# Soil Characteristics

**Grade Level**: Elementary, Middle School, High School
**Ecological Concepts**: Abiotic factors
**Arizona Science Standards**: Science as Inquiry; Life Science

**Materials:**

1) Soil test kits*
2) Soil sieves*
3) Magnifying lenses/loupes*
4) Plastic cups
5) Writing/drawing materials
6) Trowels*
7) Soil thermometers*

*May be borrowed from SCENE.

**BACKGROUND**
Soils are composed of **organic** matter (stuff that used to be alive, like plants and animals) and small **inorganic** matter. There are three basic soil types: sand, silt, and clay. Sand is comprised of tiny rock fragments and is the roughest in texture. Clay becomes sticky or greasy when wet, and very hard when dry. Silt is between sand and clay in texture. Loam is a combination of sand, silt, and clay, and has a high proportion of organic matter. It is the best soil for most plants. Almost all soils found in nature contain some proportion of two or more of the three soil types along with some organic matter. Therefore, these soils are loam, but vary in the proportions of clay, silt, sand, and organic matter.

Plants need nutrients to grow and reproduce. The necessary nutrients are provided by the decaying organic material in the soil. Levels of nutrients such as carbon (C), phosphorus (P), potassium (K), and nitrogen (N) in soil are easily tested. Plants also use many other nutrients, but the ones listed here are the most prevalent. Plant growth is also affected by other **abiotic** factors such as air and soil temperature, air moisture (humidity) and soil moisture levels.

**GUIDED INQUIRY**
**Initial Observation/Exploration Period:** Soil is an essential abiotic factor in the environment, but it is often ignored. Initial explorations could involve using hands to feel the soil types found in the habitat, using soil **sieves** to separate the different soil types, and looking at soil through magnifying lenses.Wetting small amounts of soil and feeling it is a good way to determine the texture and get an idea of the proportions of the soil types present. Or, you can fill a jar with water and place a handful or shovelful of soil in the water. Seal the jar and shake the contents. Leave it to settle out for a few hours or overnight. The heaviest soil particles (sand) will fall to the bottom, the next heaviest in the middle (silt), and the lightest will be at the top (clay). The thickness of each layer reflects the proportion of each soil type in your sample. If no layers appear, your soil is probably all clay.

**Group Discussion and Question Period:** Do some soil types have more of some nutrients than others? Do soil types vary in their ability to hold water? Do soil types vary in their ability to heat up and cool down?

**Important aspects of guided inquiry are encouraging students to generate multiple hypotheses, and letting students make decisions about what data are important and create their own data sheets. Keeping these ideas in mind, the sample in the box below illustrates how ONE OF MANY possible investigations around this topic might develop.**

**Sample Hypothesis**: Let's use the question, "Does the texture of the soil affect soil nutrient content?" Our hypothesis could be, "Sandy soil will contain fewer nutrients than soil with more clay and/or silt content." Or, "As the texture of a soil becomes coarser, the fewer nutrients it will contain."

**Sample Experiment Design**: Dig up soil from at least three different areas in your schoolyard. Include your habitat area and other parts of the school grounds with less variety of vegetation. If your school has a sand play area, you may want a sample from that, as well. Include a sample of compost if you have a compost pile. Use a **soil test kit** to test for the levels of nitrogen (N), phosphorus (P), and potassium (K) in each sample. These nutrients are the dependent **variables** and the texture of the soil at each different location is the independent **variable**. Each soil sample is an **experimental unit**. Test at least three samples from each chosen location to **replicate** the experimental units. After testing, sieve a sample from each location to determine the proportions of clay, sand and silt in that location, and record this information, along with the nutrient levels found in each sample.

Another common soil test is for pH, the acidity or alkalinity of the soil. Sonoran Desert soils tend to be alkaline (pH above a neutral 7) because the soil contains lots of calcium carbonate (limestone), an alkaline mineral. If you wanted to extend this experiment, you could look for a correlation between nutrient level and pH.

**Sample Prediction**: Soil with the highest sand content will have the lowest nutrient levels.

**Record Results**: Record the nutrient levels in each soil sample, as well as the location from which that sample was taken and the approximate percentage of clay, sand, and silt in the soil in each location.

**Sample Analysis of Data and Presentation**: Make a **bar graph** with soil texture on the horizontal axis and nutrient content on the vertical axis. **Average**the nutrient levels from the two or more samples taken from each location, and graph the average on the vertical axis.

**Discussion**: Was your hypothesis supported? If yes, go on to test other hypotheses. If not, why not? What did happen? Why? This is a great opportunity to revise your hypothesis and do another test.

**MORE**:
**All Levels**
**(a)** Put the same amount of each soil type (clay, sand, silt) in pots or cups of the same size (if using pots, they must have solid bottoms) Use at least two replicates of each soil type. Water all pots with the same amount of water; enough to thoroughly soak the soil. After five to ten minutes, pour off any water, measuring it in a liquid measuring cup or beaker to see how much water was not absorbed. Which type of soil absorbed the most water? Which absorbed the least?
**(b)** How long do different soil types retain water? Put different soil types (clay, sand, silt) in pots of the same size. Use the same amount of soil in each pot. Have at least two replicates of each type of soil. Pour the same amount of water in each pot, enough to thoroughly wet the soil, but not have standing water on the surface. You can use a soil moisture tester (available at plant nurseries) to test soil moisture. Or, you can use a hard, solid tube like a narrow pipe, to take soil cores. Push the pipe into the soil vertically, pull it out and tap out the soil in the pipe. This is a subjective measure, but the students can each look and come to a consensus as to how moist the sample is. Take samples twice a day, in the morning and afternoon, until all of the samples are completely dry. Record how long it took for the soil in each pot to dry out. Graph the data on a **bar graph**, with soil type on the horizontal axis and number of days or hours it retained moisture on the vertical axis.