



THE GLOBE PROGRAM

A Worldwide Science and Education Program



Soil (Pedosphere)

Soil Characterization

Selecting, Exposing and Defining a Soil Characterization Site





A. Why
characterize
soil profiles?

B. Select and
Define your site

C. Pit Method

D. Auger
Method

E. Near Surface
Method

F. Report data
to GLOBE

G. Visualize
data

H. Quiz yourself

I. Additional
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Goals and Objectives of this Module

Overview

This module:

- Describes how defining a soil characterization site supports scientific understanding of the Earth system
- Provides step-by-step instructions in how to select, expose and define a soil characterization site using this GLOBE protocol

Learning Objectives

After completing this module, you will be able to:

- Explain why soil characteristics are important
- Be able to determine which sampling method is appropriate to your site
- Report these data to GLOBE

Visualize these data using GLOBE's Visualization Site Estimated time needed for completion of this module: 1.5 hours



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Why is defining soil characteristics important?

Soil characterization is a fundamental step in describing and analyzing soil as part of the Earth system. The characteristics you identify will help to explain the role of the soil in exchanging matter and transferring energy with the atmosphere, biosphere and hydrosphere.

Soil characterization measurements are taken for many 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.

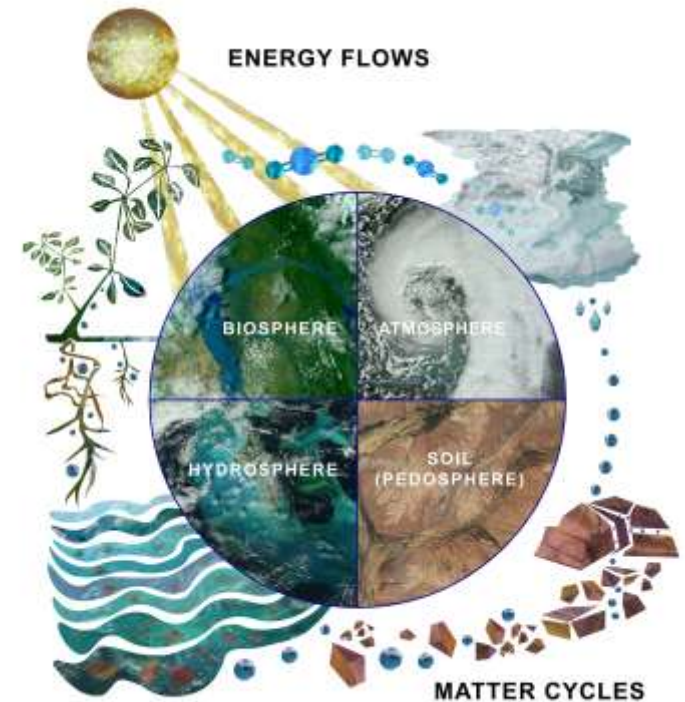


Image: Jenn Glaser and Russanne Low



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What is a Soil Profile?

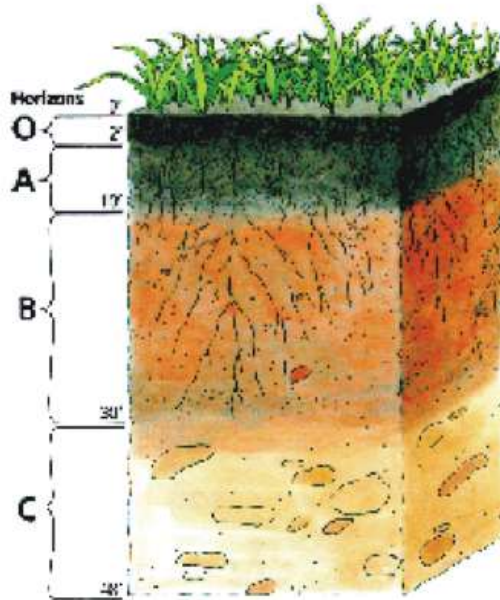


Image: USDA

A soil profile is a vertical section of soil, extending from the surface to the bedrock at the base.

The layers of soil in a soil profile are called soil horizons. They are created through the interaction of soil formation variables:

- Climate
- Organisms
- Parent Material
- Topography
- Time

These factors interact to create the soil horizons

O: organic material in the process of decomposition

A: topsoil enriched with organic particles

B: zone of deposition, where materials are leached from above and deposited in this zone by the movement of water

C: unchanged sediment that retains the mineralogical characteristics of the parent material.



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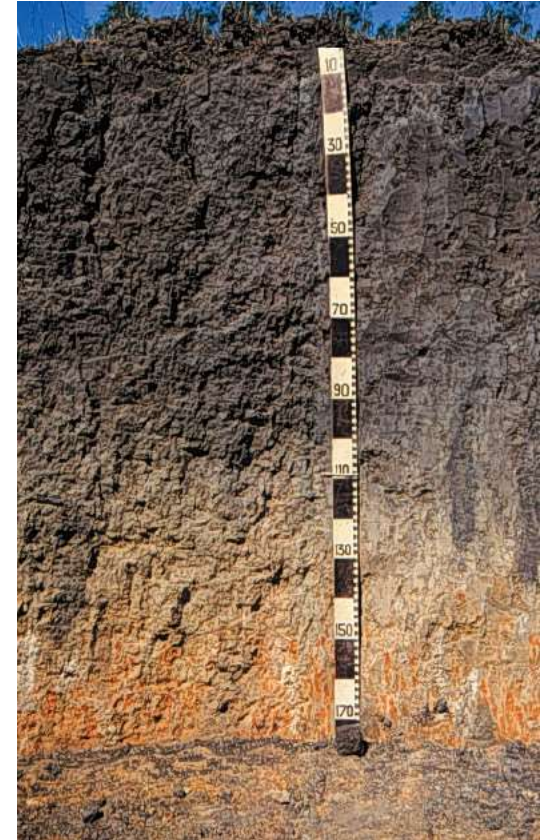
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What Soil Characterization Reveals:

Characteristics of the different soil horizons at depth:

- determine how water is stored in and moves through the soil
- indicate suitability for categories of land use
- whether there is adequate drainage
- what plants will grow and what nutrients are available
- reveal the history of a site - past climates and human settlement
- influence the local ecology and may limit what can live there.



Grassland soil in Texas, USA. The dark color at the top, in the A horizon, evidences high organic content (fertility) resulting from centuries of root decomposition. Source: GLOBE. Teacher's Guide.



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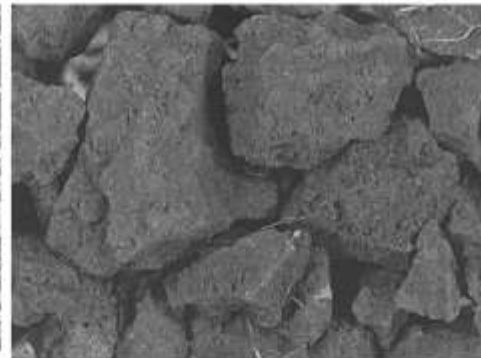
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What Soil Structure Reveals

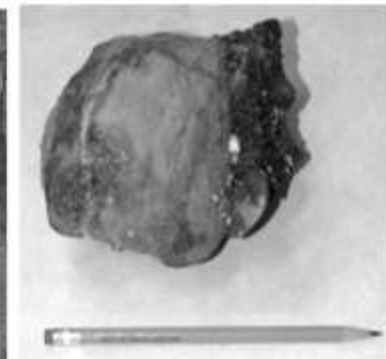
The soil structure provides information about the size and shape of pore spaces in the soil through which water and air flow, and in which plant roots grow. Here are the 7 Soil Structure Types:



Granular



Blocky



Massive



Single Grained



Prismatic



Columnar



Platy

Single Grained and Massive images courtesy Izolda Tracktenberg; other images courtesy NASA.



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What Soil Color Reveals

Soil color indicates the chemical content of the soil or the coatings on the soil particles.

For instance, dark colors usually indicate the presence of organic material.

The presence of Iron and some other minerals can produce red and yellow soils.





What Soil Consistence Reveals

Consistence is determined by how easily soil aggregates break apart

Whether a soil is **Loose**, **Friable**, **Firm**, or **Extremely Firm** determines how easy it is for roots, worms, or plows to pass through the soil.

It also indicates whether animals can create burrows in the ground or if the soil would collapse unless reinforced in some way.



Loose



Friable



Firm



Extremely Firm

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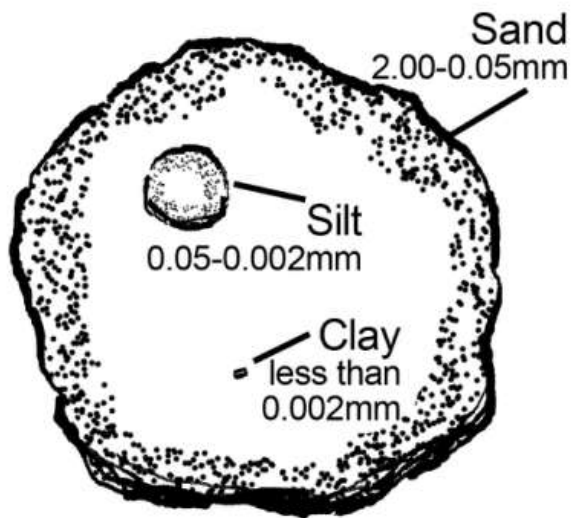
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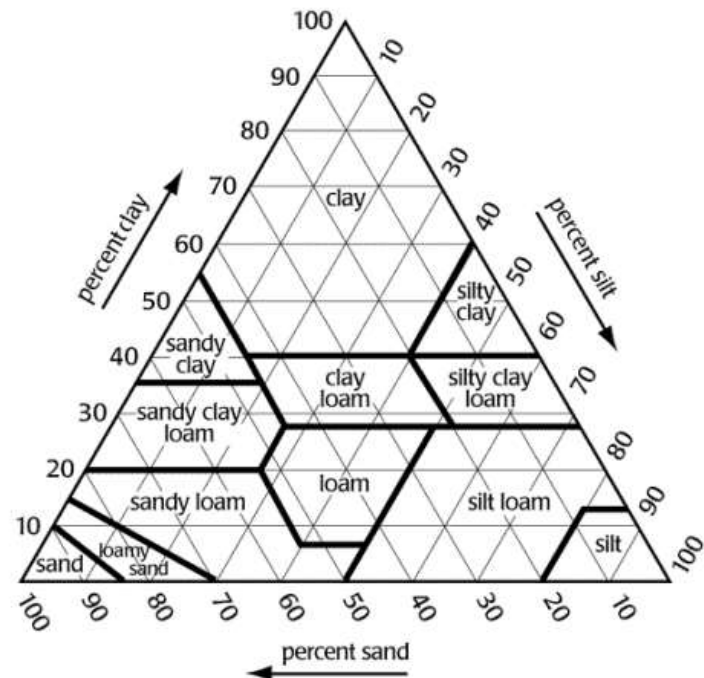
I. Additional Information

What Soil Texture Reveals

Soil Texture is determined by the relative amounts of **Sand**, **Silt**, and **Clay** in the soil. This determines to which uses the soil is best suited and gives indications of how and from what the soil was formed.



Soil particle size comparison



Soil Texture Triangle



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What the Presence of Roots, Rocks and Carbonates Reveals

Knowing the amount of roots in each horizon allows scientists to estimate the soil's fertility, bulk density, water holding capacity, and depth.

An estimate of the number of rocks in each horizon helps to understand the movement of water, heat, and air through the soil, root growth, and the amount of soil material involved in chemical and physical reactions.

The presence of carbonates in soil may indicate a dry climate or a particular type of parent material rich in calcium, such as limestone.





Selecting a Soil Characterization Site

Make sure the site is safe for digging. Notify local utility companies and school maintenance staff to make sure you do not dig into utility cables, gas pipes, water, sewer, or sprinkler systems

Where possible, the site should be covered with natural vegetation, be undisturbed and representative of the local landscape. Lawns, agricultural sites or other managed landscapes are acceptable if this is the land cover at your atmosphere investigation site.

Your site should be at least 3 meters from places where soil may have been disturbed or compacted by construction, such as roads, paths, buildings or playing fields

When possible your site should be oriented facing the Sun during the time students describe and carry out soil characterization.



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Soil (Pedosphere)



Selecting, Exposing and Defining a Soil Characterization Site

Summary of Protocol

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Where	GLOBE Characterization Site
How	Choose your method based on your study site
Prerequisites	Site definition using the Site Definition Sheet
Needed Documents	Selecting Exposing and Defining a Soil Characterization Site
	Soil Characterization Protocol Soil Characterization Profile Exposure-Auger Method Soil Characterization Profile Exposure- Near Surface Method Soil Characterization Profile Exposure-Pit Method
Time Required	2-3 45 minute class periods or one 90 minute session in the field
Level	all
Frequency	Soil characterization measurements are taken one time for a specific soil site. Collected samples can be stored for study and analysis at another time during the school year.



Equipment and Materials Needed

- Shovel, trowel or backhoe
- Flagging for marking site
- Plastic tarp or sheet
- Clinometer
- Compass
- GPS receiver
- Soil auger (if using the auger method)
- Meter stick
- GLOBE Site Definition Sheet





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Defining the Soil Characterization Site: GPS

Collect positional data using a GPS receiver. Identify the latitude, longitude and elevation of the center following instructions from the GPS field guide, below:

Turn on the receiver, making sure that you are holding it vertical and you are not blocking the antenna's view of the sky. In most receivers the antenna is internal and is located at the top of the receiver.

After an introduction message, the receiver will start to search for satellites. Some receivers may display the previous latitude, longitude, and elevation values while it is locking onto satellite signals.





Soil (Pedosphere)



Selecting, Exposing and Defining a Soil Characterization Site

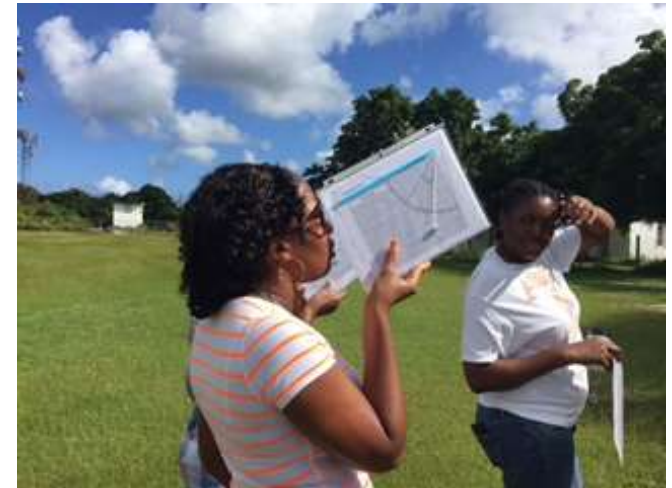
Defining the Soil Characterization Site: Slope

Identify the steepest slope that crosses the area of exposed soil.

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”.

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.



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Defining the Aspect of a Soil Site

Aspect is the direction of the steepest slope across the soil site.

This information indicates how the sun will influence soil properties.

To determine aspect:

1. Face up the steepest slope across the exposed soil area
2. Hold the compass in your hand so that the red arrow is lined up with the North position on the compass.
3. Read the number on the edge of the compass housing (which can range from 0 to 360). This aspect is 28°.





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Defining Landscape Position

The landscape position describes where a site is located on the contours of the land.

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?

Landscape position, along with slope and aspect give information about the processes that formed this soil.

Determine on which part of the landscape your soil site is located

Measure and record the distance from major site features such as buildings, roads, paths etc (up to 50 m), as well as any distinguishing characteristics of the site.

Report this as part of your Soil Site definition.

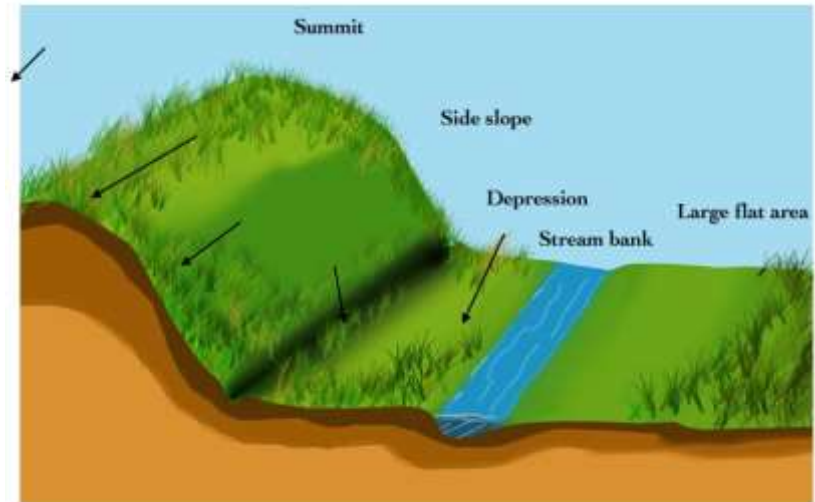


Illustration courtesy, Rich Potter

Example of descriptors: summit, slope, depression, large flat area, stream bank.



Defining Land Use

Describe current land use. Is it a natural or wilderness environment, urban, agricultural, recreational or other?

Urban



Agricultural



Recreational



Wilderness



Other



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Define Cover Type of a Soil Site

Cover type is a description of the vegetation or other material (such as gravel) on the surface of the soil. Describe and record the cover type of the site (Bare Soil, Rocks, Grass, Shrubs, Trees, or Other).

Bare Soil



Rocks



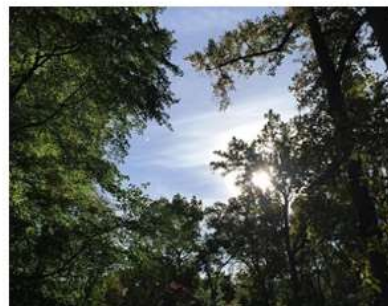
Grass



Shrubs



Trees



Other



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Describe the Parent Material from which the soil was formed:

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? Hint: This is not easy! Be sure to contact a local soil scientist to help you answer this question if the answer is not evident to you.

Some examples of parent material types:

- Bedrock
- Organic Material
- Construction Material
- Marine
- Lake
- Stream
- Wind
- Glaciers
- Volcanoes
- Loose Materials on Slope moved by gravity, or other

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Soil Characterization Profile Exposure: Pit Method

- **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). Remove the vegetation before digging.



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Soil Characterization Profile Exposure: Road Cut or Erosional Feature

- 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*.



Soil profile, exposed during a flood in 2013. Boulder Colorado, USA

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Using an Auger to Assemble a Soil Profile

An alternative way to expose a soil profile is removing soil cores from the ground using an auger.

The cores are placed end-to-end on a board or tarp to create a profile that matches the profile of the soil in the ground.



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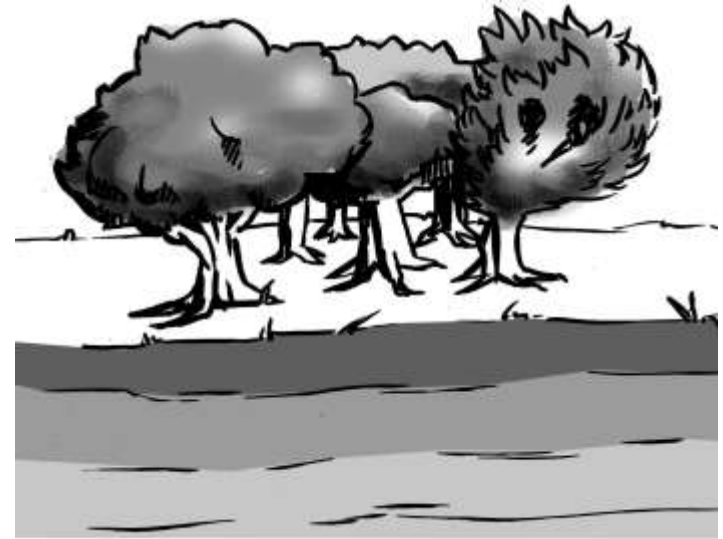


Site Requirements for the Auger Technique

Identify an area where the soil profiles should be similar and where you can dig three holes.

Spread a plastic bag, tarp, board, or other surface on the ground next to where you will dig your first hole.

A profile of the top 1 meter of soil will be assembled on this board or material by removing successive samples with the auger and laying them end-to-end.



In this illustration, the land cover is similar and the topography is level, so one hypothesis would suggest that the soil would be the same underneath.

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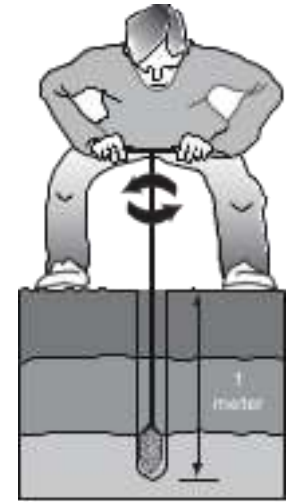
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Summary of the Auger Technique for Assembling a Soil Profile

To auger, push the auger vertically into the soil. Turn the auger clockwise as you push down. To keep from compressing the soil, don't turn the auger more than one full rotation (360°) before bringing a sample up to the surface to lay out on your board or tarp.



After removing each sample, you use the meter stick to measure the depth of the hole. Adjust the soil on the board or tarp so that the distance of the sample from the top of the profile is the same as its depth in the ground.

See the steps in the following slides....

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Using the Auger to Extract a Core from the Ground

To auger, push the auger vertically into the soil. Turn the auger clockwise as you push down. Turn the auger no more than one full rotation (360°) before bringing a sample up to the surface to lay out on your board or tarp.

Place the core on the tarp with the top of the auger at the top of the tarp. The soil will spread out on the tarp.



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Measuring the Depth of the Hole

Once you know the hole's depth, place the 0 cm of the meter stick at the top of the soil on the tarp.

In this example the depth measures 12 cm.



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Adjusting the Core to the Depth of the Hole

If the bottom of the soil sample on the tarp extends past the depth of the hole,

Adjust the soil sample to match the depth of the hole.

12 cm



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Add a Second Core to the Profile

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Auger a second time.

Remove the second auger filled with soil from the hole.

Place the second core on the tarp with the top of this auger sample placed adjacent to the bottom of the previous sample.

Push the soil out of the auger so that the top of this core lines up with the bottom of the previous one.

Align each core's position in the profile with the depth of the hole.

Use the meter stick to measure the depth of the hole after each sample and adjust the oil on the tarp to that depth.





Adjust the Length of the Second core

Place the meter stick into the hole and measure its new depth.

21 cm



Adjust the soil position in the profile to the depth in the hole

For Additional Cores:

Continue this procedure with each auger sample you take until you reach one meter in depth or you can't auger any deeper.



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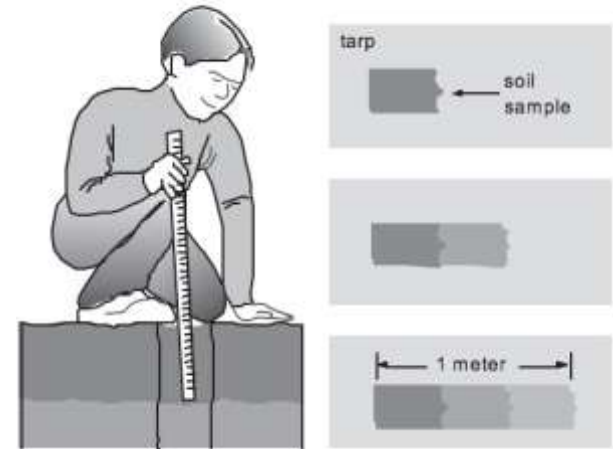
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Near Surface Method

Use this method if digging deep enough to obtain a suitable soil profile is not possible. You can still obtain valuable information about the top 10 cm of the soil, even if you cannot sample the entire 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 for a second location next to the original sample hole. Repeat again, and mix the three samples together. Treat this mixed sample as a horizon.



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.

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Safety and Mitigating Site Disturbance

- Ideally, you should do your data collection in one session. If you cannot finish your data collection in a single session, do the following so that the holes you have made in the ground are not a hazard to humans or other organisms:
 - 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 should be replaced into the soil pit in reverse order (last one out should be first one back in). Planting a tree in the hole will mark that the soil at that spot has been disturbed, so future investigations will take place in other areas.



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Selecting, Exposing and Defining a Soil Characterization Site

Entering a Soil Sample Site Definition - Step 1

- A. Why characterize soil profiles?
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Featured

2015 Surface Temperature Field Campaign

The GLOBE Program will host its annual surface temperature field campaign from 1-31 December 2015.

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RECENT MEASUREMENTS

< **Crestwood High School**, United States, Weatherbug, Measured on: 2015-12-22

[Enter Data](#)

[Visualize Data](#)

To enter data, sign into the website. Click the “Enter Data” button.



Entering a Soil Sample Site Definition - Step 2

- A. Why characterize soil profiles?
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◀ GLOBE Data

Data Entry

[Live Data Entry](#)

[Training Data Entry](#)

[Email Data Entry \(EMDE\)](#)

[Data Entry Mobile App](#)

Data Entry

GLOBE Data Entry consists of several options:



[Live Data Entry](#) – These pages are for entering environmental data – collected at defined sites, according to protocol, and using approved instrumentation – for entry into the official GLOBE science database.

Click the “Live Data Entry” link.



Soil (Pedosphere)



Selecting, Exposing and Defining a Soil Characterization Site

Entering a Soil Sample Site Definition - Step 3

- A. Why characterize soil profiles?
- B. Select and Define your site
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Site Definition

Add site type * indicates a field is required

- Atmosphere**
 - Atmosphere
 - Surface Temperature
- Hydrology**
 - Hydrology
- Land Cover/Biology**
 - Land Cover
- Earth as a System**
 - Greening
 - Phenological Gardens
- Soil**
 - Soil Characterization
 - Soil Moisture and Temperature

site name *

Name your Soil Sample Site.

Coordinates

Latitude * Longitude * Elevation *

North South East West

Enter your site's GPS coordinates.

Source of Coordinates Data *

GPS Other

Select the source of your location data.



Photos →

Select the type of site you wish to define.



Entering a Soil Sample Site Definition - Step 4

Soil Moisture and Temperature [\(Click to undo edit\)](#) - [Expand/Collapse](#) | [✕ Remove](#)

Comment (A comment about your changes is required to edit this section.) *

Add metadata and other information about your site here.

Previous Comment

Surface State

Natural



Surface Cover

Short grass (under



Canopy Cover

Some trees (within



Use the drop down menu to select the Surface State of your study site.

Use the drop down menu to select the Surface Cover of your study site.

Use the drop down menu to select the Canopy Cover of your study site.

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Entering a Soil Sample Site Definition - Step 5

- A. Why characterize soil profiles?
- B. Select and Define your site
- C. Pit Method
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Photos

Photo Date: 

Once you have entered all of the data, click, **Create Site**.

Enter the date and upload the six photos: to the north, east, south, west, upward, and downward of your site.



Soil (Pedosphere)



Selecting, Exposing and Defining a Soil Characterization Site

- A. Why characterize soil profiles?
- B. Select and Define your site
- C. Pit Method
- D. Auger Method
- E. Near Surface Method
- F. Report data to GLOBE
- G. Visualize data
- H. Quiz yourself
- I. Additional Information

Soil Characterization Site Definition Example

Site Definition

Add site type

Atmosphere

Atmosphere

Surface Temperature

Hydrology

Hydrology

Land Cover/Biology

Land Cover

Earth as a System

Greening

Phenological Gardens

Soil

Soil Characterization

Soil Moisture and Temperature

Photos →

site name * * indicates a field is required

Soil Characterization Site Near Shed

Coordinates

Latitude *

Longitude *

Elevation *

North South East West

Source of Coordinates Data *

GPS Other

Name your Soil Site.

Enter your site's location coordinates

Select the source of your location data.

Clicking Soil Characterization brings up the Site Information Page.



Entering Supplementary Information-1

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Soil Characterization Site Definition Data Entry Additional Information

Soil Characterization Expand/Collapse Remove

Comment

Add any comments about the site here.

Add metadata comments here.

Select the sample collection method.



Slope Angle

Enter the slope and aspect.

Method

Land Use

Landscape Position

Parent Material

Cover Type

Distance from Major Features

Enter the distance.

Do you want to define a horizon at this time? Yes No

Select "No" if you are not ready to describe horizons.

If you need to wait to enter supplemental data, please do so.




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Entering Supplementary Information-2

Soil Characterization Site Definition Data Entry Additional Information Example

Slope Angle:



Method:

Land Use:

Landscape Position:

Parent Material:

Cover Type:

Distance from Major Features:

Once you know your supplemental site characteristics and information, please enter it by Clicking "Edit Site" from Your School .

Do you want to define a horizon at this time? Yes No

Enter your site definition

Definition of soil horizons is covered in the module on Soil Characterization.

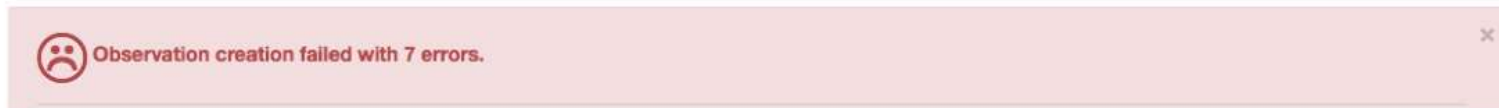


Response in Data Entry

If your data are accepted, you will see the image below.



If your data are not within the appropriate range or has other issues, you will see the following.



Address the errors the page details and resubmit your data.

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GLOBE Visualization System

The screenshot shows the GLOBE Visualization System website. The top navigation bar includes links for About, Join, Get Trained, Do GLOBE, GLOBE Data, Community, News & Events, and Support. The GLOBE Data menu is open, showing options for Data Entry, Visualize Data, Retrieve Data, and Science Honor Roll. The main content area features a 'Visualization System' section with a description: 'GLOBE provides the ability to view and interact with data measured across the world. Select the visualization tool to map, graph, filter and export data that have been measured across GLOBE protocols since 1995. Currently the GLOBE Data Visualization Tool supports a subset of protocols. Additional Features and capabilities are continually being added.' A prominent blue button labeled 'Enter the Visualization System' is visible. A left sidebar contains a 'Home' link and a 'GLOBE Data' menu with sub-links for Data Entry, Visualize Data, Retrieve Data, and Science Honor Roll.

Learn more about the GLOBE Visualization System

- Link to step-by-step tutorials on Using the Visualization System will assist you in finding and analyzing
- GLOBE data: [PDF version](#) [PowerPoint version](#)

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Quiz Yourself

1. What can you learn from soil characterization?
2. You should define your sampling site at least 3 m from path or construction area- why?
3. When would you use the near surface sampling method?
4. Why is it important to take three samples when doing the near surface sampling method?
5. What measurement is taken using a clinometer?
6. What do you use a compass for in this protocol? ‘
7. A soil sampling site with natural, undisturbed vegetation is ideal. When might you decide to identify a soil sampling site in an area with a lawn or another kind of vegetation?
8. What are the advantages of using the pit sampling method? The auger sampling method?
9. Describe some safety concerns and how to protect people and other organisms from hazards associated with this protocol?
10. True or False: with the auger method, it is not possible to obtain a valid measurement of the thickness of soil horizons

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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?

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Please provide us with feedback about this module. This is a community project and we welcome your comments, suggestions and edits! [eTraining Feedback](#)

Questions after reviewing this module? Contact GLOBE eTraining: rlo@ucar.edu

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Cover Art: Jenn Glaser, *ScribeArts*

More Information:

[The GLOBE Program](#)

[NASA Earth Science](#)

[NASA Global Climate Change: Vital Signs of the Planet](#)

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