CHAPTER 1
LESSON 2

Mapping Earth

Technology and Mapmaking

Key Concepts

- What can a topographic map tell you about the shape of Earth's surface?
- What can you learn from geologic maps about the rocks near Earth's surface?
- How can modern technology be used in mapmaking?

Before You Read

What do you think? Read the three statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

Before	Statement	After
	4. Topographic maps show changes in surface elevations.	
	5. The colors on geologic maps show the colors of the surface rocks.	
	6. Satellites are too far from Earth to collect useful information about Earth's surface.	

Study Coach

Use an Outline As you read, make an outline to summarize the information about maps. Use the main headings in the lesson as the main headings in your outline. Use the outline to review the lesson.

Read to Learn

Types of Maps

If you were going to join two pieces of wood together, you might use a hammer and nails. To scramble eggs, you could use a whisk and a skillet. Just as there are tools for doing different jobs, there are maps for different purposes.

General-Use Maps

The first maps were hand drawn by explorers and sailors. They made them to record their trading routes. Today maps are used for many purposes. Following are some everyday maps you might use.

- **Physical maps** use lines, shading, and color to indicate features such as mountains, lakes, and streams.
- **Relief maps** use shading and shadows to identify mountains and flat areas.
- **Political maps** show the boundaries between countries, states, counties, or townships. The boundaries can be shown as a variety of solid or dashed lines. Different colors might be used to indicate areas within the boundaries.

Reading Check

1. Explain Who made the first maps, and what were the maps used for?

- **Road maps** can show interstate highways or a range of roads from four-lane expressways to gravel roads. They are all useful in finding your way to and from different locations. A city road map will show more detail than a road map of the entire United States.

Topographic Maps

If you were hiking across the United States, you might want to follow level terrain. If you were piloting an airplane across the United States, you would want to fly higher than the mountains. Showing how high or low land features are is a feature of one kind of specialty map.

The shape of the land surface is called topography. *A* **topographic map** *shows the detailed shapes of Earth's surface, along with its natural and human-made features*. A topographic map shows differences in elevation. You can form a mental picture of what the landscape looks like without seeing it.

Elevation and Relief *The height above sea level of any point on Earth's surface is its* **elevation.** For example, Mt. Rainier in Washington is 4,392 m above sea level. The city of Olympia, Washington, is about 43 m above sea level. *The difference in elevation between the highest point and the lowest point in an area is called* **relief.** You calculate relief by subtracting the height of the lowest point from the height of the highest point. For example, the relief between Mt. Rainier and Olympia is 4,349 m.

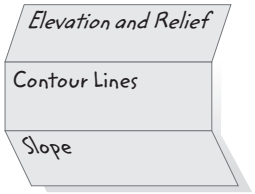
Contour lines *are lines on a topographic map that connect points of equal elevation*. Remember that lines of latitude and longitude do not really exist on Earth's surface. Similarly, contour lines do not really exist on Earth's surface. They exist only on maps.

After you learn to read contour lines, you can measure both elevation and relief on a topographical map. For example, you can use contour lines on a map to see what the elevation is for a mountain.

Interpreting Contours As you learned, contour lines represent elevation. However, the elevation might not be written on every contour line on a map. Darker contour lines, called index contours, are labeled with the elevation. To find out the elevation of the contours that are not labeled, you need to know the difference in elevation between the lines.

FOLDABLES®

Fold and label a sheet of paper to collect information about what a topographic map can show you.



Reading Check

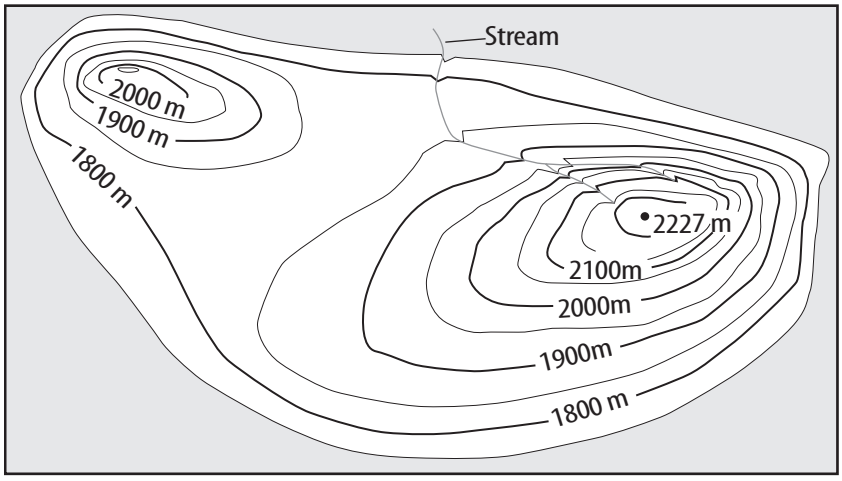
2. Define What is a topographic map?

Reading Check

3. Explain How are contour lines similar to lines of latitude and longitude?

Visual Check

4. Identify Highlight an area with a gentle slope and label it.



Contour Intervals *The elevation difference between contour lines that are next to each other is called the* **contour interval.** The map shown above has a contour interval of 50 m. You can find the elevation of an unlabeled contour by using the numbered index contours. First, find the closest index contour below the contour you are trying to identify. Then, count up to the unlabeled contour line by 50s from the index contour to find the elevation. Using this method, you can determine that the elevation of the first unlabeled contour line on the map above is 1,850 m. The closest index contour line below it is 1,800 m. By adding 50 m, you determine the height of the first unlabeled contour line.

Notice that a contour line at the top of the mountain forms a small loop with a dot in the middle of it. This dot represents the high point on the mountain—2,227 m. The V-shaped contours pointing downhill indicate ridges. The small V shape pointing uphill indicate a stream valley or drainage.

The spacing of the contours indicates slope. **Slope** *is a measure of the steepness of the land*. If the contours are spaced far apart, the slope is gradual or flat. If the contours are close together, the slope is steep.

Topographic Profiles The information that contour lines provide on a topographic map can be used to draw an accurate profile of the topography. To make a topographic profile graph, mapmakers first draw a profile line on the contour map. Then, they transfer the elevations of the contours crossed by the profile line to the *y*-axis of the topographic profile graph. Using topographic profiles can help you find the easiest path to take when crossing the land.

Key Concept Check

5. Explain What can you learn about the features at Earth's surface from studying contour lines?

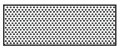
Reading Check

6. Describe how to make a topographic profile.

Symbols on Topographic Maps The United States Geological Survey (USGS) is the government agency responsible for mapping the United States. It has been mapping the United States since the late 1800s. Most topographic maps that you see are made by the USGS.

The table below shows some of the symbols used on the USGS topographic maps. Contour lines are brown on land and blue under water. Green represents vegetation, such as woods. Water in rivers, lakes, and oceans is shown in blue. Buildings are shown as black squares or rectangles, except in cities. In cities pink shading is used to indicate that housing is close together. Roads and railroads can be shown on topographic maps. Notice that different kinds of roads are represented by different symbols. If new information appears on a map, it is shown in purple.

USGS Topographic Map Symbols

Description	Symbol
Primary highway	
Secondary highway	
Unimproved road	
Railroad	
Buildings	
Urban area	
Index contour	
Intermediate contour	
Perennial streams	
Intermittent streams	
Wooded marsh	
Woods or brushwood	

Reading Check

7. Explain Why is it important for a topographic map to have a legend?

Visual Check

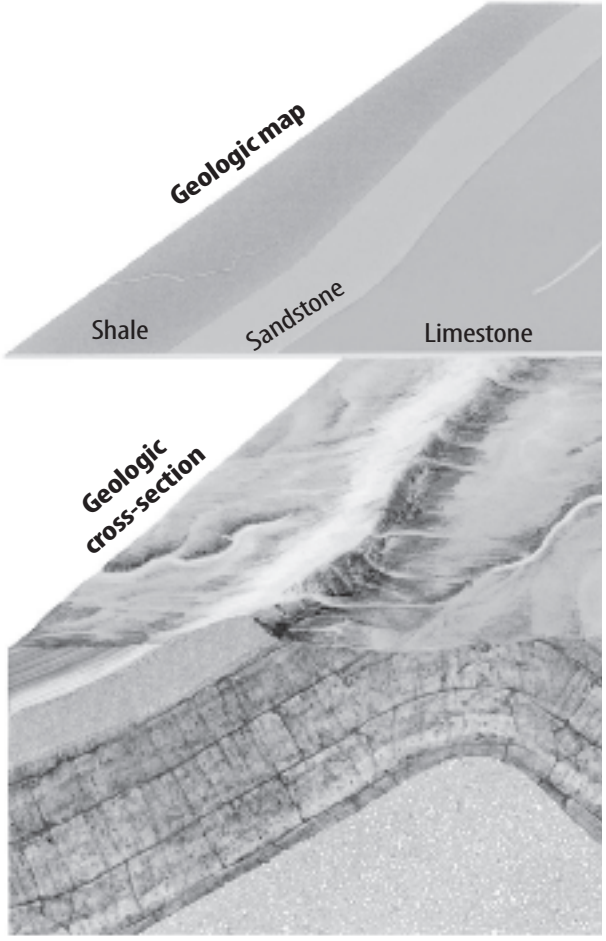
8. Contrast What is the difference between a primary highway and a secondary highway on a topographic map?

Geologic Maps

Another kind of specialty map is a geologic map. **Geologic maps** *show the surface geology of the mapped area*. It can show the rock types, their ages, and locations of faults.

Geologic Formations On a geologic map, different colors and symbols represent different geologic formations. A geologic formation is a volume of a particular kind of rock. The map legend lists the colors and symbols along with the age of the rock formation. The colors do not indicate the rock's true colors. The colors show the many formations on the map.

Geologic Cross Sections Sometimes geologists need to know what the rocks are like underground as well as on the surface. Because geologists cannot see the rocks under ground, they use other methods to collect information about geologic formations. Information can be gathered by drilling for samples, studying earthquake waves, or looking at cliffs. A cliff face is like a profile view of the ground. Geologists use this information to produce a profile view of the rocks below the ground. *The resulting diagram, showing a vertical slice through the rocks below the surface, is called a* **cross section.** A cross section of a geologic map is shown below.



Key Concept Check

9. Explain How is color used in a geologic map?

Reading Check

10. Identify How can scientists gather information about rocks below Earth's surface?

Visual Check

11. Describe What does the geologic cross section show that the geologic map does not show?

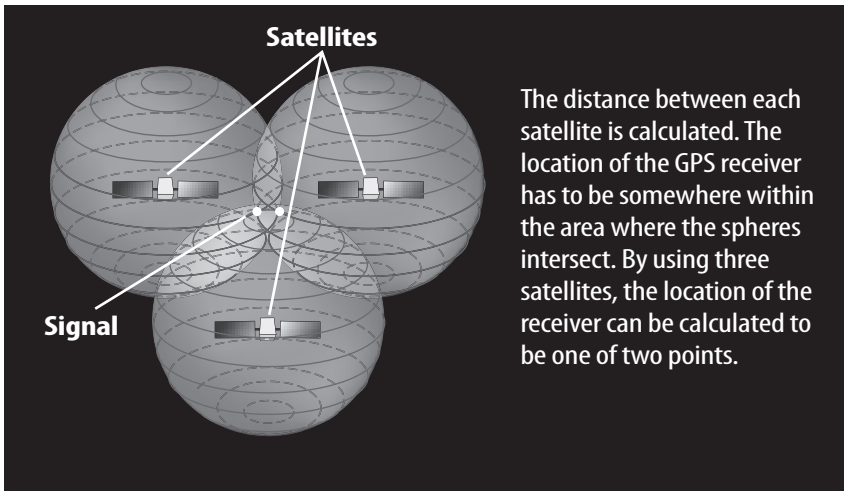
Making Maps Today

For hundreds of years, mapmakers observed Earth and gathered information from explorers. Mapmakers and explorers used tools such as compasses and telescopes to make and record measurements. Mapmakers then drew new maps by hand. Today mapmakers use computers and data from satellites to make maps.

Global Positioning System

One important resource for mapmakers today is the Global Positioning System (GPS). GPS is a group of satellites used for navigation. The 24 GPS satellites orbit Earth. They send signals back to Earth's surface. These signals are used to calculate the distance to the satellite based on the average time of the signal.

A GPS unit can receive signals from three or four different satellites, as shown below. Then the receiver calculates its location—latitude, longitude, and height above Earth's surface. GPS is used by mapmakers to locate reference points.



Originally designed for military purposes, GPS is now available for everyone. Airplane pilots and ship captains use GPS to navigate. Many people use GPS technology in their cars. Other uses include tracking wildlife for scientific data collection, detecting earthquakes, hiking, biking, land surveying, and making maps.

GPS technology continues to improve. Today, people and places can be located to the centimeter. Future improvements to safety and rescue operations are predicted. GPS technology eventually could be used to guide self-driven automobiles.

Visual Check

12. Locate Circle the location where a GPS receiver's position can be pinpointed.

Reading Check

13. Explain What are some common uses of GPS?

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Key Concept Check

14. Explain How can GPS technology be used in mapmaking?

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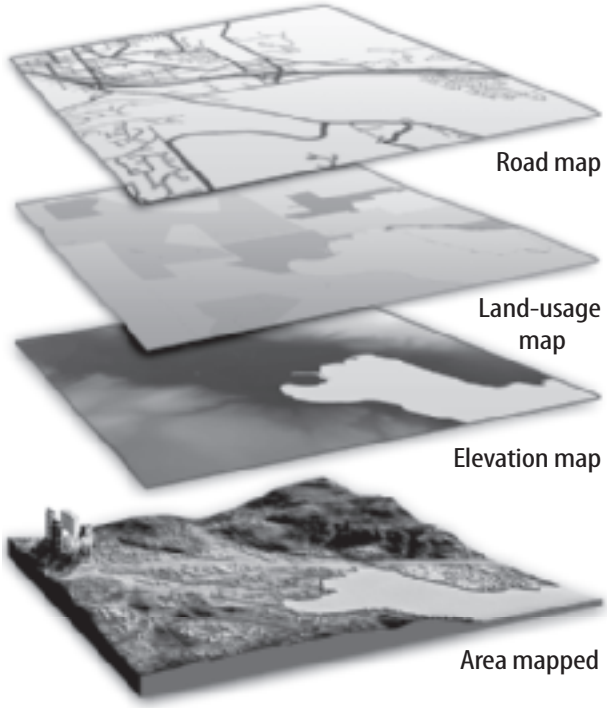
Geographic Information Systems

Geographic Information Systems (GIS) are computerized information systems used to store and analyze map data. GIS combine data collected from many different sources, including satellites, scanners, and aerial photographs. Aerial photographs are taken from above the ground. Data collection is rapid, taking only hours or minutes.

ACADEMIC VOCABULARY
aerial
(adjective) operating or occurring overhead

Mapmakers use GIS to analyze and organize those data and then make digital maps, as shown in the figure below. GIS creates different map layers of the same location. The map layers are like the layers of a cake. However, when the map layers are placed on top of one another, you can see through to the lower layers. Different layers can show land usage, elevation, roads, streams and lakes, or the type of soil on the ground.



Visual Check

15. Identify What information do digital maps show?

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Three Views Imagine setting up a model for a space shuttle landing under certain weather conditions using GIS.

- Database view begins the process by assembling information from existing databases on winds, airplane flights, landing procedures, and airport layouts.
- Map view draws from a set of interactive, digital maps that show features and their relationship to Earth's surface.
- Model view then pulls all the information together so that simulations can be run under changing weather conditions.

Reading Check

16. State What are two different ways that GIS can be used to process geographical information?

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Remote Sensing

Remote sensing *is the process of collecting information about an area without coming into physical contact with it*. There are many uses for remote sensing. This process produces maps that show detailed information about agriculture, forestry, geology, land use, and many other subjects. Often these maps cover huge areas.

Aerial photographs taken from airplanes changed mapmaking. But now, an even more powerful type of remote sensing is being used to collect data. Since the 1970s, satellites orbiting high above Earth's surface have been used to collect data.

Monitoring Change with Remote Sensing Satellites orbit Earth repeatedly. Images of a location taken at different times can be used to study changes. These images can help people quickly make maps of areas affected by natural disasters. The maps are then used to monitor damage and help organize rescue efforts.

Landsat One series of satellites used to collect data about Earth's surface is the Landsat group. *Landsat 7,* launched in 1999, completes a scan of Earth's entire surface every 16 days. Recently it was used to map the coastal waters of the United States. Comparing the recent data to similar data collected 18 years ago, scientists recognized changes in coral reefs. Landsat has been used to contribute to the GIS database as well.

TOPEX/Jason-1 A pair of satellites—*TOPEX* and its successor, *Jason-1*—have been used to determine ocean topography, circulation, sea level, and tides. It is currently being used to identify climate change. Using radar, a signal is bounced off the ocean surface to measure bulges and valleys to within 3 m. Changes in the ocean surface due to a hurricane can be monitored in this way.

Sea Beam A device that uses sonar to map the bottom of the ocean is Sea Beam. Sea Beam is mounted onboard a ship. Computers calculate the time a sound wave takes to bounce off the ocean floor and return to the ship. This gives an accurate image of the seafloor and the depth of the ocean at that point. Sea Beam is used by fishing fleets, drilling operations, and various scientists.

Reading Check

17. Define remote sensing.

Key Concept Check

18. Explain How can remote sensing be an advantage to mapmakers?

Reading Check

19. Identify What are some methods used to collect remote-sensing data?

Mini Glossary

contour interval: the elevation difference between contours that are next to each other

contour line: a line on a topographic map that connects points of equal elevation

cross section: a diagram showing a vertical slice through the rocks below the surface

elevation: the height above sea level of any point on Earth's surface

geologic map: shows the surface geology of the mapped area

relief: the difference in elevation between the highest and lowest points in an area

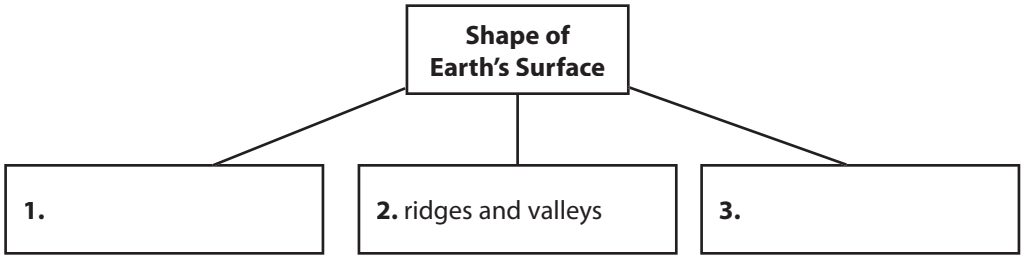
remote sensing: the process of collecting information about an area without coming into physical contact with it

slope: a measure of the steepness of the land

topographic map: shows the detailed shapes of Earth's surface, along with its natural and human-made features

1. Review the terms and their definitions in the Mini Glossary. Select two related terms and write a sentence explaining how the symbols represent Earth's features on a topographic map.

2. Fill in the graphic organizer to identify three things you can learn about the shape of Earth's surface from contour lines.



3. Compare a topographic map and a geologic map.

What do you think NOW?

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?

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END OF LESSON