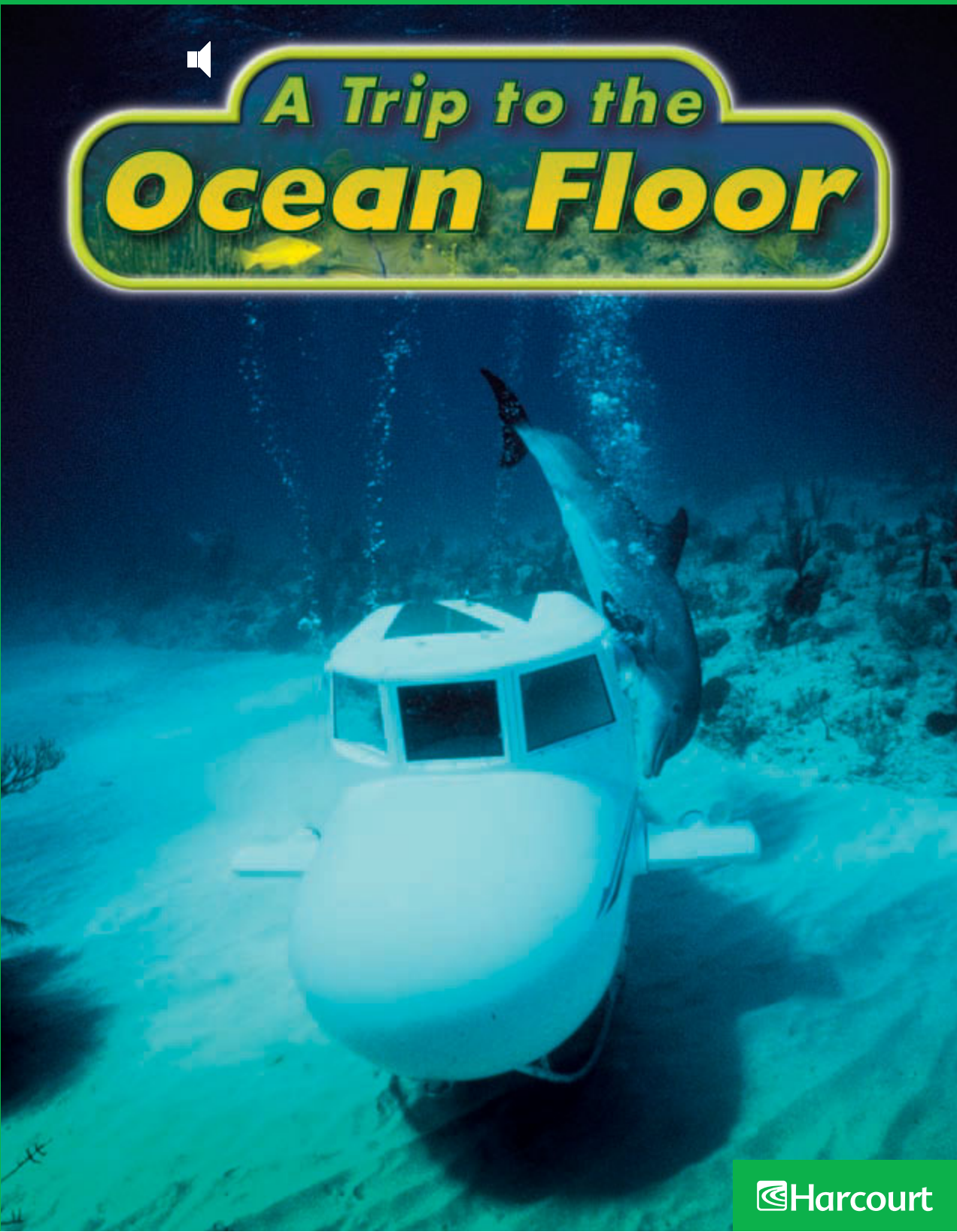

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Touring the Ocean Floor

With a whoosh, the hotdog-shaped capsule moved down below the surface. Ocean water surrounded the capsule. The capsule, called *Alvin*, was a submersible, specially made for deep-ocean diving. The three people inside the capsule were going to the bottom of the sea. That's about 3,000 meters (9,000 ft) below. They were going to visit the seafloor! This is something few people in the world have done.

One of the people inside *Alvin* for this 1993 trip was a scientist named Tim Shank. Tim was a graduate student at Rutgers University at the time.

In 1991, other scientists in *Alvin* had found themselves in the middle of an underwater volcanic eruption. They were in the Pacific Ocean about 600 miles off the coast of Mexico. This was the first time any human had seen such a thing, and they made a video recording of it. The scientists saw

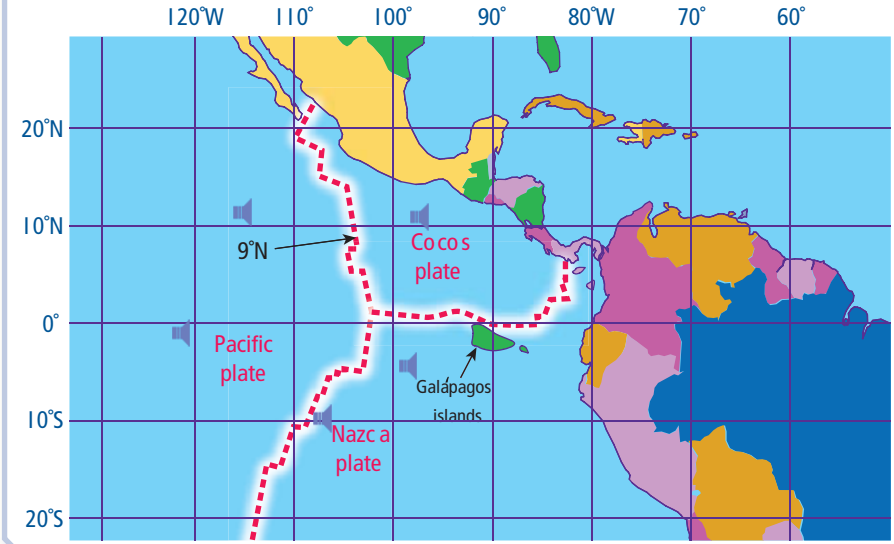
The submersible *Alvin*

water spurting. They saw bacterial material flying through the water. It looked like a snowstorm. They saw fresh lava, or hot, melted rock, coming from the volcano. They watched as the lava covered a community of live animals.

On the day of Tim Shank's dive, scientists were returning to the site of the volcano. They were curious and excited. They wanted to see whether new animals were living at the site of the eruption. Tim wondered what they would find: "Maybe these sites were all dead. Maybe they were the same as the year before. Maybe other animals have come in."

The scientists wanted to find out what kinds of new landforms there might be, as well. Scientists believed that fresh lava on the seafloor formed the youngest parts of the Earth's surface.

The site of the dive was 9° N on the East Pacific Rise.



Back inside *Alvin*, near the start of its dive, the passengers tried to find comfortable positions. It was a small space—about 2 meters (6 ft) wide. The part of the capsule that held the passengers was shaped like a sphere. *Alvin*'s design gave the submersible enough strength to hold back the pressure of water deep in the sea.

The pressure of ocean water deep below the surface can be about 280 kilograms for each square centimeter (4,000 lbs per square inch). No human can survive without protection in that kind of pressure.

Alvin had a shell that was made of titanium. Titanium is a very strong, yet light metal. With its titanium shell, *Alvin* could go as deep as 4,500 meters (14,800 ft). *Alvin* also needed to protect its passengers from the hot and the cold temperatures in the deep water.

Near any volcanic activity, the temperature can reach 350°C (660°F) or more! On the other hand, much of the ocean's water is cold. The temperature can go down to 2°C (35°F). That's nearly freezing!

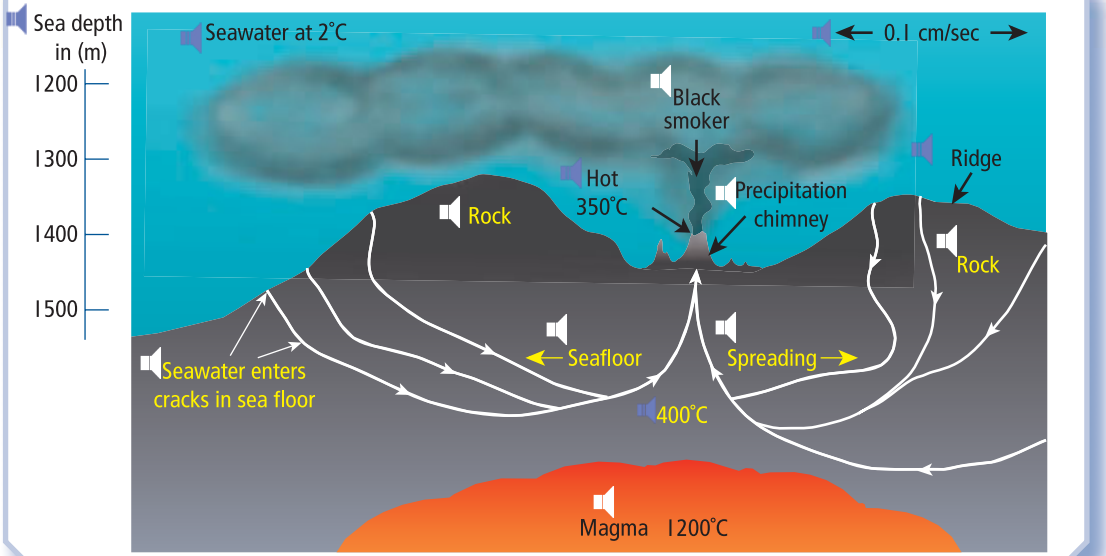
Alvin also had to provide air for passengers to breathe with a supply of oxygen from a tank.

Protected from the deep sea, the scientists and the pilot of *Alvin* fell slowly from the surface. The sunlight disappeared little by little. When *Alvin* was about 400 meters (1,300 ft) deep, the sea outside the capsule was dark. Then suddenly, little twinkles of light appeared in the waters. These were actually animals that gave off light! They looked like a beautiful light show of stars.

After about two hours of falling, *Alvin* finally reached the bottom of the ocean. What was at the bottom of the ocean—in this part of it, anyway? The scientists pulled out their notepads. They recorded what they saw, and the experiments and collections they made.

Alvin had reached the site of the volcanic eruption that it had traveled to almost two years back. For Tim, going to the site was exciting. He told the Woods Hole Oceanographic Institution, where he now works, "The areas had just blossomed into bright, white and red, pristine bouquets of tubeworms. Boom! It was so dramatic. . . . I kept on saying things like, 'Wow, see that spot. It was this way before, and now it's like this.' Meanwhile, Dan Fornari, a geologist, was reporting on all the rock formations."

How a chimney forms around a deep-sea vent



There were many formations to see. Some of them were hardened lava, and some were chimney formations as much as 6 meters (20 ft) high.

Minerals coming from vents, or openings, in the seafloor had made the chimney formations. Scientists first discovered ocean vents while using *Alvin* in 1977. Ocean vents form near cracks caused by seafloor spreading. Ocean water falls into the cracks and becomes heated by the hot, volcanic rock it runs into. The heated water quickly expands and shoots upward, forming a vent.

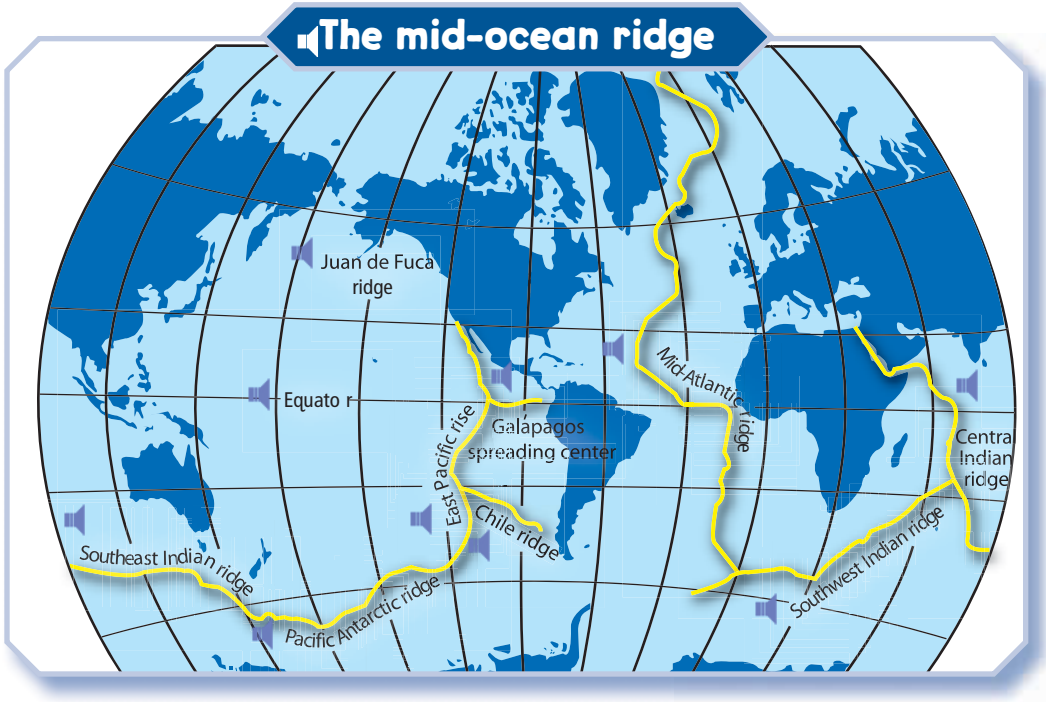
Minerals from the hot water settle around the vent as the water cools. The minerals pile up and over time form something that looks like a chimney. Scientists have given names such as "Eiffel Tower," "Statue of Liberty," and "Godzilla," to chimneys they have located around the seafloor.

Scientists have discovered that animal life grows and lives near the warm-temperature vents. Before these animals were discovered, it was thought that life could not exist without sunlight. Scientists knew that plants used sunlight for energy and that other life-forms fed on plants to live. But deep in the ocean, there is no sunlight. So how can animals live near the vents on the seafloor?

Scientists have now found that these animals use a gas called hydrogen sulfide to live. Tiny bacteria feed on the hydrogen sulfide, and other animals feed on the bacteria.

Landforms in the Sea

Long ago, some people believed that the ocean had no bottom. Others thought that there was a bottom, but it was mostly flat. Only in the last 50 years have scientists been able to learn what the seafloor is actually like. What they have found is a floor that is rocky and covered with mountains, valleys, plateaus, canyons, caves, trenches, and volcanoes! In the 1950s, sonar technology helped scientists make a map of the ocean floor. Sonar measured the time it took for sound waves to bounce off objects. Scientists looked over the map. They discovered a huge underwater mountain range that snakes around the Earth. At some places, the mountains rise some 3,000 meters (10,000 ft) above the seafloor. Yet these mountains are still under the ocean! Only in a few places do the mountains rise above the water.



This mountain range, named the mid-ocean ridge, is about 80,000 kilometers (45,000 mi) long and hundreds of kilometers wide. It covers an area greater than all of the mountain ranges above land put together.

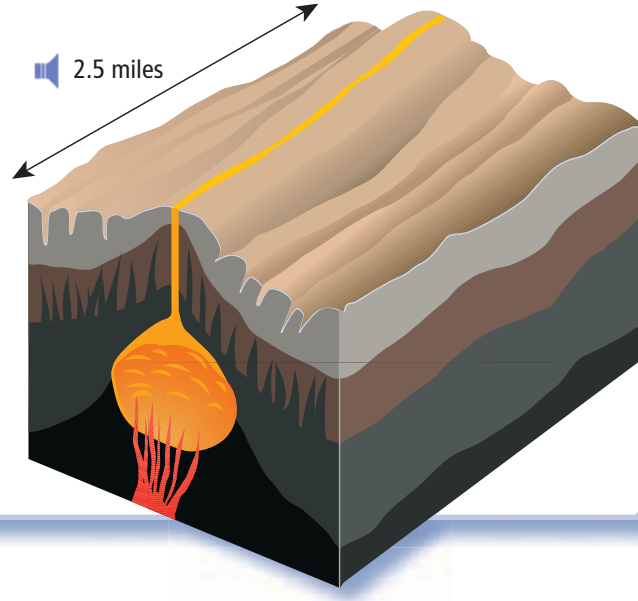
One person who has visited this underwater mountain range is Dudley Foster, who is an *Alvin* pilot. He drove *Alvin* on a mission in 1974 to study a part of the range called the Mid-Atlantic Ridge.

"We flew along the Mid-Atlantic Ridge . . . It was like flying through the Grand Canyon. The scenery is spectacular, but it is all hard volcanic rock," Dudley told *National Geographic* in 2003.

New lava and old lava make different kinds of shapes on the slopes below the ridge. There are pillow shapes, sheets, and tube shapes. At some places, the old lava is crushed into blocks of rock.

How a mid-ocean ridge forms

Portions of Earth's crust, called plates, move apart. Molten rock from below oozes up through the crack and forms a ridge.



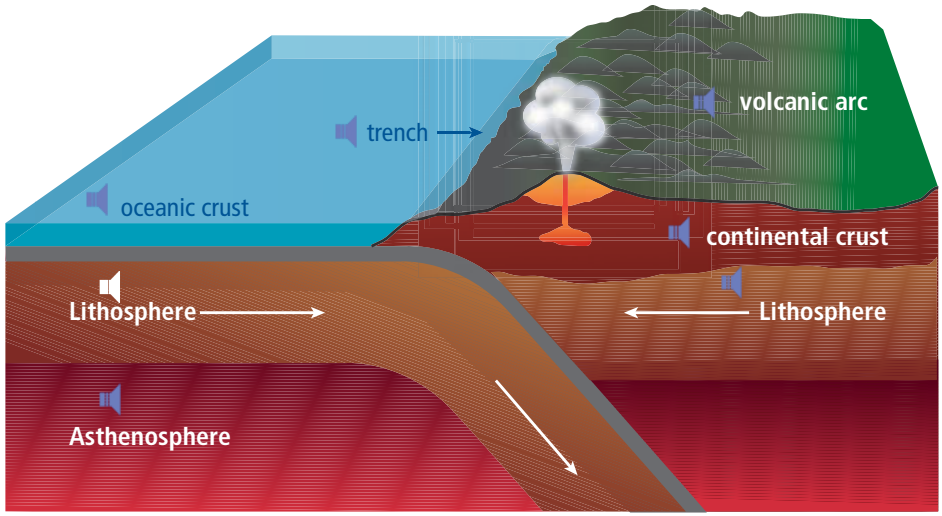
In the Pacific Ocean on a different part of the mid-ocean ridge, the *Alvin* and its scientists found what looked like a large, steamy bed of stones. It turned out that these were not stones at all but giant-sized clams and mussels! The researchers named this site "Clambake."

Some of the ocean bottom is flat, but there can be deep cracks, called fissures. The ocean floor also has faults. A fault is a break in Earth's crust.

There are also trenches. To get an idea of what a trench is like, picture yourself under the ocean walking along a flat plain. Suddenly the land drops away below your feet. You are standing at the edge of a cliff. You look down—it's a huge drop. On the other side of the cliff from you is another flat plain. The area between you and the other plain is called a trench. It is a very deep cut in the ocean floor.

How a trench forms

A trench forms when one of Earth's plates slides underneath another.



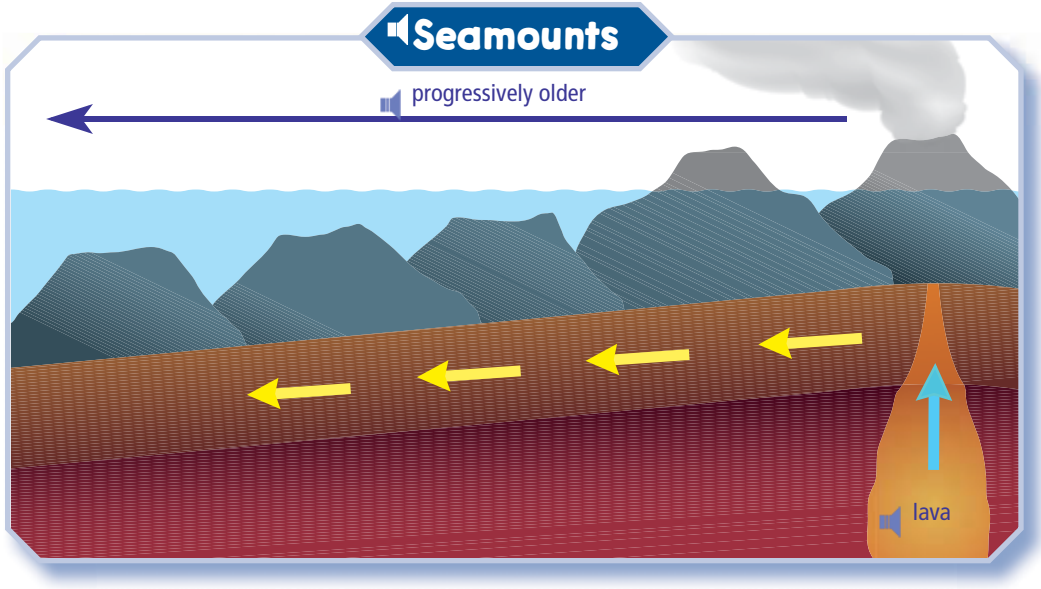
The deepest spot known on Earth is in Mariana Trench in the Pacific Ocean. It is called the Challenger Deep, and it is almost 11,000 meters (36,000 ft) deep.

Only two people have ever gone down into the Challenger Deep. They are a U.S. Navy officer named Don Walsh and a Swiss scientist named Jacques Piccard. They took the trip in the *Trieste* (tree EHST), in 1960. The *Trieste* was a special submarine that could go much deeper than *Alvin*. It took the submarine almost five hours to travel down the deep trench. Finally, it touched the bottom at 10,915 meters (35,813 ft).

"The bottom appeared light and clear, a waste of . . . ooze," Jacques said in his book, *Seven Miles Down.* "We were landing on a nice, flat bottom of . . . ooze . . . . As we were settling . . . , I saw a wonderful thing. Lying on the bottom just beneath us was some type of flatfish . . . about 1 foot long and 6 inches across . . . .Slowly, extremely slowly, this flatfish swam away. Moving along the bottom, partly in the ooze and partly in the water, he disappeared into his night. Slowly too—perhaps everything is slow at the bottom of the sea."

The Changing Land in the Sea

The landforms in the ocean can change slowly or quickly, but they are always changing. Fresh lava is pushed up all the time. The lava adds new ocean crust to both sides of the mid-ocean ridge. The lava that builds up at the ridge forms a mountain range.



In some places, one portion of the ocean crust is pushed beneath another and downward toward Earth's center, forming an ocean trench. Heat deep inside Earth melts the rock from this sinking crust. The molten rock can rise and form volcanoes.

Some volcanoes form under water. They are called seamounts. If the volcano gets big enough, its top will break through the ocean's surface, and an island is born.

The Hawaiian Islands formed from seamounts. The crust on which the seamount island forms sometimes moves away from where the lava is erupting. The old seamount is then worn away by the ocean. This is happening to the older islands in the Hawaiian chain. This is why the island experiencing all of the volcanic activity is "the Big Island."

Elsewhere in the ocean, seamounts form part of the underwater landscape, along with flat plains, trenches, and ridges.

As usual, the scientists on *Alvin* found that their time at the bottom of the ocean was running out. Although *Alvin* could remain below for 10 hours or more, a typical mission lasted about 8 hours. It took about 2 hours to get to the bottom and another 2 hours to get back up. That left scientists only 4 hours on the seafloor.

Alvin's pilot dropped the weights that hold it down and reported to the mother ship. *Alvin* was on its way up and ready to prepare for another adventure.

Think and Write

1. How are landforms in the ocean like landforms on land?
2. Why do you think more people have not visited the bottom of the ocean?
3. How are the landforms in the sea always changing?
4. **Persuasive Writing** In the early 1970s, some scientists believed that submersibles were not the best way to study the ocean. They thought that because submersibles cannot cover a great deal of area, they would not be worth the great costs. Write a paragraph discussing whether you think *Alvin* has been a good way to study the seafloor. Include two reasons to support your argument.

Hands-On Activity

Landform Models Use clay to make models of at least two different ocean landforms. When you are finished, label each landform.

School-Home Connection

Underwater Vacation Poll family members to find out which underwater landform(s) they would like to visit. Then draw a picture of the family outing aboard *Alvin*. Label the landform(s) in your picture.

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