australia, in 1968.

The following definitions incorporate the numerous suggestions received both during discussion at the Congress and by correspondence.

The symbols used to designate soil horizons are as follows:

Capital letters H, O, A, E, B, C and R indicate master horizons, or dominant kinds of departure from the assumed parent material. Strictly, C and R should not be labelled as "soil horizons" but as "layers," since their characteristics are not produced by soil-forming factors. They are listed here with the master horizons as important elements of a soil

[3] This working group met at FAO Headquarters in Rome in September 1967. It was composed of J. Bennema (Netherlands), J. Boulaine (France), D. Luis Bramão (FAO), R. Dudal (FAO), S. Evteev (Unesco), I.P. Gerasimov (U.S.S.R.), E. Mückenhausen (Federal Republic of Germany), R.W. Simonson (United States), A.J. Smyth (FAO), F.A. Van Baren (Netherlands).

profile. A combination of capital letters is used for transitional horizons.

Lower case letters are used as suffixes to qualify the master horizons in terms of the kind of departure from the assumed parent material. The lower case letters immediately follow the capital letter. Two lower case letters may be used to indicate two features which occur concurrently.

Arabic figures are used as suffixes to indicate vertical subdivision of a soil horizon. For A and B horizons the suffix figure is always preceded by a lower case letter suffix.

Arabic figures are used as prefixes to mark lithological discontinuities.

Master horizons

H: An organic horizon formed or forming from accumulations of organic material deposited on the surface, that is saturated with water for prolonged periods (unless artificially drained) and contains 30 percent or more organic matter if the mineral fraction contains more than 60 percent of clay, 20 percent or more organic matter if the mineral fraction contains no clay, or intermediate proportions or organic matter for intermediate contents of clay.

H horizons form at the surface of wet soils, either as thick cumulative layers in organic soils or as thin layers of peat or muck over mineral soils. Even when ploughed the surface soil keeps a high content of organic matter following the mixing of peat with mineral material. The formation of the H horizon is related to prolonged waterlogging, unless soils are artificially drained. H horizons may be buried below the surface.

O: An organic horizon formed or forming from accumulations of organic material deposited on the surface, that is not saturated with water for more than a few days a year and contains 35 percent or more organic matter.

O horizons are the organic horizons that develop on top of some mineral soils — for example, the "raw humus" mat which covers certain acid soils. The organic material in O horizons is generally poorly decomposed and occurs under naturally well-drained conditions. This designation does not include horizons formed by a decomposing root mat below the surface of the mineral soil which is characteristic of A horizons. O horizons may be buried below the surface.

A: A mineral horizon [4] formed or forming at or adjacent to the surface that either:

(*a*) shows an accumulation of humified organic matter intimately associated with the mineral fraction, or

(*b*) has a morphology acquired by soil formation but lacks the properties of E and B horizons.

The organic matter in A horizons is well decomposed and is either distributed as fine particles or is present as coatings on the mineral particles. As a result A horizons are normally darker than the adjacent underlying horizons. The organic material is derived from plant and animal remains and incorporated in the soil through biological activity rather than by translocation. In warm arid climates where there is only slight or virtually no accumulation of organic matter, surface horizons may be less dark than adjacent underlying horizons. If the surface horizon has a morphology distinct from that of the assumed parent material and lacks features characteristic of E and B horizons, it is designated as an A horizon on account of its surface location.

E: A mineral horizon showing a concentration of sand and silt fractions high in resistent minerals, resulting from a loss of silicate clay, iron or aluminium or some combination of them.

E horizons are eluvial horizons which generally underlie an H, O or A horizon from which they are normally differentiated by a lower content of organic matter and a lighter colour. From an underlying B horizon an E horizon is commonly differentiated by colours of higher value or lower chroma, or by coarser texture, or both.

B: A mineral horizon in which rock structure is obliterated or is but faintly evident, characterized by one or more of the following features:

(*a*) an illuvial concentration of silicate clay, iron, aluminium, or humus, alone or in combinations;

(*b*) a residual concentration of sesquioxides relative to source materials;

(*c*) an alteration of material from its original condition to the extent that silicate clays are formed, oxides are liberated, or both, or granular, blocky, or prismatic structure is formed.

[4] The term "mineral horizon" is used here to indicate that organic matter contents are lower than those present in organic horizons defined above as H and O. When necessary an additional symbol L can be used to designate limnic layers which include both organic and inorganic material. In order to secure compatibility between horizon designations and diagnostic horizons the criteria used to separate mineral and organic horizons are drawn from *Soil taxonomy* (U.S. Soil Conservation Service, 1974).

B horizons may differ greatly. It is generally necessary to establish the relationship between overlying and underlying horizons and to estimate how a B horizon has been formed before it can be identified. Consequently, B horizons generally need to be qualified by a suffix to have sufficient connotation in a profile description. A " humus B " horizon is designated as **Bh**, an " iron B " as Bs, a " textural B " as Bt, a " colour B " as Bw. It should be stressed here that the horizon designations are qualitative descriptions only. They are not defined in the quantitative terms required for diagnostic purposes. B horizons may show accumulations of carbonates, of gypsum or of other more soluble salts. Such accumulations, however, do not by themselves disstinguish a B horizon.

C: A mineral horizon (or layer) of unconsolidated material from which the solum is presumed to have formed and which does not show properties diagnostic of any other master horizons.

Traditionally, C has been used to designate "parent material." It is seldom possible to ascertain that the material underlying the A, E and B horizons and from which they are assumed to have developed is unchanged. The designation C is therefore used for the unconsolidated material underlying the solum that does not meet the requirements of the A, E or B designations. This material may, however, have been altered by chemical weathering below the soil and may even be highly weathered (" preweathered ").

Accumulations of carbonates, gypsum or other more soluble salts may be included in C horizons if the material is otherwise little affected by the processes which contributed to the formation of these interbedded layers. When a C horizon consists mainly of sedimentary rocks such as shales, marls, siltstones or sandstones, which are sufficiently dense and coherent to permit little penetration of plant roots but can still be dug with a spade, the C horizon is qualified by the suffix m for compaction.

R: A layer of continuous indurated rock. The rock of R layers is sufficiently coherent when moist to make hand digging with a spade impracticable. The rock may contain cracks but these are too few and too small for significant root development. Gravelly and stony material which allows root development is considered as C horizon.

Transitional horizons

Soil horizons in which the properties of two master horizons merge are indicated by the combination of two capital letters (for instance AE, EB, BE, BC, CB, AB, BA, AC and CA). The first letter marks the master horizon to which the transitional horizon is most similar.

Mixed horizons that consist of intermingled parts, each of which are identifiable with different master horizons, are designated by two capital letters separated by a diagonal stroke (for instance E/B, B/C). The first letter marks the master horizon that dominates. It should be noted that transitional horizons are no longer marked by suffix figures.

Letter suffixes

A small letter may be added to the capital letter to qualify the master horizon designation. Suffix letters can be combined to indicate properties which occur concurrently in the same master horizon (for example, Ahz, Btg, Cck). Normally no more than two suffixes should be used in combination. In transitional horizons no use is made of suffixes which qualify only one of the capital letters. A suffix may be used, however, when it applies to the transitional horizon as a whole (for example, BCk, ABg).

The suffix letters used to qualify the master horizons are as follows:

- b. Buried or bisequal soil horizon (for example, Btb).
- c. Accumulation in concretionary form; this suffix is commonly used in combination with another which indicates the nature of the concretionary material (for example, Bck, Ccs).
- g. Mottling reflecting variations in oxidation and reduction (for example, Bg, Btg, Cg).
- h. Accumulation of organic matter in mineral horizons (for example, Ah, Bh); for the A horizon, the h suffix is applied only where there has been no disturbance or mixing from ploughing, pasturing or other activities of man (h and p suffixes are thus mutually exclusive).
- k. Accumulation of calcium carbonate.
- m. Strongly cemented, consolidated, indurated; this suffix is commonly used in combination with another indicating the cementing material (for example, Cmk marking a petrocalcic horizon within a C horizon, Bms marking an iron pan within a B horizon).
- n. Accumulation of sodium (for example, Btn).
- p. Disturbed by ploughing or other tillage practices (for example, Ap).
- q. Accumulation of silica (Cmq, marking a silcrete layer in a C horizon).

r. Strong reduction as a result of groundwater influence (for example, Cr).

s. Accumulation of sesquioxides (for example, Bs).

t. Illuvial accumulation of clay (for example, Bt).

u. Unspecified; this suffix is used in connexion with A and B horizons which are not qualified by another suffix but have to be subdivided vertically by figure suffixes (for example, Au1, Au2, Bu1, Bu2). The addition of u to the capital letter is provided to avoid confusion with the former notations A1, A2, A3, B1, B2, B3 in which the figures had a genetic connotation. If no subdivision using figure suffixes is needed, the symbols A and B can be used without u.

w. Alteration in situ as reflected by clay content, colour, structure (for example, Bw).

x. Occurrence of a fragipan (for example, Btx).

y. Accumulation of gypsum (for example, Cy).

z. Accumulation of salts more soluble than gypsum (for example, Az or Ahz).

When needed, i, e and a suffixes can be used to qualify H horizons composed of fibric, hemic or sapric organic material respectively (U.S. Soil Conservation Service, 1974).

Letter suffixes can be used to describe diagnostic horizons and features in a profile (for example, argillic B horizon: Bt; natric B horizon: Btn; cambic B horizon: Bw; spodic B horizon: Bhs, Bh or Bs; oxic B horizon: Bws; calcic horizon: k; petrocalcic horizon: mk; gypsic horizon: y; petrogypsic horizon: my; petroferric horizon: ms; plinthite: sq; fragipan: x; strongly reduced gleyic horizon: r; mottled layers: g). But it should be emphasized that the use of a certain horizon designation in a profile description does not necessarily point to the presence of a diagnostic horizon or feature — see also under B horizon above — since the letter symbols merely reflect a qualitative estimate.

Figure suffixes

Horizons designated by a single combination of letter symbols can be vertically subdivided by numbering each subdivision consecutively, starting at the top of the horizon (for example, Bt1 - Bt2 - Bt3 - Bt4). The suffix number always follows all of the letter symbols. The number sequence applies to one symbol only so that the sequence is resumed in case of change of the symbol (for example, Bt1 - Bt2 - Btx1 - Btx2). A sequence is not interrupted, however, by a lithological discontinuity (for example, Bt1 - Bt2 - 2Bt3).

Numbered subdivisions can also be applied to transitional horizons (for example, AB1 - AB2), in which case it is understood that the suffix applies to the entire horizon and not only to the last capital letter.

Numbers are not used as suffixes of undifferentiated A or B symbols, to avoid conflict with the old notation system. If an otherwise unspecified A or B horizon should be subdivided, a suffix u is added.

Figure prefixes

When it is necessary to distinguish lithological discontinuities, Arabic (replacing former Roman) numerals are prefixed to the horizon designations concerned (for instance, when the C horizon is different from the material in which the soil is presumed to have formed the following soil sequence could be given: A, B, 2C. Strongly contrasting layers within the C material could be shown as an A, B, C, 2C, 3C... sequence).

Diagnostic horizons

Soil horizons that have a set of quantitatively defined properties which are used for identifying soil units are called "diagnostic horizons." Since the characteristics of soil horizons are produced by soil-forming processes, the use of diagnostic horizons for separating soil units ensures that the classification system is based on general principles of soil genesis. Objectivity is secured, however, in that the processes themselves are not used as criteria but only their effects, expressed quantitatively in terms of morphological properties that have identification value.

The definitions and nomenclature of the diagnostic horizons used here are drawn from those adopted in *Soil taxonomy* (U.S. Soil Conservation Service, 1974). The definitions of these horizons have been summarized and sometimes simplified in accordance with the requirements of the FAO/Unesco legend. Reference is made to *Soil taxonomy* for additional information on the concepts underlying the definitions of the diagnostic horizons and for detailed descriptions of their characteristics. Where there was compatibility between horizon designations and diagnostic horizons the ABC terminology has been combined with the diagnostic qualification.

The plaggen epipedon, the anthropic epipedon, the sombric horizon and the agric horizon of *Soil taxonomy* have not been used, since the scale of the map did not allow for separating soils which are characterized by these horizons. The duripan, fragipan, petrocalcic horizon and petrogypsic horizon have also not been used as diagnostic horizons, since information on their occurrence is not available in a number of countries. Where such horizons have been observed they are shown on the map as phases.

The terminology used to describe soil morphology is the one adopted in *Guidelines for soil profile description* (FAO, 1967). Colour notations are according to the Munsell soil colour charts. Chemical and physical characteristics are expressed on the basis of *Soil survey laboratory methods and procedures for collecting soil samples* (U.S. Soil Conservation Service, 1967).

Histic H horizon

The histic H horizon is an H horizon which is more than 20 cm but less than 40 cm thick. It can be more than 40 cm but less than 60 cm thick if it consists of 75 percent or more, by volume, of sphagnum fibres or has a bulk density when moist of less than 0.1.

A surface layer of organic material less than 25 cm thick also qualifies as a histic H horizon if, after having been mixed to a depth of 25 cm, it has 28 percent or more organic matter and the mineral fraction contains more than 60 percent clay, or 14 percent or more organic matter and the mineral fraction contains no clay, or intermediate proportions of organic matter for intermediate contents of clay. The same criteria apply to a plough layer which is 25 cm or more thick.

A histic H horizon is eutric when it has a pH (H_2O, 1 : 5) of 5.5 or more throughout; it is dystric when the pH (H_2O, 1 : 5) is less than 5.5 in at least a part of the horizon.

Mollic A horizon

The mollic A horizon is an A horizon which, after the surface 18 cm are mixed, as in ploughing, has the following properties:

1. The soil structure is sufficiently strong, so that the horizon is not both massive and hard or very hard when dry. Very coarse prisms larger than 30 cm in diameter are included in the meaning of massive if there is no secondary structure within the prisms.

2. Both broken and crushed samples have colours with a chroma of less than 3.5 when moist, a value darker than 3.5 when moist, and 5.5 when dry; the colour value is at least one unit darker than that of the C (both moist and dry). If a C horizon is not present, comparison should be made with the horizon immediately underlying the A horizon. If there is more than 40 percent finely divided lime, the limits of colour value dry are waived; the colour value, moist, should then be 5 or less.

3. The base saturation is 50 percent or more (by the NH_4OAc method).

4. The organic matter content is at least 1 percent throughout the thickness of mixed soil, as specified below. The organic matter content is at least 4 percent if the colour requirements are waived because of finely divided lime. The upper limit of organic carbon content of the mollic A horizon is the lower limit of the histic H horizon.

5. The thickness is 10 cm or more if resting directly on hard rock, a petrocalcic horizon, a petrogypsic horizon or a duripan; the thickness of the A must be at least 18 cm and more than one third of the thickness of the solum where the solum is less than 75 cm thick, and must be more than 25 cm where the solum is more than 75 cm thick.[5]

6. The content of P_2O_5 soluble in 1 percent citric acid is less than 250 ppm, unless the amount of P_2O_5 soluble in citric acid increases below the A horizon or when it contains phosphate nodules, as may be the case in highly phosphatic parent materials. This restriction is made to eliminate plough layers of very old arable soils or kitchen middens. Such a horizon is an anthropic A horizon. Because of the scale of the map it has not been possible to use it as a diagnostic horizon.

Umbric A horizon

The requirements of the umbric A horizon are comparable to those of the mollic A horizon in colour, organic matter and phosphorus content, consistency, structure and thickness. The umbric A horizon, however, has a base saturation of less than 50 percent (by the NH_4OAc method). The restriction against a massive and hard or very hard horizon when dry is applied only to those A horizons that become dry. If the horizon is always moist, there is no restriction on its consistency or structure.

Horizons which have acquired the above requirements through the slow addition of materials under cultivation are excluded from the umbric A horizon. Such horizons are plaggen A horizons. Because of the scale of the map it has not been possible to separate soils which are characterized by such man-made surface layers.

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[5] The measurement of the thickness of a mollic A horizon includes transitional horizons in which the characteristics of the A horizon are dominant — for example, AB, AE or AC.

Ochric A horizon

An ochric A horizon is one that is too light in colour, has too high a chroma, too little organic matter, or is too thin to be mollic or umbric, or is both hard and massive when dry.

In separating Yermosols from Xerosols a distinction is made between very weak and weak ochric A horizons:

1. A very weak ochric A horizon has a very low content of organic matter with a weighted average percentage of less than 1 percent in the surface 40 cm if the weighted average sand/clay ratio for this depth is 1 or less; or less than 0.5 percent organic matter if the weighted sand/clay ratio is 13 or more; for intermediate sand/clay ratios the organic matter content is intermediate. When hard rock, a petrocalcic horizon, a petrogypsic horizon or a duripan occur between 18 and 40 cm, the contents of organic matter mentioned above are respectively less than 1.2 and 0.6 percent in the surface 18 cm of the soil.

2. A weak ochric A horizon has a content of organic matter which is intermediate between that of the very weak ochric A horizon and that required for the mollic A horizon.

Argillic B horizon

An argillic B horizon is one that contains illuvial layer-lattice clays. This horizon forms below an eluvial horizon, but it may be at the surface if the soil has been partially truncated. The argillic B horizon has the following properties:

1. If an eluvial horizon remains, the argillic B horizon contains more total and more fine clay than the eluvial horizon, exclusive of differences which may result from a lithological discontinuity. The increase in clay occurs within a vertical distance of 30 cm or less:

(*a*) if any part of the eluvial horizon has less than 15 percent total clay in the fine earth (less than 2 mm) fraction, the argillic B horizon must contain at least 3 percent more clay (for example, 13 percent versus 10 percent);

(*b*) if the eluvial horizon has more than 15 percent and less than 40 percent total clay in the fine earth fraction, the ratio of the clay in the argillic B horizon to that in the E horizon must be 1.2 or more;

(*c*) if the eluvial horizon has more than 40 percent total clay in the fine earth fraction, the argillic B horizon must contain at least 8 percent more clay (for example, 50 percent versus 42 percent).

2. An argillic B horizon should be at least one tenth the thickness of the sum of all overlying horizons, or more than 15 cm thick if the eluvial and illuvial horizons are thicker than 150 cm. If the B horizon is sand or loamy sand, it should be at least 15 cm thick; if it is loamy or clayey, it should be at least 7.5 cm thick. If the B horizon is entirely composed of lamellae, the lamellae should have a thickness of 1 cm or more and should have a combined thickness of at least 15 cm.

3. In soils with massive or single grained structure the argillic B horizon has oriented clay bridging the sand grains and also in some pores.

4. If peds are present, an argillic B horizon either:

(*a*) shows clayskins on some of both the vertical and horizontal ped surfaces and in the pores, or shows oriented clays in 1 percent or more of the cross-section;

(*b*) if the B has a broken or irregular upper boundary and meets requirements of thickness and textural differentiation as defined under 1 and 2 above, clayskins should be present at least in the lower part of the horizon;

(*c*) if the B horizon is clayey with kaolinitic clay and the surface horizon has more than 40 percent clay, there are some clayskins on peds and in pores in the lower part of that horizon having blocky or prismatic structure; or

(*d*) if the B horizon is clayey with 2 to 1 lattice clays, clayskins may be lacking, provided there are evidences of pressure caused by swelling; or if the ratio of fine to total clay in the B horizon is greater by at least one third than the ratio in the overlying or the underlying horizon, or if it has more than 8 percent more fine clay; the evidences of pressure may be occasional slickensides or wavy horizon boundaries in the illuvial horizon, accompanied by uncoated sand or silt grains in the overlying horizon.

5. If a soil shows a lithologic discontinuity between the eluvial horizon and the argillic B horizon, or if only a plough layer overlies the argillic B horizon, the horizon need show clayskins in only some part, either in some fine pores or, if peds exist, on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1 percent or more of oriented clay bodies, or the ratio of fine clay to total clay should be greater by at least one third than in the overlying or the underlying horizon.

6. The argillic B horizon lacks the set of properties which characterize the natric B horizon.

Natric B horizon

The natric B horizon has the properties 1 to 5 of the argillic B horizon as described above. In addition, it has:

1. A columnar or prismatic structure in some part of the B horizon, or a blocky structure with tongues of an eluvial horizon in which there are uncoated silt or sand grains extending more than 2.5 cm into the horizon.

2. A saturation with exchangeable sodium of more than 15 percent within the upper 40 cm of the horizon; or more exchangeable magnesium plus sodium than calcium plus exchange acidity (at pH 8.2) within the upper 40 cm of the horizon if the saturation with exchangeable sodium is more than 15 percent in some subhorizon within 200 cm of the surface.

Cambic B horizon

A cambic B horizon is an altered horizon lacking properties that meet the requirements of an argillic, natric or spodic B horizon; lacking the dark colours, organic matter content and structure of the histic H, or the mollic and umbric A horizons; showing no cementation, induration or brittle consistence when moist, having the following properties:

1. Texture that is very fine sand, loamy very fine sand, or finer.

2. Soil structure or absence of rock structure in at least half the volume of the horizon.

3. Significant amounts of weatherable minerals reflected by a cation exchange capacity (by NH_4OAc) of more than 16 me per 100 g clay, or by a content of more than 3 percent weatherable minerals other than muscovite, or by more than 6 percent muscovite.

4. Evidence of alteration in one of the following forms:

(*a*) higher clay content than the underlying horizon;

(*b*) stronger chroma or redder hue than the underlying horizon;

(*c*) evidence of removal of carbonates (when carbonates are present in the parent material or in the dust that falls on the soil) reflected particularly by a lower carbonate content than the underlying horizon of calcium carbonate accumulation; if all coarse fragments in the underlying horizon are completely coated with lime, some in the cambic horizon are partly free of coatings; if the coarse fragments are coated only on the underside, those in the cambic horizon should be free of coatings;

(*d*) evidence of reduction processes or of reduction and segregation of iron reflected by dominant moist colours on ped faces, or in the matrix if peds are absent, is as follows:

(*i*) chromas of 2 or less if there is mottling,

(*ii*) if there is no mottling and the value is less than 4, the chroma is less than 1; if the value is 4 or more the chroma is 1 or less,

(*iii*) the hue is no bluer than 10Y if the hue changes on exposure to air.

5. Enough thickness that its base is at least 25 cm below the soil surface.

Spodic B horizon

A spodic B horizon meets one or more of the following requirements below a depth of 12.5 cm, or, when present, below an Ap horizon:

1. A subhorizon more than 2.5 cm thick that is continuously cemented by a combination of organic matter with iron or aluminium or with both.

2. A sandy or coarse-loamy texture with distinct dark pellets of coarse silt size or with sand grains covered with cracked coatings.

3. One or more subhorizons in which:

(*a*) if there is 0.1 percent or more extractable iron, the ratio of iron plus aluminium (elemental) extractable by pyrophosphate at pH 10 to percentage of clay is 0.2 or more, or if there is less than 0.1 percent extractable iron, the ratio of aluminium plus carbon to clay is 0.2 or more; and

(*b*) the sum of pyrophosphate-extractable iron plus aluminium is half or more of the sum of dithionite-citrate extractable iron plus aluminium; and

(*c*) the thickness is such that the index of accumulation of amorphous material (CEC at pH 8.2 minus one half the clay percentage multiplied by the thickness in centimetres) in the horizons that meet the preceding requirements is 65 or more.

Oxic B horizon

The oxic B horizon is a horizon that is not argillic or natric and that:

1. Is at least 30 cm thick.

2. Has a fine-earth fraction that retains 10 me or less ammonium ions per 100 g clay from an unbuffered N NH_4Cl solution or has less than 10 me of bases extractable with N NH_4OAc plus aluminium extractable with N KCl per 100 g clay.

3. Has an apparent cation-exchange capacity of the fine earth fraction of 16 me or less per 100 g clay by NH_4OAc unless there is an appreciable content of aluminium-interlayered chlorite.

4. Does not have more than traces of primary aluminosilicates such as feldspars, micas, glasses, and ferromagnesian minerals.

5. Has texture of sandy loam or finer in the fine earth fraction and has more than 15 percent clay.

6. Has mostly gradual or diffuse boundaries between its subhorizons.

7. Has less than 5 percent by volume showing rock structure.

Calcic horizon

The calcic horizon is a horizon of accumulation of calcium carbonate. The accumulation may be in the C horizon, but it may also occur in a B or in an A horizon.

The calcic horizon consists of secondary carbonate enrichment over a thickness of 15 cm or more, has a calcium carbonate equivalent content of 15 percent or more and at least 5 percent greater than that of the C horizon. The latter requirement is expressed by volume if the secondary carbonates in the calcic horizon occur as pendants on pebbles, or as concretions or soft powdery forms; if such a calcic horizon rests on very calcareous materials (40 percent or more calcium carbonate equivalent), the percentage of carbonates need not decrease with depth.

Gypsic horizon

The gypsic horizon is a horizon of secondary calcium sulfate enrichment that is more than 15 cm thick, has at least 5 percent more gypsum than the underlying C horizon, and in which the product of the thickness in centimetres and the percent of gypsum is 150 or more. If the gypsum content is expressed in me per 100 g of soil, the percentage of gypsum can be calculated from the product of the me of gypsum per 100 g of soil and the me weight of gypsum, which is 0.086. Gypsum may accumulate uniformly throughout the matrix or as nests of crystals; in gravelly material gypsum may accumulate as pendants below the coarse fragments.

Sulfuric horizon

The sulfuric horizon forms as a result of artificial drainage and oxidation of mineral or organic materials which are rich in sulfides. It is characterized by a pH less than 3.5 (H_2O, 1:1) and jarosite mottles with a hue of 2.5Y or more and a chroma of 6 or more.

Albic E horizon

The albic E horizon is one from which clay and free iron oxides have been removed, or in which the oxides have been segregated to the extent that the colour of the horizon is determined by the colour of the primary sand and silt particles rather than by coatings on these particles.

An albic E horizon has a colour value moist of 4 or more, or a value dry of 5 or more, or both. If the value dry is 7 or more, or the value moist is 6 or more, the chroma is 3 or less. If the parent materials have a hue of 5YR or redder, a chroma moist of 3 is permitted in the albic E horizon where the chroma is due to the colour of uncoated silt or sand grains.

An albic E horizon may overlie a spodic B, an argillic or natric B, a fragipan, or an impervious layer that produces a perched watertable.

Diagnostic properties

A number of soil characteristics which are used to separate soil units cannot be considered as horizons. They are rather diagnostic features of horizons or of soils which when used for classification purposes need to be quantitatively defined.

Abrupt textural change

An abrupt textural change is a considerable increase in clay content within a very short distance in the zone of contact between an A or E horizon and the underlying horizon. When the A or E horizon has less than 20 percent clay, the clay content of the underlying horizon is at least double that of the A or E horizon within a vertical distance of 8 cm or less. When the A or E horizon has 20 percent clay or more the increase in clay content should be at least 20 percent (for example, from 30 to 50 percent clay) within a vertical distance of 8 cm or less, and the clay content in some part of the underlying horizon (B horizon or impervious layer) should be at least double that of the A or E horizon above.

Albic material

Albic materials are exclusive of E horizons, and have a colour value moist of 4 or more, or a value dry of 5 or more, or both. If the value dry is 7 or more, or the value moist is 6 or more, the chroma is 3 or less. If the parent materials have a hue of 5YR or redder, a chroma moist of 3 is permitted if the chroma is due to the colour of uncoated silt or sand grains.

Aridic moisture regime

The concept of aridic moisture regime is used to characterize Yermosols and Xerosols and to separate them from soils, outside arid areas, which have a comparable morphology. In most years these soils have no available water in any part of the moisture control section more than half the time (cumulative) that the soil temperature at 50 cm is above 5°C (the moisture control section lies approximately between 10 and 30 cm for medium to fine textures, between 20 and 60 cm for medium to coarse textures, and between 30 and 90 cm for coarse textures). There is no period as long as 90 consecutive days when there is moisture in some or all parts of the moisture control section while the soil temperature at 50 cm is continuously above 8°C. In most years the moisture control section is never moist in all parts for as long as 60 consecutive days during 3 months following the winter solstice if mean summer and mean winter temperatures differ by 5°C or more and mean annual temperature is less than 22°C.

Exchange complex dominated by amorphous material

An exchange complex that is dominated by amorphous material shows the following characteristics:

1. The cation exchange capacity of the clay at pH 8.2 is more than 150 me per 100 g measured clay, and commonly is more than 500 me per 100 g clay. The high value is, in part, the result of poor dispersion.

2. If there is enough clay to give a 15-bar water content of the soil of 20 percent or more, the pH of a suspension of 1 g soil in 50 ml N NaF is more than 9.4 after 2 minutes.

3. The ratio 15-bar water content to measured clay is more than 1.0.

4. The amount of organic carbon exceeds 0.6 percent.

5. Differential thermal analysis shows a low temperature endotherm.

6. The bulk density of the fine earth fraction is less than 0.85 g per cm^3 at 1/3-bar tension.

Ferralic properties

The term ferralic properties is used in connexion with Cambisols and Arenosols which have a cation exchange capacity (from NH_4Cl) of less than 24 me per 100 g clay in, respectively, at least some subhorizon of the cambic B horizon or immediately underlying the A horizon.

Ferric properties

The term ferric properties is used in connexion with Luvisols and Acrisols showing one or more of the following: many coarse mottles with hues redder than 7.5YR or chromas more than 5, or both; discrete nodules, up to 2 cm in diameter, the exteriors of the nodules being enriched and weakly cemented or indurated with iron and having redder hues or stronger chromas than the interiors; a cation exchange capacity (from NH_4Cl) of less than 24 me per 100 g clay in at least some subhorizon of the argillic B horizon.

Gilgai microrelief

Gilgai is the microrelief typical of clayey soils that have a high coefficient of expansion with distinct seasonal changes in moisture content. This microrelief consists of either a succession of enclosed microbasins and microknolls in nearly level areas, or of microvalleys and microridges that run up and down the slope. The height of the microridges commonly ranges from a few cm to 1 m. Rarely does the height approach 2 m.

High organic matter content in the B horizon

For Ferralsols and Nitosols of low base saturation the terminology "high organic matter content in the B horizon" refers to an organic matter content (weighted average of the fine earth fraction of the soil) of 1.35 percent or more to a depth of 100 cm (exclusive of an O horizon if present); for Acrisols a high organic matter content in the B horizon means one or both of 1.5 percent or more organic matter in the upper part of the B horizon, or an organic matter content (weighted average of the fine earth fraction of the soil) of 1.35 percent or more to a depth of 100 cm (exclusive of an O horizon if present).

HIGH SALINITY

The term "high salinity" applies to soils which have an electric conductivity of the saturation extract of more than 15 mmhos per cm at 25°C at some time of the year, within 125 cm of the surface when the weighted average textural class of the surface is coarse, within 90 cm for medium textures, within 75 cm for fine textures, or of 4 mmhos within 25 cm of the surface if the pH (H_2O, 1:1) exceeds 8.5.

HYDROMORPHIC PROPERTIES

A distinction is made between soils which are strongly influenced by groundwater, the Gleysols, and the soils of which only the lower horizons are influenced by groundwater or which have a seasonally perched watertable within the profile, the "gleyic" groups. The Gleysols have a reducing moisture regime virtually free of dissolved oxygen due to saturation by groundwater or its capillary fringe. Since hydromorphic processes are dominant, the occurrence of argillic, natric, spodic and oxic B horizons is excluded from Gleysols by definition.

The morphological characteristics which reflect waterlogging differ widely in relation to other soil properties. For the sake of brevity, the expression "hydromorphic properties" is used in the definition of Gleysols and gleyic groups. This term refers to one or more of the following properties:

1. Saturation by groundwater, that is, when water stands in a deep unlined bore hole at such a depth that the capillary fringe reaches the soil surface; the water in the bore hole is stagnant and remains coloured when a dye is added to it.

2. Occurrence of a histic H horizon.

3. Dominant hues that are neutral N, or bluer than 10Y.

4. Saturation with water at some period of the year, or artificially drained, with evidence of reduction processes or of reduction and segregation of iron reflected by:

4.1 in soils having a spodic B horizon, one or more of the following:

(*a*) mottling in an albic E horizon or in the top of the spodic B horizon;

(*b*) a duripan in the albic E horizon;

(*c*) if free iron and manganese are lacking, or if moist colour values are less than 4 in the upper part of the spodic B horizon, either:

(*i*) no coatings of iron oxides on the individual grains of silt and sand in the materials in or immediately below the spodic horizon wherever the moist values are 4 or more and, unless an Ap horizon rests directly on the spodic horizon, there is a transition between the albic E and spodic B horizons at least 1 cm in thickness, or

(*ii*) fine or medium mottles of iron or manganese in the materials immediately below the spodic B horizon;

(*d*) a thin iron pan that rests on a fragipan or on a spodic B horizon, or occurs in an albic E horizon underlain by a spodic B horizon.

4.2 in soils having a mollic A horizon

If the lower part of the mollic A horizon has chromas of 1 or less, either:

(*a*) distinct or prominent mottles in the lower mollic A horizon; or

(*b*) colours immediately below the mollic A horizon or within 75 cm of the surface if a calcic horizon intervenes, with one of the following:

(*i*) if hues are 10YR or redder and there are mottles, chromas of less than 1.5 on ped surfaces or in the matrix; if there are no mottles, chromas of less than 1 (if hues are redder than 10YR because of parent materials that remain red after citrate-dithionite extraction, the requirement for low chromas is waived)

(*ii*) if the hue is nearest to 2.5Y and there are distinct or prominent mottles, chromas of 2 or less on ped surfaces or in the matrix; if there are no mottles, chromas of 1 or less

(*iii*) if the nearest hue is 5Y or yellower and there are distinct or prominent mottles, chromas of 3 or less on ped surfaces or in the matrix; and if there are no mottles, chromas of 2 or less

(*iv*) hues bluer than 10Y

(*v*) any colour if the colour results from uncoated mineral grains

(*vi*) colours neutral N.

If the lower part of the mollic A horizon has chromas of more than 1 but not exceeding 2, either:

(*a*) distinct or prominent mottles in the lower mollic A horizon; or (*b*) base colours immediately below the mollic A horizon that have one or more of:

(*i*) values of 4 and chromas of 2 accompanied by some mottles with values of 4 or more and chromas of less than 2

(*ii*) values of 4 and chromas of less than 2

(*iii*) values of 5 or more and chromas of 2 or less accompanied by mottles with high chroma.

4.3 in soils having an argillic B horizon immediately below the plough layer or an A horizon that has moist colour values of less than 3.5 when rubbed, one or more of the following:

(*a*) moist chromas of 2 or less;

(*b*) mottles due to segregation of iron;

(*c*) iron-manganese concretions larger than 2 mm, and combined with one or more of the following:

(*i*) dominant moist chromas of 2 or less in coatings on the surface of peds accompanied by mottles within the peds, or dominant moist chromas of 2 or less in the matrix of the argillic B horizon accompanied by mottles of higher chromas (if hues are redder than 10YR because of parent materials that remain red after citrate-dithionite extraction, the requirement for low chromas is waived)

(*ii*) moist chromas of 1 or less on surfaces of peds or in the matrix of the argillic B horizon

(*iii*) dominant hues of 2.5Y or 5Y in the matrix of the argillic B horizon accompanied by distinct or prominent mottles.

4.4 in soils having an oxic B horizon:

(*a*) plinthite that forms a continuous phase within 30 cm;

(*b*) if free of mottles, dominant chromas of 2 or less immediately below an A horizon that has a moist colour value of less than 3.5; or if mottled with distinct or prominent mottles within 50 cm of the surface, dominant chromas of 3 or less.

4.5 in other soils:

(*a*) in horizons with textures finer than loamy fine sand:

(*i*) if there is mottling, chromas of 2 or less

(*ii*) if there is no mottling and values are less than 4, chromas of less than 1; if values are 4 or more, chromas of 1 or less;

(*b*) in horizons with textures of loamy fine sand or coarser:

(*i*) if hues are as red as or redder than 10YR and there is mottling, chromas of 2 or less; if there is no mottling and values are less than 4, chromas of less than 1; or if values are 4 or more, chromas of 1 or less

(*ii*) if hues are between 10YR and 10Y and there is distinct or prominent mottling, chromas of 3 or less; if there is no mottling, chromas of 1 or less.

INTERFINGERING

Interfingering consists of penetrations of an albic E horizon into an underlying argillic or natric B horizon along ped faces, primarily vertical faces. The penetrations are not wide enough to constitute tonguing, but form continuous skeletans (ped coatings of clean silt or sand, more than 1 mm thick on the vertical ped faces). A total thickness of more than 2 mm is required if each ped has a coating of more than 1 mm. Because quartz is such a common constituent of soils, the skeletans are usually white when dry, and light grey when moist, but their colour is determined by the colour of the sand or silt fraction. The skeletans constitute more than 15 percent of the volume of any subhorizon in which interfingering is recognized. They are also thick enough to be obvious, by their colour, even when moist. Thinner skeletans that must be dry to be seen as a whitish powdering on a ped are not included in the meaning of interfingering.

PERMAFROST

Permafrost is a layer in which the temperature is perennially at or below 0°C.

PLINTHITE

Plinthite is an iron-rich, humus-poor mixture of clay with quartz and other diluents, which commonly occurs as red mottles, usually in platy, polygonal or reticulate patterns, and which changes irreversibly to an ironstone hardpan or to irregular aggregates on exposure to repeated wetting and drying. In a moist soil, plinthite is usually firm but it can be cut with a spade. When irreversibly hardened the material is no longer considered plinthite but is called ironstone.

SLICKENSIDES

Slickensides are polished and grooved surfaces that are produced by one mass sliding past another. Some of them occur at the base of a slip surface where a mass of soil moves downward on a relatively steep slope. Slickensides are very common in swelling clays in which there are marked changes in moisture content.

Smeary consistence

The term "smeary consistence" is used in connexion with Andosols characterized by thixotropic soil material, that is, material that changes under pressure or by rubbing from a plastic solid into a liquified stage and back to the solid condition. In the liquified stage the material skids or "smears" between the fingers.

Soft powdery lime

Soft powdery lime refers to translocated authigenic lime, soft enough to be cut readily with a finger nail, precipitated in place from the soil solution rather than inherited from a soil parent material. It should be present in a significant accumulation.

To be identifiable, soft powdery lime must have some relation to the soil structure or fabric. It may disrupt the fabric to form spheroidal aggregates, or white eyes, that are soft and powdery when dry, or the lime may be present as soft coatings in pores or on structural faces. If present as coatings, it covers a significant part of the surface; commonly, it coats the whole surface to a thickness of 1 to 5 mm or more. Only part of a surface may be coated if little lime is present in the soil. The coatings should be thick enough to be visible when moist and should cover a continuous area large enough to be more than filaments. Pseudomycelia which come and go with changing moisture conditions are not considered as soft powdery lime in the present definition.

Sulfidic materials

Sulfidic materials are waterlogged mineral or organic soil materials containing 0.75 percent or more sulfur (dry weight), mostly in the form of sulfides, and having less than three times as much carbonate ($CaCO_3$ equivalent) as sulfur. Sulfidic materials accumulate in a soil that is permanently saturated, generally with brackish water. If the soil is drained the sulfides oxidize to form sulfuric acid; and the pH, which normally is near neutrality before drainage, drops below 3.5. Sulfidic material differs from the sulfuric horizon in that it does not show jarosite mottles with a hue of 2.5Y or more or a chroma of 6 or more.

Takyric features

Soils with takyric features have a heavy texture, crack into polygonal elements when dry and form a platy or massive surface crust.

Thin iron pan

A thin iron pan is a black to dark reddish layer cemented by iron, by iron and manganese, or by an iron-organic matter complex, the thickness of which ranges generally from 2 mm to 10 mm. In spots it may be as thin as 1 mm or as thick as 20 to 40 mm, but this is rare. It may, but not necessarily, be associated with stratification in parent materials. It is in the solum, roughly parallel to the soil surface, and is commonly within the upper 50 cm of the mineral soil. It has a pronounced wavy or even convolute form. It normally occurs as a single pan, not as multiple sheets underlying one another, but in places it may be bifurcated. It is a barrier to water and roots. It is used here as a diagnostic property of Placic Podzols.

Tonguing

As used in the definition of Podzoluvisols, the term tonguing is connotative of the penetration of an albic E horizon into an argillic B horizon along ped surfaces, if peds are present. Penetrations to be considered tongues must have greater depth than width, have horizontal dimensions of 5 mm or more in fine textured argillic horizons (clay, silty clay and sandy clay), 10 mm or more in moderately fine textured argillic horizons, and 15 mm or more in medium or coarser textured argillic horizons (silt loams, loams, very fine sandy loams, or coarser), and must occupy more than 15 percent of the mass of the upper part of the argillic horizon.

With Chernozems, the term tonguing refers to penetrations of the A horizon into an underlying cambic B horizon or into a C horizon. The penetrations must have greater depth than width, and must occupy more than 15 percent of the mass of the upper part of the horizon in which they occur.

Vertic properties

The term "vertic properties" is used in connexion with Cambisols and Luvisols which at some period in most years show cracks that are 1 cm or more wide within 50 cm of the upper boundary of the B horizon and extend to the surface or at least to the upper part of the B horizon.

Weatherable minerals

Minerals included in the meaning of weatherable minerals are those that are unstable in a humid climate relative to other minerals, such as quartz and 1 : 1 lattice clays, and that, when weathering occurs, liberate plant nutrients and iron or aluminium. They include:

1. *Clay minerals:* all 2 : 1 lattice clays except aluminium-interlayered chlorite. Sepiolite, talc and glauconite are also included in the meaning of this group of weatherable clay minerals, although they are not always of clay size.

2. *Silt- and sand-size minerals* (0.02 to 0.2 mm in diameter): feldspars, feldspathoids, ferromagnesian minerals, glasses, micas, and zeolites.

Definitions of soil units

The definitions of soil units given in this section are listed in the order in which they are shown on the legend sheet. For the sake of brevity the definitions include only a limited number of necessary characteristics, sufficient to separate the different units. When definitions are not explicit enough for a soil to be easily placed, it is suggested that they be interpreted in conjunction with the key to the soil units which follows this chapter. The soil horizon designations, diagnostic horizons, and diagnostic properties used in this section have been defined in earlier sections of this chapter.

- The soils defined below have their upper boundary at the surface, or at less than 50 cm below the surface when they are covered with a mantle of new material. In other words, horizons buried by 50 cm or more newly deposited surface material are no longer diagnostic for classification purposes.

- The definitions listed do not express differences in soil temperature and soil moisture unless such differences are also reflected by other soil characteristics which can be preserved in samples. An exception to this rule is made for soils with an aridic moisture regime — Yermosols and Xerosols — since soil moisture in this case is the only characteristic by which these soils can be separated from others with a similar morphology.

- When two or more B horizons occur within 125 cm of the surface it is the upper B horizon which is determining for the classification, as long as it is sufficiently developed to meet the requirements of the diagnostic horizon.

- The terminology "having no diagnostic horizons other than" indicates that one or more of the diagnostic horizons listed may be present.

- All definitions of soil units listed below, with the exception of Histosols, refer to mineral soils; that is, soils that are lacking an H horizon of 40 cm or more (60 cm or more if the organic material consists mainly of sphagnum or moss or has a bulk density of less than 0.1), either extending down from the surface or taken cumulatively within the upper 80 cm of the soil, or lacking an H horizon, of a thickness even less than 40 cm, when it rests on rocks or on fragmental material of which the interstices are filled with organic matter.

- For all definitions given, except for the Lithosols, it is implied that the soil is not limited in depth by continuous coherent and hard rock within 10 cm of the surface.

- The analytical data which are used in the definitions are based on laboratory procedures described in *Soil survey laboratory methods and procedures for collecting soil samples* (U.S. Soil Conservation Service, 1967).

Fluvisols [6] (J)

Soils developed from recent alluvial deposits having no diagnostic horizons other than (unless buried by 50 cm or more new material) an ochric or an umbric A horizon, a histic H horizon, or a sulfuric horizon. As used in this definition, recent alluvial deposits are fluviatile, marine, lacustrine, or colluvial sediments characterized by one or more of the following properties:

(*a*) having an organic matter content that decreases irregularly with depth or that remains above 0.35 percent to a depth of 125 cm (thin strata of sand may have less organic matter if the finer sediment below meets the requirements);

(*b*) receiving fresh material at regular intervals and/or showing fine stratification;

(*c*) having sulfidic material within 125 cm of the surface.

Eutric Fluvisols (Je)

Fluvisols having a base saturation (by NH_4OAc) of 50 percent or more at least between 20 and 50 cm from the surface but which are not calcareous at the

[6] Most but not all Fluvisols show hydromorphic properties; however, the scale of the map did not permit a separation to be made between different drainage classes.

same depth; lacking a sulfuric horizon and sulfidic material within 125 cm of the surface.

Calcaric Fluvisols (Jc)

Fluvisols which are calcareous at least between 20 and 50 cm from the surface; lacking a sulfuric horizon and sulfidic material within 125 cm of the surface.

Dystric Fluvisols (Jd)

Fluvisols having a base saturation (by NH_4OAc) of less than 50 percent in at least a part of the soil between 20 and 50 cm from the surface; lacking a sulfuric horizon and sulfidic material within 125 cm of the surface.

Thionic Fluvisols (Jt)

Fluvisols having a sulfuric horizon or sulfidic material, or both, at less than 125 cm from the surface.

Gleysols (G)

Soils formed from unconsolidated materials exclusive of recent alluvial deposits,[7] showing hydromorphic properties within 50 cm of the surface; having no diagnostic horizons other than (unless buried by 50 cm or more new material) an A horizon, a histic H horizon, a cambic B horizon, a calcic or a gypsic horizon; lacking the characteristics which are diagnostic for Vertisols; lacking high salinity; lacking bleached coatings on structural ped surfaces when a mollic A horizon is present which has a chroma of 2 or less to a depth of at least 15 cm.[8]

Eutric Gleysols (Ge)

Gleysols having a base saturation (by NH_4OAc) of 50 percent or more at least between 20 and 50 cm from the surface but which are not calcareous within this depth; having no diagnostic horizons other than an ochric A horizon and a cambic B horizon; lacking plinthite within 125 cm of the surface; lacking permafrost within 200 cm of the surface.

Calcaric Gleysols (Gc)

Gleysols which have a calcic or a gypsic horizon within 125 cm of the surface and/or are calcareous at least between 20 and 50 cm from the surface; having no diagnostic horizons other than an ochric A horizon and a cambic B horizon; lacking plinthite within 125 cm of the surface; lacking permafrost within 200 cm of the surface.

[7] " Recent alluvial deposits " are described in the definition of Fluvisols, p. 32.

[8] Soils showing these characteristics are grouped with Gleyic Greyzems.

Dystric Gleysols (Gd)

Gleysols having a base saturation (by NH_4OAc) of less than 50 percent at least between 20 and 50 cm from the surface; having no diagnostic horizons other than an ochric A horizon and a cambic B horizon; lacking plinthite within 125 cm of the surface; lacking permafrost within 200 cm of the surface.

Mollic Gleysols (Gm)

Gleysols having a mollic A horizon or a eutric histic H horizon; lacking plinthite within 125 cm of the surface; lacking permafrost within 200 cm of the surface.

Humic Gleysols (Gh)

Gleysols having an umbric A horizon or a dystric histic H horizon; lacking plinthite within 125 cm of the surface; lacking permafrost within 200 cm of the surface.

Plinthic Gleysols (Gp)

Gleysols having plinthite within 125 cm of the surface; lacking permafrost within 200 cm of the surface.

Gelic Gleysols (Gx)

Gleysols having permafrost within 200 cm of the surface.

Regosols (R)

Soils from unconsolidated materials, exclusive of recent alluvial deposits, having no diagnostic horizons (unless buried by 50 cm or more new material) other than an ochric A horizon; lacking hydromorphic properties within 50 cm of the surface;[9] lacking the characteristics which are diagnostic for Vertisols and Andosols; lacking high salinity; when coarse textured, lacking lamellae of clay accumulation, features of cambic or oxic B horizons or albic material which are characteristic of Arenosols.

Eutric Regosols (Re)

Regosols having a base saturation (by NH_4OAc) of 50 percent or more at least between 20 and 50 cm from the surface but which are not calcareous within this depth; lacking permafrost within 200 cm of the surface.

[9] A gleyic group could occur within the Regosols showing hydromorphic properties at more than 50 cm from the surface; however, this group has not been separated in the Soil Map of the World legend.

Calcaric Regosols (Rc)

Regosols which are calcareous at least between 20 and 50 cm from the surface.

Dystric Regosols (Rd)

Regosols having a base saturation (by NH_4OAc) of less than 50 percent at least between 20 and 50 cm from the surface; lacking permafrost within 200 cm of the surface.

Gelic Regosols (Rx)

Regosols having permafrost within 200 cm of the surface.

Lithosols (I)

Soils which are limited in depth by continuous coherent hard rock within 10 cm of the surface.

Arenosols (Q)

Soils from coarse-textured unconsolidated materials, exclusive of recent alluvial deposits, consisting of albic material occurring over a depth of at least 50 cm from the surface or showing characteristics of argillic, cambic or oxic B horizons which, however, do not qualify as diagnostic horizons because of textural requirements; having no diagnostic horizons (unless buried by 50 cm or more new material) other than an ochric A horizon; lacking hydromorphic properties within 50 cm of the surface; lacking high salinity.

Cambic Arenosols (Qc)

Arenosols showing colouring or alteration characteristic of a cambic B horizon immediately below the A horizon; lacking lamellae of clay accumulation; lacking ferralic properties.

Luvic Arenosols (Ql)

Arenosols showing lamellae of clay accumulation within 125 cm of the surface; not consisting of albic material in the upper 50 cm of the soil.

Ferralic Arenosols (Qf)

Arenosols showing ferralic properties; lacking lamellae of clay accumulation within 125 cm of the surface.

Albic Arenosols (Qa)

Arenosols consisting of albic material to a depth of at least 50 cm from the surface.

Rendzinas (E)

Soils having a mollic A horizon [10] which contains or immediately overlies calcareous material with a calcium carbonate equivalent of more than 40 percent; lacking hydromorphic properties within 50 cm of the surface; lacking the characteristics which are diagnostic for Vertisols; lacking high salinity.

Rankers (U)

Soils, exclusive of those formed from recent alluvial deposits, having an umbric A horizon which is not more than 25 cm thick;[11] having no other diagnostic horizons (unless buried by 50 cm or more new material); lacking hydromorphic properties within 50 cm of the surface; lacking the characteristics which are diagnostic for Andosols.

Andosols (T)

Soils having a mollic or an umbric A horizon possibly overlying a cambic B horizon, or an ochric A horizon and a cambic B horizon; having no other diagnostic horizons (unless buried by 50 cm or more new material); having to a depth of 35 cm or more one or both of:

(*a*) a bulk density (at 1/3-bar water retention) of the fine earth (less than 2 mm) fraction of the soil of less than 0.85 g/cm^3 and an exchange complex dominated by amorphous material;

(*b*) 60 percent or more vitric [12] volcanic ash, cinders, or other vitric pyroclastic material in the silt, sand and gravel fractions;

lacking hydromorphic properties within 50 cm of the surface; lacking the characteristics which are diagnostic for Vertisols; lacking high salinity.

Ochric Andosols (To)

Andosols having an ochric A horizon and a cambic B horizon; having a smeary consistence and/or having a texture which is silt loam or finer on the weighted average for all horizons within 100 cm of the surface.

Mollic Andosols (Tm)

Andosols having a mollic A horizon; having a smeary consistence, and/or having a texture which is silt loam or finer on the weighted average for all horizons within 100 cm of the surface.

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[10] When the A horizon contains a high amount of finely divided calcium carbonate the colour requirements of the mollic A horizon may be waived.

[11] When the umbric A horizon is thicker than 25 cm, the definition of the Humic Cambisols applies.

[12] Including glass, crystalline particles coated with glass, and partially devitrified glass.

Humic Andosols (Th)

Andosols having an umbric A horizon; having a smeary consistence and/or having a texture which is silt loam or finer on the weighted average for all horizons within 100 cm of the surface.

Vitric Andosols (Tv)

Andosols lacking a smeary consistence and/or having a texture which is coarser than silt loam on the weighted average for all horizons within 100 cm of the surface.

VERTISOLS (V)

Soils having, after the upper 20 cm have been mixed, 30 percent or more clay in all horizons to a depth of at least 50 cm; developing cracks from the soil surface downward which at some period in most years (unless the soil is irrigated) are at least 1 cm wide to a depth of 50 cm; having one or more of the following: gilgai microrelief, intersecting slickensides, or wedge-shaped or parallelepiped structural aggregates at some depth between 25 and 100 cm from the surface.

Pellic Vertisols (Vp)

Vertisols having moist chromas of less than 1.5 dominant in the soil matrix throughout the upper 30 cm.

Chromic Vertisols (Vc)

Vertisols having moist chromas of 1.5 or more dominant in the soil matrix throughout the upper 30 cm.

SOLONCHAKS (Z)

Soils, exclusive of those formed from recent alluvial deposits, having a high salinity and having no diagnostic horizons other than (unless buried by 50 cm or more new material) an A horizon, a histic H horizon, a cambic B horizon, a calcic or a gypsic horizon.

Orthic Solonchaks (Zo)

Solonchaks having an ochric A horizon; lacking takyric features; lacking hydromorphic properties within 50 cm of the surface.

Mollic Solonchaks (Zm)

Solonchaks having a mollic A horizon; lacking takyric features; lacking hydromorphic properties within 50 cm of the surface.

Takyric Solonchaks (Zt)

Solonchaks showing takyric features; lacking hydromorphic properties within 50 cm of the surface.

Gleyic Solonchaks (Zg)

Solonchaks showing hydromorphic properties within 50 cm of the surface.

SOLONETZ (S)

Soils having a natric B horizon; lacking an albic E horizon which shows hydromorphic properties in at least a part of the horizon and an abrupt textural change.

Orthic Solonetz (So)

Solonetz having an ochric A horizon; lacking hydromorphic properties within 50 cm of the surface.

Mollic Solonetz (Sm)

Solonetz having a mollic A horizon; lacking hydromorphic properties within 50 cm of the surface.

Gleyic Solonetz (Sg)

Solonetz showing hydromorphic properties within 50 cm of the surface.

YERMOSOLS (Y)

Soils occurring under an aridic moisture regime; having a very weak ochric A horizon and one or more of the following: a cambic B horizon, an argillic B horizon, a calcic horizon, a gypsic horizon; lacking other diagnostic horizons; lacking the characteristics which are diagnostic for Vertisols; lacking high salinity; lacking permafrost within 200 cm of the surface.

Haplic Yermosols (Yh)

Yermosols having no diagnostic horizons other than a very weak A horizon and a cambic B horizon; lacking takyric features.

Calcic Yermosols (Yk)

Yermosols having a calcic horizon within 125 cm [13] of the surface; lacking an argillic B horizon overlying the calcic horizon; lacking takyric features.

Gypsic Yermosols (Yy)

Yermosols having a gypsic horizon within 125 cm [13] of the surface; lacking an argillic B horizon overlying the gypsic horizon; lacking takyric features.

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[13] The depth requirement varies with the weighted average textural class: less than 125 cm from the surface for coarse textures, less than 90 cm for medium textures, less than 75 cm for fine textures. When both a calcic and a gypsic horizon are present the classification of the soil is determined by the diagnostic horizon which occurs nearest to the surface.

Luvic Yermosols (Yl)

Yermosols having an argillic B horizon; a calcic or a gypsic horizon may be present if underlying the B horizon; lacking takyric features.

Takyric Yermosols (Yt)

Yermosols showing takyric features.

XEROSOLS (X)

Soils occurring under an aridic moisture regime; having a weak ochric A horizon and one or more of the following: a cambic B horizon, an argillic B horizon, a calcic horizon, a gypsic horizon; lacking other diagnostic horizons; lacking the characteristics which are diagnostic for Vertisols; lacking high salinity; lacking permafrost within 200 cm of the surface.

Haplic Xerosols (Xh)

Xerosols having no diagnostic horizons other than a weak A horizon and a cambic B horizon.

Calcic Xerosols (Xk)

Xerosols having a calcic horizon within 125 cm [14] of the surface; lacking an argillic B horizon overlying the calcic horizon.

Gypsic Xerosols (Xy)

Xerosols having a gypsic horizon within 125 cm [14] of the surface; lacking an argillic B horizon overlying the gypsic horizon.

Luvic Xerosols (Xl)

Xerosols having an argillic B horizon; a calcic or a gypsic horizon may be present if underlying the B horizon.

KASTANOZEMS (K)

Soils having a mollic A horizon with a moist chroma of more than 2 to a depth of at least 15 cm; having one or more of the following: a calcic or gypsic horizon or concentrations of soft powdery lime within 125 cm of the surface;[14] lacking a natric B horizon; lacking the characteristics which are diagnostic for Rendzinas, Vertisols, Planosols or Andosols; lacking high salinity; lacking hydromorphic properties within 50 cm of the surface when no argillic B horizon is present.[15]

Haplic Kastanozems (Kh)

Kastanozems lacking an argillic B horizon, a calcic horizon and a gypsic horizon.

Calcic Kastanozems (Kk)

Kastanozems having a calcic or a gypsic horizon; lacking an argillic B horizon overlying the calcic or gypsic horizon.

Luvic Kastanozems (Kl)

Kastanozems having an argillic B horizon; a calcic or a gypsic horizon may be present if underlying the B horizon.

CHERNOZEMS (C)

Soils having a mollic A horizon with a moist chroma of 2 or less to a depth of at least 15 cm; having one or more of the following: a calcic or gypsic horizon or concentrations of soft powdery lime within 125 cm of the surface;[14] lacking a natric B horizon; lacking the characteristics which are diagnostic for Rendzinas, Vertisols, Planosols or Andosols; lacking high salinity; lacking hydromorphic properties within 50 cm of the surface when no argillic B horizon is present;[15] lacking bleached coatings on structural ped surfaces.

Haplic Chernozems (Ch)

Chernozems lacking an argillic B horizon, a calcic and a gypsic horizon; not showing tonguing of the A horizon into a cambic B or into a C horizon.

Calcic Chernozems (Ck)

Chernozems having a calcic or a gypsic horizon; lacking an argillic B horizon overlying the calcic or gypsic horizon; not showing tonguing of the A horizon into a cambic B or into a C horizon.

Luvic Chernozems (Cl)

Chernozems having an argillic B horizon; a calcic or a gypsic horizon may be present when underlying the B horizon.

Glossic Chernozems (Cg)

Chernozems showing tonguing of the A horizon into a cambic B horizon or into a C horizon; lacking an argillic B horizon.

PHAEOZEMS (H)

Soils having a mollic A horizon; lacking a calcic horizon, a gypsic horizon and concentrations of soft powdery lime within 125 cm of the surface;[14] lacking

[14] The depth requirement varies with the weighted average textural class: less than 125 cm from the surface for coarse textures, less than 90 cm for medium textures, less than 75 cm for fine textures. When both a calcic and a gypsic horizon are present the classification of the soil is determined by the diagnostic horizon which occurs nearest to the surface.

[15] Hydromorphic properties present within 50 cm of the surface in the absence of an argillic B horizon meet the definition of the Mollic Gleysols; Kastanozems or Chernozems with hydromorphic properties combined with the presence of an argillic B horizon have not been distinguished.

a natric and an oxic B horizon; lacking the characteristics which are diagnostic for Rendzinas, Vertisols, Planosols or Andosols; lacking high salinity; lacking hydromorphic properties within 50 cm of the surface when no argillic B horizon is present;[16] lacking bleached coatings on structural ped surfaces when the mollic A horizon has a moist chroma of 2 or less to a depth of at least 15 cm.

Haplic Phaeozems (Hh)

Phaeozems lacking an argillic B horizon and which are not calcareous between 20 and 50 cm of the surface.

Calcaric Phaeozems (Hc)

Phaeozems which are calcareous at least between 20 and 50 cm of the surface; lacking an argillic B horizon.

Luvic Phaeozems (Hl)

Phaeozems having an argillic B horizon; lacking hydromorphic properties within 50 cm of the surface.

Gleyic Phaeozems (Hg)

Phaeozems having an argillic B horizon and showing hydromorphic properties within 50 cm of the surface.

Greyzems (M)

Soils having a mollic A horizon with a moist chroma of 2 or less to a depth of at least 15 cm and showing bleached coatings on structural ped surfaces;[17] lacking a natric and oxic B horizon; lacking the characteristics which are diagnostic for Rendzinas, Vertisols, Planosols or Andosols; lacking high salinity.

Orthic Greyzems (Mo)

Greyzems lacking hydromorphic properties within 50 cm of the surface.

Gleyic Greyzems (Mg)

Greyzems showing hydromorphic properties within 50 cm of the surface.

Cambisols (B)

Soils having a cambic B horizon and (unless buried by more than 50 cm or more new material) no diagnostic horizons other than an ochric or an umbric A horizon, a calcic or a gypsic horizon; the cambic B horizon may be lacking when an umbric A horizon is present which is thicker than 25 cm; lacking high salinity; lacking the characteristics diagnostic for Vertisols or Andosols; lacking an aridic moisture regime; lacking hydromorphic properties within 50 cm of the surface.

Eutric Cambisols (Be)

Cambisols having an ochric A horizon and a base saturation (by NH_4OAc) of 50 percent or more at least between 20 and 50 cm from the surface but which are not calcareous within this depth; lacking vertic properties; having a cambic B horizon not strong brown to red;[18] lacking ferralic properties in the cambic B horizon; lacking hydromorphic properties within 100 cm of the surface; lacking permafrost within 200 cm of the surface.

Dystric Cambisols (Bd)

Cambisols having an ochric A horizon and a base saturation (by NH_4OAc) of less than 50 percent at least between 20 and 50 cm from the surface; lacking ferralic properties in the cambic B horizon; lacking hydromorphic properties within 100 cm of the surface; lacking permafrost within 200 cm of the surface.

Humic Cambisols (Bh)

Cambisols having an umbric A horizon which is thicker than 25 cm when a cambic B horizon is lacking; lacking vertic properties; lacking hydromorphic properties within 100 cm of the surface; lacking permafrost within 200 cm of the surface.

Gleyic Cambisols (Bg)

Cambisols showing hydromorphic properties below 50 cm but within 100 cm of the surface;[19] lacking permafrost within 200 cm of the surface.

Gelic Cambisols (Bx)

Cambisols having permafrost within 200 cm of the surface.

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[16] Hydromorphic properties present within 50 cm of the surface in the absence of an argillic B horizon meet the definition of the Mollic Gleysols.

[17] Greyzems generally show clay migration and usually have an argillic B horizon.

[18] Rubbed soil having a hue of 7.5YR and a chroma of more than 4, or a hue redder than 7.5YR.

[19] Hydromorphic properties occurring within 50 cm of the surface or the presence of a histic H horizon meet the definition of the Gleysols.

Calcic Cambisols (Bk)

Cambisols having an ochric A horizon and showing one or more of the following: a calcic horizon, a gypsic horizon or concentrations of soft powdery lime within 125 cm of the surface;[20] calcareous at least between 20 and 50 cm from the surface; lacking vertic properties; lacking hydromorphic properties within 100 cm of the surface; lacking permafrost within 200 cm of the surface.

Chromic Cambisols (Bc)

Cambisols having an ochric A horizon and a base saturation (by NH_4OAc) of 50 percent or more at least between 20 and 50 cm from the surface but which are not calcareous within this same depth; having a strong brown to red [21] cambic B horizon; lacking ferralic properties in the cambic B horizon; lacking vertic properties; lacking hydromorphic properties within 100 cm of the surface; lacking permafrost within 200 cm of the surface.

Vertic Cambisols (Bv)

Cambisols having an ochric A horizon; showing vertic properties; lacking hydromorphic properties within 100 cm of the surface; lacking permafrost within 200 cm of the surface.

Ferralic Cambisols (Bf)

Cambisols having an ochric A horizon and a cambic B horizon with ferralic properties; lacking vertic properties; lacking hydromorphic properties within 100 cm of the surface; lacking permafrost within 200 cm of the surface.

Luvisols (L)

Soils having an argillic horizon which has a base saturation of 50 percent or more (by NH_4OAc) at least in the lower part of the B horizon within 125 cm of the surface; lacking a mollic A horizon; lacking the albic E horizon overlying a slowly permeable horizon, the distribution pattern of the clay and the tonguing which are diagnostic for Planosols, Nitosols and Podzoluvisols respectively; lacking an aridic moisture regime.

[20] The depth requirement varies with the weighted average textural class: less than 125 cm from the surface for coarse textures, less than 90 cm for medium textures, less than 75 cm for fine textures.

[21] Rubbed soil having a hue of 7.5YR and a chroma of more than 4, or a hue redder than 7.5YR.

Orthic Luvisols (Lo)

Luvisols having an argillic B horizon which is not strong brown to red;[21] lacking an albic E horizon; lacking a calcic horizon, a gypsic horizon and concentrations of soft powdery lime within 125 cm of the surface;[20] lacking ferric and vertic properties; lacking plinthite within 125 cm of the surface; lacking hydromorphic properties within 50 cm of the surface.

Chromic Luvisols (Lc)

Luvisols having a strong brown to red [21] argillic B horizon; lacking vertic and ferric properties; lacking an albic E horizon; lacking a calcic horizon, concentrations of soft powdery lime[20] and plinthite within 125 cm of the surface; lacking hydromorphic properties within 50 cm of the surface.

Calcic Luvisols (Lk)

Luvisols having a calcic horizon or concentrations of soft powdery lime, or both, within 125 cm of the surface;[20] lacking vertic properties; lacking an albic E horizon; lacking plinthite within 125 cm of the surface; lacking hydromorphic properties within 50 cm of the surface.

Vertic Luvisols (Lv)

Luvisols showing vertic properties; lacking an albic E horizon; lacking plinthite within 125 cm of the surface; lacking hydromorphic properties within 50 cm of the surface.

Ferric Luvisols (Lf)

Luvisols showing ferric properties; lacking vertic properties; lacking an albic E horizon; lacking a calcic horizon, concentrations of soft powdery lime[20] and plinthite within 125 cm of the surface; lacking hydromorphic properties within 50 cm of the surface.

Albic Luvisols (La)

Luvisols having an albic E horizon; lacking plinthite within 125 cm of the surface; lacking hydromorphic properties within 50 cm of the surface.

Plinthic Luvisols (Lp)

Luvisols having plinthite within 125 cm of the surface.

Gleyic Luvisols (Lg)

Luvisols having hydromorphic properties within 50 cm of the surface; lacking plinthite within 125 cm of the surface.

PODZOLUVISOLS (D)

Soils having an argillic B horizon showing an irregular or broken upper boundary, resulting from deep tonguing of the E into the B horizon, or from the formation of discrete nodules (ranging from 2 to 5 cm up to 30 cm in diameter) the exteriors of which are enriched and weakly cemented or indurated with iron and having redder hues and stronger chromas than the interiors; lacking a mollic A horizon.

Eutric Podzoluvisols (De)

Podzoluvisols having a base saturation of 50 percent or more (by NH_4OAc) throughout the argillic B horizon within 125 cm of the surface; lacking hydromorphic properties within 50 cm of the surface.

Dystric Podzoluvisols (Dd)

Podzoluvisols having a base saturation of less than 50 percent (by NH_4OAc) in at least a part of the argillic B horizon within 125 cm of the surface; lacking hydromorphic properties within 50 cm of the surface.

Gleyic Podzoluvisols (Dg)

Podzoluvisols showing hydromorphic properties within 50 cm of the surface.

PODZOLS (P)

Soils having a spodic B horizon.

Orthic Podzols (Po)

Podzols having a spodic B horizon which in all subhorizons has a ratio of percentage of free iron to percentage of carbon of less than 6, but which contains sufficient free iron to turn redder on ignition; having one or both of the following: an albic E horizon that is thicker than 2 cm and is continuous, and a distinct separation within the spodic B horizon of a subhorizon which is visibly more enriched with organic carbon; lacking a thin iron pan in or over the spodic B horizon; lacking hydromorphic properties within 50 cm of the surface.

Leptic Podzols (Pl)

Podzols having a spodic B horizon which in all subhorizons has a ratio of percentage of free iron to percentage of carbon of less than 6 but which contains sufficient iron to turn redder on ignition; lacking or having only a thin (2 cm or less) and discontinuous albic E horizon; lacking a subhorizon within the spodic B horizon which is visibly more enriched with carbon; lacking a thin iron pan in or over the spodic B horizon; lacking hydromorphic properties within 50 cm of the surface.

Ferric Podzols (Pf)

Podzols in which the ratio of percentage of free iron to percentage of carbon is 6 or more in all subhorizons of the spodic B horizon; lacking a thin iron pan in or over the spodic B horizon; lacking hydromorphic properties within 50 cm of the surface.

Humic Podzols (Ph)

Podzols having a spodic B horizon in which a subhorizon[22] contains dispersed organic matter and lacks sufficient free iron to turn redder on ignition;[23] lacking a thin iron pan in or over the spodic B horizon; lacking hydromorphic properties within 50 cm of the surface.

Placic Podzols (Pp)

Podzols having a thin iron pan in or over the spodic B horizon.

Gleyic Podzols (Pg)

Podzols showing hydromorphic properties within 50 cm of the surface; lacking a thin iron pan in or over the spodic B horizon.

PLANOSOLS (W)

Soils having an albic E horizon overlying a slowly permeable horizon within 125 cm of the surface (for example, an argillic or natric B horizon showing an abrupt textural change, a heavy clay, a fragipan), exclusive of a spodic B horizon; showing hydromorphic properties at least in a part of the E horizon.

Eutric Planosols (We)

Planosols having an ochric A horizon and having a base saturation of 50 percent or more (by NH_4OAc) throughout the slowly permeable horizon within 125 cm of the surface, but having no more than 6 percent sodium in the exchange complex throughout; lacking permafrost within 200 cm of the surface.

Dystric Planosols (Wd)

Planosols having an ochric A horizon and having a base saturation of less than 50 percent (by

[22] If this subhorizon is discontinuous, it should be present in at least half of a soil section large enough to study a full cycle or recurring horizon variations.
[23] Normally corresponding to less than 0.5 percent Fe in the fine earth fraction.

NH_4OAc) in at least a part of the slowly permeable horizon within 125 cm of the surface, but having no more than 6 percent sodium in the exchange complex throughout; lacking permafrost within 200 cm of the surface.

Mollic Planosols (Wm)

Planosols having a mollic A horizon or a eutric histic H horizon; having no more than 6 percent sodium in the exchange complex of the slowly permeable horizon; lacking permafrost within 200 cm of the surface.

Humic Planosols (Wh)

Planosols having an umbric A horizon or a dystric histic H horizon; having no more than 6 percent sodium in the exchange complex of the slowly permeable horizon; lacking permafrost within 200 cm of the surface.

Solodic Planosols (Ws)

Planosols having more than 6 percent sodium in the exchange complex of the slowly permeable horizon; lacking permafrost within 200 cm of the surface.

Gelic Planosols (Wx)

Planosols having permafrost within 200 cm of the surface.

ACRISOLS (A)

Soils having an argillic B horizon with a base saturation of less than 50 percent (by NH_4OAc) at least in the lower part of the B horizon within 125 cm of the surface; lacking a mollic A horizon; lacking an albic E horizon overlying a slowly permeable horizon, the distribution pattern of the clay and the tonguing which are diagnostic for Planosols, Nitosols and Podzoluvisols respectively; lacking an aridic moisture regime.

Orthic Acrisols (Ao)

Acrisols having an ochric A horizon; lacking ferric properties; lacking a high organic matter content in the B horizon; lacking plinthite within 125 cm of the surface; lacking hydromorphic properties within 50 cm of the surface.

Ferric Acrisols (Af)

Acrisols having an ochric A horizon; showing ferric properties; lacking a high organic matter content in the B horizon; lacking plinthite within 125 cm of the surface; lacking hydromorphic properties within 50 cm of the surface.

Humic Acrisols (Ah)

Acrisols having an umbric A horizon or a high content of organic matter in the B horizon, or both; lacking plinthite within 125 cm of the surface; lacking hydromorphic properties within 50 cm of the surface.

Plinthic Acrisols (Ap)

Acrisols having plinthite within 125 cm of the surface.

Gleyic Acrisols (Ag)

Acrisols showing hydromorphic properties within 50 cm of the surface; lacking plinthite within 125 cm of the surface.

NITOSOLS (N)

Soils having an argillic B horizon with a clay distribution where the percentage of clay does not decrease from its maximum amount by as much as 20 percent within 150 cm of the surface;[24] lacking a mollic A horizon; lacking an albic E horizon; lacking the tonguing which is diagnostic for the Podzoluvisols; lacking ferric and vertic properties; lacking plinthite within 125 cm of the surface;[25] lacking an aridic moisture regime.

Eutric Nitosols (Ne)

Nitosols having a base saturation of 50 percent or more (by NH_4OAc) throughout the argillic B horizon within 125 cm of the surface.

Dystric Nitosols (Nd)

Nitosols having a base saturation of less than 50 percent (by NH_4OAc) in at least a part of the argillic B horizon within 125 cm of the surface; lacking a high organic matter content in the B horizon and lacking an umbric A horizon.

Humic Nitosols (Nh)

Nitosols having a base saturation of less than 50 percent (by NH_4OAc) in at least a part of the argillic B horizon within 125 cm of the surface; having an umbric A horizon or a high organic matter content in the B horizon, or both.

[24] This requirement implies that these soils have no lithic contact within 150 cm of the surface.

[25] Normally Nitosols do not show hydromorphic properties within 50 cm of the surface; Gleyic Nitosols may occur but this unit has not been separated here.

Ferralsols (F)

Soils having an oxic B horizon.

Orthic Ferralsols (Fo)

Ferralsols having an oxic B horizon that is neither red to dusky red[26] nor yellow to pale yellow;[27] lacking an umbric A horizon and lacking a high organic matter content in the B horizon when the base saturation is less than 50 percent (by NH_4OAc) in at least a part of the B horizon within 100 cm of the surface; having a cation exchange capacity (from NH_4Cl) of more than 1.5 me per 100 g of clay throughout the oxic B horizon within 125 cm of the surface; lacking plinthite within 125 cm of the surface.

Xanthic Ferralsols (Fx)

Ferralsols having a yellow to pale yellow[27] oxic B horizon; lacking an umbric A horizon and lacking a high organic matter content in the B horizon when the base saturation is less than 50 percent (by NH_4OAc) in at least a part of the B horizon within 100 cm of the surface; having a cation exchange capacity (from NH_4Cl) of more than 1.5 me per 100 g of clay throughout the oxic B horizon within 125 cm of the surface; lacking plinthite within 125 cm of the surface.

Rhodic Ferralsols (Fr)

Ferralsols having a red to dusky red[26] oxic B horizon; lacking an umbric A horizon and lacking a high organic matter content in the B horizon when the base saturation is less than 50 percent (by NH_4OAc) in at least part of the B horizon within 100 cm of the surface; having a cation exchange capacity (from NH_4Cl) of more than 1.5 me per 100 g of clay throughout the oxic B horizon within 125 cm of the surface; lacking plinthite within 125 cm of the surface.

[26] Rubbed soil having hues redder than 5YR with a moist value of less than 4 and a dry value not more than one unit higher than the moist value.
[27] Rubbed soil having hues of 7.5YR or yellower with a moist value of 4 or more and a moist chroma of 5 or more.

Humic Ferralsols (Fh)

Ferralsols having a base saturation of less than 50 percent (by NH_4OAc) in at least a part of the B horizon within 100 cm of the surface; having an umbric A horizon or a high organic matter content in the B horizon, or both; lacking plinthite within 125 cm of the surface.

Acric Ferralsols (Fa)

Ferralsols having a cation exchange capacity (from NH_4Cl) of 1.5 me or less per 100 g of clay in at least some part of the B horizon within 125 cm of the surface; lacking an umbric A horizon and lacking a high organic matter content in the B horizon when the base saturation is less than 50 percent (by NH_4OAc) in at least a part of the B horizon within 100 cm of the surface; lacking plinthite within 125 cm of the surface.

Plinthic Ferralsols (Fp)

Ferralsols having plinthite within 125 cm of the surface.

Histosols (O)

Soils having an H horizon of 40 cm or more (60 cm or more if the organic material consists mainly of sphagnum or moss or has a bulk density of less than 0.1) either extending down from the surface or taken cumulatively within the upper 80 cm of the soil; the thickness of the H horizon may be less when it rests on rocks or on fragmental material of which the interstices are filled with organic matter.

Eutric Histosols (Oe)

Histosols having a pH (H_2O, 1:5) of 5.5 or more at least between 20 and 50 cm from the surface; lacking permafrost within 200 cm of the surface.

Dystric Histosols (Od)

Histosols having a pH (H_2O, 1:5) of less than 5.5 at least in some part of the soil between 20 and 50 cm from the surface; lacking permafrost within 200 cm of the surface.

Gelic Histosols (Ox)

Histosols having permafrost within 200 cm of the surface.

KEY TO THE SOIL UNITS

Soils having an H horizon of 40 cm or more (60 cm or more if the organic material consists mainly of sphagnum or moss or has a bulk density of less than 0.1) either extending down from the surface or taken cumulatively within the upper 80 cm of the soil; the thickness of the H horizon may be less when it rests on rocks or on fragmental material of which the interstices are filled with organic matter

HISTOSOLS (O)

Histosols having permafrost within 200 cm of the surface

Gelic Histosols (Ox)

Other Histosols having a pH (H_2O, 1:5) of less than 5.5, at least in some part of the soil between 20 and 50 cm from the surface

Dystric Histosols (Od)

Other Histosols

Eutric Histosols (Oe)

Other soils which are limited in depth by continuous coherent and hard rock within 10 cm of the surface

LITHOSOLS (I)

Other soils which, after the upper 20 cm are mixed, have 30 percent or more clay in all horizons to at least 50 cm from the surface; at some period in most years have cracks at least 1 cm wide at a depth of 50 cm, unless irrigated, and have one or more of the following characteristics: gilgai microrelief, intersecting slickensides or wedge-shaped or parallelepiped structural aggregates at some depth between 25 and 100 cm from the surface

VERTISOLS (V)

Vertisols having moist chromas of less than 1.5 dominant in the soil matrix throughout the upper 30 cm

Pellic Vertisols (Vp)

Other Vertisols

Chromic Vertisols (Vc)

Other soils developed from recent alluvial deposits, having no diagnostic horizons other than (unless buried by 50 cm or more new material) an ochric or an umbric A horizon, an H horizon, or a sulfuric horizon

FLUVISOLS (J)

Fluvisols having a sulfuric horizon or sulfidic material, or both, at less than 125 cm from the surface

Thionic Fluvisols (Jt)

Other Fluvisols which are calcareous, at least between 20 and 50 cm from the surface

Calcaric Fluvisols (Jc)

Other Fluvisols having a base saturation (by NH_4OAc) of less than 50 percent, at least in some part of the soil between 20 and 50 cm from the surface

Dystric Fluvisols (Jd)

Other Fluvisols

Eutric Fluvisols (Je)

Other soils having high salinity and having no diagnostic horizons other than (unless buried by 50 cm or more new material) an A horizon, an H horizon, a cambic B horizon, a calcic or a gypsic horizon

SOLONCHAKS (Z)

Solonchaks showing hydromorphic properties within 50 cm of the surface

Gleyic Solonchaks (Zg)

Other Solonchaks showing takyric features

Takyric Solonchaks (Zt)

Other Solonchaks having a mollic A horizon

Mollic Solonchaks (Zm)

Other Solonchaks

Orthic Solonchaks (Zo)

Other soils showing hydromorphic properties within 50 cm of the surface; having no diagnostic horizons other than (unless buried by 50 cm or more new material) an A horizon, an H horizon, a cambic B horizon, a calcic or a gypsic horizon

GLEYSOLS (G)

Gleysols having permafrost within 200 cm of the surface

Gelic Gleysols (Gx)

Other Gleysols having plinthite within 125 cm of the surface

Plinthic Gleysols (Gp)

Other Gleysols having a mollic A horizon or a eutric histic H horizon

Mollic Gleysols (Gm)

Other Gleysols having an umbric A horizon or a dystric histic H horizon

Humic Gleysols (Gh)

Other Gleysols having one or more of the following: a calcic horizon or a gypsic horizon within 125 cm of the surface, or are calcareous at least between 20 and 50 cm from the surface

Calcaric Gleysols (Gc)

Other Gleysols having a base saturation (by NH_4OAc) of less than 50 percent, at least in some part of the soil between 20 and 50 cm from the surface

Dystric Gleysols (Gd)

Other Gleysols

Eutric Gleysols (Ge)

Other soils having either a mollic or an umbric A horizon possibly overlying a cambic B horizon, or an ochric A horizon and a cambic B horizon; having no other diagnostic horizons (unless buried by 50 cm or more new material); having to a depth of 35 cm or more one or both of: (*a*) a bulk density (at 1/3-bar water retention) of the fine earth (less than 2 mm) fraction of the soil of less than 0.85 g/cm^3 and the exchange complex dominated by amorphous material; (*b*) 60 percent or more vitric volcanic ash, cinders, or other vitric pyroclastic material in the silt, sand and gravel fractions

ANDOSOLS (T)

Andosols having a mollic A horizon

Mollic Andosols (Tm)

Other Andosols having an umbric A horizon

Humic Andosols (Th)

Other Andosols having a smeary consistence and/or having a texture which is silt loam or finer on the weighted average for all horizons within 100 cm of the surface

Ochric Andosols (To)

Other Andosols

Vitric Andosols (Tv)

Other soils of coarse texture consisting of albic material occurring over a depth of at least 50 cm from the surface, or showing characteristics of argillic, cambic or oxic B horizons which, however, do not qualify as diagnostic horizons because of the textural requirements; having no diagnostic horizons other than (unless buried by 50 cm or more new material) an ochric A horizon

ARENOSOLS (Q)

Arenosols consisting of albic material

Albic Arenosols (Qa)

Other Arenosols showing lamellae of clay accumulation

Luvic Arenosols (Ql)

Other Arenosols showing ferralic properties

Ferralic Arenosols (Qf)

Other Arenosols

Cambic Arenosols (Qc)

Other soils having no diagnostic horizons or none other than (unless buried by 50 cm or more new material) an ochric A horizon

REGOSOLS (R)

Regosols having permafrost within 200 cm of the surface

Gelic Regosols (Rx)

Other Regosols which are calcareous at least between 20 and 50 cm from the surface

Calcaric Regosols (Rc)

Other Regosols having a base saturation (by NH_4OAc) of less than 50 percent, at least in some part of the soil between 20 and 50 cm from the surface

Dystric Regosols (Rd)

Other Regosols

Eutric Regosols (Re)

Other soils having an umbric A horizon which is not more than 25 cm thick; having no other diagnostic horizons (unless buried by 50 cm or more of new material)

RANKERS (U)

Other soils having a mollic A horizon which contains or immediately overlies calcareous material with a calcium carbonate equivalent of more than 40 percent (when the A horizon contains a high amount of finely divided calcium carbonate the colour requirements of the mollic A horizon may be waived)

RENDZINAS (E)

Other soils having a spodic B horizon

PODZOLS (P)

Podzols having a thin iron pan in or over the spodic B horizon

Placic Podzols (Pp)

Other Podzols showing hydromorphic properties within 50 cm of the surface

Gleyic Podzols (Pg)

Other Podzols having a B horizon in which a subhorizon contains dispersed organic matter and lacks sufficient free iron to turn redder on ignition

Humic Podzols (Ph)

Other Podzols in which the ratio of percentage of free iron to percentage of carbon is 6 or more in all subhorizons of the B horizon

Ferric Podzols (Pf)

Other Podzols lacking or having only a thin (2 cm or less) and discontinuous albic E horizon; lacking a subhorizon within the B horizon which is visibly more enriched with carbon

Leptic Podzols (Pl)

Other Podzols

Orthic Podzols (Po)

Other soils having an oxic B horizon

FERRALSOLS (F)

Ferralsols having plinthite within 125 cm of the surface

Plinthic Ferralsols (Fp)

Other Ferralsols having a base saturation of less than 50 percent (by NH_4OAc) in at least a part of the B horizon within 100 cm of the surface; having an umbric A horizon or a high organic matter content in the B horizon, or both

Humic Ferralsols (Fh)

Other Ferralsols having a cation exchange capacity (from NH_4Cl) of 1.5 me or less per 100 g of clay in at least some part of the B horizon within 125 cm of the surface

Acric Ferralsols (Fa)

Other Ferralsols having a red to dusky red B horizon (rubbed soil has hues redder than 5YR with a moist value of less than 4 and a dry value not more than one unit higher than the moist value)

Rhodic Ferralsols (Fr)

Other Ferralsols having a yellow to pale yellow B horizon (rubbed soil has hues of 7.5YR or yellower with a moist value of 4 or more and a moist chroma of 5 or more)

Xanthic Ferralsols (Fx)

Other Ferralsols

Orthic Ferralsols (Fo)

Other soils having an albic E horizon overlying a slowly permeable horizon (for example, an argillic or natric B horizon showing an abrupt textural change, a heavy clay, a fragipan) within 125 cm of the surface; showing hydromorphic properties at least in a part of the E horizon

PLANOSOLS (W)

Planosols having permafrost within 200 cm of the surface

Gelic Planosols (Wx)

Other Planosols having more than 6 percent sodium in the exchange complex of the slowly permeable horizon

Solodic Planosols (Ws)

Other Planosols having a mollic A horizon or a eutric histic H horizon

Mollic Planosols (Wm)

Other Planosols having an umbric A horizon or a dystric histic H horizon

Humic Planosols (Wh)

Other Planosols having a base saturation of less than 50 percent (by NH_4OAc) in at least a part of the slowly permeable horizon within 125 cm of the surface

Dystric Planosols (Wd)

Other Planosols

Eutric Planosols (We)

Other soils having a natric B horizon

SOLONETZ (S)

Solonetz showing hydromorphic properties within 50 cm of the surface

Gleyic Solonetz (Sg)

Other Solonetz having a mollic A horizon

Mollic Solonetz (Sm)

Other Solonetz

Orthic Solonetz (So)

Other soils having a mollic A horizon with a moist chroma of 2 or less to a depth of at least 15 cm, showing bleached coatings on structural ped surfaces

GREYZEMS (M)

Greyzems showing hydromorphic properties within 50 cm of the surface

Gleyic Greyzems (Mg)

Other Greyzems

Orthic Greyzems (Mo)

Other soils having a mollic A horizon with a moist chroma of 2 or less to a depth of at least 15 cm; having one or more of the following: a calcic or a gypsic horizon, or concentrations of soft powdery lime within 125 cm of the surface when the weighted average textural class is coarse, within 90 cm for medium textures, within 75 cm for fine textures

CHERNOZEMS (C)

Chernozems having an argillic B horizon; a calcic or gypsic horizon may underlie the B horizon

Luvic Chernozems (Cl)

Other Chernozems showing tonguing of the A horizon into a cambic B or into a C horizon

Glossic Chernozems (Cg)

Other Chernozems having a calcic or a gypsic horizon

Calcic Chernozems (Ck)

Other Chernozems

Haplic Chernozems (Ch)

Other soils having a mollic A horizon with a moist chroma of more than 2 to a depth of at least 15 cm; having one or more of the following: a calcic or gypsic horizon, or concentrations of soft powdery lime within 125 cm of the surface when the weighted average textural class is coarse, within 90 cm for medium textures, within 75 cm for fine textures

KASTANOZEMS (K)

Kastanozems having an argillic B horizon; a calcic or gypsic horizon may underlie the B horizon

Luvic Kastanozems (Kl)

Other Kastanozems having a calcic or a gypsic horizon

Calcic Kastanozems (Kk)

Other Kastanozems

Haplic Kastanozems (Kh)

Other soils having a mollic A horizon

PHAEOZEMS (H)

Phaeozems, having an argillic B horizon, showing hydromorphic properties within 50 cm of the surface

Gleyic Phaeozems (Hg)

Other Phaeozems having an argillic B horizon

Luvic Phaeozems (Hl)

Other Phaeozems being calcareous at least between 20 and 50 cm from the surface

Calcaric Phaeozems (Hc)

Other Phaeozems

Haplic Phaeozems (Hh)

Other soils having an argillic B horizon showing an irregular or broken upper boundary resulting from deep tonguing of the E into the B horizon or from the formation of discrete nodules (ranging from 2 to 5 cm up to 30 cm in diameter) the exteriors of which are enriched and weakly cemented or indurated with iron and having redder hues and stronger chromas than the interiors

PODZOLUVISOLS (D)

Podzoluvisols showing hydromorphic properties within 50 cm of the surface

Gleyic Podzoluvisols (Dg)

Other Podzoluvisols having a base saturation of less than 50 percent (by NH_4OAc) in at least a part of the B horizon within 125 cm of the surface

Dystric Podzoluvisols (Dd)

Other Podzoluvisols

Eutric Podzoluvisols (De)

Other soils having a weak ochric A horizon and an aridic moisture regime; lacking permafrost within 200 cm of the surface

XEROSOLS (X)

Xerosols having an argillic B horizon; a calcic or gypsic horizon may underlie the B horizon

Luvic Xerosols (Xl)

Other Xerosols having a gypsic horizon within 125 cm of the surface[1]

Gypsic Xerosols (Xy)

Other Xerosols having a calcic horizon within 125 cm of the surface[1]

Calcic Xerosols (Xk)

Other Xerosols

Haplic Xerosols (Xh)

Other soils having a very weak ochric A horizon and an aridic moisture regime; lacking permafrost within 200 cm of the surface

YERMOSOLS (Y)

Yermosols showing takyric features

Takyric Yermosols (Yt)

[1] The depth requirement varies with the weighted average textural class: less than 125 cm from the surface for coarse textures, less than 90 cm for medium textures, less than 75 cm for fine textures. When both a calcic and gypsic horizon are present the classification of the soil is determined by the diagnostic horizon which occurs nearest to the surface.

Other Yermosols having an argillic B horizon; a calcic or gypsic horizon may underlie the B horizon

Luvic Yermosols (Yl)

Other Yermosols having a gypsic horizon within 125 cm of the surface [1]

Gypsic Yermosols (Yy)

Other Yermosols having a calcic horizon within 125 cm of the surface [1]

Calcic Yermosols (Yk)

Other Yermosols

Haplic Yermosols (Yh)

Other soils having an argillic B horizon with a clay distribution where the percentage of clay does not decrease from its maximum amount by as much as 20 percent within 150 cm of the surface; lacking plinthite within 125 cm of the surface; lacking vertic and ferric properties

NITOSOLS (N)

Nitosols having a base saturation of less than 50 percent (by NH_4OAc) in at least a part of the B horizon within 125 cm of the surface; having an umbric A horizon or a high organic matter content in the B horizon, or both

Humic Nitosols (Nh)

Other Nitosols having a base saturation of less than 50 percent (by NH_4OAc) in at least a part of the B horizon within 125 cm of the surface

Dystric Nitosols (Nd)

Other Nitosols

Eutric Nitosols (Ne)

Other soils having an argillic B horizon; having a base saturation which is less than 50 percent (by NH_4OAc) in at least some part of the B horizon within 125 cm of the surface

ACRISOLS (A)

Acrisols having plinthite within 125 cm of the surface

Plinthic Acrisols (Ap)

Other Acrisols showing hydromorphic properties within 50 cm of the surface

Gleyic Acrisols (Ag)

Other Acrisols having an umbric A horizon or a high organic matter content in the B horizon, or both

Humic Acrisols (Ah)

Other Acrisols showing ferric properties

Ferric Acrisols (Af)

Other Acrisols

Orthic Acrisols (Ao)

Other soils having an argillic B horizon

LUVISOLS (L)

Luvisols having plinthite within 125 cm of the surface

Plinthic Luvisols (Lp)

Other Luvisols showing hydromorphic properties within 50 cm of the surface

Gleyic Luvisols (Lg)

Other Luvisols having an albic E horizon

Albic Luvisols (La)

Other Luvisols showing vertic properties

Vertic Luvisols (Lv)

Other Luvisols having a calcic horizon or concentrations of soft powdery lime within 125 cm of the surface when the weighted average textural class is coarse, within 90 cm for medium textures, within 75 cm for fine textures

Calcic Luvisols (Lk)

Other Luvisols showing ferric properties

Ferric Luvisols (Lf)

Other Luvisols having a strong brown to red B horizon (rubbed soil has a hue of 7.5YR and a chroma of more than 4, or a hue redder than 7.5YR)

Chromic Luvisols (Lc)

Other Luvisols

Orthic Luvisols (Lo)

Other soils having a cambic B horizon or an umbric A horizon which is more than 25 cm thick

CAMBISOLS (B)

Cambisols having permafrost within 200 cm of the surface

Gelic Cambisols (Bx)

Other Cambisols showing hydromorphic properties within 100 cm of the surface

Gleyic Cambisols (Bg)

Other Cambisols showing vertic properties

Vertic Cambisols (Bv)

Other Cambisols showing one or more of the following : a calcic horizon or a gypsic horizon or concentrations of soft powdery lime within 125 cm of the surface when the weighted average textural class is coarse, within 90 cm for medium textures, within 75 cm for fine textures; calcareous at least between 20 and 50 cm from the surface

Calcic Cambisols (Bk)

Other Cambisols having an umbric A horizon which is thicker than 25 cm when a cambic B horizon is lacking

Humic Cambisols (Bh)

Other Cambisols having a cambic B horizon with ferralic properties

Ferralic Cambisols (Bf)

Other Cambisols having a base saturation of less than 50 percent (by NH_4OAc) at least in some part of the B horizon

Dystric Cambisols (Bd)

Other Cambisols which have a strong brown to red B horizon (rubbed soil has a hue of 7.5YR and a chroma of more than 4, or a hue redder than 7.5YR)

Chromic Cambisols (Bc)

Other Cambisols

Eutric Cambisols (Be)

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