Technology is used to explore the Earth system.

**KEY CONCEPT**

**6.1**

**Sunshine State STANDARDS**

SC.D.1.3.1: The student knows that mechanical and chemical activities shape and reshape the Earth’s land surface by eroding rock and soil in some areas and depositing them in other areas, sometimes in seasonal layers.

SC.D.1.3.4: The student knows the ways in which plants and animals reshape the landscape (e.g., bacteria, fungi, worms, rodents, and other organisms add organic matter to the soil, increasing soil fertility, encouraging plant growth, and strengthening resistance to erosion).

**BEFORE, you learned**

- Earth has a spherical shape and supports a complex web of life
- Earth’s environment is a system with many parts

**NOW, you will learn**

- About the Earth system and its four major parts
- How technology is used to explore the Earth system
- How the parts of the Earth system shape the surface

**THINK ABOUT**

*How do these parts work together?*

Look closely at this terrarium. Notice that the bowl and its cover form a boundary between the terrarium and the outside world. What might happen to the entire terrarium if any part were taken away? What might happen if you placed the terrarium in a dark closet?

**The Earth system has four major parts.**

A terrarium is a simple example of a **system** — an organized group of parts that work together to form a whole. To understand a system, you need to see how all its parts work together. This principle is true for a small terrarium, and it is true for planet Earth.

Both a terrarium and Earth are closed systems. They are closed because matter, such as soil or water, cannot enter or leave. However, energy can flow into or out of the system. Just as light and heat pass through the glass of the terrarium, sunlight and heat enter and leave the Earth system through the atmosphere.

Within the Earth system are four connected parts: the **atmosphere** (Earth’s air), the **hydrosphere** (Earth’s waters), the **biosphere** (Earth’s living things), and the **geosphere** (Earth’s interior and its rocks and soils). Each of these parts is an open system because both matter and energy move into and out of it. The four open systems work together to form one large, closed system called Earth.
Atmosphere

The atmosphere (AT-muh-SFEER) is the mixture of gases and particles that surrounds and protects the surface of Earth. The most abundant gases are nitrogen (about 78%) and oxygen (nearly 21%). The atmosphere also contains carbon dioxide, water vapor, and a few other gases.

Before the 1800s, all studies of the atmosphere had to be done from the ground. Today, scientists launch weather balloons, fly specially equipped planes, and view the atmosphere in satellite images. The data they collect show that the atmosphere interacts with the other parts of the Earth system to form complex weather patterns that circulate around Earth. The more scientists learn about these patterns, the more accurately they can predict local weather.

Hydrosphere

The hydrosphere (HY-druh-SFEER) is made up of all the water on Earth in oceans, lakes, glaciers, rivers, and streams and underground. Water covers nearly three-quarters of Earth’s surface. Only about 3 percent of the hydrosphere is fresh water. Nearly 70 percent of Earth’s fresh water is frozen in glaciers and polar ice caps.
In the past 50 years, scientists have used deep-sea vehicles, special buoys, satellite images, and diving suits, such as the one shown on page 198, to study the world’s oceans. They have discovered that the oceans contain several layers of cold and warm water. As these layers circulate, they form cold and warm ocean currents. The currents interact with wind patterns in the atmosphere and affect Earth’s weather.

**Biosphere**

The **biosphere** (BY-uh-SFEEER) includes all life on Earth, in the air, on the land, and in the waters. The biosphere can be studied with a variety of technologies. For example, satellite photos are used to track yearly changes in Earth’s plant and animal life. As the photograph below shows, special equipment allows scientists to study complex environments, such as rain forests, without damaging them.

Scientists have learned a lot about how the biosphere interacts with the other parts of the Earth system. For example, large forests act as Earth’s “lungs,” absorbing carbon dioxide and releasing oxygen into the atmosphere. When dead trees decay, they return nutrients to the soil.

**CHECK YOUR READING** How does the hydrosphere affect the atmosphere?

**CHECK YOUR READING** Name one way the biosphere and the atmosphere interact.
Geosphere

The **geosphere** (JEE-uh-SFEER) includes all the features on Earth’s surface—the continents, islands, and sea floor—and everything below the surface. As the diagram illustrates, the geosphere is made up of several layers: crust, mantle, and outer and inner core.

**crust**: thin, rocky shell that includes continents and sea floor

**mantle**: thick layer of hot rock

**outer core**: molten metal, mostly iron

**inner core**: solid metal, mostly iron

People have studied the surface of the geosphere for centuries. Not until the 1900s, however, were people able to study Earth from space or to explore deep within the planet. Today, scientists use satellite images, sound waves, and computer modeling to develop accurate pictures of features on and below Earth’s surface. These images show that Earth constantly changes. Some changes are sudden—a volcano explodes, releasing harmful gases and dust into the air. Other changes, such as the birth of new islands, happen over millions of years.

**CHECK YOUR READING**

Give an example of matter moving from the geosphere to the atmosphere.
All four parts of the Earth system shape the planet’s surface.

Earth’s surface is worn away, built up, and reshaped every day by the atmosphere, the hydrosphere, the biosphere, and the geosphere. Here are some of the ways they affect the surface.

**Atmosphere and Hydrosphere** Not even the hardest stone can withstand wind and water. Over millions of years, rain, wind, and flowing water carve huge formations such as the Grand Canyon in Arizona or the rock towers of Utah, shown on page 200.

**Geosphere** Landmasses pushing together have set off earthquakes and formed volcanoes and mountain ranges around the world.

**Biosphere** Plants, animals, and human beings have also changed Earth’s surface. For instance, earthworms help make soils more fertile. And throughout human history, people have dammed rivers and cleared forests for farmland.

You are part of this process, too. Every time you walk or ride a bike across open land, you are changing Earth’s surface. Your feet or the bike’s tires dig into the dirt, wearing away plants and exposing soil to sunlight, wind, and water. If you take the same route every day, over time you will wear a path in the land.

**How can you model the geosphere’s layers?**

**PROCEDURE**

1. To model the layers of the geosphere, you will be using a quarter of an apple that your teacher has cut. Note: NEVER eat food in the science classroom.
2. Hold the apple slice and observe it carefully. Compare it with the diagram of the geosphere’s layers on page 200.
3. Draw a diagram of the apple and label it with the names of the layers of the geosphere.

**WHAT DO YOU THINK?**

- What are the four parts of the apple slice?
- What major layer of the geosphere does each part of the apple resemble?

**CHALLENGE** What other object do you think would make a good model of the geosphere’s layers? What model could you build or make yourself?
The photograph above shows a good example of how the four parts can suddenly change Earth's surface. A mudslide like this one can happen in a matter of minutes. Sometimes the side of a mountain may collapse, becoming a river of mud that can bury an entire town.

The four parts of the Earth system continue to shape the surface with every passing year. Scientists will continue to record these changes to update maps and other images of the planet’s complex system.

Find three examples on pages 201 and 202 that show how the parts of the Earth system shape the planet’s surface.