An Outline of the Classification of Indiana Soils

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At the last annual meeting of the Indiana Academy of Science the author presented a short paper having a related title, but that paper was devoted to a discussion of historical and philosophical aspects of soil classification and the relationship of kinds of soils to the data of other natural sciences. It contained very little specific descriptive material in regard to either the characteristics of soils or their systematic classification and did not contain a single name of a soil species, genus, or order. Moreover, only an abstract of the paper was published in the Proceedings of the Academy so that whatever repetition may exist in the content of the following paper will be new as far as publication in the Proceedings is concerned.

Obviously, the present paper is largely a new summarization of information which has been published to a considerable extent in the soils literature and is collected from scattered sources and presented here largely because of the interest in this subject expressed by persons who are not soil technicians.

The most complete summary of information about the soils of the United States, which has been published recently, is found in the 1938 Yearbook of the Department of Agriculture, entitled, "Soils and Men." That volume might better have been entitled "Men and Soils," since the first 750 pages contain relatively little soil information and only the last two or three hundred pages are used to cover the entire range of soil conditions for the whole United States. This paper will deal only with the soils of Indiana. In order to orient the material in reference to broader conditions, a few preliminary generalizations may be made.

In this discussion the soil is considered as a natural body which may be classified systematically, and the viewpoint is that the soil is a product of material modified by environmental forces under certain conditioning influences through varying periods of time. This might be stated like a formula

$$S = M \times F_c \times T$$

Some of the most important environmental forces are included under the term "climate," and from the soils standpoint, there is in Indiana a very limited range of climatic conditions which may be summed up as humid, temperate. There is nothing here like the arid climate which produces alkali soils, or the cold climate which produces tundra soils, or the hot, wet climate which produces lateritic soils as well as other regional soils groups as differentiated by climatic factors.

There is also in Indiana a limited range in the character of geological deposits from which soils have been formed; so it is impossible to have here many kinds of soil found in other parts of the world. In fact, soils identical to those in Indiana could be expected only within areas of a few nearby states where both rocks and climate are comparable. Since there is considerable similarity between the conditions in Indiana and those in Ohio, Illinois, Michigan, and Kentucky, soil classification is an inter-state problem and has been carried on through cooperation of soil departments in other states as well as with the federal soil agencies which handle inter-state or national soil classification work. Of course, there is some degree of individuality and local independence in the work, and the statements made in this paper consist of the Indiana version of the classification of Indiana soils.

The characteristics of soils grade into each other even more than the characteristics of living creatures intergrade, and, just as some biological taxonomists state there is really no such thing as a "species," it can be said that there is no such thing as a "soil type" which is the unit of classification, and yet the idea which is set up for a soil type or species is a very useful guide in arrangement of information in an orderly manner. The general idea of a "soil type" is that it is a "kind" of soil having relatively uniform characteristics in its various individual areas. The character of a soil is expressed in its gross anatomy and its internal morphology as well as by microscopic or invisible attributes such as physical and chemical constants. The gross anatomy of an individual soil area or its conformation may be described in terms of the surface land form, the area outline or soil pattern, and the nature of the boundary between the true soil and the underlying geological foundation.

Land form specifications for soils may employ geological terms such as till plain, lake plain, moraine, kame, etc. These words are used with their customary meanings; no further explanation will be made here. Land form is also described in simpler terms such as flat, slope, hill, depression, etc., or by giving the percentage of slope as well as the length of slopes, variability in slope, or range of slope. Sometimes the land form is also given in land use adaptation terms.

The outlines of soil areas may be very characteristic of a type and are observed as to whether they are: sharp or indistinct, smooth and regular or irregular, large or small, linear or round, "background" or "detail." On an unlabeled soil map it is often easy to partially identify a soil by its shape alone.

The nature of the contact between a soil body and the geological foundation is much harder to observe than the other dimensions of gross form but can be determined as abrupt or gradual, regular or irregular, distinct or indistinct, etc.

The internal morphology of soils is exhibited in the principal layers or horizons. The main facts to note about the horizons are the number and arrangement in a given soil and thickness, color, texture, structure, consistency, and physical and chemical characteristics of each horizon. There is also the matter of the kind of transition or changes between horizons and the similarities in them.

While the horizons parallel to the land surface are the most conspicuous morphological units, they are, perhaps, not the most important distinctions which can be made. Just as skin, flesh, and bone, which are conspicuous and important layers in the leg of an animal, are perhaps less important in function than the blood vessels which pass through all of them, so the layers of soils may be less significant than the system of cracks or channels which pass through several different soil layers and function there.

While soils in comparison with geological deposits are highly "organized" bodies, they are distinctly different from living organisms and may be thought of simply as the present product of dynamic, physical, and chemical interactions which are relatively slow in their changes so that the soil characteristics remain about the same for years at a time. Thus they may be classified on the basis of their present characteristics in spite of the fact that they formerly were considerably different and are undoubtedly changing in certain definite directions. At the present time, the classification of soils is based chiefly upon features and relationships which existed when the soil was at equilibrium with nature and these features remain and will persist in many respects in spite of the disturbed natural balance due to agricultural use of the soil. On the other hand, the practical classification does take into account some of the modifications due to agricultural use of the land, the recognition of erosion being the most outstanding instance of this kind. Even in the case of erosion, the scientific classification is based upon the nature of the soil profile which probably existed at a given point even though it has now been largely removed and is well on the way to becoming an entirely different soil in the same location.

Figure 1 shows in tabular form the principal characteristics of the most important soil types in Indiana. It will be noted that from a standpoint of features which can be observed in the surface form and the upper horizons of the soil profiles which reflect most strongly the environmental influences, all of the soils may be grouped under ten generalized concepts, which may be called "general soil profiles." These general profiles are arranged in orderly sequence according to gradations in characteristics, chiefly those dependent upon aeration, oxidation, and drainage. The degree and character of slope also changes systematically in this sequence with certain exceptions. The order of numbering on the columns is irregular because these numerals were established in connection with a somewhat similar table arranged in a different way and have come to have certain significance to soil technicians.

Column No. 6 includes some soils developed on some of the steepest slopes although it is possible to have soils of similar character on somewhat more gentle slopes. However, on the steep slopes the equilibrium between weathering and accumulation versus natural erosion is so much in favor of the latter that the surface material is relatively unmodified and there is little well oxidized soil material present in spite of the excessive surface drainage. In this respect this group of soils is an exception to the rule of arranging the groups in descending order of oxidation.

Column No. 5 includes soils which also are an exception to the general arrangement but for a different reason. They include the best oxidized soils of the whole list, due to the porous nature of the soil and underlying material which may consist of sands and gravels or stones. This well aerated and oxidized condition may occur in soils on topography ranging all the way from steeply sloping to flat land. In the flat land it is, of course, necessary that the water table be low enough so that the underlying sands or gravel are dry, not saturated with moisture.

The soils in column No. 4 include those which are really the best drained, aerated, and oxidized group in the sequence of *comparable* soils, and their development correlates very closely with a degree of slope which insures rapid run-off of rainfall and good aeration most of the time.

Group No. 3 includes soils of poorer aeration and oxidation than in the case of group 4, due to somewhat less surface slope. There is also an imperfectly drained and aerated condition in the lower subsoil, due either to high water table or some sort of impervious soil or geological layer.

Group No. 2 includes soils with very gently sloping surface or soils which have a relatively high water table resulting in more or less mottled coloration, due to imperfect drainage conditions throughout the profiles.

Group No. 1 includes the flattest soils which are most poorly drained and aerated and most strongly reduced of all soils occupying *convex* land forms. That is to say, although they are frequently saturated, the rainfall has the opportunity to run *off* them rather than accumulate on the surface in more or less permanent ponds.

The soils of group No. 7 lie on land slopes practically as flat as those of group No. 1, but the land surface has a slightly depressed or saucer-shaped form which tended to collect and hold water which ran off higher land and thus kept the soil under more or less ponded conditions during its developmental period. This excess moisture, through stimulation of increased plant growth and preservation of plant residues, has contributed to the presence of a darker colored surface soil and mottled subsoil colors indicative of poor internal drainage. Some of these soils formerly may have been darker but are now leached because of improved natural drainage or greater age.

Group No. 8 includes soils where the conditions in group 7 have been stronger, more continuous, and more recent so that the surface soils are darker and deeper.

Group No. 9 includes soils developed under the highest degree and most permanent condition of ponding so the surface soils are usually quite dark and deep and subsoils are always very strongly reduced to light gray or drab colors. However, this group includes soils which are still dominantly composed of mineral matter rather than organic matter.

Group No. 10 includes soils which have formed under permanently wet conditions, and the accumulation of organic matter has been so great that the content of mineral matter in the soil has become relatively very low. In other words, the parent material of these soils consists of the remains of vegetation instead of being derived chiefly from mineral and geological deposits.

Soils to be found in any column correspond at least in principle with each other. That is to say, that they represent about the same relative degree of modification as judged by aeration, oxidation, and drainage. However, because of the fundamental differences of the nature of the different parent materials, it is impossible to expect exact correspondence in appearance of all the soils within a given column. For instance, most sandstone soils found in column No. 4 are only reddish-yellow in the best oxidized condition, but some limestone soils placed in the same column may become quite reddish. Also the color of a soil developed under a forest cover is seldom as dark in the upper layers as that of practically the same soil developed under a cover of prairie grass; yet, in both cases the relative degree of oxidation may be practically the same and justify placing them in the same column.

The major groups indicated on the left hand side of the diagram may be regarded as corresponding somewhat to the time factor in soil formation. The group indicated by the letters DDD includes those in which the different layers of the soil profiles seem to be the result merely of deposition as in modern stream alluvium, which remains relatively unmodified and is considered very "young" both from a geological and soils standpoint. The group indicated by ABC includes soils which are usually from relatively young geological materials and are always youthful from the standpoint of soil formation. These letters may be interpreted as indicating that there is a more or less leached surface soil (A) with a subsoil (B) showing more or less accumulation of material leached or transported down from the surface and lying almost directly at depths usually of two to four feet upon relatively unmodified geological material (C). This generalization applies to the soils in columns No. 5, 4, 3, 2, and 1 but not to the soils in column No. 6 which might be called AC soils. This means that they have more or less leached and modified surfaces but no layers of accumulation. Instead, they lie almost directly upon the geological material. The generalization also does not apply very well to soils in columns No. 7, 8, 9 and certainly not to those in 10 because in these depressional soils there is relatively little tendency to develop an upper leached layer and a lower zone of accumulation. Instead, there are upper layers (H) darkened by humus and modified mineral subsoil layers (M) lying on some related or unrelated foundation of geological material (U).

The soils in the group indicated under the symbol ABYC are usually from geologically older material than those in the ABC group and are certainly older from the standpoint of soil development. Part of the greater depth of these profiles is taken care of by an extra layer labeled by the symbol Y which stands for the transition between the main subsoil horizon (B) and the unweathered geological material below. This generalization applies to the soils in columns No. 5, 4, 3, 2, and 1 although to some extent it also applies to those in 7, 8, and 9. The evidence of this greater maturity consists of deeper leaching and more thorough weathering of the soil material.

The soils in the group ABXYC correspond to some extent with those in the preceding general groups, but the depth of leaching is nearly doubled and the degree of weathering is much greater. As previously mentioned, the Y symbol stands for transition between the B and the C, but in this general group, especially in the soils of columns No. 1, 2, and 3, there is an especially modified layer which has been called "clay-pan," "hard-pan," "columnar horizon," etc. This is represented by the symbol X and seems to be the most strongly modified layer of the entire profile. There is some evidence of an X layer in the soils of column No. 4, but it is doubtful whether it exists in those of column No. 5, and, of course, it does not exist at all in any soil placed in column No. 6 although it may be closely associated and derived from similar materials of the same geological age as the ABXYC soils. It should also be noted in this connection that in regions where ABXYC soils are found, types belonging in the 7 column are rare and types which could be put in 8, 9, or 10 are practically unknown.

The geological material from which soils are formed is one of the most important factors in soil genesis, but it is very difficult to put into precise language or to interpret accurately. It is customary to refer to groups of soils as sandstone soils, limestone soils, or Wisconsin till soils, etc., but such expressions may or may not actually characterize the soil in any significant fashion. Soils are described and identified on the basis of their own characteristics, and sometimes these do not seem to be very closely related to the rock from which the soil is supposed to have been derived. For instance, limestone soils supposedly derived from limestone consisting of 98% calcium carbonate are found to contain no calcium carbonate. It is also true that, although an Ordovician limestone and a Mississippian limestone may apparently give rise to two different soils, the soil differences may not be due to the facts which differentiated the two different geological formations but rather to the nature of the particular minerals which remain after weathering and are actually present in the soils. The word "till" in the field of soils has little meaning if it is defined as "ice-laid," but it is more significant if interpreted as meaning heterogeneous in particle size and lithological composition. It means little in soils to think of "loess" as something which may have been deposited by the wind, but it means a great deal as a material which is now very uniform in particle size and structure.

After the factors of climate, drainage, aeration, time, and parent materials have had their effects as indicated above, the factor of natural vegetation can bring about differences in soils which would otherwise be the same. The most conspicuous case of this kind is the difference between the prairie and timbered soils. In general, prairie soils are darker colored, but they also are less likely to form clay-pans than in corresponding timbered types.

This table, together with the general characteristics considered in its construction, takes care of practically all the soils to be found in the state of Indiana, allowing, of course, for the fact that there may be types of several different textures belonging to some of the soil series named in figure 1.

There are a few cases where additional factors must be taken into account in characterizing some of the minor soils of this region. For instance, there are some so-called alkali spots where there are concentrations of salts which justify classifying the soil as a different type.

All in all, the statement and table presented above should serve as a very good working basis for checking the most important characteristics of any of our soils and in identifying them as belonging to some particular series or at least as closely resembling that series. For instance, anyone, who finds a soil with a color and slope which could be

SOIL SERIES OF INDIANA

	MAJOR PROFILE		VI	V	IV	III	II	I	VII	VIII	IX	X	
CHARACTERISTICS	% SLOPE		0 5	0-5	0-3	0-1	0-1	0-1	0 1	0-1	0-1	0-1	
	ELEVATION ABOVE WATER TABLE		5' +	5' +	3 5	2-3	1-2	0-1	0' —	— 1'	—2'	— 3' +	
	OVER FLOW	FREQUENCY	SELDOM	SELDOM	OCCASIONAL		FREQUENT	MORE FREQUENT	MORE OR LESS FREQUENTLY PONDED AS WELL AS SUBJECT TO HEADWATER FLOODS				
		DURATION	SHORT	SHORT	SHORT	SHORT	LONGER	LONGER					
		DEPTH	ONE TO TEN FEET OR MORE				DEEPER		DEEPEST				
	COLOR	SURFACE	DARK	LIGHT	BROWN	GRAYISH BROWN	MOTTLED	LIGHT GRAY	GRAY	DARK GRAY	VERY DK. GRAY	BLACK	
		SUBSURFACE	"	"	"	"	"	"	MOTTLED	GRAY	DARK GRAY	"	
		SUBSOIL	LIGHT	"	LIGHT BROWN	MOTTLED	"	MOTTLED		MOTTLED	LIGHT GRAY	DARK BROWN	
D	SWEET LOAMS				GENESEE	EEL					WABASH		
D	FROM LIMESTONE AND OHIO VALLEY				HUNTINGTON	LINSIDE							
D	FROM SANDSTONE AND OLD DRIFT				POPE	PHILO	STENDAL	ATKINS					
CHARACTERISTICS	% SLOPE		15-55+	0-25+	4-15	2-4	1-2	0-1	0-1	0-1	0-1	0-1	
	SURFACE DRAINAGE		EXCESSIVE	SLIGHT TO EXCESSIVE	GOOD	MODERATE	SLOW	VERY SLOW	INTERMIT-TENT	PONDED			
	INTERNAL DRAINAGE		GOOD	EXCESSIVE	GOOD	MODERATE	"	"	VERY SLOW			NONE	
	COLOR	SURFACE	DARK GRAY	BROWN		GRAYISH BROWN	BROWNISH GRAY	LIGHT GRAY	GRAY	DARK GRAY	VERY DK. GRAY	BLACK	
		SUBSURFACE	VARIABLE	LIGHT BROWN	LIGHT BROWN	LIGHT BR. YELLOW	MOTTLED	"	LIGHT GRAY	GRAY	DARK GRAY	"	
		UPPER SUBSOIL	"	REDDISH BROWN	YELLOWISH BROWN	BROWNISH YELLOW	"	"	MOTTLED GR. Y. & BR.		GRAY & LIGHT GR.	"	
		LOWER SUBSOIL	"	DK. REDDISH BROWN	GRAYISH BROWN	MOTTLED GR. & BR.	"	LIGHT MOTTLED	MOTTLED GR. & BR.	MOTTLED Y. GR. & BR.	MOTTLED LI. GR. & BR.	DARK BROWN	
A	HIGH LIME TILL	TIMBERED	HENNEPIN		MIAMI		CROSBY	BETHEL		BROOKSTON	CLYDE	MUCK	
		PRARIE			PARR								
	HIGH SHALE TILL				ST. CLAIR		NAPANEE				PAULDING		
	TILL ON LIMESTONE				MILTON		RANDOLPH			MILLSDALE			
	HIGH LIME GRAVEL	TIMBERED	RODMAN	FOX	MILL CREEK					WESTLAND	ABINGTON		
		PRARIE		WARSAW									
B	LOW LIME GRAVEL			OSHTEMO						BRADY	GILFORD		H
	LOW LIME SAND	OLDER		PLAINFIELD		BERRIEN				NEWTON	MAUMEE	MUCK	
		RECENT	BRIDGEMAN	CALUMET							DEMOTTE		
C	LIMY LOAMS	TIMBERED			LUCAS		HOMER						
		PRARIE			JASPER					RENSSE-LAER	MAUMEE		
	HIGH LIME SILTS AND CLAYS				MARKLAND		MC. GARY		ZIPP	MONTGOMARY	KINGS		
A	HIGH LIME TILL	TIMBERED			RUSSELL								
		PRARIE			CARRINGTON	DANA							
	HIGH SHALE MEDIUM LIME TILL				GALENA		OTIS						
	LOW LIME HIGH SANDSTONE TILL			COLOMA	HILLSDALE								M
B	SHALEY GRAVEL	TIMBERED		TRACY		HANNA							
		TRANSITION		LYDECK		ALIDA	ARDMORE						
		PRARIE		DOOR						WESTLAND	ABINGTON		
Y	HIGH LIME GRAVEL	TIMBERED		DELPHI			HOMER						
		PRARIE		WEA									
C	LOW LIME GRAVEL SANDS AND SILTS			MARTINS-VILLE		WHITTAKER	MAHALAS-VILLE						
	HIGH LIME TILL LOESS				PRINCETON	IONA	AYRSHIRE			RAGSDALE			
	LOW LIME TILL LOESS			PIKE	ALFORD		IVA						U
A	LOESS ON SILTSTONE				HOSMER		COE						
	HIGH LIME SHALEY TILL				CINCINATTI	GIBSON	AVONBURG	CLERMONT	BLANCHES-TER				
	LIMY SAND-STONE AND SHALE TILL	TIMBERED			CINCINATTI	GIBSON	VIGO						
		PRARIE					CORY						
B	TILL ON LIMESTONE				GRAYFORD								
	TILL ON OIL SHALE				JENNINGS	CANA	WHITCOMB						
X	SHALEY LIMESTONE		FAIRMOUNT		SWITZER-LAND	ALLENS	LAWRENCE	GUTHRIE					
	CHERTY LIMESTONE		CORYDON		FREDERICK	BEDFORD	LAWRENCE	GUTHRIE	BURGIN				
Y	PURE LIMESTONE				HAGERS-TOWN								
	SANDSTONE SILTSTONE AND SHALE		MUSKINGUM		ZANESVILLE	TILSIT	JOHNSBURG	LICKDALE					
C	LOW LIME SILTS			BAINBRIDGE	OTWELL	HAUBSTADT	DUBOIS	ROBINSON	HARBISON				
	LOW LIME STREAM SILTS												
	OLD OHIO RIVER SILTS AND LOAMS				WHEELING	SCIOTO-VILLE		GINAT		CHILO			

Fig. 1.

placed in column No. 4, with a well defined leached surface soil, a subsoil with clay accumulation, and with a lower subsoil consisting at a depth of about three feet of a heterogeneous material of different particle sizes and consisting of different minerals, would be justified in saying that this soil is "Miami" or at least "Miami-like."

The names in figure 1 are those of soil "series." A series is something like a genus and may include several "types," differing chiefly in texture of surface soil. A type is regarded as a species.

There is no general agreement as to higher categories in the classification. All of the soil series shown on a single line of the table are grouped as a "catena." Some of the series in any column may be considered a "family." Each complete column includes more or less related soils and the cross table grouping indicated by DDD, ABC, ABYC, and ABXYC each unites soils on a higher basis although no better name than these symbols is now available. Obviously there is still much to be done in perfecting soil classification.