Section 2.3

Objectives

- **Compare and contrast** different types of remote sensing.
- **Discuss** how satellites and sonar are used to map Earth's surface and its oceans.
- **Describe** the Global Positioning System and how it works.

Review Vocabulary

satellite: natural or human-made object that orbits Earth, the Moon, or other celestial body

New Vocabulary

remote sensing
Landsat satellite
TOPEX/Poseidon satellite
sonar
Global Positioning System
Geographic Information System

Remote Sensing

MAIN Idea **New technologies have changed the appearance and use of maps.**

Real-World Reading Link Many years ago, if you wanted a family portrait, it would be painted by an artist over many hours. Today, cameras can create a photo in seconds. Cartography has also changed. Cartographers use digital images to create maps with many more details that can be updated instantly.

Landsat Satellite

Advanced technology has changed the way maps are made. The process of gathering data about Earth using instruments mounted on satellites, airplanes, or ships is called **remote sensing.**

One form of remote sensing is detected with satellites. Features on Earth's surface, such as rivers and forests, radiate warmth at slightly different frequencies. **Landsat satellites** record reflected wavelengths of energy from Earth's surface. These include wavelengths of visible light and infrared radiation. One example of a Landsat image is shown in **Figure 2.12.**

To obtain such images, each Landsat satellite is equipped with a moving mirror that scans Earth's surface. This mirror has rows of detectors that measure the intensity of energy received from Earth. This information is then converted by computers into digital images that show landforms in great detail.

Landsat 7, launched in 1999, maps 185 km at a time and scans the entire surface of Earth in 16 days. Landsat data are also used to study the movements of Earth's plates, rivers, earthquakes, and pollution.

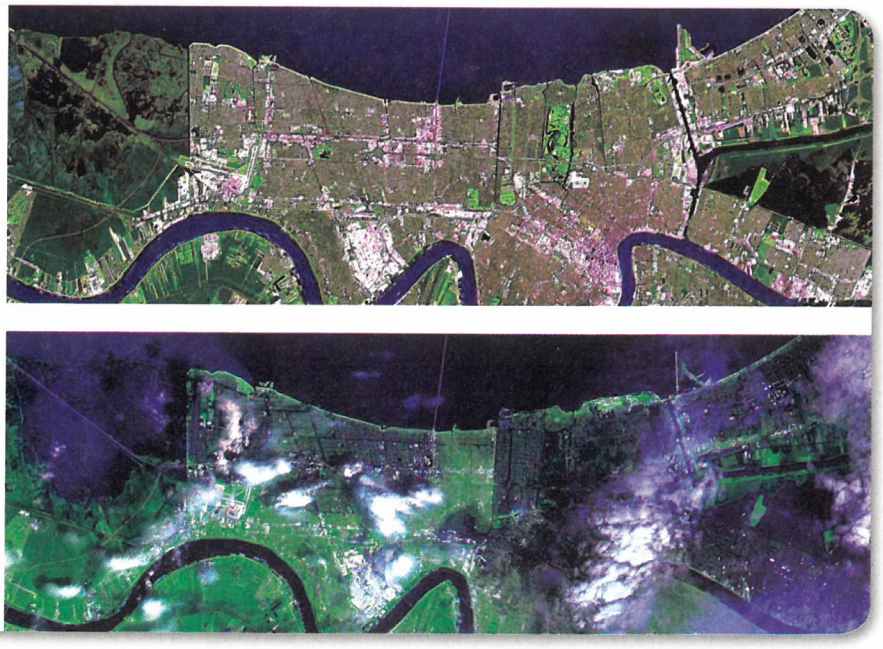


Figure 2.12 Notice the differences between the two Landsat photos of New Orleans.

Interpret ***Which image was taken after Hurricane Katrina in 2005? Explain.***

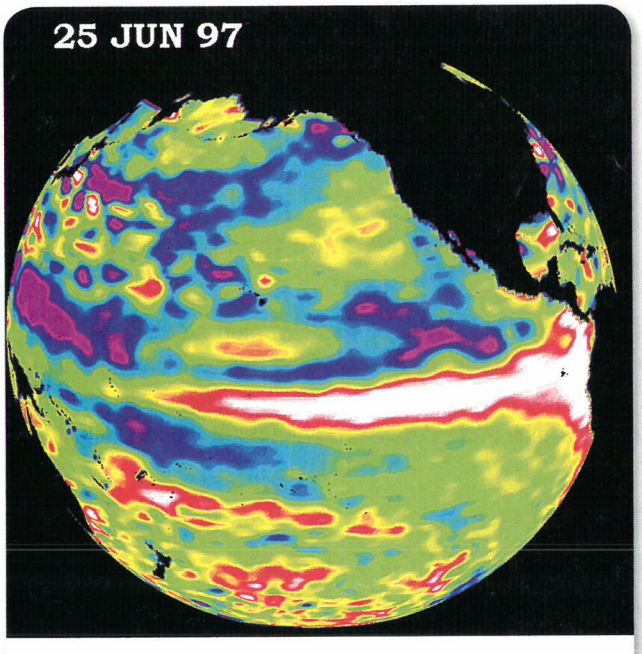


Figure 2.13 This image, which focuses on the Pacific Ocean, was created with data from *TOPEX/Poseidon*. The white color in the image shows the change in ocean depth during a hurricane event relative to normal.

FOLDABLES
Incorporate information from this section into your Foldable.

TOPEX/Poseidon Satellite

One satellite that uses radar to map features on the ocean floor is the ***TOPEX/Poseidon* satellite**. **TOPEX** stands for **top**ography **ex**periment and Poseidon (puh SY duhn) is the Greek god of the sea. Radar uses high-frequency signals that are transmitted from the satellite to the surface of the ocean. A receiving device then picks up the returning echo as it is reflected off the water.

The distance to the water's surface is calculated using the known speed of light and the time it takes for the signal to be reflected. Variations in time indicate the presence of certain features on the ocean floor. For instance, ocean water bulges over seafloor mountains and forms depressions over seafloor valleys.

These changes are reflected in satellite-to-sea measurements and result in images such as the one shown in **Figure 2.13,** that shows ocean depths during a hurricane. Using *TOPEX/Poseidon* data, scientists were able to estimate global sea levels with an accuracy of just a few millimeters and could repeat these calculations as often as every ten days. Scientists can also use this data and combine it with other existing data to create maps of ocean-floor features.

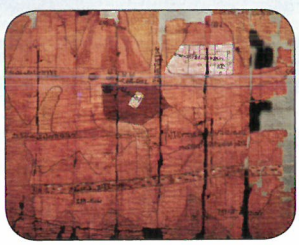
The *TOPEX/Poseidon* satellite also has been used to study tidal changes and global ocean currents. **Figure 2.14** below shows additional technological advances in cartography.

Figure 2.14

Mapping Technology

Advances in mapping have relied on technological developments.

1500 B.C. **1300 B.C.** An ancient Egyptian scribe draws the oldest surviving topographical map.



A.D. 1 **150 B.C.** The ancient Greek scientist Ptolemy creates the first map using a coordinate grid. It depicted Earth as a sphere and included Africa, Asia, and Europe.

A.D. 1154 Arab scholar Al-Idrisi creates a world map used by European explorers for several centuries. Earlier medieval maps showed Jerusalem as the center of a flat world.

1500 **1569** Flemish geographer Gerhardus Mercator devises a way to project the globe onto a flat map using lines of longitude and latitude.

Sea Beam

Sea Beam technology is similar to the *TOPEX/Poseidon* satellite in that it is also used to map the ocean floor. However, Sea Beam is located on a ship rather than on a satellite. **Figure 2.15** shows an example of a map created with information gathered with Sea Beam technology. To map ocean-floor features, Sea Beam relies on **sonar,** which is the use of sound waves to detect and measure objects underwater.

You might have heard of sonar before. It is often used to detect other objects like ships or submarines under water. This same technology allows scientists to detect changes in elevation or calculate distances between objects.

First, to gather the information needed to map the seafloor, a sound wave is sent from a ship toward the ocean floor. A receiving device then picks up the returning echo when it bounces off the seafloor.

Computers on the ship calculate the distance from the ship to the ocean floor using the speed of sound in water and the time it takes for the sound to be reflected. Sea Beam technology is used by fishing fleets, deep-sea drilling operations, and scientists such as oceanographers, volcanologists, and archaeologists.

Reading Check **Compare and contrast** Sea Beam images with *TOPEX/Poseidon* images and how each might be used.

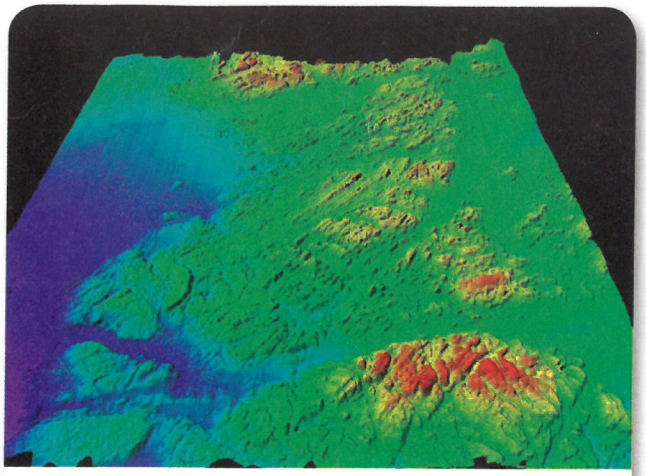
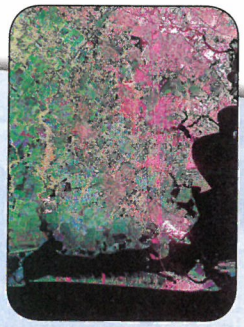


Figure 2.15 This image of Plymouth offshore was created with data from Sea Beam. The change in color indicates a change in elevation. The red-orange colors are the peaks, and the blue colors are the lowest elevations.



1752 A French cartographer first uses contour lines to represent elevation and marine depth for sailors exploring the New World.

2000 Space shuttle *Endeavour* collects the most complete topographical data of Earth, mapping almost 80 percent of Earth's land surface.

1700 1800 1900 2000

1875 Ella Eliza Fitz invents a method to mount a globe that shows the position of the Sun and the length of nights and days.

1966 Harvard University researchers develop the first computerized grid-based mapping system, the forerunner of GIS.

Concepts In Motion

Interactive Time Line To learn more about these discoveries and others, visit glencoe.com. Earth Science Online

CAREERS IN EARTH SCIENCE

Cartographer An Earth scientist who works primarily with maps is called a cartographer. A cartographer might make maps, interpret maps, or research mapping techniques and procedures. To learn more about Earth science careers, visit glencoe.com.

VOCABULARY

ACADEMIC VOCABULARY

Comprehensive
covering completely or broadly
The teacher gave the students a comprehensive study guide for the final exam.

The Global Positioning System

The **Global Positioning System (GPS)** is a satellite navigation system that allows users to locate their approximate position on Earth. There are 27 satellites orbiting Earth, as shown in **Figure 2.16,** for use with GPS units. The satellites are positioned around Earth, and are constantly orbiting so that signals from at least three or four satellites can be picked up at any given moment by a GPS receiver.

To use GPS to find your location on Earth, you need a GPS receiver. The receiver calculates your approximate latitude and longitude—usually within 10 m—by processing the signals emitted by the satellites. If enough information is present, these satellites can also relay information about elevation, direction of movement, and speed. With signals from three satellites, a GPS receiver can calculate location on Earth without elevation, while four satellite signals will allow a GPS receiver to calculate elevation also. For more information on how the satellites are used to determine location, see **Figure 2.16.**

Uses for GPS technology GPS technology is used extensively for navigation by airplanes and ships. However, as you will read later, it is also used to help detect earthquakes, create maps, and track wildlife.

GPS technology also has many applications for everyday life. Some people now have GPS receivers in their cars to help navigate to preprogrammed destinations such as restaurants, hotels, and their homes. Hikers, bikers, and other travelers often have portable, handheld GPS systems with them at all times. This allows them to find their destinations more quickly and can help them determine their location so they do not get lost. Some cell phones also contain GPS systems that can help you find your location.

Reading Check **Compare** GPS satellites with *TOPEX/Poseidon.*

The Geographic Information System

The **Geographic Information System (GIS)** combines many of the traditional types and styles of mapping described in this chapter. GIS mapping uses a database of information gathered by scientists, professionals, and students like you from around the world to create layers, or "themes," of information that can be placed one on top of the other to create a comprehensive map. These "themes" are often maps that were created with information gathered by remote sensing.

Scientists from many disciplines use GIS technologies. A geologist might use GIS mapping when studying a volcano to help track historical eruptions. An ecologist might use GIS mapping to track pollution or to follow animal or plant population trends of a given area.