Soil pH

Accompanying Worksheet: Soil pH W-S-08

Objective: Students will collect soil samples from different horizons within a profile. They will prepare the samples and measure the pH of each horizon. They will also use graphing skills to visually represent their results.

Considerations:

1. It is advised that you complete the Soil Characterization protocol before embarking on this activity, for the purpose of introducing your class to the concept of soil horizons and properly identifying them at your sample site. This is not necessary, however, as long as your class is sufficiently knowledgeable.
2. This activity may require using tools to take samples if the soil is dry or hard. Be sure that your students can handle them responsibly.
3. Choose your study site carefully. Contact local power companies to verify that your site is not located near any cables.
4. To take the pH of soil, the samples need to be dried and sieved to remove any rocks or debris. The Soil Bulk Density activity requires this as part of its activity, so we suggest you do both concurrently for a more comprehensive experience.
5. If you are sampling in an area where the soil is hard, rocky, or dry enough to make digging difficult and cannot find a natural or artificial cutaway, you may wish to forgo the depth sampling in favor of site sampling. That is, you may wish to take samples from different areas (perhaps from around a tree, in a stream bed, near a roadway, etc) at a uniform depth of 5 or 10 cm, to avoid the frustration of digging a deep hole in hard soil.

Materials: IN THE FIELD

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___ Sample containers (metal is better. We suggest soup cans or cat food cans. Failing all else, sturdy plastic drinking cups, that are cut to leave about 2 inches above the base, can be used). You will need 3 for each horizon.
___ Hammer and nail
___ Trowels
___ Meter stick
___ Plastic wrap (optional)

Materials: IN THE CLASSROOM:

___ Worksheet W-S-08
___ Scale (with at least 0.1 g sensitivity)
___ Beaker (at least 100 ml)
___ Water
___ #10 2mm sieve (alternative: Window screen. Not as scientific, but will work in a pinch)

___ Small bowl or paper plate
___ Graduated cylinder
___ Stirring rod/plastic spoon
___ pH meter, strips, or paper

BEFORE LEAVING THE CLASSROOM: (If you have already taken samples, skip to "IN THE CLASSROOM")

1. Use the hammer and nail to poke a small hole in the center of the bottom of each sample container.
2. Mark each container with a unique ID

IN THE FIELD

If the soil site has already been characterized per the Soil Characterization protocol, simply refer to the instructions pertaining to taking samples (Steps 5-7, 11).

1. Expose your study site by removing all vegetation and scraping off the top layer of soil to uncover a fresh layer.
2. Using the trowel, begin digging downward into the soil. Attempt to keep the sides of the hole as vertical as possible. This will reduce incidents of collapse. The hole should be wide enough to reach your arm down with the container. We suggest starting with a diameter of 1 foot as the hole will inevitably narrow as it gets deeper.
3. Continue digging until you see a marked change in soil texture, color, moisture, or composition. This means you have reached the second soil horizon and have thus completely exposed the first.
4. Place the container against the side of the hole and press it into the soil. The puncture you placed in the bottom of the container will allow air to escape. You will know the container is full when soil starts coming out of the puncture hole.
    a. If the soil is too hard and you are unable to press the container into the soil, lightly tap the hammer against the edges.
5. Smooth off any irregular clumps from the top of the sample to create a flat face.
6. Record on the table the depth and horizon number of the sample.
7. Take 2 additional samples at this horizon.
8. Continue digging until the second horizon is fully exposed. Repeat the sampling procedure (Steps 5-7).
9. Repeat for as many horizons as feasible.
10. You may wish to cover the sample containers in plastic wrap to avoid accidental spilling during transport.

IN THE CLASSROOM:

1. Wait until your samples have dried. The simplest way to achieve this is to set the samples on a windowsill in your classroom. Check daily if the samples are dry. Unless your samples were quite moist, 48 hours should be plenty.
    a. If you used metal containers, you also have the option of drying the samples in an oven: bake them at 100 degrees and check every 10 minutes.
2. Pour the sample through the sieve, collecting the throughput soil on the paper plate. Use your hand to lightly brush back and forth on the top of the sieve to break apart clumps push soil through. DO NOT FORCE IT! Rocks and larger objects will remain on top of the sieve. Collect soil in a bowl or paper plate.
3. Measure out 40g of soil with the scale and place the soil in the beaker.
4. Measure 40 mL of water in the graduated cylinder and pour into the beaker.

a. If you do not have 40g of soil, smaller amounts may be used. Simply adjust the amount of water so that it matches the amount of soil in a 1:1 ratio.

5. Stir the sample with the stirring rod until it is thoroughly mixed, then let the sample sit.
6. Wait until the sample separates out until an obvious supernatant forms.
    a. i.e. until most of the soil has settled onto the bottom and a clear liquid sits above it.
7. Using whatever measurement of pH you have available to you (meter, pen, paper, strips), take the pH of each sample and record on the table.
8. Calculate the average pH for each horizon and record on the table.
    a. Because pH is a logarithmic representation of the concentration of hydrogen ions (ie pH = -log($[H^+]$), calculating the arithmetic average is of little use.
    b. If your students are old enough to perform logarithmic/exponential calculations, you may choose to have them calculate the average using the formula: $[H^+] = 10^{-pH}$. Once the pHs are in terms of hydrogen ion concentration, they can be averaged normally and then returned to pH using the equation in part 8a.
    c. If your students have not yet learned logarithms, they can go to http://wgr-sw.com/pH/. This website has a tool that allows students to calculate the true average pH of their samples.
9. Refer to the worksheet for the graphing exercise and additional questions.

Adapted from GLOBE Soil pH Protocol
http://www.globe.gov/documents/352961/353769/soilph.pdf

Visit www.flagstaffscies.org for more information and field worksheets!