

Lesson 1

Reading Guide

Key Concepts 

ESSENTIAL QUESTIONS

- What are the composition and the structure of the atmosphere?
- How is water distributed in the hydrosphere?
- What are Earth's systems?
- What are the composition and the structure of the geosphere?

Vocabulary

biosphere p. 76

atmosphere p. 77

hydrosphere p. 79

groundwater p. 80

geosphere p. 81

mineral p. 81

rock p. 82



Multilingual eGlossary



Video

- BrainPOP®
- Science Video
- What's Science Got to do With It?

Earth Systems

Inquiry

A Hot Mix?

Earth is made of more than soil, minerals, and melted rocks flowing out of volcanoes. What other parts of Earth do you see in the photo? How do these parts interact?



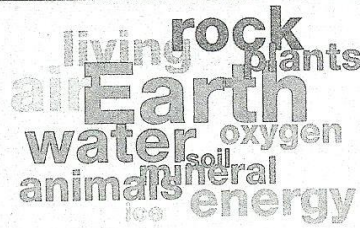
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Chapter 3

ENGAGE


How can you describe Earth? ✂

When you look out the window, you might see wispy white clouds, birds in the trees, and rolling hills in the distance. All these things are part of Earth. What else makes up Earth?



- 1 Read and complete a lab safety form.
- 2 With your partner, brainstorm a list of words that describe Earth. Limit the list to 20 words. Be creative! Record the list in your Science Journal.
- 3 Use **markers** to rewrite your list of words using different colors and letter shapes. Use **scissors** to cut out each word.
- 4 Group the words that you think relate to each other. Use a **glue stick** to fix the words to a piece of **colored paper**.

Think About This

1. What words did you use to describe Earth?
2. How did your list compare to those of other students?
3.  **Key Concept** What things do you think make up Earth?

What is Earth?

The puffy, white clouds over your head and the hard ground under your feet are both parts of Earth. The water in the oceans and the fish that live there are also parts of Earth. The planet Earth is more than a solid ball in space. It includes air molecules that float near the boundaries of outer space and molten rock that churns deep below Earth's surface.

Earth is a complex place. People often divide complex things into smaller parts in order to study them. Scientists divide Earth into four systems to help better understand the planet. The systems contain different materials and work in different ways, but they all interact. What happens in one system affects the others.

Earth's Air

The outermost Earth system is an invisible layer of gases that surrounds the planet. Even though you cannot see air, you can feel it when the wind blows. Moving air is blowing the tree in **Figure 1**.

Figure 1 Even though you cannot see air, you can see its power when it makes objects move.




Below the layer of air is the system that contains Earth's water. Like air, water can move from place to place. Some of the water is salty, and some is fresh. Fresh river water flows into the salty Pacific Ocean in Hawaii, as shown in **Figure 2**.

The Solid Earth

The next system is the solid part of Earth. It contains a thin layer of soil covering a rocky center. It is by far the largest Earth system. Because it is solid, materials in this system move more slowly than air or water. But they do move, and over time, landforms rise up and then wear away. It took millions of years for the canyon shown in **Figure 2** to form.

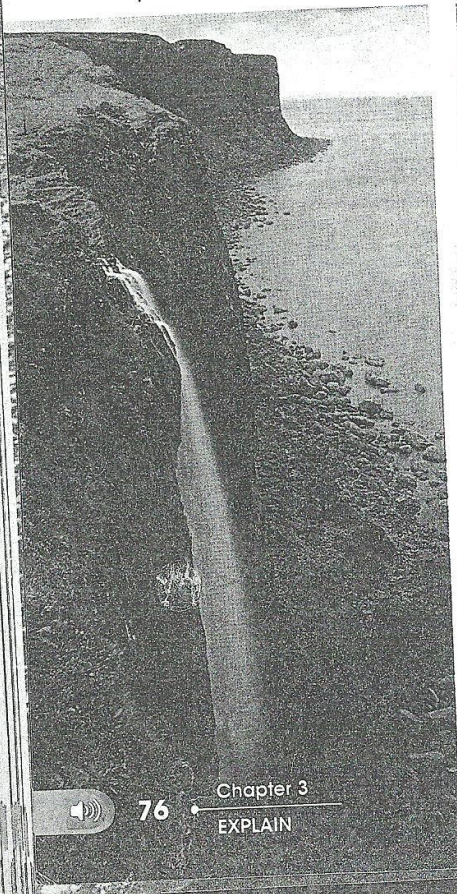
Life on Earth

The Earth system that contains all living things is the **biosphere**. Living things are found in air, water, and soil. So, the biosphere has no distinct boundaries; it is found within the other Earth systems. The living things shown in **Figure 2** are part of the biosphere. You will learn more about the biosphere when you study life science, or biology. The rest of this chapter will describe the three Earth systems made of nonliving things.

Figure 2  Air, water, rocks, and living things are all part of Earth.



Reading Check Why doesn't the biosphere have distinct boundaries?



The Atmosphere

The force of Earth's gravity pulls molecules of gases into a layer surrounding the planet. *This mixture of gases forms a layer around Earth called the atmosphere.* The atmosphere is denser near Earth's surface and becomes less dense farther from Earth. It keeps Earth warm by trapping thermal energy from the Sun that bounces back from Earth's surface. If the atmosphere did not regulate temperature, life as it is on Earth could not exist.

What makes up the atmosphere?

The atmosphere contains a mixture of nitrogen, oxygen, and smaller amounts of other gases. The graph in **Figure 3** shows the percentages of these gases. The most common gas is nitrogen, which makes up 78 percent of the atmosphere. Most of the remaining gas is oxygen.

The other gases are called trace gases because they make up only 1 percent, or a trace, of the atmosphere. Nonetheless, trace gases are important. Carbon dioxide, methane, and water vapor help regulate Earth's temperature. Note that **Figure 3** shows the percentages of gases in dry air. The atmosphere also contains water vapor. The amount of water vapor in the atmosphere generally ranges from 0 to 4 percent.

Along with gases and water vapor, the atmosphere contains small amounts of solids. Particles of dust float along with the gases and water vapor. Sometimes you can see these tiny specks as sunlight reflects off them as it shines through a window.



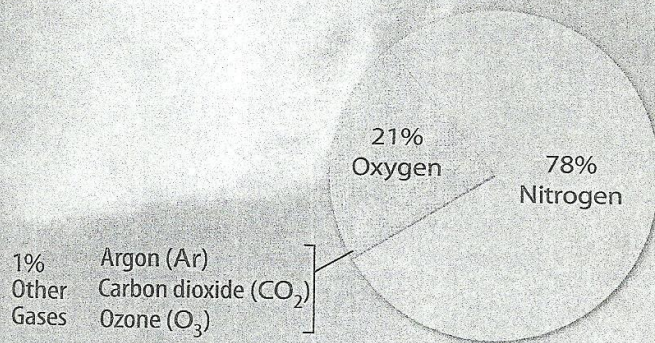
 **Key Concept Check** What is the composition of the atmosphere?

Figure 3  Dry air contains a mixture of gases. Though the atmosphere is made mainly of nitrogen and oxygen, trace gases are also important.



WORD ORIGIN

atmosphere
from Greek *atmos*, means
"vapor"; and Greek *sphaira*,
means "sphere"



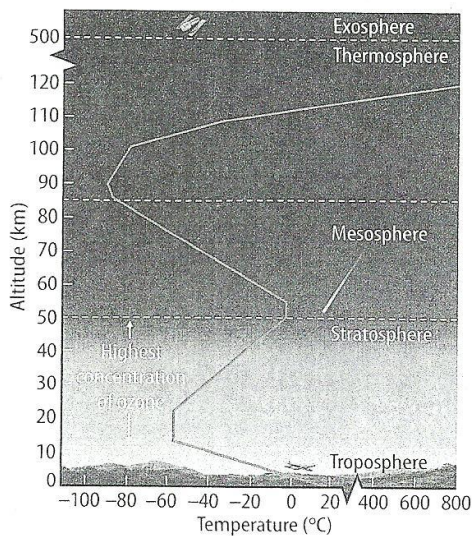


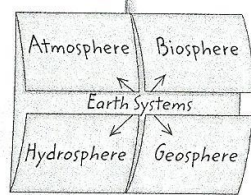
Figure 4 The atmosphere is divided into layers according to differences in temperature.

Visual Check Summarize how temperature changes as altitude increases.

Concepts in Motion Animation

FOLDABLES

Make a small, horizontal four-door book with a 1-cm center tab. Label it as shown. Use it to organize your notes on Earth systems.



Layers of the Atmosphere

The composition of the atmosphere does not change much over time. However, the temperature of the atmosphere does change. Radiant energy from the Sun heats Earth's atmosphere; however, different parts of the atmosphere absorb or reflect the Sun's energy in different ways. The red line in Figure 4 shows changes in temperature as altitude increases. These temperature changes are used to distinguish layers in the atmosphere.

The Troposphere If you have ever hiked up a mountain, you might have noticed that the temperature decreases as you climb higher. In the bottom layer of the atmosphere, called the troposphere, temperature decreases as you move upward from Earth's surface. Gases flow and swirl in the troposphere, causing weather. Although the troposphere does not extend very far upward, it contains most of the mass in the atmosphere.

The Stratosphere Above the troposphere is the stratosphere. Unlike gases in the troposphere, gases in the stratosphere do not swirl around. They are more stable and form flat layers. Within the stratosphere is a layer of ozone, a form of oxygen. This ozone layer protects Earth's surface from harmful radiation from the Sun. It acts like a layer of sunscreen, protecting the biosphere. Because ozone absorbs solar radiation, temperatures increase in the stratosphere.

Upper Layers Above the stratosphere is the mesosphere. Temperature decreases in this layer, then increases again in the next layer, the thermosphere. The last layer of Earth's atmosphere is the exosphere. The lowest density of gas molecules is in this layer. Beyond the exosphere is outer space.

Key Concept Check What are the layers of the atmosphere?



The Hydrosphere

Water is one of the most common and important substances on Earth. *The system containing all Earth's water is called the hydrosphere.* Most water is stored on Earth's surface, but some is located below the surface or within the atmosphere and biosphere. The hydrosphere contains more than 1.3 billion km³ of water. The amount of water does not change. But like the gases in the atmosphere, water in the hydrosphere flows. It moves from one location to another over time. Water also changes state. It is found as a liquid, a solid, and a gas on Earth.

 **Reading Check** How much water is in the hydrosphere?

Ocean

Scientists call the natural locations where water is stored reservoirs (REH zuh vworz). The largest reservoir on Earth is the world ocean. Though the oceans have separate names, they are all connected, making one large ocean. Water flows freely throughout the world ocean. About 97 percent of Earth's water is in the ocean, as shown in Figure 5.

Many minerals dissolve easily in water. As water in rivers and underground reservoirs flows toward the ocean, it dissolves materials from the solid Earth. These dissolved minerals make ocean water salty. Most plants and animals that live on land, including humans, cannot use salt water. They need freshwater to survive.

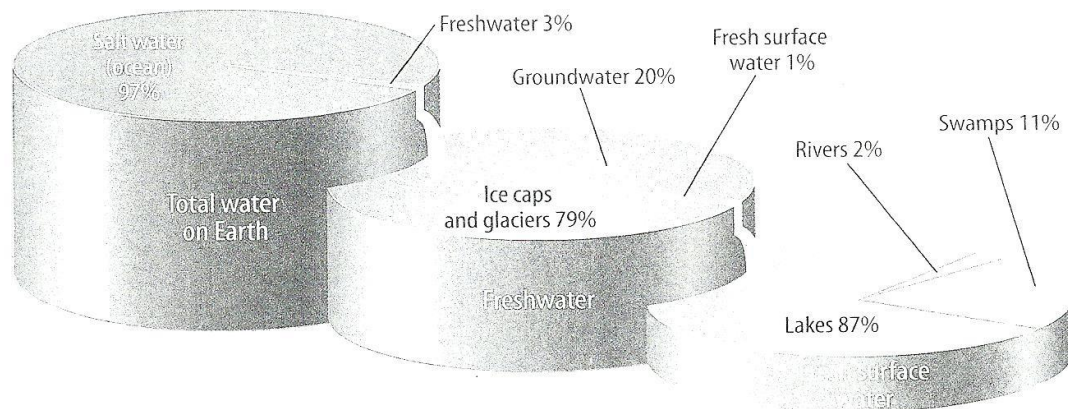
REVIEW VOCABULARY

freshwater
water that contains less than 0.2 percent dissolved salts

Distribution of Earth's Water

Figure 5 Water in the hydrosphere is found in several different reservoirs.

 **Visual Check** Where is most water on Earth located?



Lakes and Rivers

Less than 1 percent of freshwater is easily accessible on Earth's surface. This small percentage of Earth's total water must meet the needs of people and other organisms that require freshwater. Rain and snow supply water to the surface reservoirs—lakes and rivers. Water in these reservoirs moves through the water cycle much faster than water frozen in glaciers and ice caps.

Groundwater

Ice, lakes, and rivers hold about 80 percent of Earth's freshwater. Where is the remaining 20 percent? It is beneath the ground. Some rain and snow seep into the ground and collect in small cracks and open spaces called pores. **Groundwater** is water that is stored in cracks and pores beneath Earth's surface. As shown in Figure 6, groundwater collects in layers. Many people get their water by drilling wells down into these layers of groundwater.

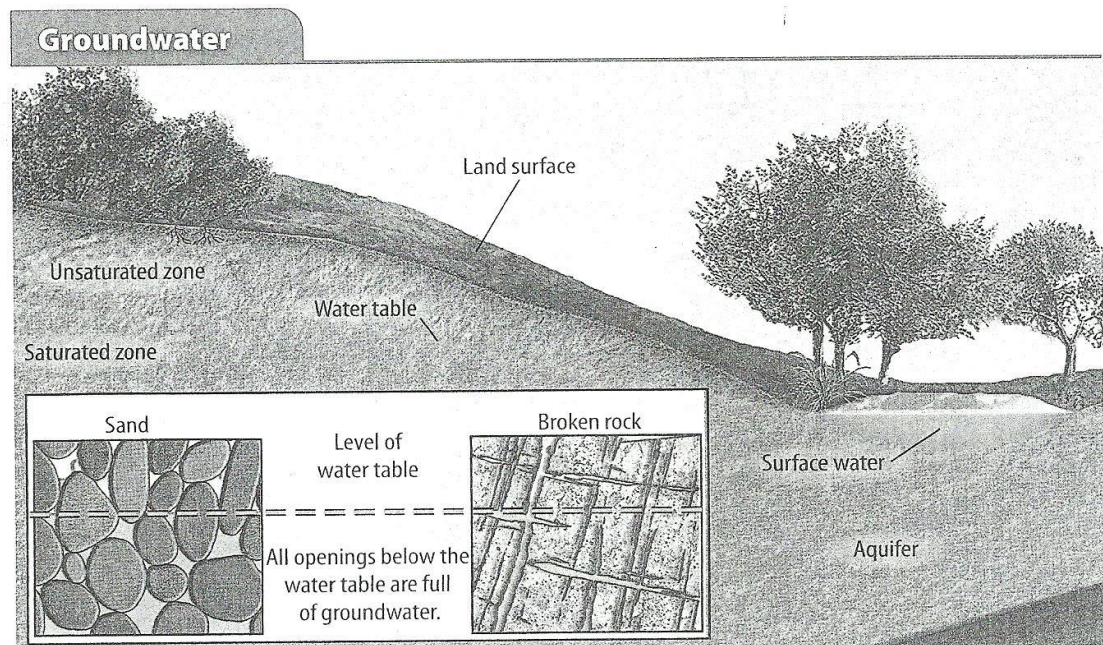


Key Concept Check How is water distributed in the hydrosphere?

The Cryosphere

Did you know that most of Earth's freshwater is frozen? The frozen portion of water on Earth's surface is called the cryosphere. About 79 percent of the planet's freshwater is in the cryosphere. The cryosphere consists of snow, glaciers, and icebergs. Water can be stored as ice for thousands of years before melting and becoming liquid water in other reservoirs.

Figure 6 Freshwater in lakes, rivers, and glaciers is visible on Earth's surface, but large amounts of groundwater are hidden below the surface.



The Geosphere

The last nonliving Earth system is the geosphere. *The geosphere is the solid part of Earth.* It includes a thin layer of soil and broken rock material along with the underlying layers of rock. The rocks and soil on land and beneath the oceans are part of the geosphere.

 **Key Concept Check** What are Earth systems?

Materials in the Geosphere


The geosphere is made of soil, rock, and metal. All of these materials are composed of smaller particles.

Minerals Have you ever seen a sparkling diamond ring? Diamond is a mineral that is mined and then later cut and polished. **Minerals** are naturally occurring, inorganic solids that have crystal structures and definite chemical compositions.

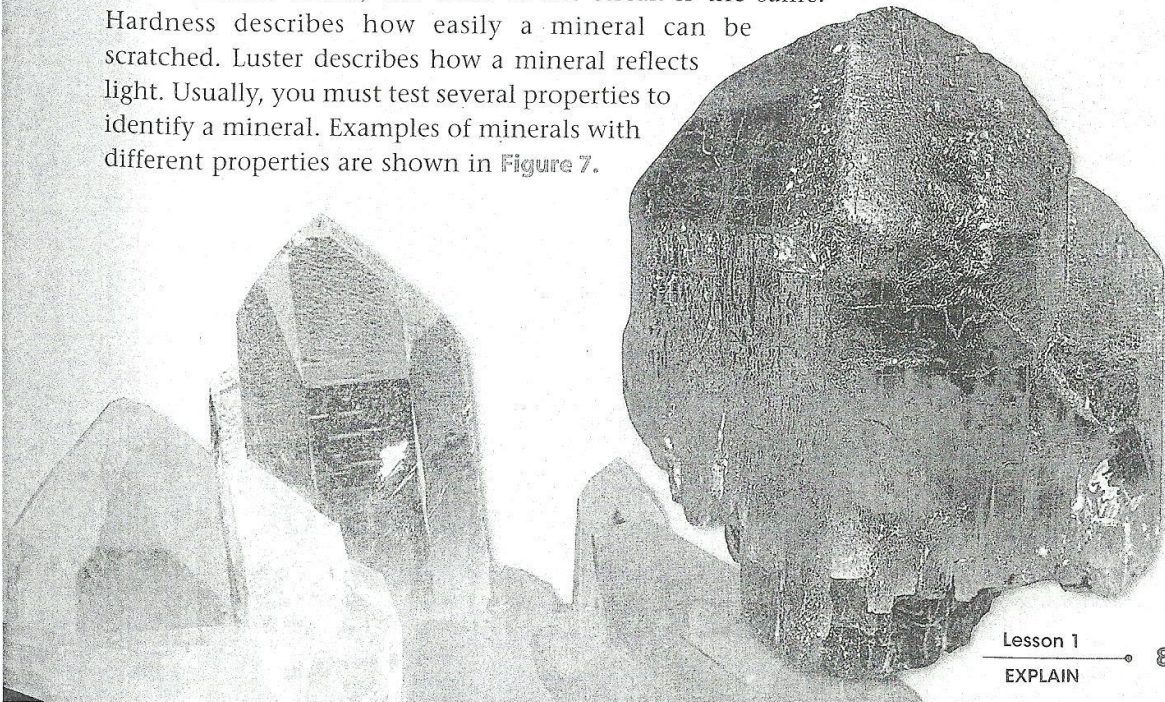
To be considered a mineral, a material must have all five characteristics listed above. For example, materials that are made by people are not minerals because they did not form naturally. Materials that were once alive are organic and cannot be minerals. A mineral must be solid, so liquids and gases are not minerals. The atoms in minerals must be arranged in an orderly, repeating pattern. Finally, each mineral has a unique composition made of specific elements.

Minerals are identified by their physical properties, which include color, streak, hardness, luster, and crystal shape. Streak is the color of a mineral's powder. Even though some minerals have different colors, the color of the streak is the same. Hardness describes how easily a mineral can be scratched. Luster describes how a mineral reflects light. Usually, you must test several properties to identify a mineral. Examples of minerals with different properties are shown in Figure 7.

Figure 7 Minerals have different properties. The quartz shown on the left has a visible crystal structure. The olivine shown on the right has a striking color.

 **Review**

Personal Tutor



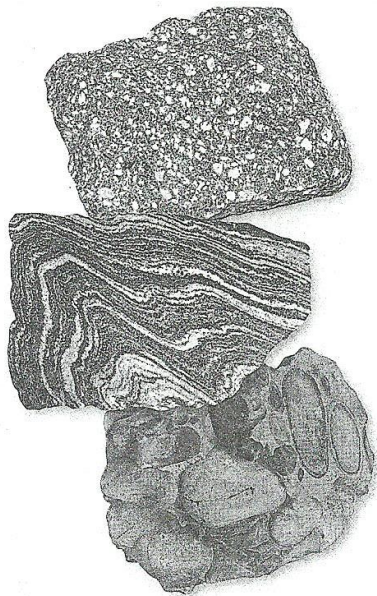


Figure 8 Diorite (top) is an igneous rock. Gneiss (center) is metamorphic. The conglomerate (bottom) is sedimentary.

Rocks Minerals are the building blocks of rocks. A **rock** is a naturally occurring solid composed of minerals and sometimes other materials such as organic matter. Scientists classify rocks according to how they formed. As shown in **Figure 8**, there are three major rock types: igneous, sedimentary, and metamorphic.

Igneous rocks form when molten material, called magma, cools and hardens. Often magma is found deep inside Earth, but sometimes it erupts from volcanoes and flows onto Earth's surface as lava. So, igneous rocks can form inside Earth or on Earth's surface.

Sedimentary rocks form when forces such as water, wind, and ice break down rocks into small pieces called sediment. These same forces carry and deposit the sediment in layers. The bottom layers of sediment are compressed and then cemented together by natural substances to form rocks.

Metamorphic rocks form when extreme temperatures and pressure within Earth change existing rocks into new rocks. The rocks do not melt. Instead, their compositions or their structures change.

Inquiry MiniLab


20 minutes

What makes the geosphere unique? 

Rocks and minerals, minerals and rocks—they always seem to go together. Can you have one without the other?

- 1 Read and complete a lab safety form.
- 2 Select a set of samples. You should have eight **minerals** and one **rock**. Identify which samples are minerals and which is the rock. Check with your teacher before moving on to step 3.
- 3 Use a **magnifying lens** to examine each mineral carefully. Note its color and other properties. Record your observations in your Science Journal.
- 4 Now, examine the rock. Do you recognize any of the minerals in the rock? Make two sets of samples—minerals that are present in the rock and minerals that are not.



2. **Generalize** What general statement can you make about the differences between rocks and minerals?
3.  **Key Concept** Based on your observations, what kinds of materials make up the geosphere?

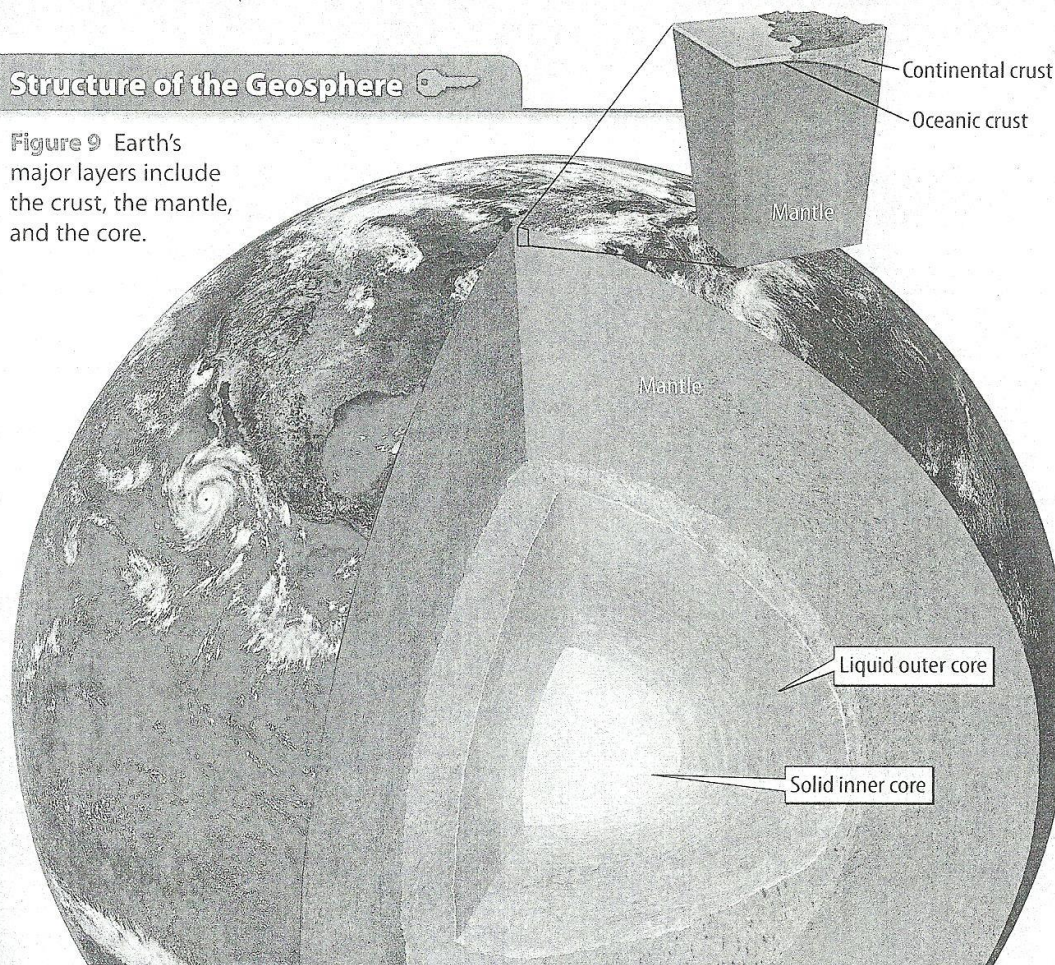
Analyze and Conclude

1. **Summarize** the mineral and rock properties you observed.



Structure of the Geosphere

Figure 9 Earth's major layers include the crust, the mantle, and the core.



Structure

Earth's internal structure is layered like the layers of a hard-cooked egg. The three basic layers of the geosphere are shown in **Figure 9**. Similar to an egg, each layer of the geosphere has a different composition.

Crust The brittle outer layer of the geosphere is much thinner than the inner layers, like the shell on a hard-cooked egg. This thin layer of rock is called the crust. The crust is found under the soil on continents and under the ocean. Oceanic crust is thinner and denser than continental crust. This is due to their different compositions. Continental crust is made of igneous, sedimentary, and metamorphic rocks. Oceanic crust is made of only igneous rock.

Mantle The middle and largest layer of the geosphere is the mantle. Like the crust, the mantle is made of rock; however, mantle rocks are hotter and denser than those in the crust. In parts of the mantle, temperatures are so high that rocks flow, a bit like partially melted plastic.

Core The center of Earth is the core. If you use a hard-cooked egg as a model of Earth, then the yolk would be the core. Unlike the crust and the mantle, the core is not made of rock. Instead, it is made mostly of the metal iron and small amounts of nickel. The core is divided into two parts. The outer core is liquid. The inner core is a dense ball of solid iron.



Key Concept Check What are the composition and the structure of the geosphere?

