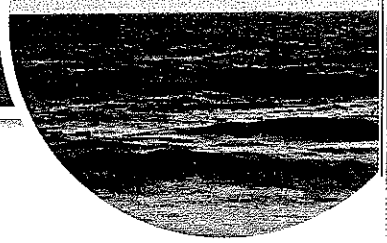
4.2 Ocean Floor Features



Reading Focus

Key Concepts

- What are the three main regions of the ocean floor?
- How do continental margins in the Atlantic Ocean differ from those in the Pacific Ocean?
- How are deep-ocean trenches formed?
- How are abyssal plains formed?
- What is formed at mid-ocean ridges?

Vocabulary

- continental margin
- continental shelf
- continental slope
- submarine canyon
- turbidity current
- continental rise
- ocean basin floor
- abyssal plains
- seamounts
- mid-ocean ridge
- seafloor spreading

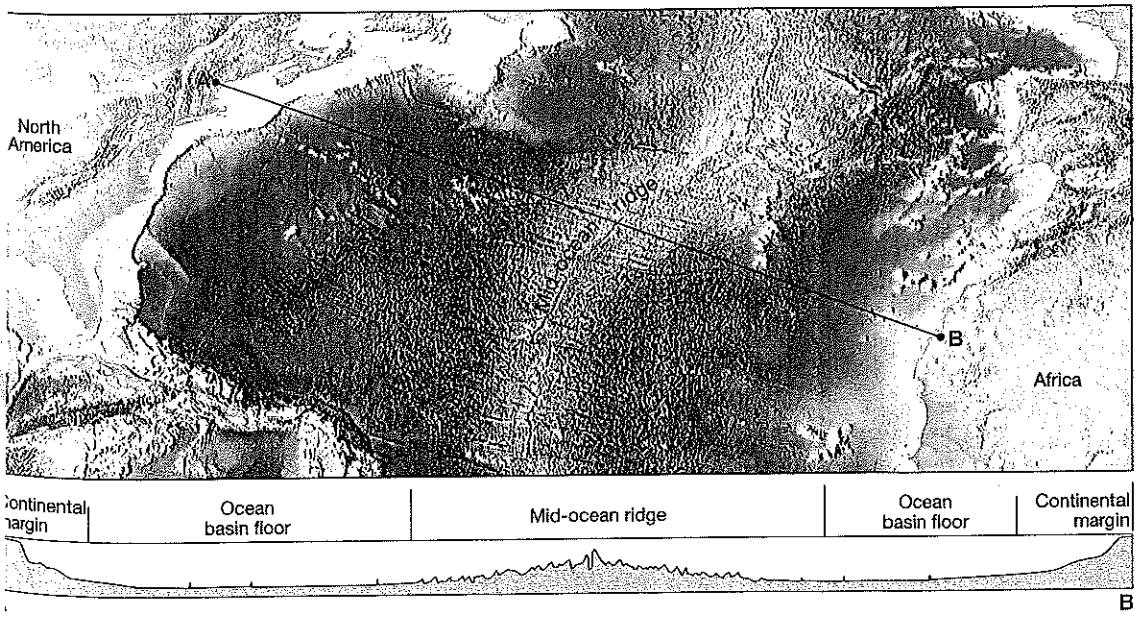
Reading Strategy

Outlining Before you read, make an outline of this section. Use the green headings as the main topics and the blue headings as subtopics. As you read, add supporting details.

I. Continental Margins
  A. Continental Shelf
  B. Continental Slope
  C. _____?_____
II. _____?_____
  A. _____?_____

Oceanographers studying the topography of the ocean floor have vided it into three major regions. **The ocean floor regions are ıe continental margins, the ocean basin floor, and the mid-ocean dge.** The map in Figure 6 outlines these regions for the North Atlantic cean. The profile at the bottom of the illustration shows the varied pography. Scientists have discovered that each of these regions has its wn unique characteristics and features.

Figure 6 Topography of the North Atlantic Ocean Basin Beneath the map is a profile of the area between points A and B. The profile has been exaggerated 40 times to make the topographic features more distinct.



Continental Margins

The zone of transition between a continent and the adjacent ocean basin floor is known as the **continental margin.** **In the Atlantic Ocean, thick layers of undisturbed sediment cover the continental margin. This region has very little volcanic or earthquake activity.** This is because the continental margins in the Atlantic Ocean are not associated with plate boundaries, unlike the continental margins of the Pacific Ocean. **In the Pacific Ocean, oceanic crust is plunging beneath continental crust. This force results in a narrow continental margin that experiences both volcanic activity and earthquakes.** Figure 7 shows the features of a continental margin found along the Atlantic coast.

Continental Shelf What if you were to begin an underwater journey eastward across the Atlantic Ocean? The first area of ocean floor you would encounter is the continental shelf. The **continental shelf** is the gently sloping submerged surface extending from the shoreline. The shelf is almost nonexistent along some coastlines. However, the shelf may extend seaward as far as 1500 kilometers along other coastlines. On average, the continental shelf is about 80 kilometers wide and 130 meters deep at its seaward edge. The average steepness of the shelf is equal to a drop of only about 2 meters per kilometer. The slope is so slight that to the human eye it appears to be a horizontal surface.

Continental shelves have economic and political significance. **Continental shelves contain important mineral deposits, large reservoirs of oil and natural gas, and huge sand and gravel deposits.** The waters of the continental shelf also contain important fishing grounds, which are significant sources of food.

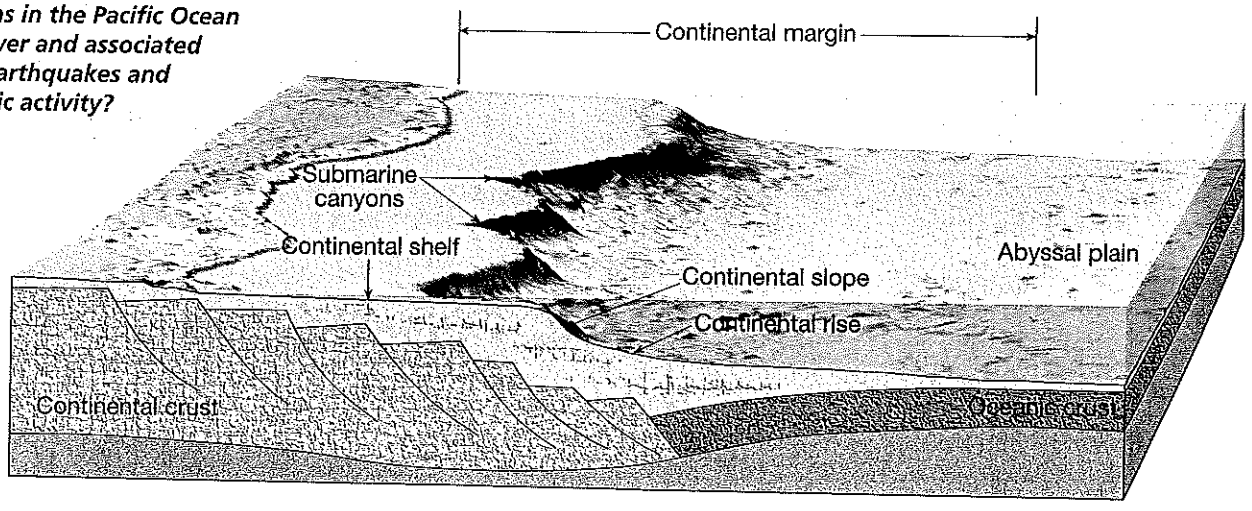


Figure 7 Atlantic Continental Margin The continental margins in the Atlantic Ocean are wider than in the Pacific Ocean and are covered in a thick layer of sediment.
Explaining ***Why are continental margins in the Pacific Ocean narrower and associated with earthquakes and volcanic activity?***

Continental Slope Marking the seaward edge of the continental shelf is the **continental slope.** This slope is steeper than the shelf, and it marks the boundary between continental crust and oceanic crust. The continental slope can be seen in Figure 7 on page 402. Although the steepness of the continental slope varies greatly from place to place, it averages about 5 degrees. In some places the slope may exceed 25 degrees. The continental slope is a relatively narrow feature, averaging only about 20 kilometers in width.

Deep, steep-sided valleys known as **submarine canyons** are cut into the continental slope. These canyons may extend to the ocean basin floor. Figure 8 shows how submarine canyons are formed. Most information suggests that submarine canyons have been eroded, at least in part, by turbidity currents.

Turbidity currents are occasional movements of dense, sediment-rich water down the continental slope. They are created when sand and mud on the continental shelf and slope are disturbed—perhaps by an earthquake—and become suspended in the water. Because such muddy water is denser than normal seawater, it flows down the slope. As it flows down, it erodes and accumulates more sediment. Erosion from these muddy torrents is believed to be the major force in the formation of most submarine canyons. Narrow continental margins, such as the one located along the California coast, are marked with numerous submarine canyons.

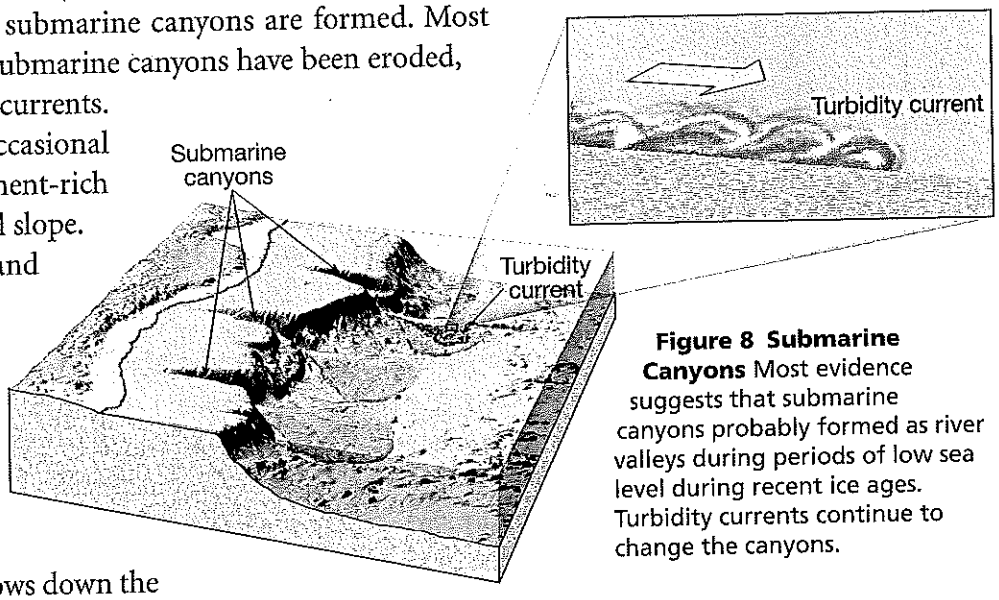


Figure 8 Submarine Canyons Most evidence suggests that submarine canyons probably formed as river valleys during periods of low sea level during recent ice ages. Turbidity currents continue to change the canyons.

Turbidity currents are known to be an important mechanism of sediment transport in the ocean. Turbidity currents erode submarine canyons and deposit sediments on the deep-ocean floor.

Continental Rise In regions where trenches do not exist, the steep continental slope merges into a more gradual incline known as the **continental rise.** Here the steepness of the slope drops to about 6 meters per kilometer. Whereas the width of the continental slope averages about 20 kilometers, the continental rise may be hundreds of kilometers wide.

Reading Checkpoint *Compare and contrast the continental slope and continental rise.*

Go Online NSTA SciLinks

For: Links on ocean floor features
Visit: www.SciLinks.org
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Q *Have humans ever explored the deepest ocean trenches? Could anything live there?*

A Humans have indeed visited the deepest part of the oceans—where there is crushing high pressure, complete darkness, and near-freezing water temperatures. In January 1960, U.S. Navy Lt. Don Walsh and explorer Jacques Piccard descended to the bottom of the Challenger Deep region of the Mariana Trench in the deep-diving submersible *Trieste*. It took more than five hours to reach the bottom at 10,912 meters—a record depth of human descent that has not been broken since. They did see some organisms that are adapted to life in the deep: a small flatfish, a shrimp, and some jellyfish.

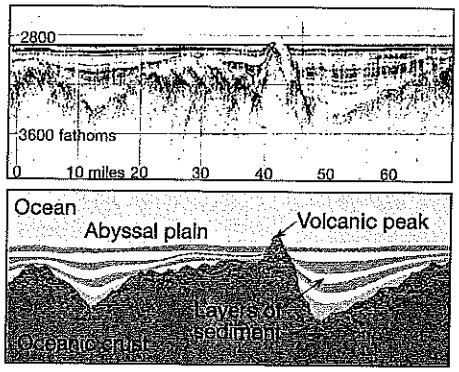


Figure 9 Abyssal Plain Cross Section This seismic cross section and matching sketch of a portion of the Madeira abyssal plain in the eastern Atlantic Ocean shows how the irregular oceanic crust is buried by sediments.

Ocean Basin Floor

Between the continental margin and mid-ocean ridge lies the **ocean basin floor.** The size of this region—almost 30 percent of Earth's surface—is comparable to the percentage of land above sea level. This region includes deep-ocean trenches, very flat areas known as abyssal plains, and tall volcanic peaks called seamounts and guyots.

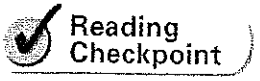
Deep-Ocean Trenches Deep-ocean trenches are long, narrow creases in the ocean floor that form the deepest parts of the ocean. Most trenches are located along the margins of the Pacific Ocean, and many exceed 10,000 meters in depth. A portion of one trench—the Challenger Deep in the Mariana Trench—has been measured at a record 11,022 meters below sea level. It is the deepest known place on Earth.

Trenches form at sites of plate convergence where one moving plate descends beneath another and plunges back into the mantle. Earthquakes and volcanic activity are associated with these regions. The large number of trenches and the volcanic activity along the margins of the Pacific Ocean give the region its nickname as the *Ring of Fire.*

Abyssal Plains **Abyssal plains** are deep, extremely flat features. In fact, these regions are possibly the most level places on Earth. Abyssal plains have thick accumulations of fine sediment that have buried an otherwise rugged ocean floor, as shown in Figure 9. **The sediments that make up abyssal plains are carried there by turbidity currents or deposited as a result of suspended sediments settling.** Abyssal plains are found in all oceans of the world. However, the Atlantic Ocean has the most extensive abyssal plains because it has few trenches to catch sediment carried down the continental slope.

Seamounts and Guyots The submerged volcanic peaks that dot the ocean floor are called **seamounts.** They are volcanoes that have not reached the ocean surface. These steep-sided cone-shaped peaks are found on the floors of all the oceans. However, the greatest number have been identified in the Pacific. Some seamounts form at volcanic hot spots. An example is the Hawaiian-Emperor Seamount chain, shown in Figure 3 on page 396. This chain stretches from the Hawaiian Islands to the Aleutian trench.

Once underwater volcanoes reach the surface, they form islands. Over time, running water and wave action erode these volcanic islands to near sea level. Over millions of years, the islands gradually sink and may disappear below the water surface. This process occurs as the moving plate slowly carries the islands away from the elevated oceanic ridge or hot spot where they originated. These once-active, now-submerged, flat-topped structures are called guyots.



What are abyssal plains?

Mid-Ocean Ridges

The **mid-ocean ridge** is found near the center of most ocean basins. It is an interconnected system of underwater mountains that have developed on newly formed ocean crust. This system is the longest topographic feature on Earth's surface. It exceeds 70,000 kilometers in length. The mid-ocean ridge winds through all major oceans similar to the way a seam winds over the surface of a baseball.

The term *ridge* may be misleading because the mid-ocean ridge is not narrow. It has widths from 1000 to 4000 kilometers and may occupy as much as one half of the total area of the ocean floor. Another look at Figure 3 shows that the mid-ocean ridge is broken into segments. These are offset by large transform faults where plates slide past each other horizontally, resulting in shallow earthquakes.

Seafloor Spreading A high amount of volcanic activity takes place along the crest of the mid-ocean ridge. This activity is associated with seafloor spreading. **Seafloor spreading** occurs at divergent plate boundaries where two lithospheric plates are moving apart. **New ocean floor is formed at mid-ocean ridges as magma rises between the diverging plates and cools.**

Hydrothermal Vents Hydrothermal vents form along mid-ocean ridges. These are zones where mineral-rich water, heated by the hot, newly-formed oceanic crust, escapes through cracks in oceanic crust into the water. As the super-heated, mineral-rich water comes in contact with the surrounding cold water, minerals containing metals such as sulfur, iron, copper, and zinc precipitate out and are deposited.

Section 14.2 Assessment

Reviewing Concepts

1. What are the three main regions of the ocean floor?
2. How do continental margins in the Atlantic Ocean differ from those in the Pacific Ocean?
3. What are trenches? How are deep-ocean trenches formed?
4. What are abyssal plains? How are abyssal plains formed?
5. What is formed at mid-ocean ridges?

Critical Thinking

6. **Comparing and Contrasting** Compare and contrast seamounts and guyots.
7. **Applying Concepts** Explain how turbidity currents are related to submarine canyons.

Writing in Science

Descriptive Paragraph Imagine you are about to take an underwater journey in a submersible across the Atlantic Ocean. Your journey begins at the coast, and you travel out toward the mid-ocean ridge. Write a paragraph describing the ocean floor features you will likely see on your journey.