Session 1.

Earth's Solid Membrane: Soil

Dirt…earth…soil…it forms where Earth's rocky crust meets the atmosphere. Although common to everyday experience, soil's origin and role in Earth processes are relatively unknown to most. In this session, participants will explore the processes of soil formation by thinking about how soil appears on a newly formed, barren volcanic island. As part of this story, we will learn about soil's composition, its role in some Earth processes, and its place in Earth's structure.

The Video

What is soil? How does it form? What is its place in Earth's structure and role in Earth processes? To answer these questions, this session takes us on a journey that begins at an organic farm and ends on the big island of Hawaii. During our journey, we visit with soil scientists Dr. Elissa Levine, Dr. Andy Kurtz, and Dr. Oliver Chadwick to learn more about that important substance under our feet.

Dr. Levine discusses the importance and fragility of soil and introduces us to the physical and chemical processes involved in soil formation. Joining soil scientists Andy Kurtz and Oliver Chadwick on the "Big Island" of Hawaii, we learn more about soil and its place in Earth's structure. We then visit Tim Mackey and his fifth graders in Lancaster, Pennsylvania, and watch as they generate ideas about the thickness of the soil layer and what lies beneath it.

After learning about the importance and complexity of soil, we check back in with Tim Mackey's students as they investigate soil samples to learn about the components of soil. During their investigation, the students look for clues to determine the type of environment from which the soil was collected. Throughout the video, participants see elementary school children being interviewed as they express their ideas about soil.

Learning Goals

During this session, you will build understandings to help you:

- Appreciate the complex nature of soil and soil formation
- Comprehend soil's place in Earth's structure

Facilitators: Be sure to remind participants that there is an assignment to be completed prior to Session 1. Details are listed on the next page.

Before Session 1

Activity One—Track Your Understanding

Facilitators: Please collect all responses and bring them to Session 8.

Below are questions related to Earth and space science topics. Answer them as best you can without assistance. This is not a test! It is a pre-assessment of what you already know about Earth and space science. Please bring these to Session 1. At the final session you will be able to see how your ideas have changed.

Earth and Space Science Questions

1. Describe several features of the Earth's structure.
2. Describe the processes that shape the Earth's surface.
3. How do soils form?
4. What is the role of soil in different Earth processes?
5. How do rocks form?
6. What can we learn about the Earth from rocks?
7. Sketch a cross section of the Earth showing its internal structure. Label your sketch, using as much detail as you can.
8. How do we know what we know about Earth's interior?
9. Describe the theory of plate tectonics. What does this tell us about the Earth's surface?
10. What causes earthquakes?
11. What do you know about volcanoes? List and summarize your ideas.
12. Draw a cross section of a volcano and label it.
13. Write a brief explanation of how the Hawaiian Islands formed.
14. How do mountains form? Draw a diagram as part of your explanation.
15. What role does water play in shaping the Earth's surface?
16. Make a list of things you know about the atmosphere.
17. Draw a sketch to scale (size and distance) of the Earth, Moon, and Sun and label it. How do they interact with each other?
18. How did the Moon form? What can we learn about the Earth from the Moon?
19. What is the nature of the Solar System? How did it form? Make a comparison chart of all the solar bodies.

Activity Two—Reading Assignment

To prepare for Session 1 activities and to learn more about concept mapping, read the article "The Theory Underlying Concept Maps and How To Construct Them" by Joseph Novak, located at http://cmap.coginst.uwf.edu/info. Print a copy and bring it to Session 1.

On-Site Activities

Getting Ready (60 minutes)

Activity One—Reading Discussion and Concept Mapping (20 minutes)

1. Working alone, write a brief explanation of how you think soil forms, and make a prediction of how far down the soil layer goes. Sketch a cross section of the Earth, and show where soil is.
2. As a whole group, discuss the Novak article on concept mapping. Make a list of the key and supporting concepts for making a concept map to address the question, "What is soil?"
3. With a partner, share your soil ideas, predictions, and drawings.

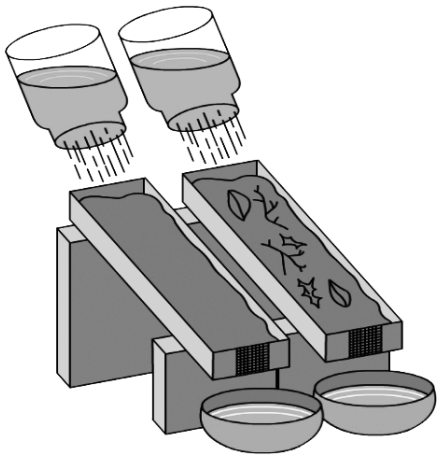
Activity Two—Soil Investigation (25 Minutes)

Facilitators: Distribute the materials listed on page 10.

1. Working with a partner, examine the two soil samples provided to you. Empty each sample onto a separate sheet of paper. Spread the soil out with your fingers or a wooden stirrer, and observe it with a magnifying glass. Identify as many different components as you can in each soil sample. Describe the characteristics of each sample including its color, texture, moisture content, stickiness, odor, or particle size. Create a comparison chart to organize your thinking.
2. Next, put your soil samples into the jars, fill the jars to the top with water, and screw the lids on tightly. Shake each jar for several minutes. Set the jars down and let the soil samples settle until after watching the video. Predict what the soil samples might look like after they settle. Include a drawing in your prediction.
3. In a group of four, compare the characteristics each set of partners came up with for the different types of soil. Discuss what you think might make soils different from each other.

Activity Three—Erosion Trays: Set Up (15 Minutes)

1. Some soils are more resistant to erosion than others. With a partner, discuss what properties of soil might be responsible for this?
2. Set up the equipment (plastic egg carton tops with the notched end toward the bottom, additional soil, containers of water, books or other items to prop up the trays, plastic bowls) to resemble the drawing below. Spread out an equal amount of the samples of soil into the trays, with one type of soil in each tray. Tilt both trays at the same angle and place the plastic bowls below the trays. Make a prediction of which soil will be more resistant to erosion by moving water. List the reasons for your thinking. Determine how you will measure the amount of erosion.



On-Site Activities, cont'd.

Viewing the Program (60 minutes)

As you view the video, think about the following focus questions:

1. How do soils result from and play a part in different Earth processes?
2. As you listen to children discuss how soil may have appeared on that barren, volcanic island, think about whether you agree or disagree with their ideas.
3. Tim Mackey has his students investigate soil samples and look for clues to the location from which each sample was collected. As you watch the students, listen to the clues they use in their thinking.

Going Further (60 minutes)

1. With a partner, discuss the processes involved in soil formation, soil's role in different Earth processes, and soil's position in the Earth's structure. Then revise your descriptions of soil formation. How has your thinking changed?
2. Recall the information on soil horizons that the scientists and the hosts presented during the video. Why is it significant that soils form in horizons?

Note: See the *Earth and Space Science* Web site to learn more about soil horizons (A Closer Look: Soil Horizons) at www.learner.org/channel/courses/essential/earthspace/session1.

3. Return to the soil samples you left settling in the jars. How did the results compare with your prediction? Revisit the characteristics you listed for each sample and add to them as necessary.
4. Can you determine where the samples came from? Did the discussion Tim Mackey's students had suggest any new ideas to you? With your partner, discuss where you think each soil sample was collected and list the evidence that supports you ideas before consulting your facilitator for the answer. Finally, as a whole group, discuss what you can learn about soil from this activity.
5. With a partner, conduct the soil erosion test, shaking the water out of the jars over each tray at the same time, and then determine which soil sample eroded the most.
   - What criteria did you use to make that determination?
   - Did the results of your test match your predictions?

   Clean the trays off and again place equal amounts of each soil into them. Make the slope of the tray steeper for the soil that eroded the least. Predict what will happen.
6. Pour water over both trays, and discuss the results:
   - What characteristics of the soil that eroded least made it more resistant to erosion by water?
   - How did adjusting the slope of the tray affect the results, if at all?
   - Why should we care about soil erosion?
7. Why are soils different from each other? Discuss this question with a partner and record your ideas. Then, share these ideas in a small group.
8. As a whole group, review the list of key and supporting concepts for making a concept map to address the question, "What is soil?" Add new concepts to the list, and develop two propositions, in the manner suggested in the Novak article on concept mapping.

Between Sessions

Homework (* = required)

All participants should complete assignments marked by the *.

About the Reading Assignment

The reading assignments for this course are selected to expose you to the research literature on children's ideas about Earth and space science and to reinforce your understanding of the science content included in each of the sessions. As you read, you are encouraged to compare your understanding of the content and the ideas typical of your students with the ideas represented in the research literature. Do you hold some of the same ideas represented in the readings? Are there ideas expressed that you understand to be scientifically inaccurate, but are not sure why? Asking these questions of yourself as you read can help you assess your own content knowledge. Occasionally, content and other readings will also be assigned to enhance your knowledge.

In some cases, there will be a specific homework task associated with a reading. In all cases, there will be small-group work connected with the assigned readings occurring during the next session.

* Reading Assignment

Ault, C. "Concept Mapping as a Study Strategy in Earth Science." *Journal of College Science Teaching*, September/October (1985): 38–44.

About the Problem Set

Homework for each session will include a problem set that will reinforce content learning by asking questions that apply or extend the Earth and space science concepts in the video. Possible answers for the problem sets are provided in the Appendix.

It should be emphasized that many questions can have a variety of answers—answers will vary depending on the understandings of the person answering the question. The intent is not to give you "right answers," but to allow you to compare your answers with those of more advanced learners in Earth and space science. At the beginning of each session, group members will review their answers for each question to address any content issues.

* Problem Set

(Suggested answers are listed in the Appendix.)

1. Make a two-column chart that lists possible components of soil. Label one column "inorganic" and the other column "organic." Make sure to include all the main components of soil. Justify your selections.
2. Explain the differences between physical and chemical weathering.
3. Write a paragraph explaining why soils are not permanent.

Between Sessions, cont'd.

About the Ongoing Concept Mapping Activity

Within each session, several fundamental concepts are explored. Creating a set of concept maps will provide you with an opportunity to reflect on your understandings of these concepts and their connections to one another as well as to see how the content in each session relates to that of other sessions.An explanation of concept mapping is listed below. Please also read Dr. Joseph Novak's article, "The Theory Underlying Concept Maps and How To Construct Them," available free online at http://cmap.cogisnst.uwf.edu/info/printer/html.

About Concept Maps

Concept maps are graphic ways of organizing and representing knowledge. They are built around concepts to which labels can be applied. Each concept is linked by words to one or several other concepts to form a proposition—a meaningful statement about some object or event in the universe.

Concept maps are hierarchically organized around a "domain" of knowledge. The domain of knowledge is the most general concept around which the map is built (e.g., rocks). Once the domain has been selected, key concepts that apply to this domain are identified that range from general (e.g., type of rock) to specific (e.g., characteristics of each rock type). This "ranking" is meant mainly to assist in building a hierarchical concept map.

It is good practice to first build a preliminary concept map (sticky notes can be useful) to allow for changes that occur as a result of thinking through the concepts and their relationships the first time. The next draft can reflect these changes. The "domain" is placed at the top of the map, with the most general key concepts in one or more levels below, depending on the number of key concepts identified and how they "rank" in relationship to the domain and to each other. The most specific concepts are placed toward the bottom of the map, underneath the concepts to which they apply.

Once the concepts are laid out, one or a few connecting words are chosen to link them in such a way that meaningful (although abbreviated) statements result. Connecting words tend to be verbs (e.g., is, have, include), but can also be conjugations (e.g., and, or) or prepositions (e.g., with, between). Connecting words should be chosen carefully, as they reflect how two concepts are understood to be related. The finished proposition represents a unit of meaning. This unit of meaning can then be built upon, revised, or assessed for understanding.

Another key feature of concept maps involves cross-links. Cross-links are connections between concepts that are made after the map is constructed by searching for relationships between different map segments. Cross-links help reveal the extent to which concepts are understood to be connected to one another. One can also cross-link different maps in this way.

* Ongoing Concept Mapping

Develop a concept map around the question "What is soil?" Reflect on the content of the video and the site investigation activities and add to your list of major concepts developed in your group of four during the site investigation activities that could be included in your map. Include as many details and connections as you can for each concept.

Between Sessions, cont'd.

About Guided Journal Entry

As you proceed through this course, one way of building and connecting understandings is to reflect upon your learning as you go. In each session, a question will be suggested to guide a journal entry. At the end of the course, these entries should help you see how your ideas have progressed.

Guided Journal Entry

Referring to Charles Ault's article "Concept Mapping as a Study Strategy in Earth Science," write about how the concept mapping activity you did helped you to organize your thinking about soil. Review the steps to concept map preparation mentioned in the article. Reflect on step five, linking related concepts. Choose one area of the concept map you created on soil and think of other possible patterns for connecting those concepts. Record one possible alternative pattern of linking. Does this restructuring affect your thinking about soil? Write about how or if your thinking changes.

About the Guided Channel-Talk Posting

Although this is a course designed to help enhance your science content knowledge, the intention is for you to use this knowledge to inform your teaching. Often, a community of learners who are also teachers can collaborate to support one another in transforming content knowledge into successful classroom action. In each session, a question will be suggested to guide a discussion on Channel-TalkEarthSpace to facilitate this type of collaboration among participants.

To subscribe to Channel-TalkEarthSpace, visit www.learner.org/mailman/listinfo/channel-talkearthspace.

Guided Channel-Talk Posting

Where do the ideas children bring to the classroom come from? Is it previous classroom experiences? Or perhaps they come from a book, entertainment media, or the child's own experience? Where does your own knowledge about soil come from? Discuss these questions in your Channel-Talk posting. Be sure to share any experiences you've had.

Suggestions for Textbook Reading

The following are suggestions for several reading topics that may provide additional background and enrichment information. These topics are likely to be addressed in any college-level Earth science/geology textbook, and can usually be located in the table of contents or index:

- Soil Components
- Chemical Weathering
- Factors Affecting Soil Formation
- Organic Matter in Soils
- Physical Weathering
- Physical Properties of Soil
- Processes of Soil Formation
- Soil Horizons

Between Sessions, cont'd.

* Preparing for the Next Session

For "Getting Ready"

One big idea in the next session is that every rock tells a story. Brainstorm the kinds of things you might learn from a rock. Then find an interesting rock to look at. What can this rock tell you? What are some questions you have about this rock? What if you knew where the rock came from? What could you learn then? Write down your ideas and bring them to the next session. Also bring your rock plus one additional rock.

Materials Needed for Next Time

Facilitator:

- Magnifying glass (1 per pair)
- Small container for water (1 per pair)

All participants:

- Copy of Novak's concept mapping article
- Copy of Ault's concept mapping article
- Two rocks
- Your soil concept map
- Your journal entry

Graduate Credit Activities

Begin your work on the annotated bibliography and action research project.