National Aeronautics and Space Administration

NASA eClips™
Educator Guide

NASA'S OUR WORLD
DIRT

Educational Product	
Educators & Students	Grades 3-5

EG-2010-07-013-LaRC

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NASA eClips™ Dirt

EDUCATOR GUIDE

National Standards:

National Science Education Standards (NSES)

Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Earth and Space Science

- Properties of earth materials

International Society for Technology in Education: National Educational Technology Standards (ISTE/NETS)

Research and Information Fluency

- Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.

Essential Questions

- What are the properties of Earth's soil?
- How does Earth's soil compare to the moon's dirt (regolith)?
- What is the relationship between rocks and Earth's soil? How does this compare to the relationship between rocks and the moon's dirt?
- What can scientists learn by studying soil and dirt?

Instructional Objectives

Students will:

- observe, analyze and compare several Earth soil samples;
- explore the difference between Earth's soil and rocks;
- observe and analyze simulated lunar regolith; and
- explain how and why dirt on the moon is different from soil typically found on Earth.

Grade Level:
3-5

Subjects:
Elementary Earth science

Pre-requisite:
This lesson builds upon Earth science concepts relating to Earth sediment, rocks, and the rock cycle.

Teacher Prep Time:
20 minutes

Lesson Duration:
Two 50-minute classes

Time Management: Class time can be reduced to one 50-minute class if students complete parts of EXPLAIN, EXTEND and EVALUATE at home.

Lesson Overview:

Students use two separate KHWL (KNOW-HOW I KNOW- WANT TO KNOW-LEARN) charts to organize their knowledge of Earth's soil and moon dirt. Working in teams, students create several slides of Earth soil for analysis.

EDUCATOR GUIDE

Through NASA eClips™ video segments, students review the rock cycle for rocks on Earth and learn about three types of lunar rocks. Students analyze simulated lunar regolith to make inferences about the formation of regolith. Student understanding is assessed using overlapping circle Venn diagrams. This lesson is developed using a 5E model of learning.

Icons flag five areas of interest or opportunities for teachers.

- **Technology Icon** highlights opportunities to use technology to enhance the lesson.
- **Modification Icon** denotes opportunities to differentiate the lesson.
- **Resources Icon** relates this lesson to other NASA educator resources that may supplement or extend the lesson.
- **Connections Icon** identifies opportunities to relate the lesson to historical references and other topics or disciplines.
- **Check for Understanding Icon** suggests quick, formative assessment opportunities.

Materials List:

EXPLORE

Per student

- Student Guide

Per group of 2

- four index cards
- a roll of wide, clear packing tape
- four different soil samples
- a hand lens for each student or one for the group

EXTEND

Per class

- 1 box lid (shoe box size)
- 1 larger box or lid that the small box lid can be placed inside
- cinnamon sugar graham crackers (enough to line the bottom of the small box)
- 3-4 mini cake donuts (covered with white powdered sugar – leave out for a day to dry out)

The soil samples for the EXPLORE activity and the simulated regolith for the EXTEND activity should be prepared before class.

- Locations to get different types of Earth soil samples for the EXPLORE activity include: playbox sand; garden soil; orange, sticky clay might be found in a park, trail, or construction site; samples from edges and bottoms of streams and ponds will have fine muddy to coarse sandy consistencies. SAFETY: Stay away from excavation vehicles and ditches. Dry samples on

foil in the sun or a warm oven for 1-3 hours to kill any bacteria. Students and teachers should wash their hands after handling samples.

- Directions for preparing simulated regolith:
    a. Gather these materials:
        - 1 box lid (shoe box size)
        - 1 larger box or lid that the small box lid can be placed inside
        - cinnamon sugar graham crackers (enough to line the bottom of the small box)
        - 3-4 stale mini cake donuts covered with white powdered sugar
    b. In an open area, spread newspaper on the floor. On the newspaper, place the small box lid inside the larger box lid.
    c. Spread an even layer of graham crackers on the bottom of the small box lid, simulating the bedrock on the moon.
    d. Crush a few graham crackers into very small crumbs and place on top of the bedrock layer. This simulates the surface layer of moon's regolith.
    e. Let the mini cake donut (micrometeoroid) fall from your hand, from above your head and into the box lid with the graham crackers. This "donut dropping" simulates the bombardment of micrometeoroids on the moon. White powder will fall off the donuts and mix with the graham cracker layer. Small pieces of the donuts may also break off and mix with the broken graham crackers. This simulates what happens when micrometeoroids hit the surface of the moon. Small particles or pieces of the micrometeoroids break off and become part of the moon's regolith.

NASA Background

Moon dirt is very different than Earth's soil. Moon dirt, or regolith, is created when micrometeoroids hit the surface of the moon, throwing debris out of impact craters and breaking the moon's rocks into smaller pieces. This fine dust covers the surface of the moon. Regolith is a mixture of moon rock and micrometeoroid particles. The composition and texture of the lunar regolith varies from place to place depending on the rock types that have been broken.

Generally the older the surface, the thicker the regolith. The regolith on young maria may be only 2 meters thick. In contrast, it is perhaps 20 meters thick in the older lunar highlands. Soil on Earth is a product of weathering. Once rocks break into smaller particles, the particles may be carried away by erosion. Bits of decayed plants and animals, called humus, combine with the smaller particles to create Earth's soil.

Scientists have been able to analyze and study the moon's regolith here on Earth. Between 1969 and 1972, six crewed Apollo missions brought back 382 kilograms (842 pounds) of lunar dirt and rock samples.

The moon's regolith has some interesting characteristics when compared to Earth's soil. The particles in moon dirt are very small (usually less than 0.1 millimeter across). These tiny particles become electrostatically charged, meaning that they can "stick" to objects like space suits and equipment. Lunar dust is almost like tiny fragments of glass or coral – odd shapes that are very sharp and lock together. The dust can easily become airborne inside a spacecraft, irritating the space explorers' lungs and eyes. The darker dust particles can even absorb sunlight and heat up whatever they coat.

Resources

21st Century Explorer

http://education.jsc.nasa.gov/explorers/p10.html

Regolith Formation

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Regolith_Formation.html

5E Inquiry Lesson Development

ENGAGE (20 minutes)

1. (**CHECK FOR UNDERSTANDING**) As a class, use a KHWL (KNOW/HOW/LEARNED) chart to organize what students **KNOW, HOW** they know this information and what they **WANT TO KNOW** about Earth's soil.
   These questions can help guide the discussion:
   - What do you **KNOW** about Earth's soil?
     (*Answers will vary but may include a discussion that Earth's soil has different colors and different textures. Students may discuss sand, clay, or mud.*)
   - Ask students to explain **HOW** they have learned the information stated about Earth's soil.
     (*Answers will vary. Many will come from student experiences such as playing in a sandbox, hiking on a trail, visiting a beach, making mud pies, etc. This is the time to help students consider the validity of their sources for information.*)
   - What do you **WANT TO KNOW** about Earth's soil?
     (*Answers will vary. Encourage students to seek answers to their questions beyond this lesson.*)

2. (**MODIFICATION**) You may choose to have students complete the KHWL chart individually in a science notebook before sharing their thoughts with the class.
3. (**TECHNOLOGY**) If available, use an interactive whiteboard for the KHWL chart for this ENGAGE preassessment.

EXPLORE

Students will create slides to observe, analyze and compare samples of soil.

Procedure

1. Have materials for the activity available for students.
2. Ask students to follow the directions in the Student Guide to create the slides and to observe and record observations of the soil samples in Chart A on page 3 of the Student Guide.
3. (**CHECK FOR UNDERSTANDING**) Guide a discussion about different types of soil.

   These questions can help guide the discussion:

   - What were some of the original materials found in the soil samples? (*Answers will vary but may include descriptions of small pieces of rocks and minerals. Students may also describe plant and animal matter.*)
   - How did the soil samples compare? (*Answers will vary but may include descriptions of different colors, textures, and materials.*)
   - How would you sort and classify the soil samples? (*Answers will vary but students may choose to sort the soils by color, texture, or sediment size.*)
   - How does geographic location impact this activity? (*Answers will vary but students should discuss how different locations have different rocks, minerals, and living matter.*)

EXPLAIN (20 minutes)

1. (**TECHNOLOGY**) Show the NASA eClips™ video segment *Our World: The Rock Cycle* (4:30) to the students. This segment can be found on the NASA eClips™ page of the NASA website:

   http://www.nasa.gov/audience/foreducators/nasaeclips/search.html?terms="the%20rock%20cycle"&category=0000

   The video may be streamed or downloaded from the nasa.gov web site; a captioned version is also available at the nasa.gov site.

(**MODIFICATION**) This video may be streamed from the NASA eClips You Tube™ channel:

http://www.youtube.com/watch?v=SRaInMDNyE8&feature=channel

2. (**CHECK FOR UNDERSTANDING**) Based upon the NASA eClips™ video segment and prior knowledge, discuss the role soil plays in the rock cycle and how rocks and soil can be used to learn more about Earth.

These questions can help guide the discussion:

- On Earth, how are soil and rocks related?
  (*Answers will vary but may include a discussion of soil, or sediment, being pressed and cemented together to create sedimentary rocks. Students may also discuss how rocks are weathered to create soil and sediment*.)
- What kind of rocks are created from soil?
  (*Sedimentary rocks are formed when sediments are pressed and cemented together*.)
- What can you infer about a geographic location when you study Earth's soil?
  (*If you look at soil samples with a hand lens, you may find pieces of rocks and minerals, nonliving plant and animal matter, and living things. These materials are clues to the formation and original location of the soil samples*.)

3. Ask students to return to the KHWL chart to add information.

EXTEND (30 minutes)

Students will analyze simulated moon dirt (regolith) to make inferences about its formation. Then, students will compare what they infer with what they have learned in the EXPLORE and EXPLAIN sections of this lesson.

1. (**CHECK FOR UNDERSTANDING**) Ask students to consider how Earth's soil is similar to dirt found on the moon. Introduce the word regolith, the term for moon dirt. Use a second KHWL chart to organize what students know, how they know this information and what they want to know about **regolith**.

   These questions can help guide the discussion:

   - What do you **KNOW** about regolith?
     (*Answers will vary but may include suggestions that moon dirt is grey and smooth. Students may have little knowledge about regolith and will learn more throughout this lesson*.)
   - Ask students to explain **HOW** they have learned the information stated about regolith.
     (*Answers will vary. This is the time to help students consider the validity of their sources for information*.)
   - What do you **WANT TO KNOW** about regolith?
     (*Answers will vary. Encourage students to seek answers to their*

questions beyond this lesson.)

- How do you think Earth's soil compares to regolith? (*Answers will vary but may include a discussion about Earth's soil forming due to weathering. Students may compare Earth's soil formation to micrometeoroids breaking the moon's rocks into tiny pieces. Students may also discuss that bits of decayed plants and animals are found in Earth's soil, but not in the moon's dirt*.)

2. Gather samples of the crushed simulated lunar regolith made earlier for each team of students. Students will use these samples to create slides.
3. (**RESOURCES**) The directions for creating regolith are from a *NASA 21st Century Explorer* lesson, *Making Regolith*. In this lesson, students create the regolith before making observations.
   a. The educator guide for this lesson may be found at: *http://ksnn.larc.nasa.gov/21Century/pdf/p10_educator.pdf*
   b. The student guide may be found at: *http://ksnn.larc.nasa.gov/21Century/pdf/p10_student.pdf*
4. Ask students to follow directions in the Student Guide EXPLORE activity to create slides and to observe and record observations of the simulated regolith in Chart B on page 4.
5. (**CHECK FOR UNDERSTANDING**) As a class, guide a discussion about the formation of the simulated regolith. These questions can help guide the discussion:
   - What do you think were some of the original materials found in the moon dirt sample? (*Answers will vary but students may guess powdered sugar and graham crackers*.)
   - Based upon your observations, what can you infer about how the "simulated" moon dirt was made? (*Answers will vary but students may discuss different ways to crush the original materials*.)
6. (**CHECK FOR UNDERSTANDING**) Return to the KWHL charts from the ENGAGE and EXTEND activities to organize student understanding and compare Earth's soil to lunar regolith.
7. (**MODIFICATION**) Challenge students to create their own "mystery" lunar regolith as a homework assignment. Students can trade "mystery regolith" samples and work to identify the original materials the next day.
8. Teachers can become certified to handle lunar rocks. To find out more, visit *http://aesp.psu.edu/professionaldevelopment.cfm*

EVALUATE (20 minutes)

1. Through discussion and the results of the EXPLORE, EXPLAIN and EXTEND experiences, determine if your students have an accurate understanding of Earth's soil and lunar regolith.
2. Return to both KHWL charts. Review the information under the KNOW column. With the help of the students, correct any misinformation placed there during the ENGAGE experience. Ask students to make a list of things they wonder about now.
3. Use an overlapping circle Venn Diagram to describe the differences and similarities between Earth soil and lunar regolith.
4. Ask students to answer this journal prompt to assess their understanding of the composition of Earth's soil and the moon's dirt.
   What can scientists learn by studying Earth's soil and the moon's dirt? (*Answers will vary. Students may talk about learning more about rocks through studying soil and dirt. They may also discuss some of the differences they have observed during this experience.*)
5. Career Clips
   a. (**TECHNOLOGY**) Show students the NASA eClips™ video segment Our World: Lunar Rock (4:30) to introduce them to Andrea Mosie, a scientist working in the Lunar Sample Laboratory Facility at NASA Johnson Space Center. This segment can be found on the NASA eClips™ page of the NASA web site: *http://www.nasa.gov/audience/foreducators/nasaeclips/search.html?terms="lunar%20Rock"&category=1000*
   The video may be streamed or downloaded from the nasa.gov web site; a captioned version is also available at the nasa.gov site.
   (**MODIFICATION**) This video may be streamed from the NASA eClips You Tube™ channel: *http://www.youtube.com/user/NASAeClips#p/c/31002AD70975DC1B/12/qbLlh21ql2U*
   Ask students to read the Career Clip found on page 5 in the Student Guide to learn more about Andrea Mosie.
   b. Discuss how your students have been thinking and acting like scientists and engineers throughout this lesson. Ask students to respond to the questions on page 5 in the Student Guide to reflect on their work.

Dirt

Essential Questions

- What are the properties of Earth's soil?
- How does Earth's soil compare to the moon's dirt (regolith)?
- What is the relationship between rocks and Earth's soil? How does this compare to the relationship between rocks and the moon's dirt?
- What can scientists learn by studying soil and dirt?

Background

Earth's soil is made-up of small pieces of rocks and minerals. You will also find humus in soil. Humus is nonliving plant or animal matter.

Weathering breaks down rocks into smaller pieces called sediments. Rocks can be weathered by wind, water, plants and animals. Once sediments are set in layers, plants may take root and push the sediments deeper. Animals, layers of rock and plants, or water may also move and mix sediments.

When plants and animals die, they are decomposed by bacteria and fungi. This is how humus forms. Humus has nutrients needed by plants to grow. Nutrients are substances that an organism needs in order to survive and grow.

Soil is described by many traits. Soil texture describes the size of the sediment, or grains. Sandy soil has many small grains called sand. Silty soil has grains smaller than sand called silt. Clay soil has the smallest grains called clay. Loam is soil made up of a mixture of sand, silt, and clay.

Soil texture affects how much water soil can hold. Clay soil holds a lot of water. Sandy soil holds very little water. Many plants grow best in loam. It is neither too wet nor too dry.

Vocabulary

Clay – Clay is soil with very small particles.

Decompose – To decompose is to break down. The process of decomposing is the breaking down of dead plants and animals into tiny pieces. When these pieces mix with dirt they form soil.

Deposit – To deposit is to drop off. Wind and water often carry sand and mud particles from one place and later deposit them somewhere else. What they drop off is called a deposit (so deposit is both a verb and a noun).

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Dirt – Dirt is made of small particles formed from the breakdown of rocks.

Humus – Humus is part of the soil that is made up of decayed organic materials.

Nutrients – Nutrients are substances that an organism (plant or animal) needs in order to survive and grow.

Loam – Loam is soil made up of a mixture of sand, silt, and clay.

Luster – Luster is a way a mineral reflects light from its surface. Words like shiny and dull describe the luster of a mineral.

Regolith – Regolith is dirt on the surface of the moon. (The vowels are pronounced like those in "LEGO" and "miss.")

Sand – Sand is rock material that has been eroded into small grains.

Sediments – Sediments are particles that have been deposited by some natural process, such as blowing wind or moving water.

Silt – Silt is made of particles smaller than sand.

Soil – Soil is a mixture of minerals, weathered rocks, and decayed plant and animal material.

Texture – Texture is the way something feels. For instance, sand feels rough (has a grainy texture) while smaller mud particles have a smoother or slimy texture.

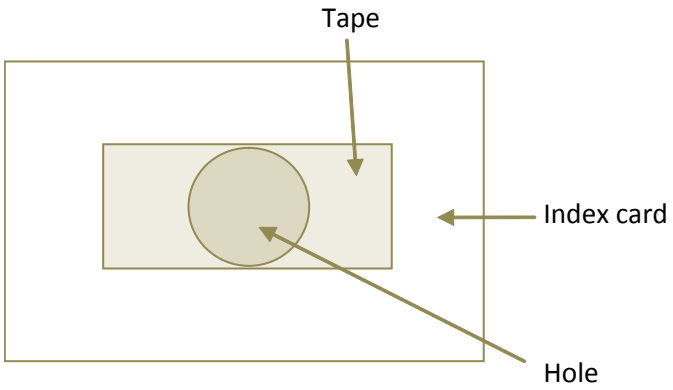
Weathering – Weathering is a process through which rocks or other materials are broken down. Wind, moving water (rivers and waves) and glaciers all cause weathering.

EXPLORE

If you look at soil samples with a hand lens, you will find many different things. Follow these directions to create soil slides. Then, use a hand lens to observe and compare the samples.

1. Directions:
   a. Cut a small circle in the center of an index card.
   b. Cover one side of the hole with clear packing tape. See Diagram 1.

Diagram 1: Soil Slide



c. Set the card down so the sticky side of the tape is facing up.
d. Sprinkle a sample of the soil on the sticky tape.
e. Use a second piece of tape to cover the sample. You have now made a soil slide.
f. Put the soil slide under the microscope or use a hand lens to examine the sample.
g. Observe the sample, taking note of the shape (round or jagged) and size of the particles. Record your observations.

2. Organize your observations in Chart A.

Chart A: Soil Observations

Sample	Color	Texture	Size	Luster	Other

3. Answer these questions based upon your observations.
   a. How are the soil samples similar?

   b. How are the soil samples different?

   c. What might cause these differences?

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EXTEND

You will learn more about lunar dirt, called regolith, during this activity.

1. Create regolith slides following the directions in step 1 of the EXPLORE section. Then, use a hand lens to observe and compare the regolith samples.
2. Organize your observations in Chart B.

Chart B: Regolith Observations

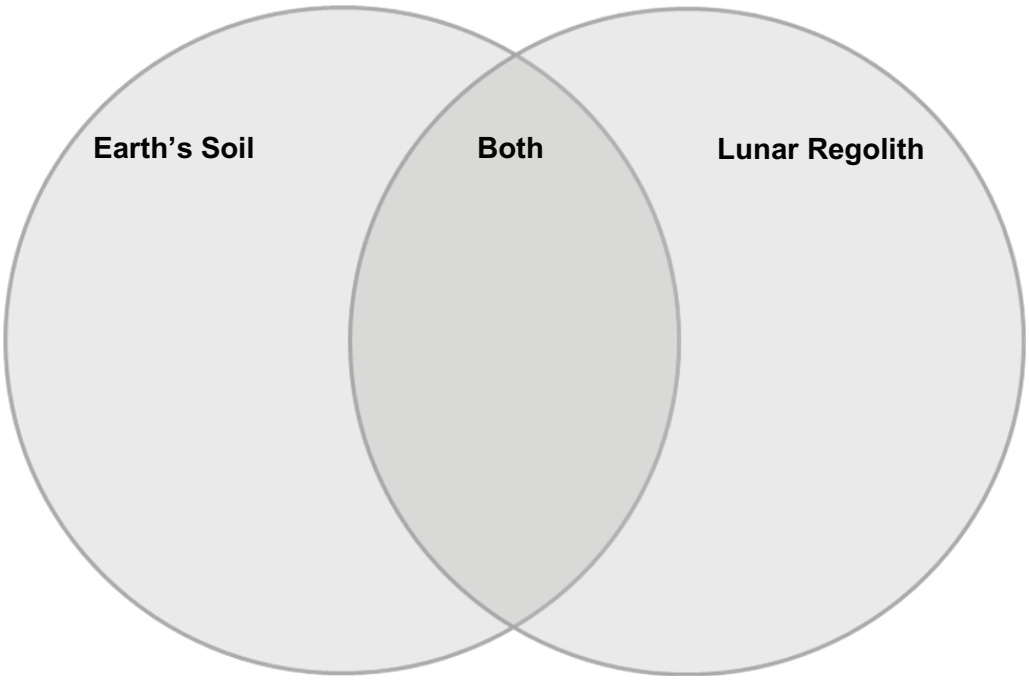
Sample	*Color*	*Texture*	*Size*	*Luster*	*Other*

3. Answer these questions based upon your observations.
   a. How do the regolith samples compare to Earth soil samples?

   b. What might cause any differences?

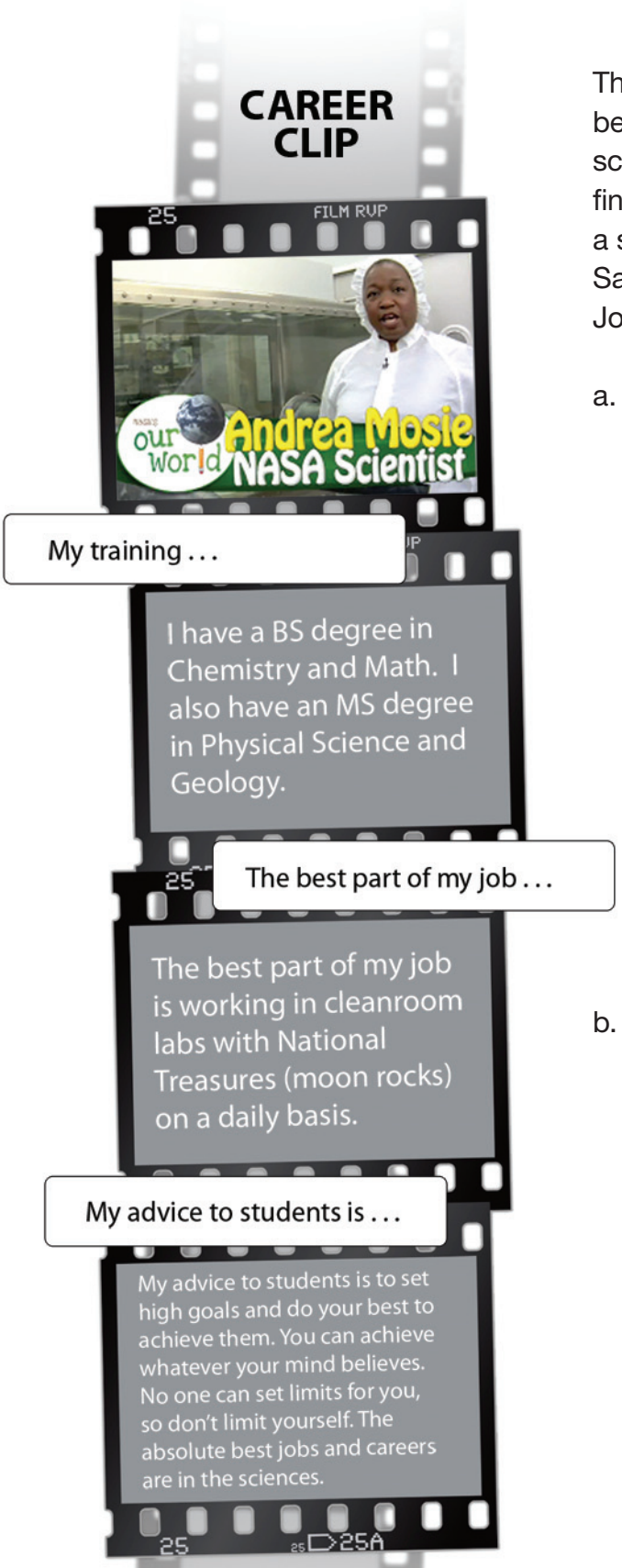
EVALUATE

1. Complete the Venn diagram comparing Earth's soil to lunar regolith.



2. What can scientists learn by studying soil and dirt?

STUDENT GUIDE



Throughout this lesson, you have been thinking and acting like scientists. Read this Career Clip to find out more about Andrea Mosie, a scientist working in the Lunar Sample Laboratory Facility at NASA Johnson Space Center.

a. How is the work that you have been doing during this lesson similar to the work Ms. Mosie does every day?

b. What can you do today that may help you prepare for a future career as a scientist?

ANSWER KEY

EXPLORE

Chart A: Soil Observations *(Answers will vary based on sources of soils.)*

Sample	Color	Texture	Size	Luster	Other
Clay Soil	Dark Red	Sticky and smooth when wet, rock hard when dry	Smallest particles	Shiny	Holds a lot of water
Loamy Soil	Dark	Gritty		Various answers	Holds water easily
Sandy Soil	Light Brown	Gritty	Biggest particles	Bright	Holds very little water
Silty Soil	Dark Brown	Smooth when dry	Smaller particles	Dull	Holds more water then sand

3. Answer these questions based upon your observations.
   a. How are the soil samples similar?
   (*Answers will vary but may include descriptions of colors, textures, and size.*)

   b. How are the soil samples different?
   (*Answers will vary but may include descriptions of different colors, textures, and size of materials in the soil.*)

   c. What might cause these differences?
   (*Answers will vary but may include discussions about the amount of sand, silt and clay the soil contains and the small pieces of rocks and minerals. Students may also describe plant and animal matter.*)

   d. How might you sort and group the samples?
   (*Answers will vary but students may choose to sort the soils by color, texture, or sediment size.*)

ANSWER KEY

EXTEND

Chart B: Regolith Observations *(Answers will vary depending upon the materials used to create the simulated lunar regolith.)*

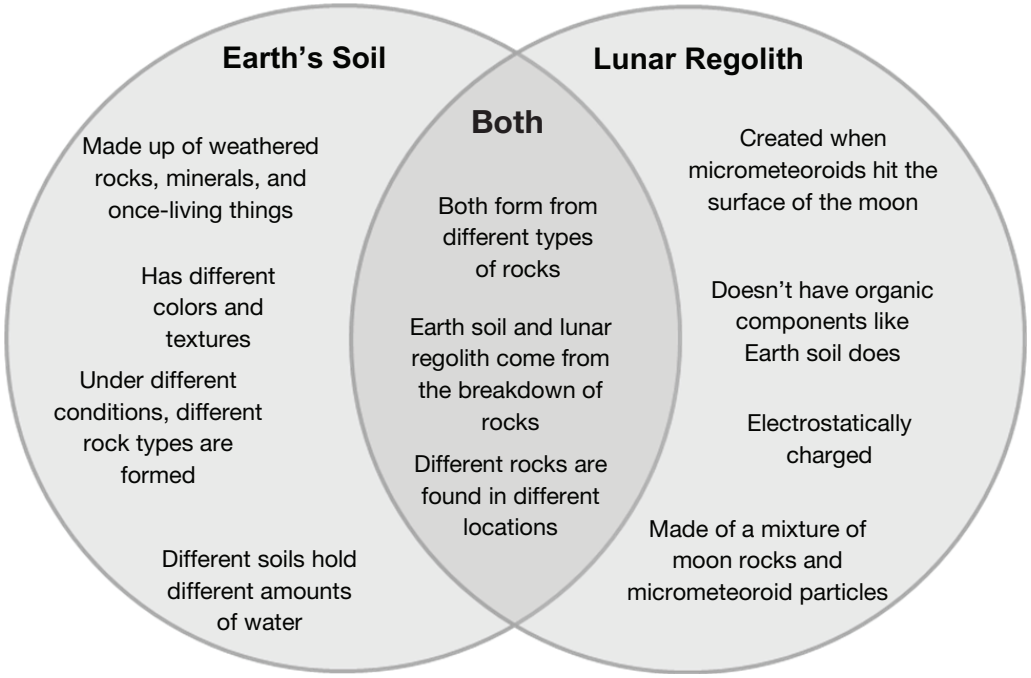
Sample	*Color*	*Texture*	*Size*	*Luster*	*Other*
Sample A	Brown	Smooth	Small	Glassy	Irregular shapes
Sample B	White	Silky	Fine	Dull	Powered

3. Answer these questions based upon your observations.
   a. How do the regolith samples compare to the soil samples?
   (*Answers will vary but may include a discussion about Earth's soil forming due to weathering. Students may compare Earth's soil formation to micrometeoroids breaking the moon's rocks into tiny pieces*.)

   b. What might cause any differences?
   (*Answers will vary but may include suggestions that Earth's soil consist of inorganic and organic matters. Regolith is a mixture of moon rock and micrometeoroid particles*.)

EVALUATE It doesn't have organic components like Earth soil.

1. Complete the Venn diagram comparing Earth's soil to lunar regolith.
   (*Answers will vary, however the illustration below provides an example*)



ANSWER KEY

2. What can scientists learn by studying soil and dirt? (*Answers will vary but students may mention that scientists found metals in the moon that could someday be mined; also, that studying dirt on the moon can help scientists understand the properties of regolith in different locations on the moon*.)

3. Career Clip
    a. How is the work that you have been doing during this lesson similar to the work Ms. Mosie does every day?
    (*Answers will vary but may include using tools, following procedures, working in a team, recording observations*.)

    b. What can you do today that may help you prepare for a future career as a scientist?
    (*Answers will vary but may include learning how to study, work in a team, and how to ask questions; also, learn more math and science at museums, science centers, zoos, etc*.)