

SECTION 2.3 INTRODUCTION

2.3 Read**What Do Earth's Crust and Interior Layers Look Like?**

□ 2 class periods*

Overview

Students read about Earth's crust and interior. Students begin by reading an evaluation of the egg model of Earth and coming up with their own model of Earth's crust and interior. Then they read about Earth's crust, mantle, and core. Students read about Earth's plates and that movement at the plate boundaries can create mountains, volcanoes, rift valleys, islands, or deep ocean trenches. Groups then construct a model of Earth that includes Earth's interior and shares them with the class. They finish the section by updating their *Project Board* including questions about what they need to learn about the movement of plates and plate boundaries. This segues into the next *Learning Set* in which students analyze earthquake data to find the plate boundaries around the regions of their Earth structures.

*A class period is considered to be one 40 to 50 minute class.

Targeted Concepts, Skills, and Nature of Science	Performance Expectations
Scientists often work together and then share their findings. Sharing findings makes new information available and helps scientists refine their ideas and build on others' ideas. When another person's or group's idea is used, credit needs to be given.	Students share their models of Earth and its interior. Students also share their ideas of what is causing the changes in the regions around their Earth structures.
Scientists must keep clear, accurate, and descriptive records of what they do so they can share their work with others and consider what they did, why they did it, and what they want to do next.	Students construct their model and describe what it is and their reasoning behind it. Students update their <i>Project Board</i> , which is a record of their ideas and what they are learning.
Identifying factors that lead to variation is an important part of scientific investigation.	Students consider what causes Earth's crust to move and read about factors scientists have used to help them model Earth's interior.

Targeted Concepts, Skills, and Nature of Science	Performance Expectations
Scientists make claims (conclusions) based on evidence obtained (trends in data) from reliable investigations.	Students make claims about what is causing the region around their Earth structures to change.
Scientists use models to simulate processes that happen too fast, too slow, on a scale that cannot be observed directly (either too small or too large), or that are too dangerous.	Students should be able to describe what a model is used for and why. Students make models of Earth.
Scientists use models and tools such as <i>Geographic Information Systems</i> , and a variety of maps to develop claims and explanations from evidence in the data.	Students use models to develop claims about what is causing the changes around the region of their Earth structures.
Earth is a system made up of different layers, each with a distinctive composition and set of characteristics. These layers interact, driving the processes that shape Earth.	Students should be able to describe the layers of Earth and construct a model of them.
Earth's crust is constantly changing. These changes are usually a very slow process that is not immediately observable. Some changes are very rapid and are observable.	Students should be able to describe that usually Earth's crust changes slowly.
Earthquake activity, volcanic activity, and topography are all evidence that Earth's crust is moving and changing.	Students should be able to describe evidence for changes in Earth's crust including volcanoes, earthquakes, and mountains rising.
Interactions between Earth's crustal plates can result in mountain-building, rift valleys, and geologic activity such as Earthquakes and volcanoes. Underwater volcanic activity may form underwater mountains, which can thrust above the ocean's surface to become islands.	Students should be able to describe that changes in regions around Earth structures is due to movement of the plates.

Materials

- 1 per student** crayons or colored pencils to draw their models and to make their Picture Dictionaries
- 1 per class** class *Project Board*
- 1 per student** *Project Board* page
- optional** candle wax
- 1 per classroom or group** opaque containers with different objects that make different sounds

Activity Setup and Preparation

- Decide whether or not you want to assign the Picture Dictionary as homework.
- Decide if you want to have opaque containers with different objects that make different sounds to help students understand indirect observations.
- Decide if you want each group to have boxes or if you will do a demonstration.
- Decide if you want to show students candle wax as an example of the texture of the crust (wax at room temperature) and magma (wax near melting point).
- Decide if you may want to use the cornstarch model when discussing Earth's core. This model is described in the *Activity Setup and Preparation* segment in *Section 2.1*.
- Decide if you want students to watch or read “Journey to the Center of the Earth” by Jules Verne.

Homework Options

Reflection

- **Science Content:** Assign the Picture Dictionary that is part of this section for homework. *(Students should draw images of structures and describe them such as mountain, earthquake, volcano, plate, crust, mantle, inner core, outer core, oceanic crust, continental crust, seismic wave, etc.)*

Preparation for Learning Set 3

- **Science Process:** What is the difference between qualitative data and quantitative data? How can these be used to help provide information about earthquakes and volcanoes? *(The purpose of this question is to get students to think about different types of data and how they can assist scientists in determining information about earthquakes and volcanoes. The next Learning Set provides students with qualitative and quantitative data about earthquakes.)*

SECTION 2.3 IMPLEMENTATION

2 class periods □

2.3 Explain

What Do Earth's Crust and Interior Layers Look Like?

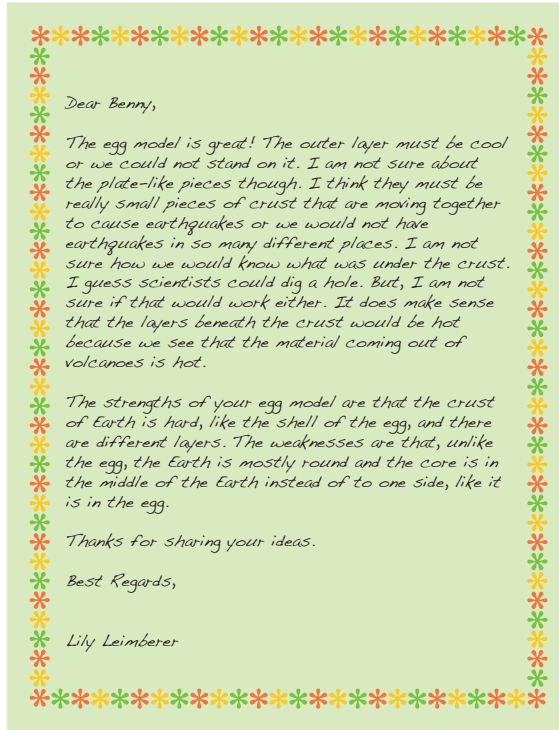
5 min.

Introduce this section by reviewing a letter evaluating the egg model of Earth.

2.3 Read

What Do Earth's Crust and Interior Layers Look Like?

In the last section, you looked at Benny's egg model of Earth and made some drawings of your own. Benny's letter suggested that Earth's crust may be broken into plate-like pieces that move. In this section you are going to learn more about Earth's crust and interior layers. Before you begin, take a look at what one student thought of Benny's ideas and his model.



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META NOTES

Eliciting students' ideas provides information about their preconceptions. Knowledge of these can help you guide students to understanding the scientific ideas presented in this section.

Engage

Elicit students' ideas about how the plates of Earth move.

TEACHER TALK


“In Benny's letter he talked about the cracked shell of an egg being like the crust of Earth and he said that these plates move. What do you think causes them to move?”

Record students' ideas. Some of these ideas should pertain to what is under the crust.

△ Guide

Let students know that they will be learning more about Earth's interior (what is under the crust) and all the layers in this section. Then read together the evaluation of the egg model (Lily's letter).

PBIS
Learning Set 2 • What Is Causing the Changes You Observe in the Region of your Earth Structure?




Stop and Think

1. What do you think about Lily's comments? Which comments do you agree with and which do you disagree with? Explain why.
2. Suggest a model of the earth that you think would represent Earth better than the egg. If you cannot show your model, then draw a picture of it.

geologist: a scientist who studies the forces that make and shape Earth.

Observing Earth's Structure

"What is inside Earth?" is one of the hardest questions **geologists** have tried to answer. A geologist is a scientist who studies the forces that make and shape Earth. You may wonder how we know what is below Earth's crust when we cannot see it.



Sometimes called the "Blue Planet," Earth's blue waters and land areas look very different from the other planets in our solar system. However, beneath its cool and inviting crust is a very different scene where temperatures are high enough to melt rock. Earthquakes and volcanoes give scientists evidence about the fiery world beneath the crust.

Perhaps at sometime you have shaken a wrapped gift to try to guess what was inside. You know that, based on the sound it makes, you can narrow down what might be inside the box. When you do this, you are making an

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Stop and Think

10 min.

Have groups answer the questions about the evaluation of the egg model.

◇ Get Going

Ask groups to review Benny's letter and to answer the two questions and discuss them as a class. Let students know how much time they have.

META NOTES

This will provide students with more hooks to add new knowledge to as they read more about Earth's crust and layers.

Observing Earth's Structure

5 min.

Discuss how geologists study the interior of Earth

△ Guide and Assess

Then have a class discussion on groups' responses.

1. Students should provide reasons to support why they agree or disagree with Lily's comments.
2. Students should show or draw a model of Earth and discuss how it describes Earth's layers.

Then, ask students what they know about Earth's crust and layers and record these.

Observing Earth's Structure

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△ Guide

Begin by asking students how they think scientists figure out what is inside Earth.

TEACHER TALK

“Do you think scientists could dig a hole and look inside at the layers of Earth as suggested in Lily’s letter? How do you think scientists figure out what is inside Earth?”

Then, describe how geologists must make indirect measurements like trying to figure out what a gift is before unwrapping it. If your students are unfamiliar with indirect observations, help them understand by having opaque containers with different objects that make different sounds. Decide if you will lead or have groups do this. This may be the first time they do an indirect observation—if so you may want them to do this activity

Let students know that scientists use waves produced by earthquakes to study what is inside Earth. You might provide an example of light waves bouncing off a glass (reflected waves) and going through it (refracted waves). When the wave goes through a different material its direction of travel changes, and its speed. Let students know that by studying the direction and speed of these earthquake waves, they are able to determine information about the different layers of Earth.

META NOTES

Indirect measurements are more common than one may think. For example, the speed of an object is determined by measuring the distance traveled and the time of travel.

META NOTES

If students need additional help with indirect measurements you may want them to determine the shape of an object submerged in a dark fluid so that they cannot see the object. Rather have them use sticks to determine the shape of the object.

2.3 Read

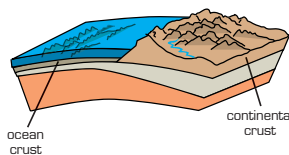
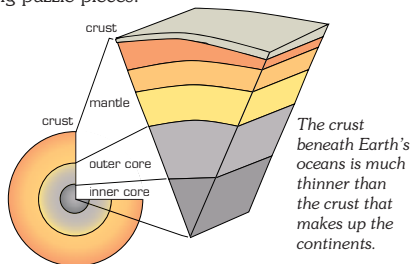
indirect observation. When geologists want to study Earth's interior, they also use indirect observations. Instead of shaking a gift box, geologists use the different waves produced by earthquakes that travel through the earth. The geologists look to see the paths the different seismic waves travel and how fast they travel through Earth. Using the data from these waves, they have learned that Earth's interior is made up of several layers. You will learn more about earthquakes and the waves they produce later on in this Unit.

What are the Layers of Earth?

The three main layers of the Earth are the **crust**, the **mantle**, and the **core**. Each has its own materials and conditions. The crust is the layer of rock that forms Earth's outer shell. This layer is brittle and cool compared to the rest of the Earth. The crust is also divided into large pieces called **plates**. The plates look like big puzzle pieces.

Earth's Crust

The crust varies in thickness from 5 to 75 km (3-47 miles). The thinnest parts of the crust are under the oceans. These parts are called **oceanic crust**. The thickest parts of the crust are the continents. These parts are called **continental crust**. The rock in the crust is brittle and easily crumbles, much like a piece of cold wax. If you squeeze a piece of cold wax between your fingers it will crack and crumble.



The continental crust in the Himalayas is 75 km (47 miles) thick. Mount Everest, the highest mountain in the world, is part of the Himalayas.

indirect observation: a method of observation used when data cannot be gathered by direct means, such as observing the actual object or event.

crust: the outermost layer of Earth, forming the rocky outer shell.

mantle: layer of Earth between the bottom of the crust and the outer core.

core: center of Earth.

plate: one of the pieces that make up Earth's crust.

oceanic crust: the thinnest parts of the crust, located under the oceans.

continental crust: the thickest parts of the crust, located at the continents.

What are the Layers of Earth?

20 min.

Discuss the various layers of Earth.

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△ Guide

Begin by reminding students that there are three main layers: the crust, mantle, and core.

Earth's Crust

5 min.

Discuss Earth's crust.

plates. They look like big puzzle pieces.

Earth's Crust

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The crust beneath Earth's oceans is much thinner than the crust that makes up the continents.

between the bottom of the crust and the outer core.

core: center of Earth.

plate: one of the pieces that make up Earth's crust.

oceanic crust: the thinnest parts of the crust, located under the oceans.

continental crust: the thickest parts of the crust, located at the continents.

△ Guide

Then, let the students know that the crust is divided into pieces called plates and is brittle and cool compared to the other layers of Earth. Let students know that the crust varies in thickness between 5 km (3 miles) and 75 km (47 miles). Then ask students where they think the thinnest and thickest parts of the crust are. Let them know that the thinnest crust is under the oceans and called the oceanic crust and the thickest is the continental crust that makes up the continents.

Describe the texture of the crust—the rock is brittle and crumbles easily like cold wax.

TEACHER TALK

“What do you think the mantle is like?”



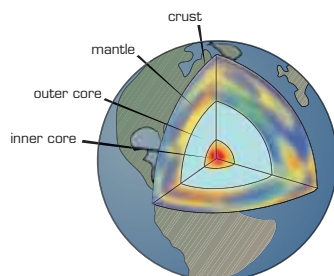
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Earth's Mantle

Below the crust is a layer of hot fluid rock called the mantle.

The mantle is like wax that has been heated to just below the melting point. Just below melting point, rock is able to flow and change shape like putty.

The mantle is the thickest layer of Earth. It is about 2900 km (1800 miles) thick. The temperatures in this layer vary from 1600°F in the upper mantle, near the crust, and about 4000°F in the lower mantle, closer to the core.



Unlike many illustrations that show the mantle as a solid layer, the material found in the mantle is actually flowing and moving.

The wide temperature range causes the fluid rock in the mantle to flow and move. When this layer moves, the crust moves with it.

Earth's Core

Below the mantle is Earth's core. It consists of the **outer core** and an **inner core**. The outer core is a layer of molten, or melted, metal. Inside the outer core is the inner core. The inner core is a dense ball of solid metal. Temperatures in the inner core reach 9032°F. At this temperature, the metals making up the core normally melt. However, extreme pressure from the weight of the layers above squeezes the atoms of iron and nickel so tightly that they form a solid. They have no space to spread out and become liquid. The energy to move rock in the mantle comes from this hot core.

outer core: layer of melted, or molten, metal below Earth's mantle.

inner core: the dense ball of solid metal at the center of Earth.

Earth's Plates

The plates making up Earth's crust float on top of the semi-solid fluid mantle. Some of the plates are pulling away from each other, while others are pushing toward each other. Some of the plates are sliding past each other. The areas where these plates meet are called **plate boundaries**.

Earth's Mantle

5 min.

Discuss the mantle.

META NOTES

Although the lower mantle is at a higher temperature it doesn't flow as well as the upper mantle because it is also under a much higher pressure.

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△ Guide

Next, discuss the mantle. Begin by eliciting students' ideas about the mantle.

Then, describe the mantle using the student text as a guide. Let students know that the upper mantle that lies just below the crust is like wax near its melting point. It can flow and change its shape like putty.

Point out that the mantle is the thickest layer of Earth, being about 2900 km or 1800 miles thick. Emphasize how much thicker this layer is than the crust (580 times thicker than the thinnest part of the crust and 38 times thicker than the thickest part of the crust.)

Next, discuss the temperature. Ask students how hot they think the mantle is. Then let them know that there are two parts to the mantle, the upper mantle near Earth's surface is about 1600°F and the lower mantle near Earth's core is about 4000°F.

Then, point out that this temperature change causes the rock in the mantle to flow and move, and when the mantle moves the crust moves with it. You may want to project the image of the layers in the student text.

Earth's Core

5 min.

Discuss Earth's core.

outer core:
layer of melted,
or molten, metal
below Earth's
mantle.

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Earth's Core

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△ Guide

Ask students what they think the core is like.

TEACHER TALK

“What do you think the consistency of the core is like? What shape do you think it has? How big is it? What do you think its temperature is relative to the mantle?”

META NOTES

You may want to use the cornstarch model of the core suggested in *Section 2.2*.

Then, describe Earth's core using the student text as a guide. Point out that there is an inner and outer core. Describe how the outer core is liquid metal and that the inner core is solid metal. Let students know that the inner core temperatures reach 9032°F, which would normally cause the material that makes it (mainly iron and nickel) to be a liquid, but the high pressure turns it into a solid. The hot core is what heats up the lower mantle.

Earth's Plates

5 min.

Discuss Earth's plates and how they move.

Earth's Plates

The plates making up Earth's crust float on top of the semi-solid fluid mantle. Some of the plates are pulling away from each other, while others are pushing toward each other. Some of the plates are sliding past each other. The areas where these plates meet are called **plate boundaries**.

△ Guide

Next, discuss Earth's plates. Ask a few students to describe how they think Earth's plates are moving. Then describe how Earth's crust “floats” on top of the mantle, and that the plates move because the mantle moves. Some of the plates move toward each other, some away, and some slide past each other.

Then describe plate boundaries and let students know that it is at these boundaries where movement occurs and mountains, volcanoes, rift valleys, islands, or deep ocean trenches can form.

Then describe that the movement of these plates is slow and that the bigger the plate the slower the movement.

2.3 Read

As the plates move, they cause changes in Earth's surface. Movement at the plate boundaries can create mountains, volcanoes, rift valleys, islands, or deep ocean trenches.

The plates move at very slow rates. Depending on their size, some move faster than others. Very large plates that have thick heavy continents on them move much slower than smaller plates that do not have much continental crust. This explains why it has taken millions of years for Earth to look like it does today and why Earth does not seem to change now.

Stop and Think

1. What kind of indirect evidence do geologists use to study the structure of Earth? Why can they not use direct evidence?
2. Explain why we cannot feel Earth's plates moving over a long period of time. When can we feel Earth's plates moving over a short period of time?



Conference

Earlier in this *Learning Set* you drew a picture of what you thought caused changes in Earth's crust and interior layers. Since then you have read a pen pal letter from Benny Makmur in which he shared his model of Earth and his ideas about its structure. You also investigated and read about Earth's crust and its interior layers. Now, with your group, create a model of Earth's



The crack shown in the photograph is a plate boundary in the African Rift Valley.

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EARTH STRUCTURES AND PROCESSES

Get Going

Let students know that they will work in groups to answer the questions and then there will be a class discussion on their responses. Then let them know how much time they have to finish.

Stop and Think

10 min.

Have groups answer the questions and have a class discussion.

META NOTES

You may want to point out that scientists make direct measurements of substances on Earth's surface and how they are affected by temperature, pressure, and waves. This information gives them insight into what the chemical composition of the interior of Earth is, even though they cannot obtain materials from the lower mantle or core.

META NOTES

You may want to point out that the plates move on the average 5 cm per year. Human hair grows about 15 cm per year.

Conference

10 min.

Have groups create a model of Earth and a Picture Dictionary.

△ Guide and Assess

Have a class discussion on groups' responses. Look for the following ideas and guide students towards these as needed.

1. Students' responses should state that geologists use waves created by earthquakes to study the interior of Earth and that they cannot use direct evidence because Earth is too big and too dangerous in its interior to study directly.
2. Students' explanations should have information from the student text to back up the claims. For example: We cannot feel Earth's plates moving over a long period of time because the plates move very slowly. The plates move very slowly because the mantle underneath them moves very slowly. The bigger plates move more slowly than the smaller plates. However, we can feel Earth's plates moving over a short period of time near the plate boundaries. When they interact with each other they cause changes in Earth's surface and can cause earthquakes and volcanoes.

Conference

Earlier in this *Learning Set* you drew a picture of what you thought caused changes in Earth's crust and interior layers. Since then you have read a pen pal letter from Benny Makmur in which he shared his model of Earth and his ideas about its structure. You also investigated and read about Earth's crust and its interior layers. Now, with your group, create a model of Earth's



△ Guide

Transition by pointing out to the class that they may now have a different idea of what the Earth's interior is and that as a group they should create a new model (an object or a drawing) of Earth's interior and crust. Emphasize that their model should contain a description of each layer.

The picture dictionary could be assigned as homework. If it is done in class, students should begin it after finishing their models. Let students know what words they should put in their dictionaries (crust, mantle, core, plate, inner core, outer core, oceanic crust, continental crust, plate boundaries, and any others they may need), and that they will be adding to this dictionary during the Unit.

□ Assess

Check that groups are including a description of the parts of their model, and that students understand how to draw their picture dictionary.

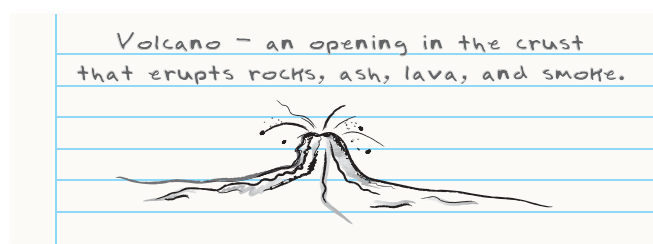


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crust and interior layers using everything you have learned. Your model may be as simple as a drawing or an object that you think represents the Earth's layers well.

You have also been introduced to a lot of new words in this section that are used to describe Earth's structure. These words will most likely be used in your answer to this Unit's *Big Question*. To help you remember them, you will create a *Picture Dictionary*. You can write the word, its definition, and a picture that represents the word on an index card. When you are finished, use a hole-punch to make a hole in the upper right hand corner of each card. This way you can use yarn or a metal ring to keep the index cards together. Begin your *Picture Dictionary* with the words from this section: crust, mantle, core, plate, inner core, outer core, oceanic crust, continental crust, and plate boundaries.

Feel free to add any other terms you think are important. You will also be adding to your *Picture Dictionary* later in this Unit. Here is an example of one student's *Picture Dictionary* entry.



Communicate

Share Your Models

Each group will present their most recent model of Earth's crust and interior layers to the class. Very briefly, one group member will point out the different parts of Earth shown on your model. Another group member will then explain why you chose the model that you did and how it represents Earth's structure. When all of the groups have presented their models, they can be displayed around the classroom.

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△ Guide

Have each group briefly present their model. Emphasize that they will need one group member to point out the different parts of Earth shown in the model and another to explain why they chose the model they did and how it represents Earth's structure.

Let the students know that they should ask questions if they are not sure about how something in the model represents Earth. Also point out that they should think about the strengths and weaknesses of each model.

After each group has presented ask them to describe a strength and a weakness of their model. This will assist them in evaluating their model and others and reinforce their understanding of Earth's interior. Then have the group display their model in the classroom.

Communicate: Share Your Models

15 min.

Have students present their models and as a class discuss them.

□ Assess

During the presentations pick out the strengths and weaknesses of the models being presented to help you assess the third *Reflect* question.

Reflect

10 min.

Have groups answer the three questions and discuss them as a class.

2.3 Read

Reflect

1. What do you think is causing the changes and movements in the region of your Earth structure?
2. Suppose one of the groups in your class used a peach to model Earth's crust and interior layers. What is one strength and one weakness of this model?
3. Describe the strengths and weaknesses of your model of Earth's crust and interior layers.

Update the Project Board

You are beginning to gather a lot of information that can help you answer the Big Question for this Unit, *How can you explain the changes happening around the regions of certain earth structures?* You need to add information that you have found out about Earth's crust and interior layers to the *Project Board*.

To help you decide what information to add to the board, write four things that you think are important. Next to each of your ideas, write in which column of the *Project Board* you think your information belongs. Remember that any information added to the column *What are we learning?* must be supported with information in the *What is our evidence?* column.

Also, write two new questions you have now that you have learned more about Earth's structure. What questions are you interested in answering? Be prepared to share all of your ideas with the class as you update the *Project Board*.

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△ Guide

Have groups answer the three questions and discuss their answers as a class.

△ Guide and Assess

As the class is discussing student responses, look for the following:

1. Students should describe what they think is changing during an earthquake or volcanic eruption. Most should mention movement of Earth's plates.
2. Students should point out one of the following strengths and weaknesses of using a peach to model Earth:

Strengths: The peach model has three main layers—skin, meat, and seed that represent the crust, mantle, and core respectively. The skin is thin compared to the rest, just as the crust is thin. The mantle is the most substantial part for both the peach and Earth.

Weaknesses: The peach's skin is not in plates and does not move like Earth's crust. The peach's temperature is very different from Earth's. The core is spherical, not oval and is part liquid. The mantle has a different texture than the peach.

3. Students should describe the strengths and weaknesses of their model.

When the class has finished discussing the questions, transition to the *Project Board*.

TEACHER TALK

“In this *Learning Set* you have been introduced to many things about Earth. You've created a model that describes the important features of Earth. Now it is time to update what you have learned on the *Project Board* and the new questions you may have.”

Update the *Project Board*

You are beginning to gather a lot of information that can help you answer the Big Question for this Unit, *How can you explain the changes happening around the regions of certain earth structures?* You need to add information that you have found out about Earth's crust and interior layers to the *Project Board*.

To help you decide what information to add to the board, write four things that you think are important. Next to each of your ideas, write in which column of the *Project Board* you think your information belongs. Remember that any information added to the column *What are we learning?* must be supported with information from the *What is the evidence?* column.

Update the *Project Board*

10 min.

Guide a discussion of groups' questions, and update the *Project Board*.

○ Engage

Begin by asking groups to make a list of 4 things they think are important and next to each write which column of the *Project Board* these items belong in. Then ask each group for their list and make a class record of the important items.

△ Guide

Then remind students that columns three and four of the *Project Board* are for placing what they have learned and the evidence that supports it, and column two is for new questions they have that will help them answer the Unit question: *How can you explain the changes happening around the region of your Earth structure?*

As a class sort the important items (claims) listed for column 3 (*What have we learned?*) and group similar claims together the supporting evidence for it (column 4).

TEACHER TALK

“From the class list we made, look at all the items you think go in the *What have we learned?* column (column 3). Are there any similar items that we can group together?

(After grouping begin with the first item, write it in the Project Board and ask the class for supporting evidence.)

Think about this claim (*item for column 3*). What should we write as the evidence that supports it?”

◇ Evaluate

Before moving on, make sure everyone’s ideas have been discussed. The most important items to have on the *Project Board* are those that provide information helpful to answering the Unit question. Make sure that information about how the mantle movement causes the crust to move.

Examples for columns 3 and 4

- **Column 3 (Claim):** The Earth is made of three main layers, the crust, mantle, and core. |

Column 4 (Evidence): Scientists use earthquake waves to indirectly measure properties of Earth’s interior. These indirect measurements provide evidence that the Earth is made up of these three main layers.

- **Column 3 (Claim):** Earth’s crust varies in thickness between 5 km and 75 km. The thinnest crust is under the oceans and called the oceanic crust and the thickest is the continental crust that makes up the continents. The rock that makes up the crust is brittle and crumbles easily like cold wax.

Column 4 (Evidence): By measuring the reflected and refracted earthquake waves scientists have determined how thick the crust

META NOTES

Students have not been informed of all the different measurements scientists make to determine properties of Earth’s interior. You may want to let them know that scientists use astronomical information, gravitational information, information about Earth’s magnetic field, measurements of properties of substances in the lab, and laboratory models as well as earthquake waves to learn more about Earth’s interior.

is. Scientists also can measure directly properties of the substances that make up Earth's crust. They also observe how it changes do to movement of its plates.

- **Column 3 (Claim):** The mantle is about 2900 km, and is the thickest part of Earth. It has two distinct parts, the upper mantle and the lower mantle. The upper mantle is like wax near its melting point. It can flow and change its shape like putty. The upper mantle is about 1600°F and the lower is about 4000°F, this temperature difference causes movement in the upper mantle.

Column 4 (Evidence): Scientists have observed mantle when it reaches Earth's surface as lava through volcanoes. From this they can determine what the upper mantle is composed of and its properties (e.g its melting point). Scientists use indirect measurements of the mantle (how earthquake waves are reflected and refracted) to determine its thickness and other properties.

- **Column 3 (Claim):** Earth's core has an inner and outer region. The outer core is liquid metal and that the inner core is solid metal. The core is mainly made up of iron and nickel. The inner core reaches temperatures of 9032°F, and is solid because of the high pressure the materials are under.

Column 4 (Evidence): Scientists have measured earthquake waves that have interacted with the core. From this they have determined properties of the core.

- **Column 3 (Claim):** Earth's plates move because of movement in the mantle below it. Some of the plates move toward each other, some away, and some slide past each other.

Column 4 (Evidence): Scientists know the mantle moves because of the difference in temperature between the upper and lower mantle. This movement causes Earth's crustal plates to move. The plate boundaries are where movement is observed (changes in Earth structures) and mountains, volcanoes, rift valleys, islands, or deep ocean trenches can form.

After completing columns 3 and 4 ask students to review the class list again and to pick out things that belong in the second column. If there is nothing they listed for the 2nd column then ask groups to think of questions to add to the *Project Board*.

META NOTES

Encourage students to connect this to changes observed in the region of their Earth structure.



What's the Point?

At the start of this section, you gathered your own ideas about what is causing the changes in the region of your Earth structure. You then read that the outer layer of Earth is made up of a cool crust that is divided into pieces called plates. These plates shift and move on top of the hot inner layer, called the mantle. This movement results in short term events like earthquakes and volcanic eruptions, and long term changes like mountain building. This stress and strain between the plates occurs where the plates meet, the plate boundaries. So, if you want to find the plate boundaries, follow the earthquakes. In this section, you also read about the interior layers of Earth.



◆ Evaluate

Questions should pertain to how the interior of Earth affects the changes on Earth's surface. Some examples are provided below.

Examples for Column 2:

- Do volcanoes/earthquakes only happen along plate boundaries?
- Do volcanoes/earthquakes always happen when there is plate movement?
- Is movement of the plates the only thing that causes changes in Earth structures?

