Making Maps

Maps Help Us Understand the Earth

STEMTaught® **Grade 4**

Next Generation Science

Earth's Systems 4-ESS2-2: Analyze and interpret data from maps to describe patterns of Earth's features. Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.

Making Maps- Maps Help Us Understand the Earth

ISBN 978-1-952346-80-4

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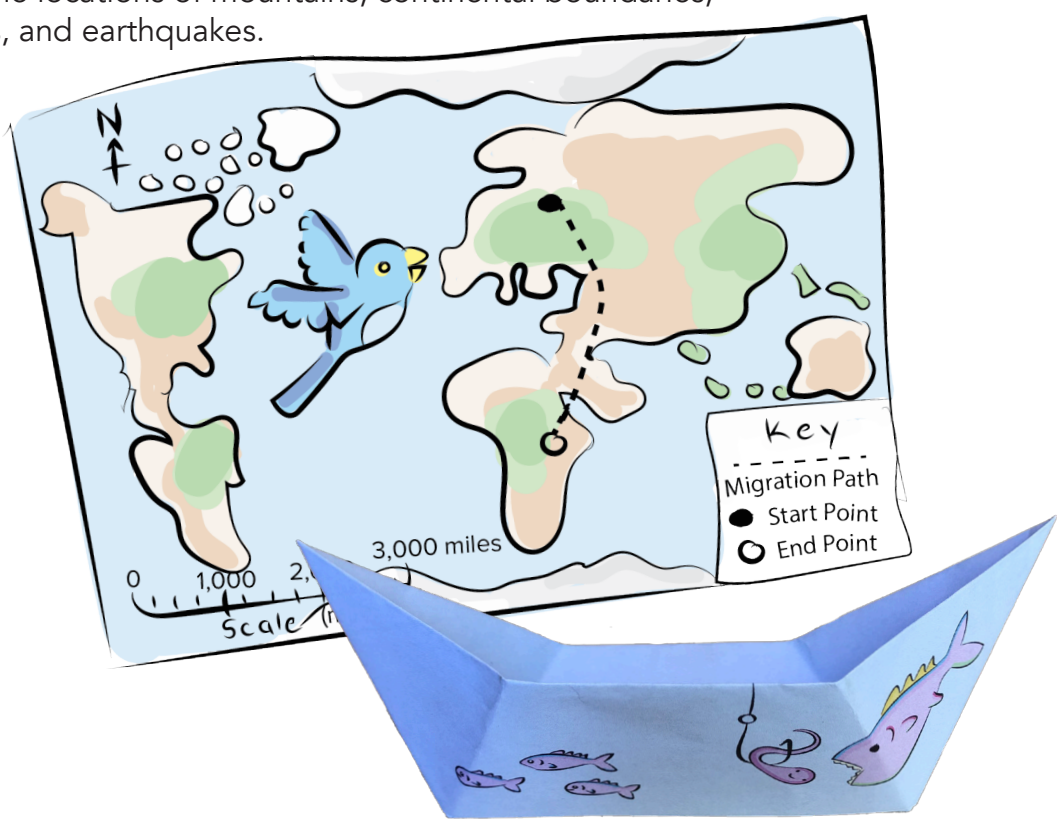


THE MAP THAT CHANGED THE WORLD

Marie Tharp maps the ocean floor

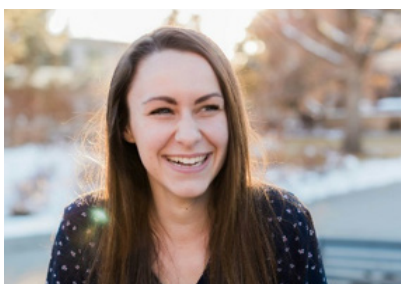
Marie Tharp

Earth Scientist, (1920–2006)
University of Michigan, Ann Arbor

This story features the writing and life work of Marie Tharp, the scientist who made the first topographic map of the ocean which proved the theory of plate tectonics.

"Papa always told me, 'when you find your life's work, make sure it is something you can do, and most important, something you like to do.' I studied hard, but there weren't many opportunities for women in 1940. I never would have gotten the chance to study geology if it hadn't been for *World War II*. Girls were needed to fill the jobs left open because the guys were off fighting. The geology department at the University of Michigan opened its doors to women. I earned a master's degree in geology and then went on to get a degree in math."

Authors and Illustrators



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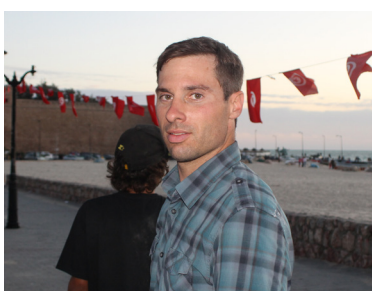

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Part 1

Marie helped her dad make maps

Marie started making maps when she was a little girl. Her father was a professional mapmaker and Marie helped him gather the information he needed to make his maps.

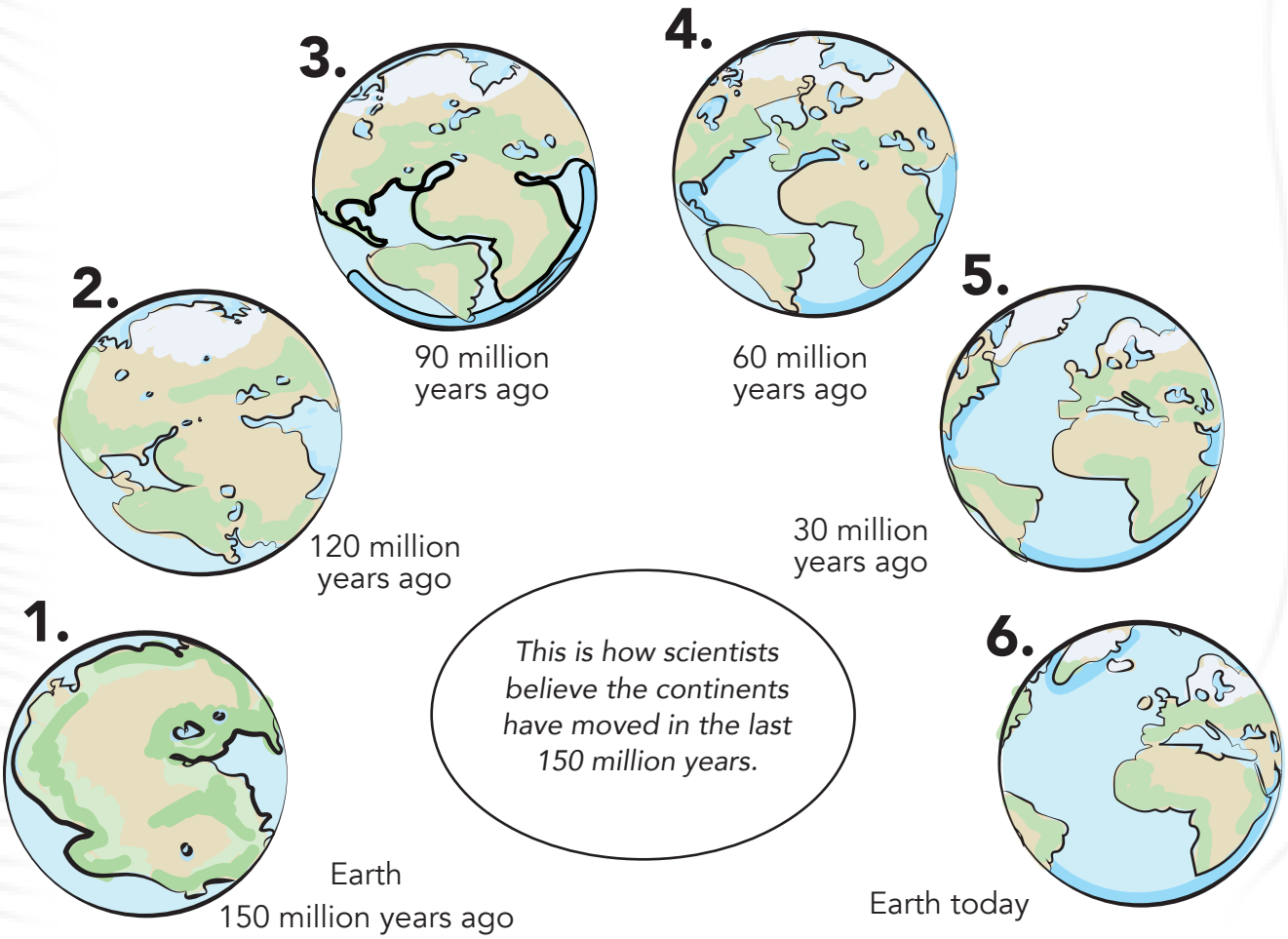
Marie's Journal Entry

"My father, William Tharp, was a soil surveyor. Papa spent his time in the field, collecting data used to make soil maps. We were constantly on the move. By the time I had finished high school I had attended nearly 24 different schools, and I had seen a lot of different landscapes. I guess I had map making in my blood."

Marie's father was a professional surveyor and mapmaker. As a child, Marie helped her father make maps.

When Marie was in elementary school, a scientist named Alfred Wegener hypothesized that all the continents were slowly moving away from each other and that they had once been connected. At the time, everyone thought this idea was crazy! How could continents move? Mr. Wegener spent the rest of his life trying to prove his theory, but he never did figure out what made the continents move.

The continents are moving



How long does it take for the continents to move far enough for Earth to look entirely different?

Part 2

What is under the ocean?

The ocean floor was the last unmapped feature of the Earth. Marie's curiosity about the ocean floor led her to a job at which she was to create a topographic map of the ocean floor.

Marie's Journal Entry

"All that water, miles deep...proved an ample barrier, preventing anyone from getting any explanation of what lay at the bottom of the ocean. On any map of the world, three-quarters of the Earth was shown as a featureless blue space between the continents. Scientists thought the ocean floor was a flat, unchanging plain, a dumping ground slowly filled by sediments eroding from land. Early depth measurements were collected using ropes and cannonballs as weights. With 200 measurements obtained in this way, the Navy marked a plateau in the middle of the North Atlantic on an 1854 map. These measurements suggested that the ocean floor was slightly more complex than previously thought."

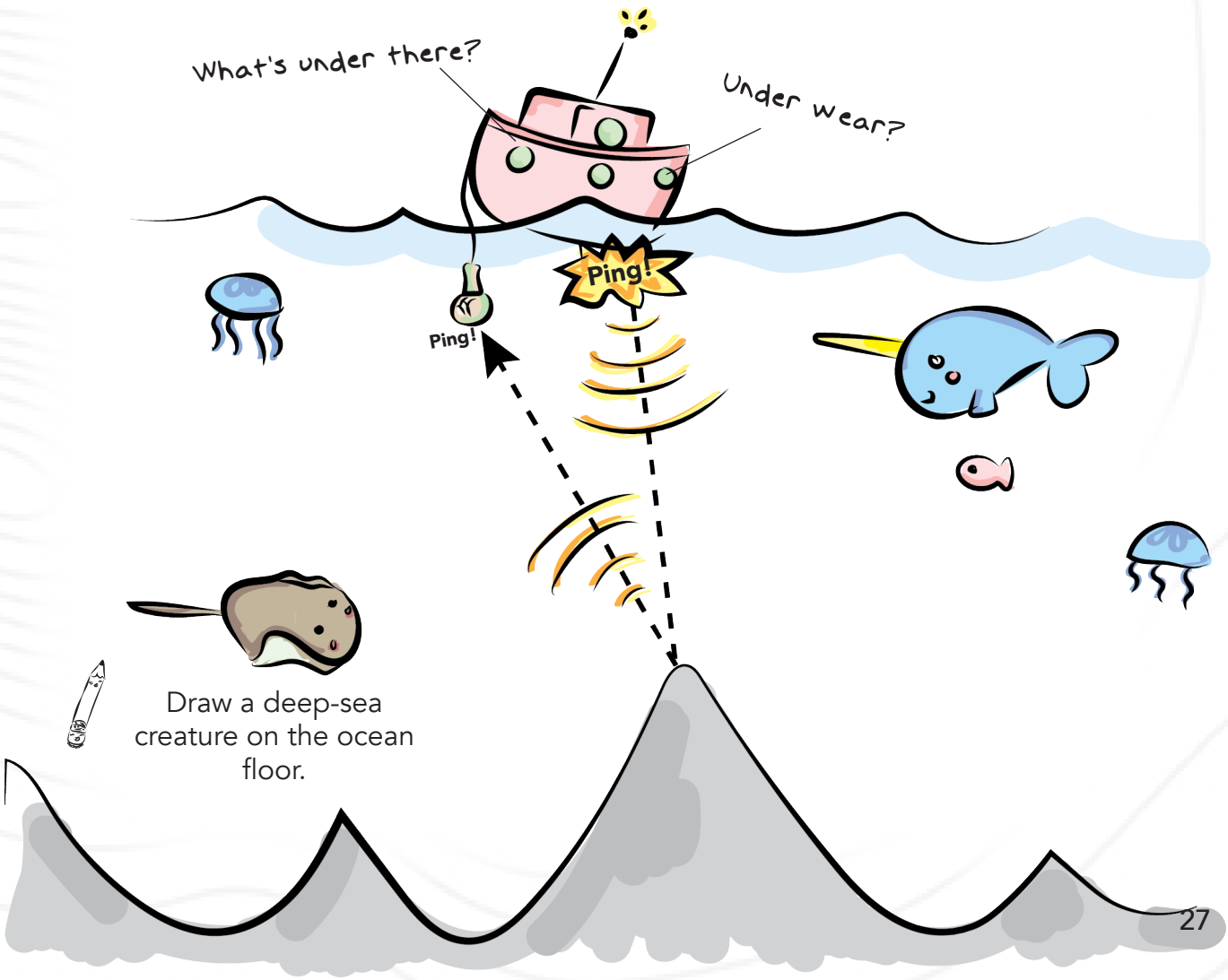
A sailor used a rope to lower a cannonball into the water. They would then measure where the cannonball touched the bottom.

Sound waves helped map the sea floor

Scientists wanted to find a better way to measure the depth of the sea floor. Instead of using ropes to measure the water's depth, they started to experiment with sound waves. Sound waves travel underwater very well. When sound waves are made and bounce back to you from another surface it is called an echo. Maire sent out sound waves underwater and used their echoes to tell how deep the ocean floor was.

Marie's Journal Entry

"A sound signal, usually an electronic ping, would be sent out from the ship at a regular interval. A microphone inside the hull of the ship would pick up the echo when it returned. The time it took for the ping to return would help us know how deep or shallow the surface of the ocean floor was below."



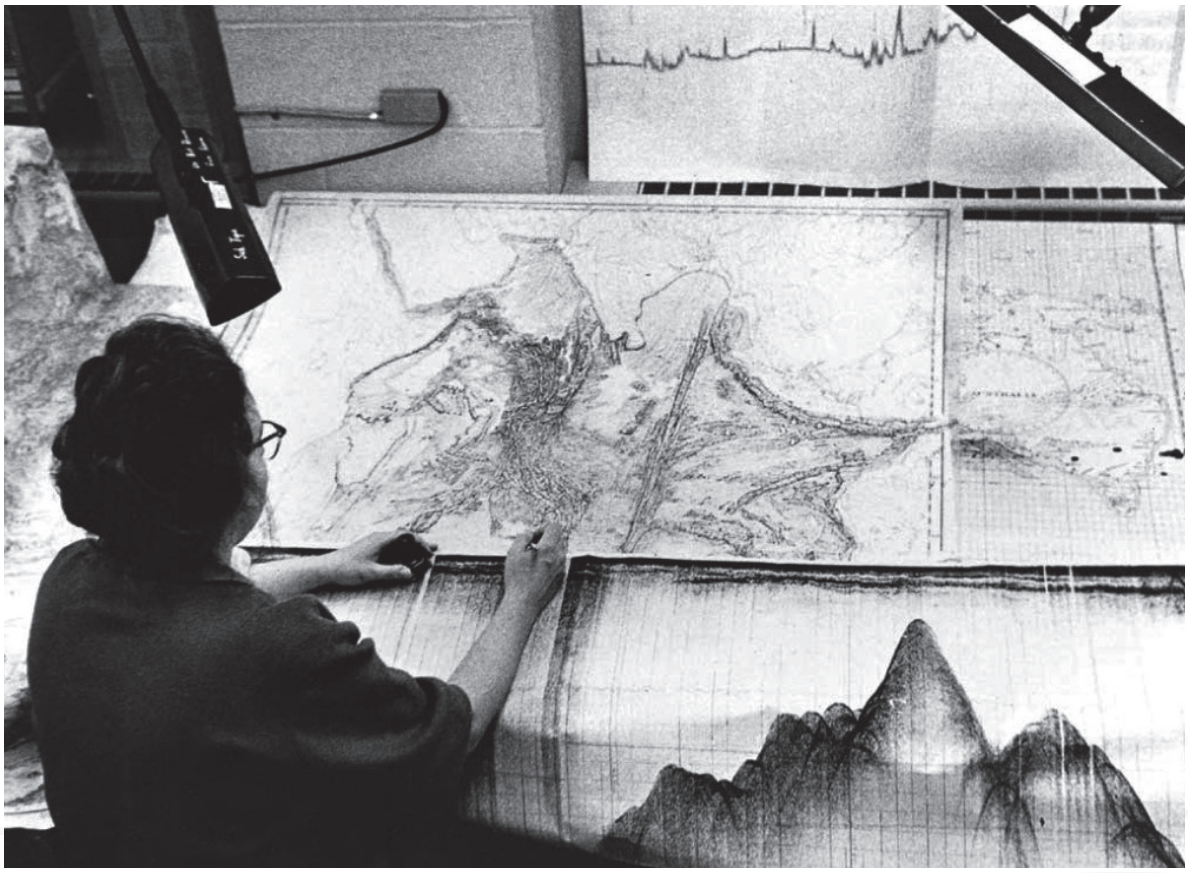
Part 3

Marie mapped profiles of the sea floor

Marie took all the depth measurements they had collected and created detailed profiles from the data. A **profile** is the outline of something from a side view. Computers had not been invented yet, so Marie did all the calculations and drew the detailed profiles by hand.

Marie's Journal Entry

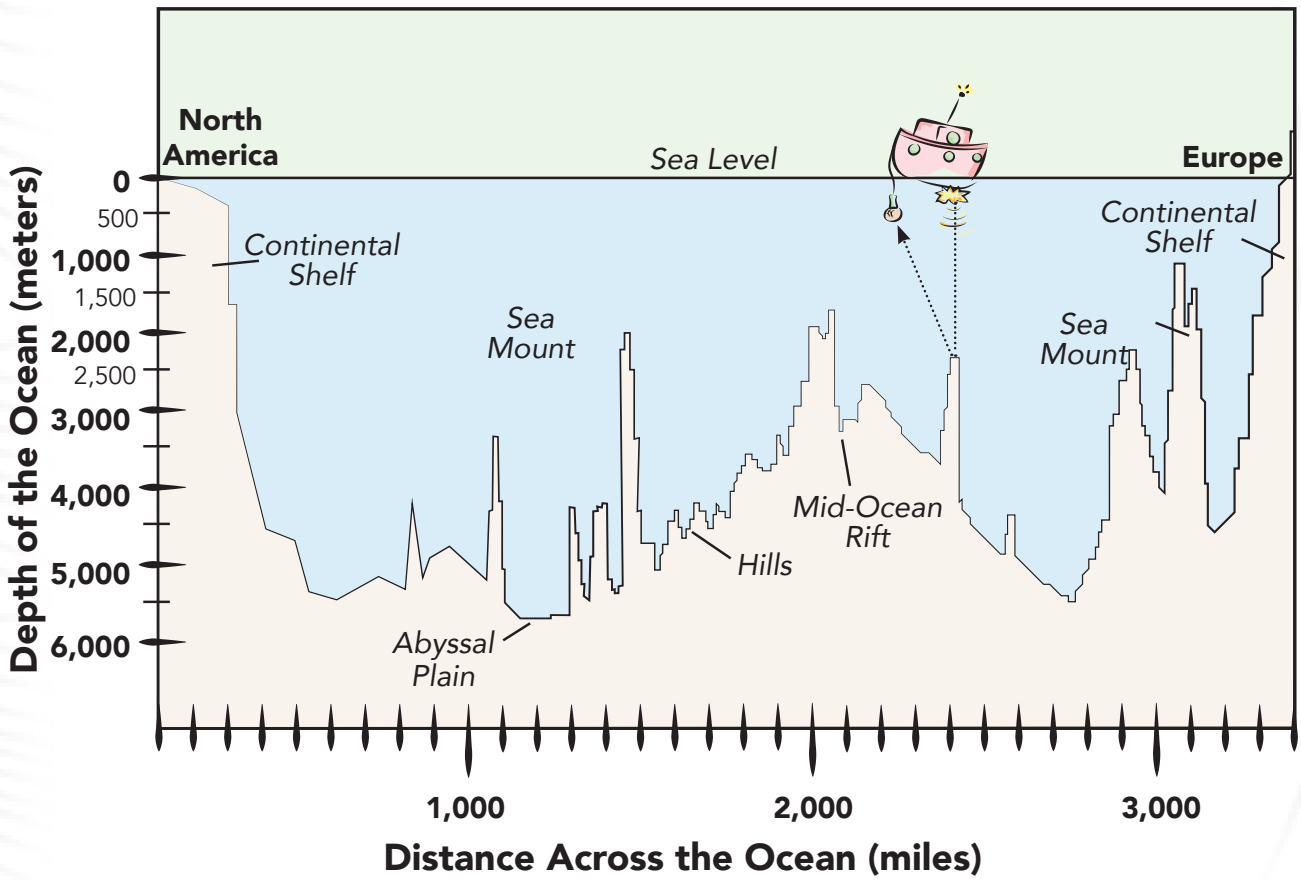
"Tens of thousands of sonic depth measurements in the North Atlantic ocean had been obtained from 1946-1952. We had endless rows of sounding numbers that I was supposed to turn into highly detailed and complete sea floor profiles. I went to work. We plotted profiles of the topography along the ship's course. The profiles had to be drawn in a consistent manner. Any mistakes had to be redrawn."



Marie used the measurements taken by the ship to make topographic maps of the ocean floor. She drew her maps by hand.

If you took the ocean floor and sliced it like a loaf of bread, the shape of one piece would show you a side profile of the ocean floor. Marie was able to combine many of these profiles, or slices, to understand what a 3D view of the ocean floor would look like.

Atlantic Floor Profile



Plot the depth of each creature on the profile.

Scuba diver
330 meters

Leatherback sea turtle
1,000 Meters

Angler fish
3000 meters

Emperor penguin
550 Meters

Vampire squid
1,200 meters

Part 4

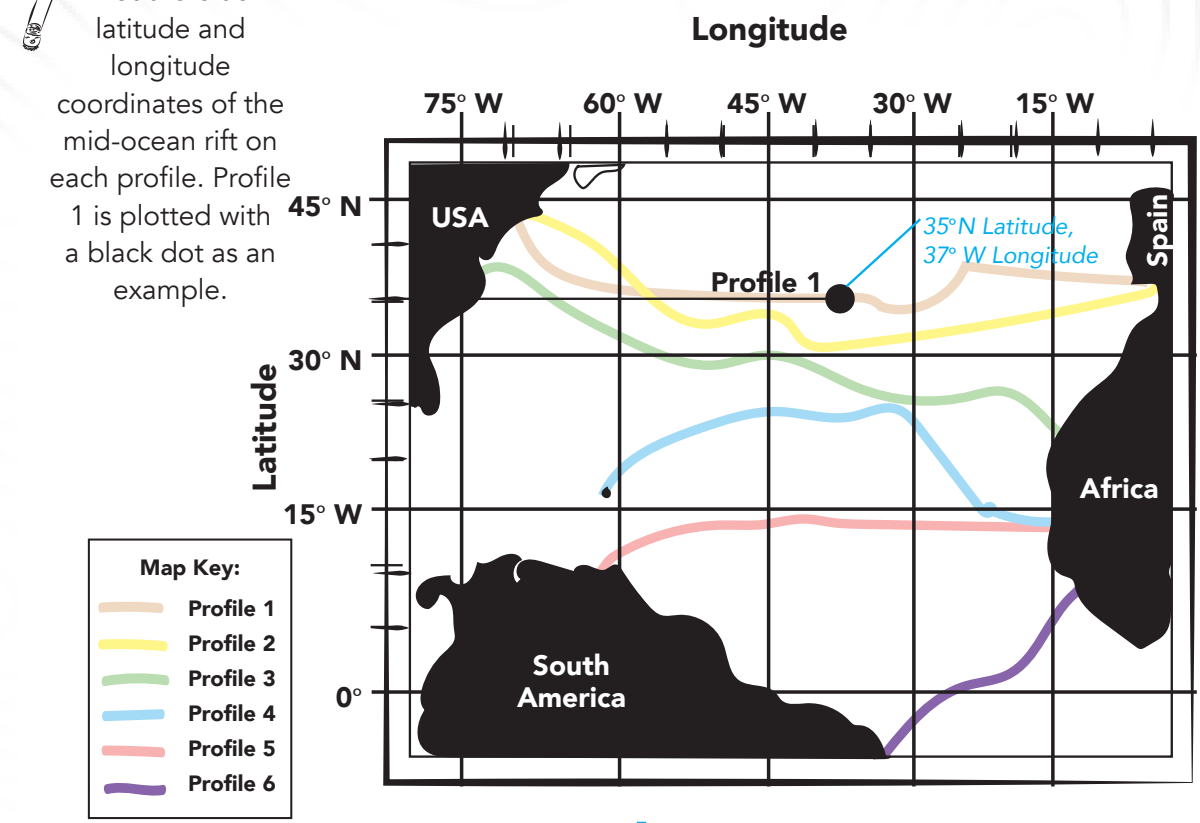
Marie discovered the Mid-Atlantic Rift

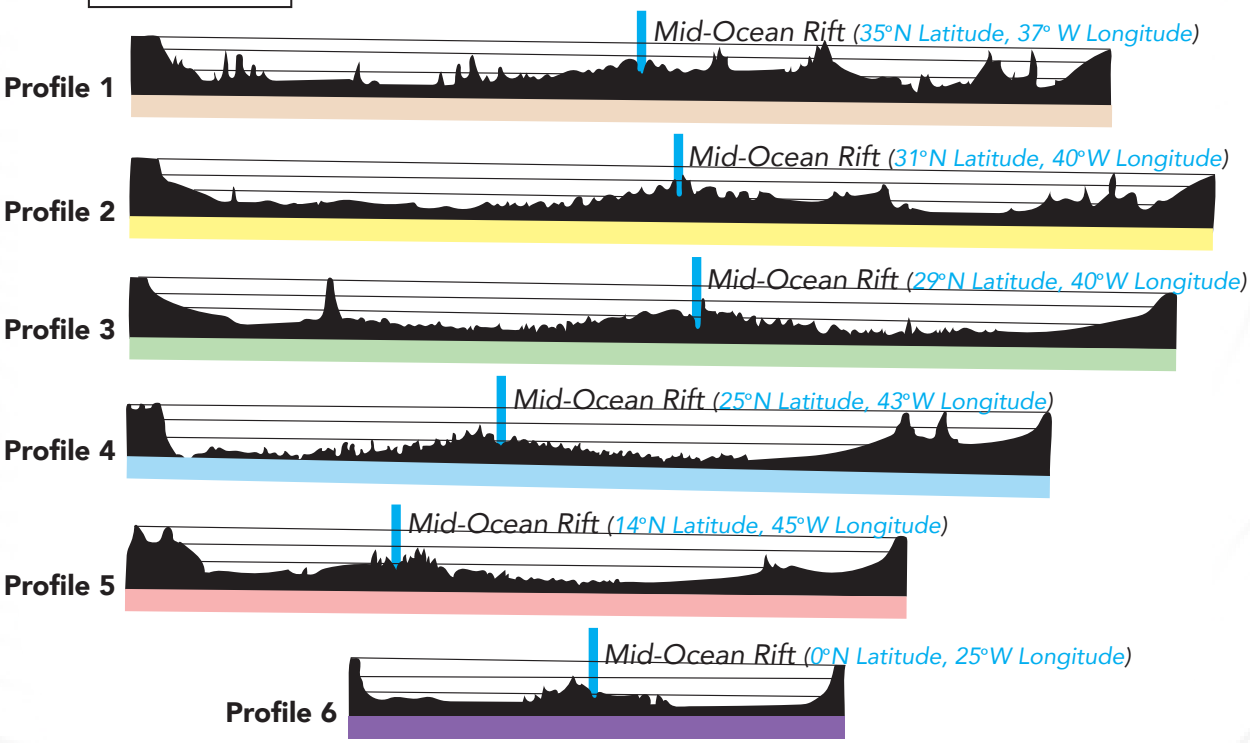
In each of Marie's six profiles of the Atlantic Ocean, she discovered a mountain-like feature with a similar V-shaped valley. She named this feature the mid-ocean rift. The **mid-oceanic rift** is an underwater mountain system with a large valley in the middle. Marie suspected that the mid-ocean rift was evidence that the continents were moving apart because of magma pushing up there.

Marie's Journal Entry

"After weeks of work, I completed six profiles of the North Atlantic Ocean. Immediately I noticed the general similarity in the shape of the ridge in each profile. The individual mountains didn't match up but the cleft in the middle did. I thought it might be a rift valley that continued along the axis of the entire ocean. If there were such a thing as continental drift, it seemed logical that something like a mid-ocean rift valley might be involved. The valley would form where new material came up from deep inside the Earth, splitting the mid-ocean ridge in two and pushing the sides apart."

Plot the blue latitude and longitude coordinates of the mid-ocean rift on each profile. Profile 1 is plotted with a black dot as an example.





Marie's six profiles of the ocean floor. In each profile she found a ridge with a similar valley, which she named the mid-ocean rift.

At first, nobody believed Marie's theory that the mid-oceanic rift was caused by moving continental plates.

Marie's Journal Entry

"When I showed what I found to my team member he groaned and said, "It cannot be! It looks too much like continental drift." Almost everyone in the United States thought that continental drift was impossible. He initially dismissed my interpretation of the profiles as "girl talk," but I thought the rift valley was real and I kept looking for it in all the data I could get."

Marie had trouble convincing other scientists of her theory that the continents were moving.

What forms the mid ocean ridges?

Think, Pair, Share!

Part 5

Marie proved that the continents move

Through careful observation and thinking, Marie plotted other types of data on her map to show that the rift valley was connected to the movement of the continents. She used this evidence to convince others that her theory was true.

Marie's Journal Entry

"Another geologist was hired to plot the locations of earthquakes in the oceans. He worked at a table next to me. Because all our data was on maps of the same scale, we could superimpose the maps on a light table, and we saw that all of the earthquakes lined up with the rift valley. By then I was certain that the rift valley existed!"

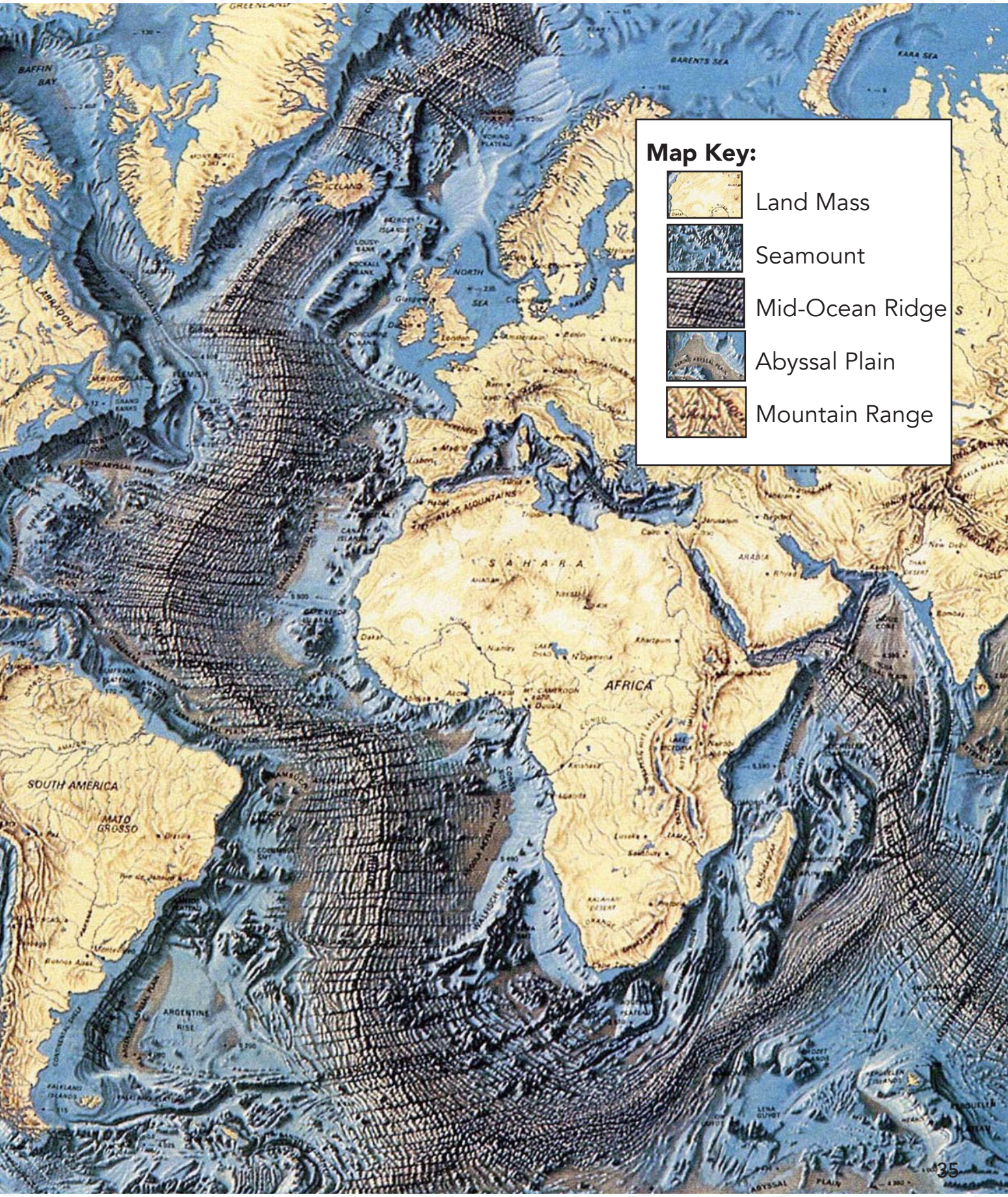
Marie's discovery was the key to unlocking an understanding of plate tectonics. **Plate tectonics** describes how the Earth's crust is divided into plates that float on a hot mantle and move. All of the Earth's land and water sits on these plates that are moving apart in some places and crashing into each other in other places. Plate tectonics explains how mountains and volcanoes form along plate boundaries. It also explains how earthquakes happen because of the slow movements of these large plates.

Marie Tharp's Map of the Ocean Floor

Find the mid-ocean ridges. Color them with a colored pencil.

Find a mountain range on land. Circle it with a pencil.

Find sea mounts, or underwater mountains. Draw a square around them.


Map Key:
Land Mass
Seamount
Mid-Ocean Ridge
Abyssal Plain
Mountain Range
BAFFIN BAY
GREENLAND
BARENTS SEA
KARA SEA
ICELAND
NORTH SEA
LABRADOR
FLEMISH CAP
GRAND BANKS
ATLANTIC OCEAN
SAHARA
AFRICA
ARABIA
SOUTH AMERICA
MATO GROSSO
ARGENTINE RISE
WALVISCH RIDGE
ABYSSAL PLAIN

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ISBN 9781952346804

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