Soils

Figure 1. A soil profile being compared to a Munsell color chart, which can help determine soil properties. Credit: Betts.

Soil forms as the solid rock of the Earth, called bedrock, breaks down. It usually takes thousands of years for soil to form from bedrock. In some places, soil forms directly on top of bedrock. In other places, soil forms on a thick layer of loose rock and mineral material. This material, called sediment, has been carried from distant areas by rivers or glaciers.

How do different types of soil form?

There are many kinds of soil. A group of soil scientists from the U.S. determined a way of grouping soils that is used around the world. This grouping has hundreds of named soil types! All soils, however, are made of just a few main components. Soil consists of fine particles of minerals and rocks, decaying organisms, and living fungi, plants, and animals, many of which are microscopic.

What determines the type of soil that forms? The most important factors are bedrock type and climate. Different kinds of bedrock make different kinds of soil, contributing different elements. Climate determines how much water is present to aid in chemical reactions that create soil. Young soils have just started to form. In young soils, bedrock is more important than climate in determining the type of soil. In older soils, which have become fully formed, climate is usually more important. Climate can not only help form soil, but it can also contribute to the maintenance of soil: what organisms live in an area, the average temperature and precipitation over time, and other interactions that can change or maintain the initial soil that forms in an area.

Most soils are only a meter or two deep. The nature of the soil changes as you go down into the ground. When soil scientists study a soil, they look carefully at the whole thickness of the soil. This type of section of soil is called a soil profile. They then study what makes up the soil, which can help determine its properties.

What materials make up soil?

Soil scientists separate soil using a stack of several sieves. The sieves have holes with slightly different sizes. The coarsest sieve is at the top of the stack, and the finest sieve is at the bottom. Most soils contain many kinds of material. All soils consist mainly of two kinds of material: particles of minerals and rocks, and organic matter. Organic matter is any matter that is or once was living.

Figure 2. Running soil tests that can determine the chemistry and properties of a soil sample. Credit: McCabe.

Soil is likely to have several kinds of rock and mineral particles. A few kinds are very common. The three most common kinds are quartz particles, feldspar particles, and small pieces of rock. A soil sample is very likely to have a lot of at least one of these three kinds of particles. Quartz particles have irregular shapes. They look gray and glassy. Their surfaces are often stained brown or orange, because they are coated with rust. Feldspar particles are usually white or cream-colored. Their surfaces are often flat, at least partly, rather than irregular. There are many kinds of rock particles. You can tell them apart from the mineral particles because rocks are made of many different particles of minerals, all stuck tightly together.

The finest part of a soil sample is probably mostly very small flakes of clay. They are too small for you to see even with a hand lens. Sandy soils are loose and easy to dig. Soils with a lot of clay are harder to dig. Some plants like sandy soils and others like soils with more clay. Most soils have lots of organic matter. Some of the organic matter is in the form of living things, such as earthworms, insects, and microorganisms. Most soils are also rich in decaying plants. If the plant has decayed only slightly, you can usually recognize scraps of leaves, roots, and seeds. When the plant has decayed more, it turns into a soft, fine, dark material called humus. Humus is very important in soils. New plants can easily put their roots into humus. It is also good at holding water for later use by growing plants.

How important are water and other chemicals in soil?

Knowing how water passes through soil is very important. For example, engineers need to know how quickly water will drain away from buildings or bridges. Drainage rates are also important to farmers, landscapers, gardeners, environmental scientists, and other professionals. Water is one chemical found in soil. There are many others. Some of the chemicals in soil are very important for plant growth. Farmers and gardeners often test their soil for these chemicals using soil-testing kits. These kits can be bought at gardening or hardware stores.

Soil-testing kits can test to see how acidic or basic a soil is. (Vinegar is acidic, and many soaps are basic.) The measure for how much acid or base there is called the pH level. A pH of 7 means that there is no more acid than base present. The solution is neutral. Lower numbers than 7 indicate acids. Higher numbers indicate the presence of bases. The pH controls how well plants use the food (nutrients) available in the soil. Different plants like different pH levels. The testing kit you use may tell you which plants do better at a given pH. The pH level in soil can be changed by adding chemicals.

Three chemicals are very important for plants. They are:

- nitrogen that affects the growth of leaves;
- phosphorus that helps roots grow strong;
- potassium that helps flowers and fruits grow.

Soil-testing kits can tell you how much of each chemical there is in a soil sample. Different plants need different amounts of these chemicals. Lawn grasses need a high level of nitrogen. Fruits need less nitrogen, but higher levels of phosphorus and potassium. Root vegetables need lower levels of nitrogen and potassium and much higher levels of phosphorus.

What is soil erosion and how can we control it?

Water or air that moves over a soil surface applies forces to the soil particles on the surface. If the forces are large enough, they move the particles. The stronger the current or wind, the more particles are put into motion. Larger and heavier particles tend to roll or hop near the soil surface. Finer and lighter particles are carried upward from the soil surface. In nature, the finest particles may be carried for hundreds or even thousands of kilometers high in the atmosphere before they fall out!

Figure 3. Soil erosion in a floodplain. Credit: Betts.

Soil erosion is a serious problem in many areas of the world. Soil takes thousands of years to form, but much of it can be eroded by just a few unusually heavy rainstorms or strong winds. Bare soil surfaces are very likely to be eroded by a sudden heavy rainstorm. The running water can cut a channel, called a gully, in the soil surface. Once the gully is cut, the force of the water is focused there. This deepens the channel. One very good way to reduce soil erosion is to keep the soil surface covered with vegetation. Another way is to plant crops in rows that follow the contours of the land surface rather than running up and down a slope.