MAN has a passion for classifying everything. There is reason for this; the world is so complex that we could not understand it at all unless we classified like things together. Just as plants, insects, birds, minerals, and thousands of other things are classified, so also are soils. The why and the how of modern soil classification is here explained, and the characteristics and uses of the great groups of soils throughout the world are given.

Soil Classification

By Mark Baldwin, Charles E. Kellogg, *and* James Thorp [1]

THE soil is a more or less continuous body covering that portion of the land surface of the earth upon which plants grow. That its characteristics vary from place to place probably was recognized by man as soon as agriculture began. The importance of such variations is emphasized in all the early writings dealing with agricultural affairs. This recognition of different kinds of soils and the application of names to them were early steps in soil classification made to satisfy a definite practical need. According to early Chinese records, a classification of soils, made largely on the basis of their color and structure, was developed by the engineer Yu during the reign of the Emperor Yao about 4,000 years ago (*405*).[2]

The soil type as conceived by the modern scientist represents the combined expression of all those forces and factors that, working together, produce the medium in which the plant grows. The fundamental soil types can be described and their capabilities for use can be defined through the interpretation of experimental data and experience. After these types have been defined, knowledge regarding them can be accumulated and classified; and with their distribution shown on maps, this knowledge may be extended to definite areas of land easily and directly.

Since there are a great number of different kinds of soil varying from one another in different degrees of contrast, it is necessary to group them into progressively higher categories in order that the maximum application of our knowledge may be made.

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[2] Italic numbers in parentheses refer to Literature Cited, p. 1181.

EARLY SYSTEMS OF CLASSIFICATION

The early recognition of soil differences was based on local observations and served local or limited purposes. Many were based on single features of the soil, such as texture or color. These differentiations, while incomplete, were scientifically valid, since they dealt with true soil differences. The rise of geology as a distinct science with field methods and the recognition of the close relationship between soil and its parent material (in most instances the geological formation beneath it) led to a classification based on the composition of the underlying formations, such as the one defined by Fallou (*107*). Other systems of classification,[3] based on features lying outside the soil itself or only partly on soil characteristics, were developed. Some were based on geology strictly, others on physiography, plant ecology,[4] or agricultural quality, or combinations of these. Some of the schemes were fairly complete, in the sense of providing categories[5] and groups for the various features under observation. Thus Richthofen's system (*308*), based for the most part on the geology of the parent material, was sufficiently broad and complete to encompass practically all of the materials of the earth's surface. But it was not a soil classification; the units and the groups were not defined on the basis of soil characteristics, and the nomenclature was geological.

About 1870 a new school of soil science was founded in Russia under the leadership of Dokuchaiev. The scientists of this school recognized that each soil has a definite morphology, or form and structure, which is associated with a particular combination of vegetation, climate, relief, parent material, and age. They stressed the fact that soil is not a geological formation but an independent natural body, and they developed systems of classification in harmony with this new concept. Sibirtsev's Genetical Soil Classification of 1895 (*1*) illustrates in brief form the early trend of Russian soil science toward a genetic soil classification:

Division A. Soils wholly developed or zonal	1. Laterite soils. 2. Aeolian-loess soils. 3. Desert-steppe soils. 4. Chernozem. 5. Gray-forest soils. 6. Podzolized soddy (turfy) soils. 7. Tundra soils.
Division B. Intrazonal soils	8. Alkaline soils. 9. Moor-and-bog soils.
Division C. Immature soils	10. Coarse soils. 11. Alluvial soils.

Here the concept of three main groups of soil, zonal, intrazonal, and azonal (immature) was first presented. The first includes those soils having well-developed soil characteristics that reflect the influ-

[3] For a good discussion of some of the early schemes of soil classification see Afanasiev (*1*).

[4] Plant ecology deals with the mutual relations between plants and their environment, i. e., the relationship of plants to soil, land relief, climate, and other organisms.

[5] The term "category" is used in the sense of a class to which objects of knowledge may be reduced and by which they may be arranged in a system of classification. It is approximately equivalent to "class," but this term has already been appropriated in soil science for the various grades of soil texture, such as loam, sandy loam, and clay loam. It should be clearly distinguished from "group." Similar soils may be placed in a group, the Bellefontaine series; several similar series may be placed in a broader group, the Miami family; and several similar families in a still broader group, the Gray-Brown Podzolic great soil group. Any one particular series, family, or great soil group is a group of soils, but series, family, and great soil group, conceived as separate parts in a system of classification, are categories. Thus Bellefontaine is not a category of soil classification but one particular group of soils in the category "series."

ence of the active factors of soil genesis—climate and vegetation; the second, those soils having more or less well-developed soil characteristics that reflect the dominating influence of some local factor of relief, parent material, or age over the normal effect of the climate and vegetation; and the third, those soils without well-developed soil characteristics.

These early Russian investigators were concerned chiefly with the determination of general characteristics and the recognition of soil units that could be given broad geographic expression. They did not define local soil types or groups within the lower categories. As the Russian workers developed their science, the classification came more and more to be based upon soil characteristics and less and less on the environmental factors that produced them.

DEVELOPMENT IN THE UNITED STATES

About 40 years ago soil survey work was instituted in the United States for the purpose of defining and mapping the important soil types in the country. This research was started in the Department of Agriculture and naturally had agronomic purposes. The investigations have continued, in cooperation with the agricultural experiment stations of the States and Territories, up to the present time. Naturally as the science has progressed and as an increasing amount of knowledge has become available, there has been a continued development toward a system based strictly on soil characteristics—less on the environmental and external features and more on the internal soil morphology. From the beginning, in the field classification of soils all features have been taken into consideration that appeared to the scientist to influence the suitability of soils for crops.

> The classification is based mainly upon the physical properties and condition of the soil . . . any chemical feature, such as deposits of marl, or highly calcareous soils, or of highly colored soils is considered as well as character of the native vegetation and the condition of crops. . . . only such conditions as are apparent in the field, such as the texture as determined by the feel and appearance, the depth of soil and subsoil, the amount of gravel, the condition as to drainage, and the native vegetation or known relation to crops, are mapped (*459*).

A system of nomenclature was set up: "Each well-defined area is established as a class and given a local name." The term "class" referred to the texture of the surface soil. The geographical significance of the word "area" is apparent. The unit of classification, called the type elsewhere in the report, had a definite geographical expression. In fact, the choice of a place name as part of the soil-type name, as Roswell sandy loam, is significant and probably implied the concept of restricted distribution for any given type. The scale of the maps (1 inch = 1 mile) was considered ample to allow the delineation of all features of significance. Thus was laid the groundwork for the establishment of soil units, through the accumulation of soil data in the field, and the delineation of the boundaries of the units.

In the same report there is an implied grouping of these soil types, as indicated by the names Roswell loam and Roswell sandy loam, and the development of the concept of the soil series. The basis of the grouping, however, was not clearly conceived. Later the grouping of soil types into soil series had its basis in common geologic origin (not composition) of the parent material. Thus the Miami soil types were grouped into a single soil series (Miami), because they were "derived from glacial drift."

This grouping of soils on the basis of the geological origin of the parent material from which they were developed led to the grouping of soil types that had few true soil characteristics in common in a single soil series. The result was naturally confusing, and the purpose of classification was defeated. This defect gradually and necessarily was corrected as soil science developed in the United States.

As the work progressed, correlation of soil types between widely separated areas was attempted, and this in itself revealed the necessity of more rigid definitions of the soil units if the work was to have wide value either scientifically or practically. There was a gradual shifting from the geological definition of soil series to one strictly pedological, i. e., one based entirely on soil characteristics, and in 1920 Marbut (*236*), then chief of the United States Soil Survey, definitely listed eight features of the soil profile necessary to the definition of a soil unit. These features were:

(1) Number of horizons in the soil profile.[6]

(2) Color of the various horizons, with special emphasis on the surface one or two.

(3) Texture of the horizons.

(4) Structure of the horizons.

(5) Relative arrangement of the horizons.

(6) Chemical composition of the horizons.

(7) Thickness of the horizons.

(8) Geology of the soil material.

In his paper Marbut further analyzed the data from the soil surveys, which by that time had extended into most parts of the United States, and empirically and logically proceeded to the building up of the broader divisions or categories of soil classification, basing the definition of the groups entirely on soil characteristics. The hundreds of soil types and phases, used as units of mapping, comprised the first or lowest category and included all soils. He was now prepared to group the soils of the United States in broader categories. Accordingly, the multitude of soil types were combined on the basis of their characteristics into two great groups—since named by him the Pedocals and the Pedalfers—to form the highest category. The names were coined by combining the Greek word "pedo" (ground) with an abbreviation of the Latin word "calcis" or "calx" (lime) and with abbreviations of the Latin words "alumen" and "ferrum" (aluminum and iron). Pedocals are distinguished by the accumulation of carbonates of calcium or of calcium and magnesium in all or a part of the soil profile. Pedalfers are distinguished by the absence of carbonate of lime accumulation and usually by an accumulation of iron and aluminum compounds. Marbut, of course, recognized the relationship of these great soil groups to the climatic zones of the country, the first to the subhumid, semiarid, and arid regions, the second to the humid regions. The Pedocals and Pedalfers were subdivided into groups in lower categories on the basis of their character-

[6] Many of the soil terms used are explained in the previous articles, and short definitions are given in the Glossary.

istics. The technical details of the system are set forth in Marbut's last great monograph (*236*). His grouping by categories is summarized in table 1.

Table 1.—*Soil categories*

Category VI	Pedalfers (VI–1)	Pedocals (VI–2)
Category V	Soils from mechanically comminuted materials. Soils from siallitic decomposition products. Soils from allitic decomposition products.	Soils from mechanically comminuted materials.
Category IV	Tundra. Podzols. Gray-brown Podzolic soils. Red soils. Yellow soils. Prairie soils Lateritic soils. Laterite soils.	Chernozems. Dark-brown soils. Brown soils. Gray soils. Pedocalic soils of Arctic and tropical regions.
Category III	Groups of mature but related soil series. Swamp soils. Glei soils. Rendzinas. Alluvial soils. Immature soils on slopes. Salty soils. Alkali soils. Peat soils.	Groups of mature but related soil series. Swamp soils. Glei soils. Rendzinas. Alluvial soils. Immature soils on slopes. Salty soils. Alkali soils. Peat soils.
Category II	Soil series.	Soil series.
Category I	Soil units, or types.	Soil units, or types.

In his publication Marbut discussed the "geologic, topographic, physiographic, climatic, and biologic factors" of soil formation, distinguishing between the dynamic (climatic and biologic) factors and the passive factors. He pointed out the geographic significance of these factors and the consequent geographic distribution of the product of their interaction, the soil. The soil proper (the solum) is distinguished from the underlying material (C horizon), and the features which form the differentiating characteristics of soils are mentioned. The categories are defined, and the groups within the categories are described and named.

The desirability of geographic expression in broad zones, correlated with other broad geographic features, was recognized by Marbut in the emphasis he placed upon the so-called mature (zonal) soils, his category IV.

Those kinds of soils which bear the impress of local features of the environment do not find a fully satisfactory place in the scheme, in spite of the profound differences which distinguish them from their associated normal or mature (zonal) soils. They are listed in category III of Marbut's table. In examining such soils it is evident that they are of two general kinds: (1) Those soils which have definitely developed and in many instances strongly developed profile characteristics that reflect a local but dominating feature of the environment or parent material, such as poor drainage or calcareous parent material; (2) those soils which are without definite profile features, owing to youth, characteristics of parent material, or conditions of relief that prevent or inhibit the development of such features.

These two great groups of soils without normally developed profiles are broadly similar to the groups called intrazonal and azonal (or immature) by Sibirtzev in 1895. Glinka (*124*) objected to these names, as well as to the name "zonal," partly because of their geographical connotations. This may be a valid objection to the use of these words in soil classification, but the concepts seem sound, and in the absence of a better nomenclature, these words are used as the names for the groups of the highest category in the system of classification outlined in the following pages.

All the great soil groups listed in Marbut's scheme of classification (categories III and IV) are still recognized, but some changes in names and in the arrangement of categories have been found desirable. The characteristics of the great soil groups are briefly described in the article Formation of Soil and are summarized in table 3 in the Appendix (p. 996). Before proceeding further with a discussion of the higher categories of classification, it will be necessary to define more precisely the lower categories as they are now conceived.

SIMPLE UNITS OF CLASSIFICATION

Three categories are commonly recognized in the classification of soils in the field—(1) series, (2) type, and (3) phase. The grouping of these units in higher categories will be dealt with presently.

The most important of these field units is the soil series—defined as a group of soils having horizons similar as to differentiating characteristics and arrangement in the soil profile and developed from a particular type of parent material. Except for texture, especially of the A horizon, the morphological features of the soil profile, as exhibited in the physical characteristics and thicknesses of the soil horizons, do not vary significantly within a series. These characteristics include especially structure, color, and texture (except the texture of the A horizon, or surface soil) but not these alone. The content of carbonates and other salts, the reaction (or degree of acidity or alkalinity), and the content of humus are included with the characteristics which determine series.

Each soil in a series is developed from parent material of similar character. Parent material for soil is produced from rocks through the forces of weathering. Similar parent materials may be produced from different geological deposits and in different ways, and unlike parent materials may be produced from the same rocks because of differences in weathering. It is the character of the parent material itself which is important.

It follows that the external characteristics and environmental conditions of the soils within a series will also be similar. Each series has its characteristic range in climate and relief. Ordinarily the more strongly the soil characteristics are developed, the narrower is this range in external features. Except for young soils or those owing their distinctive characteristics to some unusual feature of the parent material, all the soil types within a series have essentially the same climate. It is to be expected, of course, that any differences in climate or relief sufficient to influence the native vegetation significantly would be reflected in the internal characteristics of the soil.

Variations in texture, especially of the A horizon, occur within a series. In former years soils having considerable range in texture throughout the entire profile were sometimes included within a series.

Significant differences in the texture of the B horizon or of the parent material are now considered to be sufficient grounds for recognizing new series.

The soil series are given names taken from place names near the spot where the soil was first defined, such as Miami, Hagerstown, Mohave, Houston, and Fargo. Many of the first series recognized in the United States were given such broad definitions that it became necessary to split them into several series after the soils had been studied more thoroughly. For example, several soil series are now recognized for soils included with the Miami and Carrington as first defined. Of course, the definitions of series cannot be made more closely than the limits of observation and measurement with available field techniques. Such techniques have improved considerably during the past 40 years, and there is promise of their further development.

The soil type is the principal unit used in detailed soil researches. The definition of soil type is identical with that of soil series, except that the texture of the A horizon does not vary significantly. Thus, there may be one or more types within a series, differentiated from one another on the basis of the texture of the surface soil, the upper 6 to 8 inches. Since the greater part of the roots of crop plants are in this upper soil layer and since this part of the soil is directly involved in tillage and fertilization, especial emphasis has been given its texture.

Attention has already been directed to the determination and nomenclature of soil textural classes. The class name of the A horizon (or average of the surface soil to a depth of 6 to 8 inches in soils with weakly developed profiles), such as sand, sandy loam, loam, silt loam, clay loam, or clay, is added to the series name to give the complete name of the soil type. For example, Miami loam and Miami silt loam are two soil types within the Miami series. With the exception of the texture of the surface soil, these two soil types have the same differentiating characteristics, both internal and external. In Bog soils the word peat or muck, whichever is appropriate, is added to the series name to give the complete name of the soil type.

During the time when special emphasis was placed on the geological character of the parent material, soil series were defined in terms that allowed a wide range in soil characteristics, and several types were included within a series. In a few instances the texture of the soil beneath the surface layer was given major emphasis in determining the class name of the soil type before the present concepts were so precisely defined. As the definitions of soil series came to be made more accurately in terms of soil characteristics, there were fewer types within each series. This is to be expected, for it is inconceivable that soils varying greatly in texture would be similar in their other characteristics. Young or otherwise undeveloped soils, such as alluvial soils, may have a considerable range in texture, although by no means the whole range from sand to clay, and still fall within the limits of a particular series. Well-developed soils are now being classified in series having but one or two or, at most, three types. As research continues, the series with only one type will become still more common. Within the range permitted in a soil type there may be small differences in climate—frostiness, for example—of much greater significance to crop plants than to the native plants. Similarly differences in relief, of little or no importance to the native vegetation, may be significant in the use of the soil when the land is cultivated. Such differences are recognized and mapped as phases of specific types.

A phase of a soil type, then, is defined on the basis of characteristics of the soil, or of the landscape of which the soil is a part, that are of importance in land use but are not differentiating characteristics of the soil profile. The three most important of such characteristics are slope, stoniness, and the degree of accelerated erosion. For example, from the point of view of land use, there are five principal classes of land defined according to slope, as follows:

(1) Nearly level to level land, on which external drainage is poor or slow. From the point of view of slope there is no difficulty in the use of agricultural machinery nor is there likelihood of water erosion.

(2) Gently undulating land, on which external drainage is good but not excessive. All types of ordinary agricultural machinery may be used with ease, and there is little likelihood of serious water erosion.

(3) Gently rolling lands, on which external drainage is good to free but not excessive. Ordinary agricultural machinery may be used, but the heavier types of equipment with difficulty. On soils subject to erosion there is likelihood of water erosion where intertilled crops are planted.

(4) Strongly rolling land, on which agricultural machinery cannot be used. External drainage is free, but sufficient water is available for a good grass cover. Soil erosion is likely to be serious on land planted to cultivated crops.

(5) Steeply sloping and hilly land, on which external drainage is so excessive that good pasture grasses cannot maintain themselves, although trees may be able to do so.

Frequently soil types have no greater range in slope than that allowed within one slope class, but other soil types have a greater range, and in such instances the variations are recognized as phases. The important criteria of these slope classes is not the percentage of slope but their land-use definitions. In itself slope has a limited significance; its importance can be studied and evaluated only in respect to a definite type of soil. For example, some soils with a 5-percent slope erode easily when devoted to clean cultivation, whereas others erode very little under such treatment, even with slopes in excess of 50 percent.[7]

In a similar way phases are defined for differences in stoniness and accelerated erosion (*195*).

HIGHER CATEGORIES OF CLASSIFICATION

The soil series are grouped in higher categories according to their characteristics. Of particular importance to our purpose are the great soil groups. Several of the great soil groups in the United States include hundreds of soil series, differing from one another in important ways because of differences in parent material, relief, and age, but all showing the same general sort of profile. Groups of soils between series and great soil groups, or families of closely related soil series,

[7] The percentage of slope indicates the number of feet drop for 100 feet in a horizontal plane. A 5-percent slope drops 5 feet in 100, a 50-percent slope 50 feet in 100, and so on.

have been recognized, such as the Miami family, including the Miami, Bellefontaine, Hillsdale, Russell, Fox, and similar soils. On the whole, however, there has been no consistent grouping of all series into strictly defined families intermediate between the soil series and the great soil groups, and based on soil characteristics. This problem may be expected to receive an increasing amount of attention as research proceeds.

The great soil groups, in turn, can be placed in several suborders and three orders—(1) zonal, (2) intrazonal, and (3) azonal.

Except where the continuity of the landscape is interrupted by mountains or large bodies of water, zonal soils occur over large areas, or zones, limited by geographical characteristics. Thus the zonal soils include those great groups having well-developed soil characteristics that reflect the influence of the active factors of soil genesis—climate and living organisms (chiefly vegetation). These characteristics are best developed on the gently undulating (but not perfectly level) upland, with good drainage, from parent material not of extreme texture or chemical composition that has been in place long enough for the biological forces to have expressed their full influence.

The intrazonal soils have more or less well-developed soil characteristics that reflect the dominating influence of some local factor of relief or parent material over the normal effect of the climate and vegetation. Any one of these may be associated with two or more zonal groups, but no one with them all.

The azonal soils are without well-developed soil characteristics either because of their youth or because conditions of parent material or relief have prevented the development of definite soil characteristics. Each of them may be found associated with any of the zonal groups.

The arrangement of the principal groups of soils according to these concepts is shown in table 2 in the Appendix (p. 993). The distribution of the more extensive great soil groups in the United States is shown on the map of soil associations at the end of this Yearbook. In only a few instances are there areas of the intrazonal and azonal groups large enough to separate on a small-scale map, but they occur scattered throughout the regions generally occupied by the zonal soils. In those parts of the country where climate and other conditions change greatly within short distances, as in the far Western States, it is not everywhere possible to separate the zonal groups on small-scale maps.

Although the classification must proceed from the small groups upward to the progressively larger groups differentiated by a decreasing number of characteristics, the details of this process are too voluminous to develop here. As there are several thousand individual soil types in the United States, no attempt will be made here to discuss them. The reader will need to consult the separate soil survey reports of particular areas for the description of local soil types.[8]

The scheme of soil classification outlined in table 2 (p. 993) is designed to make it possible to trace any local soil type logically and directly from the lowest to the highest category. It is believed that all soils will fall into one of the three orders, zonal, intrazonal, or azonal, but

[8] The Soil Survey Division has published more than 1,500 individual maps and reports since its initiation in 1899. The Illinois Agricultural Experiment Station and some other research institutions have published a few additiona soil maps.

it will probably be necessary to add new suborders and great soil groups from time to time as more is learned about the soils of the world.

Geographic Association of Soil Units

In order that the data of soil science may be understood and made available for the solution of practical problems it is necessary that these units of classification be expressed upon maps. The significance of the data shown by such maps is dealt with elsewhere, but their relationship to the problem of classification may be discussed briefly here. The simple units—series, types, and phases—must be shown upon large-scale maps in order that their relationship to one another, to the other local features of the landscape, and to the detailed pattern of human occupancy may be understood. In order that broader relationships may be understood and regional problems attacked, smaller scale maps showing the distribution of soil groups in the higher categories, especially the great soil groups, must be compiled.

Since the soil is the combined product of climate, living organisms, relief, parent material, and age, each different combination of these factors will produce a different soil. If all variations in each factor were measurable, and had measurable influences on the soil, individual soil types would be so numerous that they would occupy points. In a strict sense each soil profile is individual; no two are identical in every detail. Since there can be some range in the environmental factors without producing measurable differences in the soil, each soil type occupies an area rather than a point. The size and shape of individual areas varies greatly in different places.

By constantly enlarging the scale of a map, individual soil types can be shown separately, regardless of the size of the separate areas or the complexity of their pattern. If the scale is fixed at any practical point, however, certain soil types must be grouped together and shown as complexes. As the scale of the map is decreased, the number of such complexes will increase and the number of individual soil types shown will decrease. The definitions of individual complexes are made in terms of the geographic pattern of the soil units making up the complex.

Thus there is an important difference between geographic groups or associations of soils and groups based strictly on soil characteristics in the system of classification. For example, one may find series, types, and phases of Bog soils, Half Bog soils, alluvial soils, and Gray-Brown Podzolic soils in such close association that the individual great soil groups can be shown only on maps of a scale of an inch to the mile or even larger. On any small-scale map it would be impractical to delineate these groups separately. Since they have no common internal characteristics, it is out of the question to place a soil of the Gray-Brown Podzolic great group and one from the great group of Bog soils in the same order or suborder, to take an extreme example. Although they are intimately associated geographically and have the same climate, their profiles and the chemical and physical properties of their horizons are entirely unlike. The fact that an oak tree and a pine tree may be growing side by side is insufficient reason for placing them in the same species or family. The ecologist must recognize and define particular associations of plants if he wishes to make a generalized or schematic map of vegetation. Similarly an alluvial soil and a Bog soil cannot be classified in the same order, but they can form a part of an association or complex, defined as consisting of certain closely associated soil types with a characteristic pattern of distribution.

The soil complex is used frequently in both detailed and reconnaissance soil mapping and on generalized maps. It is a unit for the purposes of mapping, not a category in soil classification. Two complexes may be quite unlike, yet be composed of the same soil units, in different proportions or in different patterns. The differences between the soil units—series, types, and phases—may be due to differences in any factor responsible for their development. Ordinarily any one complex will lie within the region of one zonal great soil group, and differences between the units composing it will be due to variations in parent material, relief, or age. In mountainous regions, however, where environmental conditions are very complex, the zonal groups of soils may be closely associated in intricate patterns. On any small-scale map, showing the distribution of the zonal great soil groups (Chernozem, Podzol, etc.), soils belonging to intrazonal and azonal groups necessarily are included in the area occupied by a particular group of zonal soils. Thus the great soil groups, as shown on these maps, are, in a sense, complexes of the normal zonal soils and their geographic associates in the intrazonal and azonal groups.

Soils may be grouped in other ways for specific studies. Especially it may be important to group together all the soils in a soil region developed from the same parent material but differing in relief and in degree and character of profile development. Figure 2 (p. 890) shows such a series of profiles, developed from similar parent material. These soils may be expected to occur in association, although not necessarily in equal proportion. They may make an intricate pattern or a simple one. For such a group Milne (*265*) has suggested the appropriate term "catena" (Latin for chain). It may or may not be possible to map the catena, depending upon the uniformity of the factors other than relief. The concept of the catena has proved useful in the United States as a means of facilitating the logical grouping of soil units and for remembering their characteristics and relationships.

NOTES ON NOMENCLATURE[9]

Marbut's terms "Pedocal" and "Pedalfer" have a useful connotation, but they seem to form a better basis for a grouping within the great soil groups than for forming a separate category. It is not feasible, for example, to classify Degraded Chernozem under Pedocal, since it has many of the features of a Pedalfer while still retaining, in some instances, a good part of its carbonate of lime accumulation—one of the principal distinguishing characteristics of the Pedocal. Prairie soils, on the other hand, have no lime accumulation but do have dark-colored, humus-rich A horizons, much like those of the Chernozems, and show but little evidence of podzolization.

Several great soil groups have been renamed in order to eliminate such geographical terms as "southern," "northern," and "eastern." Even if valid for the United States, these terms are inappropriate in Mexico, South America, and other parts of the world. Descriptive terms have been substituted. For example southern brown soils are renamed Reddish Brown soils; northern dark-brown

[9] This section is intended primarily for soil scientists and students of soil science.

soils are now given the European name of Chestnut soils; and southern dark-brown soils are now called Reddish Chestnut soils. Noncalcic Brown soils show several characteristics common to podzolic soils, and, although their profiles are relatively weakly developed, they seem to belong within the outer range of the Pedalfers.

Distinctions among soils of the deserts are not sharp. Characteristics seem to depend largely on vegetation and temperature conditions, and there is much evidence to support the view that age and former relief have been extremely important in determining their character. Brown and Reddish Brown Pedocal soils are indicated as transitional between suborders 1 and 2. Possibly they might comprise another suborder, but it is not certain whether this disposal of them would be justified. They correspond respectively to Marbut's Brown and southern Brown soils.

Chernozem, a literal translation of which is black earth, was formerly described to include not only the nearly black Pedocal soils of the northern Great Plains, but also the dark-brown soils of the southern Great Plains, which have a definitely red or pink tinge, especially in the lower horizons. It is now thought that the latter belong more properly to the southern dark-brown group, for which the new name "Reddish Chestnut soil" is proposed. The subhumid parts of the southern Great Plains, where one would expect to find Chernozem, are underlain by soft marly limestones with black or very dark brown Rendzina soils developed upon them.

The Noncalcic Brown soils seem to owe their characteristics to the wet-dry subhumid climate and to the forest-grass vegetation characteristic of their environment. They were first recognized as a broad group in China under the name Brown soils (*355*), but as this term conflicts with the Brown Pedocal soils, the name "Shantung Brown" soils (*407*) was proposed later. The alternative name of Noncalcic Brown soils has the advantage of eliminating geographic restrictions and at the same time of clearly distinguishing these soils from the Brown Pedocals.

The proposed term "Brown Podzolic" soils covers a great group of soils that have some of the morphological features of immature Podzols. Their recognition as a group of category IV is based upon the wide geographic distribution of their characteristic profile and upon the apparent equilibrium of the well-developed soils with their environment.

Much of Marbut's Southern Prairie belongs to the Rendzina group (as was fully recognized by Marbut himself). Some relatively small areas of true Prairie soils do exist in warm-temperate humid areas of the United States. They have a reddish-brown color and are called Reddish Prairie soils, in conformity with the terminology used for the Pedocals of warm climates. Since much of the Reddish Prairie soil, now recognized in the United States, is developed on red materials, it is not yet known to what extent the color is inherited and to what extent it is developmental. Certainly the Reddish Prairie soils generally contain somewhat less organic matter than the Prairie soils of cooler regions.

It is well-known that there are important areas of Prairie soils in tropical regions, but their characteristics are not yet well enough known to make possible their proper classification.

Table 2 (p. 993) shows an overlap in suborders between the podzolized and lateritic soils. This is because many of the soils whose parent materials are of a lateritic nature show strong morphological and chemical evidences of podzolization. Laterization and podzolization are both active in the humid Tropics. Soils of the Tropics in general, and especially those of the humid and wet-dry Tropics, are not satisfactorily classified. This is more because of a lack of systematized study of data than of a lack of data, although there is still need for a vast amount of field and laboratory work on these soils. For example, we know that there are interrelationships involving Red and Yellow soils, some of which are sticky and plastic, whereas others are granular and friable. Colloids of some have low silica-alumina and silica-sesquioxide ratios, while in others the reverse is true. Marbut proposed the name "Tropical Red Loams" for soils containing a high percentage of friable clays. Although these soils contain much clay, their friable nature gives them a physical character more closely akin to loam. This group corresponds closely to the Reddish-Brown Lateritic soils of the present classification. Yellowish-Brown Lateritic soils have similar physical properties but a decidedly different color. To what extent the chemical properties differ has not yet been determined.

Many soils of the humid wet-dry tropical regions are developed on residual material showing a strong degree of reticulate mottling, apparently caused by partial segregation of iron compounds from clays. This type of mottling is characteristic of the material originally called Laterite by Buchanan, but it is very common throughout the region of lateritic soils even where chemical characteristics are different from those originally recognized as Laterites. Some of the Red and Yellow soils of the tropical regions are characterized by high organic content in the surface soil, while in others there is but little organic material. Although rocks weather very rapidly in humid tropical regions, the factor of time still remains very important in the development of soils; it is not yet known to what extent this factor influences the characteristics of soils that must be recognized in classification.

Much has been written, especially by European pedologists, concerning Terra Rossa (literally translated as red earth). The term has been widely applied to red soils developed under the warm-temperate Mediterranean type of climate, marked by wet and dry seasons. Many writers have preferred to limit Terra Rossa to soils developed on limestones, while some would have it include any red soil in a Mediterranean climate. According to Blanck's Handbuch der Bodekunde (*38*), Terra Rossas include red soils which vary greatly as to silica-alumina and silica-sesquioxide ratios in the colloidal fraction, and as to lime content. Some analyses show more than 10 percent of calcium oxide, whereas others show only a trace. It is well known that red soils developed on limestones vary in character from strongly podzolized red soils, on the one hand, to true Laterites on the other, and from strongly acid soils to those high in free carbonate of lime. Silica-alumina ratios vary from considerably more than two to much less than one. It seems evident from these facts that Terra Rossa cannot be classified satisfactorily until it has been defined more exactly. At present its only distinction lies in its color.

The terms "halomorphic," "hydromorphic," and "calomorphic" are not entirely satisfactory, since soil genetics rather than soil characteristics are implied. These names were used because they are conveniently short and because certain soil characteristics are associated with high salt content, with wet conditions, and with the presence of absorbed calcium. It would be desirable for these terms to be more descriptive in nature. Broad groups under these suborders more nearly conform to the desirable descriptive name.

The term "Planosol" is being proposed to cover those soils with claypans and cemented hardpans not included with the Solonetz, Ground-Water Podzol, and Ground-Water Laterite. Families of Planosols correspond to associated normal zonal soils. For example, the Grundy family represents the Planosol associated with the Prairie, the Clermont that associated with the Gray-Brown Podzolic, and the Crete that associated with the Chernozem.

Brown Forest soils are here recognized as calomorphic because of their high absorbed calcium. They seem to correspond to Ramann's original Braunerde and are distinguished from the associated Gray-Brown Podzolic soils by lack of evidence of podzolization. They are somewhat leached but have not developed eluvial and illuvial horizons to any appreciable extent. Incomplete evidence indicates that Brown Forest soils may extend well into the Tropics.

Ground-Water Laterites are characterized by hardpans or concretional horizons rich in iron and aluminum compounds and sometimes in manganese. The only family of this group shown in the table is the Tifton, and the Tifton and Caguas series are given as examples. The Caguas series, as mapped in Puerto Rico, includes both Ground-Water Laterite with hardpan and soils with concretionary horizons. These inclusions were made because of scale limitations on the map and not because of a misunderstanding of the character of the soils involved.

Although the azonal soils bear a much stronger imprint of their geological origin than the zonal and intrazonal soils, the fact remains that climatic and vegetation zones have had some influence on their character and development. Azonal soils of desert regions, particularly the Lithosols, are usually alkaline in reaction and often are actually calcareous even where the rock materials do not contain free lime. Lithosols within the Podzol region are likely to be acid in reaction, but this is not always the case and certainly is not true where the parent rocks contain free lime.

Alluvial soils as recognized in the field may or may not have some of the local zonal influences impressed in their characteristics. Their character depends very largely on their source, but local conditions of drainage and vegetation very soon have some influence on their nature after their deposition by streams. Alluvial soils support a larger proportion of the world's population than do any other great soil group. Family separations in alluvial soils depend largely on the character and source of the silts, sands, and clays of which they are composed and, as with other soils, each takes its name from a well-known and representative soil series.

It will be noticed at once that the nomenclature of the great soil groups involves the use of many color terms; indeed, these terms are the sole ones used in many instances. It is recognized that color is not the most important characteristic of soils. In fact some shade or tint of brown is the most common color of soils throughout the world. Yet the use of these color terms has come to mean more than mere color. For example, the term Chestnut implies not only the color of the A horizon but also the prismatic structure of the B horizon, the accumulation of lime in the substrata, and the grassy vegetation under which the soils develop. This implication comes not from the name itself but from its common use among pedologists during the last few decades for soils with a particular combination of characteristics. Similar statements could be made for other soils of the well-recognized groups. It is hoped and believed that the new names proposed in this classification will come to have equal significance when the characteristics of these newly recognized groups become as well known.

Table 3 gives general information concerning the properties of the soils of the great groups and briefly mentions certain features of their environment and their more important uses.

APPENDIX[10]

Table 2.—*Classification of soils on the basis of their characteristics*

Category VI Order		Category V Suborder	Category IV Great soil groups	Category III Family [1]	Category II Series [1]	Category I Type [1]
Zonal soils	Pedocals	Soils of the cold zone	1. Tundra soils			
		1. Light-colored soils of arid regions	2. Desert soils	Mesa	Mesa	Mesa gravelly loam.
					Chipeta	Chipeta silty clay loam.
			3. Red Desert soils	Mohave	Mohave	Mohave loam.
					Reeves	Reeves fine sandy loam.
			4. Sierozem	Portneuf	Portneuf	Portneuf silt loam.
			5. Brown soils	Joplin	Joplin	Joplin loam.
					Weld	Weld loam.
			6. Reddish Brown soils	Springer	Springer	Springer fine sandy loam.
					White House	White House coarse sandy loam.
		2. Dark-colored soils of the semi-arid, subhumid, and humid grasslands.	7. Chestnut soils	Rosebud	Rosebud	Rosebud fine sandy loam.
					Keith	Keith silt loam.
			8. Reddish Chestnut soils	Amarillo	Amarillo	Amarillo fine sandy loam.
					Abilene	Abilene clay.
			9. Chernozem soils	Barnes	Barnes	Barnes very fine sandy loam.
			10. Prairie soils	Carrington	Carrington	Carrington loam.
					Tama	Tama silt loam.
			11. Reddish Prairie soils	Zaneis	Zaneis	Zaneis very fine sandy loam.
					Renfrow	Renfrow silt loam.
	Pedalfers	3. Soils of the forest-grassland transition.	12. Degraded Chernozem soils.			
			13. Noncalcic Brown or Shantung Brown soils.	Holland	Holland	Holland sandy loam.
					Vista	Vista sandy loam.
					Fallbrook	Fallbrook fine sandy loam.
					Sierra	Sierra coarse sandy loam.
				Placentia	Placentia	Placentia fine sandy loam.
					Ramona	Ramona sandy loam.
				Weihaiwei	Weihaiwei	Weihaiwei loam.
					Tinghsien	Tinghsien fine sandy loam.
		4. Light-colored podzolized soils of the timbered regions.	14. Podzol soils	Kalkaska	Kalkaska	Kalkaska loamy sand.
					Au Train	Au Train loamy sand.
				Rubicon	Rubicon	Rubicon sand.
					Roselawn	Roselawn sand.
				Hermon	Hermon	Hermon loam.
					Colton	Colton loamy sand.
					Becket	Becket loam.

[10] Unfamiliar terms in these tables are defined in the Glossary, p. 1162.

Table 2.—*Classification of soils on the basis of their characteristics*—Continued

Category VI Order	Category V Suborder	Category IV Great soil groups	Category III Family	Category II Series	Category I Type
Zonal soils — Pedalfers	4. Light-colored podzolized soils of the timbered regions (cont'd).	15. Brown Podzolic soils	Gloucester	Gloucester	Gloucester loam.
					Gloucester sandy loam.
				Merrimac	Merrimac sandy loam.
					Merrimac loamy sand.
		16. Gray-Brown Podzolic soils	Miami	Miami	Miami silt loam.
				Fox	Fox silt loam.
				Bellefontaine	Bellefontaine loam.
			Plainfield	Plainfield	Plainfield loamy sand.
				Coloma	Coloma loamy sand.
			Chester	Chester	Chester loam.
				Frederick	Frederick silt loam.
			Porters	Porters	Porters loam.
	5. Lateritic soils of forested warm-temperate and tropical regions.	17. Yellow Podzolic soils	Norfolk	Norfolk	Norfolk sandy loam.
		18. Red Podzolic soils (and Terra Rossa).	Orangeburg	Orangeburg	Orangeburg sandy loam.
				Greenville	Greenville sandy loam.
				Magnolia	Magnolia sandy loam.
				Cecil	Cecil sandy loam.
		19. Yellowish-Brown Lateritic soils	Coto	Coto	Coto clay.
		20. Reddish-Brown Lateritic soils	Bayamón	Bayamón	Bayamón clay.
		21. Laterite soils	Nipe (ferruginous).	Nipe	Nipe clay.
				Rosario	Rosario clay.
	1. Halomorphic (saline and alkali soils of imperfectly drained arid regions and littoral deposits.	1. Solonchak or saline soils	Sage	Sage	Sage clay.
			Lahontan	Lahontan	Lahontan clay loam.
				Fresno	Fresno clay loam.
		2. Solonetz soils	Phillips	Phillips	Phillips loam.
				Rhoades	Rhoades loam.
			Beadle	Beadle	Beadle silt loam.
		3. Soloth soils	Arvada	Arvada	Arvada clay loam.
				Beckton	Beckton silty clay loam.
		4. Wiesenböden (Meadow soils)	Clyde	Clyde	Clyde silty clay loam.
				Webster	Webster silty clay loam.
		5. Alpine Meadow soils	Duncom	Duncom	Duncom silt loam.
		6. Bog soils	Edwards	Edwards	Edwards muck.
			Carlisle	Carlisle	Carlisle muck.
				Pamlico	Pamlico muck.
			Greenwood	Greenwood	Greenwood peat.
				Spaulding	Spaulding peat.

Intrazonal soils	2. Hydromorphic soils of marshes, swamps, seep areas, and flats.	7. Half Bog soils	Maumee	Maumee	Maumee loam.
				Bergland	Bergland loam.
		8. Planosols	Grundy	Grundy	Grundy silt loam.
				Oswego	Oswego silt loam.
			Clermont	Clermont	Clermont silt loam.
				Vigo	Vigo silt loam.
			Crete	Crete	Crete silt loam.
				Idana	Idana silty clay loam.
		9. Ground-Water Podzol soils	Saugatuck	Saugatuck	Saugatuck loamy sand.
				Allendale	Allendale sandy loam.
			Leon	Leon	Leon sand.
				St. Johns	St. Johns loamy sand.
		10. Ground-Water Laterite soils	Tifton	Tifton	Tifton fine sandy loam.
				Caguas	Caguas clay.
	3. Calomorphic	11. Brown Forest soils (Braunerde)	Brooke	Brooke	Brooke clay loam.
			Burton	Burton	Burton loam.
		12. Rendzina soils	Houston	Houston	Houston clay.
				Soller	Soller clay loam.
				Bell	Bell clay.
			Aguilita	Aguilita	Aguilita clay.
				Diablo	Diablo clay.
Azonal soils		1. Lithosols	Underwood	Underwood	Underwood stony loam.
				McCammon	McCammon loam.
			Muskingum	Muskingum	Muskingum stony silt loam.
			Dekalb	Dekalb	Dekalb stony loam.
		2. Alluvial soils	Wabash	Wabash	Wabash clay loam.
				Cass	Cass loam.
			Laurel	Laurel	Laurel fine sandy loam.
				Sarpy	Sarpy very fine sandy loam.
			Sharkey	Sharkey	Sharkey clay.
			Genesee	Genesee	Genesee silt loam.
				Huntington	Huntington silt loam.
			Gila	Gila	Gila very fine sandy loam.
				Pima	Pima silty clay loam.
			Hanford	Hanford	Hanford loam.
				Yolo	Yolo loam.
		3. Sands (dry)			

[1] Families, series, and types listed are intended only as examples to illustrate the system of classification. When all of the soils of the United States (and of the world as a whole) are studied and classified, many more families, a few thousand series, and thousands of local soil types will have to be recognized.

Table 3.—*General characteristics of soils and their environs*

ZONAL

Zonal soils	Profile	Native vegetation	Climate	Natural drainage	Soil-development processes	Productivity (crop plants)	Present use
Tundra	Dark-brown peaty layers over grayish horizons mottled with rust. Substrata of ever-frozen material.	Lichens, moss, flowering plants, and shrubs.	Frigid humid	Poor	Gleization and mechanical mixing.		Pasture and a few short-season crops. Hunting and trapping are associated enterprises.
Desert	Light-gray or light brownish-gray, low in organic matter, closely underlain by calcareous material.	Scattered shrubby desert plants.	Temperate to cool; arid.	Good to imperfect.	Calcification	Medium to high, if irrigated.	Grazing in large units. Intensively farmed in small units where irrigated. Crops specialized in many places.
Red Desert	Light reddish-brown surface soil, brownish-red or red heavier subsoil closely underlain by calcareous material.	Desert plants, mostly shrubs.	Warm-temperate to hot; arid.	do	do	do	Do.
Sierozem	Pale grayish soil grading into calcareous material at a depth of 1 foot or less.	Desert plants, scattered short grass, and scattered brush.	Temperate to cool; arid.	do	do	do	Do.
Brown	Brown soil grading into a whitish calcarerous horizon 1 to 3 feet from surface.	Short-grass and bunch-grass prairie.	Temperate to cool; arid to semiarid.	Good	do	High, if irrigated	Large farms of small grain (if unirrigated). Ranching in large units.
Reddish Brown	Reddish-brown soil grading into red or dull-red heavier subsoil and then into whitish calcareous horizon, either cemented or soft.	Tall bunch grass and shrub growth.	Temperate to hot; arid to semiarid.	do	do	Moderate to high, if irrigated. Not suited to dry farming. Grazing good.	Grazing in large units. Small specialized farms where irrigated.
Chestnut	Dark-brown friable and platy soil over brown prismatic soil with lime accumulation at a depth of 1½ to 4½ feet.	Mixed tall- and short-grass prairie.	Temperate to cool; semiarid.	do	do	Medium. High where irrigated.	Cereal grains, especially wheat and grain sorghums throughout the world. Excellent grazing in large units.

Reddish Chestnut.	Dark reddish-brown cast in surface soil. Heavier and reddish-brown or red sandy clay below. Lime accumulation at a depth of 2 feet or more.	Mixed grasses and shrubs.	Warm-temperate to hot; semiarid.	do	do	do	Cereal grains and cotton. Excellent grazing in large units.
Chernozem	Black or very dark grayish-brown friable soil to a depth ranging up to 3 or 4 feet grading through lighter color to whitish lime accumulation.	Tall- and mixed-grass prairie.	Temperate to cool; subhumid.	do	do	Medium to high. High to very high where irrigated.	Small grains and corn in moderate-sized or large units.
Prairie	Very dark-brown or grayish-brown soil grading through brown to lighter colored parent material at a depth of 2 to 5 feet.	Tall-grass prairie	Temperate to cool-temperate, humid.	do	Calcification with weak podzolization.	High	Medium to small farm units. General farming, with emphasis on corn, hogs, and cattle.
Reddish Prairie	Dark-brown or reddish-brown soil grading through reddish-brown heavier subsoil to parent material. Moderately acid.	Tall- and mixed-grass prairie.	Warm-temperate, humid to subhumid. Possibly some tropical conditions.	do	do	Medium to high	Wheat, oats, corn, cotton, hay, and forage crops.
Degraded Chernozem.	Nearly black A, somewhat bleached grayish A_2, incipient heavy B, and vestiges of lime accumulation in deep layers.	Forest encroaching on tall-grass prairie.	Temperate and cool; subhumid to humid.	do	Calcification followed by podzolization.	Medium to high. Low where strongly degraded.	Agriculture intermediate between Chernozem and Podzol. Of little importance in the United States.
Noncalcic Brown (Shantung Brown).	Brown or light-brown friable soil over pale reddish-brown or dull-red B horizon.	Mostly deciduous forest of thin stand with brush and grasses.	Temperate or warm-temperate; wet-dry, subhumid to semiarid.	do	Weak podzolization and some calcification.	Medium. High were irrigated.	Grazing, dry farming with small grains, specialized irrigated crops including fruits.
Podzol	A few inches of leaf mat and acid humus, a very thin dark gray A_1 horizon, a whitish-gray A_2 a few inches thick, a dark or coffee-brown B_1 horizon, and a yellowish-brown B_2. Strongly acid.	Coniferous, or mixed coniferous and deciduous forest.	Cool-temperate, except in certain places where the climate is temperate; humid.	do	Podzolization	Usually low. Medium under good practices.	Small subsistence farms, including dairying. Wood lots and pasture important.

Table 3.—*General characteristics of soils and their environs*—Continued

ZONAL—Continued

Zonal soils	Profile	Native vegetation	Climate	Natural drainage	Soil-development processes	Productivity (crop plants)	Present use
Brown Podzolic	Leaf mat and acid humus over thin dark-gray A, and thin gray-brown or yellowish-brown A_2 over brown B horizon which is only slightly heavier than surface soil. Solum seldom more than 24 inches thick.	Deciduous or mixed deciduous and coniferous forest.	Cool-temperate; humid. Effective moisture slightly less than in Podzol.	Good	Podzolization	Low to medium. High where heavily fertilized and well managed.	Small subsistence farms, dairying, wood lots, and pasture. Specialized truck crops near large cities are important.
Gray-Brown Podzolic.	Thin leaf litter over mild humus over dark-colored surface soil 2 to 4 inches thick over grayish-brown leached horizon over brown heavy B horizon. Less acid than Podzols.	Mostly deciduous forest with mixture of conifers in places.	Temperate; humid	do	do	Medium. High where well fertilized and managed.	Small farm units with general farming. Wide variety of crops. Some specialization. (Much industrial activity.)
Yellow Podzolic	Thin dark-colored organic covering over pale yellowish-gray leached layer 6 inches to 3 feet thick over heavy yellow B horizon over yellow, red, and gray mottled parent material; acid.	Coniferous or mixed coniferous and deciduous forest.	Warm-temperate to tropical; humid.	Imperfect to good.	Podzolization with some laterization.	Poor. Responsive to good management and fertilization.	Small to medium-sized farm units. Subsistence crops. Cotton, tobacco, peanuts, and some fruit and vegetables. Few livestock. Many wood lots and forested areas.
Red Podzolic	Thin organic layer over yellowish-brown or grayish-brown leached surface soil over deep-red B horizon. Parent material frequently reticulately mottled red, yellow, and gray; acid.	Deciduous forest with some conifers. (With cogonales—burned-over areas covered with cogon, tall coarse grasses.)	do	Good	Podzolization and laterization.	Medium. Responsive to fertilization and good management.	Small to medium-sized farms, with cotton, peanuts, tobacco, and subsistence crops. Much waste land and forests.
Yellowish-Brown Lateritic.	Brown friable clays and clay loams over yellowish-brown heavy but friable clays. Acid to neutral.	Evergreen and deciduous broad-leaved trees. Tropical selva. (Some cogonales.)	Tropical; wet-dry. High to moderate rainfall.	Good externally. Good or excessive internally.	Laterization and some podzolization.	Low. Medium with irrigation and fertilization.	Small farm units, with subsistence and some specialized crops. Some forests.

Reddish Brown Lateritic.	Reddish-brown or dark reddish-brown friable granular clayey soil over deep-red friable and granular clay. Deep substrata reticulately mottled in places.	Tropical rain forest to edge of savannah. (Some cogonales.)	Tropical; wet-dry. Moderately high rainfall.	Good externally and internally.	Laterization with little or no podzolization.	Low to medium. Medium to high where fertilized and irrigated.	Small farm units with subsistence crops. Plantations of citrus, pineapple, sugarcane, etc. Some forest.
Laterite	Red-brown surface soil. Red deep B horizon. Red or reticulately mottled parent material. Very deeply weathered.	Tropical selva and savannah vegetation. (Some cogonales.)	Tropical; wet-dry. High to moderate rainfall.	Good externally. Good or excessive internally.	Laterization and a little podzolization.	Low. Medium to high with heavy irrigation and fertilization.	Small farm units with wide variety of subsistence crops. Some specialization on plantations. Large areas of waste land and forest. Mined for iron and aluminum in places.

INTRAZONAL

Intrazonal soils	Profile	Native vegetation	Climate	Factors responsible for development	Natural drainage	Soil-development processes	Productivity (crop plants)	Present use
Solonchak	Gray thin salty crust on surface, fine granular mulch just below, and grayish friable salty soil below. Salts may be centrated above or below.	Sparse growth of halophytic grasses, shrubs, and some trees.	Usually subhumid to arid. May be hot or cool.	Poor drainage with evaporation of capillary water. Salty accumulations.	Poor or imperfect.	Salinization	Very low except where washed free of salts.	Some grazing. Much waste land. Used for producing salt and saltpeter in places.
Solonetz	Very thin to a few inches of friable surface soil underlain by dark, hard columnar layer, usually highly alkaline.	Halophytic plants and thin stand of others.	do	Improved drainage of a sodium Solonchak.	Imperfect	Solonization (desalinization and alkalization).	Low (medium where reclaimed).	Same use as associated normal soils.
Soloth	Thin grayish - brown horizon of friable soil over whitish leached horizon underlain by dark-brown heavy horizon.	Mixed prairie or shrub.	Usually subhumid to semiarid. May be hot or cold.	Improved drainage and leaching of Solonetz.	Imperfect to good.	Solodization (dealkalization).	Low to medium	Do.
Wiesenböden (Meadow).	Dark-brown or black soil grading, at a depth of 1 or 2 feet, into grayish and rust-mottled soil.	Grasses and sedges.	Cool to warm; humid to subhumid.	Poor drainage	Poor	Gleization and some calcification.	Generally high or very high when drained.	Used in connection with associated normal soils. Drained areas similar to Prairie.

Tabe 3.—*General characteristics of soils and their environs*—Continued

INTRAZONAL—Continued

Intrazonal soils	Profile	Native vegetation	Climate	Factors responsible for development	Natural drainage	Soil-development processes	Productivity (crop plants)	Present use
Alpine Meadow.	Dark-brown soil grading, at a depth of 1 or 2 feet, into grayish and rust soil, streaked and mottled.	Grasses, sedges, and flowering plants.	Cool-temperate to frigid (alpine).	Poor drainage and cold climate.	Poor	Gleization ond some calcification.	Yields limited by cool climate.	Mostly summer pasture.
Bog	Brown, dark-brown, or black peat or muck over brown peaty material.	Swamp forest or sedges and grasses.	Cool to tropical; generally humid.	Poor drainage. Water-covered much of the time.	Very poor	Gleization	Low or medium. High in some places where drained.	Special crops when drained. Undrained areas in forest - swamp or marsh plants.
Half Bog	Dark-brown or black peaty material over grayish and rust-mottled mineral soil.	do	do	do	do	do	Medium to high when drained. Some low.	Used in connection with normal soils for pasture or forest, where undrained, and for special crops where drained.
Planosols	Strongly leached surface soils over compact or cemented claypan or hardpan. Some have normal A and B horizons above the claypan or hardpan—a secondary profile.	Grass or forest	Cool to tropical; humid to subhumid.	Flat relief, imperfect drainage, and great age.	Imperfect or poor.	Podzolization, gleization. Also laterization in tropics.	Medium to low	Crops, pasture, and forest trees, varying with regions in which they occur.
Ground-Water Podzols.	Organic mat over very thin acid humus, over whitish-gray leached layer up to 2 or 3 feet thick, over brown or very dark-brown cemented hardpan or ortstein. Grayish deep substrata.	Forest of various types.	Cool to tropical; humid.	Imperfect drainage and usually sandy material.	do	Podzolization	Low to medium in cool areas. Low in warm areas.	Forest. Some land planted to regional crops and pasture grasses.

Ground-water Laterites.	Gray or gray-brown surface layer over leached yellowish-gray A_2 over thick reticulately mottled cemented hardpan at a depth of 1 foot or more. Hardpan up to several feet thick. Laterite parent material. Concretions throughout.	Tropical forest	Hot and humid; wet and dry seasons.	Poor drainage and considerable or great age.	do	Podzolization and laterization.	Low to medium	Subsistence crops, sugarcane, and forest trees.
Brown Forest (Braunerde).	Very dark brown friable surface soil grading through lighter colored soil to parent material. Little illuviation. High absorbed calcium.	Forest, usually broad-leaved.	Cool-temperate to warm-temperate; humid.	High calcium colloids and youth.	Good	Calcification with very little podzolization.	High	Subsistence and regional crops, pasture and forest.
Rendzina	Dark grayish-brown to black granular soil underlain by gray or yellowish, usually soft, calcareous material.	Usually grassy. Some broad-leaved forest.	Cool to hot; humid to semiarid.	High content of available lime carbonate in parent material.	do	Calcification	do	Regional and special crops. Pasture grasses.

AZONAL

Azonal areas	Profile	Vegetation	Climate	Drainage	Soil-development processes	Productivity and present use
Lithosols	Thin, stony surface soils—little or no illuviation. Stony parent materials.	Depends on climate.	All climates. Most characteristic of deserts; least so of humid Tropics.	A wide range, mostly good to excessive.	Those characteristic of the region. Little effect has been made.	Forestry, grazing, barren. Some agriculture on limited areas. Low productivity.
Alluvial soils	Little profile development. Some organic matter accumulated. Stratified.	do	All climates except extremely frigid ones.	A wide range, mostly poor to good.	do	Practically all crops of world represented. Yields vary from very high to very low. Large proportion of world's population supported by production from alluvial soils. Both subsistence farms and large plantations on these soils.
Sands, dry	Essentially no profile. Loose sands.	Scanty grass or scrubby forest. Much of land has no vegetation.	Humid to arid, temperate to hot.	Excessive	do	Very seldom used except for grazing.