Section 2

The Study of Earth Science

Reading Preview

Key Concepts

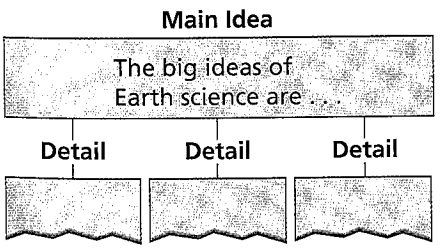
- What are the big ideas of Earth science?
- What are the branches of Earth science?
- How do Earth scientists use models?

Key Terms

- Earth science • system
- energy • constructive force
- destructive force • geologist
- oceanographer
- meteorologist • astronomer
- environmental scientist

Target Reading Skill

Identifying Main Ideas As you read the Big Ideas of Earth Science section, write the main idea in a graphic organizer like the one below. Then write three supporting details that further explain the main idea.



Lab zone Discover Activity

What Do Earth Scientists Study?

1. Preview Figure 7, which shows several different careers in Earth science.
2. Based on the figure, make a list of the different branches of Earth science.

Think It Over

Predicting What do you think a scientist in each career would study? Write your prediction beside each branch of Earth science on your list.

Leonard Strachan is an astronomer, but he doesn't study the night sky. "I'm a daytime astronomer," he says. "I study the sun." And the instruments he uses are not on a mountaintop. They are on a satellite in space between Earth and the sun. "The sun," Dr. Strachan says, "doesn't just shine as a steady yellow ball. It's always changing. Every so often the sun shoots out a huge cloud of gas particles into space. Within days the particles crash into Earth's upper atmosphere. They cause auroras: shimmering, glowing light shows in the sky. The particles interfere with radio waves. Pagers and cellular phones can stop working. Even our electrical power can be affected."

Dr. Strachan studies the sun to help scientists learn to predict this "space weather." He also collects data that can prove or disprove scientists' theories about the sun.

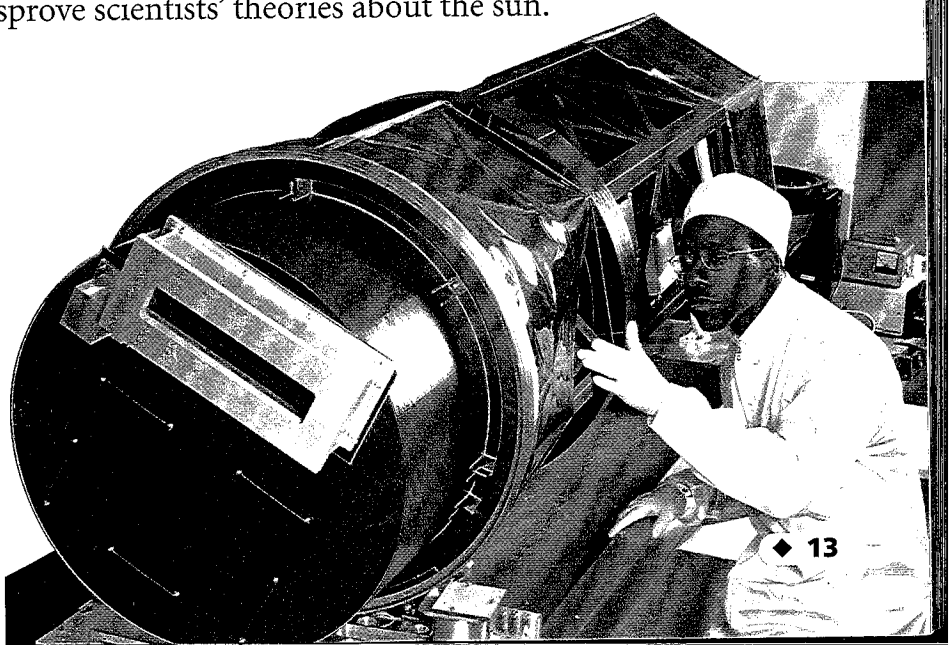


FIGURE 5
Observing the Sun
Dr. Strachan collects data using an instrument on this satellite, the Solar and Heliospheric Observatory, or SOHO.

Big Ideas of Earth Science

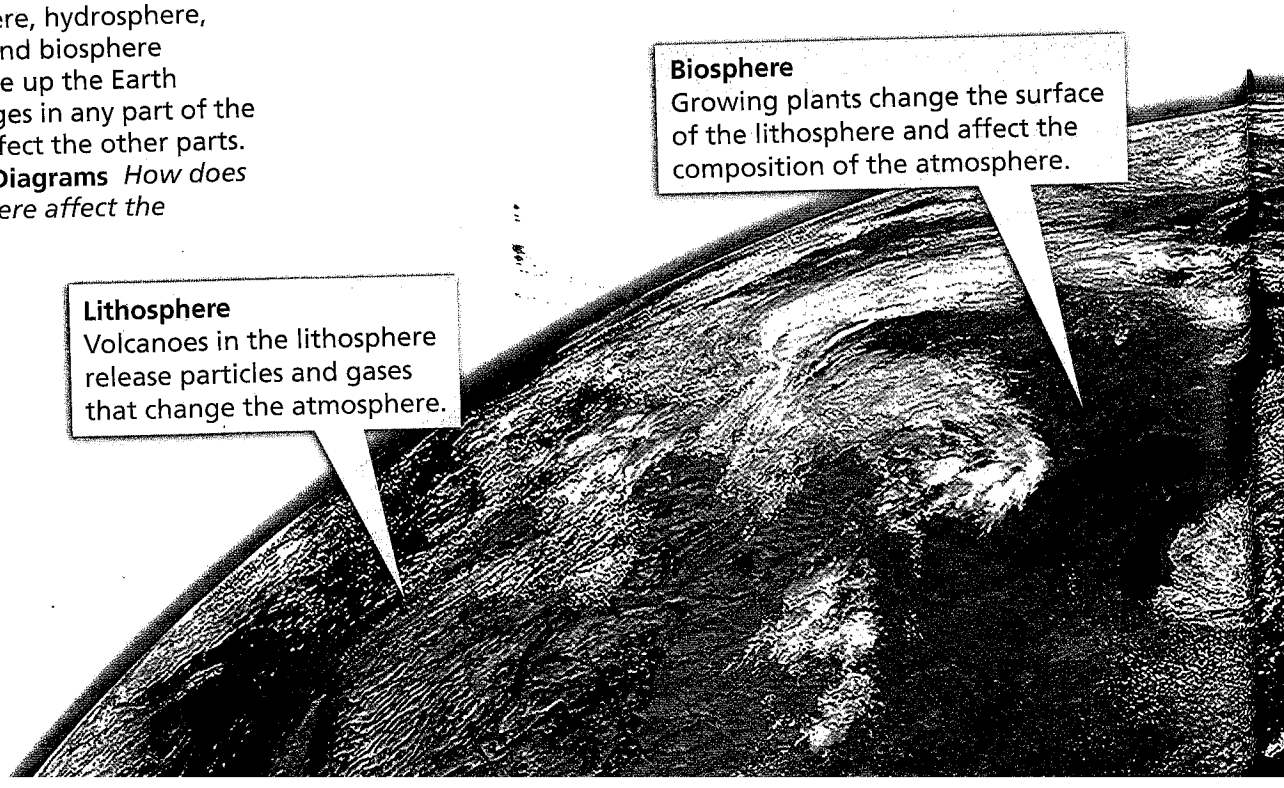
Throughout history, people have observed the skies above them and the Earth around them. Over thousands of years, scientists have built a body of knowledge based on these observations. **Earth science** is the term for this knowledge about Earth and its place in the universe. **Earth scientists use several big ideas to guide their work: the structure of the Earth system, Earth's history, and Earth in the solar system.**

The Structure of the Earth System Scientists often divide Earth into four parts, or spheres: the lithosphere, hydrosphere, atmosphere, and biosphere. Earth's outermost sphere is the atmosphere (AT muh sfeer), the mixture of gases that surrounds the planet. Earth's oceans, lakes, rivers, and ice form the hydrosphere (HY druh sfeer). Earth's solid rocky outer layer is called the lithosphere (LITH uh sfeer). All living things—whether in the air, in the oceans, or on and beneath the land surface—make up the biosphere (BY uh sfeer).

These four spheres aren't separate. They make up the Earth system. A **system** is a group of parts that work together as a whole. A change in one part of the Earth system affects all the other parts. Matter and energy constantly move from one part of the Earth system to another. Matter is what makes up everything in the universe. **Energy** is the ability to do work or cause change. For example, in the water cycle, water moves from the oceans, to the atmosphere, to the land, and back to the oceans.

FIGURE 6
Earth as a System

The atmosphere, hydrosphere, lithosphere, and biosphere together make up the Earth system. Changes in any part of the system can affect the other parts.
Interpreting Diagrams *How does the hydrosphere affect the atmosphere?*



The sun provides energy for the water cycle and many other processes on Earth's surface. The sun's energy is transferred to Earth as radiation, a form of energy that can move through space. The energy for other processes comes from the heat of Earth's interior. For example, deep inside Earth, some rock melts, forming the material that erupts from volcanoes.

Earth's History As you will learn later in this book, scientists have evidence that Earth is 4.6 billion years old! During this long span of time, Earth has not stayed the same. Instead, constructive and destructive forces have changed Earth's surface throughout its history. **Constructive forces** shape Earth's surface by building up mountains and landmasses. **Destructive forces** slowly wear away mountains and every other feature on Earth's surface.

Earth in the Solar System You have probably looked at the full moon and noticed the round craters in its surface. The craters formed when large objects from space struck the moon. Scientists have found similar craters on Earth. These craters are a reminder that Earth is not alone in space. It is part of the solar system.

The solar system is made up of the sun and the planets—with their moons—that move around the sun. The solar system also contains objects of different sizes, from dust-sized particles to large chunks of rock and ice. These objects are also in motion around the sun. Understanding the other planets and objects in the solar system helps scientists understand Earth and its history.

Reading Checkpoint **How do constructive forces shape Earth?**

Lab zone Try This Activity

Energy for Earth

You can observe how the sun provides energy for processes on Earth's surface.

1. Pour 100 mL of tap water into a clear plastic jar and tighten the lid.
2. Place the jar in the sun for 10 minutes.
3. Move the jar to a shaded location and wait several minutes.
4. Observe the sides of the jar. What do you see?

Predicting If you left the jar open in the sun for a full day, what would happen to the water in the jar?

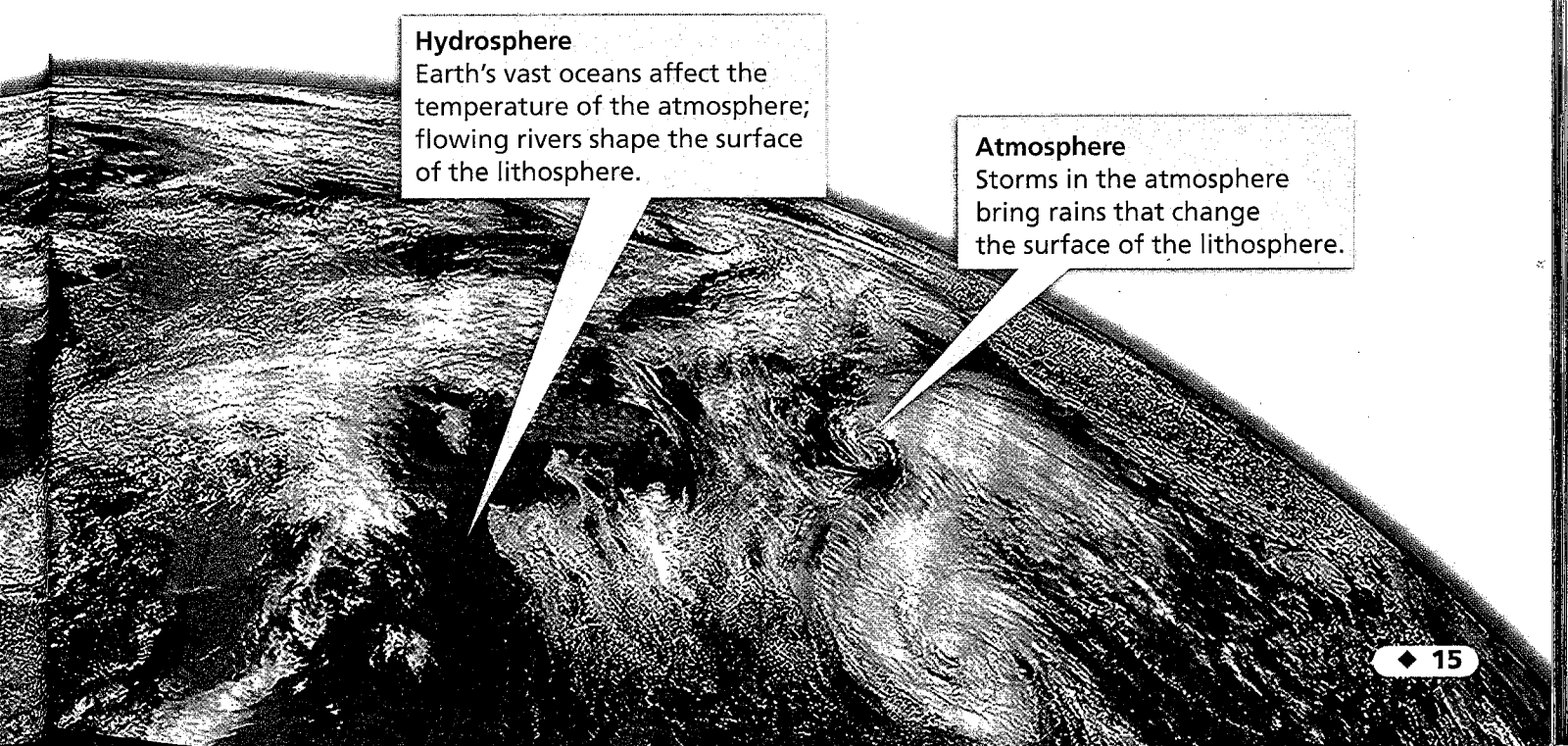
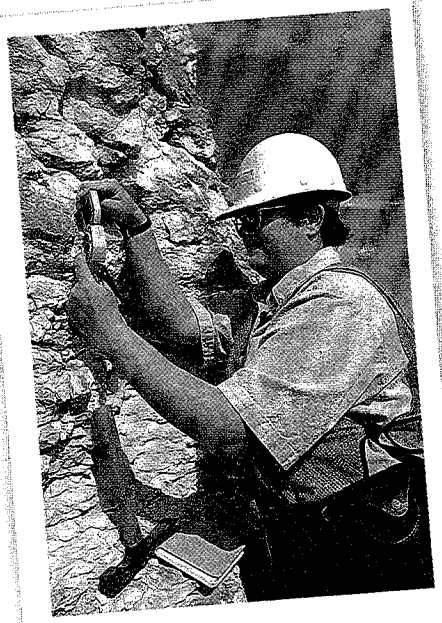


FIGURE 7

Careers in Earth Science

If you worked as an Earth scientist, you might release a weather balloon into the atmosphere. You might pilot a submersible deep beneath the ocean or chip samples of rock from a mountain.

Oceanographers ▲
These oceanographers have donned scuba gear to observe the interactions of living things on the ocean floor.



Geologists ▲
The work of geologists often takes them outdoors—in this case, to a rocky mountainside.

The Branches of Earth Science

Earth science has several different branches. **In this book, you will learn about geology, oceanography, meteorology, astronomy, and environmental science.**

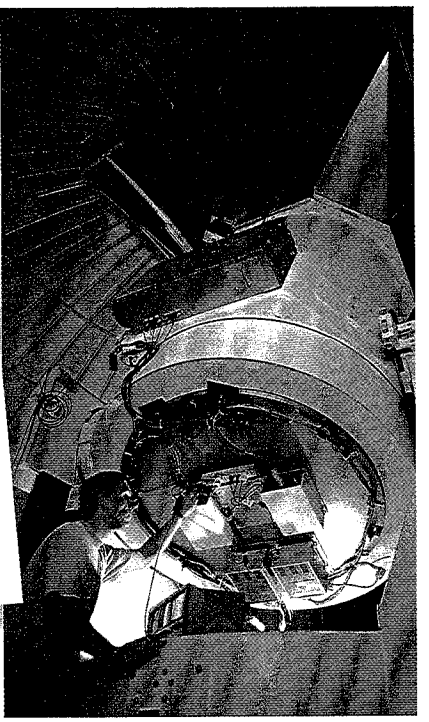
Geology Geology is the study of the solid Earth. **Geologists** study the forces that have shaped Earth throughout its long history. Geologists study the chemical and physical characteristics of rock, the material that forms Earth's hard surface. Geologists describe the features sculpted in rock and soil by water, wind, and waves.

The science of geology began in the late 1700s. Geologists of that time studied the rocks on the surface. Those geologists concluded that Earth's land features are the work of natural forces that slowly build up and wear down the land.

Oceanography Oceanography is the study of Earth's oceans. **Oceanographers** study everything from the chemistry of ocean water to the shape of the ocean floor to living things in the ocean's depths. Scientists in related fields study Earth's fresh water in lakes, rivers, and glaciers and beneath the surface.

◀ Meteorologists
Meteorologists use data from weather satellites to monitor storms such as hurricanes. Computers process and display weather data.

Environmental Scientists ▶
These environmental scientists are testing water samples to find evidence of environmental change or pollution.



Astronomers ▲
Astronomers use telescopes to observe distant objects in space.

Meteorology Meteorology is the study of Earth's atmosphere. Meteorologists do much more than just forecast tomorrow's weather. **Meteorologists** are scientists who gather information about conditions in the atmosphere from around the world. Scientists in related fields study the forces that change Earth's climate.

Astronomy Astronomy is the study of the universe beyond Earth. Some **astronomers** focus on the solar system. Other astronomers observe stars and galaxies in an effort to understand the universe and its history.

Environmental Science Some Earth scientists, called **environmental scientists,** study Earth's environment and resources. Environmental scientists work together to determine the effects of human activities on Earth's land, air, water, and living things. They try to solve problems, such as pollution, that result from the use of resources.

Reading Checkpoint **What is a meteorologist?**

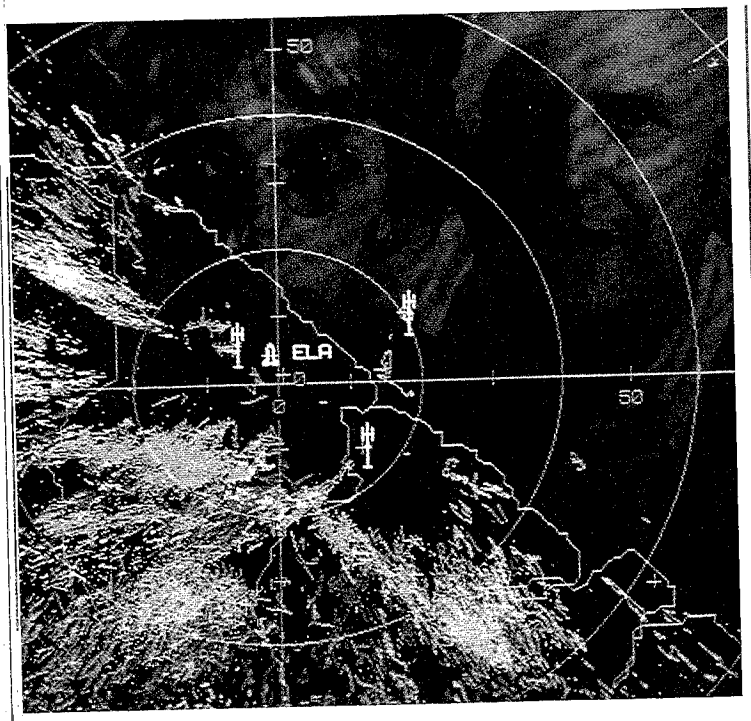


FIGURE 8
Modeling Earth's Weather
This weather map is a model of changing conditions in Earth's atmosphere.

Models in Earth Science

Making models helps people study and understand things that are complex or can't be observed directly. Models are very useful in Earth science. You can't fit the whole atmosphere or lithosphere inside a laboratory! Even if you could, your experiment might need to last for millions of years. **For these reasons, Earth scientists often use models to represent complex objects or processes.** For example, meteorologists create models of how storms such as tornadoes and hurricanes form. In Figure 8 you can see one type of model used in Earth science—a weather map.

Earth scientists sometimes use models or computer simulations to test a hypothesis. A simulation is a model that imitates something in the real world. Scientists compare the results obtained from a simulation with known facts. This helps them decide whether the simulation supports the hypothesis. Because some information may be missing from a model, the model may not fully explain the process it represents.

Reading Checkpoint **What is a simulation?**

Section 2 Assessment

Target Reading Skill Identifying Main Ideas Use your graphic organizer to help you answer Question 1 below.

Reviewing Key Concepts

1. a. **Reviewing** What are the big ideas of Earth science?
   b. **Explaining** Why do scientists view Earth as a system?
   c. **Relating Cause and Effect** Give an example of how one of the spheres of the Earth system can affect at least one of the other spheres.
2. a. **Listing** List the five branches of Earth science.
   b. **Summarizing** What do geologists do?
   c. **Classifying** What type of Earth scientist would probably study the effects of human activities on coral reefs? Explain.
3. a. **Explaining** Why are models useful in Earth science?
   b. **Applying Concepts** A geologist wants to make a model showing how a flood can change a river valley. Why would the geologist first collect data from many different floods?

Writing in Science

A Day in the Life Research one of the Earth science careers in Figure 7. Based on your research, write a paragraph describing a typical workday for that type of Earth scientist. In your description, include the science inquiry skills the scientist would use on the job.

Lab zone **Skills Lab**

Speeding Up Evaporation

Problem

What factors increase the rate at which water evaporates?

Skills Focus

developing hypotheses, controlling variables, drawing conclusions

Materials

- water
- plastic dropper
- stopwatch
- 2 plastic petri dishes
- 1 petri dish cover
- 3 index cards
- paper towels
- lamp

Procedure

PART 1 Effect of Heat

1. How do you think heating a water sample will affect how fast it evaporates? Record your hypothesis.
2. Place each petri dish on an index card.
3. Add a single drop of water to each of the petri dishes. Try to make the two drops the same size.
4. Position the lamp over one of the dishes as a heat source. Turn on the light. Make sure the light does not shine on the other dish. **CAUTION:** *The light bulb will become very hot. Avoid touching the bulb or getting water on it.*
5. Observe the dishes every 3 minutes to see which sample evaporates faster. Record your result.

PART 2 Effect of Wind

6. How do you think fanning the water will affect how fast it evaporates? Record your hypothesis.
7. Dry both petri dishes and place them over the index cards. Add a drop of water to each dish as you did in Step 3.
8. Use an index card to fan one of the dishes for 5 minutes. Be careful not to fan the other dish.
9. Observe the dishes to see which sample evaporates faster. Record your result.

Analyze and Conclude

1. **Developing Hypotheses** Did the evidence support both hypotheses? If not, which hypothesis was not supported?
2. **Controlling Variables** What was the manipulated variable in this experiment? The responding variable?
3. **Drawing Conclusions** Make a general statement about factors that increase the rate at which the water evaporates.
4. **Communicating** What everyday experiences helped you make your hypotheses at the beginning of the experiment? Explain how hypotheses differ from guesses.

Design an Experiment

How do you think increasing the surface area of a water sample will affect how fast it evaporates? Write your hypothesis and then design an experiment to test it. *Obtain your teacher's permission before carrying out your investigation.*