Seafloor Spreading

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CHAPTER 1 Seafloor Spreading

Lesson Objectives

- List the main features of the seafloor: mid-ocean ridges, deep sea trenches, and abyssal plains.
- Describe what seafloor magnetism tells scientists about the seafloor.
- Describe the process of seafloor spreading.

Vocabulary

- echo sounder
- seafloor spreading
- trenches

Introduction

Ocean research during World War II gave scientists the tools to find out how the continents move. The evidence all pointed to seafloor spreading.

Seafloor Bathymetry

Before World War II, people thought the seafloor was completely flat and featureless. There was no reason to think otherwise.

Echo Sounders

But during the war, battleships and submarines carried echo sounders. Their goal was to locate enemy submarines (**Figure** 1.1). **Echo sounders** produce sound waves that travel outward in all directions. The sound waves bounce off the nearest object, and then return to the ship. Scientists know the speed of sound in seawater. They then can calculate the distance to the object that the sound wave hit. Most of these sound waves did not hit submarines. They instead were used to map the ocean floor.

Features of the Seafloor

Scientists were surprised to find huge mountains and deep trenches when they mapped the seafloor. The mid-ocean ridges form majestic mountain ranges through the deep oceans (**Figure** 1.2).

Deep sea trenches are found near chains of active volcanoes. These volcanoes can be at the edges of continents or in the oceans. **Trenches** are the deepest places on Earth. The deepest trench is the Mariana Trench in the southwestern

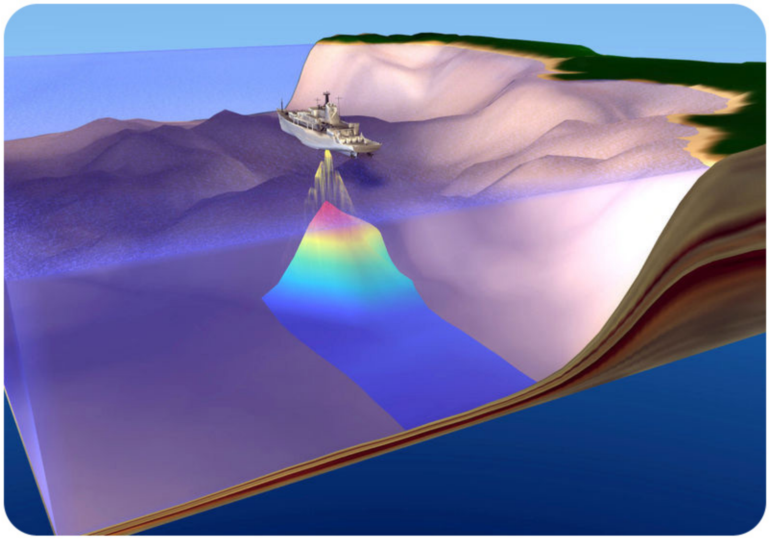

FIGURE 1.1
A ship sends out sound waves to create a picture of the seafloor below it. The echo sounder pictured has many beams and as a result it creates a three dimensional map of the seafloor beneath the ship. Early echo sounders had only a single beam and created a line of depth measurements.

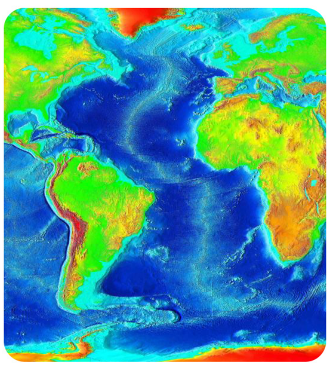

FIGURE 1.2
A modern map of the eastern Pacific and Atlantic Oceans. Darker blue indicates deeper seas. A mid-ocean ridge can be seen running through the center of the Atlantic Ocean. Deep sea trenches are found along the west coast of Central and South America and in the mid-Atlantic, east of the southern tip of South America. Isolated mountains and flat, featureless regions can also be spotted.

Pacific Ocean. This trench plunges about 11 kilometers (35,840 feet) beneath sea level. The ocean floor does have lots of flat areas. These abyssal plains are like the scientists had predicted.

Seafloor Magnetism

Warships also carried magnetometers. They were also used to search for submarines. The magnetometers also revealed a lot about the magnetic properties of the seafloor.

Polar Reversals

Indeed, scientists discovered something astonishing. Many times in Earth's history, the magnetic poles have switched positions. North becomes south and south becomes north! When the north and south poles are aligned as they are now, geologists say it is normal polarity. When they are in the opposite position, they say that it is reversed polarity.

Magnetic Stripes

Scientists were also surprised to discover a pattern of stripes of normal and reversed polarity. These stripes surround the mid-ocean ridges. There is one long stripe with normal magnetism at the top of the ridge. Next to that stripe are two long stripes with reversed magnetism. One is on either side of the normal stripe. Next come two normal stripes and then two reversed stripes, and so on across the ocean floor. The magnetic stripes end abruptly at the edges of continents. Sometimes the stripes end at a deep sea trench (**Figure** 1.3).

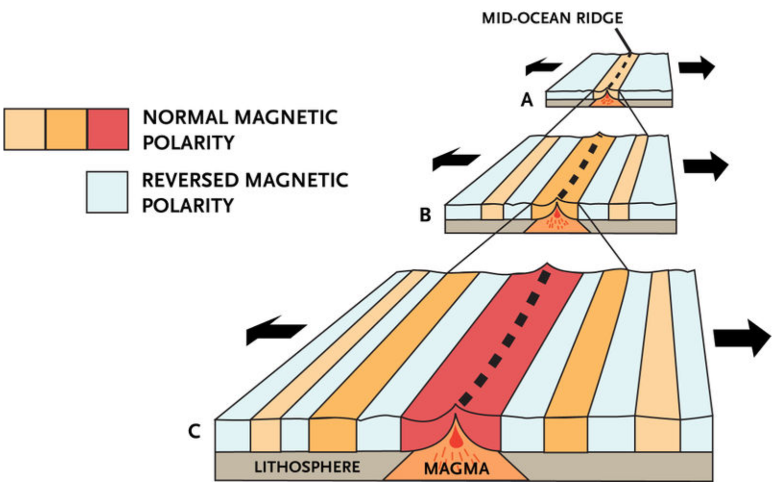

FIGURE 1.3
Scientists found that magnetic polarity in the seafloor was normal at mid-ocean ridges but reversed in symmetrical patterns away from the ridge center. This normal and reversed pattern continues across the seafloor.

Seafloor Ages

The scientists used geologic dating techniques on seafloor rocks. They found that the youngest rocks on the seafloor were at the mid-ocean ridges. The rocks get older with distance from the ridge crest. The scientists were surprised to find that the oldest seafloor is less than 180 million years old. This may seem old, but the oldest continental crust is around 4 billion years old.

Scientists also discovered that the mid-ocean ridge crest is nearly sediment free. The crust is also very thin there. With distance from the ridge crest, the sediments and crust get thicker. This also supports the idea that the youngest rocks are on the ridge axis and that the rocks get older with distance away from the ridge (**Figure** 1.4). Something causes the seafloor to be created at the ridge crest. The seafloor is also destroyed in a relatively short time.

The Seafloor Spreading Hypothesis

The **seafloor spreading** hypothesis brought all of these observations together in the early 1960s. Hot mantle material rises up at mid-ocean ridges. The hot magma erupts as lava. The lava cools to form new seafloor. Later, more lava erupts at the ridge. The new lava pushes the seafloor that is at the ridge horizontally away from ridge axis. The seafloor moves!

In some places, the oceanic crust comes up to a continent. The moving crust pushes that continent away from the ridge axis as well. If the moving oceanic crust reaches a deep sea trench, the crust sinks into the mantle. The creation and destruction of oceanic crust is the reason that continents move. Seafloor spreading is the mechanism that Wegener was looking for!

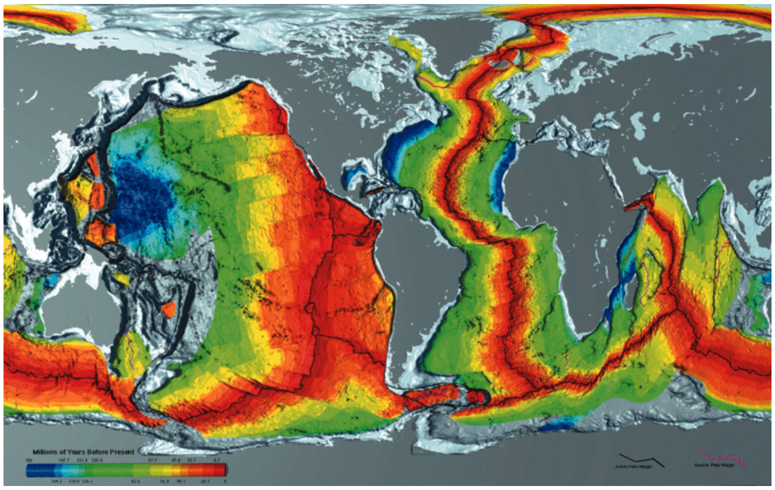

FIGURE 1.4
Seafloor is youngest near the mid-ocean ridges and gets progressively older with distance from the ridge. Orange areas show the youngest seafloor. The oldest seafloor is near the edges of continents or deep sea trenches.

Lesson Summary

- Using technologies developed during World War II, scientists were able to gather data that allowed them to recognize that seafloor spreading is the mechanism for Wegener's drifting continents.
- Maps of the ocean floor showed high mountain ranges and deep trenches.
- Changes in Earth's magnetic field give clues as to how seafloor forms and the importance of mid-ocean ridges in the creation of oceanic crust.
- Seafloor spreading processes create new oceanic crust at mid-ocean ridges and destroy older crust at deep sea trenches.

Lesson Review Questions

Recall

1. Describe a mid-ocean ridge. What geological processes are happening there?

2. Describe deep sea trenches and abyssal plains and their relative ages.

Apply Concepts

3. Using what you've learned about echo sounders, how do bats and dolphins use sound waves to create pictures of their worlds?

Think Critically

4. Why is the oceanic crust so young? Why is the continental crust so old?

5. Describe how continents move across the ocean basins.

6. Where would plate tectonics theory be if World War II hasn't happened?

Points to Consider

- How were the technologies that were developed during World War II used by scientists for the development of the seafloor spreading hypothesis?
- In what two ways did magnetic data lead scientists to understand more about plate tectonics?
- How does seafloor spreading provide a mechanism for continental drift?
- Describe the features of the North Pacific Ocean basin described in terms of seafloor spreading.

References

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