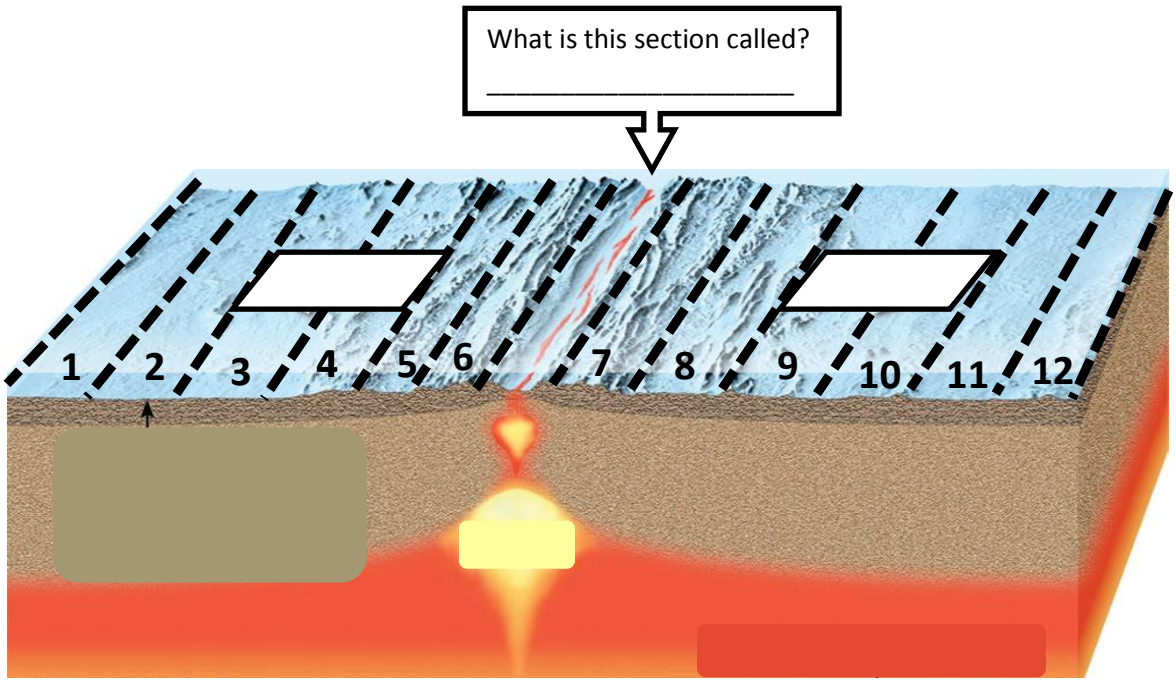
Station 1: Age of ocean floor

Seafloor spreading is a process of plate tectonics. New oceanic crust is created as large slabs of the Earth's crust split apart from each other and magma moves up to fill the gap. The large slabs of rock that make up the Earth's crust are called *tectonic plates*. As they slowly move away from each other beneath the ocean floor, hot magma from the Earth's mantle bubbles to the surface. This magma is then cooled by seawater. The new rock forms a new part of the Earth's crust. Seafloor spreading occurs along mid-ocean ridges, which are large mountain ranges rising above the ocean floor. The newest oceanic crust is located near the center of the ridge, the actual site of seafloor spreading. The Mid-Atlantic Ridge, which separates the North American plate from the Eurasian plate, and the South American plate from the African plate, is the site of new oceanic crust in the middle of the Atlantic Ocean. Over time, new oceanic crust pushes older crust farther away. New bodies of water and even continents can be created through seafloor spreading. The Red Sea, for example, was created through seafloor spreading, as the African plate and the Arabian plate tear away from each other. Today, the northern Sinai Peninsula connects the Middle East (Asia) with North Africa. Eventually, geologists predict, seafloor spreading will expand the Red Sea so that it will completely separate the two continents.

Questions:

1. Explain why the youngest/newest ocean floor rocks are found at the center of the ridge?
2. What type of rock forms at the mid-ocean ridges? _____
3. On the diagram below, draw arrows in the boxes to show the direction the plates are moving.
4. The ocean floor rock is divided into numbered sections. Which two sections are youngest? Which are oldest?
   Youngest layers: _____ Oldest layers: _____
5. What sections are the same ages as layer 9? _____ layer 11? _____



Credits

Dunn, Margery. "Exploring Your World: The Adventure of Geography" . 1993. Web. 9 February 2014. http://education.nationalgeographic.com/education/encyclopedia/seafloor-spreading/?ar_a=1

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Station 2: Historical Importance of Sea Floor Spreading

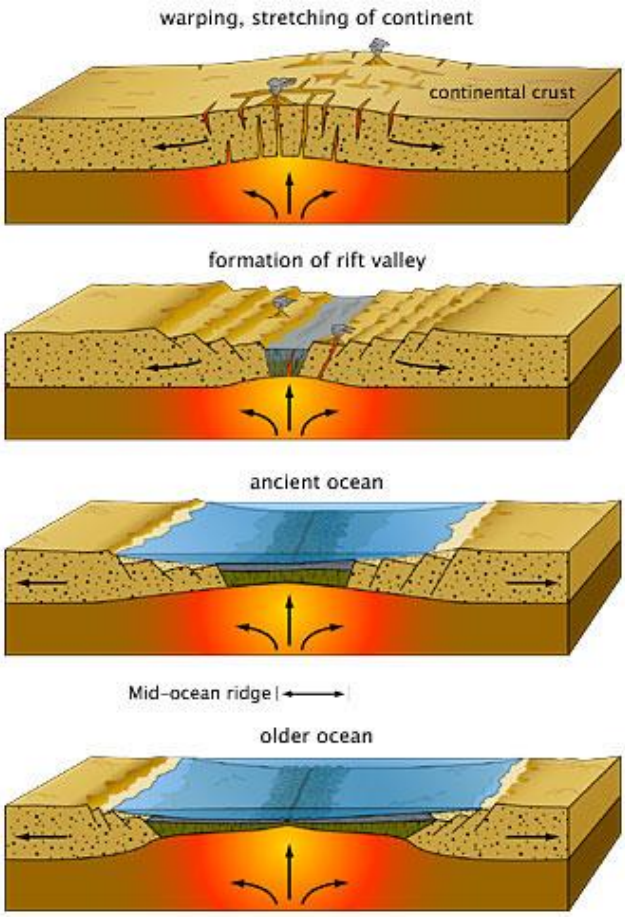
In the early 1900's, a German meteorologist Alfred Wegener proposed the Theory of Continental Drift. His theory was not widely accepted by the scientific community because in large part, Wegener could explain how the plates moved. He thought the continents "plowed" through the oceans. Alfred Wegner died in 1930 with his life's work being unaccepted as an accurate explanation of Earth's changing surface. In the 1950's, mapping of the ocean floor increased dramatically due to the end of World War II. Large underwater mountain ranges were discovered in the middle of the Atlantic Ocean and also in the Southern Pacific Ocean. After further investigations of these areas, scientist realized that the ocean floor was splitting in half and each half including the continents were moving away from the other. They called it Sea-Floor Spreading and it explained how Pangaea broke apart and that the continents were moving like Alfred Wegener described. The Theory of Continental Drift and the sea floor spreading discovery together formed the most important geologic theory called the Theory of Plate Tectonics.

Questions:

1. Explain how sea-floor spreading gave Alfred Wegener's theory of Continental Drift credibility and acceptance from the scientific community?

2. Is the Atlantic Ocean getting bigger or smaller? Explain how you know.

3. Why do you think the Theory of Plate Tectonics is called the most important geologic theory?



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Station 3: Mechanism for plate movement:

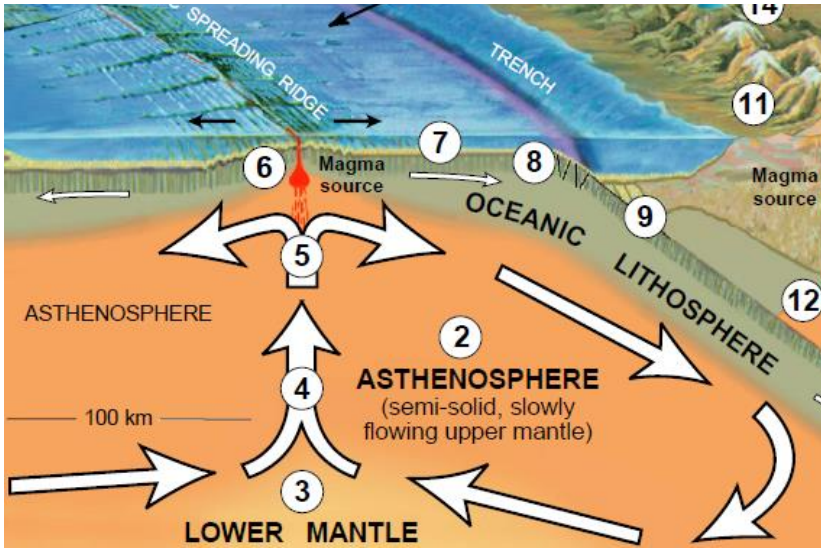
The Theory of Plate Tectonics states that the Earth's outermost layer is fragmented into a dozen or more large and small solid slabs, called *lithospheric plates or tectonic plates*, that are moving relative to one another as they ride atop hotter, slowly moving mantle material (called the asthenosphere). The average rates of motion of these plates ranges from less than 1 to more than 15 centimeters per year. With some notable exceptions, nearly all the world's earthquake and volcanic activity occur along or near boundaries between plates.

How do the plates move?

The following numbered statements correspond to the numbered locations on the diagram below. So as you read each statement, look at the image consider the information.

3. Deep within the asthenosphere the pressure and temperature are so high that the rock can soften and partly melt. The softened but dense rock can flow very slowly (think of Silly Putty) over time. Some areas of the core/mantle boundary will get hotter than others and cause slowly moving *convection currents* to form within the semi-solid asthenosphere.

4. The convection currents form as some areas of the asthenosphere get hotter and less dense. The less dense material rises because it's surrounded by more dense material. As they rise and approach the surface, convection currents diverge at the base of the lithosphere.



5. The diverging currents exert a weak tension or "pull" on the solid plate above it. Tension and high heat flow weakens the floating, solid plate, causing it to break apart. The two sides of the now-split plate then move away from each other, forming a DIVERGENT PLATE BOUNDARY.

Questions:

1. What are the two names for the plates?
2. Do they all move the same speed?
3. In YOUR words, explain what causes the plates to move? Write complete sentences and include words like density, convection and heat.

Credits

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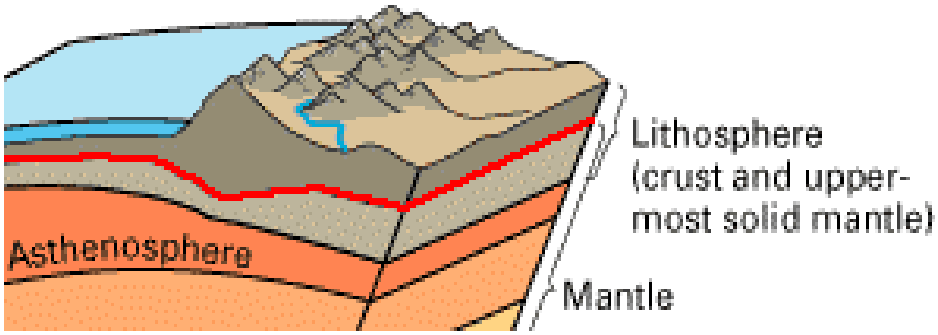
Station 4: Internal Geologic Structure of Plate Tectonics

The following numbered statements correspond to the numbered locations on the diagram below. So as you read each statement, look at the image and consider the information.

1. There are two basic types of *lithospheric plates*: *continental and oceanic*. Continental lithosphere has a lower density because it is made of mostly of *granite*. Oceanic lithosphere is more dense than continental lithosphere because it is composed of mostly of *basalt*. A plate may be made up entirely of oceanic or continental lithosphere, but most plates have both oceanic and continental.

2. Beneath the lithospheric plates lies the *asthenosphere*, a layer of the mantle composed of more dense semi-solid rock. Because the plates are less dense than the asthenosphere beneath them, they are floating on top of the asthenosphere.

3. Between the crust and the mantle, the *Mohorovicic Discontinuity, or "Moho",* is the boundary between the crust and the mantle. The red line in the drawing at right shows its location. The Moho was discovered in 1909 by Andrija Mohorovicic , a Croatian seismologist. He realized that the velocity of a seismic wave is directly related to the density of the material that it is moving through. Mohorovicic discovered that seismic waves accelerated abruptly at certain depths Below the Moho. He inferred that the density of the Earth material must be significantly higher below the Moho and therefore it represents a different layer.



Questions:

1. On your answer sheet, label each layer where it's appropriate.
2. Complete the chart on your answer sheet.
3. If the Asthenosphere is "almost" liquid, how can the solid rock plates float on it without sinking?
4. What is the boundary called between the Mantle and Crust and how was it discovered? You should write multiple sentences in response.

Credits

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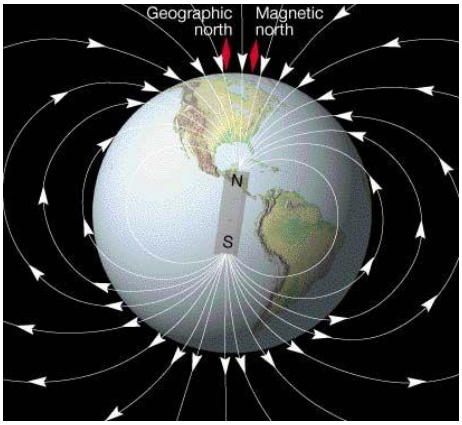
Station 5: Magnetic Polarity of the Sea Floor

At certain locations in the world, the ocean floor is splitting apart because it's made of two different plates. As the plates slowly move away from each other, hot magma from the Earth's mantle bubbles to the surface. This magma is then cooled by seawater. The new rock forms a new part of the plate, so the plate gets bigger with time.



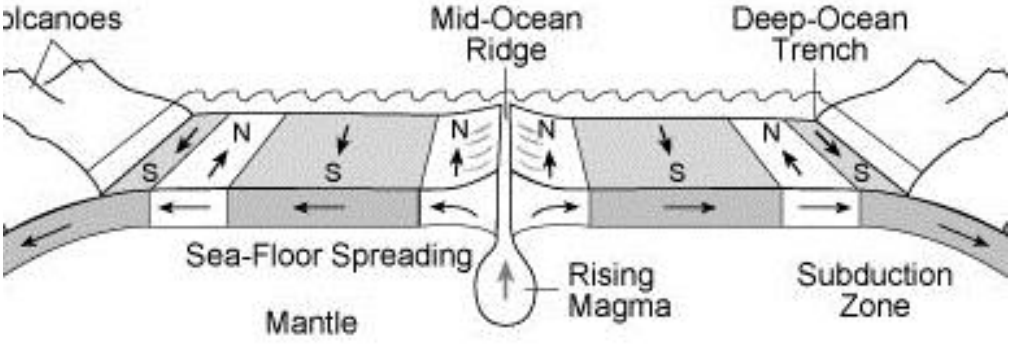
The magma has metallic elements in it like *iron* and while the material is liquid, the elements are floating around. Due to Earth's magnetic field (see diagram), the metallic elements will act like tiny magnets and point towards magnetic north (the North Pole). Once the material cools and hardens into solid rock, the metallic elements no longer can move and become a permanent record of where magnetic North was when the rocks formed.

The rocks at the spreading center (AKA mid-ocean ridge) are newly formed and therefore are the youngest. The rocks farther away from the mid-ocean ridge are older because as more magma comes up, it pushes the existing rock away from the ridge. Each section of ocean floor rock shows the magnetic position of Earth's magnetic field. Scientist were shocked to observe that the magnetism of the rocks wasn't always the same, which means Earth's magnetic field wasn't always in the same position. In fact, it has "flipped" completely many times in Earth's past.

Where Santa lives is called the North Pole or geographic North and that doesn't change. Presently, Earth's magnetic North is also geographic North, which is called ***normal polarity***. In the past, the magnetic North was aligned with geographic South, which is called ***reversed polarity***.

Normal polarity

Reversed polarity



Questions:

1. How does the age of the sea floor rock change as distance from the mid-ocean ridge increases?
2. According to the diagram above, rocks presently forming have what type of polarity?
3. Explain how rocks have magnetic polarity.
4. Explain what "reversed polarity" means?
5. Rocks that are equal distances from the mid-ocean ridge will be the same age. What can you conclude about their polarity?

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