

Soils Overview

Provided by the Soil Science Society of America

WHAT IS SOIL? Soils are complex mixtures of minerals, water, air, organic matter (the decaying remains of once-living things), and countless organisms. It forms at the surface of land—it is the “skin of the earth.” Soil is capable of supporting plant life and is vital to life on earth. There are more organisms in a handful of soil (some say tablespoon, but that is for moist climates) than there are people on the planet. These organisms primarily decompose plant and animal residues, but are responsible for many other processes, as well, especially in making nutrients available for plants to use.

Soil, as formally defined in the *Soil Science Society of America Glossary of Soil Science Terms*, is:

- 1 The unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.
- 2 The unconsolidated mineral or organic matter on the surface of the earth that has been subjected to and shows effects of genetic and environmental factors of: climate (including water and temperature effects), and macro- and microorganisms, conditioned by relief, acting on parent material over a period of time.

So then, what is dirt? Dirt is what gets on our clothes or under our fingernails. It is soil that is out of place in our world—whether tracked inside by shoes or on our clothes. Dirt is also soil that has lost the characteristics that give it the ability to support life—it is “dead.”

Soil performs many critical functions in almost any ecosystem (whether a farm, forest, prairie, marsh, or suburban watershed). There are seven general roles that soils play:

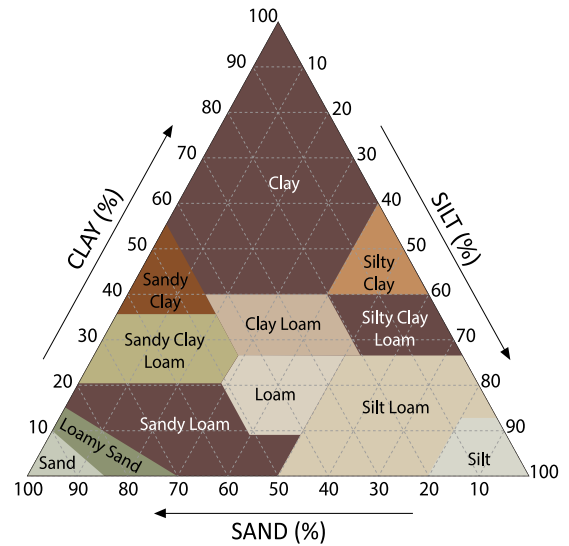
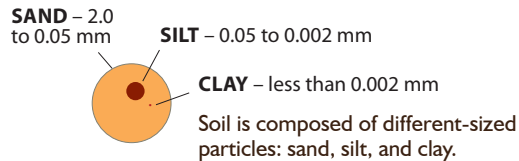
- 1 Soils serve as media for growth of all kinds of plants.
- 2 Soils modify the atmosphere by emitting and absorbing gases (carbon dioxide, methane, water vapor, and the like) and dust.
- 3 Soils provide habitat for animals that live in the soil (such as groundhogs and mice) to organisms (such as bacteria and fungi), that account for most of the living things on Earth.
- 4 Soils absorb, hold, release, alter, and purify most of the water in terrestrial systems.
- 5 Soils process recycled nutrients, including carbon, so that living things can use them over and over again.
- 6 Soils serve as engineering media for construction of foundations, roadbeds, dams and buildings, and preserve or destroy artifacts of human endeavors.
- 7 Soils act as a living filter to clean water before it moves into an aquifer.

What is Soil?

There are many soil properties that help us describe and manage soils. Some of the important physical properties are described below.

Soil Texture

The particles that make up soil are categorized into three groups by size – sand, silt, and clay. Sand particles are the largest and clay particles the smallest. Most soils are a combination of the three. The relative percentages of sand, silt, and clay are what give soil its texture. A clay loam texture soil, for example, has nearly equal parts of sand, silt, and clay.



A soil texture triangle helps identify the soil type.

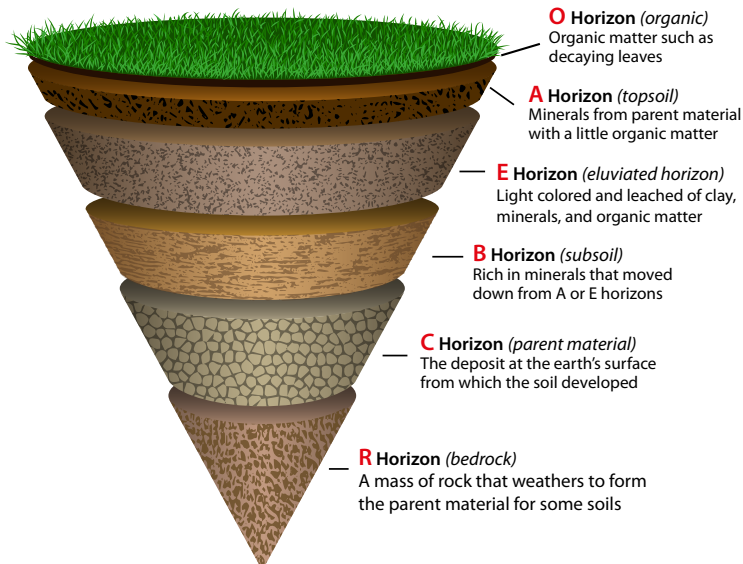
There are 12 soil textural classes represented on the soil texture triangle on the right. This triangle is used so that terms like “clay” or “loam” always have the same meaning. Each texture corresponds to specific percentages of sand, silt, or clay. Knowing the texture helps us manage the soil.

Soil Structure

Soil structure is the arrangement of soil particles into small clumps, called pedes or aggregates. Soil particles (sand, silt, clay and even organic matter) bind together to form pedes. Depending on the composition and on the conditions in which the pedes formed (getting wet and drying out, or freezing and thawing, foot traffic, farming, etc.), the ped has a specific shape. They could be granular (like gardening soil), blocky, columnar, platy, massive (like modeling clay) or single-grained (like beach sand). Structure correlates to the pore space in the soil which influences root growth and air and water movement.

Soil Color

Soil color is influenced primarily by soil mineralogy—telling us what is in a specific soil. Soils high in iron are deep orange-brown to yellowish-brown. Those soils that are high in organic matter are dark brown or black. Color can also tell us how a soil “behaves”—a soil that drains well is brightly colored and one that is often wet and soggy will have a mottled pattern of grays, reds, and yellows.



Soil Profile

There are different types of soil, each with its own set of characteristics. Dig down deep into any soil, and you’ll see that it is made of layers, or horizons (O, A, E, B, C, R). Put the horizons together, and they form a soil profile. Like a biography, each profile tells a story about the life of a soil. Most soils have three major horizons (A, B, C) and some have an organic horizon (O).

How does soil become soil?

There are many different soils in the world. All soils are different because of where and how they formed. Over time, **5 major factors** play a part in how a soil forms. Together these factors are called **C L O R P T**.

Soil Formation – C L O R P T – for short!

Soils differ from one part of the world to another, even from one part of a backyard to another. They differ because of where and how they formed. Five major factors interact to create different types of soils:



Climate

CL—Temperature and moisture influence the speed of chemical reactions, which in turn help control how fast rocks weather and dead organisms decompose. Soils develop fastest in warm, moist climates and slowest in cold or arid (dry) ones.



Organisms

O—Plant roots spread, animals burrow, and bacteria eat. These and other soil organisms speed up the break down of large soil particles into smaller ones. Roots are a powerful soil-forming force, cracking rocks as they grow. And roots produce carbon dioxide that mixes with water, forming an acid that wears away rock.



Relief

R—The shape of the land and the direction it faces make a difference in how much sunlight a soil gets and how much water it holds. Deeper soils form at the bottom of a hill than at the top because gravity and water move soil particles down the slope.



Parent material

P—Just like you inherited characteristics from your parents, every soil inherits traits from the materials in which it forms. Soils that formed from limestone bedrock, for example, are rich in calcium. Soils that formed from materials at the bottom of lakes are high in clay.



Time

T—Older soils differ from younger soils because they have had longer to develop. In the northern US, soils tend to be young because glaciers covered the surface during the last Ice Age. In the southern US, there were no glaciers, so the soils have been exposed for a longer time, making them more weathered.

Soil Degradation

Soil degradation is a human-induced or natural process which impairs the capacity of soil to function.

As an example, in 3000 BC, the Sumerians built large cities in the deserts of Southern Mesopotamia. Using irrigation, they farmed the desert soils and created large food surpluses that made their civilization possible. But around 2200 BC, the civilization collapsed. Scientists debate why, but one reason may be tied to the soil. Irrigating in dry climates can cause a buildup of salt, a process called salinization. Few crops can tolerate salt. The soil in this region still remains too salty to grow crops.

Other activities that degrade the soil include contamination, desertification, and erosion.

Soil is Inter-Disciplinary

Soil has been a defining component of cultures since the beginning of civilization. Some of the first written words were recorded on clay tablets and water was carried in clay pitchers. It provides the base for all buildings (although some may be able to support a skyscraper and some others may not be able to support your weight), it holds the clues of past cultures (to be revealed by archeologists or erosion), it supports the web of life (connecting all ecosystems), provides materials to build houses, is a source of nutraceuticals (definite in the *American Heritage Dictionary* as a food or naturally occurring food supplement thought to have a beneficial effect on human health), and of course, provides the base for our food, fiber, feed, and even some biofuels.

Soils are always forming and changing.



Additions. Rain adds water. Dust adds minerals. Animal wastes add organic matter and nutrients. Humans add fertilizers.



Losses. Water in soil evaporates. Nutrients are taken up by plants. Soil particles wash away in a storm. Organic matter may decompose into carbon dioxide.



Translocations (*when things move within the soil*). Gravity pulls water (carrying minerals and nutrients) down from top to bottom. Evaporating water draws minerals up from the bottom to top. Organisms carry material every which way.



Transformations (*when things change into other things*). Dead leaves decompose into smaller organic materials. Rock weathers into soft clay. Oxygen reacts with iron, “rusting” the soil to a reddish color.