Session 3.

Journey to the Earth's Interior

The theory of plate tectonics represents a unifying set of ideas that have great power in explaining and predicting major geologic events. In this session, we continue to explore this theory by focusing on how it is possible for tectonic plates to move. This leads us to examine the Earth's internal structure and the dynamic nature of its interior, which reveals another story of the Earth that rocks can tell.

The Video

How is it possible for tectonic plates—giant masses of rock the size of continents and oceans—to move? To better understand the theory of plate tectonics, we need to understand what is happening inside the Earth. No one has ever journeyed to the center of the Earth, except in the movies. What would such a journey reveal about the interior of the Earth?

In the video, *our* journey starts at the Earth's surface. Just what is a tectonic plate? And how do we know that plates move? Dr. Keith Klepeis, who studies plate boundaries, offers evidence from current scientific theory to help us answer these questions, which lead us to questions about lava: What is lava, what clues does lava give us about the Earth's interior, and how is lava connected to plate movement? Dr. Dave Sherrod, a vulcanologist with the Hawaiian Volcano Observatory, takes us to an active lava flow as a starting point for building answers, with earthquakes becoming an important source of evidence.

During the video, we watch elementary school students being interviewed as they explore their ideas about how continents move and how the Earth is structured internally. We also visit Keedar Whittle, a science coordinator in Dorchester, Massachusetts, and listen in as his sixth graders discuss earthquakes and the nature and source of lava.

Learning Goals

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

- Explain how we know about the Earth's exterior and interior
- Describe the internal structure of the Earth and the nature of its layers
- Describe how igneous rocks are formed
- Relate the nature of lava and its source to the movement of tectonic plates

On-Site Activities

Getting Ready (60 minutes)

Activity One—Problem Set and Reading Discussion (20 minutes)

1. In a small group, review the answers from the problem set for Session 2.
2. With a partner, review and discuss each other's concept maps for sedimentary rocks.
3. Think about what you know about the Earth's interior. Discuss how or where this topic might connect to your concept maps.
4. Session 2's homework asked group members to be prepared to discuss the ideas expressed by the authors that are most useful in teaching about rocks. As a group, discuss these ideas.

Activity Two—Continental Movement, Tectonic Plates, and Lava (15 minutes)

1. To prepare for today's session, you were asked to think about how continents could group together and then move apart. You were asked to write about your initial ideas and create a diagram as part of your explanation. As a whole group, share your ideas and diagrams.
2. Briefly discuss and record the group's ideas about the questions below. Your group will revisit these questions after the video.
   - What are tectonic plates? What are they made of?
   - How thick are tectonic plates?
   - What is lava?
   - Is lava a solid or a liquid? What are the reasons for your thinking?
   - Where in the Earth does lava come from? What are the reasons for your thinking?
   - What can lava tell us about the Earth?

Activity Three—Models of Earth's Interior (15 minutes)

1. Rejoin your partner. Create a drawing of a cross-section of the Earth, and label the drawing with as much detail as you can. Incorporate relevant ideas from the previous activity into your drawing.
2. Think about the common objects listed below. With a partner, select the object you feel best represents the earth, and explain why.

Basketball	Baseball
Onion	Rock
Hard-boiled egg	Globe
Apple	Orange
Avocado	Piece of cherry-filled chocolate
Golf ball	"Jaw breaker" candy

On-Site Activities, cont'd.

Activity Four—Slinkys® and Silly Putty® (10 minutes)

With a partner, complete one of the activities below. Be sure that both activities are completed by the group.

Facilitators: Provide Slinkys for Activity A.

Activity A: Discuss your ideas about what happens during an earthquake. What is the nature of the motion that is felt? Use the Slinky to model the following two types of motions:

- **Motion #1:** Hold each end of the Slinky so that it is stretched out horizontally on the floor. Take turns pushing one end of the Slinky toward the other.
- **Motion #2:** Hold each end of the Slinky so that it is stretched out horizontally on the floor. Take turns sliding one end of the Slinky perpendicular to the other.

Record your answers to the following questions:

- How would you describe each motion?
- In an earthquake, how might these motions be produced?
- How might the motions of earthquakes provide information about the Earth's interior?

Facilitators: Provide Silly Putty for Activity B.

Activity B: Each partner should take a portion of Silly Putty and manipulate: squeeze it, stretch it, compress it, roll it up into a ball, and bounce it off of the table. Take one of these samples and flatten the ball *slightly*, push it onto a large index card, and then trace the outline of the edge of the Silly Putty ball onto the card with a pen. Put aside the card with the Silly Putty and place the other sample back in its container. Is Silly Putty a solid or a liquid? Record your answer, and the reasons for your thinking.

Viewing the Program (60 minutes)

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

1. What feature of the Earth's interior allows the movement of tectonic plates?
2. The children interviewed have a range of notions about what the interior of the Earth is like. As you watch, keep track of their ideas and compare them to your own.
3. Watch the students in the featured classroom as they manipulate the Slinky toys and Silly Putty. Use their results to inform your work following the video.

On-Site Activities, cont'd.

Going Further (60 minutes)

1. As a whole group, spend a few minutes discussing the video. Dr. Sherrod said that igneous rocks originate from the melting of Earth's materials. Volcanic rock is one kind of igneous rock. Talk about how the formation of this type of igneous rock compares to how sedimentary rocks form. Comment upon their similarities and differences.

Note: See the *Earth and Space Science* Web site to learn more about igneous rocks (A Closer Look: Igneous Rocks) at www.learner.org/channel/courses/essential/earthspace/session3.

2. Revisit and discuss each of the questions from Activity Two in Getting Ready. Evaluate the answers created by the group before the video, and rewrite them to reflect any new understandings. You may wish to make a copy for your own records.
3. What feature of the Earth's interior allows plate movement to occur? Discuss this with your partner. Return to the cross-section of the Earth you completed in Activity Three in Getting Ready and critique its accuracy. Then, amend the original diagram you brought to this session to represent any new understandings.
4. As a whole group, share the experiences you had in the Slinky and Silly Putty activities.

Activity A: Participants who completed activity A should demonstrate the two slinky motions for the rest of the group.

- What general term is used to describe both of these motions?
- What specific term is used to describe motion #1? Motion #2?
- How are these motions alike? How are they different?
- How is each motion a source of information about the Earth's interior?

Note: See the *Earth and Space Science* Web site to learn more about how earthquakes help map the Earth's interior (A Closer Look: Mapping Earth's Interior) at www.learner.org/channel/courses/essential/earthspace/session3.

Activity B: Participants who completed activity B should retrieve the card with the ball of putty on it and trace a circle around the edge of the putty again before removing it from the card. Show the results to the rest of the group.

- What do the markings on your card look like?
- What happened to the putty?
- How did your results compare to the results of the students in the featured classroom?
- Is Silly Putty a solid or a liquid? Justify your answer.
- What part of Earth's interior does the putty model?

Between Sessions

Homework (* = required)

* Reading Assignment

King, C. "The Earth's Mantle Is Solid: Teacher's Misconceptions About the Earth and Plate Tectonics." *School Science Review* 82, 298 (2000): 57–64.

As you read this article, identify two teachers' ideas that compare to your own or are prevalent among students that you have. For each idea, define a question about the related content and try to answer it.

* Problem Set

(Suggested answers are listed in the Appendix.)

1. Consider the following statement: "The rock that makes up the Earth's mantle flows." Do you agree or disagree? Explain the reasons for your answer.
2. Identify the type of igneous rock that is most common and explain its origin.
3. How do we know about the nature of Earth's exterior (i.e., tectonic plates)? How do we know about the nature of its interior (i.e., structural layers)?

* Ongoing Concept Mapping

Develop a concept map for the concept "Earth's interior." Reflect on the video and other session activities to identify key concepts to include in your map. Be sure to incorporate what you have learned about Earth's mantle in your map.

Guided Journal Entry

During this session, you worked with materials that were used as physical models to represent the Earth's interior. Analogies are verbal models (that may have a physical basis) that are useful in the same way—they help to construct understanding of one thing in terms of another (e.g., rocks are like stories). Generate several analogies that are meaningful to you for things that you have learned during Sessions 1 (about soil), 2 (about rocks), and 3 (about Earth's interior). Record these in your journal. Think about which of these could be useful in elementary science teaching. Explain your thinking in your journal entry.

Guided Channel-Talk Posting

The topic of Earth's structure has applications at many grade levels. How does the structure of the Earth apply to the science curriculum in your classroom? In your Channel-Talk posting for this week, describe a unit you could develop that integrates what you have learned about the structure of the Earth from Sessions 1, 2, and 3. Tailor the unit to meet the needs of your grade level.

Suggestions for Textbook Reading

- Formation of igneous rocks
- Lava and magma
- Differentiation of Earth's interior
- Nature of Earth's layers
- Classification of igneous rocks
- Seismic waves
- Earth's internal structure

Between Sessions, cont'd.

* Preparing for the Next Session

For "Getting Ready"

Think about what you know about volcanoes, and draw and label a cross-section sketch. Consider the following questions: What is a volcano, and how and where do they form?

Materials Needed for Next Time

Facilitator:

- No materials need to be brought by the facilitator

All participants:

- Your cross-section sketch of a volcano

Graduate Credit Activities

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