The Makeup of Soils

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SOIL is the thin layer of broken up and decomposing rocks and minerals that cover, or try to cover, the earth's surface. When the rocks are hard and resistant they, of course, break up slowly and dissolve with considerable difficulty. These rocks are the granites, quartzites, and sandstones.

Examples of rocks that break up easily are the shales, slates, and limestones. The shales are especially soft while the limestones also dissolve quite easily.

The term mineral means a definite chemical compound. Rocks are made up of different minerals cemented together by various substances. When we say that rocks break up and decompose it is the same as saying that the chemical compounds within the rocks are reacting and changing. Thus it is that rocks are not strictly inert materials.

The harder rocks produce sandy soils and the softer ones produce soils with an abundance of fine particles, or clay. Sandstones and granites are made out of quite different minerals than are shales and limestones. Shales and limestones have much more plant food in them than do sandstones and granites. During weathering, limestones lose the greater part of the plant food by having it dissolved out. Soils from shales and slates are usually rich in plant food, while soils from sandstones and granites are poor in plant food.

PROPERTIES OF SAND AND CLAY

SAND and clay may be compared as follows:

SAND

Desirable properties. Gritty, does not stick, warms quickly.

Undesirable properties. Holds too little water and plant food.

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Only once in a blue moon does a man pop into the picture who actually knows his "stuff." Professor Cubbon does and the NATIONAL GREENKEEPER *is proud to print his knowledge exclusively.*

CLAY

Desirable properties. Holds abundance of water and plant food.

Undesirable properties. Sticky, inclined to bake and pack, warms and drains slowly.

Organic matter added to sand or clay helps to improve physical condition, increases the amount of soluble plant food, and in the case of sandy soils aids in the holding of water. It causes all soils to be more active, and is generally so beneficial that the amount of organic matter in soil is thought to be a good measure of soil fertility.

The average soil contains about 5% organic matter by weight, the rest being minerals. Mineral soils as a group, contain less than 20% organic matter. When the organic matter is above 20% the soil is said to be organic. The two most common examples of organic soil are peat and muck. Peat and muck usually form under water and for that reason do not decompose rapidly. In fact, the organic matter in peat and muck decomposes with some difficulty.

Peat is usually brown in color, and only moderately decomposed. Pieces of the original plant tissue can be identified in peat. Muck is nearly always black in color and has been much more decomposed than peat.

Both peat and muck have nitrogen, but insufficient phosphorus and potash. The nitrogen is slowly available, however. In order to make organic soils produce properly it is advisable to make generous additions of phosphorus, potash, and lime, plus some material such as manure to aid in the decomposition of the peat or muck.

SOIL CAN BE TESTED WITH THE FINGERS

A MECHANICAL analysis of a mineral soil determines the amounts of sand and clay making up that soil. The procedure of such an analysis is long and not too satisfactory, and usually by testing soil between the fingers a person can tell near enough for practical purposes the proportion of sand and clay. Clay sticks to the fingers whether wet or dry and gives a soft floury feel. Sand need never be mistaken because of its grittiness.

Most soil classifications make use of the term silt. Silt must be regarded as coarse clay since it has the general properties of clay. Having decided how much sand and clay are present in your soil, you can form a fairly definite opinion as to the physical condition, water and nutrient holding capacity of the soil. The finer the soil the more plant food is held by absorption. Many fine soils (clays) are so poorly drained that plants cannot grow on them to make use of the plant food contained.

The word loam in its strictest sense means a soil having about equal properties of sand and clay. Because of its greater influence clay makes up a relatively small per cent of the total soil weight, compared to sand. Following is an outline of the various soils named by the United States Bureau of Soils with the percentages of sand, silt, and clay indicated:

1. SOILS CONTAINING LESS THAN 20% CLAY.

Soils Containing Less Than 15% Silt and Clay:

Sand:

Coarse sand (35% or more fine gravel and coarse sand and less than 50% fine or very fine sand).

Sand (35% or more fine gravel, coarse and medium sands, and less than 50% fine or very fine sand).

Fine sand (50% or more fine and very fine sands).

Very fine sand (50% or more very fine sand).

Soils Containing from 15 to 20% Silt and Clay:

Loamy Sand:

Loamy coarse sand (35% or more fine gravel and coarse sand, and less than 35% fine and very fine sand).

Loamy sand (35% or more fine gravel, coarse and medium sands, and less than 35% fine and very fine sand.

Loamy fine sand (35% or more fine and very fine sand).

Loamy very fine sand (35% or more very fine sand).

Soils Containing from 20 to 50% Silt and Clay:

Sandy loam:

Coarse sandy loam (45% or more fine gravel and coarse sand).

Sandy loam (25% or more fine gravel, coarse and medium sands, and less than 35% very fine sand).

Fine sand loam (50% or more fine sand, or less than 25% fine gravel, coarse and medium sand).

Very fine sandy loam (35% or more very fine sand).

Soils Containing 50% or More Silt and Clay:

Loam and silt loam:

Loam (less than 20% clay, from 30 to 50% silt, and from 30 to 50% sand).

Silt loam (less than 20% clay, 50% or more silt, and less than 50% sand).

2. SOILS CONTAINING FROM 20 TO 30% CLAY:

Clay loam:

Sandy clay loam (less than 30% silt, and from 50 to 80% sand).

Clay loam (from 20 to 50% silt, and from 20 to 50% sand).

Silty clay loam (from 50 to 80% silt, and less than 30% sand).

3. SOILS CONTAINING 30% OR MORE CLAY:

Clay:

Sandy clay (from 30 to 50% clay, less than 20% silt, and 50 to 70% sand).

Clay (30% or more clay, less than 50% silt, and less than 50% sand).

Silty clay (from 30 to 50% clay, from 50 to 70% silt, and less than 20% sand).

Soils are named by the United States Bureau of Soils according to the amounts of sand and clay, the rock or rocks from which the soil was produced, and the kind ofweathering processes that made soil out of the rocks.

The first point has already been discussed. The second is not so important from a soil-productivity point of view, but for classification purposes it is most necessary. There are red, white, brown sandstones and naturally each color will produce a distinct kind of soil. Also there are soft and hard shales and slates, and blue and gray and black shales and slates, thus giving soils that are of various colors and characteristics.

WEATHERING CHANGES SOIL CONDITION

THE third point in classification is based on the kind of weathering that the soil has undergone. Weathering means the sum total of natural forces that have acted upon rocks and minerals; the breaking up of rocks, the carrying away of fine particles, and the removal of all soluble material. The fine particles and soluble material are dumped somewhere else, either along streams or in bodies of water. Frost action breaks apart rocks and soil particles by the expansion of water to make ice, and so makes fine paricles that are carried in running water. All streams are muddy during the time frost in leaving the ground in spring, simply because the ice has separated the different particles and left them free to wash away.

Where does this material go? Some of it is dropped along the stream where the current of water is not swift. Some is dropped in the edge of whatever body of water the stream empties into. All of this material represents the richest part of the soil toward the headwaters of the stream. Weathering therefore takes away valuable plant food from soils located in the uplands and puts it either in the ocean, in a lake, or along the stream in its lower parts. These latter are called flood plains, and generally flood plain soils are the most fertile we have. Surely they are more fertile than the upland soil from which they were stolen.

RESIDUAL SOIL IS GENERALLY POOR

THE upland soils are mostly called residual, meaning what is left behind. Since the best part of the soils are washed down the streams, residual soils are generally among the poorest we have. The soil classification is based on these differences in soil fertility and on the kind of weathering.

A residual soil on a hillside looks and behaves quite differently from a flood plain soil in the valley below it, therefore a different name must be given to each. With many different kinds of rocks the number of names that are necessary to describe all of the many distinct soil types in the United States can be easily imagined. These names are so numerous as to be burdensome. It seems best to disregard the type names of soils and to consider soils from the point of view only of proportion of sand, clay, and organic matter.

In the northeastern and northern sections of the U. S. the soils were at one time covered with a sheet of ice. This sheet of ice moved forward (southward) from a center located in southern Canada where snow accumulated in large quantities. The ice was several thousand feet thick. When the weather became warmer, or when less snow fell, the ice sheet melted back toward the north. Thus a distinct north and south movement of ice took place, slowly, of course.

The total effect of all this movement was to mix and grind the soil or rocks underneath. If the material happened to be soft then the ice had easy grinding and produced fine soils. When the rocks (soils) were hard, such as sandstone, grinding had little effect. Such soils are coarse and thin.

The fine soils (soft rocks) when crushed by a thick sheet of ice were packed so much that they usually have hardpans and drain very poorly. Little packing was done to sandy soils because such soils contain too few soft particles.

GLACIAL SOIL HAS HIGH FERTILITY

THE grinding process did one other thing of importance. Newly pulverized rocks and minerals contain an abundance of plant food elements on the surfaces of the particles. Weathering gradually dissolves these elements and removes them from the soil. Therefore a fresh glacial (ice-produced) soil has higher fertility than a soil which has been exposed to weathering for a long time.

The glacial soils of northeastern U. S. are only a few thousand years old. Compare these with the residual soils of more southerly regions that are one or two million years old. Remember, however, that rocks which crushed most easily by the ice also produced the worst hardpan, and that these hardpan soils are often physically unfit to produce satisfactory plant growth.

All weathering processes in areas of average rainfall simply result in a dissolving out of plant food. Fortunately this solution process is very slow, otherwise all plant food would have been removed long ago. The continued removal of plant food (mostly bases) has caused soils that have come from limestone to be acid and actually in need of lime.

THINK THIS ONE OVER

In most limestone soils the impurity actually makes the soil since the lime carbonate dissolves out easily. If a certain limestone contains 1% impurity, then a hundred feet of the stone would produce just one foot of soil, everything but the impurity being washed away.

In determining the approximate condition of a soil the depth, texture, and color of surface and subsoil should be considered. The older the soil becomes the more yellow it is. This is due to natural weathering. Red soils become yellow in time but yellow soils are usually infertile. If drainage is not good in a soil, a bluish gray color, especially in the subsoil, is a tell-tale. The blue color indicates lack of oxidation caused by the soil being full of water the greater part of the year.

An idea of the importance of the various soil properties can be had from the following score card which is used by one of the middle western states for judging farm lands:

Texture (fine, medium, or coarse)	10 points
Character of subsoil (fine, medium, or coarse texture, loose or compact)	10 points
Depth of surface soil	15 points
Topography (as influencing erosion drainage, and ease of handling)	15 points
Color of soil (black, brown, red, gray, as indicating productivity)	15 points
Nature of wild and crop growth (as indicating productivity)	10 points
Test for acidity (the score of acid soils should be reduced according to the degree of acidity)	10 points
Present stage of fertility as influenced by past management (as shown by the land itself and by its history)	15 points

ACTUAL SIZES OF PARTICLES

The U. S. Bureau of Soils recognizes seven groups of particles as making up the main part of soil. The grouping is on the basis of size of particle, as can be seen from the following comparison:

NAME OF GROUP	DIAMETER OF PARTICLE
Fine gravel	1/12 to 1/25 inch
Coarse sand	1/25 to 1/50 inch
Medium sand	1/50 to 1/100 inch
Fine sand	1/100 to 1/250 inch
Very fine sand	1/250 to 1/500 inch
Silt	1/500 to 1/5000 inch
Clay	1/5000 inch and smaller

Any particles larger than 1/12 inch diameter are considered to have no influence on soil fertility, and are quite likely to be a nuisance in the handling of soil.

The ideal soil is one that can be worked when fairly wet and that will not resist breaking up when dry. The loam soil comes as near to this ideal as any because of the small amount of clay and the relatively large percent of sand.

The best test of soil makeup and condition is to make a mud pie, allow it to dry, and then see how easily the pie breaks up. To be most satisfactory it should break under moderate pressure in the hands. If a hammer is needed to pulverize the mass, better discard the entire lot.

If greens are made out of clay soil and attempts are made to add sand to improve the condition, remember that about two parts sand are required for each part clay to produce a true loamy condition. That is the reason why clay soils are given up so easily. Too much sand is needed to complete the job of loosening the clay. The reverse situation is not so bad because clay is twice as effective as sand in changing the physical condition of the soil.

The adding of organic matter to soils to improve soil condition is discussed under that topic in a later article. As with sand and clay, however, it is difficult to get the proper amount worked into the soil.

Important Review Topics

Physical importance of sand and clay.

Color and depth of soil.

General fertility of the soil (influence of fine particles on amount of plant food and water held).

General fertility as influenced by weathering (residual, flood plain, glacial, etc., soils).

Development of hardpan in glacial soils.

Loss of plant food, mostly bases, from soil in humid sections of country.