QR CODE

The World Beneath My Feet

A Closer Look At Soil

GLOBE Goes to Camp *Vision*

Empowering learners of all ages through NASA Citizen Science STEAM focused explorations within a community-based learning ecosystem

GLOBE Goes to Camp *Mission*

Cultivating a sense of environmental stewardship one camper, one camp, one community at a time

Table of Contents

Materials

For Learning Sequences Ages 5-12

- [ ] Soil Observation Notebook
- [ ] Pencils
- [ ] Colored pencils
- [ ] Paper lunch bags
- [ ] Shovel or soil sample probe
- [ ] Tooth picks
- [ ] Magnifying lenses
- [ ] Colored markers
- [ ] Crayons
- [ ] Getting to Know Soils Student Activity Sheets 1, 2 and 3
- [ ] Soil samples from near home
- [ ] 16 oz clear jars with lids
- [ ] Watercolor paper
- [ ] Water
- [ ] Glue
- [ ] Paint brushes
- [ ] Labels for containers
- [ ] Dry soil samples (at least 48 oz)
- [ ] Organic compostable scraps (at least 5 tbsp)
- [ ] Mallet or other tool for crushing dried soil
- [ ] Paper plates and cups
- [ ] Literature on soil types and the role of decomposers
- [ ] Magnifying lenses
- [ ] Soil Treasure Hunt Student Activity Sheets 1 and 2
- [ ] White paper
- [ ] Pipe cleaners
- [ ] Styrofoam balls (small, medium, and large)
- [ ] Long toothpicks or skewers
- [ ] Silly string
- [ ] Cookie sheet (optional)
- [ ] Measuring cups (at least 8 oz)
- [ ] Measuring spoon (at least 1 tbsp)
- [ ] Soil thermometer
- [ ] Permanent markers
- [ ] Stirrers
- [ ] Rulers

Extension Materials

- [ ] At least 3 soil samples each from a different location at the soil study site
- [ ] Soil core sampler tool
- [ ] Paper soil sample bags (3 per group of two)
- [ ] Soil Journal Pages
- [ ] Skewers (optional)
- [ ] Strainer (optional)
- [ ] Quart size clear plastic bags (optional)
- [ ] Large white board or 3 poster sized pieces of white paper
- [ ] Activity Card Sheets 1-6

Elementary Story Books

- [ ] The Scoop on Soils (GLOBE Elementary Story Book)
- [ ] Dirt The Scoop on Soil by Natalie M Rosinsky (Elementary K-5)
- [ ] The Street Beneath My Feet by Charlotte Guillian (Elementary to Middle School)
- [ ] Up in the Garden and Down in the Dirt by Kate Messner (Preschool to Elementary)

For Learning Sequences Ages 10-18

- [ ] Soil Observation Notebook
- [ ] Pencils
- [ ] Colored pencils
- [ ] Soil Moisture Sensor
- [ ] Data Collection Sheet
- [ ] Infrared (IR) thermometer
- [ ] Soil thermometer
- [ ] Air thermometer
- [ ] Compass
- [ ] Soil sample probe or shovel
- [ ] Paper bags
- [ ] Markers
- [ ] 16 oz clear jars with lids
- [ ] Water
- [ ] Three 500 mL beakers or clear containers of similar size labelled in cm to pour or catch water
- [ ] 1.2 L samples of soil. Each sample should have varied colors, texture, structure, consistency, density, pH, fertility, layering, and composition
- [ ] Fine mesh screen that does not absorb or react with water
- [ ] Clock/timer/stopwatch
- [ ] Mud pies (at least 7, with 2 of 7 frozen)
- [ ] Ice cubes or marbles/marble-sized rocks
- [ ] Sandpaper (medium grit)
- [ ] Eyedropper
- [ ] Spray bottle
- [ ] Small plastic buckets/tubs
- [ ] Plastic drop cloth, tarp, newspaper for indoor or hard outdoor surfaces such as concrete or asphalt
- [ ] Paper towels
- [ ] Safety goggles
- [ ] Gloves (optional)
- [ ] Paint trays (or aluminum foil pans/shallow plastic bins with wood blocks/planks/books to create a slightly angled slope)
- [ ] 1/2 liter (4-5 cups) of loose soil per paint tray
- [ ] Hair dryer
- [ ] Two 50 mL graduated cylinders or measuring cups

The NASA "Why"?

NASA isn't all about outer space. A major part of NASA missions and explorations have to do with the planet we live on, from the atmosphere to the pedosphere. One of NASAs Earth-focused satellites is the Soil Moisture Active Passive (SMAP) mission. SMAP employs an orbiting observatory to map soil moisture, to detect whether soils are frozen or thawed, to help scientists understand the links between Earth's water, energy, and carbon cycles, and to improve predictions of weather, climate, floods, and droughts.

Scan this QR code to learn more about SMAP and other NASA missions.

The Community "Why"?

The properties of soil are unique to every place on Earth due to the difference in the soil forming factors working together in any particular place. These factors include the parent materials from which the soil forms, the position in the landscape where the soil is found, the topography, the plants and animals living in the soil, the climate in the area where the soil forms, and the amount of time the other factors have been interacting.

Every day, every person on Earth depends on soil whether we realize it or not. Where we live, what we eat, and how we dress can all somehow be related to soil. Healthy soil is the foundation for crops that people and animals use daily. By preserving soil, we ensure that it remains adequate as a resource that helps supply us food and other products.

Data on soil temperature, moisture, and the physical and chemical properties of soils is invaluable to scientists in hydrology, climatology, meteorology, biology, anthropology, and other disciplines, but not just scientists are concerned with soil. Knowing how many weeks in a year have relatively dry compared to wet soil conditions, how land cover affects soil moisture, and how soil moisture can vary even within a single plot of land or a given day can inform significant choices being made in your community. Remember the importance of considering and asking questions about the soil where you live.

Scan this QR code to learn more about how being a GLOBE Citizen Scientist can help us learn more about our Earth's pedosphere.

Activity

Intro Video: NASA's Earth Minute

Time: 2 min

Materials: Internet access

The best way to monitor soil moisture is not from the ground; it is from space. Tracking soil moisture helps us improve weather forecasts and climate models, and helps farmers make informed decisions on when to plant, water, or harvest crops. Knowing when the soil under our feet is getting too dry also helps us plan for droughts, prepare for food shortages, and identify places where wildfires might start.

The Soil Moisture Active Passive (SMAP) mission is one of the ways NASA observes the Earth's soil moisture from space. Follow the QR code to learn about SMAP and related NASA-led research.

Journal Prompts:

What important information is made available by using NASA satellites to monitor soil moisture?

How might the data on soil moisture collected by NASA satellites be utilized?

Observation Notebooks

Time: 15 min (varies)

Materials: Soil Observation Journal Pages, colored pencils, pencil

Soil Journal pages formatted according to each soil activity are available through GLOBE. Provide copies of these pages for each learner to form their Soil Journals; in addition to the GLOBE pages, learners could add blank pages to the journal to be filled out with notes, observations, questions, sketches, etc. For each soil activity, learners will use their Soil Journals to record the answers to any Journal Prompts. Encourage each learner to customize their journals and label them with their names.

Journal Prompts:

What do you think you might find if you dug a hole in field of grass? How about at a construction site? Would it be the same or different from the holes you might dig elsewhere?

Before beginning the soil investigation activities, write down what you currently know about soil. Come up with a question about soil that you would like to find an answer to.

Learning Sequence Ages 5-12

Activity

Getting To Know Soil (Part 1)

Time: 45 minutes

Materials: The Scoop on Soil (GLOBE Elementary Story Book), Getting to Know Soils Student Activity Sheet 1, paper lunch bags, shovel or soil sample probe, tooth picks, magnifying lenses, markers/colored pencils/crayons

This activity, separated into two parts, is intended to introduce learners to the properties of soil by using touch, sight, and smell to make observations and encourage questions.

Soil Not Dirt

Soil, in addition to being host to living organisms, is composed of **inorganic** rocks and **minerals**, air, water, and decaying **organic** matter. The defining properties of soil are its **color**, **texture**, **structure**, **consistency**, **density**, **pH**, and **fertility**. The soil characteristics of an area has important influence on land use, natural disaster preparedness, **satellite imagery** interpretations, vegetation growth in landscapes, **soil moisture**, and **surface temperature**. The main functions of soil are plant growth, water filtration through **pore space**, providing habitats for living organisms, and as a resource for human infrastructure development.

Soil is deposited in layers over time; the layers have varied chemical compositions and textures. A **soil horizon** is one of these deposited layers found within a **soil profile**. Younger soils are nearer to **bedrock**. Both highly developed soils, such as those found in **tropical regions**, and younger soils are unlikely to have many distinct horizons. More horizons can be found within a soil profile in **temperate climates** (such as under forest vegetation). Horizon identification is done by noting changes in soil characteristics with depth.

Pedologists (soil scientists) study and preserve soil. We know that soil is an extremely important resource and maintaining the health of Earth's **pedosphere** is pertinent to the wellbeing of the Earth system as a whole. To acknowledge the respectable role of soil, note that "dirt" is only misplaced soil, and when scientists discuss the pedosphere, they differentiate this by rightly calling it soil, not "dirt".

Safety

Instructors should investigate soil collection sites before this activity to ensure they are free from potential safety hazards (wasp nests, fox dens, fire ant mounds, etc). Protective clothing, appropriate footwear, and sunscreen should be worn.

Interpretive Nature Walk

To begin Part 1 of this activity, read the GLOBE Elementary Storybook *The Scoop on Soils*, which is available to download for free on the GLOBE Elementary web page, aloud to learners or have them read it individually. Hand out paper bags (at least 1 for each different soil sampling location) and shovels or soil sample probes to each group of 3 or 4 learners. Utilizing soil sample probes is recommended as it is particularly useful in observing the soil profile with depth. Guide the groups on a hike throughout the pedosphere investigation sites, collecting soil samples at 3 different locations; ideal collection sites will have soils of varied characteristics such as **soft, silty soil** from a creek bed, **sandy soil**, and **clay rich soil**. Ask learners to predict what they might find out about the different soil samples if they were to study each kind carefully. After developing a list of predictions about the soil, distribute the various tools and supplies for Part 1 of **Getting To Know Soil** among the groups of learners, emphasizing the need to keep different soil samples separate. Have learners spend time investigating the different soil samples using their various senses - feeling the soil with their fingers, smelling the soil, making visual observations, etc. After experimenting with the different soil types, have the learners record observations of each soil type on the **Getting to Know Soil Activity Sheet 1**. They may also include a smudge of each soil sample with a description as a way to record the soil color. Have the learners share their observations with the class and record them on chart paper. Lead learners in discussion of the soil **texture** and **color**, focusing on any inorganic matter they might have seen or felt.

Journal Prompts:

Why is soil so important?

If you were growing a garden, what do you think might happen if the soil had too much clay? How might this affect the vegetation?

Sketch a picture of a garden with your favorite vegetables growing in it.

Learning Sequence Ages 5-12

Activity

Getting to Know Soil (Part 2)

Time: 30 minutes

Materials: soil samples from home, 16 oz clar jars with lids, markers/colored pencils/crayons, Getting to Know Soils Student Activity Sheets 2 and 3

This activity, separated into two parts, is intended to introduce learners to the properties of soil through using touch, sight, and smell to make observations and encourage questions.

Identifying Type and Composition of Soils

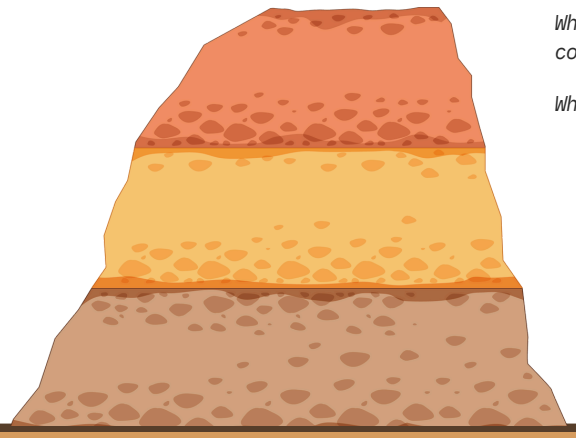
To prepare, instructors should lead a discussion on **soil characterization**. The GLOBE pedosphere protocols provide resources on soil characterization which may be helpful as a supplement to this activity. **Structural classifications** of soil are **granular**, **blocky**, **prismatic**, **columnar**, **platy**, or *having no visible structure* (**single grained** or **massive soils**). **Soil consistency** may be described as **loose**, **friable**, **firm**, or **extremely firm**. **Soil texture** should be categorized by **particle composition and size** (percent clay, percent silt, and percent sand). **Clay** is a mineral particle less than 0.002 mm in size that has a sticky and dense feel when moistened and rubbed between the fingers. **Silt** is a mineral particle between 0.002 and 0.05 mm in size that has a floury and smooth feel when moistened and rubbed between the fingers. **Sand** is a mineral particle between 0.05 and 2.0 mm in size that has a gritty feel when moistened and rubbed between the fingers.

Investigation

Begin part two by explaining that **soil composition** is **inorganic matter** (clay, silt, and sand), **pore space** filled with air and/or water, and **organic matter** (living and dead plants and animals). Tell learners that in this part of the activity, they will look at soil from one of their soil samples. Have each group of learners put one sample of soil they collected into a jar that is partially filled with water. Tell them to put a top on the jar, shake the jar, and then observe what happens after 2 minutes, 10 minutes, and 24 hours. Have them record their observations on the **Getting to Know Soil Activity Sheet 2**. Know that organic materials are usually expected float to the surface and the inorganic materials settle into layers of different sizes and colors (the organic layer will be at the top, then clay, silt, and sand). Also, mark the water level on the jar at the start and observe how it changes.

Figure 1 USDA Soil Texture Triangle

Give each learner a copy of the **Getting to Know Soil Activity Sheet 3** and invite them to discuss the various layers or other features found in the soil. Focus on the visible features you can see in the profile, such as color, **grain size**, roots, rocks, etc. Have the learners complete the words and color in the different layers on the **Getting to Know Soil Activity Sheet 3**, matching colors with layers in the jar of soil. Have them cut out both the profile and cover sheet and staple the cover sheet to the top. To review the layers, have the learners read a word and lift the corresponding flap to check that they correctly identified the word. If you would like to take this activity to a more advanced level, have the learners write in more information and observations about each layer on the back of its flap. Older learners can also write the whole word rather than filling in the blanks.



Journal Prompts:

What are some examples of mineral differences in the soil collections being studied?

What causes soil to vary in color?

Activity

Painting With Soil

Time: 75 min (Part 1 & 2)

Materials: (Part 1) paper bags, shovel or soil sample probe; (Part 2) water, watercolor paper, glue, paint brushes, mallet or other tool for crushing dry soil, paper plates, paper cups

Learners will collect assorted soil samples and will then investigate and use those samples to create a medium for their unique piece of art.

Safety

Instructors should investigate soil collection sites before this activity to ensure they are free from potential safety hazards (wasp nests, fox dens, fire ant mounds, etc). Protective clothing, appropriate footwear, and sunscreen should be worn.

Collect Soil Samples

As with the Getting To Know Soil activity, hand out paper bags (1 for each different soil sampling location) and shovels/soil sample probes to each group of learners. Guide the groups on a hike throughout the property, collecting soil samples at 3 to 6 different locations (ideal collection sites will provide soils that vary in color and inorganic minerals). Once learners are back in their workspace, place soil samples on paper plates, allowing them to dry completely.

Paint With Soil

Once dry, use your soil-crushing tool (small mallet/mortar/pestle) on the samples, focusing on the differences in color resulting from the constituent inorganic matter, organic matter, and the **weathered parent material** of the soil. In individual cups, gradually add glue and water to the soil while mixing until a consistency resembling paint is reached. Each soil sample should create a different color of paint.

Once the paint is mixed and learners begin creating their art, share with them the history of soil as a medium for creating pottery, dyeing clothes, and painting cave walls and faces. Emphasize the importance of soil to vegetation and the Earth in general. Mention that the organisms which humans consume also feed on the plants grown in soil, and that plants release the oxygen we breathe into the air. Also mention that many organisms find shelter in soil. Introduce **soil filtration** of **groundwater** as a means of removing contaminants from water. Ask learners what things we use in everyday life are made of soil or things found in soils (building materials, for example, or cosmetics).

Have the learners share their artistic creations with the group, noting the source of each soil type within their paintings. The art could be showcased as a gallery or put together in a book. Instructions on making book covers are available as extension activities outlined in the full **Painting With Soil** activity instructions.

Journal Prompts:

What were the different colors you used in your painting?

Why do you think soil comes in so many different colors?

What might the color of the soil tell us about where it was found or how it was formed?

What are some other ways soil can be used in art?

Learning Sequence Ages 5-12

Activity

Soil Treasure Hunt

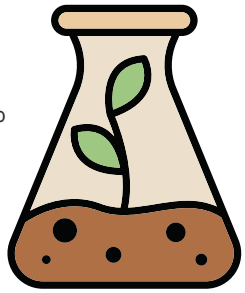
Time: 1 hr

Materials: Books on decomposers' relationship to different types of soil (see Literature Connections page), paper bags, shovel/soil sample probe, tooth picks, magnifying lenses, markers/colored pencils/crayons, Soil Treasure Hunt Student Activity Sheets 1 & 2

Safety

Instructors should investigate soil collection sites before this activity to ensure they are free from potential safety hazards (wasp nests, fox dens, fire ant mounds, etc). Protective clothing, appropriate footwear, and sunscreen should be worn.

Soil Collection and Sorting



Go over the informative literature with the learners. As the topic of decomposition is discussed, point out any **fungi** growing on logs or **tree snags** (upright, naturally decomposing trees). Once they exhibit an understanding of what **decomposers** do and how that relates to soil, hand out paper bags and shovels or soil sample probes to groups of 3 to 4 learners. Enough paper bags should be given so that there is at least one designated bag per soil sampling location. Lead the groups on a hike throughout the soil investigation site to collect soil samples at three different locations. Ideally, collection sites will vary in soil composition, such as forest soil rich in **humus** (dark, moist soil composed of bits of decaying organic matter) and earthworms, meadow soil hosting plants and roots, and soil found near human structures. Ask learners for their predictions about what inorganic matter (sand, silt, and clay) and, especially, what organic matter they might expect to find in each sample. Have each learner write at least one prediction and one question about soil on a **Soil Treasure Hunt Activity Sheet 1**.

Distribute various tools (toothpicks, magnifying lenses, etc.) to small groups of learners. They can sort each of their soil samples on the **Soil Sorting Sheets** (you may want to laminate these for multiple uses) based on particle size, plant material, and animal material. If the learners find decomposers in the soil such as beetles, snails, earthworms, etc., have them show the other groups, draw them on their **Treasure Hunt Activity Sheet 1**, and release them back outside where the soil was collected. If no decomposers are found, discuss possible organisms that function as decomposers and the role that they play in overall soil health and composition. Bring up points which further the discussion, such as that decomposers break down dead organic matter into nutrients that are then used for plant growth. Explain that decomposers are nature's "natural recyclers" who free up space in the ecosystem by repurposing decomposing organic matter into other forms like humus. At the end of the activity, generate a group discussion by having learners take turns to share their observations, findings, and illustrations with the class.

Journal Prompts:

Imagine what life is like beneath the soil. Draw and write about the life of a tiny decomposer, a tree root, or any other thing you can imagine finding down, down below.

What is the role of decomposers in nature? Name some examples decomposers.

What are some examples of the inorganic material that may be found in soil?

Modifications and Extensions

Earthworms

Fill a clear plastic or glass container with sand, potting soil, and dead leaves. Put earthworms in the container and cover the outside of the container with black construction paper. Water the container so it is moist but not soggy every 2-3 days.

After 3 days, remove the paper and observe the differences in how the soil looks. Notice what the earthworms have done to change the soil. Cover the container again and keep checking every 2-3 days for changes.

Field Guide to "Soil Friends"

Create a field guide to illustrate the "soil friends" your learners might find in your local soil. Some common "soil friends" are earthworms, insects, spiders, centipedes, and millipedes. You can either put information about the "soil friends" on a bulletin board or print up small guides the learners can take outside to use as a reference when they are exploring in the soil.

Learning Sequence Ages 5-12

Activity

Let's Build A Soil Model

Time: 30 min

Materials: Pipe cleaners, styrofoam balls (small, medium, large), long toothpicks/skewers, silly string, cookie sheet (recommended)

Safety

Instructors should use judgement in determining whether or not to use toothpicks. Straws or coffee stirrers could be a safer choice with younger learners.

Overview

In this activity, learners will work together in groups of 3 or 4 to create soil models representing the inorganic matter, organic matter, and pore space found in soil.

The porosity of soil is a ratio of the volume of space occupied by water and/or air compared to the volume of solids in a unit of soil. Porosity varies depending on the composition of soil. Sandy soils have lower porosity than clayey or silty soils. The porosity of soil can be related to the bulk density and the particle density. Soil bulk density is a measure of how dense and compacted a sample of soil is. The bulk density of soil depends on the structure of the soil, how compacted the soil is, the porosity, and the composition of the soil particles. Soils made of minerals will have a different bulk density than soils made of organic material. The particle density of a soil measures the mass of a soil sample in a given volume of particles. Particle density differs from bulk density because bulk density includes the volume of the solid portion of the soil along with the spaces where air and water are found.

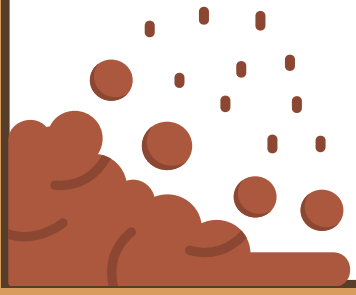
Soils with high concentrations of organic matter and lower bulk densities are more porous. Porous soils can store more air and water; the porosity of soil can indicate the rate at which air, water and heat might move through the soil profile. Understanding porosity also helps pedologists better understand soil health and fertility, and predict erosional events such as flooding.

Investigation

Begin with a class demonstration of how soil reacts when no organic matter is present. Place several Styrofoam balls on a cookie sheet or table and call on a learner to come up to blow on the balls. Because no organic matter is present, the balls will move around freely. Without organic matter, soil is easily moved and has a hard time retaining water and air. This is what happens with erosion. Explain to the learners that the **pore space** is crucial to healthy soil. Show the learners a completed soil model to demonstrate how much pore space there is between the organic and inorganic matter, and remind them that this would vary based on the soil composition.

Separate learners into groups of three or four. Each group will be given nine balls total: three small balls to represent clay, three medium balls to represent silt, and three large size balls to represent sand. Each group will also be given pipe cleaners and/or toothpicks. These will represent the organic matter that is found in soil (leaves, insects, plants, etc.) Each group will then build their soil models by connecting the balls together using pipe cleaners/toothpicks. As the instructor walks around, ask learners to identify which ball represents which mineral and what their pipe cleaners represent.

After each group has completed their model, the instructor can spray the silly string on the learners' models. This string represents **glomalin**, the biotic "glue" created by the secretions of organic materials. This acts as a natural binding agent that helps stabilize the soil. Now that the learners have completed their models, have them place their models on their tables and try to blow them around. This is a demonstration of the importance of organic materials in soil and how the organic materials help to prevent erosion. Have the learners start breaking down their models, taking pieces off one at a time. Let them see how this affects their models. This is another way they can see what happens to soil when erosion occurs.



Journal Prompts:

Can you think of a place you have visited that is composed of a lot of inorganic matter and very little organic matter?

Think like an engineer. You are building a house. You may only use one of the following: sand, silt or clay, to build your bricks. Which component would you choose and why?

Learning Sequence Ages 5-12

Activity

The Great Decomposer

Time: 45 min (Day 1) + 15 minutes/day for 2-week observation period

Materials: Measuring cups (at least 8 oz), 1 tbsp measuring spoons (0.5 oz), soil thermometer, permanent markers, stirring sticks, ruler, handouts (Learning Activity Sheets, Observation Sheets, Drawing Sheets, and Data Sheets), mason jars with holes in lids, mason jar labels, dry soil samples (at least 48 oz per group), 5 tbsp organic scraps (2.5 oz) per jar *NOTE: DO NOT USE MEAT, DAIRY, OR ANY PROCESSED FOODS*

Overview

Learners will work together in groups (2-3) to conduct an experiment examining the impacts that moisture and climate have on the rate of decomposition. Each group will maintain and observe a set of variables over a period of 2 weeks. Then, the observations and rates of decomposition will be compared.

Preparation

Set up stations in the classroom that will serve as the sunny and shaded environmental conditions required for the experiment. Label each jar according to moisture level (dry, moist, wet) and climate/location (sun vs shade).

Introduce learners to the 5 soil formation factors:

- **parent material** - the underlying geological material in which soil horizons form. Soils typically inherit a great deal of structure and minerals from their parent material. Soil parent material often includes loose sand, silt, and rocks deposited by wind, water, glaciers, or rock and mudslides.
- **climate** - Heat, rain, ice, snow, wind, sunshine, and other environmental forces break down the parent material and affect the speed at which soil forms.
- **organisms** - all living things in or on the soil (including plants, animals, microorganisms, and fungi) that impact the way soil forms. Their dead remains are the organic matter that enriches soil as it decomposes.
- **topography** - The location of soil on a landscape can affect how climate processes impact it.
- **time** - it takes time for soil to form. Deposition of parent material can take thousands of years or might happen quickly during a large storm. The climate forces that break down the parent material take hundreds to thousands of years. Organisms can affect soil in minutes to days, and also over longer periods of time

Procedure: Maintenance and Observations

Tell learners that they will be conducting an experiment by combining soil, organic scraps, and differing amounts of water. Each of the jars will be placed in either a sunny or shaded location. Ask learners to make predictions about the impact of moisture and climate/location on the organic scraps over time. Write down the predictions. Ask learners to complete the steps on the **Great Decomposer Learning Activity Sheet**.

Designate 3 days a week for maintenance and observation. On these days, saturate the WET jars by adding ½ cup water, use 2-4 tbsp water to moisten the jars marked MOIST. Every day for at least 2 weeks, have learners examine the containers for any changes. Measure and write down the height of the compost mix and the temperature of the compost mix (as shown with a soil thermometer in degrees and as approximated by touch). Also note on the **Observation Sheets** the appearance of the compost and any notable changes.

Interpreting the Data

At the end of the investigation, graph and discuss the results. Identify whether any of the predictions made by the learners were correct. Ask why they think their predictions proved correct or incorrect, and how the different treatments and environmental conditions of their jars impacted the rate of decomposition exhibited. Compare the soil in the jars and discuss which factors may contribute to the formation of healthier soil by significant decomposition of the compost. Have learners come up with advice they would give to farmers who want richer, healthier soil.

Modifications and Extensions

To expedite the decomposition process , keep earthworms in the compost jars. Additionally, the impact of the addition of earthworms can be studied by comparing observations on a jar hosting earthworms and a control jar that is without earthworms but otherwise identical.

If this activity is being completed in a weekly camp setting, each group of campers can maintain/observe throughout their camp week, examining the changes over time on their final day of camp. This can be an ongoing project throughout a camp month or summer.

Journal Prompts:

What factors influence the rate at which organic compost breaks down?

How might decomposition be impacted by too little or too much water?

Describe and draw the steps needed to make a successful compost bin.
Include details about where you would build it (sun vs shade),
what you might add to it, and how you would care for it to result in healthy compost.

Learning Sequence Ages 5-12

Activity Extensions

Soil Detectives: Creating A Soil Profile

Time: 75 min
Materials: 3 soil samples from different areas of the soil study site, soil core sampler, paper bags, permanent markers, colored pencils, Soil Journal pages; optional: skewers, strainers, magnifying glasses, paper plates, shovels, quart sized plastic bags

Safety

Instructors should investigate soil collection sites before this activity to ensure they are free from potential safety hazards (wasp nests, fox dens, fire ant mounds, etc). Protective clothing, appropriate footwear, and sunscreen should be worn.

Overview

The purpose of this activity is to have learners use their senses to compare and contrast multiple soil samples they collect from different sites (forest, creek bank, grassy field, etc.) and connect what they learn about each soil to its surrounding habitat. The **Soil Detectives Journal** pages learners will record their information in are available to print in the full activity document.

Investigation

Use a soil core sampling tool to create a soil profile. Stick the tool into the ground firmly and twist until the column fills up with several inches of soil. Have learners sketch the column of soil including the soil layers or horizons before pouring it into the lunch bag. Use a permanent marker to label each bag with the location, date, and time of collection. Next, have the learners use all of their senses to compare and contrast the way each soil feels, looks, and smells. Sketch and/or record details about the soil's color, texture, smell and things found in each sample, such as organisms, in their soil journal. Paper plates, toothpicks, strainers, and magnifying glasses may be used to explore the soil sample. Share and discuss in a large group.

Journal prompt:

Imagine that you have an airplane that can fly you around the world. You are able to obtain a soil sample from the Sahara Desert and a soil sample from a rainforest in Costa Rica. How do these soil samples feel, smell, and look? Write down any similarities or differences. What do you think makes the samples so different?

We All Need Soil!

Time: 1 hr (Parts 1 & 2)
Materials: Large whiteboard/3 large poster papers, Activity Card Sheets 1-6 (1 set/group)

Safety

Instructors should investigate soil collection sites before this activity to ensure they are free from potential safety hazards (wasp nests, fox dens, fire ant mounds, etc). Protective clothing, appropriate footwear, and sunscreen should be worn.

Overview

Learners will generate lists of what makes up soil, what lives in soil, and how soil is used by living things. They will make connections between a plant or an animal and how they use soil to secure food or make a home.

Preparation

Make two charts on two of the poster sized pieces of paper or create two columns on a whiteboard. Label one "What makes up soil?" and the other "What lives in soil?"; create another chart with the title "How Soil is Used by Living Things" and divide this chart into three sections: Plants, Animals, and Humans. Cut out and laminate a set of cards (**Activity Card Sheets 1-6**) for each group of learners.

Investigation

With the charts you have made, start by asking learners to develop a list of what makes up soil and record on the chart. Ask learners to generate ideas of what lives in soil and record their ideas.

Using the chart "How Soil is Used by Living Things," ask learners to complete each section of the chart separately as to how plants, animals, and humans use soil. Discuss connections between how each group uses soil to survive. For example, plants use soil to grow and animals eat the plants that grow in the soil. Show the group the activity cards. Review all of the cards so the learners are familiar with the pictures and vocabulary. Show them how to lay out all of the cards by type (i.e. Group 1, Group 2, Group 3, Soil, and Home/Food). Demonstrate the process that students will use to make soil connections. Take a card from each pile and lay them out on a table or floor in a sequence that leads to a connection. Break into groups of two to four learners and give each group a set of cards. Have the learners come up with as many connections as they can. After all of the small groups have arranged their connections, have them share their soil connections with the group.

Journal prompt:

Write a thank you card to soil for all the ways it benefits you and the world.

Learning Sequence Ages 10-18

Activity

A Field Of View: Digging Into Soil

Time: 75 min (Parts 1 & 2)

Materials: Observation Notebooks, Digging Around Data Sheets, pencils, IR thermometer, soil thermometer, air thermometer, soil moisture sensor, compass

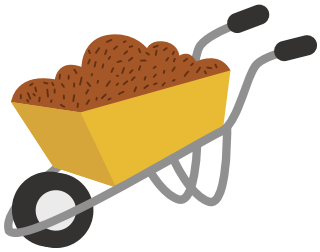
Safety

Instructors should investigate soil collection sites before this activity to ensure they are free from potential safety hazards (wasp nests, fox dens, fire ant mounds, etc). Protective clothing, appropriate footwear, and sunscreen should be worn.

Overview

Learners will investigate variations in the soils at 5 spots around the soil investigation site to understand that soil properties like moisture, temperature, color, and texture exhibit considerable variability across a single landscape. They will also identify factors affecting the appearance of soil and the soils water capacity such as slope, shade, plants, and compaction.

Investigation



Begin by asking learners which side (North or South) of a slope, at the soil investigation site, would get the most sunlight. If possible, bring learners to a nearby slope to help them answer the question. Ask them where they would look to go hunt for worms or other soil dwelling invertebrates, and why they would choose there. Remind them that organisms need water, air, and nutrients to survive, and that in denser compacted soils, it is more difficult for these resources to be accessed.

At the soil investigation site, divide learners into groups of three to five. Each group should have a shovel and their Observation Journals. Have groups look for differences in soil properties at five different places in the site by digging up a small amount of soil. Have them examine and touch their samples, and record what they find in their Observation Journals. Ask them to note types of plants, presence of rocks, roots, and organisms (such as earthworms), how hard or easy it is to dig, distances to items on the landscape or other things they notice. Have learners list the areas they investigated from the wettest to the driest. Note how the moisture content may be affected by the location, the type of plant cover, or other things at the site.

In the second part of this activity, learners will complete the **Digging Around Data Sheets** and have a discussion on what they observed. They will sketch the field view of the area when facing North, East, South, and West; emphasize the need to take care to incorporate all of the factors associated with the soil in the landscape. Examine the characteristics of the soil at each of these spots. At each spot, record soil surface temperature, air temperature & soil temperature at depth in the chart provided on the Digging Around Data Sheet.

Journal Prompts:

Where in the soil investigation site would soils be most alike?

Where would you locate the soils that are most typical for your area? Look for large areas within your site which have common characteristics.

Which areas have similar soil forming factors?

What types of land cover affect soil moisture?

Learning Sequence Ages 10-18

Activity

Just Passing Through

Time: 1 hr

Materials: Clear 2 liter bottle, three 500 mL beakers or other clear container marked by cm, soil samples, fine mesh screen, water, clock or timer

Overview

To develop an understanding of **water filtration** and **flow rate** through different soils, learners will time how long it takes for a measured amount of water (300 mL) to pass through different soil samples. Students will consider the **porosity** of the samples by observing how much water is retained as **soil moisture**, and the water filtration capacity of the samples by comparing the clarity of the water before and after it passes through the soil.

Investigation

Create the soil filtration system by removing the labels and lids of the 2 L bottles and cutting off the bottoms. Place a piece of mesh screen large enough to cover the cap opening inside the bottle,and pour 3 to 4 cm of sand onto the screen to prevent clogging. Once the bottle is prepared, place it with the mesh side down in a beaker or clear container, leaving room for any water that seeps through to be collected. Pour a different 1.2 L sample of soil into each prepared bottle over the layer of sand.

The depth of the investigation and subsequent discussions should be adjusted to the abilities of the learners. Detailed suggestions can be found in the full GLOBE pedosphere learning activities documents, but generally should begin with characterizing the soil samples and hypothesizing how the various soil samples will affect the behavior and appearance of the water as it filters through the bottle, followed by measuring, timing, documenting, and comparing of the actual results to the hypotheses. Saturated soil may also be experimented on again by pouring an additional 300 mL of water into the bottle and seeing if there are changes compared to water filtering through unsaturated soil. As an extension, measure the pH of distilled water and predict possible changes in the pH as the water filters through different samples.

Journal prompts:

How can you change the way your soil holds water?

Which soil property would you look for if you wanted to build a garden?

Describe the circumstances within soil that might lead to tremendous flooding and/or erosion.

Imagine that a huge rainstorm is expected in your area. How will a rainstorm of this type affect members of your community?

Learning Sequence Ages 10-18

Activity

Soil Makers: Breaking It Down

Time: 1 hr

Materials: Observation Sheets, pre-made mud pies (at least 1 frozen), ice cubes, medium grit sandpaper, water, eyedroppers, spray bottles, small plastic buckets/tubs, plastic drop cloth/tarp/newspaper for indoors or hard surfaces outdoors such as concrete or asphalt, paper towels; optional: safety goggles, gloves

Safety

Due to the hands-on nature of handling soil, instructors may want to advise learners to wear clothing that can get dirty or provide protective clothing or aprons. If possible, instructors should provide safety goggles to prevent sediment from getting into the learner's eyes. Gloves may be worn if desired.

Preparation

Prepare “mud pies” of soil combined with water at least three days before beginning the experiment. Form the mud pies using soil mixed with enough water so that the soil is wet but not runny. Take a palm-sized amount of mud and form into a patty by hand or with a mold. Place two to five mudpies per learner in each group, still wet, in a freezer, and allow them to freeze overnight. Keep frozen until needed. Set the rest of the mud pies aside to dry completely in the sun or a warm place. It may take up to 3 days for them to completely dry by air. The amount of mud pies needed will depend on the group's size. Learners can do the activity individually or in small groups. If materials are limited, set up different stations around the area for each investigation and have the learners rotate around the stations.

Investigation

To develop an understanding of the geologic phenomena of the breaking down or dissolving of rocks and minerals, learners will model weathering by performing different investigations on mud pies. Through their investigations, learners will get a broad understanding of the natural causes that contribute to weathering. Learners will test different materials to model different types of physical weathering.

Before beginning the experiment, provide a copy of the **Weathering Observation Sheet** to each learner. Introduce the concept of weathering to the learners. You may choose to read a book about soil and/or weathering. Discuss the three types of weathering (physical, chemical, and biological) and have the learners include examples on their **Weathering Observation Sheets** in Section 1. Inform learners that this activity focuses on physical weathering and that the mud pies are a model for rock or consolidated sediment. Break into small groups or have individual learners space out a bit. Hand out the observation sheet. Go over the observation sheet with the learners. Explain how they will follow the directions to test the ice/marble, sandpaper, dropper, spray bottle, bucket/tub, as well as dropping their mud pie on a hard surface. As the learners observe what happens to their mud pies, learners will fill out Section 2 of the **Weathering Observation Sheet**.

Give each group two to five of the nonfrozen mud pies (at least one per person) and let them begin their investigations. Once learners have completed those investigations, hand out the frozen mud pies and have each learner or group look closely at the mud pie. The learners should be able to see the ice crystals that have formed in the mud pie. Do not worry if the mud pie breaks apart because it will only help to illustrate the properties of water that cause it to expand and break apart a rock as it freezes. If time permits, let the learners use some of the materials on their frozen mud pie and record their observation. After experimenting with the mud pies, have the learners gather as a group to compare their thoughts about what natural phenomenon of physical weathering each investigation represented. Did the learners/groups come up with the same answers to each one?

Journal prompts:

Imagine a rock in a creek on a mountain. Describe the factors that might contribute to weathering of the rock. How do these factors change the way the rock looks and feels over time? Sketch the rock before and after weathering.

What types of weathering processes can change a landscape quickly and what types of weathering processes can change a landscape very slowly?

Learning Sequence Ages 10-18

Activity

Soil Makers: All Carried Away

Time: 1 hr

Materials: Activity Sheets, paint trays/aluminum pans or shallow bins propped up to slope, 1/2 liter soil in each tray, at least 16 oz of sediment granules or pebbles (2-64 mm) per tray, paper towels; optional: safety goggles, gloves; glacier investigation: ice cubes and frozen mud pies; wind investigation: hair dryer, clock/timer/stopwatch; rain investigation: eye droppers and spray bottles filled with water; flood/flow investigation: two 50 mL graduated cylinders or measuring cups with water; beach investigation: water

Safety

Due to the hands-on nature of handling soil, instructors may want to advise learners to wear clothing that can get dirty or provide protective clothing or aprons. If possible, instructors should provide safety goggles to prevent sediment from getting into the learner's eyes. Gloves may be worn if desired.

Overview

Erosion is the process by which earthen materials such as soil are worn away and transported by natural forces such as wind or water. Learners will model soil erosion by performing different investigations on soil. Through their investigations, learners will get a broad understanding of the natural causes that contribute to erosion. Learners will test different variables to affect rates of erosion.

Preparation

Use a waterproof or permanent markers to draw a line every 5 cm across each paint tray or its alternative. Prepare the soil trays by firmly packing a mixture of soil and rocks at the raised end of the paint tray. Or, if using a pan or bin, fill one half with the soil and rock mixture and then stack wrapped books or wood planks/blocks under the soil end of the pan or bin to create a gentle slope (about 3 to 15 degrees). Secure the pan or bin in place with tape or rubber bands. Keep additional soil available during the activity to replace lost soil when they repack their trays between investigations.

Investigation

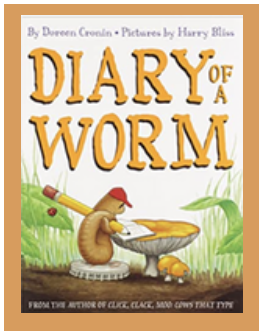
Before beginning the experiment, provide a copy of **On the Move: Erosion Activity Sheet** to each learner. Introduce the concept of erosion to the learners. Discuss the ways erosion can occur (wind, water, glacial ice, waves, gravity, human activities) as well as landforms that can develop due to erosion (cliffs, caves, mesas, valleys, etc). Ask the learners to write down the examples they came up with on their **On the Move: Erosion Activity Sheets** in Section 1. Tell the learners that they will be conducting several investigations to model different causes of erosion while testing multiple variables to see how rates of erosion change with different conditions. Break into small groups of two to four students and go over the activity sheets with the learners. Explain how they will follow the directions on their activity sheet as to how to test the glacier, wind, rain, flow, flood and beach scenarios. Give each group a soil tray and the materials for each scenario and let them begin their investigations. Learners will be eroding the soil models representing loose sediments or natural soil deposits throughout the activity. As they observe what happens to the soil, ask the learners to share their observations with their group and fill out Section 2 of their activity sheets. After describing how much and how far the sediment moved, learners may need to replace the soil in their tray/pan/bin. After experimenting with their soil trays, have the groups come back together in a large group to compare the outcomes of each modelled scenario.

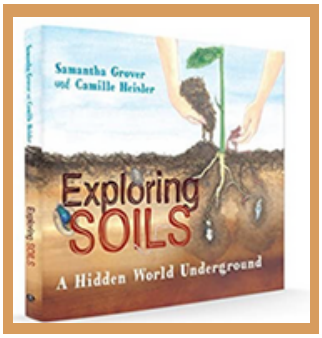
Journal prompts:

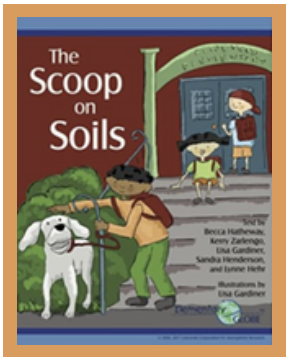
Imagine that you are in Antarctica looking at glaciers: How do you think the glaciers impact erosion? Sketch out and describe your predictions.

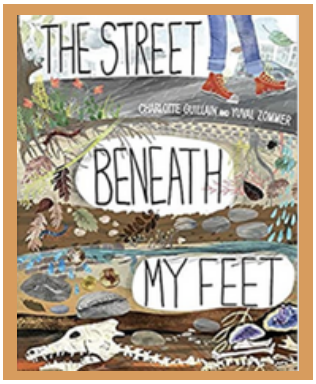
How are landforms created by erosion?

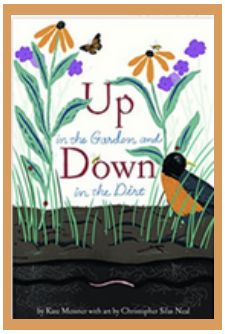
Literature Connections

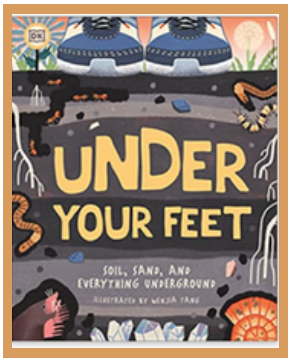


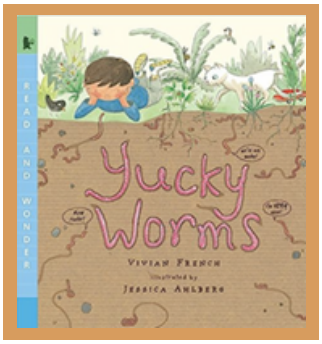












Resources & Citations

Next Generation National Science Standards Alignment

4-ESS2-1: Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Citations

U.S. Department of Agriculture. *(Soil) Textural Triangle.* Accessed July 30, 2024. Available: https://www.nrcs.usda.gov/sites/default/files/2022-11/Texture%20and%20Structure%20-%20Soil%20Health%20Guide_0.pdf

Learn more about Global Learning Observations to Benefit the Environment (GLOBE) Program and more Earth science activities on the GLOBE website.

Further pedosphere learning materials as well as protocols on the hydrosphere, biosphere, and atmosphere, and information about using and downloading the GLOBE Observer app are also available.

Name of socials/websites/etc

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To participate, download the app, register with an email address then go outside and follow the prompts in the app to observe your environment.