**4. Plate Tectonics II**

**Seafloor Spreading**

In the early 1960s, samples of basaltic ocean crust were dredged up from various locations across the ocean basins. The samples were then analyzed to test for their ___ properties, which led to the discovery of something quite intriguing.

What was discovered about the magnetic properties of the ocean floor rocks as you move further and further away from a mid-ocean ridge?

_______________________________________________________________________

The magnetic polarity that is the same as what exists currently on Earth is called ______ polarity (i.e., compasses point towards current-day magnetic north).

The magnetic polarity that is the opposite of what exists currently on Earth is called __________ polarity (i.e., compasses would point towards current-day magnetic south).

Are paleomagnetic reversals seen in rocks of all the Earth’s oceans? YES or NO

What was discovered about the pattern of magnetic reversals on one side of a ridge compared to the opposite side of the ridge? ____________________________________________

The evidence suggested that new basaltic crust must have been generated at the ridge and then been pushed to either side at a later time when the next cycle of lava got squeezed out of the middle of the ridge. As each new cycle of basaltic lava erupted, it cooled and preserved a record the Earth’s magnetic field in the magnetic minerals inside the rock.

So why does the paleomagnetic field recorded in the ocean rocks change through time?

_______________________________________________________________________

How often does the magnetic pole switch happen on Earth? _______________

So the ocean floor acts like a conveyor belt, carrying volcanic rocks to either side of the ridge further and further away from each other as new material forms at the ridge.

What happens to the continents during this whole process?

_______________________________________________________________________

In other words, the continental and oceanic crust move together, rather than the continents plowing through the oceanic crust.

This is how continental drift happens. Individual continents start out as a single continent that tears apart; then the pieces slowly move away from each other as a new ocean basin is created between them by seafloor spreading.

**Age of Oceanic Crust**

The age of oceanic crust ________________ AWAY from the ridge.
Where are the youngest oceanic crustal rocks? ________________________________
Where are the oldest oceanic crustal rocks? ________________________________
How old are these rocks? ________________________________

The oldest rocks were once at the ridge itself, when the ridge initially formed and split the continents apart.

**The Tectonic Plates**

The combination of continent and oceanic crust on either side of a ridge represents a tectonic plate, which is constantly on the move.

Do all tectonic plates have continents on them? YES or NO

Where does the fastest plate motion occur on Earth? ________________________________
How fast is the spreading rate at this ridge? ______ cm/year

How many tectonic plates are there? _______________

These plates consist of brittle crust and upper mantle, (called the ________________) floating around on an underlying weak and ductile layer called the ________________.

The current plates were once arranged in such a way as to form the supercontinent of _________________. By looking at the rates of spreading happening along the ridges today, it can be determined how fast various plates have been moving apart through geologic time, so we can reconstruct their motions moving backwards in time.

Pangea began to break apart during the _________________ Period.

How long ago was this? ___________million years ago.

Web fun: http://www.odsn.de/odsn/services/paleomap/animation.html

It has been suggested that the continents may all come together again someday and the whole process will start again. This ongoing cycle of plate motions is called the _________________, named after the geologist who first promoted modern concepts of plate tectonics in 1965.

Over what time span is this plate tectonic cycle thought to occur?

Every ________________ years.

**Plate Boundaries**

Seafloor spreading implies that the plates are moving apart from each other. Subduction implies the plates are colliding. A third possibility arises where two plates are simply sliding past each other.

What do we call these three types of plate boundaries?

1) _________________ (e.g. mid-ocean ridges and rift valleys)
Divergent Boundaries

Divergent plate boundaries represent locations where plates are moving apart along a huge crack in the lithosphere (e.g., mid-ocean ridges).

What are divergent boundaries called on land? ____________________

On land, divergent boundaries represent locations where the crust is being stretched and uplifted by underlying basaltic magma that starts to erupt into the valleys as they pull apart. Volcanic eruptions and earthquakes are common.


Eventually, the middle of the valley turns into ______________ as a new ocean basin is created.

Where is this happening today? ________________________________

Where has a new, narrow ocean basin already formed where Africa split apart from Arabia?

______________________________

Convergent Boundaries

New oceanic lithosphere is created at a divergent boundary. So where does oceanic lithosphere go to die? At a convergent boundary, where two plates collide, it gets consumed back into the mantle by the process of ___________________. This process keeps Earth's surface area constant through time.

It also explains why the oldest oceanic crust is only 180 million years old; all older oceanic crust has been subducted.

List the three different types of convergent boundaries:

_________________________________  __________________________________  __________________________________

- **Ocean-ocean**: this is where two ocean plates collide, causing the oldest, coldest, and densest of the two to subduct beneath the other, forming an ocean trench on the seafloor.

As the subducting ocean plate gets deeper, it starts to melt and the magma rises to the surface of the plate that doesn't subduct, which is called the _____________________.

This forms a line of volcanic ocean islands called an ________________, usually a few 100 km away from the trench.

Location examples: ____________________________________________________

- **Ocean-continent**: this is where oceanic lithosphere subducts beneath a continent.
Why is it that oceanic lithosphere always subducts but continental lithosphere never does?

Melting of the subducting plate and rising of the magma produces a line of volcanoes on the continent called a ______________________

Location example: __________________________

- **Continent-continent**: a final possibility is where continents collide with continents. This occurs when all the oceanic lithosphere between two continents gets subducted, resulting in the continents coming together.

When the continents collide, why does neither one of them subduct?

Instead, the continents forming a huge mountain range along a line where the continents collides, called a ______________________. Earthquakes are common here.

Location example: __________________________ (where ___________ collided with ___________)

What can be found at the top of Mt. Everest, and why? ________________________

Many mountain belts around the world show tell-tale signs of having been formed at convergent plate boundaries sometime in the geologic past (e.g., Appalachians).

**Transform Boundaries**

The final type of plate boundary is a transform boundary. This is where two plates slide past each other along a long fault called a ___________________.

Fracture zones that offset mid-ocean spreading ridges are transform faults (e.g. along the mid-Atlantic ridge).

Geologic features can be offset by 100s of km along transform faults, and sometimes they even come onland, such as the ________________________ in California.

**Driving Mechanism for Plate Tectonics**

So why do we get plate tectonics in the first place? What is driving the motion of the plates across the asthenosphere?

Plate motions are probably driven by a process in the mantle called _________________.


This may occur in just the asthenosphere or in the entire mantle. The process involves mantle material moving heat upwards towards the surface, where it cools and then moves back downward again the repeat the process, forming a convection cell.

Sometimes, a huge jet of molten magma called a ________________ rises from the outer core boundary and pierces the crust at a site called a ________________.

As a result of the plate moving across the stationary hot spot, a line of islands may be formed over time at the Earth’s surface.

**FINAL QUESTION:**

Where is an example of where a line of islands formed in this way?

____________________________