How Do Scientists Study the Ocean Floor?

The ocean floor can be as far as 11,000 m below the surface of the ocean. People cannot survive at such great depths without a lot of special equipment. Scientists sometimes use such equipment to travel to the ocean floor. However, scientists can also study the ocean floor from the surface of the ocean. They can even study the ocean floor from outer space!

STUDYING THE OCEAN FLOOR WITH SHIPS

People cannot survive the high pressures on the ocean floor. Therefore, in order to explore the deep zone, scientists had to build an underwater vessel that can survive under high pressures. One such vessel is called Deep Flight. Future ships may be able to carry scientists to 11,000 m below the ocean’s surface.

Scientists can also use Remotely Operated Vehicles, or ROVs, to explore the ocean floor directly. These ROVs carry special equipment deep below the ocean surface. Scientists control ROVs using radio signals from the surface. Because ROVs do not carry people, they can explore parts of the ocean floor that are too dangerous for people to travel to.

National Science Education Standards
ES 1b

STUDY TIP

Compare As you read, make a chart showing the similarities and differences between the different ways that scientists study the ocean floor.

READING CHECK

1. Explain Why did scientists have to build a special ship to explore the deep zone?

Critical Thinking

2. Infer Deep Flight and other deep-ocean vessels have very thick windows and walls. Why do you think this is?
STUDYING THE OCEAN FLOOR WITH SONAR

Sonar stands for sound navigation and ranging.

Sonar instruments on a ship send pulses of sound down into the ocean. The sound bounces off the ocean floor and returns to the ship. The deeper the water, the longer it takes for the sound to return to the ship. Scientists use sonar to determine how deep the ocean floor is. They know that sound travels about 1,500 m/s in ocean water. They measure how long it takes for the sound to return to the ship. Then, they use this information to figure out how deep the ocean floor is.

STUDYING THE OCEAN FLOOR USING SATELLITES

Geosat was once a top-secret military satellite. Today, scientists use Geosat to study the ocean floor indirectly. Underwater features, such as mountains and trenches, affect the height of the ocean surface. Scientists can use Geosat to measure the height of the water on the ocean surface. They can use these measurements to make detailed maps of the ocean floor.

What Are the Features of the Ocean Floor?

Because most of the ocean floor is covered by kilometers of water, it has not been thoroughly explored. However, scientists do know that many of the features of the ocean floor are caused by plate tectonics.

Scientists divide the ocean floor into two major regions: the continental margin and the deep-ocean basin. The continental margin is the edge of a continent that is covered by ocean water. The deep-ocean basin begins at the edge of the continental margin and extends under the deepest parts of the ocean.
CONTINENTAL SHELF, SLOPE, AND RISE

There are three main parts of the continental margin: the continental shelf, the continental slope, and the continental rise. The continental shelf is the part of the margin that begins at the shoreline and slopes gently toward the open ocean. It continues until the ocean floor begins to slope more steeply. The depth of the continental shelf can reach 200 m. ✅

The continental slope is the steepest part of the continental margin. It begins at the edge of the continental shelf and continues down to the flattest part of the ocean floor. The depth of the continental slope ranges from about 200 m to about 4,000 m.

The continental rise is the base of the continental slope. It is made of large piles of sediment. The continental rise covers the boundary between the continental margin and the deep-ocean basin.

The Continental Margin

The deep-ocean basin includes the abyssal plain, mid-ocean ridges, rift valleys, seamounts, and ocean trenches. The abyssal plain is the flat, almost level part of the ocean basin. The abyssal plain is covered by layers of sediment. Some of the sediment comes from land. Some of it is made of the remains of dead sea creatures. These remains settle to the ocean floor when the creatures die.
PLATE TECTONICS AND OCEAN FLOOR FEATURES

Remember that tectonic plates move over Earth’s surface. Where the plates touch, they can slide past each other, collide with each other, or move away from each other. The movement of tectonic plates creates features, such as mountains, on land. Tectonic movements can also form features on the ocean floor. These features include seamounts, mid-ocean ridges, rift valleys, and ocean trenches.

The Deep-Ocean Basin

SEAMOUNTS

A volcanic mountain on the ocean floor is called a seamount. Some seamounts form when magma pushes its way between tectonic plates and erupts to form a mountain. Other seamounts form far away from the edges of tectonic plates. These areas are called hot spots. At these locations, magma rises from within Earth and breaks through a tectonic plate.

As lava continues to erupt at a seamount, the mountain gets taller. If it gets tall enough to rise above the ocean’s surface, it is called a volcanic island. The islands of the state of Hawaii are volcanic islands.
MID-OCEAN RIDGES

A long mountain chain that forms on the floor of the ocean is a **mid-ocean ridge**. Mid-ocean ridges form where tectonic plates move apart. This motion produces a crack in the ocean floor called a **rift valley**. Magma rises through the rift and cools to form new rock. The ridge is made of this new rock. ✓

Most mid-ocean ridges are far below the ocean surface. However, Iceland is one place on Earth where the mid-ocean ridge has risen above the ocean’s surface.

OCEAN TRENCHES

Long, narrow valleys in the deep-ocean basins are called **ocean trenches**. Trenches form where tectonic plates are moving together. As the plates move toward each other, one plate sinks under the other plate in a process called **subduction**. ✓

Subduction causes pressure to increase on the plate that is sinking. Water and other fluids are squeezed out of the rock and sediments on this plate. These fluids cause mantle rock to melt and form magma. The magma rises to the surface and erupts to form a chain of volcanoes.

Ocean trenches are some of the deepest places on Earth. For example, the Marianas Trench in the Pacific Ocean is nearly 11,000 m deep.

<table>
<thead>
<tr>
<th>Feature</th>
<th>What it is</th>
<th>Where it is found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seamount</td>
<td>flat part of the ocean basin, covered in sediment</td>
<td>in the deep-ocean basins</td>
</tr>
<tr>
<td></td>
<td></td>
<td>where plates move apart</td>
</tr>
<tr>
<td>Rift valley</td>
<td>crack in the crust at a mid-ocean ridge</td>
<td></td>
</tr>
<tr>
<td>Ocean trench</td>
<td>long, narrow valley on the ocean floor</td>
<td></td>
</tr>
</tbody>
</table>
**SECTION VOCABULARY**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>abyssal plain</td>
<td>a large, flat, almost level area of the deep-ocean basin</td>
</tr>
<tr>
<td>continental rise</td>
<td>the gently sloping section of the continental margin located between the continental slope and the abyssal plain</td>
</tr>
<tr>
<td>continental shelf</td>
<td>the gently sloping section of the continental margin located between the shoreline and the continental slope</td>
</tr>
<tr>
<td>continental slope</td>
<td>the steeply inclined section of the continental margin located between the continental rise and the continental shelf</td>
</tr>
<tr>
<td>mid-ocean ridge</td>
<td>a long, undersea mountain chain that forms along the floor of the major oceans</td>
</tr>
<tr>
<td>ocean trench</td>
<td>a long, narrow, and steep depression on the ocean floor that forms when one tectonic plate subducts beneath another plate; trenches run parallel to volcanic island chains or to the coastlines of continents; also called a trench or a deep-ocean trench</td>
</tr>
<tr>
<td>rift valley</td>
<td>a long, narrow valley that forms as tectonic plates separate</td>
</tr>
<tr>
<td>seamount</td>
<td>a submerged mountain on the ocean floor that is at least 1,000 m high and that has a volcanic origin</td>
</tr>
</tbody>
</table>

1. **List**  Name four ways that scientists study the ocean floor.

2. **Describe**  How do plate movements form ocean trenches?

3. **Identify**  Where does the sediment on the abyssal plain come from? Give two sources.

4. **Explain**  How do mid-ocean ridges form?
6. A glacier deposits unsorted material if, as it melts, the sediment in it drops to the ground. A glacier deposits sorted material if, as it melts, its water carries smaller sediment farther than larger sediment.

SECTION 4 THE EFFECT OF GRAVITY ON EROSION AND DEPOSITION
1. the steepest slope at which particles do not move downhill
2. The slope is greater than the angle of repose.
3. They can carry away, bury, and destroy habitats.
4. heavy, wet soil; removal of plant roots; earthquakes; construction
5. Water probably decreases the angle of repose, because wetting soil that is not moving can cause it to start moving downhill.
6. Creep happens slowly.

<table>
<thead>
<tr>
<th>Type of mass movement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landslide</td>
<td>Material moves suddenly and rapidly down a slope.</td>
</tr>
<tr>
<td>Rock fall</td>
<td>Loose rocks fall down a steep slope.</td>
</tr>
<tr>
<td>Mudflow</td>
<td>A large amount of mud moves downhill very quickly.</td>
</tr>
<tr>
<td>Lahar</td>
<td>Water mixes with volcanic ash to produce a fast-moving, dangerous mudflow.</td>
</tr>
<tr>
<td>Creep</td>
<td>Material moves downhill very slowly.</td>
</tr>
</tbody>
</table>

Review
1. landslides, mudflows, rock falls, creep, lahars
2. Mass movement can cause property damage and injury.
3. If the angle of a slope is greater than the angle of repose, mass movement will occur.
4. gravity
5. Landslides involve the fast movement of large amounts of materials of many different sizes. In mudflows, there is fast movement of mud only.
6. size, shape, weight, and composition of the particles making up the material

Chapter 13 Exploring the Oceans

SECTION 1 EARTH’S OCEANS
1. the continents
2. Pacific, Atlantic, Indian, Southern, Arctic
3. volcanoes
4. Plate tectonics has caused the continents to move.
5. sodium and chlorine
6. rocks and minerals on land
7. The hot, dry weather causes ocean water to evaporate, and salt is left behind.
8. The Mississippi River brings fresh water into the Gulf of Mexico.
9. Fast-moving water tends to have low salinity.
10. by convection
11. The temperature would be less uniform, because the cool and warm water would not mix as efficiently.
12. The equator receives more sunlight.
13. the movement of water between the ocean, the atmosphere, and the land
14. into the oceans
15. Air absorbs heat from the oceans.
16. currents

Review
1. All of the oceans are connected, so water and other materials can flow between them. Therefore, they can all be considered to be part of a single body of water.
2. water movement and climate
3. The hot, dry climate causes water to evaporate from the oceans, but the salt remains behind in the liquid water.
4. The sun cannot heat the water in the thermocline, and the warm water above cannot easily mix with the colder water.
5. A simple diagram of the water cycle should be drawn. It should include descriptions of evaporation, condensation, and precipitation.

SECTION 2 THE OCEAN FLOOR
1. The pressure there is too high for people to survive without a ship.
2. They need to be thick in order to withstand the high pressures in the deep ocean.
3. a process in which sound signals are used to determine the distance to an object
4. The time for sound to travel to the ocean floor is 2 s. Then, 2 s × 1,500 m/s = 3,000 m.
5. continental margin, deep-ocean basin
6. continental shelf, continental slope, continental rise
7. continental shelf, continental slope, continental rise
8. It would be flat and uniform, without any mountains or valleys in it.
9. a volcanic mountain on the sea floor
10. where tectonic plates are moving apart
11. An ocean trench is a deep depression in the ocean floor where a tectonic plate subducts.

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<tr>
<td>Seamount</td>
<td>an underwater volcano</td>
<td>at plate boundaries or in the middle of a plate</td>
</tr>
<tr>
<td>Abyssal plain</td>
<td>flat part of the ocean basin, covered in sediment</td>
<td>in the deep-ocean basins</td>
</tr>
<tr>
<td>Mid-ocean ridge</td>
<td>long underwater mountain chain</td>
<td>where plates move apart</td>
</tr>
<tr>
<td>Rift valley</td>
<td>crack in the crust at a mid-ocean ridge</td>
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**Review**

1. Scientists use underwater vessels, sonar, and satellite information to study the ocean floor.
2. When plates move together, one plate sinks beneath another. This produces a large, deep trench in the ocean floor.
3. Some comes from the land. Some is made of the remains of sea creatures that settle to the bottom when the creatures die.
4. Tectonic plates move apart, creating tension. Cracks form in the crust. Melted rock rises through the cracks, cools, and hardens. The hardened rock forms the ridge.

**SECTION 3 LIFE IN THE OCEAN**

1. plankton, nekton, benthos
2. the ocean floor, the area near it, and the organisms that live there
3. between the low-tide and high-tide limits
4. They attach themselves to rocks.
5. about 645 ft
6. The sublittoral zone is always underwater.
7. The animals eat other animals for food.
8. the abyssal plain
9. a hot-water vent in the ocean floor
10. in ocean trenches
11. the water above the benthic environment
12. above the continental shelf
13. oceanic zone

**SECTION 4 RESOURCES FROM THE OCEAN**

1. Fish are a renewable resource because they can usually reproduce faster than we hunt them. If we hunt them too quickly, they are a nonrenewable resource.
2. removing salt from sea water
3. Most places are not close enough to the ocean to use tidal power.
4. the tides cannot be used up
5. for energy and to make plastics
6. They form deep underwater.

**Review**

1. fish, seaweed
2. Desalination is a method people use to make fresh water from ocean water.
3. Water enters a bay behind a dam as the tide rises. When high tide reaches its peak, the gate closes. The gate remains closed as the tide falls. The gate opens at low tide, and water rushes through the dam. This moves the turbines to generate electricity.
4. iron, copper, manganese, phosphorus, nickel
5. water, minerals, oil, tides
6. People consume more fish than can be harvested from the oceans without causing fish to become too scarce. By farming the fish, people ensure a supply of fish without reducing wild populations too much.