IDENTIFICATION AND NOMENCLATURE
OF SOIL HORIZONS

The description of a soil profile consists mainly of descriptions of its several horizons. A soil horizon may be defined as a layer of soil, approximately parallel to the soil surface, with characteristics produced by soil-forming processes. One soil horizon is commonly differentiated from an adjacent one at least partly on the basis of characteristics that can be seen in the field. Yet laboratory data are sometimes required for the identification and designation of horizons as well as for their more detailed characterization. The soil profile, as exposed in a cut or section, includes the collection of all the genetic horizons, the natural organic layers on the surface, and the parent material or other layers beneath the solum that influence the genesis and behavior of the soil.

Besides genetic soil horizons, many soils have layers inherited from stratified parent material. In making soil examinations, all distinguishable layers, or horizons, are separately described, regardless of genesis. These descriptions need to be completely objective and clearly able "to stand on their own," regardless of presumed genesis or nomenclature. Objective descriptions are the basic stuff of soil classification. Nothing can substitute for them. The more laboratory data there are available on collected samples, the more important the descriptions become; without them, the laboratory data cannot be safely interpreted, if indeed, they are relevant at all.

The profiles of numerous soils having properties quite unlike those of the original material have some characteristics due partly to inheritance from stratified parent material as well as to soil-forming processes, as in an alluvial terrace; or even partly to geological processes accompanying soil formation. That is, a soil with a well-developed profile may be gradually covered with volcanic ash, loess, windblown sand, or alluvium, for example, without seriously injuring the vegetation. The surface horizon becomes thickened and the lower part of the soil profile gradually passes beyond reach of active soil-forming processes.

Soil profiles vary in an almost endless number of ways. The important characteristics to be described have already been listed,
and separate sections of this Manual explain the classes and terms for describing each one. Soil profiles vary widely in thickness, from mere films to those many feet thick. Generally in temperate regions, soil profiles need to be examined to depths of 3 to 5 feet. Normal soils are thinner toward the poles and thicker toward the Equator. Yet even in temperate regions, deeper layers, say to 6 feet or more, may be so important to soil drainage that they need to be examined, especially in the study and mapping of soils to predict their response to reclamation through irrigation or drainage.

Soil profiles vary widely in the degree to which genetic horizons are expressed. On nearly fresh geological formations, like new alluvial fans, sand drifts, or blankets of volcanic ash, no genetic horizons may be distinguished at all. As soil formation proceeds, they may be detected in their early stages only by laboratory study of the samples, and then later with gradually increasing clarity in the field.

In describing a soil profile, one usually locates the boundaries between horizons, measures their depth, and studies the profile as a whole before describing and naming the individual horizons.

DESIGNATIONS FOR HORIZONS AND LAYERS

It is not absolutely necessary to name the various soil horizons in order to make a good description of a soil profile. Yet the usefulness of profile descriptions is greatly increased by the proper use of genetic designations, like A, B, and C. Such interpretations show the genetic relationships among the horizons within a profile, whereas simple numbers like 1, 2, 3, 4, and 5, or undefined letters like a, b, c, and so on, tell us nothing but depth sequence. The genetic designations make possible useful comparisons among soils. One cannot usefully compare arbitrarily defined "12- to 24-inch" layers of different soils, but B horizons can be usefully compared.

It is assumed that each horizon or layer designation used is merely a symbol indicating the considered judgment of the person describing the soil relative to kind of departure from the original material from which it has formed, including the zero degree of departure in the case of R and some C layers. This implies that each symbol indicates merely an estimate, not a proven fact. It implies that when reading a symbol one must reconstruct mentally the character of the parent material, for this was done when the designation was assigned. It implies that the processes that have caused change need not be known. It also implies that specific morphology need not be consistent from profile to profile and that morphology relative to an estimated parent material is the criterion for judgment. The parent material of the horizon in question, not the material in the horizon or layer designated by the symbol C, is used as the basis of comparison. Morphology is interpreted relative to this assumed parent material, not in terms of absolute values of properties.

CONVENTIONS GOVERNING USE OF SYMBOLS

1. Capital letter symbols include O, A, B, C, and R. They indicate dominant kinds of departures from the parent material. More than one kind of departure may be indicated by a single capital letter,
providing these departures are within the limits of the definitions given further along in this chapter.

2. In a description of a given profile, if a horizon designated by O, A, or B is subdivided, the subdivisions are indicated by placing an arabic number after the capital letter. Thus, symbols such as O1, O2, A1, A2, A3, B1, B2, and B3 are obtained. Each symbol derived in this way stands for an integral unit, and each unit requires its own definition. A given arabic numeral therefore has different implication when combined with different capital letters. Thus, the symbols O1, O2, A1, and A2 indicate specific kinds of O and A master horizons. The symbols A3, B1, and B3 are transitional horizons. Likewise, the symbol B2 indicates that part of the B horizon that is of a nature not transitional either to A or to C. Even if both B1 and B3 are absent, if the B horizon of a given profile is subdivided, the symbol B2, not B, is used. The symbols O, A, and B each indicate a unit that, according to need, can have several subdivisions or none. The symbol C, however, indicates a unit that is not subdivided in the manner of O, A, and B. If a horizon is subdivided, this is done only in the manner described in the following paragraph 3, and the arabic numeral assigned has no consistent meaning except vertical sequence.

3. Vertical subdivision within an otherwise undifferentiated horizon is indicated by primary or secondary arabic numbers assigned, in order, from the topmost subdivision downward. These are not used with O, A, or B without a primary arabic number. Thus, secondary numbers are used with O1, O2, A1, A2, A3, B1, B2, B3, and C. Primary arabic numbers are used with C and Ap. Thus, we use C1 and C2, Ap1 and Ap2, but A11 and A12, B21, B22 or B23, as needed, without consistency in meaning beyond the fact that we have made a subdivision. The reason for the subdivision may be indicated in the text of the description or by a lower case letter suffix.

4. Lower case letters are used as suffixes to indicate selected subordinate departures from the assumed parent material or to indicate selected, specific kinds of major departures from the definition assigned to the symbol O, A, B, C. These are regarded as alternatives to narrative statements of equivalent interpretations in the profile description. These suffixes follow the arabic number in the letter-number combined symbols discussed under item 2 above (A2g or B3ca), or they may follow the capital letter of a master horizon if it is not subdivided (Bt or Ap). These suffixes also follow arabic numbers used solely for vertical subdivision described under item 3 above, as A21g and A22g or C1ca and C2ca. An exception is made with the lower case letter p. This is used only with the letter A (Ap) and is comparable to the A1 or A2.

5. Roman numerals are prefixed to the master horizon or layer designations (O, A, B, C, R) to indicate lithologic discontinuities either within or below the solum. The first, or uppermost, material is not numbered, for the Roman numeral I is understood; the second contrasting material is numbered II, and others encountered are numbered III, IV, and so on, consecutively with depth. Thus, for example, a sequence from the surface downward might be A2, B1, II B2, II B3, III C1, III C2.
A lithologic discontinuity is a significant change in particle size distribution or mineralogy that indicates a difference in the material from which the horizons have formed. A change in the clay content associated with an argillic horizon (textural B) does not indicate a difference in parent material. Appearance of gravel, or a change in the ratios between the various sand separates, will normally suggest a difference in parent materials. One purpose in identifying lithologic discontinuities is to distinguish between those differences between horizons that are the result of pedo-genesis and those that are geologic. Consequently, a designation with a different Roman number would not normally be used for a buried soil in a thick loess deposit. The difference between the properties of the buried soil and the overlying loess are presumably the result of pedo-genesis. But a stone line usually indicates a need for another Roman number. The material above the stone line is presumed to be transported. If the transport was by wind or water, one must suspect that during the movement there was some sorting of the material according to size.

6. An illuvial or B horizon (together with its overlying eluvial or A horizon if one is present) is called a sequum. If more than one sequum is present in vertical sequence, the lower sequum is given A and B designations with a prime accent, as $A'$2, $B'$2. The prime accents are not used however for buried soils. These carry the lower case letter b.

**MASTER HORIZONS AND LAYERS**

*Organic horizons*

O—Organic horizons of mineral soils. Horizons: (1) formed or forming in the upper part of mineral soils above the mineral part; (2) dominated by fresh or partly decomposed organic material; and (3) containing more than 30 percent organic matter if the mineral fraction is more than 50 percent clay, or more than 20 percent organic matter if the mineral fraction has no clay.

Intermediate clay content requires proportional organic-matter content

The O horizons may be present at the surface horizon of mineral soils, or at any depth beneath the surface in buried soils, but they have been formed from organic litter derived from plants and animals and deposited on the surface. The O horizons do not include soil horizons formed by illuviation of organic material into mineral material, nor do they include horizons high in organic matter formed by a decomposing root mat below the surface of a mineral material.

Because organic horizons at the surface may be rapidly altered in thickness or be destroyed by fire or by the activities of man or other animals, the depth limits of organic horizons that are at the surface are always measured upward from the top of the underlying mineral material. Two subdivisions are recognized:

O1—Organic horizons in which essentially the original form of most vegetative matter is visible to the naked eye

Identifiable remains of soil fauna, or their excrement, may be present, and the horizon may be filled with fungal hyphae. The vegetative matter may be essentially unaltered, as freshly fallen leaves, or may be leached of its most soluble constituents and discolored. The O1 corresponds to the L and some F layers mentioned in literature on forest soils and to the horizon formerly called Aoo.
O2—Organic horizons in which the original form of most plant or animal matter cannot be recognized with the naked eye

Remains of parts of plants and animals commonly can be identified with magnification, and excrement of soil fauna is commonly a large part of the material present. The O2 corresponds to the H layer and some F layers described in literature on forest soils and to the horizon formerly called Ao.

The organic horizons in organic soils are not defined here. They are currently under discussion. The organic B horizons in mineral soils are defined under B horizon, along with the mineral horizons.

Mineral horizons and layers

Mineral horizons contain less than 30 percent organic matter if the mineral fraction contains more than 50 percent clay or less than 20 percent organic matter if the mineral fraction has no clay. Intermediate clay content requires proportional content of organic matter.

A—Mineral horizons consisting of: (1) horizons of organic-matter accumulation formed or forming at or adjacent to the surface; (2) horizons that have lost clay, iron, or aluminum with resultant concentration of quartz or other resistant minerals of sand or silt size; or (3) horizons dominated by 1 or 2 above but transitional to an underlying B or C horizon.

A1—Mineral horizons, formed or forming at or adjacent to the surface, in which the feature emphasized is an accumulation of humified organic matter intimately associated with the mineral fraction.

The mineral particles have coatings of organic material, or the soil mass is darkened by organic particles; the horizon is as dark as, or darker than, adjacent underlying horizons. The mineral fraction may be unaltered or may have been altered in a manner comparable to that of A2 or B. The organic fraction is assumed to have been derived from plant and animal remains deposited mechanically on the surface of the soil, or deposited within the horizon without translocation of humified material through an intervening horizon that qualifies for a horizon designation other than A1.

A2—Mineral horizons in which the feature emphasized is loss of clay, iron, or aluminum, with resultant concentration of quartz or other resistant minerals in sand and silt sizes.

Such horizons are commonly but not necessarily lighter in color than an underlying B. In some soils the color is determined by that of the primary sand and silt particles, but in many soils, coats of iron or other compounds, apparently released in the horizon and not translocated, mask the color of the primary particles. An A2 is most commonly differentiated from an overlying A1 by lighter color and is generally measurably lower in organic matter. An A2 is most commonly differentiated from an underlying B in the same profile by lighter color, or coarser texture, or both. A2 horizons are commonly near the surface, below an O or A1 horizon and above a B, but the symbol A2 may be used either above or below subsurface horizons; position in the profile is not diagnostic. For horizons at the surface that would qualify equally well as either A1 or A2, the designation A1 is given preference over A2.

A3—A transitional horizon between A and B, and dominated by properties characteristic of an overlying A1 or A2 but having some subordinate properties of an underlying B.
No distinction is made between the different kinds of horizons that are transitional from A1 or A2 to different kinds of B; they obviously may be quite unlike one another, but the burden of characterization rests on the description of the transitional horizon, plus inferences that can be made after noticing the symbols assigned to the overlying and underlying horizons. The symbol A3 normally is used only if the horizon is underlain by a B horizon. However, where the profile is truncated from below in small places by rock, so as to eliminate the horizon that would be designated B, the symbol A3 may be used for the horizon that is above the rock. For example, in one part of a pedon, a horizon may be transitional between A and B, and thus appropriately designated A3. But, in another part of the same pedon, the same horizon rests on rock and may appropriately be called A3, even though there is no underlying B.

The symbol A3 is confined to those kinds of transitional zones in which some properties of the underlying B are superimposed on properties of A throughout the soil mass. Those kinds of “transitional horizons” in which parts that are characteristic of A enclose parts characteristic of B are classified as A and B.

**AB—A horizon transitional between A and B, having an upper part dominated by properties of A and a lower part dominated by properties of B, and the two parts cannot conveniently be separated into A3 and B1.**

Such combined horizons are normally thin; they should be separated if thick enough to permit separation.

**A&B—Horizons that would qualify for A2 except for included parts constituting less than 50 percent of the volume that would qualify as B.**

Commonly, A and B horizons are predominantly A2 material partially surrounding thin, columnar-like upward extensions of the B or wholly surrounding small, isolated spheres, ellipsoids, or other bodies that would qualify as B. In such horizons the A2 appears to be encroaching on an underlying B.

**AC—A horizon transitional between A and C, having subordinate properties of both A and C, but not dominated by properties characteristic of either A or C.**

**B—Horizons in which the dominant feature or features is one or more of the following: (1) an illuvial concentration of silicate clay, iron, aluminum, or humus, alone or in combination; (2) a residual concentration of sesquioxides or silicate clays, alone or mixed, that has formed by means other than solution and removal of carbonates or more soluble salts; (3) coatings of sesquioxides adequate to give conspicuously darker, stronger, or redder colors than overlying and underlying horizons in the same sequum but without apparent illuviation of iron and not genetically related to B horizons that meet requirements of 1 or 2 in the same sequum; or (4) an alteration of material from its original condition in sequums lacking conditions defined in 1, 2, and 3 that obliterates original rock structure, that forms silicate clays, liberates oxides, or both, and that forms granular, blocky, or prismatic structure if textures are such that volume changes accompany changes in moisture.**

It is obviously necessary to be able to identify the kind of B before one can establish that a horizon qualifies as B. There is no common diagnostic property or location in the profile by means of which all kinds of B can be identified. There are, however, marginal cases in which a horizon might qualify as either of two kinds of B. In such cases, the horizon description should indicate the kind of B that characterizes the dominant condition, in the judgment of the person
describing the soil. Laboratory work may be needed for identification of the kind of B, or even to determine that a given horizon is a B.

B1—A transitional horizon between B and A1 or between B and A2 in which the horizon is dominated by properties of an underlying B2 but has some subordinate properties of an overlying A1 or A2

An adjacent overlying A1 or A2 and an adjacent underlying B2 are essential to characterization of a horizon as B1 in a virgin soil. In a few instances the horizon may still be recognized in a truncated soil by comparing the truncated profile with a profile of the same soil that has not been truncated. The symbol B1 is confined to those kinds of transitional horizons in which some properties of the overlying, adjacent A1 or A2 are superimposed on properties of B throughout the mass of the transitional horizon. Those kinds of transitional horizons containing parts characteristic of B, separated by abrupt boundaries from parts characteristic of an overlying A2, are classified as B&A.

B&A—Any horizon qualifying as B in more than 50 percent of its volume including parts that qualify as A2

Such horizons commonly have many vertical tongues of A2 material that extend downward into the B from the A2 or they have thin horizontal bands of A2-like material, which lie between thicker bands of B and are connected with tongues extending from the A2. Tubes filled with A1 material, as in krotovinas or earthworm channels, in a B horizon should be described but should not be designated as B and A. Many B horizons have A2-like material in widely spaced narrow cracks. Such features should be described, but the horizon should be designated as B and A only if the A2 material constitutes more than 10 percent of the volume of the horizon.

B2—That part of the B horizon where the properties on which the B is based are without clearly expressed subordinate characteristics indicating that the horizon is transitional to an adjacent overlying A or an adjacent underlying C or R

This does not imply that the B2 horizon in a given profile must express to uniform degree the properties diagnostic of B or that it must be confined to a zone of maximum expression in the absolute sense. The horizon B3, which is transitional from B2 to C, commonly exhibits the subordinate properties of C by expressing in lower degree the properties of an adjacent B2. Before the designation B3 is justified, the degree of expression of B2 must be low enough that the properties of C are clearly evident. The definition does not imply that a given kind of B2 has the same degree of expression in all profiles. In some profiles the most strongly expressed part of the B horizon, which would be designated B2, may be as weakly expressed as B3 in other profiles. The designation B2 is used strictly within the frame of reference of a single profile and not in an absolute sense of degree.

B3—A transitional horizon between B and C or R in which the properties diagnostic of an overlying B2 are clearly expressed but are associated with clearly expressed properties characteristic of C or R

The designation B3 is used only if there is an overlying B2; this applies even though the properties diagnostic of B are weakly expressed in the profile. Where an underlying material presumed to be like the parent material of the solum is absent, as in A–B–IIC
profiles, B3 is used below B2 in the sense of a horizon transitional to an assumed original parent material. Use of the symbol IIC involves an estimate of at least the gross character of the parent material of the horizons above it. B3 in such cases is based on this estimate of the properties of the parent material of the B. B3 is not used as a horizon transitional from IB2 to IIC or IIR.

C—A mineral horizon or layer, excluding bedrock, that is either like or unlike the material from which the solum is presumed to have formed, relatively little affected by pedogenic processes, and lacking properties diagnostic of A or B but including materials modified by: (1) weathering outside the zone of major biological activity; (2) reversible cementation, development of brittleness, development of high bulk density, and other properties characteristic of fragipans; (3) gleying; (4) accumulation of calcium or magnesium carbonate or more soluble salts; (5) cementation by such accumulations as calcium or magnesium carbonate or more soluble salts; or (6) cementation by alkali-soluble siliceous material or by iron and silica.

This definition is intended to exclude horizons that meet the requirements of A or B but to include certain kinds of alteration that, historically, have been considered to be little influenced by the activity of organisms. These alterations include chemical weathering deep in the soil. Some soils are presumed to have developed in materials already highly weathered, and such weathered material that does not meet requirements for A or B is considered C. Development of the firmness, brittleness, and high density characteristic of fragipans is, by itself, not a criterion of A or B. Fragipans that have distinct silicate clay concentrations are to be indicated as Bx or simply as B. Fragipans lacking such clay concentration, however, are considered to be within the definition of C and are designated Cx. Accumulations of carbonates, gypsum, or more soluble salts are permitted in C if the material is otherwise considered to be little affected by other processes that have contributed to genesis of associated horizons. Such horizons are designated as Cca, Ccs, Csa. Even induration by such materials is permitted and this can be indicated by the suffix m, as in Ccam. Induration by alkali-soluble siliceous material is also permitted and may be indicated by Csim. Induration by iron and silica does not exclude the horizon from C, and horizons or layers thus indurated would be designated Cm. Horizon C, as defined, is intended to include the diagnostic horizons indicated by ca, cs, and sa, and the alkali-soluble pans, the iron-silica pans, and the fragipans, provided these layers do not meet the requirements of B. The C horizon now includes the contrasting layers of unconsolidated material formerly designated as D. It also includes the former G horizon, if that horizon cannot be designated as A or B. Historically, C has often incorrectly been called parent material. In fact it is impossible to find the parent material from which the A and B horizons have developed; that material has been altered. For this reason, C never was parent material, but was merely presumed to be like parent material. As C is now defined, even this assumption is dropped.

The differentiation between C1 and C2 that was formerly made has been dropped because it is untenable when applied to the variety of conditions recognized as C. Deletion of C1 makes Arabic numerals applied to C indicative only of vertical sequence within C.
R—Underlying consolidated bedrock, such as granite, sandstone, or limestone. If presumed to be like the parent rock from which the adjacent overlying layer or horizon was formed, the symbol R is used alone. If presumed to be unlike the overlying material, the R is preceded by a Roman numeral denoting lithologic discontinuity as explained under the heading.

SYMBOLS USED TO INDICATE DEPARTURES SUBORDINATE TO THOSE INDICATED BY CAPITAL LETTERS

The following symbols are to be used in the manner indicated under the heading Conventions Governing Use of Symbols.

b—Buried soil horizon

This symbol is added to the designation of a buried genetic horizon or horizons. Horizons of another solum may or may not have formed in the overlying material, which may be similar to, or different from, the assumed parent material of the buried soil.

cs—An accumulation of carbonates of alkaline earths, commonly of calcium

This symbol is applied to A, B, or C horizons. Possible combinations are A1cs, A2cs, B1cs, B2cs, B3cs. A2cs is probably also possible where accumulation has occurred in an A2 formed under different conditions, but it is not common. The presence of secondary carbonates alone is not adequate to justify the use of the cs symbol. The horizon must have more carbonates than the parent material is presumed to have had.

cs—An accumulation of calcium sulfate

This symbol is used in a manner comparable to that of ca. Calcium sulfate accumulations commonly occur in the C below ca accumulations in chernozemic soils but may occur in other horizons as well. Before the symbol cs is used, the horizon must have more sulfates than the parent material is presumed to have had.

cn—Accumulations of concretions or hard nonconcretionary nodules enriched in sesquioxides with or without phosphorus.

The nodules indicated by the symbol cn must be hard when dry but need not be indurated. The horizon description should characterize the nodules. Nodules, concretions, or crystals do not qualify as cn if they are of dolomite or more soluble salts, but they do qualify if they are of iron, aluminum, manganese, or titanium.

f—Frozen soil

The suffix f is used for soil that is thought to be permanently frozen.

g—Strong gleying

The suffix g is used with a horizon designation to indicate intense reduction of iron during soil development, or reducing conditions due to stagnant water, as evidenced by base colors that approach neutral, with or without mottles. In aggregated material, ped faces in such horizons generally have chroma of 2 or less as a continuous phase, and commonly have few or faint mottles. Interiors of peds may have prominent and many mottles but commonly have a network of threads or bands of low chroma surrounding the mottles. In soils that are not aggregated, a base chroma of 1.0 or less, with or without mottles, is indicative of strong gleying. Hues bluer than 10Y are also indicative of strong gleying in some soils. Horizons of low chroma in which the color is due to uncoated sand or silt particles are not con-
sidered strongly gleyed. Although gleying is commonly associated with wetness, especially in the presence of organic matter, wetness by itself is not a criterion of gleying. The symbol $g$ may be applied to any of the major symbols for mineral horizons and should follow the horizon designations, as A2g, A21g, A3g, B1g, B2g, B3g, and Cg. $Bg$ may be used where B horizons cannot be subdivided into B1, B2, and B3.

No lower case letter is used as a suffix with horizon designations to indicate reduction of iron less intense than that indicated by $g$. Not given a special designation but described in detail is the condition generally associated with (1) common to many, distinct to prominent mottles on base colors of chroma stronger than 2 in unaggregated material, or (2) evidenced by base chroma greater than 2 with few to common, faint to distinct mottles on ped faces and common to many distinct to prominent mottles in ped interiors in well-aggregated material.

**h—Iluvial humus**

Accumulations of decomposed illuvial organic matter, appearing as dark coatings on sand or silt particles, or as discrete dark pellets of silt size, are indicated by $h$. If used, this suffix follows the letter B or a subdivision of B, as Bh or B2h.

**ir—Iluvial iron**

Accumulations of illuvial iron as coatings on sand or silt particles or as pellets of silt size; in some horizons the coatings have coalesced, filled pores, and cemented the horizon.

**m—Strong cementation, induration**

The symbol $m$ is applied as a suffix to horizon designations to indicate irreversible cementation. The symbol is not applied to indurated bedrock. Contrary to previous usage, $m$ is not used to indicate firmness, as in fragipans, but is confined to indurated horizons which are essentially (more than 90 percent) continuous, though they may be fractured.

**p—Plowing or other disturbance**

The symbol $p$ is used as a suffix with A to indicate disturbance by cultivation or pasturing. Even though a soil has been truncated and the plow layer is clearly in what was once B horizon, the designation Ap is used. When an Ap is subdivided, the arabic number suffixes follow, as Ap1 and Ap2, for the Ap is considered comparable to A1, A2, or B2.

**sa—An accumulation of salts more soluble than calcium sulfate**

This symbol may be applied to the designation of any horizon and in its manner of use is comparable to that described for ca or cs. If the symbol is used, the horizon must have more salt than the parent material is presumed to have had.

**si—Cementation by siliceous material, soluble in alkali.** This symbol is applied only to C

The cementation may be nodular or continuous. If the cementation is continuous the symbol sim is used.
t—Illuvial clay

Accumulations of translocated silicate clay are indicated by the suffix t (Ger. ton, clay). The suffix t is used only with B, as B2t, to indicate the nature of the B.

x—Fragipan character

The symbol x is used as a suffix with horizon designations to indicate genetically developed properties of firmness, brittleness, high density, and characteristic distribution of clay that are diagnostic of fragipans. Fragipans, or parts of fragipans, may qualify as A2, B, or C. Such horizons are classified as A2, B, or C, and the symbol x is used as a suffix to indicate fragipan character. Unlike comparable use of supplementary symbols, the symbol x is applied to B without the connotative arabic numeral normally applied to B. Arabic numerals used with C to indicate only vertical subdivision of the horizon precede the x in the symbol, as C1x, C2x.

All lower case symbols except p follow the last arabic number used, as B3ca, A2g, A21g. If the horizon is not subdivided, the symbol follows the capital letter, as Cg, Bt. The symbol p is restricted to use with A because of the common difficulty of deciding which horizons have been included in the plow layer.

It will be noted that the connotation of the symbol m has been changed to prohibit its use with “fragipans” and that definitions of the other symbols have been modified or elaborated. The symbols si and x have been added, and the symbols r, G, D, M, and u have been dropped.

SUBDIVISION OF HORIZONS

In a single profile it is often necessary to subdivide the horizons for which designations are provided, for example, to subdivide Ap, A1, A2, A3, B1, B2, B3, or C so that detailed studies of morphology, sampling, and similar work can be correctly recorded. In some cases, such subdivision is arbitrary in relation to differences observable in the field; in others, it may be needed to differentiate within a horizon on bases not provided by unique horizon symbols. In all such cases, the subdivisions are numbered consecutively, with arabic numbers, from the top of the horizon downward, as B21, B22, B23. If the suffixes consisting of lower-case letters are being used, the arabic numbers precede all lower-case suffixes except p as B21t, C1g, C2g, but Ap1, Ap2.

LITHOLOGIC DISCONTINUITES

Roman numerals are prefixed to the appropriate horizon designations when it is necessary to number a series of layers of contrasting material consecutively from the surface downward. A soil that is all in one kind of material is all in material designated by the numeral I. This numeral therefore can be omitted from the symbol, as it is understood that all the material is I. Similarly, the uppermost material in a profile having two or more contrasting materials is always designated I. Consequently, for the topmost material, the numeral I can be omitted from the symbol because it is always understood. Numbering starts with the second layer of contrasting material, which is designated II, and each contrasting material below this second layer is numbered
consecutively, III, IV, and so on, downward as part of each horizon designation. Even though a layer below a layer designated by II is similar to the topmost layer, it is given the appropriate consecutive number in the sequence. Where two or more horizons developed in one of the numbered layers, the Roman number is applied to all the horizon designations in that material.

Following are two examples of horizon sequences using this convention:

A1—A2—B1—B2—IIA'2—IIB'x—IIC1x—IIC2x—IIC3—IVR.

In the first example, the first contrasting layer is unnumbered; the second layer, starting in the B2, is indicated by Roman II, as IIB22; the third, within the C, by the symbol IIC. In the second example, the first contrasting layer is unnumbered; the second, starting at the top of A'2, is numbered II; the third, starting in the middle of the fragipan is numbered III, even though the fragipan is partly in C; and the fourth, starting below C, is indicated by IVR. Note that arabic numerals are used independently of the Roman numerals, in the conventional manner, both as connotative symbols and for vertical subdivision.

THE SOLUM

The solum may be defined simply as the genetic soil developed by soil-building forces. In normal soils, the solum includes the A and B horizons, or the upper part of the soil profile above the parent material.

Although the concept of solum is commonly understood by soil scientists, this definition is deceptively simple. Especially in some of the intrazonal soils, the actual sola are not easily determined; and in some soils their lower limits can be set only arbitrarily, say at 6 feet or 2 meters, or at the lower limit of plant roots. Used with such soils, the term "solum" may need to be defined in relation to the particular soil.

These difficulties concerning the solum arise mainly from the fact that the processes of soil formation often merge with broad geological processes. Although it is important to distinguish between geological and soil-forming processes, it is equally important to recognize that they usually go on together and that soils are being influenced by both. It is of little use to argue semantically about certain phenomena in the profile that are the result of combinations of the two sets of processes or that can be ascribed sometimes to one and sometimes to the other. These difficulties are illustrated by some common examples in the paragraphs following.

Croûte calcaire.—Croûte calcaire, or hardened caliche, is often found in thick masses overlain by only a few inches of soil. The common Cca horizons of Chernozems, let us say, are easily conceived as part of the soil profile, although they are not within the solum. Their genesis and relationships to the solum raise no particular difficulties. It is another matter, however, to include some 10 to 25 feet of croûte calcaire under a Reddish-Brown soil as a part of its

1 Admittedly this may appear to be somewhat arbitrary. In many Chernozems and Chestnut soils it may seem that the solum could be defined to include the Cca; but in some developed from materials low in calcium the Cca comes deep within the C, far below the solum.
profile. Doubtless this croûte calcaire is related to the solum and should be described in any description of the soil profile; but certainly broad long-time geological processes have been at work, as well as soil-forming processes.

Laterite.—Laterite includes the sesquioxide-rich, highly weathered clayey material that is hardened irreversibly to concretions, hardpans, or crusts when dehydrated, and hardened relics of such materials more or less mixed with quartz and other diluents. Laterite is found in many soils and is a distinguishing feature of Ground-Water Laterite soil. In the profile of a Ground-Water Laterite soil one may designate the horizons easily as A1, A2, A3, and B1, down into the B2 or, perhaps, into the B3. The same material may continue practically without change for another 25 feet or so with no definite place for dividing the solum from the material underneath it. It would be unreasonable to exclude the upper part of the laterite from the solum; and it seems unreasonable to include the lower part, far removed from the influence of organisms.

Gleyed soil material.—Gleyed soil material may begin a few inches below the surface of hydromorphic soils and, in some instances, continue on down for many feet essentially unchanged. Such conditions can arise through the gradual filling of a wet basin, with the A horizon gradually being added to at the surface and being gleyed beneath. Finally the A rests on a thick mass of gleyed material, which may be relatively uniform, especially in sandy types. Obviously the upper part belongs in the solum, while the lower part does not. This illustration does not extend to all gleyed soils. In many the gleyed horizon is clearly a part of the solum and has a clear lower boundary with the C.

Permafrost.—Permanently frozen ground under soils of the arctic and subarctic regions is called permafrost. The upper boundary, or *permafrost table*, is said to be coincident with the lower limits of seasonal thaws. The upper boundary of frozen ground varies, of course, from month to month during the summer and from year to year, depending upon the season. The soil that freezes and thaws seasonally is above the permafrost table. The frozen ground may extend downward many feet, even several hundred feet. Here again, the morphologist may properly place some part of the frozen ground in the soil profile, or even in the solum, as a kind of "thermal" hardpan, especially if it contains organic matter and bears a definite relationship to the upper horizons or solum. In many soils with permafrost, the permafrost table is deep beneath the solum, within the C or below it.

Some soils have no solum at all although they support plants. Examples include very young soils from recent accumulations of volcanic ash, alluvium, or loess. At least some time is required after vegetation has become established before recognizable genetic horizons are formed.

**POPULAR TERMS FOR SOIL LAYERS**

Several popular terms have long been used to refer to certain soil horizons or groups of horizons—terms that are exceedingly difficult to define precisely. They are very old and have been used by laymen in widely different senses.
Topsoil is a general term that is used in at least four senses: (1) For the surface plowed layer (Ap) and thus as a synonym for surface soil; (2) for the original or present A1 horizon, and thus exceedingly variable in depth among different soils; (3) for the original or present A horizon; and (4) for presumed fertile soil or soil material, usually rich in organic matter, used to top-dress road banks, parks, gardens, and lawns.

The authors know of no way to settle on a specific definition that would make the term even reasonably clear in soil descriptions. It should be avoided except as a top-dress material.

Surface soil refers to the soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The depth varies among different soil regions. If the term is used without qualification, reference is made to the existing surface soil, regardless of origin. If reference is made to a former condition, the term needs to be modified to original surface soil, as in the statement, "50 percent of original surface soil has been lost by sheet erosion."

Subsurface soil refers to that part of the A horizon below the surface soil. In soils of weak profile development subsurface soil can be defined only in terms of arbitrary depths.

Subsoil refers to the B horizon of soils with distinct profiles. In soils with weak profile development, subsoil can be defined as the soil below the surface soil in which roots normally grow or in terms of arbitrary depths. It is a poor term inherited from the days when "soil" was conceived only as the plowed soil; hence that under it was "subsoil."

Substratum is any layer beneath the solum, either conforming (C or R) or unconforming.

MEASUREMENT OF HORIZONS

The designations and descriptions of several horizons of the soil profile follow their identification and location within the profile. The description of the profile as a whole can be aided greatly by a scaled diagram, sketch, or photograph on which the horizon boundaries are shown.2

DEPTH AND THICKNESS

The profile description needs to include for each horizon (or layer) both (1) thickness in inches (or centimeters) and (2) depth of horizon boundaries below the top of A1.3 If both sets of figures vary widely, it will be necessary to give the two sets separately to avoid confusion.

2 The reader will find many schemes for measuring horizons in various publications. The best ones are those coupled with conventional outlines of soil characteristics so that none is inadvertently omitted. C. C. Nikiforoff outlined an excellent scheme in his Method of Recording Soil Data. Soil Sci. Soc. America Proc. 1: 307–317. 1936. The scheme he outlines needs only revision in classes and grades of horizon characteristics to bring it up to date with current practices. (See also p. 157.)

3 This standard applies to all soils except Bogs and Half Bogs, in which the measurement begins at the top of the peat or muck, not counting fresh leaves or twigs. In other soils, if the A1 is missing, the measurement is taken from the top of the AP or other surface horizon, say the A2 in severely burned podzolic soils or the B2 of a truncated profile if it now lies at the surface.
Figure 29.—Profile of a Podzol or sandy material illustrating an exceedingly irregular horizon boundary.

The upper boundary of a B2 horizon, for example, may lie from 10 to 18 inches beneath the top of A1, and the lower boundary from 20 to 32 inches below the top of the A1; while the thickness may vary from 8 to 16 inches, not 2 to 22 inches as might be interpreted from the figures for depth below the top of the A1. Even the figures for thickness and for depth do not describe very irregular horizons adequately. The main body of the A2 of a Podzol, for example, may be 5½ to 8½ inches thick, with an upper boundary ½ to ¾ inch deep, and a lower boundary generally 5 to 8 inches deep but with irregular tongues extending down to 18 inches. The lower boundary of the underlying B2 may vary similarly—as little as 10 inches deep to as much as 24 inches, but with a thickness of only 4 inches to not more than 12 inches.

In sandy Podzols with microrelief it is not unusual to find tongues of A2 actually bending under the B2 in such a way that a vertical cut into the soil will pass through A1, A2, B2, back into a bulging tongue of A2, then into B2 again, and finally through the B3 into the C. This example illustrates the need for a considerable trench for examining soil profiles and especially for taking samples, else serious errors may rise. Many soil horizons have similar tongues or other discontinuities, such as the common krotovinas of Chernozem and Chestnut soils, for example.

HORIZON BOUNDARIES

Horizon boundaries vary (1) in distinctness, and (2) in surface topography. Some boundaries are clear and sharp, as those between A2 and B2 horizons in most solodized-Solonetz and well-developed Podzols. Again they may be diffuse, with one horizon
gradually merging into another, as between the A1 and A3 of Chernozem or the B2 and B3 of many Latosols. With these diffuse horizons, the location of the boundary requires time-consuming comparisons of small samples of soil from various parts of the profile until the midpoints are established. Small markers can be inserted until all horizons of the profile are worked out; then measurements can be taken; and finally the individual horizons can be described and sampled. Sampling can often begin with the lowest horizon to good advantage.

The distinction of the horizons to the observer depends partly upon the contrast between them—some adjacent ones are highly contrasting in several features—and partly upon the width of the boundary itself or the amount of the profile in the transition between one horizon and the next. The characteristic widths of boundaries between soil horizons may be described as (1) abrupt, if less than 1 inch wide; (2) clear, if about 1 to 2½ inches wide; (3) gradual, if 2½ to 5 inches wide; and (4) diffuse, if more than 5 inches wide.

The topography of different soil horizons varies, as well as their distinctness. Although observations of soil horizons are made in profiles or sections, and so photographed or sketched, we must continually recall that they are not "bands" (or literally "horizons" as that word is understood in everyday speech) but rather three-dimensional layers that may be smooth or exceedingly irregular. Horizon boundaries may thus be described as (1) smooth, if nearly a plane; (2) wavy or undulating, if pockets are wider than their depth; (3) irregular, if irregular pockets are deeper than their width; and (4) broken, if parts of the horizon are unconnected with other parts, as the B₂ in the limestone cracks of a truncated Terra Rossa.

**HORIZONTAL VARIATIONS**

The profiles of soils having well-developed microrelief cannot be satisfactorily described from pits. To describe such soils, or to understand how one soil profile merges into another at the soil boundary, a long trench is dug so that horizons may be measured, described, sketched, and sampled at appropriate horizontal intervals. Small stakes may be set on the margin of the trench at 6- or 12-inch intervals as reference points. Using one stake as a zero point, the relative elevations of the others can be measured with an ordinary surveyor's level or Y-level.

For the purpose of observing any horizontal cracking or patterns in the soil, it is often revealing to remove soil horizons, one by one from the top down, from an area of a square yard or more. One may, for example, discover gross hexagonal cracking of hardpans or claypans, unsuspected from the vertical cut alone, that suggest previous influences of freezing, moistening, or desiccation that have been interrupted by coverings now changed to a part of the solum.
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