

Expedition 6 - Commotion Beneath the Ocean

Not attempting to answer questions on expeditions will result in point deductions on course workbook (**two or more blank answers** will result in a deduction of 2-4 points; a 5 point deduction will be assessed if **more than five answers** are left blank).

Remember to use the worksheet to take notes just as if you were listening to a lecture!

Many of the figures in this worksheet and the online expedition are derived from "This Dynamic Earth" by Jacqueline Kious and Robert Tilling of the U.S. Geological Survey. (<http://pubs.usgs.gov/publications/text/dynamic.html>)

Plate tectonics was a revolution in the earth sciences, which was launched by oceanographers. In this class we will use tectonics to examine:

- the formation and recycling of the seafloor and oceanic lithosphere,
- formation of trenches, volcanic islands
- motions of the seafloor
- marine hazards, such as the locations of earthquakes and volcanoes

**1. Introduction**

Is the Earth a dynamic planet? \_\_\_\_\_ (yes or no)

Why or why not? \_\_\_\_\_

---



From "This Dynamic Earth" by Jacqueline Kious and Robert Tilling of the U.S. Geological Survey.

## 2. The Theory of Plate Tectonics



What is continental drift? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

What is the name of the supercontinent? \_\_\_\_\_

When did the continents last form a large, single continent? (circle the correct answer):

- a. 18,000 years ago
- b. 180,000 years ago
- c. 1,800,000 years ago
- d. 18,000,000 years ago
- e. before 180,000,000 years ago

The breakup of Pangea resulted in the formation of the modern ocean basins as continental masses drifted apart, allowing seawater to flow between the land masses.

## 3. Formation of the Modern Ocean Basins

As the continents drift apart, new crust is formed beneath the sea to fill the space.

The shorelines of which of the following pairs of continents can be easily seen to match up across an ocean (circle the correct answer):

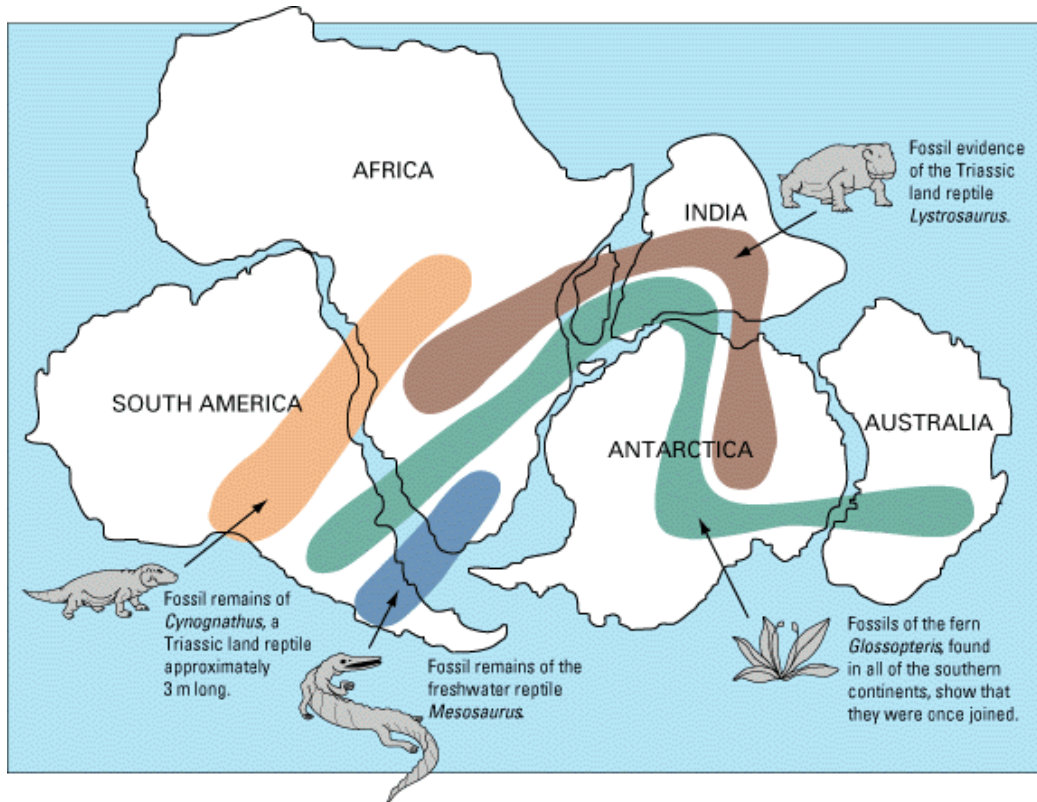
- a. Australia and South America
- b. North America and Asia
- c. South America and Africa
- d. Eurasian and Antarctica

## 4. Evidence of Continental Fit

Evidence were used to support the hypothesis of the fit of the continents into Pangea

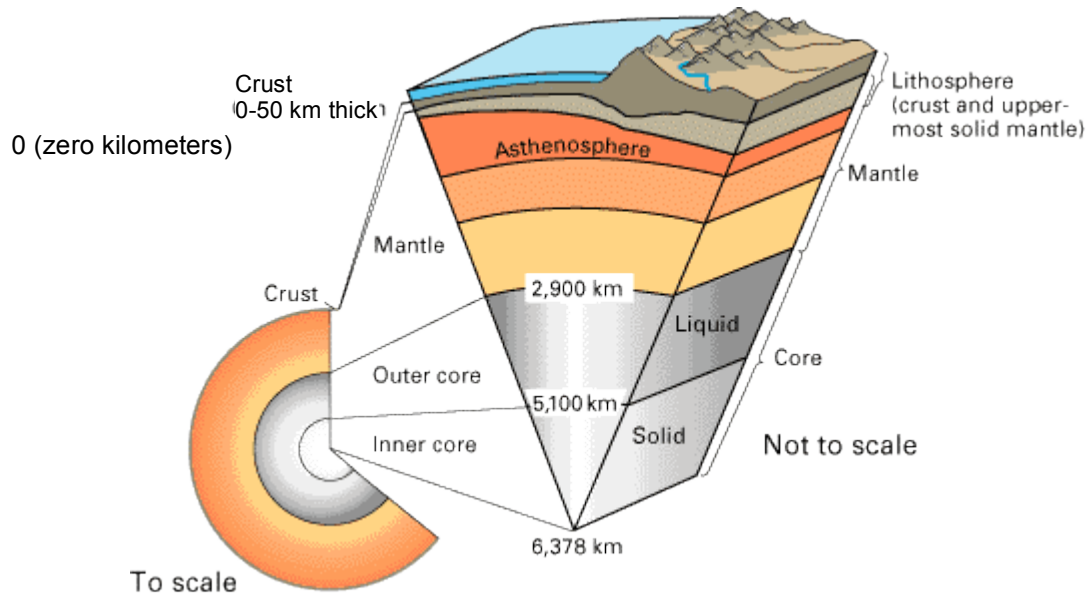
- Some fossils match across oceans when continents are realigned with past positions
- Some rock types match across oceans when continents are realigned with past positions
- The distribution of ancient swamps and sedimentary deposits formed by ancient glaciers align in proper places when continents are realigned into their past positions, just like pieces of a jigsaw puzzle.

See diagram below



From "This Dynamic Earth" by Jacqueline Kious and Robert Tilling of the U.S. Geological Survey.

## 5. Earth's Interior



From "This Dynamic Earth" by Jacqueline Kious and Robert Tilling of the U.S. Geological Survey.

List the layers within the Earth

---

---

---

---

## 6. Earth as a Heat Engine

What is convection?

---

---

---

How does convection cause the movement of material within the Earth?

---

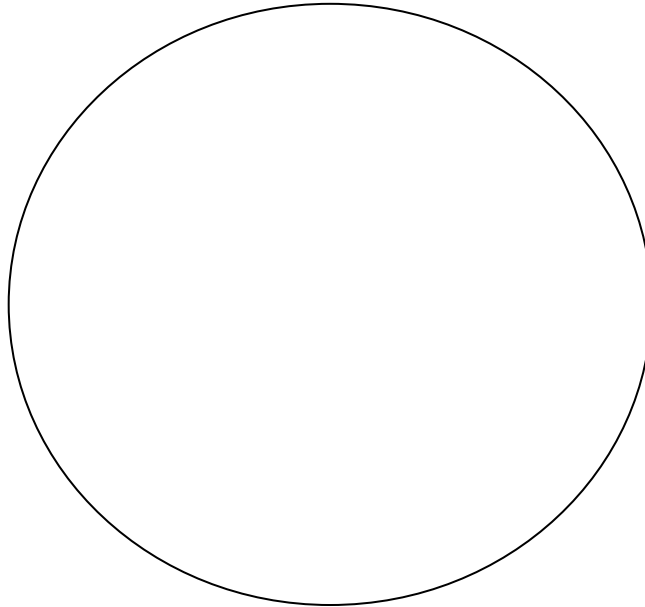
---

---

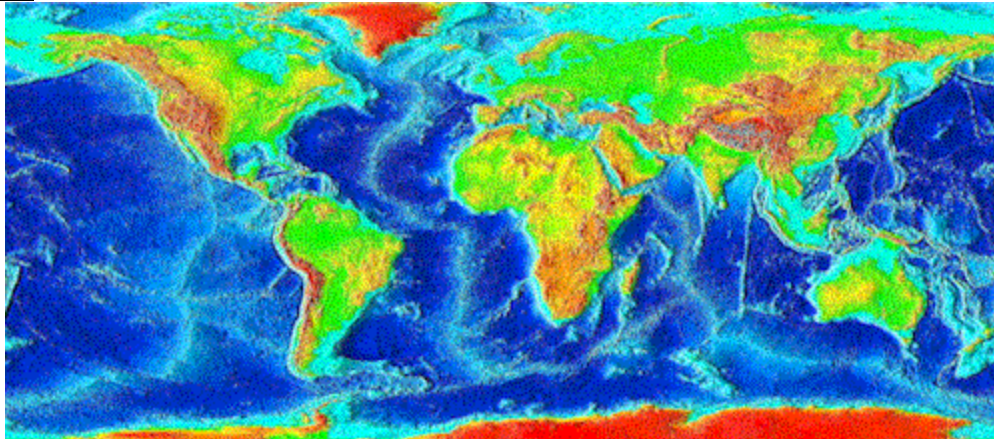
Which layers in the Earth are involved in convection?

---

Draw a picture of convection within the earth



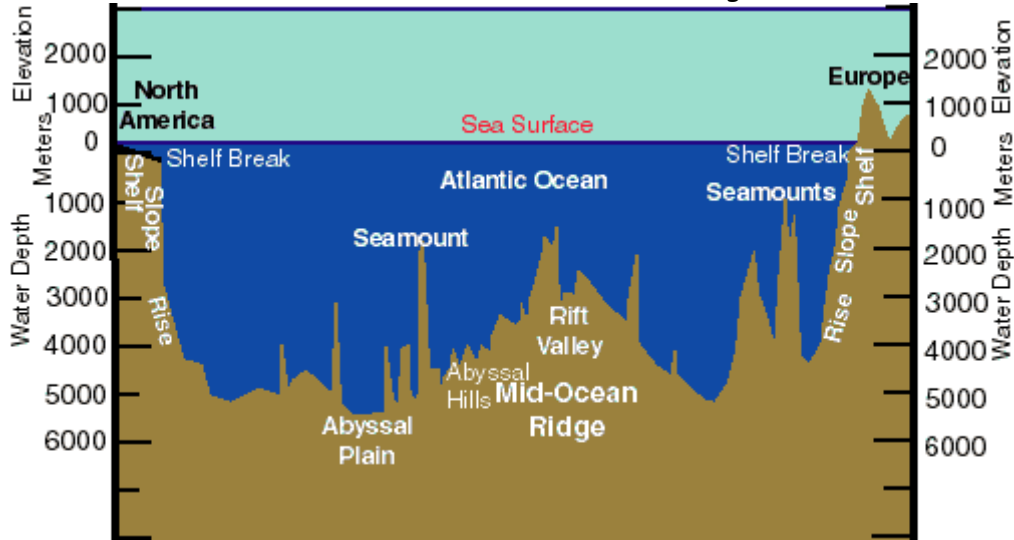
**7. Mapping the Mid-Ocean Ridge System - one of the locations where heat escapes the earth**



From National Geophysical Data Center <http://www.ngdc.noaa.gov/mgg/image/2minrelief.html>

**Using a red pencil trace in the locations of the mid-ocean ridges on the diagram above**

Below is a profile of the seafloor across the Atlantic Ocean - draw an arrow showing the location of the Mid-Atlantic Ridge?



8. On a Mid-Ocean Ridge - Know how the mid-ocean ridge system encircles the globe and the locations of mid-Atlantic Ridge and East Pacific Rise

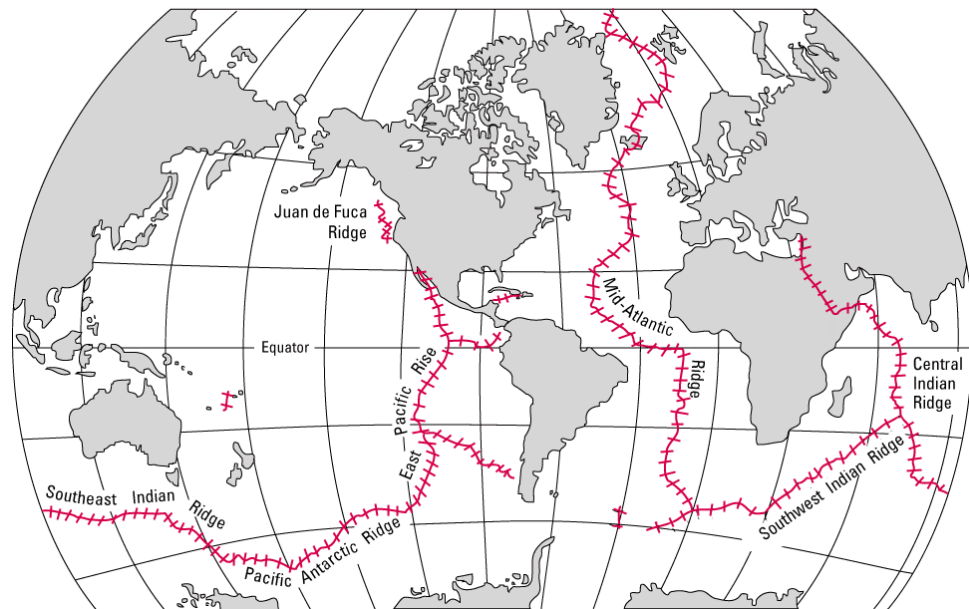
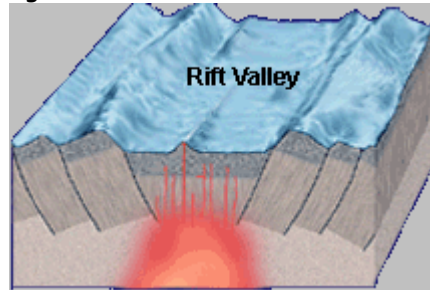


Figure on preceding page from "This Dynamic Earth" by Jacqueline Kious and Robert Tilling of the U.S. Geological Survey.

Know locations of mid-ocean ridges !!!!!!!

What are the mid-ocean ridges (circle the correct answer)?

- a. nonvolcanic mountains
- b. isolated mountains on the seafloor
- c. long chains of volcanoes that extend from one ocean basin to the next



Rift valley marking divergent plate boundary at mid-ocean ridge

9. **Seafloor Spreading** - Understand this concept! It will be on exam!

Make a simple, but very clear diagram illustrating the seafloor spreading hypothesis



Include the motions of mantle convection in the diagram above.

***A portion of the earth's mantle is in slow, constant motion, called convection, because:***

- a. *the rocks are radioactive*
- b. *temperature of the crust alters the mantle*
- c. *temperature affects the density of the rocks, causing warm rocks to be less dense with respect to cold rocks which are relatively more dense*
- d. *temperature affects the density of the rocks, causing warm rocks to be more dense and cold rocks to be less dense*
- e. *higher density rocks rise whereas lower density rocks sink*

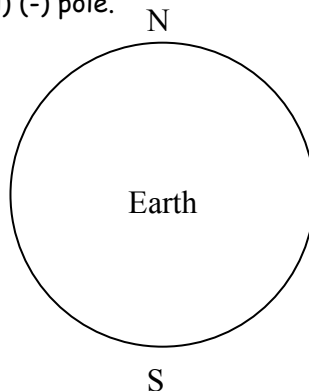
Know about the formation of Earth's crust and its movement away from mid-ocean ridges with time.

What is meant by the term "marine magnetic anomalies" or sometimes called seafloor magnetic stripes? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

### 10. Earth's Magnetic Field

The magnetic field is generated by the electrical currents in the liquid outer core.  
-- You should know the direction and orientation of the lines of force of the Earth's magnetic field

- **Make a sketch of the Earth and surrounding lines of force of the magnetic field** (it is nearly a Dipole Field, similar to that of a bar magnet). These lines of force point outward from the southern pole (S) (+ pole), are nearly parallel to Earth's surface at the equator and point in, towards the interior of the Earth, at the northern (N) (-) pole.

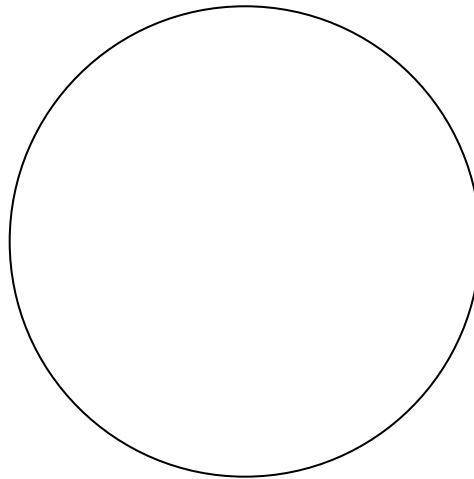


**Question -- The lines of force of the earth's magnetic field: (circle correct answer)**

- a. point towards the north pole and are nearly parallel to the lines of longitude
- b. point towards the south pole and are nearly parallel to the lines of longitude
- c. point towards the North America and are nearly parallel to the lines of latitude
- d. show no organized behavior or direction

**11. Magnetic Patterns Over Time**

In the previous problem, you drew a picture of the lines of force of the Earth's magnetic field as it is today (so-called normal polarity), now draw one showing the Earth's reversed field (or reversed polarity) as it has been at many times in the past



**12. Reading the Magnetic Patterns**

How are the marine magnetic patterns used as scientific evidence of seafloor spreading? \_\_\_\_\_

\_\_\_\_\_

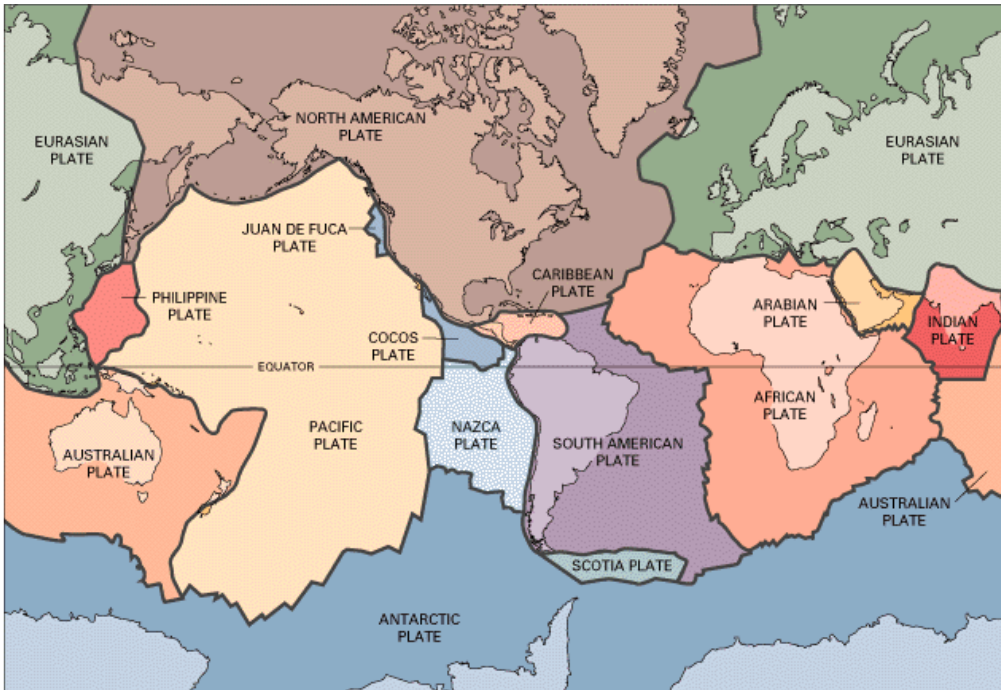
\_\_\_\_\_

\_\_\_\_\_

**13. The Plates**

*List and Know Names of at least 9 of the Major Plates*

- |          |          |
|----------|----------|
| 1. _____ | 2. _____ |
| 3. _____ | 4. _____ |
| 5. _____ | 6. _____ |
| 7. _____ | 8. _____ |
| 9. _____ |          |



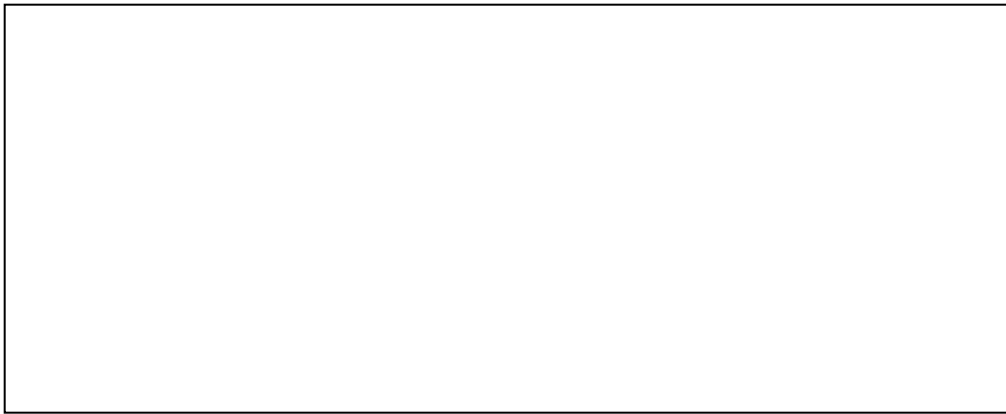
From "This Dynamic Earth" by Jacqueline Kious and Robert Tilling of the U.S. Geological Survey.

**14. More on the Plates**

What is the lithosphere? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

What is the asthenosphere? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Draw a picture showing a plate composed of the *rigid* lithosphere floating on the *hot, mobile* asthenosphere.



**1 minute essay - Summarize what you learned in this expedition - Avoid the "I learned a lot about" syndrome -- show some insight**

---

---

---

---

---

---

---

---

Post any questions on this expedition under "Exped 6 - Commotion - Any Questions?" in Desire2Learn Discussions

**In order to receive credit for completing this expedition and gain access to the answer key,**

**Go to Desire2Learn Email and send "Bye Don"**

- **"End Expedition 6" in Subject Line. (VERY IMPORTANT)**
- **Include "Bye Don" in body of email,**
- **Include "Completion Word" (see last page of expedition) and write your name in body of e-mail message**

