INTERNATIONAL SOIL MUSEUM
UTRECHT

THE USDA SYSTEM OF SOIL CLASSIFICATION

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I. INTRODUCTION

In 1951 the Soil Survey Staff, Soil Conservation Service of the United States Department of Agriculture took the decision to develop a new basic system of soil classification. The reason for this was the increasing difficulty to accommodate all newly mapped soils in the classification in use at that time, without substantially changing it. It was felt that a fresh approach should be made to develop a scheme of soil classification that would include as many of the new data as possible, provide for the incorporation of data that would become available in the future and furnish a basis for predicting how the various soils would respond to modern management.

It was realized that a comprehensive system could only be developed with the co-operation of many soil scientists, including man experienced with a wide variety of soils. Consequently the system was developed by a series of approximations, testing each one to discover its defects and thus gradually approaching a workable system. The first approximations were circulated to only a few scientists, mainly in the United States. The third and all subsequent ones were circulated to an ever-increasing number of people, also outside the US. Finally, to secure the widest possible criticism, the 7th Approximation was published in 1960. Since then changes have been issued in "Supplements" (1964, 1966, 1967, with amendment in 1968).

The final text will be published in the near future under the title: SOIL TAXONOMY, A Basic System of Soil Classification for Making and Interpreting Soil Surveys. 1/

Parts of the preliminary text have been made available to a limited number of soil scientists in 1970 and 1973.

In 1965 the Soil Survey Staff began to use the classification. It became widely known, also outside the US, mainly because of the following reasons:

- The system claims to be a comprehensive one, and indeed the knowledge of many soil scientists from many countries has been incorporated. It seems possible to accommodate most soils of the world more or less satisfactory.

1/ Taxonomy is a narrower term than classification. Classification includes taxonomy, but it also includes classifications for specific practical purposes. Taxonomy is the part of classification that is concerned primarily with relationships.

- Classes and differentiating criteria have been defined more precisely and accurately than in any other classification system.
- A number of new fundamental concepts concerning soil mapping and classification has been introduced.

For these reasons the new system has attracted wide attention throughout the world and it has already stimulated much discussion and guided new research. Moreover, the concepts have inspired some countries to develop adaptations for local use, e.g. the Netherlands.
The new system has also strongly influenced the legend of the FAO-Unesco Soil Map of the World.

II. THE PREVIOUS SYSTEM

The US soil classification in use until 1965 was that of Baldwin, Kellogg and Thorp. This was published in 1938 and revised in 1949 by Thorp and Smith. It is a multicategoric system, i.e. individuals or classes of lower category are grouped into classes of higher category to show the relations between classes. This classification is a modification of the earlier system by C.F. Marbut (1927, 1936).

At the highest categorical level three orders are recognized:
- Zonal soils, including those soils having well-developed soil characteristics that reflect the influence of the active factors of soil formation, especially climate and vegetation.
- Intrazonal soils, having more or less well-developed soil characteristics that reflect the dominating influence of some local factor, such as relief, parent material or drainage, over the zonal effect of climate and vegetation.
- Azonal soils, without well-developed soil characteristics, because an insufficient length of time, the nature of the parent material or the rapid rate of erosion or deposition have prevented the development of definite soil characteristics.

The orders are subdivided into 10, mostly unnamed, suborders, and these into 37 great soil groups. The lower categories are soil family, soil series and soil type. Notably the great soil groups have become widely known outside the US. Examples are Gray-Brown Podzolic soils, Brown Podzolic Soils and Red-Yellow Podzolic soils, which have been recognized in many countries.
The lowest categories, soil series and soil types, are used especially for the definition of soil mapping units. The soil series is a group of

soils having soil horizons similar in differentiating characteristics and arrangement in the soil, except for the texture of the surface soil, and developed from a particular type of parent material.
The soil type is a subdivision of the soil series, based on the texture of the surface soil (Soil Survey Staff, 1951).
To bridge the gap between the soil series and the great soil group the category of the soil family was proposed. However, the lack of consistent guidelines to arrange the soil series into families created serious difficulties.

Deficiences of this system

Many soil surveys have been carried out in the US since 1938 and many new soil series were described. It soon became apparent that it would be impossible to find places for all series without substantially changing the system. In addition, fundamental shortcomings became more and more in view.
The main deficiences of the 1938 classification can be summarized as follows:

- The definitions of the classes were brief and vague and the differentiating criteria had not been defined in a quantitative sense. This resulted in serious differences of opinion on the interpretation.
- The definitions of the classes were in terms of central concepts rather than in terms of boundaries between classes. This made the placement of marginal individuals a subjective matter.
- The definitions were based primarily on the genesis or the properties of virgin soils. Cultivated soils were either ignored, or classified on the basis of the properties they were presumably to have when virgin.
- A number of soil series did not seem to fit into any recognized great soil group and some soils could be placed equally well in more than one great soil group.
- The nomenclature was causing confusion. The names had never been clearly defined and many of the older ones had been used with different meanings in different countries, or even within the same country.

III. THE NEW CLASSIFICATION

III.1. Objectives of the new soil classification

In 1951, with more soil data available than ever before, it seemed possible to develop a new system of soil classification that would avoid the deficiences mentioned above.

The major considerations guiding the development of the new system were:

- The classification should be multicategoric, with few classes in the highest category and a large number in the lowest category. The lower classes must be as specific as possible about a great number of soil properties, because many properties are important in soil use. Higher categories are essential for organizing and understanding the lower categories and, in addition, they are useful for comparing soils of large areas, but are of limited value for the transfer of experience. They permit the mind to grasp the concepts and relationships of the soils.
- The definitions of the differentiating criteria should be based upon properties that are observable or measurable, either in the field or in the field laboratory. These properties should be stated in terms of soil properties, not genetic processes or environmental factors.
- Classes should be defined primarily by class boundaries. Although a definition by central concept has the advantage that the definition of the class may be easier to remember and understand, it must be recognized that the present knowledge is insufficient to determine this central concept.
- The system should be able to accommodate all soils, not only those which have not been under cultivation or affected in other ways by man's activity. The system should be flexible and a means should be provided to recognize new classes when new combinations of soil properties important to our purposes are found.
- A new system of nomenclature should be attempted. The names should be connotative, i.e. suggesting the more important properties of the class, and from the name one should be able to recognize both the category of the class and the class in any of the higher categories to which it belongs.

III.2. The unit of classification: the soil individual or polypedon

Classification presupposes the presence of individuals, which can be classified. A soil individual is not found as a separate and distinct unit, clearly separated from all other individuals like a plant, but it grades on its margins to other soil individuals with unlike properties. Therefore, a concept of the soil individual must be developed before soils can be classified.

The Soil Survey Staff defined for this purpose the soil individual or polypedon (Greek: pedon = ground) as a unit of soil that differs from its adjoining units in the landscape in one or more properties to such a degree that the combination of all properties result in different responses to management. The boundaries of such a unit of classification come at a place where there has been or is now a significant difference in one or more soil

forming factors: climate, parent material, living organisms, age of the land form, and relief.
The limits of the polypedon are also the conceptual limits between soil series, which are the classes of the lowest category in the Soil Taxonomy. Every polypedon can be classified into a soil series, but a series normally has a wider range in its characteristics than a single polypedon.

A polypedon is built up of one or more contiguous similar pedons. A pedon is the smallest volume that can be called "a soil". It shows the nature and arrangement of the horizons and variability in the other properties. It has three dimensions. Its lower limit is the somewhat vague limit between the soil and the "not-soil" below. Its area is large enough to represent the nature of the horizons and variability that may be present and ranges from 1 to 10 m^2, depending on this variability.
The polypedon may then be defined as a group of contiguous similar pedons bounded on all sides by "not-soil" or by pedons of unlike character. A polypedon has a minimum area of more than 1 m^2 and an unspecified maximum area.It has some characteristics, such as shape, transitional margins, and natural boundaries, that are not possessed by any of its component pedons. The polypedons are the real things that we want to classify into series and higher categories.

III.3. The categories and their classes

Like the earlier system, the new soil classification system is a multicategoric system, with one or more differentiating characteristics at each categorical level dividing soils into mutually exclusive classes. It has the advantage of assisting memory and facilitating the construction of a key for identification.
The highest category, Orders, has ten classes. It replaces the Zonal, Intrazonal and Azonal orders of the previous system, but it has a somewhat lower level of abstraction. Each order has been subdivided into Suborders. Lower categories are Great Groups, Subgroups, Families and Series. The soil type, the lowest category in the previous system, has not been retained.

III.4. Nomenclature 1/

It was decided not to retain the names of the 1938 classification. A completely new system of nomenclature was introduced, using coined names, as short as possible and with connotations enough to help users remember

1/ See Appendix I and Appendix II.

the names. The names suggest some of the major properties characteristic for the class, and show the categorical level of that class and its relation to other classes in the same category as well as in higher categories.

The order names have a common ending: sol. For example soils that show only slight and recent development are grouped in the order Entisols. The name is intended to suggest the young character of the soil, ent being derived from recent. A formative element is abstracted of the name of each order. It is used as ending for all the names of all suborders, great groups and subgroups. In Entisols the formative element is ent. Thus any name ending in ent can be identified as a subdivision of Entisols.

The suborder names consist of two syllables: a prefix and the formative element. Thus Entisols in recent water-deposited sediments which still show some of the original stratification are called Fluvents (Latin: fluvius = river).

The great group names are coined by prefixing one or more additional formative elements to the suborder name. Thus they may have three or more syllables. The Fluvents that are usually dry in the summer are called Xerofluvents (Greek: xeros = dry)

The subgroup names consist of the name of the great group, preceded by one or more adjectives. The adjective Typic is used for the subgroup that is thought to typify the central concept of the great group. Subgroups that have in addition to the properties of their own group some characteristics of another class, carry the name of the other class in adjective form. For example, Xerofluvents which have -notwithstanding their general dry nature- some characteristics associated with wetness might carry the adjective Aquic (Latin: aqua = water). The subgroup name is Aquic Xerofluvent.

The family names carry the name of the subgroup with adjectives that specify the texture, the mineralogy, the temperature regime and other soil characteristics; e.g. Aquic Xerofluvent, fine, montmorillonitic, mesic. This family includes soils with a fine (clayey) texture, consisting predominantly of montmorillonite and having a temperate soil temperature regime (Greek: mesos = moderate).

The series names have not been changed. They continue to be abstract names, which are mostly taken from the locality in which they were first described or have the most typical occurrence, e.g. Lahontan series.

III.5. The differentiating criteria of the system

The ABC nomenclature, as defined in the Soil Survey Manuel (Soil Survey Staff, 1951 and 1962) and in the FAO Guidelines for Soil Description, is

still used as the standard for describing and defining soil horizons in the field. For classification purposes however, more strict definitions of soil horizons were needed and the concept of diagnostic horizons was developed.
A number of horizons and other soil characteristics have been defined very precisely in order to serve as differentiating criteria. All definitions are so-called operational definitions, i.e. the operations (methods) that one uses to determine the criteria are specified so that the definitions have the most precise meaning possible.
The reader is cautioned that diagnostic horizons are not synomymous with A, B or C horizons. A surface diagnostic horizon for example, may include part or all of an illuvial B horizon if the properties, as defined, extend from the surface into or through the B horizon.
Classification in the highest categories is, in most cases, based on the presence or absence of diagnostic horizons. In the lower categories other diagnostic properties, like soil moisture regime, soil temperature regime, presence or absence of lithic contacts, and particle size classes are used in addition.

III.6. Diagnostic horizons

Two kinds of diagnostic horizons are recognized: surface and subsurface horizons.
The surface diagnostic horizons are called epipedons (Greek: epi = over or upon, pedon = soil). The reader is cautioned that the following brief descriptions are incomplete and abbreviated. For full details reference is made to the original definitions in the 7th Approximation and Soil Taxonomy.

III.6.1. Diagnostic Surface horizons

Mollic epipedon (Latin: mollis = soft)
This is a thick, dark-coloured, humus-rich horizon with a high base saturation and a strong structure, so that the soil is not both massive and hard or very hard in the major part when dry. It contains over 1 percent organic matter (0,6 percent organic carbon). The base saturation is over 50 percent by the NH_4OAc method and Ca is the dominating cation. Colour values are lower than 3.5 when moist and 5.5 when dry, and chromas less than 3.5 when moist. The thickness is more than 25 cm. However, under specified conditions, e.g. if the horizon is underlain by hard rock or indurated soil material (lithic or paralithic contact, petrocalcic horizon or duripan, as defined later), its thickness is

10 cm or more. If the solum is less than 75 cm, the thickness is more than one-third of the solum. The mollic epipedon has less than 250 ppm P_2O_5 soluble in 1 percent citric acid, except when the parent material is highly phosphatic. This restriction is used to eliminate plow layers of very old arable soils and kitchen middens, that gave acquired, under use, the properties of the mollic epipedon. If the soil is not irrigated, some part of it is moist 3 months or more of the year (cumulative) in more than 7 out of 10 years.

Anthropic epipedon (Greek: anthropos = man)
This epipedon conforms to all the requirements of the mollic epipedon, but it has more than 250 ppm P_2O_5 soluble in citric acid. It is formed under long-continued use by man, either as a place of residence or for growing irrigated crops.

Umbric epipedon (Latin: umbra = shade, hence dark)
The umbric epipedon is comparable to the mollic epipedon in its colour, organic carbon, consistence, structure, P_2O_5 content, and thickness requirements. It includes those thick, dark surface horizons that have base saturation of less than 50 percent (by NH_4OAc). The organic matter content may be even higher in umbric than in mollic epipedons.

Histic epipedon (Greek: histos = tissue)
The histic epipedon consists of peat or muck. It may be covered with a thin layer of mineral material. If plowed it may contain mineral material due to mixing. The histic epipedon is either saturated with water for 30 consecutive days or more at some time in most years, or it is artificially drained. Its thickness generally varies from 20-60 cm, but may be thicker or thinner under specified conditions. It contains 18 percent organic carbon or more, but may have less under specified conditions.

Plaggen epipedon (German: plagge = sod)

This is a man-made surface layer, more than 50 cm thick, that has been produced by long-continued manuring. In medieval times, before introduction of chemical fertilizers, sod or other materials were commonly used for bedding livestock and the manure being spread on the field. The mineral materials brought in by this kind of manuring eventually produced an appreciably thickened A_p horizon. The plaggen epipedon commonly contains artifacts. It normally shows spade marks throughout as well as remnants of thin stratified beds of sand. Its occurrence is possibly restricted to parts of western Europe.

Ochric epipedon (Greek: ochros = pale)
This epipedon is one that is too light in colour, too high in chroma, too low in organic matter or too thin to be mollic, umbric, anthropic, plaggen, or histic, or it is both hard and massive when dry.
It includes eluvial horizons that are at or near the surface (the A_2 horizon and an albic horizon) and extends to the first underlying diagnostic illuvial horizon (argillic, natric or spodic horizon). If the underlying horizon is a B horizon of alteration (cambic or oxic horizon) and there is no surface horizon that is appreciably darkened by humus, the most convenient lower limit of the ochric epipedon is the base of the plow layer, or an equivalent depth in a soil that has not been plowed.

III.6.2. Diagnostic subsurface horizons
Diagnostic subsurface horizons form below the surface, though they may at times form immediately below a leaf litter. They may be exposed at the surface if the overlying horizons have been eroded.

Argillic horizon (Latin: argilla = white clay)
This is a horizon of accumulation of illuvial silicate clay. Clay -especially fine clay- has been carried downwards by percolating water from the overlying horizons into the illuvial horizon. It is deposited in this horizon as clay skins, also called clay coatings or cutans, on ped faces and on the walls of pores.
In medium-textured soils the ratio of the clay in the argillic horizon to that in the eluvial horizon must be 1.2 or more. For example, if the overlying eluvial horizon has 20 percent clay, the argillic horizon has at least 1.2 times 20 percent = 24 percent.
In coarse-textured soils (if the eluvial horizon contains less than 15 percent clay) the argillic horizon contains at least 3 percent more clay than the eluvial horizon. For example, if the eluvial horizon has 11 percent clay, the argillic horizon has at least 11 + 3 = 14 percent.
In sands and loamy sands and in some loess the argillic horizon commonly forms as a series of lamellae, that are sometimes called fibres. Only the lamellae are considered in comparing textures and determining the thickness of an argillic horizon.
In fine-textured soils (more than 40 percent clay) the argillic horizon contains at least 8 percent more clay than the eluvial horizon. For

example, if the overlying horizon has 45 percent clay, the argillic horizon contains at least 45 + 8 = 53 percent clay.
If the argillic horizon is sand or loamy sand, it is at least 15 cm thick. If it is loamy or clayey, it is at least 7.5 cm thick. If it is composed entirely of lamellae, lamellae 1 cm or more thick should have a combined thickness of at least 15 cm.
It should be emphasized that a subsurface horizon may contain more clay than the overlying horizons, without being an argillic horizon. The finer texture may be the result of stratification of the parent material. Such horizons do not show evidences of illuvial clay in the form of clay skins in pores and on the ped faces.

Natric horizon (natrium = sodium)
The natric horizon is a special kind of argillic horizon. It has, in addition to the properties of the argillic horizon, an appreciable amount of exchangeable sodium and a prismatic, or more commonly, columnar structure.

Agric horizon (Latin: ager = field)
This is an illuvial horizon immediately under the A_p horizon, formed under cultivation, that contains amount of illuvial silt, clay and humus. After long-continued cultivation, changes immediately below the plow layer become apparent. The worm channels, root channels, or ped surfaces become coated with a dark-coloured mixture of organic matter, silt and clay. The accumulation may also take the form of thick lamellae, varying from a few mm to about 1 cm.

Sombric horizon (French: sombre = dark)
This horizon is thought to be restricted to the cool, moist soils of high plateaus and mountains in tropical and subtropical regions.
It has formed under free drainage and contains illuvial humus that is neither associated with aluminium (as in the spodic horizon), nor dispersed by sodium (as is common in the natric horizon). It has a lower CEC than the spodic horizon, and the base saturation (by NH_4OAc) is less than 50 percent. The sombric horizon has lower colour value or chroma, or both, than the overlying horizon and commonly contains more organic matter than the overlying horizon. In the field it is easily confused with a buried A_1 horizon, but can be distinguished by lateral tracing.

Spodic horizon (Greek: spodos = ash)
This is a horizon of illuvial organic matter and sesquioxides of aluminium, with or without sesquioxides of iron. The sesquioxides may come from dissolution of primary minerals in the eluvial horizon or from cycling by plants. It has a high exchange capacity, large surface area and high water retention. Spodic horizons occur only in humid environments. They are most common in cold and temperate climates but also occur in hot climates.
Colours of the spodic horizon are mostly redder than 10YR. They change markedly with depth within the horizon. The lowest values, reddest hues, or highest chromas are in the upper part. In virgin soils, the spodic horizon usually lies below an illuvial mineral horizon, normally an albic horizon. Using a hand lens the organic matter commonly may be observed as black of dark brown pellets of silt size and as coatings of a mixture of organic matter with iron and aluminium sesqui oxides on mineral sand grains. If the coatings are very thick the horizon may be cemented.(ortstein).
A horizon is not a spodic horizon if it is so thin, so near the surface, and so weakly expressed that plowing a few times to a depth of 12.5 cm obliterates all traces.

Placic horizon (Greek: plax = flat stone)
The placic horizon is a thin, black to dark reddish pan cemented by iron, by iron and manganese, or by an iron-organic matter complex. Its thickness generally ranges from 2 mm to 10 mm. The placic horizon occurs in very humid climates. It can be easily identified because the hard brittle pan differs so much from the materials in which it occurs.

Cambic horizon (Latin: cambiare = to change)
This is a horizon of alteration. It has soil structure and there is little or no evidence of illuviation.
Sandy materials,with textures coarser than loamy very fine sand are excluded from cambic horizons, because recognition of alteration of sands is difficult and may lead to different interpretations.
Cambic horizons lie immediately below an epipedon, or they are at the surface if the soil has been truncated.
The original structure of the parent rock has been at least partially destructed by frost, animals or roots. Aggregation of soil particles into peds has taken place, i.e. it has soil structure rather than rock structure..In addition, the horizon is altered chemically. The cambic

horizon has lost sesquioxides and/or bases, through leaching. The chemical alteration has occurred in various ways, depending on the environmental conditions:

(1) In the presence of fluctuating groundwater the free iron is generally reduced and then concentrated into mottles or concretions or it is removed altogether, causing a horizon dominated by colours with low chroma on ped faces or in the matrix.

(2) In the absence of both groundwater and carbonates, in temperate humid climates the formation of clay and sesquioxides from easily weatherable minerals generally results in brownish colours. In humid tropical regions, the colours are commonly more reddish than brownish. The chroma commonly is higher or the hue redder in the cambic horizon than in the underlying C.

(3) In cambic horizons that form in humid climates from highly calcareous materials, there has been mostly a considerable loss of carbonates. However, the soil is commonly calcareous throughout due to the mixing activity of the soil fauna, in particular of earth worms, which produce a granular or a crumb structure.

(4) In arid and semi-arid climates, carbonates are usually but not always present. They have been redistributed and partially or completely removed. Volume changes of the soil material, accompanying seasonal changes in moisture, tend to produce prismatic structure, sometimes with very coarse prisms.

Although cambic horizons give a great diversity of appearance, the general concept is that of an altered horizon, which is not the result of additions of mineral substances by illuviation. The degree of alteration may be slight to strong, but some weatherable minerals are present. Rock structure is absent in more than half of the volume of all subhorizons. Soil structure normally is present, but some horizons are massive.

Oxic horizon (Latin: oxide = oxide)

This is a very strongly altered horizon, which is at least 30 cm thick. It is a residual concentration of hydrated oxides of iron or aluminium, or both, with variable amounts of 1 : 1 lattice clays (e.g. kaolinite) and some highly insoluble minerals such as quartz sand. It has a low cation retention capacity and apparent cation-exchange capacity and there are virtually no weatherable minerals. Only a trace of the clay is water dispersable.

Soils with oxic horizons generally occur on very old stable geomorphic surfaces,which may be mid-Pleistocene.
Oxic horizons are seldom found outside tropical or subtropical climates, and occur mainly below 1500-2000 m altitude. The oxic horizon normally underlies an epipedon or ithas been exposed by erosion. The boundaries with adjacent horizons normally are diffuse. Most oxic horizons appear massive in fresh pits, but many have a very weak, very coarse prismatic structure that is visible only in old cuts. A fragment crushes easily to very fine granules. The material has a low plasticity and high friability.
Colour is not diagnostic for this horizon. Someoxic horizons have varying shades of grey, brown, and red, or have mixtures of these colours in medium or coarse mottles.

Duripan (Latin: durus = hard)
This is a subsurface horizon that is cemented by silica, to the degree that fragments from the air-dry horizon do not slake after prolonged soaking in water or in HCL. As a consequence it has a very firm or extremely firm consistence when moist and is always brittle.
Duripans occur primarily in soils of sub-humid Mediterranean or of arid climates, i.e. soils that are seasonally dry or that are usually dry. Geographically duripans are restricted largely to areas of volcanism, where pyroclastic materials, containing great quantities of easily weatherable glass can liberate silica at a rapid rate.

Fragipan (Latin: fragilis = brittle)
A fragipan is a loamy subsurface horizon, that is seemingly cemented when dry, having a hard or very hard consistence and a high bulk density. When moist it has a moderate to weak brittleness. It is usually mottled, is slowly or very slowly permeable to water and it impedes root growth. The fragipan may, but does not necessarily underlie a cambic, spodic, argillic, or albic horizon.

Albic horizon (Latin: albus = white)
This is an eluvial horizon, more or less equivalent with an A_2, from which clay and free iron oxides have been removed. The colour is determined by the colour of the primary sand and silt particles rather than by coatings on these particles. It has grey, white, or other colours with high values. The albic horizon is usually underlain by a spodic, natric, or argillic horizon, a fragipan or a relatively impervious layer that can produce a perched water table.

Calcic horizon (Latin: calx = lime)

This is a horizon of secondary accumulation of calcium carbonate or of calcium and magnesium carbonate. The accumulation may be in the C horizon, but it may also be in a variety of other horizons, such as a mollic epipedon, an argillic or natric horizon or a duripan.

The calcic horizon has two forms:

(1) The underlying materials have less carbonate than the calcic horizon. This calcic horizon is thicker than 15 cm and it contains at least 15 percent of calcium carbonate equivalent. It has at least 5 percent more carbonate than an underlying layer.

(2) The calcic horizon is 15 cm or more thick, has a calcium carbonate equivalent of 15 percent or more, and contains 5 percent or more (by volume) of identifiable secondary carbonates as pendants on pebbles, concretions or soft powdery forms. If this horizon rests on very highly calcareous materials with 40 percent or more calcium carbonate equivalent, the percentage of carbonates need not decrease with depth.

Petrocalcic horizon (Greek:petros = stone)

This is a continuous, cemented or indurated calcic horizon, cemented by calcium carbonate. The horizon is usually much more than 10 cm thick. Dry fragments do not slake in water. It cannot be penetrated by spade or auger when dry. The petrocalcic horizon seems to be mainly restricted to surfaces older than the Holocene. It is a mark of advanced soil evolution.

Gypsic horizon

The gypsic horizon is a non-cemented or weakly cemented horizon of enrichment with secondary sulfates that is 15 cm or more thick and has at least 5 percent more gypsum ($CaSO_4 . 2H_2O$) than the underlying material, and in which the product of thickness in cm and the percentage of gypsum is 150 or more.

Petrogypsic horizon

This is a gypsic horizon that is strongly enough cemented with gypsum that dry fragments do not slake in water and that roots cannot enter. The gypsum content usually exceeds 60 percent .

Salic horizon (Latin: sal = salt)

A horizon of accumulation of appreciable amounts of salt, more soluble than gypsum. It is 15 cm or more thick and it contains more than 2 percent salt, and the product of its thickness in cm and the salt percentage by weight is 60 or more.

Sulfuric horizon

This is a very acid (pH less than 3.5 in water) horizon having yellow mottles of Jarosite ($KFe_3(SO_4)_2(OH)_6$). It is characteristic for acid sulfate soils. The horizon is highly toxic to plants and virtually free of living roots.

III.7. Other diagnostic soil characteristics (incomplete)

Abrupt textural change

This is a abrupt change from an ochric epipedon or an albic horizon to an argillic horizon with a very appreciable increase in the clay content in a very short distance in depth.

Gilgai

Gilgai is the micro relief typical of clayey soils that have a high coefficient of expansion with changes in moisture and that have distinct seasonal changes in moisture. It consists of micro-basins and micro-knolls in nearly level areas, or of micro-valleys and micro-ridges that run down the slope. The ridges vary from a few centimeters to a meter in height.

Lithic contact (Greek: lithos = stone)

A lithic contact is a boundary between soil and continuous, coherent, underlying material. The underlying material is hard and digging it with a spade is impractical.

Mottles that have chroma of 2 or less

The word "mottles" means marked with spots of contrasting colours. This refers to colours in a horizon in which parts have chroma of 2 or less, moist, and value, moist, of 4 or more, whether or not that part is dominant in volume or whether or not it is a continuous phase surrounding spots of higher chroma.
A horizon with such mottles is saturated with water at some period of the year or the soil is artificially drained.

Paralithic contact

A paralithic contact is a boundary between soil and continuous, coherent, underlying material. It differs from the lithic contact in that the underlying material -normally a partly consolidated sedimentary rock such as sandstone, siltstone, marl or shale- is less hard. The material may be dug with difficulty with a spade.

Permafrost

This is a continuously frozen layer, frequently occurring in arctic regions.

Petroferric contact

This is a boundary between soil and a continuous layer of indurated material in which iron is an important cement and organic matter is absent or is present only in traces. It is distinguished from a placic horizon and from an indurated spodic horizon (ortstein), which both contain organic matter.

Plinthite (Greek: plinthos = brick)

This is an iron-rich, humus-poor, mixture of clay with quartz and other diluents. The red, indurating portions of the layer are usually mottled with yellowish or dark red, greyish, or white bodies.
It hardens irreversibly to an ironstone hardpan or to irregular aggregates with repeated wetting and drying, especially if exposed to heat from the sun. It is then called ironstone.

Slickensides

Slickensides are polished and grooved surfaces produced by one mass sliding past another. They are very common in swelling clays that have marked changes in moisture content.

Soil moisture regimes

The soil moisture regime refers to the presence or absence either of groundwater or of water held at tensions of less than 15 bars in the soil or in specific horizons by periods of the year.
Five classes of moisture regimes have been distinguished so far:

(1) Aquic — Seasonal or permanent saturation with water, causing reducing conditions with consequent gleying. For differentiating in the highest categories of soils, the whole soil must be

saturated. In the subgroups only the lower horizons are saturated.

(2) Aridic and Torric — These terms are used for the same moisture regime, but in different categories of the taxonomy. Dry during prolonged periods when the soil is warm or hot.

(3) Udic — Moist throughout the year.

(4) Ustic — Intermediate between the aridic and udic regimes. Limited moisture, but present in the season when the soil is suitable for plant growth.

(5) Xeric — Alternating moist and dry conditions in the soil, with the moist period in the season when the soil is cool.

It should be noted that reference is made to soil conditions rather than climatic conditions. These two are closely correlated, but correlation is not perfect.

Soil temperature regimes

The following soil temperature regimes have been distinguished:

(1) Pergelic — Mean annual soil temperature is lower than 0^{o} C.

(2) Cryic — Mean annual soil temperature is higher than 0^{o} C but lower than 8^{o} C.

(3) Frigid — Warmer than cryic in summer, with mean annual soil temperature lower than 8^{o} C, and more than 5^{o} C difference between mean winter and mean summer soil temperatures. 1/

(4) Mesic — Mean annual soil temperature is 8^{o} C or higher, but lower than 15^{o} C, and more than 5^{o} C difference between mean winter and mean summer soil temperatures. 1/

(5) Thermic — Mean annual soil temperature is 15^{o} C or higher but lower than 22^{o} C and more than 5^{o} C difference between mean winter and mean summer soil temperatures. 1/

(6) Hyperthermic — Mean annual soil temperature is 22^{o} C or higher and more than 5^{o} C difference between mean winter and mean summer soil temperatures. 1/

1/ Measured at a depth of 50 cm below the surface or at a lithic or paralithic contact, whichever is shallower.

If the temperature class names have the prefix "iso" (e.g. Isothermic), the mean winter and mean summer soil temperatures differ by less than 5° C. 1/

IV. THE ORDERS

There are ten orders, differentiated by the presence or absence of diagnostic horizons and diagnostic properties. Each order has a different set of diagnostic horizons and properties, representing differences, both in kind and degree, of soil development. They are as follows: 1/

ENTISOLS

These are primarily soils that lack diagnostic horizons other than an ochric epipedon (which is, in essence, the absence of any other diagnostic epipedon). They include soils of slight and recent development. A few are sands with albic horizons; some soils in coastal marshes have histic epipedons. They may have anthropic and agric horizons and may have sulfidic materials.

Most have no diagnostic horizons. The reasons for this lack vary. In many, time has been too short for horizons to be formed. These soils may be on steep, actively eroding slopes, or on floodplains that receive new deposits of alluvium at frequent intervals.

Some Entisols are very old and consist mostly of quartz or other minerals that do not alter to form horizons. Buried horizons are permitted if they are buried to depths of more than 50 cm, or more than 30 cm under specified conditions.

As an order, the only common features are the vitual absence of diagnostic horizons and the mineral nature of the soil. The major factors limiting horizon development are:

- Cold or warm xeric climates may limit the amount and duration of water movement in the soil and the biotic influence on the soil.
- Solifluction, creep or erosion may remove surficial material from the site as fast as or faster than most pedogenic horizons can form.
- New material may be added to the surface of the soil as fast as or faster than the new material can be assimilated into a pedogenic horizon. (alluvial floodplain, delta, footslope, shorelands, etc.)

1/ It should be noted that in this section only the more important characteristics of the soils are mentioned. For detailed information see the 7th Approximation (1960) and Supplement (1967) and Selected Chapters of the Soil Taxonomy (1970) and Preliminary, Abridged Text of the Soil Taxonomy (1973).

Suborders of Entisols

Aquents are the wet Entisols. They are permanently or seasonally wet (saturated) and even if artificially drained, they have bluish grey (gleyed) or very mottled horizons. Some have sulfidic materials within 50 cm of the mineral surface. These wet Entisols may be in tidal marshes, in deltas, floodplains, or in wet very sandy deposits. They are usually in recent sediments.

Arents are better drained than Aquents and have fragments of diagnostic horizons below the A_p. The great disturbance of the deeper horizons has in most cases been by deep plowing, spading, or moving by man, but a homogenized deep A_p horizon has not been produced.

Fluvents are soils on alluvial deposits. They are mostly brownish to reddish coloured loamy and clayey soils with an irregular organic matter content with depth. Stratification is common in alluvium and in soils derived from it.

Orthents are loamy and clayey soils, better drained than Aquents, with a regular decrease in organic matter content with depth. They are primarily on recent erosion surfaces. A few are in recent loamy or fine eolian solifluction or glacial deposits, in debris from recent landslides and mudflows and in recent sandy skeletal alluvium.

Psamments are the sandy Entisols, with textures of loamy fine sand or coarser and are better drained than Aquents. They are primarily in sands of shifting or stabilized sand dunes, cover sands, or in sandy parent materials. Psamments on old stable surfaces consist of quartz sands that cannot form diagnostic horizons. Gravelly and very gravelly sands are grouped with the Orthents; these occur primarily in arid regions.

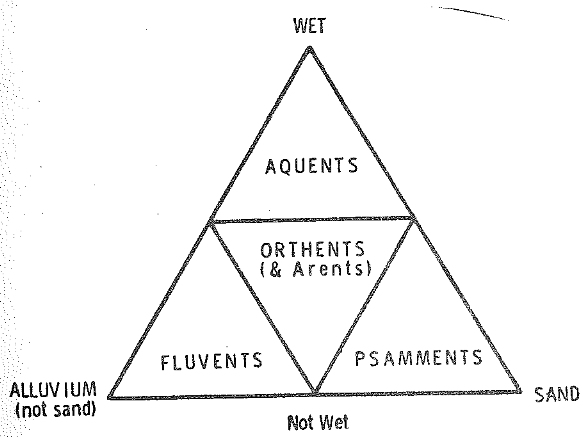


Diagram showing some relationships between suborders of Entisols. 1/

1/ Diagrams in this text are from Buol, Hole & McCracken (1973).

VERTISOLS

These are the cracking clays, mostly montmorillonite, that shrink and swell over the seasons, and that have wide deep cracks (more than 1 cm wide at 50 cm depth) during seasons of deficient moisture.
When the cracks are open, soil fragments from the surface fall or are washed into the cracks and generate pressure when the cracks close in the humid season. This may result in slickensides (shining pressure faces), the wedged-shaped structural aggregates and the typical gilgai relief.
Although a dry season is a necessity, its duration is highly variable.
An alkaline reaction is a feature common to the various parent materials (calcareous sedimentary rocks, basic igneous rocks, basalt, ash, and their alluvial deposits).
Vertisols generally are in depressions, some have gentle slopes.

Suborders of Vertisols

Torrerts are the Vertisols of arid climates. They are usually dry in all parts of the solum and the cracks are open to the surface in most years unless irrigated.

Uderts are the Vertisols of humid climates. They are usually moist and cracks open at some time during the year, according to the weather. In some years the cracks may not open at all, or may not be as wide as 1 cm at 50 cm depth. Most of these soils have a very dark grey to black surface horizon that is 30 cm or more thick, resting on a grey to brownish clay.

Usterts are the Vertisols in monsoon climates and in temperate regions with low summer rainfall. They have cracks that open and close once or more than once a year, but remain open for a total of 90 or more days a year, but not all year.

Xererts are the Vertisols that have cool wet winters and warm dry summers, characteristic of the Mediterranean climates. They have cracks that open and close regularly once every year and remain open for 60 or more consecutive days a year.

Number of Days per Year That Cracks Are Open

<90 cumulative <60 consecutive	>90 cumulative	>60 consecutive	All year in most yr
UDERTS	USTERTS	XERERTS	TORRERTS

INCEPTISOLS

These are soils with one or more diagnostic horizons that can form rapidly. They occur mainly in (sub)humid climates.
Most have one or more of the following horizons: an umbric or ochric epipedon, a cambic horizon, a fragipan, a duripan. They lack illuvial horizons as a rule and the direction of soil development is not yet evident from the marks left by the various soil forming processes, or the marks left are too weakly expressed to permit classification in another order.
The definition of this order is complicated, but the most common horizon sequences are an ochric epipedon over a cambic horizon, with or without an underlying fragipan, or an umbric epipedon overlying a cambic horizon with or without an underlying duripan or fragipan. All soils with plaggen epipedons are included. Calcic and placic horizons and mollic epipedons may be common in local areas but are rare in general.

Suborders of Inceptisols

Criteria of wetness, mineralogy, and temperature are used to separate the order into six suborders.

Aquepts are saturated with water at some period of the year unless artificially drained. They mostly have grey to black surface horizons, and mottled grey and rusty subsurface horizons beginning at depths of less than 50 cm. Most have a cambic horizon, and some have a fragipan in addition. Some may have a plaggen epipedon. A sulfuric horizon may occur.

Plaggepts have dark brown or black plaggen epipedons.

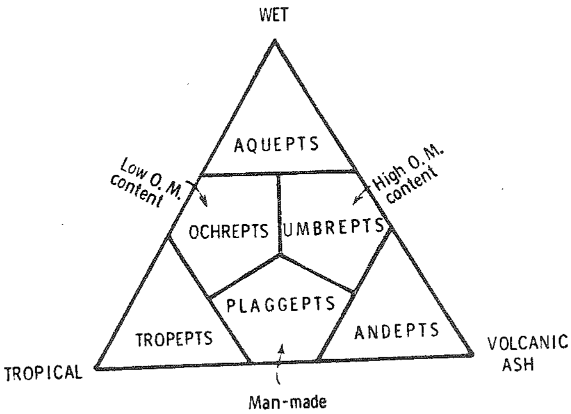
Andepts are developed on volcanic materials. They have a fine earth fraction with bulk density less than 0.85 g/cc in the epipedon and/or a cambic horizon, and amorphous material is the dominant source of the exchange complex. Vitric volcanic ash, cinders, or other vitric pyroclastic materials constitute 60 percent or more of the silt, sand and gravel fractions.

Tropepts are brownish to reddish, more or less freely drained soils in tropical regions, where mean annual soil temperature is 8^{o} C or higher and have less than 5^{o} C difference between mean summer and mean winter temperatures. Most have an ochric epipedon and a cambic horizon.

Umbrepts are the acid, dark reddish or brownish coloured, freely drained, organic-rich soils with an umbric epipedon. A mollic epipedon is rarely present in undisturbed Umbrepts, but is readily found by the rather common management practice of adding lime. An anthropic epipedon may be present.

Ochrepts are mainly the light coloured, brownish, more or less freely drained soils. Most have an ochric epipedon and a cambic horizon. In addition, some have clacic horizons, fragipans or duripans.

Diagram showing some relationships between suborders of the Inceptisols.



ARIDISOLS

These are primarily the soils of dry places. They have an ochric or anthropic epipedon and one or more of the following subsurface horizons: argillic, cambic, natric, gypsic, salic, calcic, petrocalcic or duripan.
There is almost always some carbonates in Aridisols and in most of them a distinctive zone where lime has accumulated in a large quantity (sometimes cemented into a petrocalcic horizon) occurs somewhere below the surface layer.
They occur under a sparse vegetation of desert shrubs and grasses and show too little effect of organic matter accumulation to produce a mollic epipedon.
A part of the Aridisols has argillic horizons, while a surface "pavement" of gravel (possibly formed by deflation of the fine earth) is present over many.

Suborders of Aridisols

Argids have an argillic or natric horizon. Those with an argillic horizon have formed on the oldest geomophic surfaces, as on the crests of dissected alluvial fans.

Orthids are without argillic or natric horizons, but have one or more other pedogenic horizons. They are found on geologically younger sideslopes and surfaces of intermediate age.

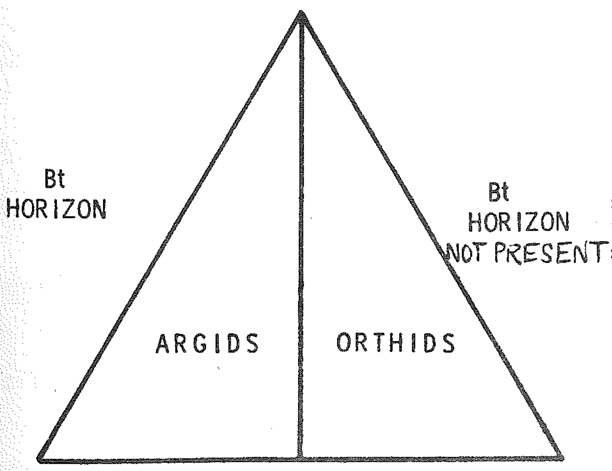


Diagram showing some relationships between suborders of Aridisols.

MOLLISOLS

These are mainly the very dark coloured soils of the steppe and prairie and have a base saturation in the deeper horizons of more than 50 percent. Nearly all have a mollic epipedon. 1/

They may or may not have albic, argillic, calcic, cambic and natric horizons. Some have duripans or petrocalcic horizons. They include most of the associated hydromorphic soils and also a few soils developed under forest from such high lime parent materials that the epipedon is mollic.

The predominant process in Mollisols is melanization,the process of darkening of the soil by addition of organic matter, by which the mollic epipedon or dark surface horizon extends down into the profile.

It is a bundle of several specific processes:

1. Extension of roots of prairie/steppe vegetation into the profile.
2. Partial decay of organic materials in the soil, producing some relatively stable, dark compounds.
3. Reworking of the soil and organic matter by earthworms, ants, moles, rodents, etc with formation of dark soil-organic matter complexes and mixtures,krotovinas (filled burrows) and mounds.
4. Eluviation and illuviation of organic and some mineral colloids, giving dark cutans on ped faces.

Suborders of Mollisols

Albolls have an albic horizon and fluctuating groundwater. Below the albic horizon there is either an argillic or, rarely, a natric horizon.

Aquolls show characteristics associated with wetness

Borolls have mean annual soil temperatures of less than 8 °C, excluding Aquolls.

Rendolls occur in humid regions. They have a mollic epipedon that rests on the calcareous parent materials or on a cambic horizon rich in carbonates. They have no argillic or calcic horizons.

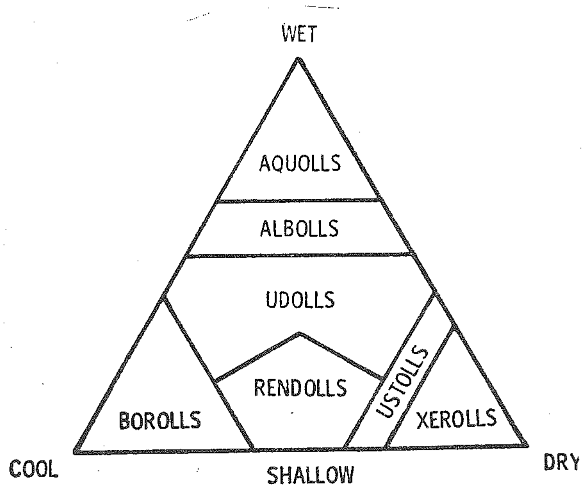
1/ Please note that the presence of a mollic epipedon does not qualify a soil as a Mollisol. Mollic epipedons are present also in some Vertisols and Inceptisols.

U dolls are more or less freely drained soils of humid continental climates. They are not dry for as much as 90 days per year or 60 consecutive days per year. In addition to the mollic epipedon, cambic or argillic horizons may be present.

Ustolls are more or less freely drained soils of subhumid to semiarid climates. They are dry for more than 90 days per year, but not as much as 60 consecutive days per year.

Xerolls occur in the Mediterranean climates. They are dry for more than 60 consecutive days in most years. Characteristically, they have relatively thick mollic epipedons, cambic or argillic horizons, accumulation of carbonates in the lower part of the B horizon, and are neutral in most horizons.

Diagram showing some relationships between suborders of Mollisols.



SPODOSOLS

These soils have a spodic horizon (a horizon of accumulation of amorphous humus, iron, and aluminium), or a placic horizon cemented by iron that rests on a fragipan or on a albic horizon that rests on a fragipan and that meets all requirements of a spodic horizon except thickness.

Suborders of Spodosols

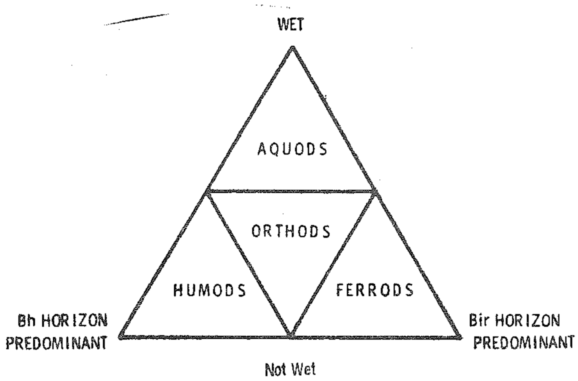
Aquods are commonly saturated with water or, if artificially drained, display such evidences of former wetness (histic epipedon, mottling in the albic or upper spodic horizons, duripan in the albic horizon). They are primarily in sandy deposits.

Ferrods are not as wet as Aquods and have as much as or more than six times as much free (elemental) iron as carbon in the spodic horizon.

Humods are the more or less freely drained soils that have large accumulations of organic carbon relative to iron in some or all subhorizons of the spodic horizon.

Orthods are the more or less freely drained soils that have horizons of accumulation of aluminium, iron and organic carbon in which no one of these elements dominates.

Diagram showing some relationships between suborders of Spodosols.



ALFISOLS

These soils have either an argillic or natric horizon that is not under a spodic or oxic horizon. The base saturation is more than 35 percent at 1.25 m below the top of the argillic horizon or 1.8 m below the surface, or at a lithic or paralithic contact, whichever is shallower.

These are soils in which loss of bases by leaching is offset to some degree by additives from dust, water, or release by weathering of primary minerals.

Suborders of Alfisols

Aqualfs are the wet Alfisols. They are grey and mottled, seasonally saturated, or if artificially drained, display evidence of former wetness such as mottles, low chromas, and Fe-Mn concretions 2 mm or more in diameter. Groundwater may be deep most of the year, but horizons with low hydraulic conductivity restrict the downward movement of water and extend the period of saturation.

Boralfs are not as wet as Aqualfs and are cool (mean annual temperature less than 8 ^{o}C) and commonly exhibit an albic horizon that tongues into the argillic or natric horizon (glossic).

Udalfs are not as wet as Aqualfs nor as cool or glossic as Boralfs. They have an udic moisture regime and are brownish or reddish, more or less freely drained soils.

Ustalfs are mostly reddish coloured soils of warm subhumid to semiarid regions. They usually have an ustic moisture regime (annually dry for less than 60 consecutive days). They commonly have a carbonate accumulation at the base of the solum.

Xeralfs are mostly reddish coloured soils of regions with Mediterranean climates. They have a xeric moisture regime (annually dry for more than 60 consecutive days).

(Alfisols - cont.)

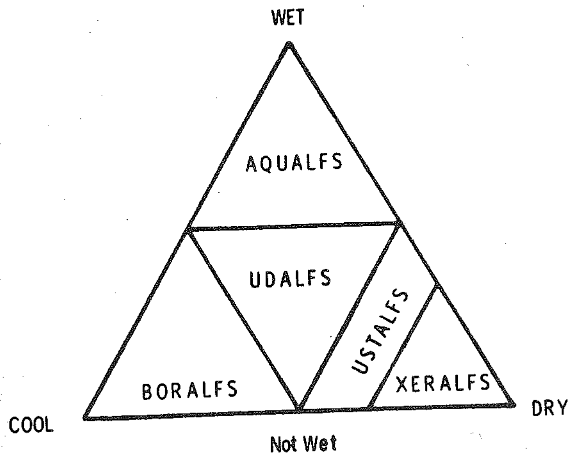


Diagram showing some relationships between suborders of Alfisols.

ULTISOLS

These are the soils of humid climates, with or without long dry season. The base saturation may be extremely low throughout, or it may decrease with depth, but it is less than 35 percent at 1.25 m below the top of the argillic horizon, or 1.8 m below the soil surface, or at a lithic or paralithic contact, whichever is shallower.
The release of bases by weathering usually equals or is less than the removal by leaching and it is normal that the bulk of the bases are held in the vegetation and surface few centimeters of the soil.
They may have a mollic epipedon (usually created by liming of an umbric epipedon) if the underlying material has a sufficiently low base status. Common features are plinthite and fragipans.
It may be added that the one chief characteristic of the base status of less than 35 percent used to separate the Ultisols from the Alfisols (with more than 35 percent) is an arbitrary limit of doubtful genetic or practical significance, since addition of lime soon changes the base saturation percentage. Nevertheless, some kind of distinction need to be made between a soil of low base status (10-30 percent) and one of high base status (50-70 percent)

Suborders of Ultisols

Aquults are the grey or olive soils of wet places, where the groundwater is very close to the surface part of the year and is deep at another, or are artificially drained with low chroma, mottles or Fe-Mn concretions larger than 2 mm in diameter.

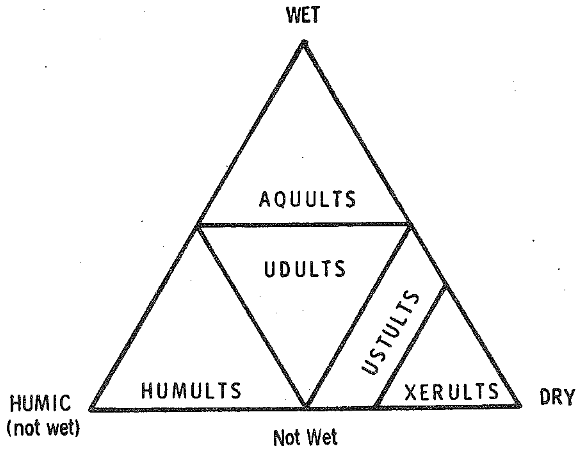
Ustults are drier than Aquults, have an ustic moisture regime. They are low in organic matter content.

Xerults occur in the areas with Mediterranean climates. Organic matter contents are low.

Humults have high organic matter contents but do not have other characteristics associated with wetness.

Udults occur in humid regions with an udic moisture regime. They are drier than Aquults. Organic matter contents are low but the water table remains below the solum most of the year, and the grey, mottled colours of the Aquults do not appear directly below the A horizon.

Diagram showing some relationships between suborders of Ultisols.



OXISOLS

These soils have oxic horizons (almost completely weathered residual concentrations of free oxides, 1:1 lattice clays, and insoluble minerals such as quartz) within 2 m of the surface or plinthite that forms a continuous phase within 30 cm of the mineral surface of the soil, and with no spodic or argillic horizon overlying the oxic horizon. Oxisols are confined to the intertropical regions. They are greyish, reddish or yellowish and occur mostly on gentle slopes on surfaces of great age. They are nearly featureless soils for the most part without clearly marked horizons.

Suborders of Oxisols

Aquox are the wet Oxisols, either with continuous phase plinthite within 30 cm of the mineral surface; or are either water saturated during some time of the year or artificially drained and have an oxic horizon with characteristics associated with wetness. They occur in shallow depressions that are commonly flooded during the rainy season, or they lie at the base of a slope where they receive seepage water. The latter usually have plinthite at the surface that is recementing transported ironstone pisolites or fragments that are one form of what is called laterite.

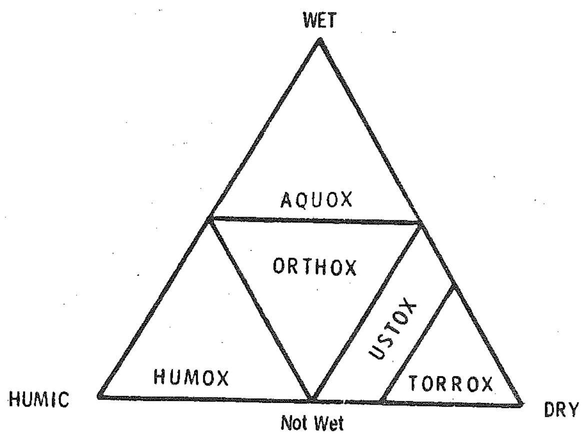
Humox occur in relatively cool humid climates. They are mostly reddish in hue, have high contents of organic matter and a low base status. They are always moist or have no period when the soil is dry in any horizon below the surface 18 cm for 60 consecutive days or more in most years. They have no plinthite that forms a continuous phase within 30 cm of the surface if the soil is saturated with water at this depth at some time of the year.

Orthox have no or short dry seasons. They are most common near the equator. They are yellowish to reddish in colour. They have less organic matter than the Humox. Like the Humox they have no plinthite.

Torrox occur in arid climates, are dominantly red in colour, have little organic matter, and relatively high base saturation. They have torric moisture regimes.

Ustox are mostly red and dry in all parts of the moisture control section for extended periods. But they are also moist during at least a 90-day rainy season. They have an ustic moisture regime.

Diagram showing some relationships of suborders of Oxisols.



HISTOSOLS

These are the dominantly organic soils, commonly called bogs or moors, or peat and mucks. A very few consist of shallow organic materials resting on rock or rubble.

Organic materials either; are saturated with water for prolonged periods, or are artificially drained, and have (a) 18 percent or more organic carbon if the mineral fraction is 50 percent or more clay, or (b) have 12 percent or more organic carbon if the mineral fraction has no clay, or (c) have proportional intermediate organic carbon contents if the clay fraction is intermediate; or are never saturated with water for more than a few days, and have 20 percent or more organic carbon.

More than half of the upper 80 cm of Histosols consists of organic materials, unless rock or fragmental materials are shallower than this depth, a rare condition, or the bulk density is very low. For specific depths reference is made to the original text.

Suborders of Histosols

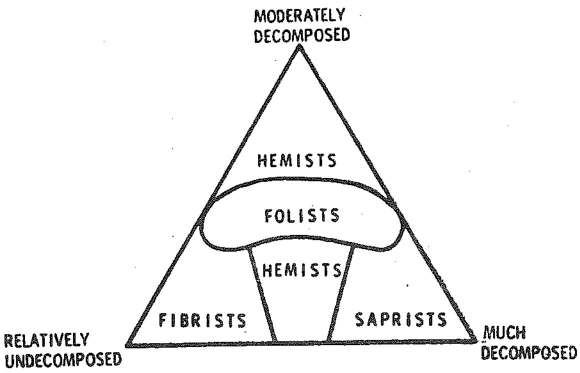
Fibrists consist largely of plant remains so little decomposed that they are not destroyed by rubbing and the botanic origin can be readily determined. They may consist either of partially decomposed wood or of plant remains of herbaceous plants such as mosses, grasses, sedges, and papyrus, or mixtures.

Folists are the more or less freely drained soils, that consist primarily of O horizons, derived from leaf litter, twigs, and branches, but not Sphagnum, resting on rock or on fragmental materials consisting of gravel, stones and boulders with the interstices filled or partially filled with organic materials. They mostly occur in very humid climates from the tropics to high latitudes.

Hemists are primarily soils in which the organic materials have been decomposed enough that the botanic origin or up to two-thirds of the materials cannot be readily determined, or the fibers are largely destroyed by rubbing between the fingers. The groundwater is at or very close to the surface at nearly all times unless artificial drainage has been supplied. Soils with sufuric horizons or sulfic materials are included without regard to the stage of decomposition. They occur from the equator to the tundra zone.

Saprists consist of almost completely decomposed plant remains. The botanic origin cannot be directly observed for the most part. The soils are usually black. They occur in areas where the groundwater tends to fluctuate within the soil. They are the result of aerobic decomposition. When drained, fibric and hemic materials decompose to sapric materials and if deeply drained, either artificially or naturally, the Fibrists and Hemists are converted, after some decades, to Saprists.

Diagram showing some relationships between suborders of Histosols.



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Names of Orders, Suborders and Great Groups

Order	Suborder	Great Group
ENTISOLS	Aquents	Cryaquents
		Fluvaquents
		Haplaquents
		Hydraquents
		Psammaquents
		Sulfaquents
		Tropaquents
	Arents	Arents
	Fluvents	Cryofluvents
		Torrifluvents
		Tropofluvents
		Udifluvents
		Ustifluvents
		Xerofluvents
	Orthents	Cryorthents
		Udorthents
		Usthortents
		Torriorthents
		Troporthents
		Xerorthents
	Psamments	Cryopsamments
		Quartzipsamments
		Torripsamments
		Tropopsamments
		Udipsamments
		Ustipsamments
		Xeropsamments
VERTISOLS	Torrerts	Torrerts
	Uderts	Chromuderts
		Pelluderts
	Usterts	Chromusterts
		Pellusterts
	Xererts	Chromoxererts
		Pelloxererts
INCEPTISOLS	Andepts	Cryandepts
		Durandepts
		Dystrandepts
		Eutrandepts
		Hydrandepts
		Placandepts
		Vitrandepts
INCEPTISOLS	Aquepts	Andaquepts
		Cryaquepts
		Fragiaquepts
		Halaquepts
		Haplaquepts
		Humaquepts
		Placaquepts
		Plinthaquepts
		Sulfaquepts
		Tropaquepts
	Ochrepts	Cryochrepts
		Durochrepts
		Dystrochrepts
		Eutrochrepts
		Fragiochrepts
		Ustochrepts
		Xerochrepts
	Plaggepts	Plaggepts
	Tropepts	Dystrochrepts
		Eutrochrepts
		Humitropepts
		Sombritropepts
		Ustropepts
	Umbrepts	Cryumbrepts
		Fragiumbrepts
		Haplumbrepts
		Xerumbrepts
ARIDISOLS	Argids	Durargids
		Haplargids
		Nadurargids
		Natrargids
		Paleargids
	Orthids	Calciorthids
		Camborthids
		Durorthids
		Gypsiorthids
		Paleorthids
		Salorthids
MOLLISOLS	Albolls	Argialbolls
		Natralbolls

Names of Orders, Suborders and Great Groups (continued)

Order	Suborder	Great Group
MOLLISOLS	Aquolls	Argiaquolls
		Calciaquolls
		Cryaquolls
		Duraquolls
		Haplaquolls
		Natraquolls
	Borolls	Argiborolls
		Calciborolls
		Cryoborolls
		Haploborolls
		Natriborolls
		Paleborolls
		Vermiborolls
	Rendolls	Rendolls
	Udolls	Argiudolls
		Hapludolls
		Paleudolls
		Vermudolls
	Ustolls	Argiustolls
		Calciustolls
		Durustolls
		Haplustolls
		Natrustolls
		Paleustolls
		Vermustolls
	Xerolls	Argixerolls
		Calcixerolls
		Durixerolls
		Haploxerolls
		Natrixerolls
		Palexerolls
SPODOSOLS	Aquods	Cryaquods
		Duraquods
		Fragiaquods
		Haplaquods
		Placaquods
		Sideraquods
		Tropaquods
	Ferrods	Ferrods
	Humods	Cryohumods
		Fragihumods
		Haplohumods
		Placohumods
		Tropohumods
SPODOSOLS	Orthods	Cryorthods
		Fragiorthods
		Haplorthods
		Placorthods
		Troporthods
ALFISOLS	Aqualfs	Albaqualfs
		Duraqualfs
		Fragiaqualfs
		Glossaqualfs
		Natraqualfs
		Ochraqualfs
		Plinthaqualfs
		Tropaqualfs
		Umbraqualfs
	Boralfs	Cryoboralfs
		Eutroboralfs
		Fragiboralfs
		Glossoboralfs
		Natriboralfs
		Paleboralfs
	Udalfs	Agrudalfs
		Ferrudalfs
		Fragiudalfs
		Fraglossudalfs
		Glossudalfs
		Hapludalfs
		Natrudalfs
		Paleudalfs
		Rhodudalfs
		Tropudalfs
	Ustalfs	Durustalfs
		Haplustalfs
		Natrustalfs
		Paleustalfs
		Plinthustalfs
		Rhodustalfs
	Xeralfs	Durixeralfs
		Haploxeralfs
		Natrixeralfs
		Palexeralfs
		Plinthoxeralfs
		Rhodoxeralfs

Names of Orders, Suborders and Great Groups (continued)

Order	Suborder	Great Group
ULTISOLS	Aquults	Albaquults
		Fragiaquults
		Ochraquults
		Paleaquults
		Plinthaquults
		Tropaquults
		Umbraquults
	Humults	Haplohumults
		Palehumults
		Plinthohumults
		Sombrihumults
		Tropohumults
	Udults	Fragiudults
		Hapludults
		Paleudults
		Plinthudults
		Rhodudults
		Tropudults
	Ustults	Haplustults
		Paleustults
		Plinthustults
		Rhodustults
	Xerults	Haploxerults
		Palexerults
OXISOLS	Aquox	Gibbsiaquod
		Ochraquod
		Plinthaquod
		Umbraquod
	Humox	Acrohumox
		Gibbsihumox
		Haplohumox
		Sombrihumox
	Orthox	Acrorthox
		Eutrorthox
		Gibbsiorthox
		Haplorthox
		Sombriorthox
		Umbriorthox

Order	Suborder	Great Group
OXISOLS	Torrox	Torrox
	Ustox	Acrustox
		Eutrustox
		Haplustox
		Sombriustox
HISTOSOLS	Fibrists	Borofibrists
		Cryofibrists
		Luvifibrists
		Medifibrists
		Sphagnofibrists
		Tropofibrists
	Folists	Borofolists
		Cryofolists
		Tropofolists
	Hemists	Borohemists
		Cryohemists
		Luvihemists
		Medihemists
		Sulfihemists
		Sulfohemists
		Tropohemists
	Saprists	Borosaprists
		Cryosaprists
		Medisaprists
		Troposaprists

from: SOIL TAXONOMY (U.S.Dept.Agric.1973)

Soil order names and their formative elements

Order	Formative Element	Derivation	Mnemonicon
Vertisol	ert	L.—*verto*, turn	inv*ert*
Entisol	ent	(nonsense syllable)	rec*ent*
Inceptisol	ept	L.—*inceptum*, beginning	inc*ept*ion
Aridisol	id	L.—*aridus*, dry	ar*id*
Spodosol	od	Gr.—*spodos*, wood ashes	P*od*zol; *od*d
Ultisol	ult	L.—*ultimus*, last	*ult*imate
Mollisol	oll	L.—*mollis*, soft	m*oll*ify
Alfisol	alf	(nonsense syllable)	Ped*alf*er
Oxisol	ox	Fr.—*oxide*, oxide	*ox*ide
Histosol	ist	Gr.—*histos*, tissue	h*ist*ology

SOURCE: Soil Survey Staff 1960.

Formative elements of suborder names

Formative Element	Derivation	Mnemonicon	Meaning or Connotation
alb	L.—*albus*, white	*alb*ino	Presence of albic horizon (a bleached eluvial horizon)
and	Modified from *Ando*	*And*o	Andolike
aqu	L.—*aqua*, water	*aqu*arium	Characteristics associated with wetness
ar	L.—*arare*, to plow	*ar*able	Mixed horizons
arg	Modified from argillic horizon; L.—*argilla*, white clay	*arg*illite	Presence of argillic horizon (a horizon with illuvial clay)
bor	Gr.—*boreas*, northern	*bor*eal	Cool
ferr	L.—*ferrum*, iron	*ferr*uginous	Presence of iron
fibr	L.—*fibra*, fiber	*fibr*ous	Least decomposed stage
fluv	L.—*fluvius*, river	*fluv*ial	Flood plains
hem	Gr.—*hemi*, half	*hem*isphere	Intermediate state of decomposition
hum	L.—*humus*, earth	*hum*us	Presence of organic matter
lept	Gr.—*leptos*, thin	*lept*ometer	Thin horizon
ochr	Gr.—base of *ochros*, pale	*och*er	Presence of ochric epipedon (a light-colored surface)
orth	Gr.—*orthos*, true	*orth*ophonic	The common ones
plag	Modified from Ger. *Plaggen*, sod		Presence of plaggen epipedon
psamm	Gr.—*psammos*, sand	*psamm*ite	Sand textures
rend	Modified from Rendzina	*Rend*zina	Rendzinalike
sapr	Gr.—*sapros*, rotten	*sapr*ophyte	Most decomposed stage
torr	L.—*torridus*, hot, dry	*torr*id	Usually dry
trop	Modified from Gr.—*tropikos*, of the solstice	*trop*ical	Continually warm
ud	L.—*udus*, humid	*ud*ometer	Of humid climates
umbr	L.—*umbra*, shade	*umbr*ella	Presence of umbric epipedon (a dark-colored surface)
ust	L.—*ustus*, burnt	combu*st*ion	Of dry climates, usually hot in summer
xer	Gr.—*xeros*, dry	*xer*ophyte	Annual dry season

SOURCE: Soil Survey Staff 1967.

Formative elements of great group names

Formative Element	Derivation	Mnemonicon	Meaning or Connotation
acr	Modified from Gr.—*Akros*, at the end	*acr*olith	Extreme weathering
agr	L.—*ager*, field	*agr*iculture	An agric horizon
alb	L.—*albus*, white	*alb*ino	An albic horizon
and	Modified from *Ando*	*Ando*	Andolike
anthr	Gr.—*anthropos*, man	*anthr*opology	An anthropic epipedon
aqu	L.—*aqua*, water	*aqu*arium	Characteristic associated with wetness
arg	Modified from argillic horizon; L.—*argilla*, white clay	*arg*illite	An argillic horizon
calc	L.—*calcis*, lime	*calc*ium	A calcic horizon
camb	L.—*cambiare*, to exchange	change	A cambic horizon
chrom	Gr.—*chroma*, color	*chroma*	High chroma
cry	Gr.—*Kryos*, cold	*cry*stal	Cold
dur	L.—*durus*, hard	*dur*able	A duripan
dystr	Modified from Gr.—*dys*, ill; *dystrophic*, infertile	*dystr*ophic	Low base saturation
eutr eu	Modified from Gr.—*eu*, good; *eutrophic*, fertile	*eutr*ophic	High base saturation
ferr	L.—*ferrum*, iron	*ferr*ic	Presence of iron
frag	Modified from L.—*fragillis*, brittle	*frag*ile	Presence of fragipan
fragloss	Compound of *fra(g)* and *gloss*		See the formative elements *frag* and *gloss*
gibbs	Modified from *gibbsite*	*gibbs*ite	Presence of gibbsite
gloss	Gr.—*glossa*, tongue	*gloss*ary	Tongued
hal	Gr.—*hals*, salt	*hal*ophyte	Salty
hapl	Gr.—*haplous*, simple	*hapl*oid	Minimum horizon
hum	L.—*humus*, earth	*hum*us	Presence of humus
hydr	Gr.—*hydro*, water	*hydr*ophobia	Presence of water
hyp	Gr.—*hypnon*, moss	*hyp*num	Presence of hypnum moss
luo, lu	Gr.—*louo*, to wash	ab*lu*tion	Illuvial
moll	L.—*mollis*, soft	*moll*ify	Presence of mollic epipedon
nadur	Compound of *na(tr)* and *dur*		
natr	Modified from *natrium*, sodium		Presence of natric horizon
ochr	Gr.—base of *ochros*, pale	*och*er	Presence of ochric epipedon (a light-colored surface)
pale	Gr.—*paleos*, old	*pale*osol	Old development
pell	Gr.—*pellos*, dusky		Low chroma
plac	Gr.—base of *plax*, flat stone		Presence of a thin pan
plag	Modified from Ger.—*Plaggen*, sod		Presence of plaggen horizon
plinth	Gr.—*plinthos*, brick		Presence of plinthite
quartz	Ger.—*quarz*, quartz	*quartz*	High quartz content
rend	Modified from Rendzina	*Rend*zina	Rendzinalike
rhod	Gr.—base of *rhodon*, rose	*rhod*odendron	Dark red colors
sal	L.—base of *sal*, salt	*sal*ine	Presence of salic horizon
sider	Gr.—*sideros*, iron	*sider*ite	Presence of free iron oxides
sombr	Fr.—*sombre*, dark	*somb*er	A dark horizon
sphagno	Gr.—*sphagnos*, bog	*sphagn*um moss	Presence of sphagnum moss
torr	L.—*torridus*, hot and dry	*torr*id	Usually dry
trop	Modified from Gr.—*tropikos*, of the solstice	*trop*ical	Continually warm
ud	L.—*udus*, humid	*ud*ometer	Of humid climates
umbr	L.—base of *umbra*, shade	*umbr*ella	Presence of umbric epipedon
ust	L.—base of *ustus*, burnt	comb*ust*ion	Dry climate, usually hot in summer
verm	L.—base of *vermes*, worm	*verm*iform	Wormy, or mixed by animals
vitr	L.—*vitrum*, glass	*vitr*eous	Presence of glass
xer	Gr.—*xeros*, dry	*xer*ophyte	Annual dry season

SOURCE: Soil Survey Staff 1967.