SECTION 1

The Seafloor

As You Read

What You'll Learn

- **Differentiate** between a continental shelf and a continental slope.
- **Describe** a mid-ocean ridge, an abyssal plain, and an ocean trench.
- **Identify** the mineral resources found on the continental shelf and in the deep ocean.

Vocabulary

continental shelf
continental slope
abyssal plain
mid-ocean ridge
trench

Why It's Important

Oceans cover nearly three fourths of Earth's surface.

The Ocean Basins

Imagine yourself driving a deep-sea submersible along the ocean floor. Surrounded by cold, black water, the lights of your vessel reflect off of what looks like a mountain range ahead. As you continue, you find a huge opening in the seafloor—so deep you can't even see the bottom. What other ocean floor features can you find in **Figure 1?**

Ocean basins, which are low areas of Earth that are filled with water, have many different features. Beginning at the ocean shoreline is the continental shelf. The **continental shelf** is the gradually sloping end of a continent that extends under the ocean. On some coasts, the continental shelf extends a long distance. For instance, on North America's Atlantic and Gulf coasts, it extends 100 km to 350 km into the sea. On the Pacific Coast, where the coastal range mountains are close to the shore, the shelf is only 10 km to 30 km wide. The ocean covering the continental shelf can be as deep as 350 m.

Figure 1
This map shows features of the ocean basins. Locate a trench and a mid-ocean ridge.

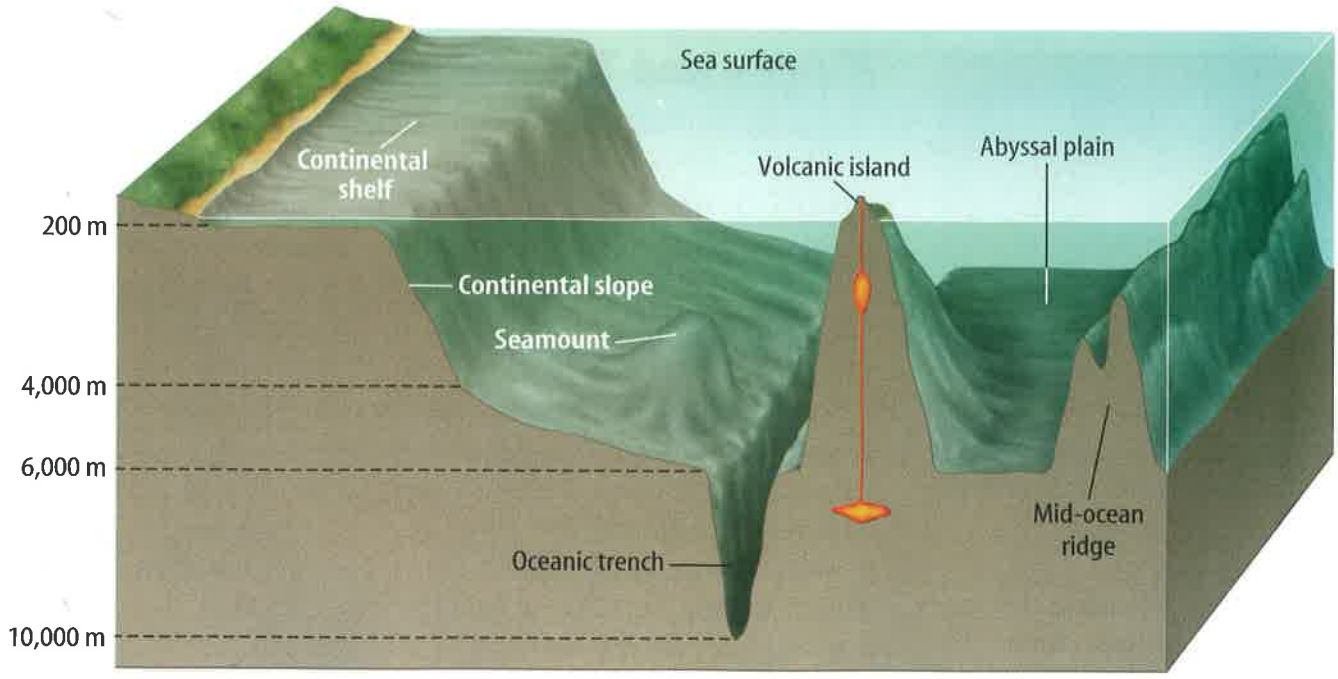
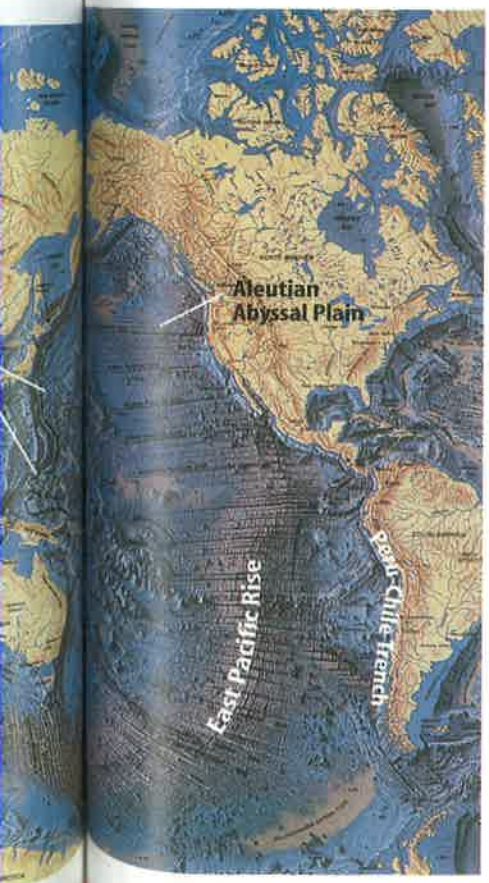


Figure 2 shows that beyond the shelf, the ocean floor drops more steeply, forming the continental slope. The **continental slope** extends from the outer edge of the continental shelf down to the ocean floor. Beyond the continental slope lie the trenches, valleys, plains, mountains, and ridges of the ocean basin.

In the deep ocean, sediment, derived mostly from land, settles constantly on the ocean floor. These deposits fill in valleys and create flat seafloor areas called **abyssal** (uh BIH sul) **plains.** Abyssal plains are from 4,000 m to 6,000 m below the ocean surface. Can you locate the abyssal plain shown in **Figure 2?**



In the Atlantic Ocean, areas of extremely flat abyssal plains can be large. One example is the Canary Abyssal Plain, which has an area of approximately 900,000 km^2. Other abyssal plains found in the Atlantic Ocean include the Hatteras and Demerara Abyssal Plains, both shown in **Figure 1.** Some areas of abyssal plains have small hills and seamounts. Seamounts are underwater, inactive volcanic peaks. They most commonly are found in the Pacific Ocean. Can you locate a seamount in **Figure 1?**

Reading Check *What are seamounts?*

Figure 2
Ocean basin features are continuous from shore to shore. (Features in this diagram are not to scale.) *Where does the continental shelf end and the continental slope begin?*

SCIENCE Online

Research Visit the Glencoe Science Web site at **science.glencoe.com** for more information about ocean basins. Communicate to your class what you learn.

Figure 3
New seafloor forms at mid-ocean ridges. A type of lava called pillow lava lies newly formed at this ridge on the ocean floor.

Ridges and Trenches

Locate the Mid-Atlantic Ridge in **Figure 1.** Mid-ocean ridges can be found at the bottom of all ocean basins. They form a continuous underwater ridge approximately 70,000 km long. A **mid-ocean ridge** is the area in an ocean basin where new ocean floor is formed. Crustal plates, which are large sections of Earth's uppermost mantle and crust, are moving constantly. As they move, the ocean floor changes. When ocean plates separate, hot magma from Earth's interior forms new ocean crust. This is the process of seafloor spreading. New ocean floor is being formed at a rate of approximately 2.5 cm per year along the Mid-Atlantic Ridge.

New ocean floor forms along mid-ocean ridges as lava erupts through cracks in Earth's crust. **Figure 3** shows newly erupted lava on the seafloor. When the lava hits the water, it cools quickly into solid rock, forming new seafloor. While seafloor is being formed in some parts of the oceans, it is being destroyed in others. Areas where old ocean floor slides beneath another plate and descends into Earth's mantle are called subduction zones.

Reading Check *How does new ocean floor form?*

Math Skills Activity

Calculating a Feature's Slope

Example Problem

If the width of a continental shelf is 320 km and it increases in depth a total of 300 m in that distance, what is its slope?

Solution

1	*This is what you know:*	width = 320 km increase in depth = 300 m
2	*This is what you need to find:*	slope: s
3	*This is the equation you need to use:*	s = increase in depth ÷ width
4	*Solve the equation by substituting in known values:*	s = 300 m ÷ 320 km = 0.94 m/km

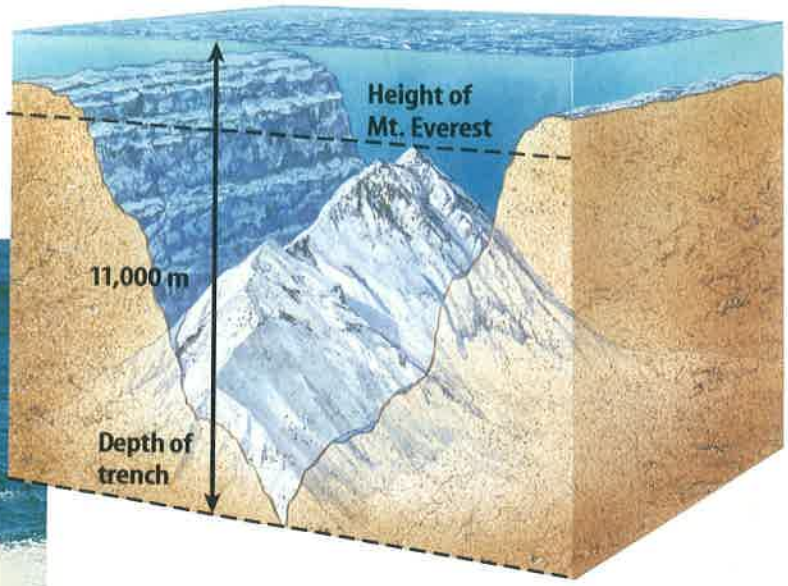
Practice Problem

The width of a continental slope is 40 km. It increases in depth by 2,000 m. What is the slope of the continental slope?

For more help, refer to the Math Skill Handbook.

Figure 4
Located at subduction zones, trenches are important ocean basin features.

A In 1960, the world's deepest dive was made in the Mariana Trench. The *Trieste* carried Jacque Piccard and Donald Walsh to a depth of almost 11 km.



B If Earth's tallest mountain, Mount Everest, were set in the bottom of the Mariana Trench of the Pacific Basin, it would be covered with more than 2,000 m of water.

Subduction Zones On the ocean floor, subduction zones are marked by deep ocean trenches. A **trench** is a long, narrow, steep-sided depression where one crustal plate sinks beneath another. Most trenches are found in the Pacific Basin. Ocean trenches are usually longer and deeper than any valley on any continent. One trench, famous for its depth, is the Mariana Trench. It is located to the south and east of Japan in the Pacific Basin. This trench reaches 11 km below the surface of the water, and it is the deepest place in the Pacific. **Figure 4A** shows the deep-sea vessel, the *Trieste,* that descended into the trench in 1960. **Figure 4B** shows that the Mariana Trench is so deep that Mount Everest could easily fit into it.

Mineral Resources from the Seafloor

Resources can be found in many places in the ocean. Some deposits on the continental shelf are relatively easy to extract. Others can be found only in the deep abyssal regions on the ocean floor. People still are trying to figure out how to get these valuable resources to the surface. As you read, suggest some methods that could be used to retrieve hard-to-reach resources.

TRY AT HOME
Mini LAB

Modeling the Mid-Atlantic Ridge

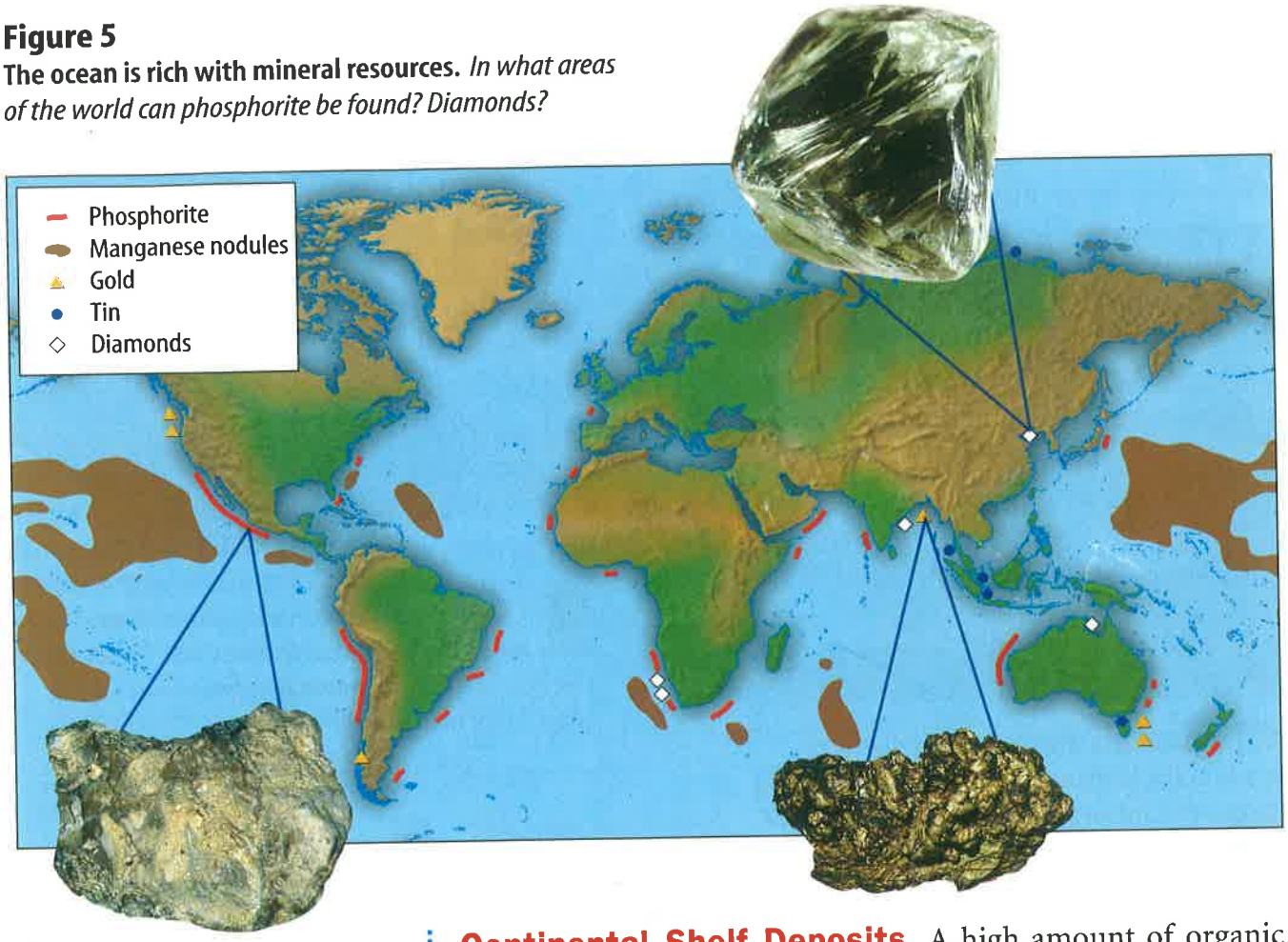
Procedure

1. Set two **tray tables** 2 cm apart.
2. Gather ten **paper towels** that are still connected. Lay one end of the paper towels on each table so the towels hang down into the space between the tables.
3. Slowly pull each end of the paper towels away from each other.

Analysis

1. Explain how this models the Mid-Atlantic Ridge.
2. How long does it take for 2.5 cm of new ocean crust to form at the Mid-Atlantic Ridge? How long does it take 25 cm to form?

Figure 5
The ocean is rich with mineral resources. *In what areas of the world can phosphorite be found? Diamonds?*



Continental Shelf Deposits A high amount of organic activity occurs in the waters above the continental shelf, and sediment accumulates to great thickness on the ocean floor. This is why many different kinds of resources can be found there, such as petroleum and natural gas deposits. Approximately 20 percent of the world's oil comes from under the seabed. To extract these substances, wells are drilled into the seafloor from floating vessels and fixed platforms.

Other deposits on the continental shelf include phosphorite, which is used to make fertilizer, and limestone, which is used to make cement. Sand and gravel, both economically important, also can be dredged from the continental shelf.

Rivers that flow into oceans transport important minerals to the continental shelf from land. Sometimes the energy of ocean waves and currents can cause denser mineral grains that have been brought in by rivers to concentrate in one place. These deposits, called placer (PLAHS ur) deposits, can occur in coastal regions where rivers entering the ocean suddenly lose energy, slow down, and drop their sediment. Metals such as gold and titanium and gemstones such as diamonds are mined from placer deposits in some coastal regions. **Figure 5** shows where some resources in the ocean can be found.

Deep-Water Deposits Through the holes and cracks along mid-ocean ridges, plumes of hot water billow out into surrounding seawater. As the superheated water cools, mineral deposits sometimes form. As a result, elements such as sulfur and metals like iron, copper, zinc, and silver can be concentrated in these areas. Today, no one is mining these valuable materials from the depths because it would be too expensive to recover them. However, in the future, these deposits could become important.

Other mineral deposits can precipitate from seawater. In this process, minerals that are dissolved in ocean water come out of solution and form solids on the ocean floor. Manganese nodules are small, darkly colored lumps strewn across large areas of the ocean basins. **Figure 6** shows these nodules. Manganese nodules form by a chemical process that is not fully understood. They form around nuclei such as discarded sharks' teeth, growing slowly, perhaps as little as 1 mm to 10 mm per million years. These nodules are rich in manganese, copper, iron, nickel, and cobalt, which are used in the manufacture of steel, paint, and batteries. Most of the nodules lie thousands of meters deep in the ocean and are not currently being mined, although suction devices similar to huge vacuum cleaners have been tested to collect them.

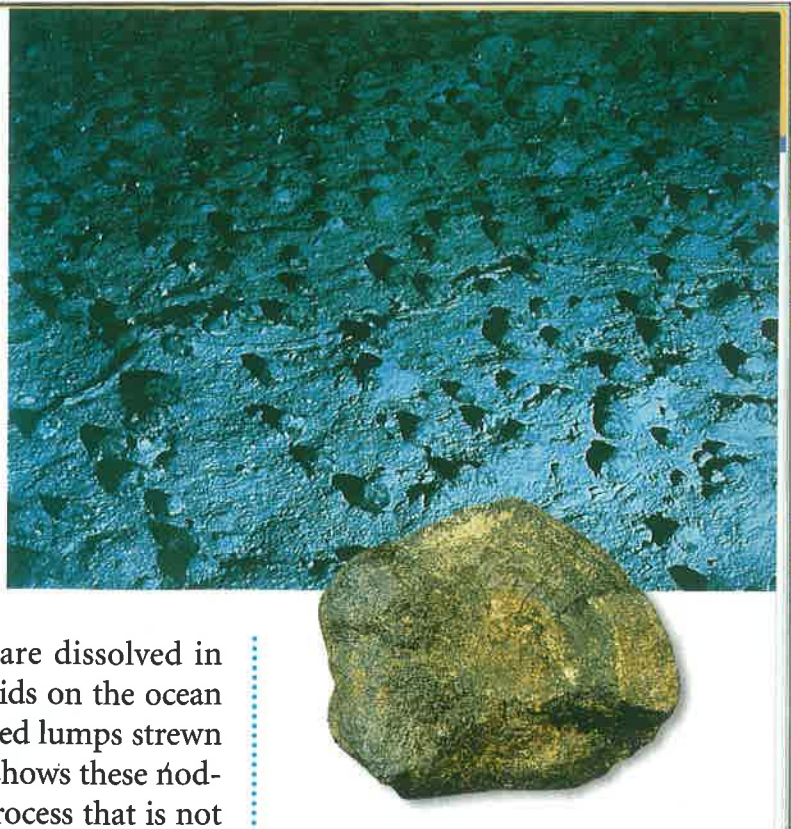


Figure 6
These manganese nodules were found on the floor of the Pacific Ocean. *Can you think of an efficient way to gather them from a depth of 4 km?*

Section 1 Assessment

1. Compare and contrast continental shelves and continental slopes.
2. Contrast mid-ocean ridges and trenches.
3. Describe what an abyssal plain looks like and how it forms.
4. How do placer deposits form? Name two examples of placer deposits that are mined. How do manganese nodules form?
5. **Think Critically** Depth soundings, taken as a ship moves across an ocean, are consistently between 4,000 m and 4,500 m. Infer over which area of seafloor the ship is passing.

Skill Builder Activities

6. **Comparing and Contrasting** Compare and contrast the Atlantic Ocean Basin with the Pacific Ocean Basin. Which basin contains many deep-sea trenches? Which basin is getting larger with time? **For more help, refer to the Science Skill Handbook.**
7. **Using Statistics** Each year for three years, the distance between two locations across an ocean basin increases by 1.8 cm, 4.1 cm, and 3.2 cm, respectively. What is the average rate of separation of these locations during this time? **For more help, refer to the Math Skill Handbook.**