Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Period\_\_\_\_

**NOTE OUTLINE: Chap 17 Plate Tectonics**

# Objectives

1. Describe early evidence that led people to suggest that Earth’s continents may have once been joined.
2. Discuss evidence of continental drift.
3. Explain why continental drift was not accepted when it was first proposed.
4. Explain the theory of plate tectonics.
5. Compare & contrast the 2 types of plate boundaries and the features, location, & direction of movement of each. (Features include: subduction, trenches, ridges, mountains, islands)
6. Explain the process of convection.
7. Summarize how convection in the mantle is related to the movements of tectonic plates.
8. Summarize the evidence that led to the discovery of seafloor spreading.
9. Explain the significance of magnetic patterns on the seafloor.
10. Explain the process, cause, features and evidence of seafloor spreading.

**Alfred Wegener**

* 1. Alfred Wegener proposed the theory of
	2. Continental Drift theory: continents were originally joined as a landmass called
		1. Wegener proposed that Pangaea began to break up 200 million years ago and began drifting apart
		2. The process is occurring.
	3. Wegener’s evidence for continental drift went beyond the “puzzle fit” the map-makers had seen. and includes:
	4.
	5.
	6.

**Wegner’s Evidence Continued**

* + 1. **Evidence from Rocks:** Similar rock types between:
			- mountains in & rocks in
			- &
		2. **Evidence from Fossils:**  Similar fossils & plants have been found on widely separated continents:
			- Continents must have once been joined & had a climate to grow the fern
			- Antarctica must have been closer to the to have a enough climate to grow the fern
		3. **Ancient Climactic Evidence**
			- deposits have been found in Antarctica
				* It forms from dead swamp plants. Swamps only occur in an area that is
				* This indicates that Antarctica was once , closer to the .
			- deposits in Africa, India, S. America, and Australia
				* This suggests that these areas were closer to the at one time
* **Problems with Wegener’s Continental Drift Theory**
	+ Problems caused it to be rejected in the early 1900’s because of these 2 “flaws”:
		- Wegener couldn’t explain what caused the caused the continents to
		- Wegener couldn’t explain how the continents could move without
			* Ideas about the ocean floor were wrong until the mid-1900s. Scientists thought the seafloor was flat, older then the continents and unchanging-ALL WRONG.

**Magma Meltdown Demonstration**

|  |
| --- |
| **Magma Meltdown:** |
| What do you see? | What is occurring inside the lava lamp? |
| Why is this happening? |

**Magma Meltdown Questions**

1. Which structure in the lava lamp is represented by radioactive elements giving off heat?
2. Explain why heated lava/magma becomes less dense?
3. If Earth’s plates are being moved around by magma, explain two possible interactions that could happen.

4. Write a paragraph, at least four sentences, to fully explain the motion inside the lava lamp. (Use the words: density (dense), convection current, rises, sinks, magma, heat(-ing/-ed), and cool(-ing/-ed) in your explanation).

**Convection**

* Convection is the **organized motion/movement** of large groups of molecules based on their relative \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Convection is also defined as the transfer of energy by \_\_\_\_\_\_\_\_\_\_\_\_\_ of a heated substance; the **transfer of heat energy through a liquid or a gas**
	1. Example: How does hot water move in a pan when you cook pasta noodles?
* Due to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of gases or liquids (**Part** of the liquid/gas is heated faster)

**Causes of Plate Motions**

**Convection**: The transfer of thermal energy by the movement of heated matter

* 1. Warms, , and becomes &
	2. material sinks due to gravity
	3. Forms a cycle or

**Earth’s Convection Process**

1. Magma closer to radioactive elements decaying in the core becomes heated, , becomes and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. As it rises towards the crust, it cools, , becomes , and \_\_\_\_\_\_\_\_\_\_\_.
3. Reheats and rises. This keeps repeating
4. This motion of magma leads to plate movements & produces Earthquakes and Volcanic Activity.

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**Theory of Plate Tectonics**

* Theory states that the Earth’s & rigid upper mantle are broken into enormous slabs called .
* Plates move in different directions and at different rates.
* = Where tectonic plates interact

**Plate Boundaries: 3 Main Types**

* 1. Divergent
	2. Convergent
	3. Transform (We will discuss this in more detail in a later chapter)
		+ 1. **Divergent Boundaries:** Plates move
		+ There are 2 subtypes of divergent boundaries, depending on their location:
	4. forms if the divergent boundary is \_\_\_\_\_\_\_\_\_\_\_
* Mid-Ocean Ridge is a with
* Causes the ocean basin to widen.



<http://geology.com/nsta/divergent-plate-boundaries.shtml>

* Ocean contain the mountain range on Earth
	+ occur along the ridges
1. forms if the divergent boundary is
* As the continent is torn farther and farther apart, the rift valley gets deeper and deeper.
* It may eventually fill with water and become an ocean
* Example Rift Valley Locations:



* **BOTH types of divergent** boundaries new crust
* Divergent boundaries ocean basins and earth’s surface
* Volcanoes and earthquakes are common along both rift valleys and mid-ocean ridges
* Explains why young rock is in the middle of the ocean and older rock near the continents.
1. **Convergent Boundaries:** Plates & move
2. *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ MAY* occur: One plate the other
	* + - crust material
			- Due to differences in density
			- May create deep-sea trenches, volcanoes & volcanic islands – depending on where the boundary is located

**There are three subtypes of Convergent Boundaries:**

1. **Oceanic-Oceanic Convergent** 

 <http://geology.com/nsta/convergent-plate-boundaries.shtml>

1. **Subduction**
	* The & oceanic plate descends below the \_\_\_\_ oceanic plate
* Forms deep-sea , island , & earthquakes
1. **Deep-sea** \_\_\_\_\_\_\_\_\_\_\_\_are narrow & elongated depressions with very steep sides
	* Deepest trench: Marianna trench is over 11km deep
2. An **Island Arc** is a \_\_\_\_\_\_\_\_of islands that form from volcanic activity above the subduction zone
	* Example Arcs: Aleutian Islands near Alaska, and Japan & Phillipines
3. **Oceanic-Continental Convergent**



 <http://geology.com/nsta/convergent-plate-boundaries.shtml>

1. Subduction
	* ocean plate descends below the continental plate
	* Ocean plates are dense because they are made primarily of
	* Continental plates are less dense because they are made primarily of
2. Forms along the edge of continents
3. Mountain ranges, volcanoes, deep focus earthquakes may occur along the continental edge
4. Example locations: Peru-Chile trench & Andes Mountains along western edge of
5. **Continental-Continental Convergent**



<http://geology.com/nsta/convergent-plate-boundaries.shtml>

1. Subduction
	* Both continental plates are too due to
	* Therefore, there is
2. mountain ranges, extremely folded
3. Earthquakes present
4. Example location:

**Seafloor Spreading Theory**

* SUMMARY: New ocean crust is formed at ocean ridges & is destroyed at deep-sea trenches
	+ 1. Proposed by Harry Hess
		2. Theory provided answers to the 2 flaws of Wegener’s Continental Drift hypothesis
			- Seafloor spreading caused the landmasses to move
			- Landmasses didn’t shatter because they weren’t plowing through the ocean crust. Rather, the ocean floor & continents
		3. Magma is & dense at the mid-ocean ridge, so it fills the gap in the ridge
		4. Magma in the gap cools, forming new ocean floor
		5. More & more magma rises & hardens, forcing the previous rock to move away from the ridge
		6. Therefore, rock is near the ridge & age farther from the ridge

 **Paleomagnetism:**

* 1. Magnetic record of rocks containing
	2. Basalt contains iron minerals which get “stuck” pointing towards Earth’s as it cools & hardens
	3. The iron minerals show a pattern of which indicate a change in Earth’s magnetic field

 **Ocean Rocks and Sediments**

1. Rocks near the ridges are the , age increases with distance from the ridge
2. Oceanic rocks are much than continental rocks

**Mantle Convection Currents in the Asthenosphere**

* 1. in the aesthenosphere is thought to cause the plate movements
* Asthenosphere is layer of the mantle that and allows the plates to move

	+ - Hot mantle material is less dense & rises, as it cools it sinks again
	1. **Rising** part of the current occurs at boundaries

		1. Causes upward & lateral forces that
		2. As plates separate, rising cools & forms new
	2. **Sinking** part of the current occurs at boundaries, pulling plate material down
1. Sometimes forms

 



**Bellringer #1**

1. What theory suggests that South America and Africa were once part of a larger continent that broke and moved apart?
2. Who was the German scientist who proposed the most famous version of this theory?
3. List 3 lines of evidence he used to support his theory.
4. **Thinking Critically:** Oil deposits approximately 200 million years old have been discovered in Brazil. Where might geologists find oil deposits of a similar age? **Explain.**

**Bellringer #2**

1. What is convection?
2. What heats magma?
3. What does heated magma do?
4. What happens when magma cools?
5. Draw a diagram of a convection current. Make sure to label rising magma, sinking magma, more dense, and less dense in your picture.

**Bellringer #3**

What type of plate boundary is it IF???

1. Plates are pulling apart
2. Plates are sliding past each other
3. Boundary where you will see mountains
4. Boundary that creates mid ocean ridges
5. San Andreas Fault
6. Mid-Atlantic Ridge
7. Where we see lots of quakes and volcanic activity

**Bellringer #4**

* **Are the following features typical for an oceanic to oceanic convergent boundary?**

 A = Usually present B = Not usually present

* 1. Volcanoes
	2. Ocean ridge
	3. Folded mountains
	4. Subduction
	5. Rift valley
* What evidence suggests that Africa & India were once closer to the South Pole?

**Bell Ringer # 5 Plate Boundary Review**

* Look at the circled boundary on the projected image:
	1. What type of boundary is it?
	2. What are 3 landforms or movements that are likely to be present?

**Bellringer #6 Evidence & Features at Boundaries**

1. Multiple Choice - Magnetic minerals in undisturbed rocks on the ocean floor will:
	1. Indicate where magnetic pole was at the time of formation
	2. Align with “north” as we know it to be now, no matter what
	3. Change in their direction of alignment slowly over time
2. How do glacial deposits in Africa, India, Australia, and South America support the idea of continental drift?
3. **THINKING CRITICALLY:** Why are the magnetic bands in the eastern Pacific Ocean so far apart compared to the magnetic bands along the Mid-Atlantic Ridge?

**Bellringer #7**

1. If sea floor spreading centers create new crust constantly, does that mean the earth is getting bigger? Explain.
2. Describe the age of rocks at a mid-ocean ridge.

**Bellringer #8**

1. How will lithospheric plates that are directly above a **rising** current move?
	* Together or apart?
2. How will a plate above a **sinking** current move?
	* Together or apart?
3. Use ONE word to describe the
	* Lithosphere:
	* Aesthenosphere
4. Which contains the plates? Lithosphere or Aesthenosphere?
5. Which has convection currents? Litho or Aesthenosphere?
6. Which has oceanic crust? Lithosphere or Aesthenosphere?
7. Which is hotter? Lithosphere or Aesthenosphere?