Selecting, Exposing, and Defining a Soil Characterization Site

A. Selecting a Site for Soil Characterization Protocols

Soil characterization measurements are taken for different reasons, including,

- supporting the interpretation of soil moisture and temperature, land cover, and atmosphere measurements;
- complementing and extending land cover mapping;
- developing soil maps of a region; and
- providing information for computer modeling.

For GLOBE, most schools focus on the first of these objectives, and for this a teacher could include soil characterization measurements at the same site where soil moisture data are collected. If students will be collecting *soil characterization data* together with *land cover sample data*, then both can be included in the same site definition. If students will be developing a soil map of their region (e.g., watershed) or their 15 km by 15 km GLOBE Study Site, or if they would like to use their data for computer modeling, multiple sites throughout the region should be defined all including soil characterization in the site definition parameters. For instance, students may wish to sample soil at the top, side, and bottom of a hill; or next to a stream or lake and upland on both sides of the water body. Comparisons of soil characteristics from two or more nearby sites can provide the basis for interesting inquiry or student research projects. If you decide to add soil characterization data collection to an already existing site, that can also be done by editing the site.

No matter which site location is chosen, the following steps should be considered:

1. The site needs to be safe for digging. Teachers and students should check with local utility companies and school maintenance staff to be sure that they do not dig into or disturb utility cables, water, sewer, or natural gas pipes, or sprinkler irrigation systems.
2. A site should be chosen that looks similar to the rest of the landscape and, if possible, is covered with natural vegetation. Lawns, agricultural sites, or other managed landscapes are acceptable if this is the cover that is located at the atmosphere and soil moisture and temperature measurement sites.
3. The site chosen should be relatively undisturbed. It should be at least 3 meters from buildings, roads, paths, playing fields, or other places where soils may have been compacted or disturbed by construction. If this is not possible, it is important to indicate that information in the metadata for the site.
4. The site should be oriented so that the sun shines on the soil profile at the time students carry out the soil characterization measurements to ensure the soil characteristics are clear for both naked-eye observations and photography. In some cases, sites are chosen where sunlight does not strike the soil profile (e.g., existing exposed profiles or pits dug under tree canopies). In these cases, students will need to take samples to a place where there is sunlight to determine the soil color.

B. Defining a Site for Soil Characterization Protocols

After students have selected and exposed a soil characterization site, they define the site according to a number of factors. They record their descriptions in their GLOBE Science Notebooks and onto the *Site Definition Sheet*. This information is important for students and scientists to understand the way the Earth system is functioning at that location. The following factors are defined:

Latitude, Longitude and Elevation: The location of the site is determined according to lines of latitude and longitude and elevation above sea level. These coordinates are established using a Global Positioning System (GPS) receiver if available. If not, students check the box labeled "Other" and record how they obtained latitude, longitude and elevation.

Site Exposure Method: The approach used by students to expose and study the soil is identified as the pit method, auger method or near surface method.

Site Location: Soil characterization data are important for interpreting soil moisture and temperature measurements, atmospheric measurements and land cover measurements. Soil characterization protocols can be added to any existing site.

Slope: The slope describes the angle at which the land of the site varies from a horizontal surface and is measured in degrees with an instrument called a clinometer. See *Land Cover/Biology Investigation Instruments*.

Aspect: The aspect is the direction of the steepest slope across the exposed soil site. This information indicates how the sun will influence soil properties. In the Northern Hemisphere, south facing slopes face the sun and tend to be drier and more weathered, while north facing slopes tend to be cooler. The opposite relationship occurs in the Southern Hemisphere.

Landscape Position: The landscape position describes the contours of the land at the soil characterization site. These descriptors, slope, aspect and landscape position, indicate the processes and inputs that helped form the soil at the site. For example, this information determines whether the soil was formed by erosion or deposition. It can also establish whether rain falling on the site will run off, settle into a pond, or infiltrate into the ground.

Cover Type: Cover type is a description of the vegetation or other material (such as pavement or gravel) on the surface of the soil. If nothing is covering the soil then it is described as bare soil. Otherwise, the material covering the soil can be described as rocks, grass, shrubs, trees or other.

Parent Material: The material from which the soil develops is called the parent material. Identifying the parent material of the soil helps to interpret its texture, mineralogy, weathering rate, and fertility.

Land Use: The manner in which the land is used at the soil site can be defined as urban, agricultural, recreational, wilderness or other. Land use can have a formidable effect on soil formation and help to interpret and explain a soil's properties and development.

Distance from Major Features and Other Distinguishing Characteristics of the Site: Other information or *metadata* about the site that does not fit into any of the above categories should also be recorded.

C. Exposing the Soil Profile

There are three options for exposing the soil at a Soil Characterization Site:

1. **Pit Method:** Students dig a soil pit approximately 1 meter deep (or until an impenetrable layer is reached) and as big around as is necessary to easily observe all of the soil horizons from the bottom to the top of the pit (approximately 1.5 x 1.5 m wide). In some situations, students may be able to perform the soil characterization measurements at a site where the soil profile has already been exposed through human or natural action (e.g., a road cut or the side of a ravine). In these instances, teachers need to make sure that the site is safe for students and there is no objection to them scraping the surface soil away to expose a fresh soil *face*.

2. **Auger Method:** Students use a soil auger or probe to remove soil samples to a depth of 1 meter.
3. **Near Surface Method:** Students use a garden trowel or shovel to remove soil samples. Students dig to a depth of at least 10 cm. If deeper digging is possible, students should dig up to 1 meter.

Note: Some steps of the *Soil Characterization Protocol* vary depending upon which method students chose to expose their site.

Suggestions for Digging and Managing a Soil Characterization Site

Pit Method

- Digging is much easier when the soil is moist. If possible, plan digging shortly after a rain.
- As soil is removed from the pit, place it carefully in piles representing each of the natural layers as they occur in the profile.
- The removed soil can be put on a tarp or other type of plastic sheet to make cleaning up the site easier.
- Cover piles of removed soil with plastic to prevent them from eroding away.
- Request help from parents, school personnel, students, or other volunteers.
- Contact a local USDA Natural Resources Conservation Service office (in the United States), or other agricultural organization or university. Many times, a soil scientist or other professional will be willing to assist you in digging a pit and helping describe the characteristics of the soil profile.
- Surround the pit with a fence and mark it with flags to alert people to where it is.
- Cover the pit with boards or some other material to keep animals or debris from falling in when it is not being used.
- When finished with the soil characterization measurements, the horizons need to be replaced into the soil pit in reverse order (last one out should be first one back in).
- Plan to plant a tree at the soil sampling site location. Once the pit for the tree has been dug, identify the horizons in the profile, conduct the soil characterization measurements, collect laboratory samples and then plant the tree in the soil pit.

Auger Method

- Identify an area where four auger holes can be dug and where the soil profiles are similar.
- A Dutch auger, as described in the Toolkit is best for most soil, especially for rocky, clay-rich, or dense soils.
- A sand auger is needed if the soil is very sandy in texture. In some places, the soil is mostly peat and a special peat auger should be used.
- A bucket auger may be better for dry, desert soils.
- Students need a horizontal surface (e.g., the ground) on which to display the vertical soil profile.
- Spread a plastic sheet, tarp, board, or other surface on the ground next to where the augur holes are dug for laying out the profile.
- A rain gutter trough or other type of tube or container, one meter in length, can be used to lay out the soil sample removed from the auger. This allows for the sample to be labeled, transported and stored.
- Assemble a profile of the top 1 meter of soil by removing successive samples from the ground with the auger and laying them end-to-end.

Near Surface Method

- Use this method if digging deeper is not possible.
- Be sure to take triplicate (3) samples in the same area to obtain a good concept about the variability in soil properties that occurs across the surface of the study site.

Questions for Guiding Students

The following questions can be used to engage and guide students in selecting, exposing and defining their soil characterization site:

Is the soil moist or dry, difficult or easy to dig, warm or cool?

Can you distinguish differences in color, structure, roots, rocks, or other soil properties as the soil is being removed?

What is the parent material from which the soil was formed? Was it bedrock? If so, look for rocks on the surface to tell you something about the kind of rock. Could your soil have been deposited by water or wind, by a glacier or volcano?

What are the types of plants and animals you might find in the soil and the general area around your site? Include small organisms in the soil such as earthworms or ants.

Where is your soil located on the landscape? Is it on a hilltop, slope, or bottom of a hill? Is it next to a stream or on a flat plain? On what kind of landform is it found?

What is the general climate at your soil site? Is it sunny, shaded, hot, cold, moist, or dry?

What is the recent land use in this area? Has it been stable for a long time, or has it been plowed, its trees cut, used for construction, or undergone some other disturbance recently?

Questions for Further Investigation

How has the history of this area (human activity) affected this soil?

How has land cover affected this soil?

How has local climate (microclimate) affected this soil?

How has this soil affected local human history?

How has location in the landscape influenced this soil?

How would soils with different slopes differ from each other?

How does aspect affect soil properties?

Soil Characterization Profile Exposure – Pit Method

Field Guide

Task

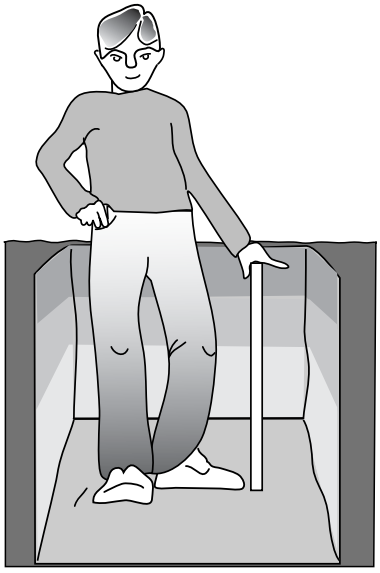
To dig a soil pit that exposes a soil profile for soil characterization measurements and to define the site

What You Need

- ❑ Shovels, trowels, backhoe or other digging implements
- ❑ Flags for marking the site
- ❑ Fence, boards, or other protection to surround and cover a pit when not in use
- ❑ Plastic tarp or other plastic sheet to cover piles of soil
- ❑ *Site Definition Sheet*
- ❑ Help with digging!
- ❑ Clinometer (made from materials described in the *Land Cover Investigation*)
- ❑ Local information about your site
- ❑ Compass
- ❑ GPS receiver or other means of determining coordinates

In the Field

Exposing the Soil Profile



1. Identify a location where you can dig a soil pit.
2. Dig the soil pit approximately 1 meter deep (or until a hard layer is reached). Make the pit as big around as is necessary to easily observe all of the soil horizons from the bottom to the top of the pit (approximately 1.5 m x 1.5 m).
3. As soil is removed from the pit, place it carefully on a plastic sheet like a tarp in piles representing each of the natural layers of the profile. The horizons need to be replaced in reverse order (last out, first in) once you are finished using the pit. Cover the pile of soil with plastic to prevent the soil from eroding (blowing or washing) away.
4. Surround the pit with a fence and mark it with flags to alert people of its location.
5. Cover the pit with boards or some other material to keep animals or debris from falling in when it is not being used.

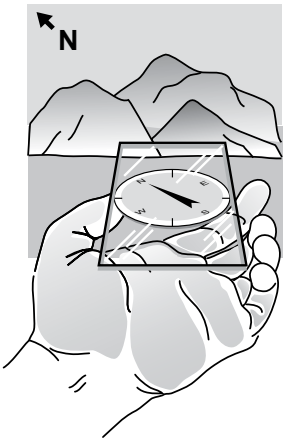
Defining the Site for Soil Characterization Protocols

1. Give the site a unique name (e.g., front of school). Record this on the *Site Definition Sheet*.
2. Determine the latitude, longitude, and elevation of the site using a GPS receiver or other method such as a topographic map. Record this information on the *Site Definition Sheet*.
3. Identify the steepest slope that crosses the area of exposed soil.

   a. Two students (A and B) are needed whose eyes are at about the same height to measure the slope. One other student (C) is needed to be the "reader" and "recorder".

   b. Student A holds the clinometer (made from materials described in the *Land Cover Investigation*) and stands down slope while Student B walks to the opposite side of the hole. Students A and B should be about 30 m apart (or as far apart as possible). Student C should stand next to Student A.

   c. Looking through the clinometer, Student A sites the eye level of Student B. Student C reads the angle of slope on the clinometer in degrees, and records this reading on the *Site Definition Sheet*.



4. Identify the aspect of the steepest slope:

   a. Face up the steepest slope across the exposed soil area.

   b. Hold the compass in your hand so that the red arrow is lined up with the North position on the compass.

   c. Read the number on the edge of the compass housing (which can range from 0 to 360).

   d. Record this value on the *Site Definition Sheet*.
5. Record "Pit" as the method used to expose the soil profile.
6. Record whether the site is on or off school grounds.
7. Record a description of the site location (as detailed as possible when completing the site definition sheet).
8. Describe and record the position on the landscape where the site is found. (Summit, Side Slope, Depression, Large Flat Area, or Stream Bank)
9. Describe and record the cover type of the site (Bare Soil, Rocks, Grass, Shrubs, Trees, or Other).
10. Describe and record the type of parent material from which the soil was formed at the site (Bedrock, Organic Material, Construction Material, Marine, Lake, Stream, Wind, Glaciers, Volcanoes, Loose Materials on Slope moved by gravity, or Other).
11. Describe and record the land use at the site (Urban, Agricultural, Recreation, Wilderness, or Other)
12. Measure and record the distance (up to 50 m) of the site from major features (e.g., buildings, power poles, roads, etc.).
13. Describe and record any other distinguishing characteristics of this site.

Soil Characterization Profile Exposure – Auger Method

Field Guide

Task

Use an auger to expose a soil profile for characterization measurements and define the site.

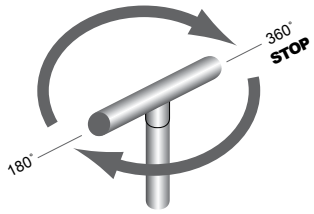
What You Need

- ❑ Soil auger
- ❑ Clinometer (made from materials described in the *Land Cover Investigation*)
- ❑ Compass
- ❑ GPS receiver or other means of determining coordinates
- ❑ Meter Stick
- ❑ Local information about your site
- ❑ Plastic tarp or other plastic sheet to lay out the soil profile
- ❑ *Site Definition Sheet*

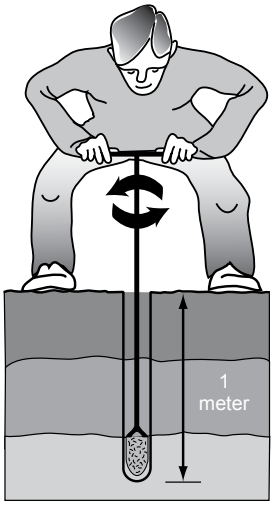
In the Field

Exposing the Soil Profile

1. Identify a location where an auger can be used to expose a soil profile.
2. Spread a plastic sheet, tarp, board, etc. on the ground next to where the first hole will be dug and where the sun will shine on the profile.



3. Remove the surface vegetation.
4. Place the auger at the top of the soil and turn the auger one complete revolution (360˚) to dig into the ground. Do not turn the auger more than one complete circle (360˚) to prevent the soil from being compacted.
5. Remove the auger with the sample from the hole and hold the auger over the plastic sheet.



6. Transfer the sample from the auger to the plastic sheet as gently as possible. Place the top of this sample just below the bottom of the previous sample.
7. Measure the depth of the hole with a metric ruler. Adjust the sample on the plastic bag, tarp, or board so that its bottom is no further from the top of the soil profile than this depth.
8. Record the depths at which there are differences in soil properties. (This will help to determine the top and bottom depths of the horizons for soil characterization.)

Defining the Site for Soil Characterization Protocols

1. Give the site a unique name (e.g., front of school). Record this on the *Site Definition Sheet*.
2. Determine the latitude, longitude, and elevation of the site using a GPS receiver or other method such as a topographic map. Record this information on the Site Definition Sheet.
3. Identify the steepest slope that crosses the area of exposed soil.

   a. Two students (A and B) are needed whose eyes are at about the same height to measure the slope. One other student (C) is needed to be the "reader" and "recorder".

   b. Student A holds the clinometer (made from materials described in the *Land Cover Investigation*) and stands down slope while Student B walks to the opposite side of the hole. Students A and B should be about 30 m apart (or as far apart as possible). Student C should stand next to Student A.

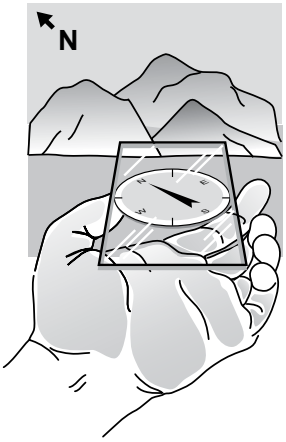
   c. Looking through the clinometer, Student A sites the eye level of Student B. Student C reads the angle of slope on the clinometer in degrees, and records this reading on the *Site Definition Sheet*.
4. Identify the aspect of the steepest slope:

   a. Face up the steepest slope across the exposed soil area.

   b. Hold the compass in your hand so that the red arrow is lined up with the North position on the compass.

   c. Read the number on the edge of the compass housing (which can range from 0 to 360).

   d. Record this value on the *Site Definition Sheet*.



5. Record "Auger" as the method used to expose the soil profile.
6. Record whether the site is on or off school grounds.
7. Record a description of the site location (as detailed as possible when completing the site definition sheet).
8. Describe and record the position on the landscape where the site is found. (Summit, Side Slope, Depression, Large Flat Area, Stream Bank)
9. Describe and record the cover type of the site (Bare Soil, Rocks, Grass, Shrubs, Trees, or Other).
10. Describe and record the type of parent material from which the soil was formed at the site (Bedrock, Organic Material, Construction Material, Marine, Lake, Stream, Wind, Glaciers, Volcanoes, Loose Materials on Slope moved by gravity, or Other).
11. Describe and record the land use at the site (Urban, Agricultural, Recreation, Wilderness, or Other)
12. Measure and record the distance (up to 50 m) of the site from major features (e.g., buildings, power poles, roads, etc.).
13. Describe and record any other distinguishing characteristics of this site.

Soil Characterization Profile Exposure – Near Surface Method

Field Guide

Task

Expose the top 10 cm of soil for soil characterization measurements and define the site.

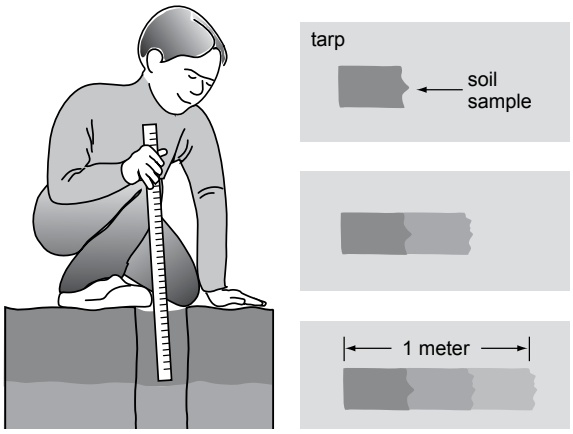
What You Need

- ❑ Meter Stick or metric ruler
- ❑ Local information about your site
- ❑ GPS receiver or other means of determining coordinates
- ❑ Clinometer (made from materials described in the *Land Cover Investigation*)
- ❑ Compass
- ❑ *Site Definition Sheet*

In the Field

Exposing the Soil Profile

1. Identify a location where the surface of the soil can be exposed.
2. Remove the surface vegetation.
3. Use a garden trowel or shovel to carefully remove the top 10 cm of soil from a small area and set it on the ground.
4. Repeat Steps 1, 2, and 3 above for a location next to the original sample hole. Repeat again, and mix the three samples together. Treat this mixed sample as a horizon.

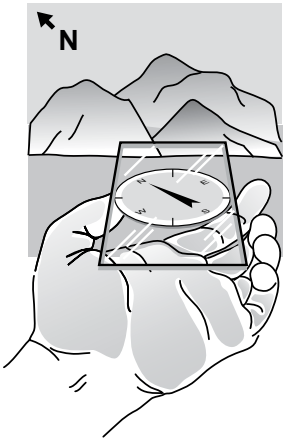


Defining the Soil Characterization Site

1. Give the site a unique name (e.g., front of school). Record this on the Site Definition Sheet.
2. Determine the latitude, longitude, and elevation of the site using a GPS receiver or other method such as a topographic map. Record this information on the Site Definition Sheet.
3. Identify the steepest slope that crosses the area of exposed soil.

   a. Two students (A and B) are needed whose eyes are at about the same height to measure the slope. One other student (C) is needed to be the “reader” and “recorder”.

   b. Student A holds the clinometer (made from materials described in the *Land Cover Investigation*) and stands down slope while Student B walks to the opposite side of the hole. Students A and B should be about 30 m apart (or as far apart as possible). Student C should stand next to Student A.



c. Looking through the clinometer, Student A sites the eye level of Student B. Student C reads the angle of slope on the clinometer in degrees, and records this reading on the *Site Definition Sheet*.

4. Identify the aspect of the steepest slope:
   a. Face up the steepest slope across the exposed soil area.
   b. Hold the compass in your hand so that the red arrow is lined up with the North position on the compass.
   c. Read the number on the edge of the compass housing (which can range from 0 to 360).
   d. Record this value on the *Site Definition Sheet*.
5. Record “Near Surface” as the method used to expose the soil profile.
6. Record whether the site is on or off school grounds.
7. Record a description of the site location (as detailed as possible when completing the site definition sheet).
8. Describe and record the position on the landscape where the site is found. (Summit, Side Slope, Depression, Large Flat Area, Stream Bank)
9. Describe and record the cover type of the site (Bare Soil, Rocks, Grass, Shrubs, Trees, or Other).
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11. Describe and record the land use at the site (Urban, Agricultural, Recreation, Wilderness, or Other)
12. Measure and record the distance (up to 50 m) of the site from major features (e.g., buildings, power poles, roads, etc.).
13. Describe and record any other distinguishing characteristics of this site.