

Section 2

The Ocean Floor

Key Concept Many different technologies have helped scientists study the topography of the ocean basins.

What You Will Learn

- Scientists use sonar, underwater vessels, drilling, and satellites to study the ocean floor.
- Ocean floor features formed because of tectonic plate movement.

Why It Matters

Understanding the topography of the ocean basins helps scientists understand the processes that formed the topography of the continents.

What lies at the bottom of the ocean? This question was once unanswerable. By using new technology, scientists have learned a lot about the ocean floor. Scientists have discovered many different landforms on the ocean floor.

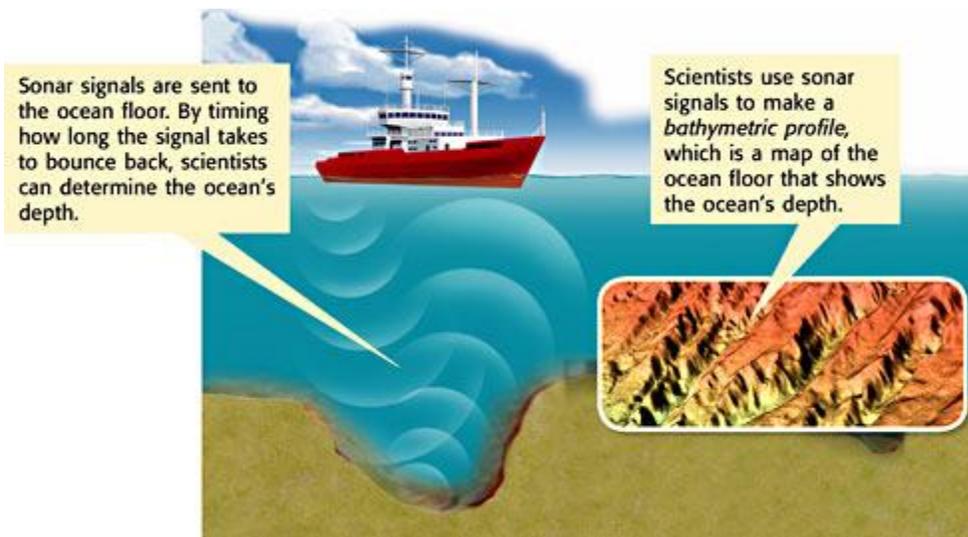
Studying the Ocean Floor

How can scientists study the ocean floor when it can be as much as 4,000 m below the ocean surface? Scientists can use underwater vessels to explore the ocean floor. But they can also study the ocean floor from the ocean's surface. They can even study the ocean floor from space!

Seeing by Sonar

Sonar stands for sound navigation and ranging. Scientists use sonar to determine the ocean's depth by sending sound pulses from a ship down into the ocean. The sound moves through the water, bounces off the ocean floor, and returns to the ship. The deeper the water is, the longer the round trip takes. Scientists then calculate the depth by multiplying half the travel time by the speed of sound in water (about 1,500 m/s). This process is shown in **Figure 1**.

Figure 1 Ocean Floor Mapping with Sonar



Underwater Vessels

Just as astronauts explore space by using rockets, scientists explore the oceans by using underwater vessels. One piloted research vessel, *Deep Flight*, is shown in **Figure 2**. Future models of *Deep Flight* will be designed to transport scientists to depths of up to 11,000 m!



Figure 2 Like the Wright brothers' first successful airplane, Deep Flight sets the stage for a bright future—this time with underwater “flight.”

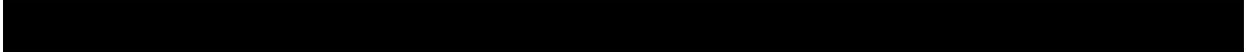
Scientists also use remotely operated vehicles, or ROVs, to explore the ocean. One interesting ROV is *JASON II*, which is “flown” from the surface by remote control. *JASON II* can be used to explore the sea floor at depths that are too dangerous for piloted vessels to go.

The Integrated Ocean Drilling Program (IODP)

The Integrated Ocean Drilling Program (IODP) is an international program that studies the sea floor by ocean drilling. Scientists drill cores, or long tubes of rock and sediment, from the sea floor. By studying the layers of rock and sediment from the cores, scientists learn about the history of Earth. For example, through drilling, scientists have found evidence of sea-floor spreading. Sea-floor spreading is a process responsible for the formation of many features on the ocean floor.

Studying via Satellite

Geosat, once a top-secret military satellite, has been used to measure slight changes in the height of the ocean's surface. Different underwater features, such as mountains and trenches, affect the height of the water above them. Scientists measure the different depths of the ocean and use the measurements to make detailed maps of the sea floor. Maps made from satellite data can cover much more territory than maps made by using sonar.



Ocean-Floor Basics

Imagine being an explorer assigned to map uncharted areas on Earth. You might think that there are not many areas on Earth left to explore. But what about the bottom of the ocean? Because it is underwater and some areas are so deep, much of the ocean floor is still not completely explored.

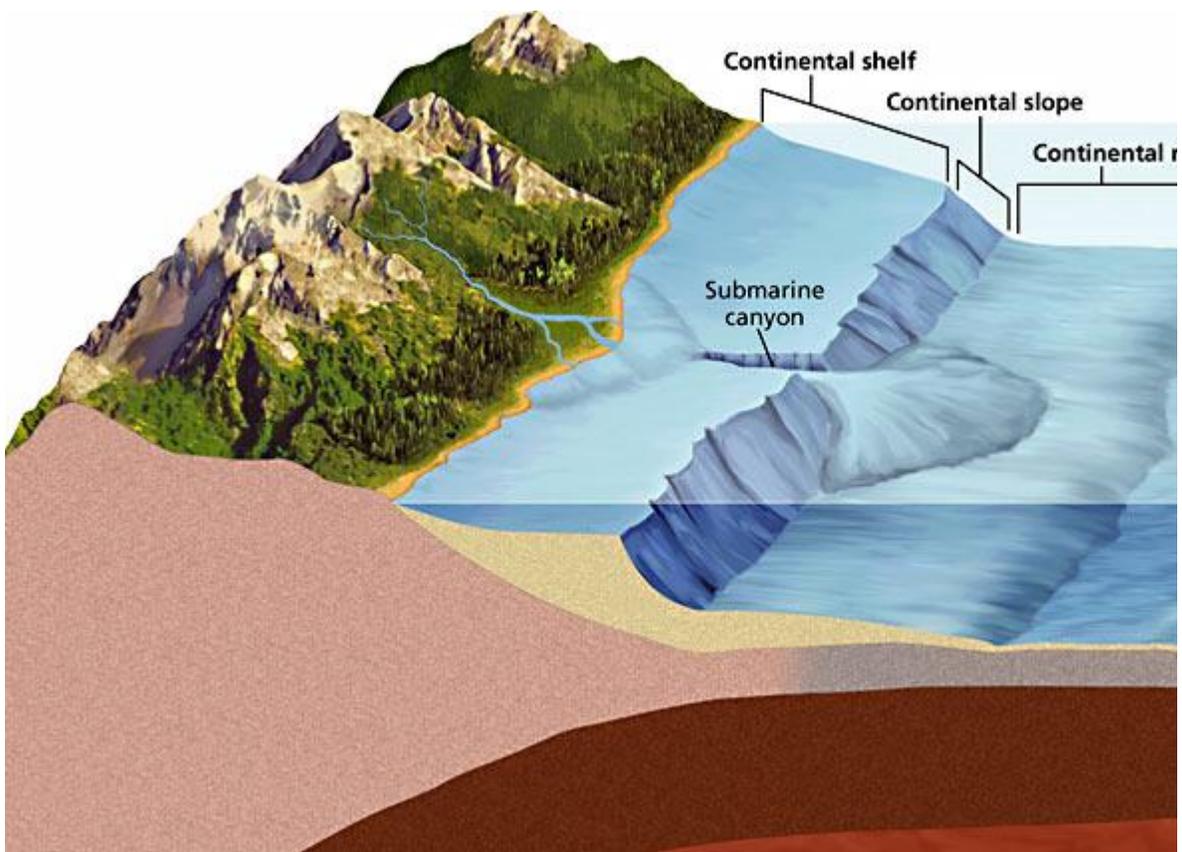
Two Major Regions of the Ocean Floor

The ocean floor has two major regions. One region, the *continental margin*, is the edge of the continent that is covered by ocean water. The other region, the *deep-ocean basin*, begins at the end of the continental margin and extends under the deepest parts of the ocean. To get an idea of the difference between the two, imagine that the ocean is a giant swimming pool. The continental margin is the shallow end of the pool. The deep-ocean basin is the deep end of the pool.

Subdivisions of the Ocean Floor

The continental margin is subdivided into the continental shelf, the continental slope, and the continental rise. These divisions are based on depth and changes in slope. The deep-ocean basin consists of the abyssal plain, mid-ocean ridges, rift valleys, and ocean trenches, as shown in **Figure 3**. Mid-ocean ridges and ocean trenches mark the boundaries of Earth's tectonic plates.

Figure 3 Ocean Floor Features



Tectonic Plates and Ocean-Floor Features

If you could go to the bottom of the ocean, you would see the world's longest mountain chain. This mountain chain is about 64,000 km (40,000 mi) long. You would also see canyons deeper than the Grand Canyon. Why does the ocean floor have such impressive features? How did these features form? The answers have to do with plate tectonics.

You may know that the movement of tectonic plates forms features, such as mountains and volcanoes, on land. But these movements also form features on the ocean floor. Convection

within Earth causes tectonic plates to move. The plates slide past each other, collide with each other, or move away from each other. As a result, seamounts, mid-ocean ridges, and trenches form. These features can be found on or near the abyssal plain.

Standards Check What process is responsible for the formation of features on the ocean floor?



Abyssal Plain

The large, flat, almost level area of the deep-ocean basin is called the **abyssal plain**. Abyssal plains are the flattest regions on Earth. They are covered with layers of fine sediment. Wind and ocean currents carry some of this sediment from the continental margins. Other sediment is made of the remains of marine organisms. Those remains settle to the ocean floor when the organisms die.

Seamounts

A submerged volcanic mountain on the ocean floor is called a *seamount*. The President Jackson Seamounts are shown in **Figure 4**. Seamounts are at least 1,000 m high. They may form where magma pushes its way between tectonic plates. As the magma cools and builds up, it forms a mountain. Seamounts can also form far away from a tectonic plate boundary. Areas of volcanic activity within the interior of tectonic plates are called *hot spots*. At a hot spot, magma rises up from deep inside Earth and breaks through the overlying plate. The resulting volcano may grow into a seamount.

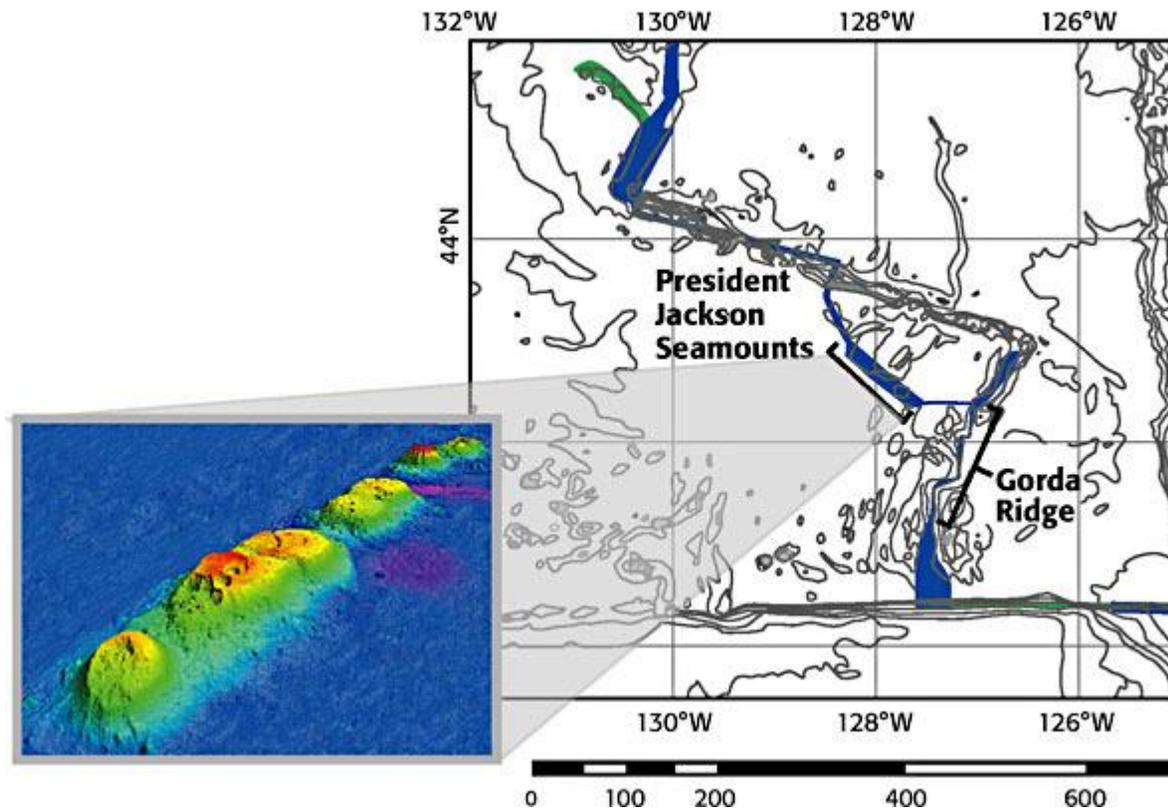


Figure 4 The President Jackson Seamounts are a chain of eight underwater volcanoes off the coast of California and Oregon.

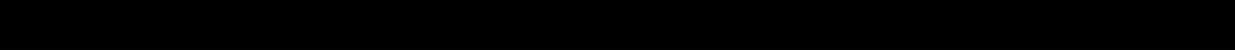
If a seamount builds up above sea level, it becomes a volcanic island. Over time the volcanic island may sink and become eroded by waves. The erosion forms a flat-topped, submerged seamount called a *guyot* (GEE OH).

Mid-Ocean Ridges

A long, undersea mountain chain that forms along the floor of the ocean is called a **mid-ocean ridge**. For the most part, mid-ocean ridges do not rise above sea level. However, Iceland is one place where a mid-ocean ridge has risen above the ocean's surface. Mid-ocean ridges form where plates move apart from each other. This motion creates a crack in the ocean floor called a *rift*. Magma rises through this rift and cools to form new rock. The ridges are made of this hot, new rock.

Standards Check Explain how the movement of tectonic plates causes the formation of mid-ocean ridges.

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Ocean Trenches

Long, narrow depressions located in the deep-ocean basins are called **ocean trenches**. The Mariana Trench, which is in the western Pacific Ocean, is the deepest place in Earth's crust. Trenches form where one tectonic plate moves under another tectonic plate. This process is called *subduction*.

As a plate subducts under another plate, the pressure on the subducting plate rises. Water and other fluids are squeezed out of the rock and sediments. These fluids cause surrounding rock to melt and form magma. The magma rises to the surface to form arcs of volcanoes along the trench. Earthquakes also may occur along subduction zones when one plate subducts under another.

Section Summary

- Scientists study the ocean floor by using sonar, underwater vessels, drilling, and satellites.
 - The ocean floor is divided into two regions—the continental margin and the deep-ocean basin.
 - The continental margin consists of the continental shelf, the continental slope, and the continental rise.
 - The deep-ocean basin consists of the abyssal plain, mid-ocean ridges, trenches, and seamounts.
 - Mid-ocean ridges and trenches mark the boundaries of tectonic plates.
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