Sea-Floor Spreading

Important Questions
If the seafloor is 4.6 billion years old (the age of the Earth), why isn't there more sediment down there?
Why are the oldest fossils from the ocean floor only 180 million years old, when marine fossils found on land can be much older?

Harry Hess
Harry Hess (1906-1969) was the captain of an assault transport ship during World War II.
He was also a professor of geology at Princeton University.
As his ship carried troops from the U.S. across the Pacific Ocean, he was able to take sonar readings of the ocean floor.

Sonar
Sonar - a device that sends out sound waves and times their return after reflecting off of an object; used to measure depths of the oceans.

Mid-Ocean Ridge
What Hess discovered was a mid-ocean ridge that ran down the center of each ocean.
This ridge, Hess theorized, was where magma rose from underground to the ocean floor, forming new crust
As this new crust formed, the ocean floor moved outward
Magma from deep in the Earth forces its way up between two plates, pushing them apart.
As it nears the ocean floor, the magma cools and solidifies into new rock, which is then pushed apart by another round of magma.
These spreading centers are called mid-ocean ridges because many are found in the oceans and are usually higher than surrounding parts of the ocean floor.
a rift valley in the ocean

Question: If new crust is always being formed, why doesn't the Earth expand like a balloon?
Answer: As this new crust moves outward, it cools and becomes denser
Eventually, it sinks back into the mantle to be melted and recycled over and over.
This process of sinking and melting is called Subduction

Evidence
Rocks around the mid-ocean ridge are very young.
The farther you travel from the ridge, the older the rocks are.
The oldest rocks on the ocean floor are found near the deep ocean trenches
Seismic information proved that oceanic crust was sinking into the deep ocean trenches.
Magnetic Stripes also helped prove Hess' theory.
Magnetic minerals will arrange themselves in line with the magnetic fields of the Earth.
Right now, all new magnetic minerals are facing North
However, Earth's magnetic field "flip-flops" every half a million or so (500,000 years ago, your compass would have pointed **south**!); and any seafloor formed then would have formed minerals facing south.
Before then, the minerals face north again, and even further back, south again, and so on.

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Answers!
Although the Earth is 4.6 billion years old, rock on the sea floor only lasts about 200-250 million years from the time it forms at the mid-ocean ridge to the time it dives back into the mantle.

All of the sediment is carried with it, as well as any fossils that might have formed.

These sediments and fossils are destroyed as they re-melt underground.

Continental Drift
Hess' theory of sea-floor spreading also supported Wegener's idea of continental drift (of which Hess had been a believer).
As the ocean floor spread apart, it pushed the continents along with it!

Chpt 3 powerpoint notes pg 1 E

pg 92-96 + ppt

Notes on Scientific Theory, Wegener, and Continental Drift:
Pages 6-7 and 12 Chpt 1 in textbook

1. Science is a way of learning bout the natural world. Science is also the knowledge gained through that process.

Big Ideas: As scientists seek to understand the natural world, they use skills such as observing, inferring, and predicting. Successful scientists also possess certain attitudes, or habits of mind.

2. Using one or more of your senses to gather information is observation Scientist use their senses (hearing, seeing, tasting, touching, smelling) and equipment (technology) to help them observe. For example thermometers, mass scales, seismographs, microscopes, telescopes, satellites, sonar equipment, etc. As new technology is invented and used, we can observe and learn more.

3. When you explain or interpret the things that you observe you are infering or making an inference. Inferences are not wild guesses and are based on what you already know or prior knowledge.

p9 7

4. Predicting means making a forecast of what will happen in the future based on past experience or evidence.

5. **Scientific attitudes or habits of mind: (curiosity, honesty, open- mindedness, skepticism and creativity)**
Curiosity is what drives a scientist to ask questions that no one has thought of before.
Honesty requires that scientist to report their findings truthfully.
Open-mindedness helps a scientist to accept new and different ideas.
Scientists are Skeptical or they doubt an idea until it has been fully tested.
Creativity helps scientists come up with new ways of solving problems.

6. A Theory is a well-tested scientific concept that explains a wide range of observations. An accepted theory has withstood repeated tests. But if tests fail to support a theory, scientist change the theory, or abandon it. A theory has an explanation with it.

7. A Law is a statement that describes what scientists expect to happen every time under a particular set of conditions. A scientific law (unlike a theory) does not provide an explanation for the observed pattern in nature. Examples of scientific laws: The Law of Superposition (in horizontal rock layers the oldest layer is at the bottom) Law of Gravity

(p12)

Alfred Wegener: In 1910 a young German scientist (geologist and meteorologist), proposed a radical hypothesis of continental drift. In 1912 he gave a lecture on his new theory. He published his ideas in his book called *The Origin of Continents and Oceans* in 1915.

State Alfred Wegner's hypothesis about how the Earth's continents have moved:
all continents were once together in a single landmass and have since drifted apart

According to Wegener, the continents drifted together to form the supercontinent known as Pangea meaning "all lands". According to Wegner Pangaea existed about 300 million years ago. This was when reptiles and winged insects first appeared. Tropical forest, which later formed coal deposits covered large parts of the Earth's surface.

What happened to the Super Continent of Pangaea? Wegner believed that over tens of millions of years, (starting about 200 million years ago) Pangaea began to slowly break apart and the pieces slowly moved toward their present day locations. Those pieces became the continents that we have today. (Europe, Asia, Africa, Australia, North America, South America, Antarctica)

Wegner's evidence (land features, fossils, and evidence from climate)

Land Features: When Wegner pieced together the pieces of the map he found that land features on continents lined up such as mountain belts or mnaes. The mountain range of the Appalachian mountain lines up with those in Greenland, England, and Scandinavia. The mountains are made of similar structure and comparable age. Rocks found in northwestern Africa match up with those in eastern Brazil in South America. Wegner also noticed that the coal fields in Europe and North America matched up.

Fossil Evidence: A fossil is any trance of an ancient organism that has been preserved in rock. *Glossopteris* is a fern like plant that lived 250 million years ago. Glossopteris has been found in rocks in Africa, South America, Australia, India, and Antarctica. Reptiles Mesosaurus and Lystrosaurus are also evidence as their fossils are found in land separated by oceans.

Evidence from climate: Spitsbergen an island in the Arctic Ocean has fossils of tropical plants. The island must have had a tropical climate at one time. South Africa shows evidence of glaciers that once covered the area.

Why was Wegener's hypothesis rejected by other scientist in his time?
Wegner could not provide a satisfactory explanation for the mechanism or forces that pushes and pulls the continents.

E 11 more details