Soil Structure

Soil Structure Hand-Out

Objectives:

Upon completion of this section:

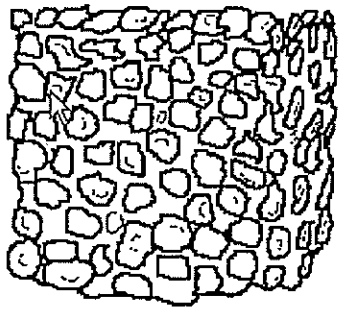
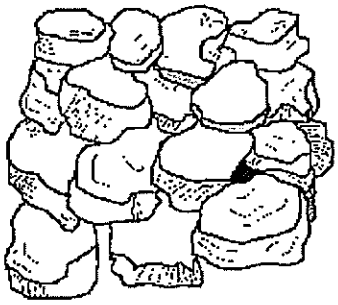
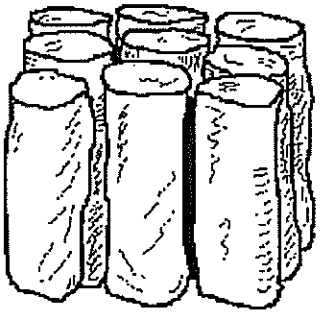
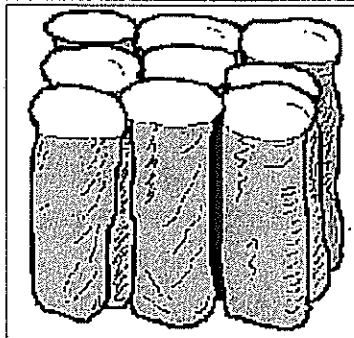
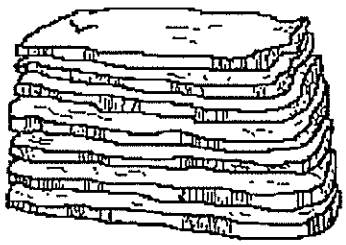
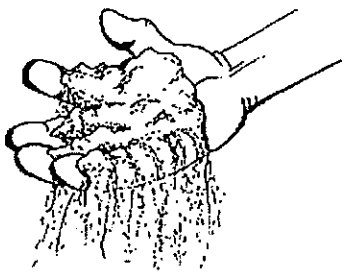
You will be able to identify types of soil structure

You will be able to Interpret Soil Structure in Context with Soil Permeability

Soil Structure is the aggregation of Soil Particles into a larger grouping of aggregates (peds) that result from pedogenic processes. *"How They Stick Together"*

There is inherent structure in many everyday things we see.

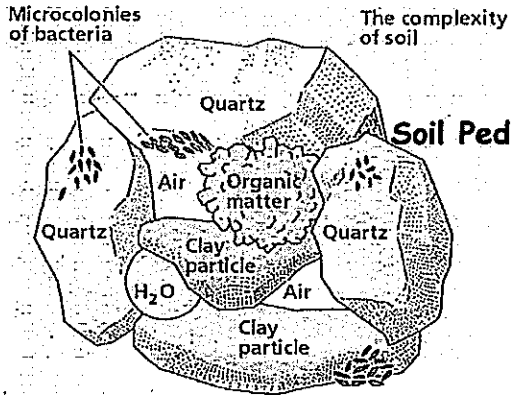
Humans like to classify things. But in this case, the classification is a reflection of expected water movement properties of soil. This can be useful during drainfield design.

		
Granular: Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.	***(Angular and Subangular)*** **Blocky**: Irregular blocks that are usually 1.5 - 5.0 cm in diameter.	**Prismatic**: Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.
		
Columnar: Vertical columns of soil that have a salt "cap" at the top. Found in soils of arid climates. ***We will not review this one***	**Platy**: Thin, flat plates of soil that lie horizontally. Usually found in compacted soil.	**Single Grained**: Soil is broken into individual particles that do not stick together. Always accompanies a loose consistence. Commonly found in sandy soils.

Soils are no different. There are structural patterns that repeat at regular intervals. These patterns reflect soil properties that ultimately relate to water movement in the soil. We can see and describe these properties, which enable more accurate permeability estimates.

Structure is important because it affects water movement through the soil.

Soil structure determination is difficult and subjective. You cannot accurately identify soil structure with an auger.



A soil ped is a natural unit of soil structure composed of many different materials. A ped is in contrast with a clod which is formed artificially.

Peds are the natural units of soil that will fall out into your hand when you pick up a chunk of soil.

Single Grain Structure is usually associated with Textural Group I soils such as sand and loamy sand.

Granular Structure is usually associated with surface horizons such as A and A_p horizons.

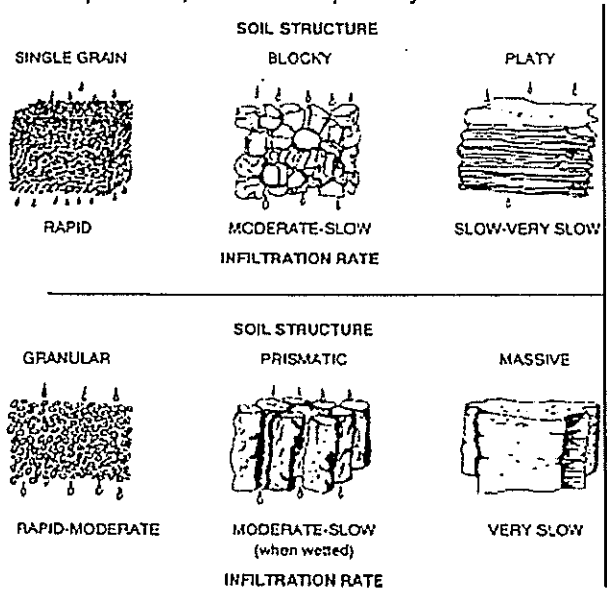
Subangular and Angular Blocky Structure is usually associated with the B_t or other subsoil horizons.

Platy Structure is usually associated with E, B_t, B_{tx}, & B_x horizons. *Restrictive*

Prismatic Structure is usually associated with the B_t and other horizons. *Restrictive*

Massive Structure is usually associated with the C horizon. *May be Restrictive*

It implies a lack of structure. There are no interconnected pores that will transmit water or air.
It is less than a desirable structure for wastewater disposal and treatment. Often used for drainfields due to coarse particles, which have porosity.



SOIL STRUCTURE

Soil structure refers to units composed of primary particles. The cohesion within these units is greater than the adhesion among units. As a consequence, under stress, the soil mass tends to rupture along predetermined planes or zones. These, in turn, bound the structure unit. Compositional differences of the fabric matrix appear to exert weak or no control over where the bounding surfaces occur. If compositional differences control the bounding surfaces of the body, then the term "concentration" is employed. The term Structural Unit is used for any repetitive soil body that is commonly bounded by planes or zones of weakness that are not an apparent consequence of compositional differences. A structural unit that is the consequence of soil development is called a ped. The surfaces of peds persist through cycles of wetting and drying in place. Commonly, the surface of the ped and its interior differ as to composition or organization, or both, because of soil development. Earthy clods and fragments stand in contrast to peds, for which soil forming processes exert weak or no control on the boundaries. At least adjacent to the surface of the body, clods exhibit some rearrangement of primary particles to a denser configuration through mechanical means. The same terms and criteria used to describe structured soils should be used to describe the shape, grade, and size of clods. Structure is not inferred by using the terms interchangeably. A size sufficient to affect tilth adversely must be considered. The distinction between clods and fragments rests on the degree of consolidation by mechanical means. Soil fragments include (1) units of undisturbed soil with bounding planes of weakness that are formed on drying without application of external force and which do not appear to have predetermined bounding planes, (2) units of soil disturbed by mechanical means but without significant rearrangement to a denser configuration, and (3) pieces of soil bounded by planes of weakness caused by pressure exerted during examination with size and shape highly dependent on the manner of manipulation.

Some soils lack structure and are referred to as Structureless. In structureless layers, no units are observable in place or after the soil has been gently disturbed, such as by tapping a spade containing a slice of soil against a hard surface or dropping a large fragment on the ground. When structureless soils are ruptured, soil fragments, single grains or both, result. Structureless soil material may be either single grain or massive. Soil material of single grains lack structure. In addition, it is very friable, soft or loose. On rupture, more than 50 percent of the mass consists of discrete mineral particles. Massive soil material also lacks structure but differs from single grain in that upon rupture it does not break along any predictable boundary and may result in soil fragments or soil fragments and single grains.

Some soils have simple structure, each unit being an entity without component smaller units. Others have compound structure, in which large units are composed of smaller units separated by persistent planes of weakness.

In soils that have structure, the shape, size, and grade (distinctness) of the units are described--in that order. Field terminology for soil structure consists of separate sets of terms designating each of the three properties, which by combination form the names for structure.

Shape

Several basic shapes of structural units are recognized in soils. Supplemental statements about the variations in shape of individual peds are needed in detailed descriptions of some soils. The following terms describe the basic shapes and related arrangements:

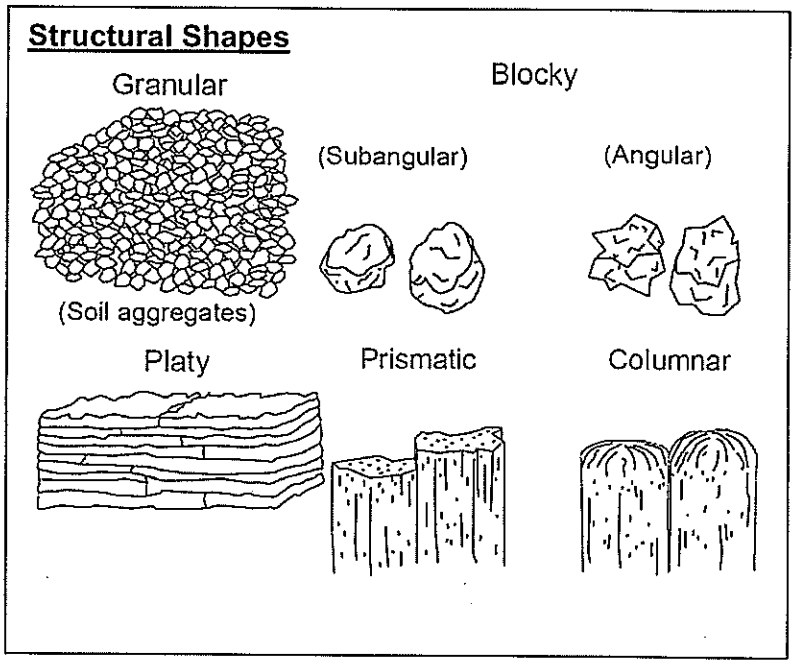
platy: The units are flat and plate-like. They are generally oriented horizontally and are usually overlapping. Platy structure is illustrated in figure of Structure shapes. A special form, lenticular platy structure, is recognized for plates that are thickest in the middle and thin toward the edges.

prismatic: The individual units are bounded by flat or slightly rounded vertical faces. Units are distinctly longer vertically, and the faces are typically casts or molds of adjoining units. Vertices are angular or subrounded; the tops of the prisms are somewhat indistinct and normally flat. Prismatic structure is illustrated in figure of Structure shapes.

columnar: The units are similar to prisms and are bounded by flat or slightly rounded vertical faces. The tops of columns, in contrast to those of prisms, are very distinct and normally rounded, as illustrated in figure of Structure shapes.

blocky: The units are block-like or polyhedral. They are bounded by flat or slightly rounded surfaces that are casts of the faces of surrounding peds. Blocky structural units are nearly equidimensional but grade to prisms and to plates. The structure is described as angular blocky if the faces intersect at relatively sharp angles; as subangular blocky if the faces are a mixture of rounded and plane faces and the angles are mostly rounded. Angular blocky units are illustrated in figure of Structure shapes.

granular: The units are approximately spherical or polyhedral and are bounded by curved or very irregular faces that are not casts of adjoining peds. Granular units are illustrated in figure of Structure shapes.



Size

Five classes are employed: very fine, fine, medium, coarse, and very coarse. The size limits of the classes differ according to the shape of the units. The size limit classes are given in table 3-13. The size limits refer to the smallest dimension of plates, prisms, and columns. If the units are more than twice the minimum size of "very coarse" the actual size is given: "prisms 30 to 40 cm across."

Table 3-13. Size classes of soil structure

Shape and size of structure**

Class*	Platy	Prismatic & Columnar	Blocky	Granular
Very fine	<1	<10	<5	<1
Fine	1 to 2	10 to 20	5 to 10	1 to 2
Medium	2 to 5	20 to 50	10 to 20	2 to 5
Coarse	5 to 10	50 to 100	20 to 50	5 to 10
Very coarse	>10	>I00	>50	>10

*In describing plates, "thin" is used instead of "fine" and "thick" instead of "coarse".
**Sizes are in mm.

Grade

Grade describes the distinctness of units. Criteria are the ease of separation into discrete units and the proportion of units that hold together when the soil is handled. Three classes are used:

weak: The units are barely observable in place. When gently disturbed, the soil material parts into a mixture of whole and broken units and much material that exhibits no planes of weakness. Faces that indicate persistence through wet-dry-wet cycles are evident if the soil is handled carefully. Distinguishing structurelessness from weak structure is sometimes difficult. Weakly expressed structural units in virtually all soil materials have surfaces that differ in some way from the interiors.

moderate: The units are well formed and evident in undisturbed soil. When disturbed, the soil material parts into a mixture of many whole units, some broken units, and material that is not in units. If peds are

present, they part from adjoining peds to reveal nearly entire faces that have properties distinct from those of fractured surfaces.

strong: The units are distinct in undisturbed soil. They separate cleanly when the soil is disturbed. When removed, the soil material separates mainly into whole units. If peds are present, they have distinctive surface properties.

The distinctness of individual structural units and the relationship of cohesion within units to adhesion between units determine grade of structure. Cohesion alone is not specified. For example, individual structural units in a sandy loam A horizon may have strong structure, yet they may be less durable than individual units in a silty clay loam B horizon of weak structure. The degree of disturbance required to determine structure grade depends largely on moisture content and percentage and kind of clay. Only slight disturbance may be necessary to separate the units of a moist sandy loam having strong granular structure, while considerable disturbance may be required to separate units of a moist clay loam having strong blocky structure.

The three terms for soil structure are combined in the order (1) grade, (2) size, (3) shape. "Strong fine granular structure" is used to describe a soil that separates almost entirely into discrete units that are loosely packed, roughly spherical, and mostly between 1 and 2 mm in diameter.

The designation of structure by grade, size, and shape can be modified with other appropriate terms when necessary to describe other characteristics. Surface characteristics of units are described separately. Special structural units, such as the wedge-shaped units of Vertisols, are described in appropriate terms.

Compound structure

Smaller structural units may be held together to form larger units. Grade, size, and shape are given for both and the relationship of one set to the other is indicated: "strong medium blocks within moderate coarse prism", or "moderate coarse prismatic structure parting to strong medium blocky."

SOIL CONSISTENCE

Soil Consistence (Soil Survey Manual, 1951)

Consistence of the soil according the Soil Survey Staff (1951) is necessary in order to understand soil pedon descriptions written in the past.

Soil consistence comprises the attributes of soil material that are expressed by the degree and kind of cohesion and adhesion or by the resistance to deformation or rupture. Every soil material has consistence irrespective of whether the mass be large or small, in a natural condition or greatly disturbed, aggregated or structureless, moist or dry. Although consistence and structure are interrelated, structure deals with the shape, size, and definition of natural aggregates that result from variations in the forces of attraction within a soil mass, whereas consistence deals with the strength and nature of such forces themselves.

The terminology for consistence includes separate terms for description at three standard moisture contents (dry, moist, and wet). If moisture conditions are not stated in using any consistence term, the moisture condition is that under which the particular term is defined. Thus friable used without statement of the moisture content specifies friable when moist; likewise, hard used alone means hard when dry, and plastic means plastic when wet. If a term is used to describe consistence at some moisture content other than the standard condition under which the term is defined, a statement of the moisture condition is essential. Usually it is unnecessary to describe consistence at all three standard moisture conditions. The consistence when moist is commonly the most significant, and a soil description with this omitted can hardly be regarded as complete; the consistence when dry is generally useful but may be irrelevant in descriptions of soil materials that are never dry; and the consistence when wet is unessential in the description of many soils but extremely important in some.