Inside Earth

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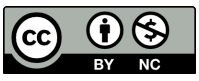

CHAPTER 1

Inside Earth

Lesson Objectives

- Compare and describe each of Earth's layers.
- Compare some of the ways geologists learn about Earth's interior.
- Define oceanic and continental crust and the lithosphere.
- Describe how heat moves, particularly how convection takes place in the mantle.
- Compare the two parts of the core and describe why they are different from each other.

Vocabulary

- asthenosphere
- convection cell
- continental crust
- core
- crust
- lithosphere
- mantle
- meteorite
- oceanic crust
- plate tectonics
- seismic waves

Introduction

From outside to inside, Earth is divided into crust, mantle, and core. Each has a different chemical makeup. Earth can also be divided into layers with different properties. The two most important are lithosphere and asthenosphere.

How Do We Know About Earth's Interior?

If someone told you to figure out what is inside Earth, what would you do? How could you figure out what is inside our planet? How do scientists figure it out?

Seismic Waves

Geologists study earthquake waves to "see" Earth's interior. Waves of energy radiate out from an earthquake's focus. These are called **seismic waves** (**Figure** 1.1). Seismic waves change speed as they move through different materials. This causes them to bend. Some seismic waves do not travel through liquids or gases. Scientists use all of this information to understand what makes up the Earth's interior.

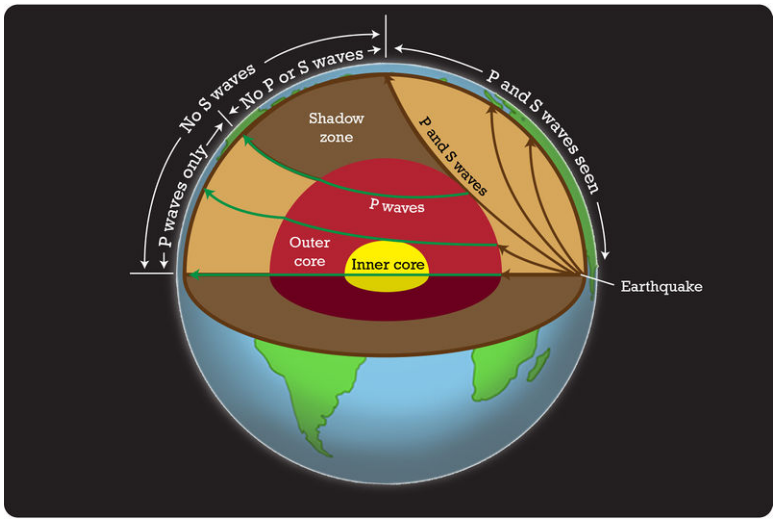

FIGURE 1.1

The properties of seismic waves allow scientists to understand the composition of Earth's interior.

Meteorites

Scientists study **meteorites** to learn about Earth's interior. Meteorites formed in the early solar system. These objects represent early solar system materials. Some meteorites are made of iron and nickel. They are thought to be very similar to Earth's core (**Figure** 1.2). An iron meteorite is the closest thing to a sample of the core that scientists can hold in their hands!

FIGURE 1.2

The Willamette Meteorite is a metallic meteorite that was found in Oregon.

Crust

Crust, mantle, and core differ from each other in chemical composition. It's understandable that scientists know the most about the crust, and less about deeper layers (**Figure** 1.3). Earth's **crust** is a thin, brittle outer shell. The crust is made of rock. This layer is thinner under the oceans and much thicker in mountain ranges.

Oceanic Crust

There are two kinds of crust. **Oceanic crust** is made of basalt lavas that flow onto the seafloor. It is relatively thin, between 5 to 12 kilometers thick (3 - 8 miles). The rocks of the oceanic crust are denser (3.0 g/cm^3) than the rocks that make up the continents. Thick layers of mud cover much of the ocean floor.

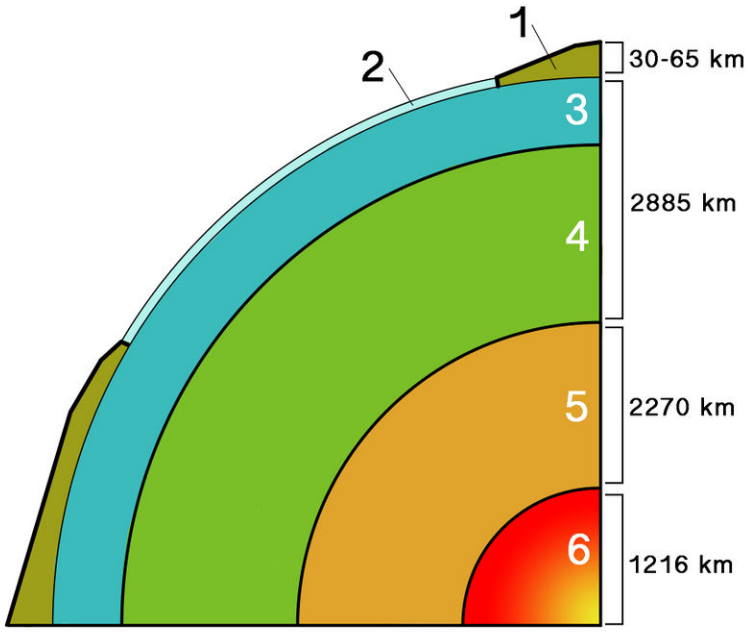

FIGURE 1.3

A cross-section of Earth showing the following layers: (1) continental crust, (2) oceanic crust, (3) upper mantle, (4) lower mantle, (5) outer core, (6) inner core.

Continental Crust

Continental crust is much thicker than oceanic crust. It is 35 kilometers (22 miles) thick on average, but it varies a lot. Continental crust is made up of many different rocks. All three major rock types —igneous, metamorphic, and sedimentary —are found in the crust. On average, continental crust is much less dense (2.7 g/cm3) than oceanic crust. Since it is less dense, it rises higher above the mantle than oceanic crust.

Mantle

Beneath the crust is the **mantle**. The mantle is made of hot, solid rock. Through the process of conduction, heat flows from warmer objects to cooler objects (**Figure** 1.4). The lower mantle is heated directly by conduction from the core.

Hot lower mantle material rises upwards (**Figure** 1.5). As it rises, it cools. At the top of the mantle it moves horizontally. Over time it becomes cool and dense enough that it sinks. Back at the bottom of the mantle, it travels horizontally. Eventually the material gets to the location where warm mantle material is rising. The rising and sinking of warm and cooler material is convection. The motion described creates a convection cell.

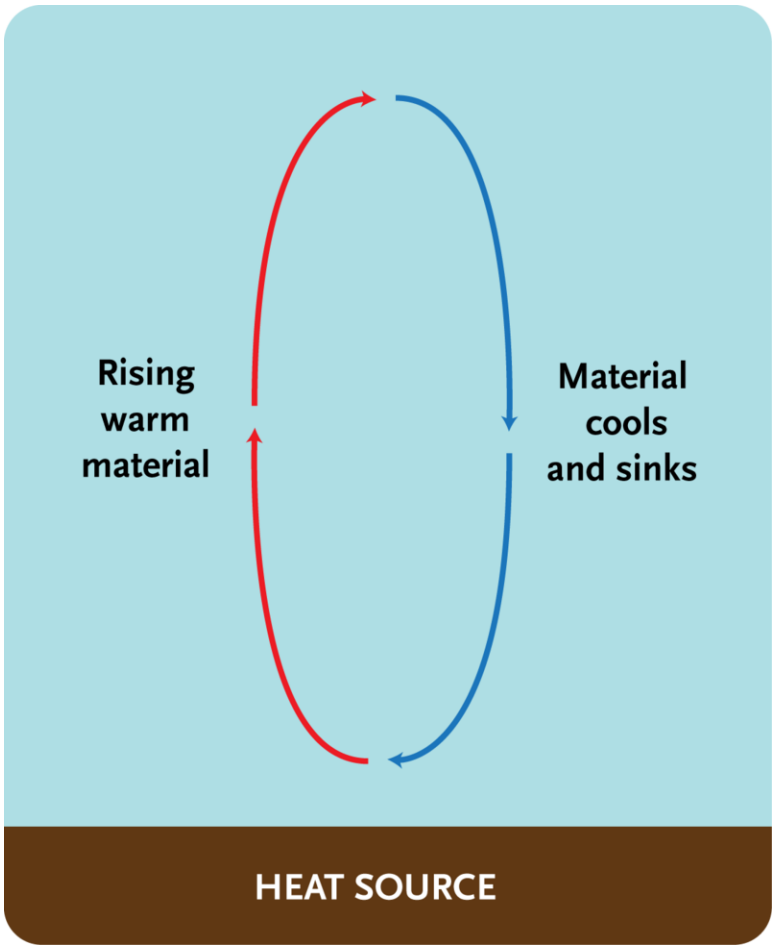

FIGURE 1.4

In the process of conduction, heat flows from warmer objects to cooler objects.

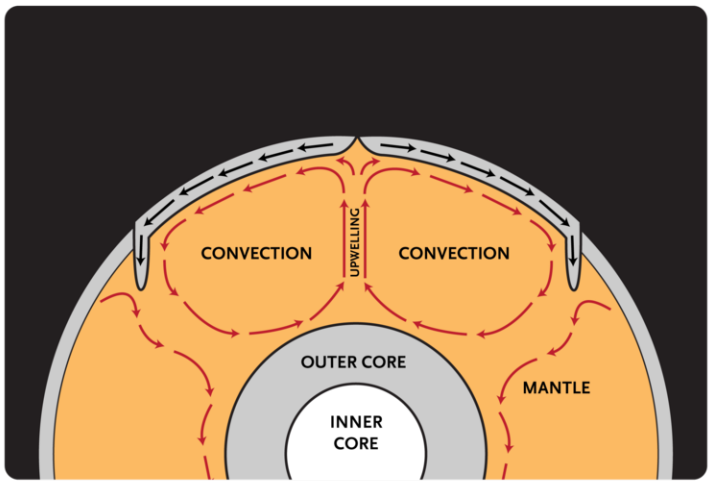

FIGURE 1.5

The rising and sinking of mantle material of different temperatures and densities creates a convection cell.

Core

The dense, iron **core** forms the center of the Earth. Scientists know that the core is metal from studying metallic meteorites and the Earth's density. Seismic waves show that the outer core is liquid, while the inner core is solid. Movement within Earth's outer liquid iron core creates Earth's magnetic field. These convection currents form in the outer core because the base of the outer core is heated by the even hotter inner core.

Lithosphere and Asthenosphere

Lithosphere and asthenosphere are layers based on physical properties. The outermost layer is the **lithosphere**. The lithosphere is the crust and the uppermost mantle. In terms of physical properties, this layer is rigid, solid, and brittle. It is easily cracked or broken.

Below the lithosphere is the **asthenosphere**. The asthenosphere is also in the upper mantle. This layer is solid, but it can flow and bend. A solid that can flow is like silly putty.

Lesson Summary

- The Earth is made of three layers with different composition: the crust, mantle, and core.
- The lithosphere is made of the rigid, brittle, solid crust and uppermost mantle.
- Beneath the lithosphere, the asthenosphere is solid rock that can flow.
- The hot core warms the base of the mantle, which creates convection currents in the mantle.

Lesson Review Questions

Recall

1. List two ways that scientists learn about what makes up the Earth's interior.

2. What type of rock makes up the oceanic crust?

3. What types of rock make up the continental crust?

Apply Concepts

4. Describe the properties of the lithosphere and asthenosphere. What parts of the Earth do these layers include?

5. When you put your hand near a pan above a pan filled with boiling water, does your hand warm up because of convection or conduction? If you touch the pan, does your hand warm up because of convection or conduction?

Think Critically

6. List two reasons that scientists know that the outer core is liquid.

7. Suppose that Earth's interior contains a large amount of lead. Lead is very dense: 11.34 g/cm^3. Would the lead be more likely to be found in the crust, mantle, or core?

Points to Consider

- The oceanic crust is thinner and denser than continental crust. All crust sits atop the mantle. What might our planet be like if this were not true.
- If sediments fall onto the seafloor over time, what can sediment thickness tell scientists about the age of the seafloor in different regions?
- How might convection cells in the mantle affect the movement of plates of lithosphere on the planet's surface?

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