GreatHearts®

Earth Science 8

April 20 - 23

Time Allotment:30 minutes per day

Student Name: ___________________________________

Teacher Name: ___________________________________

Earth Science 8: The Solar System
April 20 - April 23

Packet Overview

Date	Objective(s)	Page Number
Monday, April 20	1. Students will understand the origins of the theory of plate tectonics and explain the interior structure of the Earth	2
Tuesday, April 21	1.Students will be able to explain Alfred Wegener's theory of continental drift, evidence in favor of that theory, and the flaws in that theory.	7
Wednesday, April 22	1. Students will be able to explain the mechanism of seafloor spreading and why this phenomenon helps support Wegener's theory.	10
Thursday, April 23	1. Students will be able to explain the mechanism behind the slow yet continuous movement of lithospheric plates.	14
Friday, April 24	Day off!	

Additional Notes: Students are to designate a specific location in their home for their workspace to learn about Earth and Space.

This could be a table or desk anywhere in the home that could be labeled their school zone. By doing so, the students will have a stable work environment that they will keep all of their learning materials organized, they can visit, and take a rest from.

Academic Honesty

I certify that I completed this assignment independently in accordance with the GHNO Academy Honor Code.

Student signature:

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I certify that my student completed this assignment independently in accordance with the GHNO Academy Honor Code.

Parent signature:

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Lesson 1: Monday, April 20

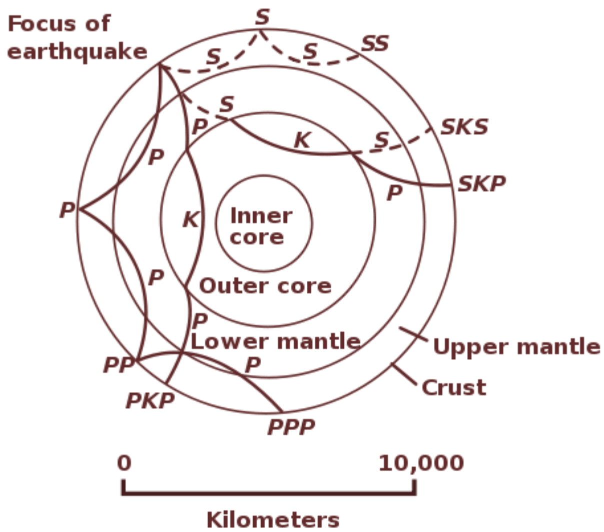
Plate Tectonics

***Plate tectonics* is the unifying theory of geology.** This important theory explains why Earth's geography has **changed through time** and **continues to change today**. It explains why some places are prone to earthquakes and some are not; why some regions have deadly volcanic eruptions, some have mild ones, and some have none at all; and why mountain ranges are located where they are. **Plate tectonic motions affect Earth's rock cycle, climate, and the evolution of life.** Plate tectonic theory is relatively recent, having been developed by scientists during the twentieth century.

Before you can learn about plate tectonics, you need to know something about the **layers** that are found inside Earth. From outside to inside, the **planet is divided into crust, mantle, and core.** Often geologists talk about the **lithosphere**, which is the crust and the uppermost mantle. The lithosphere is **brittle**–it is easily cracked or broken–whereas the mantle beneath it behaves plastically; it can bend. Geologists must use ingenious methods, such as tracking the properties of earthquake waves, to learn about the interior of our planet.

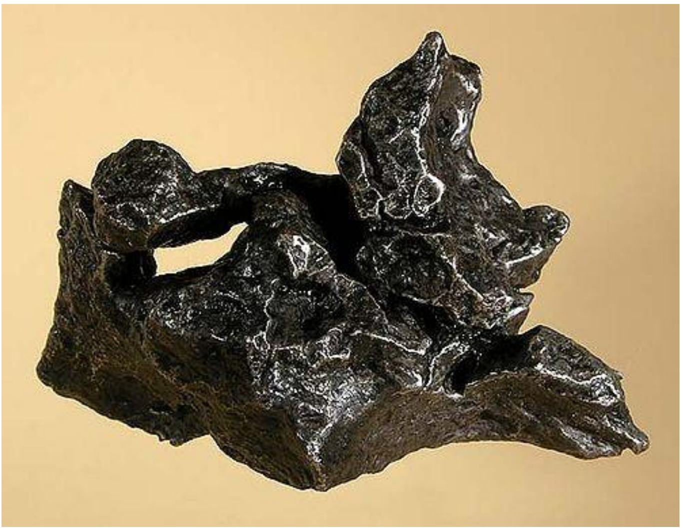
The Earth is composed of **several layers**. On the outside is the relatively cold, brittle **crust**. Below the crust is the hot, **convecting mantle**. At the center is the dense, **metallic inner core.** How do scientists know this? Rocks yield clues, but geologists can only see the outermost rocky layer. Rarely, a rock or mineral, like a diamond, may come to the surface from deeper down in the crust or the mantle. Mostly, though, Earth scientists must use other clues to figure out what lies beneath the planet's surface.

One way scientists learn about Earth's interior is by looking at **seismic waves** (below). Seismic waves travel outward in all directions from where the ground breaks at an earthquake. There are several types of seismic waves, each with different properties. Each type of wave moves at different speeds through different types of material and the waves bend when they travel from one type of material to another. Some types of waves do not travel through liquids or gases and some do. So scientists can track how seismic waves behave as they travel through Earth and can use the information to understand what makes up the planet's interior. Much more about earthquakes and seismic waves will be discussed in our upcoming lesson on Earthquakes.



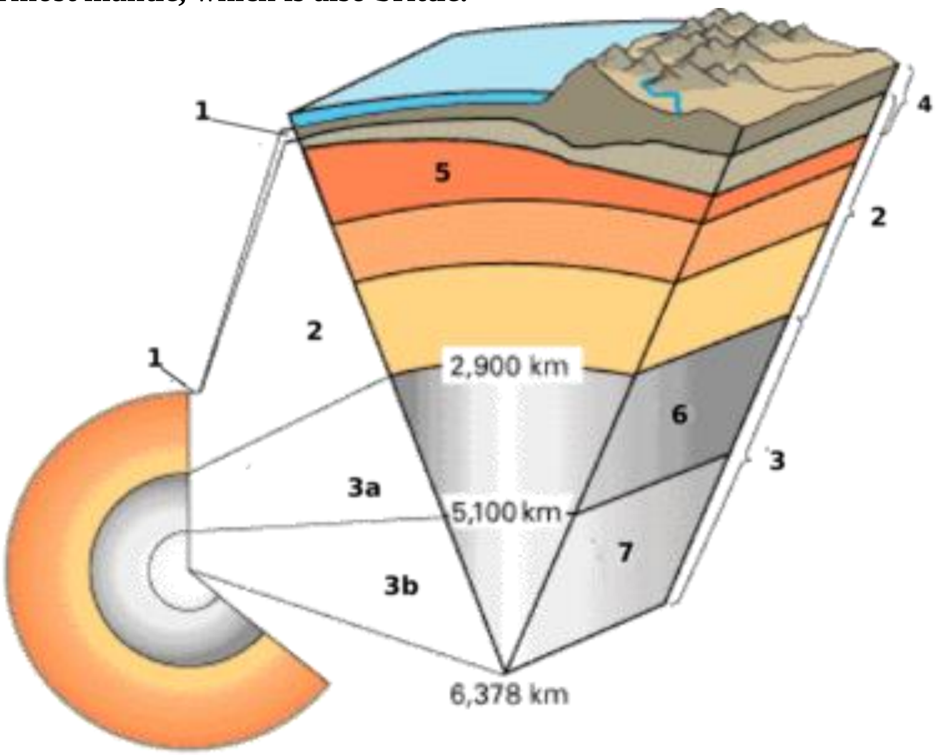
Different types of seismic waves bend or even disappear as they travel encounter the different properties of the layers that make up Earth's interior. Letters describe the path of an individual P wave or S wave.

Scientists also learn about Earth's interior from rocks from outer space. **Meteorites** are the remains of the material that the early solar system formed from. Some iron and nickel meteorites are thought to be very similar to Earth's core (below). For this reason they give scientists clues as to the core's makeup and density. An iron meteorite is the closest thing to a sample of the core that scientists can hold in their hands!



Crust and Lithosphere

Of course, scientists know the most about Earth's outermost layer and less and less about layers that are found deeper in the planet's interior (below). **Earth's outer surface is its crust**; a thin, brittle outer shell made of rock. Geologists call the outermost, brittle, mechanical layer the lithosphere. **The difference between crust and lithosphere is that lithosphere includes the uppermost mantle, which is also brittle.**



A cross section of Earth showing the following layers: (1) crust (2) mantle (3a) outer core (3b) inner core (4) lithosphere (5) asthenosphere (6) outer core (7) inner core. The lithosphere is made of the crust plus the uppermost part of the mantle. The asthenosphere is directly under the lithosphere and is part of the upper mantle.

The crust is the very thin, outermost solid layer of the Earth. The crust varies tremendously; from thinner areas under the oceans to much thicker areas that make mountains. Just by looking around and thinking of the places you've been or seen photos of, you can guess that the crust is not all the same. Geologists make an important distinction between two very different types of crust: oceanic crust and continental crust. Each type has its own distinctive physical and chemical properties. This is one of the reasons that there are ocean basins and continents.

Oceanic crust is relatively thin, between 5 to 12 kilometers thick (3 to 8 miles). This crust is made of basalt lavas that erupt onto the seafloor. Beneath the basalt is gabbro, an igneous intrusive rock that comes from basalt magma but that cools more slowly and develops larger crystals. The basalt and gabbro of the oceanic crust are dense (3.0 g/cm3) when compared to the average of the rocks that make up the continents. Sediments cover much of the oceanic crust, primarily rock dust and the shells of microscopic sea creatures, called plankton. Near shore, the seafloor is thick with sediments that come off the continents in rivers and on wind currents.

Continental crust is much thicker than oceanic crust, around 35 kilometers (22 miles) thick on average. Continental crust is made up of many different rocks of all three major types: igneous, metamorphic, and sedimentary. The average composition of continental crust is about that of granite. Granite is much less dense (2.7 g/cm3) than the basalt and gabbro of the oceanic crust.

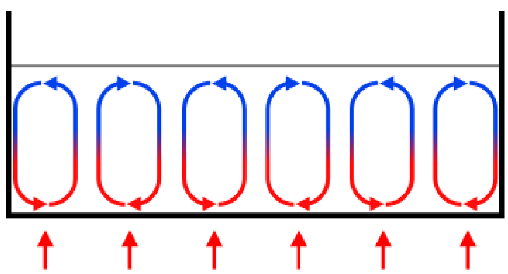
Because it is thick and has relatively low density, continental crust rises higher above the mantle than oceanic crust, which sinks into the mantle to form basins. When filled with water these basins form the planet's oceans.

Since it is a combination of the crust and uppermost mantle, the lithosphere is thicker than the crust. Oceanic lithosphere is about 100 kilometers (62 miles) thick. Continental lithosphere is about 250 kilometers (155 miles) thick.

Mantle

Beneath the crust lies the mantle. Like the crust, the **mantle is made of rock**. The mantle is differentiated from the crust by an increase in rock density as indicated by a sudden increase in seismic wave velocities. One very important feature of the mantle is that it is **extremely hot.** Although the higher temperatures far exceed the melting points of the mantle rocks at the surface the mantle is almost exclusively solid. The heat in the mantle is mainly due to heat rising from the core. Through the process of **conduction**, heat flows from warmer objects to cooler objects until all are the same temperature. Knowing the ways that heat flows is important for understanding how the mantle behaves. So here, we return to our old friend **convection.**

Heat can flow in two ways within the Earth. If the material is solid, heat flows by conduction, and heat is transferred through the rapid collision among atoms. If a material is fluid and able to move—that is, it is a gas, liquid, or a solid that can move (like toothpaste)—heat can also flow by **convection**. In convection, currents form so that warm material rises and cool material sinks. This sets up a **convection cell** (below).



In a convection cell, warm material rises and cool material sinks. In mantle convection, the heat source is Earth's core.

Remember: **Convection** occurs when a pot of water is heated on a stove. The stove heats the bottom layer of the water, which makes it less dense than the water above it, so the warmer bottom water rises. Since the layer of water on the top of the pot is not near the heat source, it is relatively cool. As a result, it is denser than the water beneath it and so it sinks. Within the pot, convection cells become well established as long as there is more heat at the bottom of the pot than on the top. Convection cells also explain the global wind patterns and the development of thunderstorms, as we recently studied.

Convection cells are also found in the mantle. Mantle material is heated by the core and so it rises upwards. When it reaches the surface of the Earth, it moves horizontally. As the material moves away from the core's heat, it cools. Eventually the mantle material at the top of the convection cell becomes cool and dense enough that it sinks back down into the deeper mantle. When it reaches the bottom of the mantle, it travels horizontally just above the core. Then it reaches the location where warm mantle material is rising, and the mantle convection cell is complete.

Core

At the planet's center lies a dense metallic **core**. Scientists know that the core is metal for two reasons: The first is that some meteorites are metallic and they are thought to be representative of the core. The second is that the **density** of Earth's surface layers is much less than the overall density of the planet. We can calculate Earth's density using our planet's rotation. If the surface layers are less dense than the average for the planet, then the interior must be denser than the average. Calculations indicate that the core is about 85% iron metal with nickel metal making up much of the rest. These proportions agree with those seen in metallic meteorites. Seismic waves indicate that the outer core must be liquid and the inner core must be solid.

If Earth's core were not metallic, the planet would not have a magnetic field. Metal conducts electricity, but rock—which makes up the mantle and crust—does not. The best conductors are metals that can move, so scientists assume that the magnetic field is due to convection in the liquid outer core. These convection currents form in the outer core because the base of the outer core is heated by the even hotter inner core.

Key Terms

convection cell

A circular pattern created by the rising of less dense warm material and the sinking of more dense cool material.

core

The dense metallic center of Earth. The outer core is liquid and the inner core is solid.

crust

The rocky outer layer of Earth's surface. The two types of crust are continental and oceanic.

lithosphere

The layer of solid, brittle rock that makes up the Earth's surface. The lithosphere is composed of the crust and the uppermost mantle.

mantle

The middle layer of Earth, between the crust and the core. The mantle is made of hot rock that circulates by convection.

plate tectonics

The theory that Earth's surface is divided into lithospheric plates that move on the planet's surface. The driving force behind plate tectonics is mantle convection.

seismic waves

Also called earthquake waves. Seismic waves give scientists information on Earth's interior.

Review Questions

1. What types of rock make up the oceanic crust?

2. What types of rock make up the continental crust?

3. List two reasons that scientists know that the outer core is liquid.

<u>Lesson 2: Tuesday, April 21</u>

Continental Drift

An important piece of plate tectonic theory is the **continental drift** idea. This was developed in the early part of the 20th century, mostly by a single scientist, **Alfred Wegener**. His hypothesis states that continents move around on Earth's surface and that they were once joined together as a single supercontinent (below). Wegener's idea eventually helped to form the theory of plate tectonics, but while Wegener was alive, scientists did not believe that the continents could move.

The continents fit together like pieces of a puzzle. This is how they looked 250 million years ago.

Look at the map below and imagine that each continent is actually a piece in a jigsaw puzzle. Can you fit the pieces together? (hint: look at South America and Africa in particular).

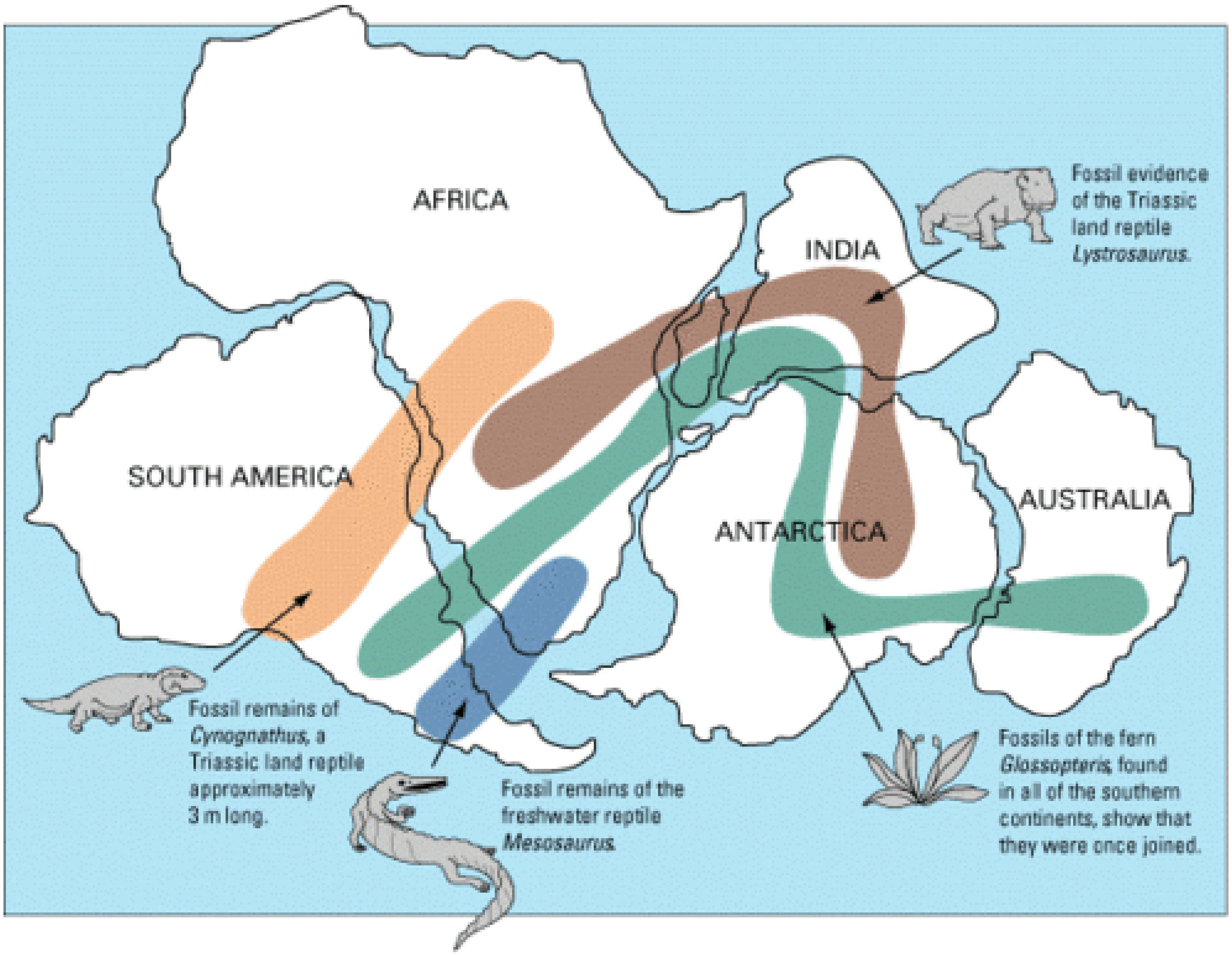
Wegener proposed that the continents were not stationary but that they had moved during the planet's history. He suggested that at one time, all of the continents had been united into a single super continent. He named the super continent **Pangaea**, meaning 'entire earth' in ancient Greek. Wegener further suggested that Pangaea broke up long ago and that the continents then moved to their current positions. He called his hypothesis **continental drift**.

Evidence for Continental Drift

Besides the fit of the continents, Wegener and his supporters collected a great deal of evidence for the continental drift hypothesis. Wegener found that this evidence was best explained if the continents had at one time been joined together.

Wegener discovered that **identical rocks could be found on both sides of the Atlantic Ocean.** These rocks were the same type and the same age. Wegener understood that the rocks had formed side-by-side and that the land has since moved apart. Wegener also matched up mountain ranges that had the same rock types, structure and ages, but they are now on opposite sides of the Atlantic Ocean. The Appalachians of the eastern United States and Canada, for example, are just like mountain ranges in eastern Greenland, Ireland, Great Britain, and Norway. Wegener concluded that they formed as a single mountain range that was separated as the continents drifted.

Wegener also found evidence from **fossils (**the remains or impression of a prehistoric organism preserved in rock). He found fossils of the same species of extinct plants and animals in rocks of the same age, **but on continents that are now widely separated**. Wegener suggested that the continents could not have been in their current positions because the organisms would not have been able to travel across the oceans. For example, fossils of the seed fern *Glossopteris* are found across all of the southern continents. But the plants' seeds were too heavy to be carried across the ocean by wind. *Mesosaurus* fossils are found in South America and South Africa, but the reptile could only swim in fresh water. *Cynognathus* and *Lystrosaurus* were reptiles that lived on land. **Both of these animals were unable to swim, let alone swim across wide seas!** Their fossils have been found across South America, Africa, India and Antarctica. **Wegener proposed that the organisms had lived side by side, but that the lands had moved apart after they were dead and fossilized.**



Wegener used fossil evidence to support his continental drift hypothesis. The fossils of these organisms are found on lands that are now far apart. Wegener suggested that when the organisms were alive, the lands were joined, and the organisms were living side-by-side.

Although Wegener's evidence was correct, most geologists at the time **rejected** his hypothesis of continental drift**. These scientists argued that there was no way to explain *how* solid continents could plow through solid oceanic crust**. At the time, scientists did not understand how solid material could move. Wegener's idea was nearly forgotten until technological advances presented puzzling new information and gave scientists the tools to develop a mechanism for Wegener's drifting continents.

Review Questions

1. How can the locations where ancient fossils are found be used as evidence for continental drift?

2. In the face of so much evidence in support of continental drift, how could scientists reject the idea?

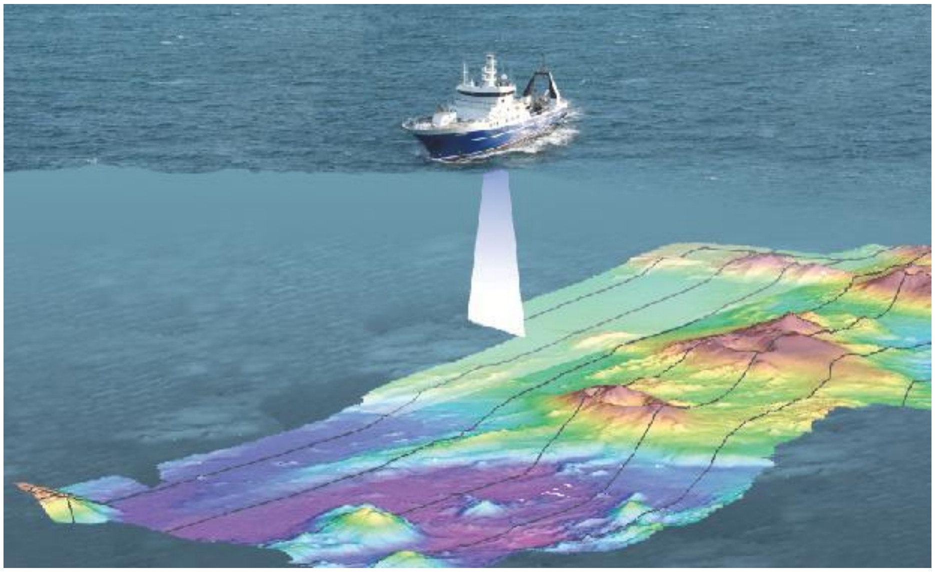
Lesson 3: Wednesday, April 22

Seafloor Spreading

It was actually World War II that gave scientists the tools they needed to find the **mechanism** for continental drift that had eluded Wegener and his colleagues. Scientists used maps and other data gathered during the war to develop the **seafloor spreading hypothesis**. This hypothesis traces oceanic crust from its **origin at a mid-ocean ridge** to **its destruction at a deep sea trench.** Scientists realized that seafloor spreading could be the mechanism for continental drift that they had been looking for.

Seafloor Bathymetry

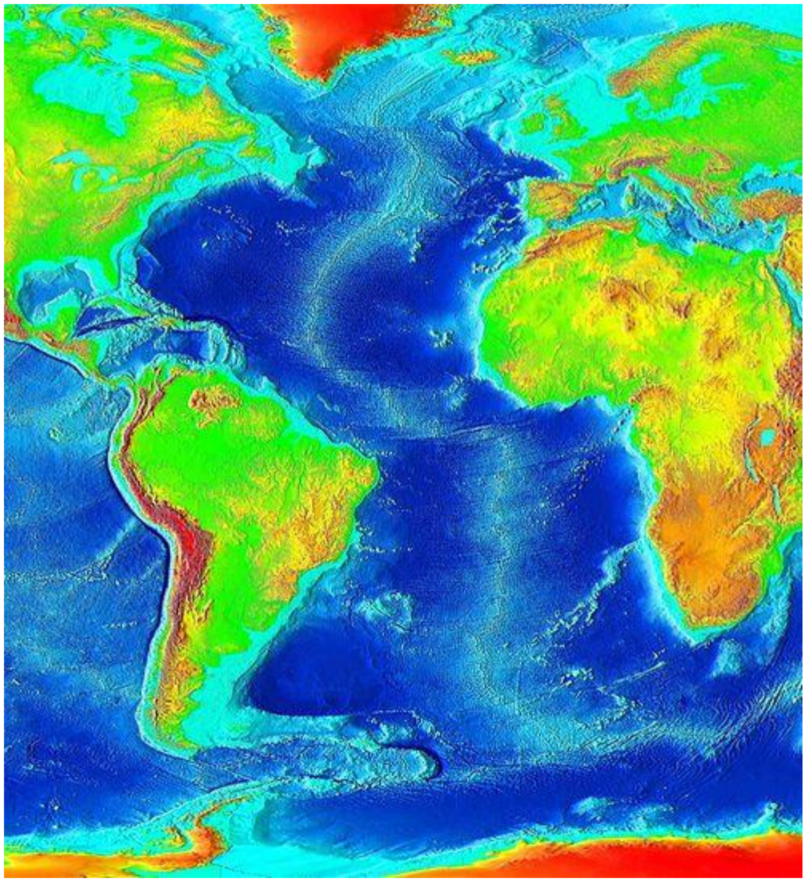
During the war, warships carried **sonar** to locate enemy submarines. Sonar is a system designed to find objects under water and for to measure how far away they are by emitting sound pulses and detecting or measuring their return after being reflected. In other words, sonar uses echoes. Sonar devices produce sound waves that travel outward in all directions, bounce off the nearest object, and then return to the ship. The round-trip time of the sound wave is then recorded. By knowing the speed of sound in seawater, scientists can calculate the distance to the object that the sound wave hit. During the war, the sound waves rarely encountered an enemy submarine, and so most of the sound waves ricocheted off the ocean bottom.



A ship sends out sound waves to create a picture of the seafloor below it.

After the war, scientists pieced together the bottom depths to produce **a map of the seafloor**. This is known as a **bathymetric map** and is similar to a topographic map of the land surface. Bathymetric maps reveal the features of the ocean floor as if the water were taken away.

The bathymetric maps that were produced at this time astonished scientists. Most had thought that the ocean floor was completely flat but the maps showed something completely different. As we know now, majestic mountain ranges extend in a line through the deep oceans. Amazingly, the mountain ranges are connected as if they were the seams on a baseball. These mountain ranges are named mid-ocean ridges. The **mid-ocean ridges** and the areas around them rise up high above the deep seafloor (below).



A modern bathymetric map of the Atlantic Ocean. Darker blue indicates deeper seas. A mid-ocean ridge can be seen running through the center of the Atlantic Ocean.

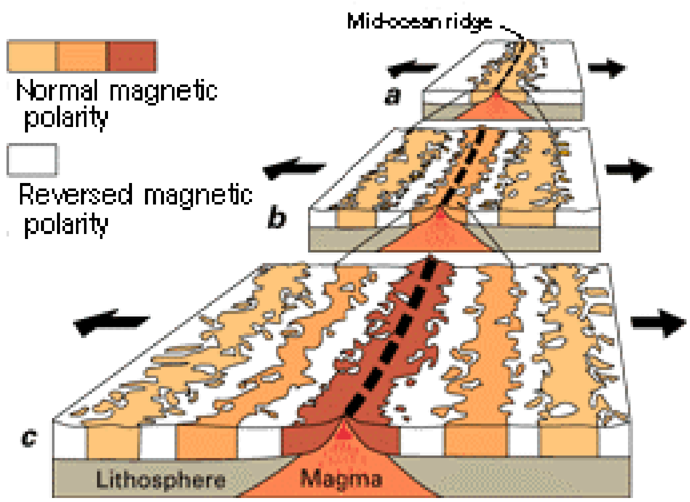
Another astonishing feature is the deep sea trenches that are found at the edges of continental margins or in the sea near chains of active volcanoes. **Trenches are the deepest places on Earth.** The deepest trench is the **Marianas Trench** in the southwestern Pacific Ocean, which plunges about 11 kilometers (35,840 feet) beneath sea level

Besides these dramatic features, there are lots of flat areas, called **abyssal plains**, just as the scientists had predicted. But many of these plains are dotted with volcanic mountains. These mountains are both large and small, pointy and flat-topped, by themselves as well as in a line. When they first observed the maps, the amazing differences made scientists wonder what had formed these features.

Seafloor Magnetism

In addition to sonar, another wartime device used to hunt submarines led to new discoveries about the ocean floor. **Magnetometers** (devices that measure magnetism) that were attached to ships to search for submarines discovered a lot about the magnetic properties of the seafloor.

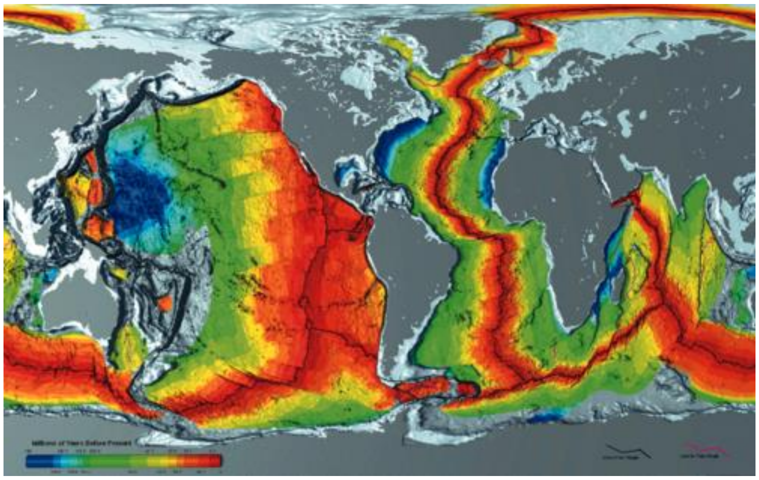
In fact, using magnetometers, scientists discovered an astonishing feature of Earth's magnetic field. Sometimes, no one really knows why, the magnetic poles switch positions. North becomes south and south becomes north! When the north and south poles are aligned as they are now, geologists say the polarity is normal. When they are in the opposite position, they say that the polarity is reversed.



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.

Scientists were surprised to discover that the normal and reversed magnetic polarity of rocks on the seafloor creates a pattern of magnetic stripes! There is one long stripe with normal polarity, next to one long stripe with reversed polarity and so on across the ocean bottom. Another amazing feature is that the stripes form mirror images on either side of the mid-ocean ridges. The ridge crest is of normal polarity and there are two stripes of reversed polarity of roughly equal width on each side of the ridge. Further distant are roughly equal stripes of normal polarity, beyond that, roughly equal stripes of reversed polarity, and so on. The magnetic polarity maps also show that the magnetic stripes end abruptly at the edges of continents, which are sometimes lined by a deep sea trench (above).

So what does this all mean for seafloor spreading? Though the science behind the discovery of these magnetic variations is very complex, the conclusion is straightforward. **Rocks close to the mid ocean ridge are younger than rocks further away from it.**



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.

The scientists also discovered that the seafloor was thinner at the ridge axis and grew thicker as the crust became older. This is because over time, additional magma cools to form rock. The added sediments also increase the thickness of the older crust.

The Seafloor Spreading Hypothesis

Scientists brought all of these observations together in the early 1960s to create the **seafloor spreading hypothesis**. They suggested that hot mantle material rises up toward the surface at mid-ocean ridges. This hot material is buoyant and causes the ridge to rise, which is one reason that mid-ocean ridges are higher than the rest of the seafloor.

The hot magma at the ridge erupts as lava that forms new seafloor. When the lava cools, its magnetite crystals take on the current magnetic polarity. The polarity is locked in when the lava solidifies and the magnetite crystals are trapped in position. Reversals show up as magnetic stripes on opposite sides of the ridge axis. As more lava erupts, it pushes the seafloor that is at the ridge horizontally away from ridge axis. This continues as the formation of new seafloor forces older seafloor to move horizontally away from the ridge axis.

It is the creation and destruction of oceanic crust, then, that is the mechanism for Wegener's drifting continents. Rather than drifting across the oceans, the continents ride on a conveyor belt of oceanic crust that takes them around the planet's surface.

One of the fundamental lines of evidence for continental drift is the way the coastlines of continents on both sides of the Atlantic Ocean fit together. So let's look at how seafloor spreading moves continents in the Atlantic by looking more closely at the image above. New oceanic crust is forming at the mid-ocean ridge that runs through the center of the Atlantic Ocean basins, which is called the Mid-Atlantic Ridge. Stripes of different magnetic polarity are found on opposite sides of the Mid-Atlantic Ridge. These stripes go all the way to the continents, which lie on opposite sides of the Atlantic. **So new seafloor forming at the Mid-Atlantic Ridge is causing the Americas and Eurasia to move in opposite directions!**

Key terms

abyssal plains
Very flat areas that make up most of the ocean floor.
bathymetric map
A map of the seafloor created from the measurement of water depths.
Sonar
A device that uses sound waves to measure the depth to the seafloor.
mid-ocean ridge
The location on the seafloor where magma upwells and new seafloor forms. Mid-ocean ridges are the dominant feature of divergent plate boundaries found in the oceans.
seafloor spreading
The mechanism for moving continents. The formation of new seafloor at spreading ridges pushes lithospheric plates on the Earth's surface.
trench
A deep hole in the seafloor where subduction takes place. Trenches are the deepest places on Earth.

Review Questions

1. Describe how sound waves are used to develop a map of the features of the seafloor.

2. Describe why continents move across the ocean basins as if they are on a conveyor belt rather than as if they are drifting, as was Wegener's original idea.

Lesson 4: Thursday, April 23

Plate Tectonics, continued.

Wegener's continental drift hypothesis had a great deal of evidence in its favor but it was largely abandoned because his theory did not explain *how* the continents moved. When seafloor spreading came along, scientists recognized that the mechanism to explain drifting continents had been found. Like the scientists did before us, we are now ready to merge the ideas of continental drift and seafloor spreading into a new all-encompassing idea: the **theory of plate tectonics.**

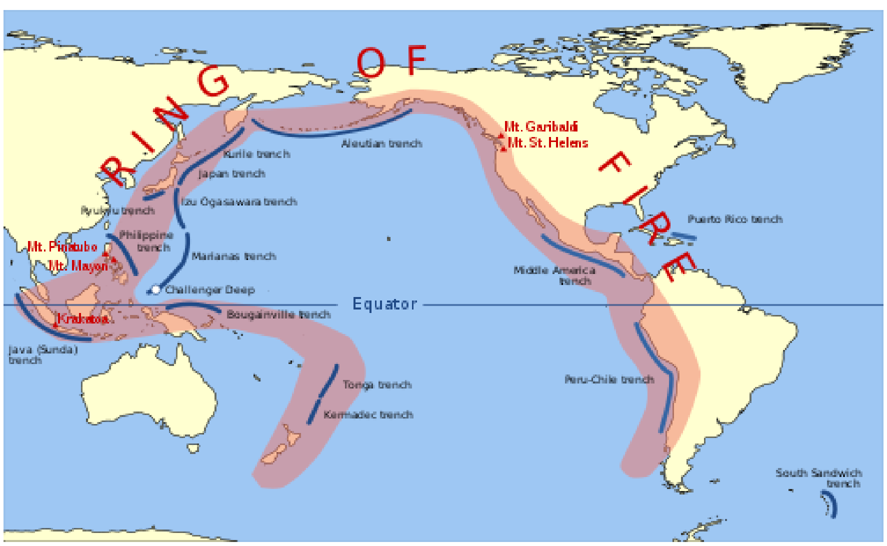
Earth's Tectonic Plates

Now you know that seafloor and continents move around on Earth's surface. But what is it that is actually moving? In other words, what is the "plate" in plate tectonics? This question was also answered due to war, in this case the Cold War.

Although seismographs had been around for decades, during the 1950s and especially in the early 1960s, scientists set up seismograph networks to see if enemy nations were testing atomic bombs. Seismographs record seismic waves. Modern seismographs are sensitive enough to detect nuclear explosions.

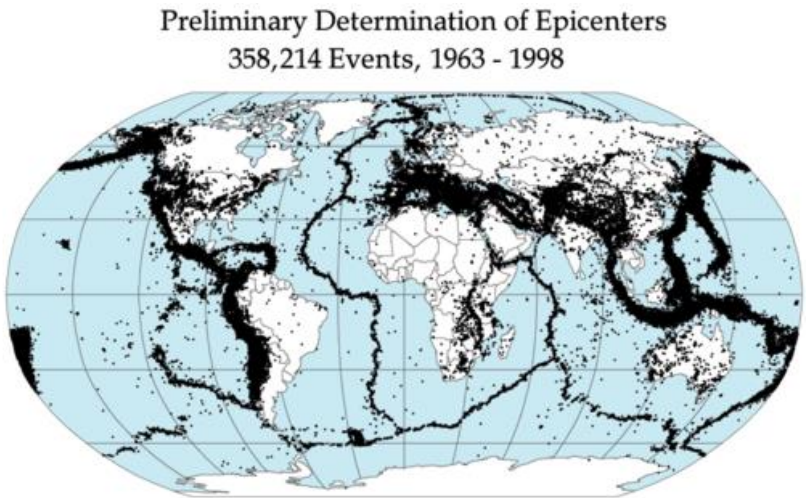
While watching for enemy atom bomb tests, the seismographs were also recording all of the earthquakes that were taking place around the planet. These seismic records could be used to locate an earthquake's **epicenter**, the point on Earth's surface directly above the place where the earthquake occurs. Earthquakes are associated with large cracks in the ground, known as **faults**. Rocks on opposite sides of a fault move in opposite directions.

Earthquakes are not spread evenly around the planet, but are found mostly in certain regions. In the oceans, earthquakes are found along mid-ocean ridges and in and around deep sea trenches. Earthquakes are extremely common all around the Pacific Ocean basin and often occur near volcanoes. The intensity of earthquakes and volcanic eruptions around the Pacific led scientists to name this region the Pacific Ring of Fire (below). Earthquakes are also common in the world's highest mountains, the Himalaya Mountains of Asia, and across the Mediterranean region.



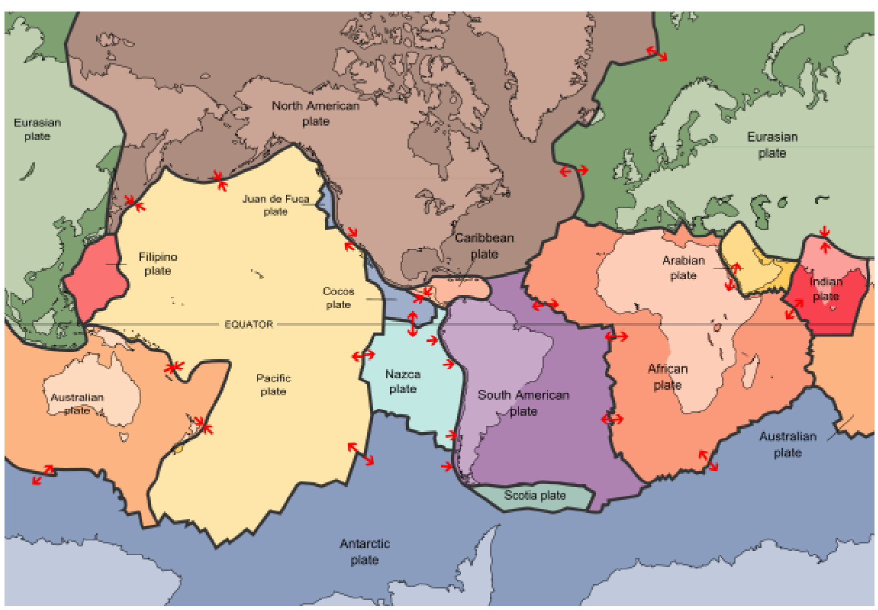
The pink swatch outlines the volcanoes and active earthquake areas found around the Pacific Ocean basin, which is called the Pacific Ring of Fire.

Scientists noticed that the earthquake epicenters were located along the mid-ocean ridges, trenches and large faults that mark the edges of large slabs of Earth's lithosphere. They named these large slabs of lithosphere **plates**. The movements of the plates were then termed plate tectonics. A single plate can be made of all oceanic lithosphere or all continental lithosphere, but nearly all plates are made of a combination of both.



A map of earthquake epicenters shows that earthquakes are found primarily in lines that run up the edges of some continents, through the centers of some oceans, and in patches in some land areas. Each dot represents one earthquake.

The lithosphere is divided into a dozen major and several minor plates. The plates' edges can be drawn by connecting the dots that are earthquake epicenters. Scientists have named each of the plates and have determined the direction that each is moving (below). Plates move around the Earth's surface at a rate of a few centimeters a year, about the same rate fingernails grow.



The lithospheric plates and their names. The arrows show whether the plates are moving apart, moving together, or sliding past each other.

How Plates Move

We know that seafloor spreading moves the lithospheric plates around on Earth's surface but what drives seafloor spreading? The answer is a familiar one: **mantle convection**. At this point it would help to think of a convection cell as a rectangle or oval. Each side of the rectangle is a limb of the cell. The convection cell is located in the mantle. The base is deep in the mantle and the top is near the crust. There is a limb of mantle material moving on one side of the rectangle, one limb moving horizontally across the top of the rectangle, one limb moving downward on the other side of the rectangle, and the final limb moving horizontally to where the material begins to move upward again.

Now picture two convection cells side-by-side in the mantle. The rising limbs of material from the two adjacent cells reach the base of the crust at the mid-ocean ridge. Some of the hot magma crystallizes and creates new ocean crust. This seafloor moves off the axis of the mid-ocean ridge in both directions when still newer seafloor erupts. The oceanic plate moves outward due to the eruption of new oceanic crust at the mid-ocean ridge.

Beneath the moving crust is the laterally moving top limb of the mantle convection cells. Each convection cell is moving seafloor away from the ridge in opposite directions. This horizontal mantle flow moves with the crust across the ocean basin and away from the ridge. As the material moves horizontally, the seafloor thickens and both the new crust and the mantle beneath it cool. Where the limbs of the convection cells plunge down into the deeper mantle, oceanic crust is dragged into the mantle as well. This takes place at the deep sea trenches. As the crust dives into the mantle its weight drags along the rest of the plate and pulls it downward. The last limbs of the convection cells flow along the core. The material is heated and so is ready to rise again when it reaches the rising limb of the convection cell. As you can see, each convection cell is found beneath a different lithospheric plate and is responsible for the movement of that plate.

Another example: Imagine two sponges floating in a pot of water. If the water is still, the sponges will stay still as well. Now imagine you start heating the water. As the water heats, it becomes turbulent and unstable, even before it starts to boil. This is because the heat is causing **convection**. Heat makes the water at the bottom of the pot near the fire start to rise, while the cooler water near the surface will sink. This motion in the water will cause the sponges to start to move as well. Think of tectonic plates as these sponges. Rock in the mantle, heated by the earth’s core, is like the water heated by the fire below the pot. The rock slowly but surely rises from the heat, then cools off near the surface causing it to sink. Because of this, the continents on top of all that rock move! This is how **plate tectonics** are caused by **mantle convection**

Plate Boundaries

Back at the planet's surface, the edges where two plates meet are known as **plate boundaries**. Most geologic activity, including volcanoes, earthquakes, and mountain building, takes place at plate boundaries where two enormous pieces of solid lithosphere interact.

Think about two cars moving around a parking lot. In what three ways can those cars move relative to each other? They can move away from each other, they can move toward each other, or they can slide past each other. These three types of relative motion also define the three types of plate boundaries:

- **Divergent plate boundaries**: the two plates move away from each other.
- **Convergent plate boundaries**: the two plates move towards each other.
- **Transform plate boundaries**: the two plates slip past each other.

We will discuss the different types of plate boundaries in greater depth an upcoming lesson.

Key Terms:

epicenter
: The point on the Earth's surface directly above an earthquake's focus, which is the place where the ground breaks.

fault
: A fracture along which there has been movement of rock on one or both sides.

plate
: A slab of the earth's lithosphere that can move around on the planet's surface.

plate boundary
: A location where two plates come together.

plate tectonics
: The theory that the Earth's surface is divided into lithospheric plates that move on the planet's surface. The driving force behind plate tectonics is mantle convection.

Minor Assessment:

The process of convection has been behind many of the phenomena we have studied this year, from global wind patterns to local sea and land breezes to the formation of thunderstorms and now to the movement of the continents themselves. What is convection, and how, in particular, does it impact geology? (4-6 sentences)