

Inside the Earth

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

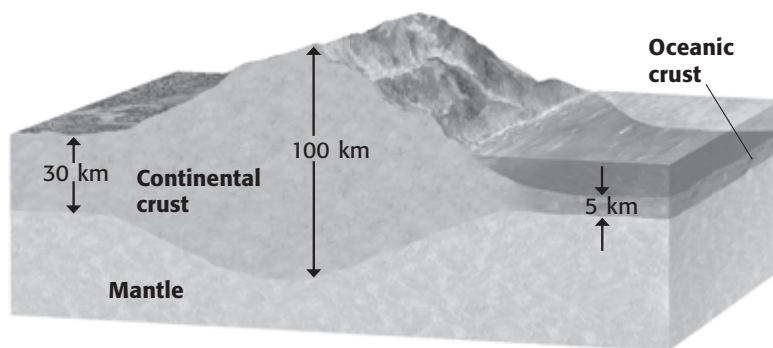
- What are the layers inside Earth?
- How do scientists study Earth's interior?

What Is Earth Made Of?

Scientists divide the Earth into three layers based on composition: the crust, the mantle, and the core. These divisions are based on the compounds that make up each layer. A *compound* is a substance composed of two or more elements. The densest elements make up the core. Less-dense compounds make up the crust and mantle.

THE CRUST

The thinnest, outermost layer of the Earth is the **crust**. There are two main kinds of crust: continental crust and oceanic crust. *Continental crust* forms the continents. It is thicker and less dense than oceanic crust. Continental crust can be up to 100 km thick. *Oceanic crust* is found beneath the oceans. It contains more iron than continental crust. Most oceanic crust is 5 km to 7 km thick. ✓



Oceanic crust is thinner and denser than continental crust.



Summarize As you read, make a chart showing the features of Earth's layers. Include both the compositional layers and the physical layers.



1. Compare How is oceanic crust different from continental crust?

Math Focus

2. Identify What fraction of the thickness of the thickest continental crust is the thickness of the oceanic crust? Give your answer as a reduced fraction.

SECTION 1 Inside the Earth *continued***THE MANTLE**

The layer of the Earth between the crust and the core is the **mantle**. The mantle is much thicker than the crust. It contains most of the Earth's mass. The mantle contains more magnesium and less aluminum than the crust. This makes the mantle denser than the crust. ✓

READING CHECK

3. Explain Why is the mantle denser than the crust?

No one has ever visited the mantle. The crust is too thick to drill through to reach the mantle. Therefore, scientists must use observations of Earth's surface to draw conclusions about the mantle. In some places, mantle rock pushes to the surface. This allows scientists to study the rock directly.

Another place scientists look for clues about the mantle is the ocean floor. Melted rock from the mantle flows out from active volcanoes on the ocean floor. These underwater volcanoes have given scientists many clues about the composition of the mantle. ✓

READING CHECK

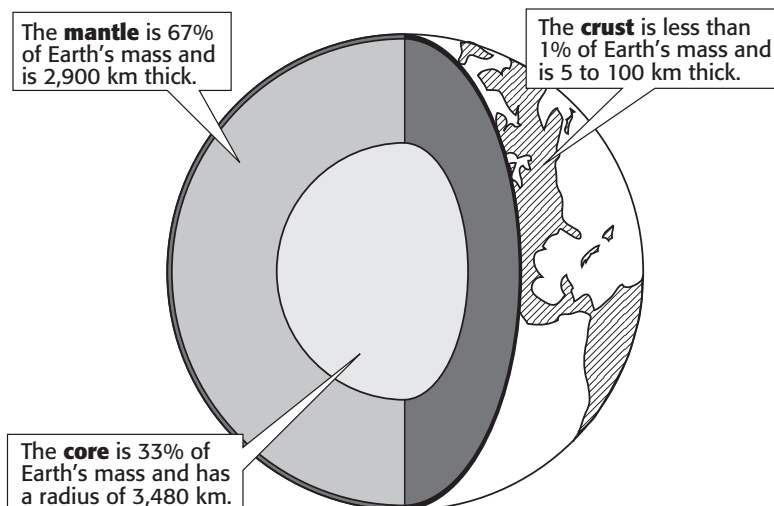
4. Identify How can scientists learn about the mantle if they cannot study it directly?

THE CORE

The layer beneath the mantle that extends to the center of the Earth is the **core**. Scientists think the core is made mostly of iron and smaller amounts of nickel. Scientists do not think that the core contains large amounts of oxygen, silicon, aluminum, or magnesium.

TAKE A LOOK

5. List What are the three compositional layers of the Earth?

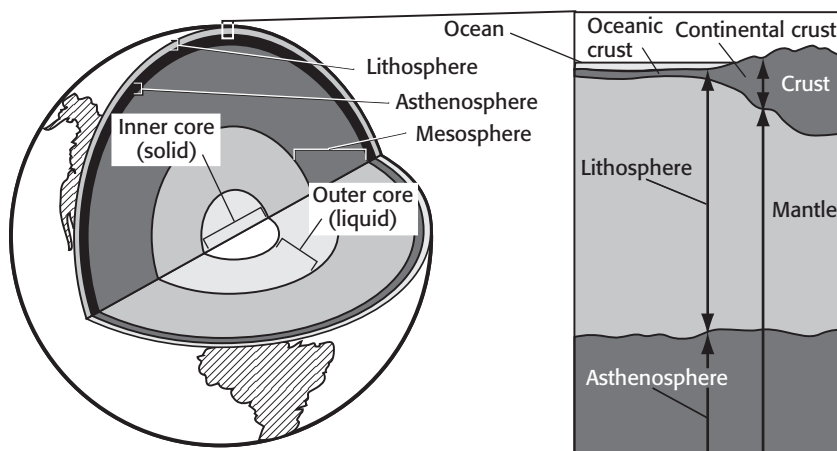


SECTION 1 Inside the Earth *continued***EARTH'S PHYSICAL STRUCTURE**

Scientists also divide Earth into five layers based on physical properties. The outer layer is the **lithosphere**. It is a cool, stiff layer that includes all of the crust and a small part of the upper mantle. The lithosphere is divided into pieces. These pieces move slowly over Earth's surface. ✓

The **asthenosphere** is the layer beneath the lithosphere. It is a layer of hot, solid rock that flows very slowly. Beneath the asthenosphere is the **mesosphere**, which is the lower part of the mantle. The mesosphere flows more slowly than the asthenosphere.

There are two physical layers in Earth's core. The outer layer is the *outer core*. It is made of liquid iron and nickel. At the center of Earth is the *inner core*, which is a ball of solid iron and nickel. The inner core is solid because it is under very high pressure.

**What Are Tectonic Plates?**

Pieces of the lithosphere that move around on top of the asthenosphere are called **tectonic plates**. Tectonic plates can contain different kinds of lithosphere. Some plates contain mostly oceanic lithosphere. Others contain mostly continental lithosphere. Some contain both continental and oceanic lithosphere. The figure on the top of the next page shows Earth's tectonic plates.

READING CHECK

6. Define What is the lithosphere?

Critical Thinking

7. Infer What do you think is the reason that scientists divide the Earth into two different sets of layers?

TAKE A LOOK

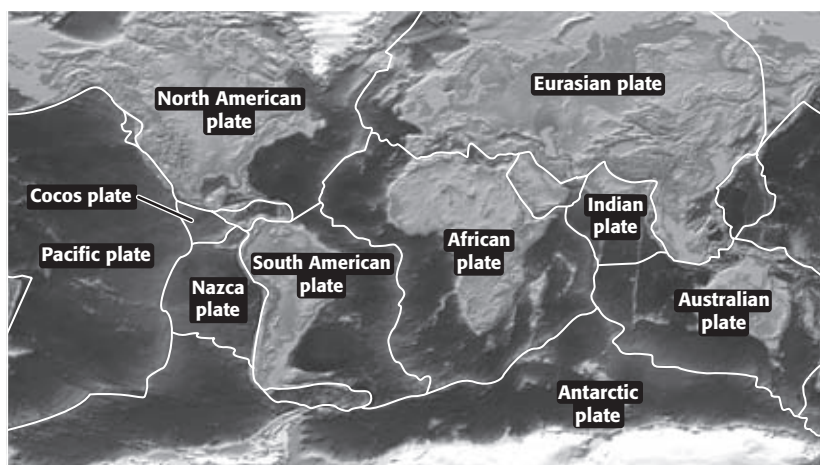
8. Describe What are the five layers of Earth, based on physical properties?

SECTION 1 Inside the Earth *continued***TAKE A LOOK**

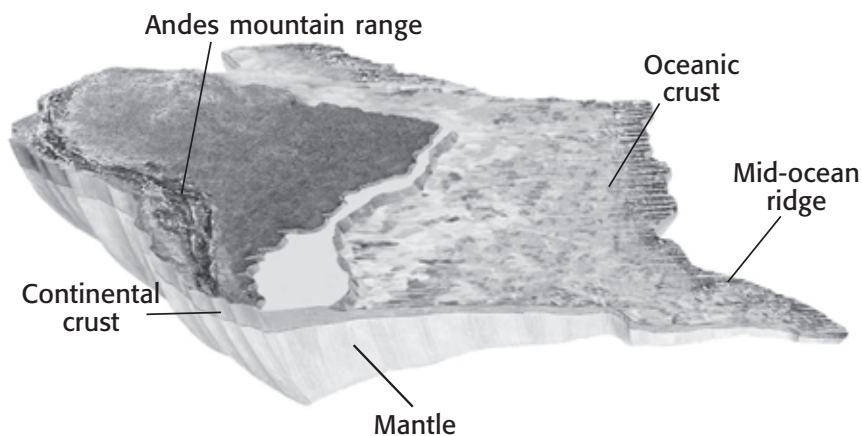
9. Identify Give the name of one plate that contains mostly oceanic lithosphere and of one plate that contains mostly continental lithosphere.

Oceanic: _____

Continental: _____

**STRUCTURE OF A TECTONIC PLATE**

The tectonic plates that make up the lithosphere are like pieces of a giant jigsaw puzzle. The figure below shows what a single plate might look like if it were separated from the other plates. Notice that the plate contains both continental and oceanic crust. It also contains some mantle material.

**TAKE A LOOK**

10. Compare Which type of crust is thicker, oceanic crust or continental crust?

This figure shows what the South American plate might look like if it were lifted off the asthenosphere. Notice that the plate is thickest where it contains continental crust and thinnest where it contains oceanic crust.

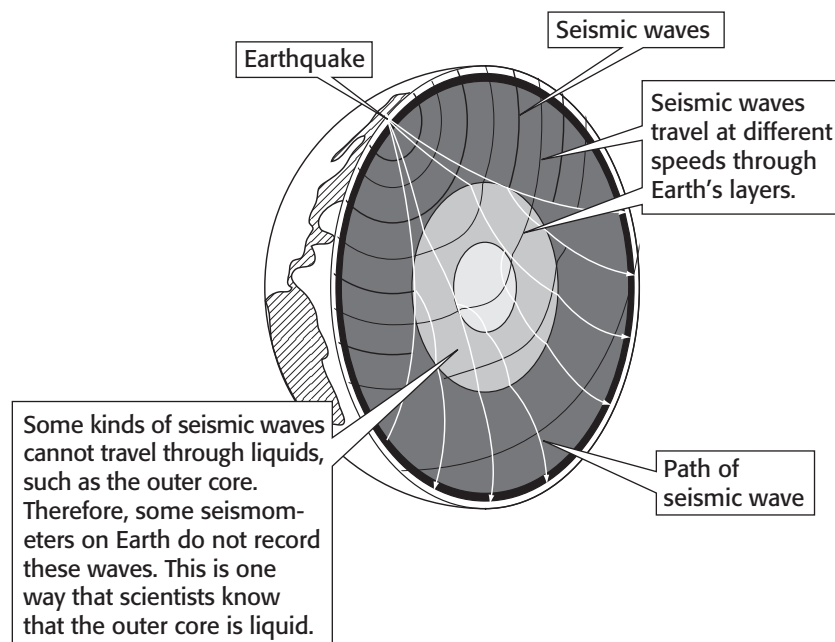
SECTION 1 Inside the Earth *continued*

How Do Scientists Study Earth's Interior?

How do scientists know things about the deepest parts of the Earth? No one has ever been to these places. Scientists have never even drilled through the crust, which is only a thin layer on the surface of the Earth. So how do we know so much about the mantle and the core?

Much of what scientists know about Earth's layers comes from studying earthquakes. Earthquakes create vibrations called *seismic waves*. Seismic waves travel at different speeds through the different layers of Earth. Their speed depends on the density and composition of the material that they pass through. Therefore, scientists can learn about the layers inside the Earth by studying seismic waves. ✓

Scientists detect seismic waves using instruments called *seismometers*. Seismometers measure the times at which seismic waves arrive at different distances from an earthquake. Seismologists can use these distances and travel times to calculate the density and thickness of each physical layer of the Earth. The figure below shows how seismic waves travel through the Earth.



✓ READING CHECK

11. Define What are seismic waves?

TAKE A LOOK

12. Explain What is one way that scientists know the outer core is liquid?

Section 1 Review

SECTION VOCABULARY

asthenosphere the soft layer of the mantle on which the tectonic plates move

core the central part of the Earth below the mantle

crust the thin and solid outermost layer of the Earth above the mantle

lithosphere the solid, outer layer of Earth that consists of the crust and the rigid upper part of the mantle

mantle the layer of rock between the Earth's crust and core

mesosphere the strong, lower part of the mantle between the asthenosphere and the outer core

tectonic plates a block of lithosphere that consists of the crust and the rigid, outermost part of the mantle

1. Describe Complete the table below.

| | Crust | Mantle | Core |
|-------------------------|--------------------------|---------------|-------------|
| Thickness or radius | | | 3,430 km |
| Location | outer layer of the Earth | | |
| Percent of Earth's mass | | | |

2. Compare How is the inner core similar to the outer core? How are they different?

3. Compare How is the crust different from the lithosphere? How are they the same?

4. Identify Give three ways scientists can learn about the Earth's mantle.

SECTION 5 TIME MARCHES ON

1. dinosaurs
2. by studying rocks and fossils
3. about 50 million years
4. Paleocene, Eocene, Oligocene, Miocene, Pliocene
5. by changes in life on Earth
6. Paleozoic
7. Paleozoic
8. Birds and mammals did not evolve until after the Paleozoic era.
9. Reptiles were the dominant land animals during the era.
10. Being warm-blooded and having young develop inside the mothers' bodies could allow mammals to survive in a wider temperature range than dinosaurs. If the extinction was caused by climate change, mammals would have been more likely to survive.

Review

1. eon, era, period, and epoch
2. about 4.6 billion years
3. Different kinds of rocks form in different environments. Different kinds of organisms live in different environments. By studying the rocks and fossils that formed long ago, geologists can infer which environments existed then.
4. Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, Permian
5. by mass extinctions
6. Possible answers: sudden events and gradual events; examples of sudden/gradual events

Chapter 4 Plate Tectonics

SECTION 1 INSIDE THE EARTH

1. The continental crust is thicker and contains less iron than oceanic crust.
2. about 1/20
3. The rock in the mantle contains more magnesium and less aluminum than the crust.
4. by studying rock that erupts from the mantle
5. crust, mantle, core
6. the upper, rigid layer of Earth made of the crust and some of the mantle

7. Possible answer: Different scientists are interested in different properties of the Earth.
8. lithosphere, asthenosphere, mesosphere, inner core, outer core
9. Oceanic: Pacific
Continental: African
10. continental crust
11. vibrations created by earthquakes
12. Some kinds of seismic waves cannot travel through it.

Review

| | Crust | Mantle | Core |
|--------------------------------|--------------------------|---------------------------|--------------------------|
| Thickness or radius | 5 km to 100 km | 2,900 km | 3,430 km |
| Location | outer layer of the Earth | middle layer of the Earth | inner layer of the Earth |
| Percent of Earth's mass | less than 1% | 67% | 33% |

2. The inner core is solid, but the outer core is liquid. Both are made of iron and nickel.
3. The lithosphere contains the crust and some of the mantle.
Both the crust and the lithosphere are the outermost layers of Earth.
4. by studying mantle rocks that push to the surface, by studying rocks on the sea floor, using seismic waves

SECTION 2 RESTLESS CONTINENTS

1. They were once part of a single continent.
2. Europe; they share similar-aged mountain rocks.
3. The same kinds of fossils are found on widely separated continents.
4. about 200 million years ago
5. North America and Europe were connected; India and Asia were separated.
6. an underwater mountain chain
7. when Earth's magnetic poles change places
8. They are mirror images of each other.

Review

1. The shapes of continental coastlines seem to match. Similar fossils are found on widely separated continents. Mountain chains of similar ages and compositions are found on widely separated continents.