## Lesson 5: Soil Structure

Two soils with the same texture may have distinctly different physical properties because of the arrangement of soil particles. The arrangement of individual soil particles into different size units or peds is called **soil structure**. Topsoil structure is the most observable and is easier to amend or destroy than the subsoil structure.

## What is Soil Structure?

Weathering converts parent material into soil. Shrinking and swelling (caused by wetting and drying, freezing and thawing) and root penetration cause shifting, loosening, and forming of pore space. Microbes, plants, and animals produce cementing agents that bind and stabilize the soil into units. This is a never-ending process, unless interfered with by cultivation. As a result, soil structure becomes stronger and more distinct with time.

Soil structure forms when individual grains of sand, silt, and clay are bound together physically and/or chemically. Plant roots, organic matter, and cay particles all provide physical and chemical binding agents. These bound particles form larger units called **peds**. A ped is a single unit of soil structure. A ped ranges in size from about 1 mm to 10 cm. The shape of the peds formed determines the type of structure: granular, platy, blocky, or prismatic. See Figure 5.1.

## Importance of Soil Structure

Soil structure is important because it modifies some of the desirable and undesirable effects of texture on soil behavior. Structure creates relatively large pores, which favor water entry into and movement within the soil. Even clayey soils, which tend to have tiny pores, can have good rates of water infiltration if they have a well-developed A horizon structure. Good soil structure also means good aeration and a favorable balance between pores that contain air and pores that store water for plant use. Soils with good structure are easy to till and provide ideal environments for plant root growth. In short, good structure means better tilth in the topsoil.

Soil structure can be destroyed by over-tilling or tilling when the soil is wet. Over-tilling destroys the soil structure because aggregates are crushed. Tilling when the soil is wet compacts the soil and causes it to puddle, or run together. The pore spaces collapse and the soil structure is destroyed. Structure can also be destroyed when organic matter is reduced through burning or removing residues.

In poor soil structures, the pore space is reduced. Infiltration rates and aeration are adversely affected, making it difficult for plants to grow.

## Formation of Soil Structure

Organic matter is vital to the formation and maintenance of good soil structure. Organic matter tends to aggregate (clump) tiny soil particles, especially clay, into small clumps that have definite shapes. Some topsoils of northern Missouri are naturally high in organic matter. The structure in these areas tends to be well developed, and the soil resists breakdown from tillage and raindrop impact. Many southern Missouri topsoils are naturally low in organic matter. The soil structure tends to be weakly formed and unstable. These soils have a higher erosion hazard.

Maintaining the organic-matter content is essential to sustain good soil structure. Mixing animal wastes and crop residues into the soil is an excellent way to do this. One of the real benefits of conservation tillage programs is the use of crop residues to form stable soil structures.

## Types of Soil Structure

Common types of soil structure include granular, platy, blocky, and prismatic. Soils that do not have peds are said to be either **massive** or **single grain**. "Massive" and "single grain" do not refer to structure; they are terms used if the soil is structureless. Each of the common structure types is illustrated and described in Figure 5.1.

### *Compound Structure*

Some soil horizons have large structural aggregates that can be further subdivided into smaller aggregates of a different shape. Examples are blocks that break into

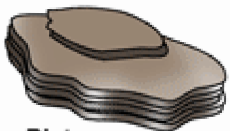
Figure 5.1 – Types of Soil Structure

## STRUCTURED

Granular

### GRANULAR

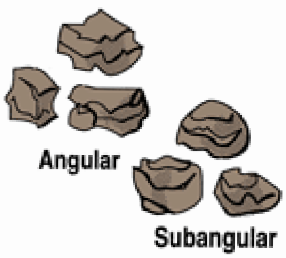
Granular structure is roughly spherical, like Grape Nuts™ cereal. The structure is usually 1–10 mm in diameter. It is most common in surface horizons (A horizons) where plant roots, microorganisms, and sticky products of organic matter decomposition bind soil grains into aggregates.



Platy

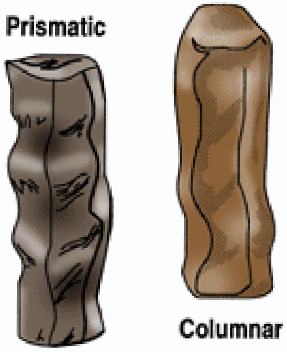
### PLATY

Platy structure consists of flat peds that lie horizontally in the soil. Most are less than 2 cm thick. Platy structure is not common, but occurs mostly in subsurface horizons or dense layers (E and Bx horizons).




### BLOCKY

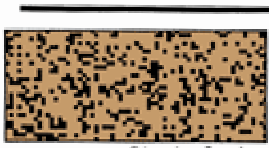
Blocky structure consists of peds that are roughly cube-shaped with generally flat surfaces. Blocky structures are divided into two types: **angular blocky** structure has edges and corners that remain sharp, whereas **subangular blocky** structure has edges and corners that are rounded. Sizes commonly range from 5 to 50 mm across. Blocky structures are typical in the subsoil (B and Bt horizons). They form by repeated expansion and contraction of clay materials.




### PRISMATIC

In prismatic structure, peds are taller than they are wide. They often have five sides. Sizes are commonly 10–100 mm across. Prismatic structure is most common in the lower part of the subsoil (B and BC horizons). The prisms in some strongly developed soils have rounded tops because the tops have lost their corners by eluviation (downward movement of material). These prisms are called **columnar.**

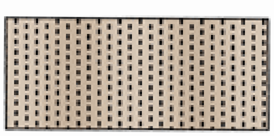
## STRUCTURELESS



Single Grain

### SINGLE GRAIN

In some very sandy soils, every grain acts independently and there is no binding agent to hold the grains together into peds. Permeability is rapid, but fertility and available water capacity are low.



Massive

### MASSIVE

Compact, coherent soil is not separated into peds of any kind. Massive, claylike soils usually have very small pores, slow permeability, and poor aeration.

**Note:** There are some terms that may be unfamiliar at this time. If more information on horizons is needed, see Lesson 6.

plates and prisms that break into blocks. Technical soil descriptions would include both situations.

## Grades of Soil Structure

The grade of soil structure refers to the strength and stability of structural peds. Structural grade is described using the terms **strong**, **moderate**, and **weak**.

Strong structures are stable structures. They provide favorable air-water relations and good soil tilth. Weak structures are unstable. Their surface soil readily slakes (breaks down) and seals (forms a crust) when irrigated or tilled. Weak structures slow down water movement into and within the soil and increase the erosion hazard. See Figure 5.2.

Figure 5.2 – Grades of Soil Structure

**Strong:** The units (peds) are distinct in undisturbed soil. They separate cleanly into whole units when the soil is disturbed. See Plate 6, p. 50-B.

**Moderate:** The units (peds) are well formed and evident in undisturbed soil. They part into a mixture of whole peds and broken units when the soil material is disturbed.

**Weak:** The units (peds) are barely observable in place. Most become broken when the soil material is undisturbed.

Two aspects of structural development work together to indicate the grade:

1. How well the entire soil mass is subdivided into distinct peds.

2. How well the grains in individual peds are held together to resist breakdown and give the peds stability.

## Determining Type and Grade of Soil Structure

The grade and type of soil structure can be determined by carefully observing the soil and by gently breaking it apart.

1. The first step is to study a large aggregate of soil to see if structural peds are evident. If you can detect the shapes of individual peds, then the grade is probably strong.

2. The next step is to fill your hand with a large aggregate of soil. Observe how easily the soil aggregate breaks out into your hand. The easier it breaks out, the stronger the structure. Observe also the shapes of the peds that lie in your hand.

3. Then, hold a large piece of the soil in both hands and gently apply pressure to break the soil apart. If the soil breaks easily along a natural plane of weakness, it has separate into distinct peds. If the soil fractures randomly, leaving an irregular, dull surface, a break has forced through a ped.

4. The ease with which the soil mass breaks into peds and the amount of unaggregated soil that remains indicates the structural grade. The shapes of the peds broken out of the soil indicate the structural type.

## Improving Soil Structure

Although soil structure becomes stronger and more distinct with time, it is not easy to improve and it usually takes several years if the structure is really weak. The most effective methods for improving soil structure in the surface layer are good residue management and use of minimum tillage, or no-till, with crop rotations that include pasture and hay crops. Deep-rooted legumes (such as alfalfa) are effective, as are barnyard manure and green manure crops (plowed under grasses or legumes).

## Summary

The original parent material is structureless, either massive or single grain. Weathering converts parent material into soil. Soil structure forms when individual grains of sand, silt, and clay are bound together physically and/or chemically. The arrangement of individual soil particles into different size units, or peds, is called soil structure.

A ped is a single unit of soil structure. A ped ranges in size from about 1 mm to 10 cm depending on the shape: granular, platy, blocky, or prismatic. The shape of the peds formed determines the type of structure. The grade of soil structure refers to the strength and stability of structural peds. Structural grades are strong, moderate, or weak.

Soil structure is important because it modifies some of the desirable and undesirable effects of texture on soil behavior. Structure is related to water infiltration, aeration, soil tilth, and the environment for plant root growth. The type and grade of soil structure can be determined by observing the soil and gently breaking it apart. Soil structure can be improved by increasing organic matter content, using minimum tillage or no-till, and good residue management. Soil structure is broken down by over-tilling or tilling when the soil is wet.

## Credits

Huddleston, J. Herbert, and Gerald F. Kling. *Manual for Judging Oregon Soils*. Corvallis: Oregon State University Extension Service, 1984.

Soil Survey Division Staff. *Soil Survey Manual, Handbook #18,* rev. Washington, DC: U.S. Government Printing Office, U.S. Department of Agriculture, Soil Conservation Service, 1993.