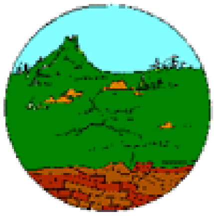
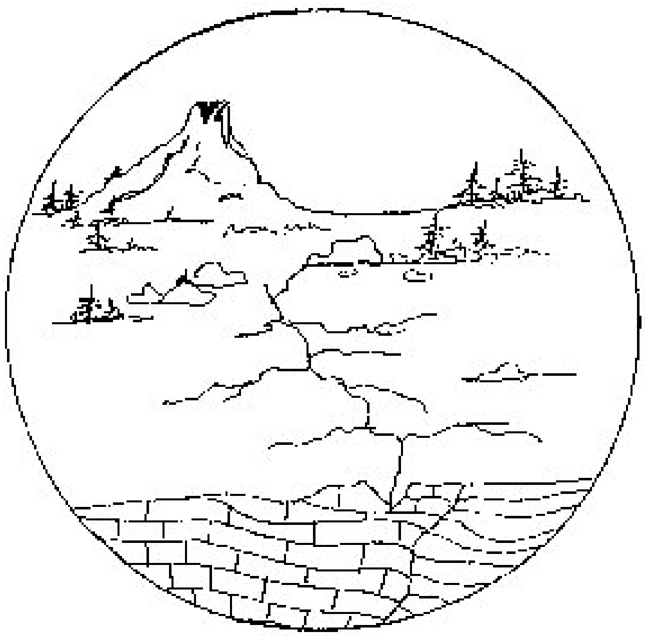


Plate Tectonic Cycle

Earth's Moving Force

SIXTH GRADE

PLATE TECTONICS



1 WEEK
LESSON PLANS AND
ACTIVITIES

PLATE TECTONIC CYCLE
OVERVIEW OF SIXTH GRADE

VOLCANOES

WEEK 1.
PRE: *Comparing the structure of different types of volcanoes.*
LAB: *Plotting 3 different types of volcanoes on a globe.*
POST: *Researching where volcanoes occur around the world.*

EARTHQUAKES

WEEK 2.
PRE: *Comparing energy waves from earthquakes.*
LAB: *Experimenting with energy waves through different substances.*
POST: *Observing fault movements.*

PLATE TECTONICS

WEEK 3.
PRE: *Locating different plates.*
LAB: *Illustrating the difficulty in defining and counting plates.*
POST: *Observing the movement of the Earth's crust.*

HAZARDS

WEEK 4.
PRE: *Comparing earthquakes in Alaska and Hawaii.*
LAB: *Designing structures that withstand different earthquakes intensities.*
POST: *Comparing earthquake dangers in different areas.*

PLATE TECTONIC CYCLE - PLATE TECTONICS (6)

PRE LAB

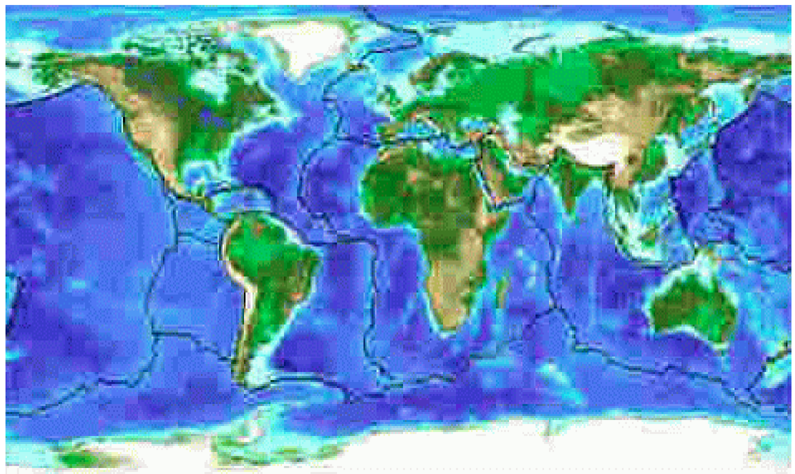
> Students name the plates on a world map.

OBJECTIVES:

1. Comparing plate boundaries.
2. Locating different plates.

VOCABULARY:

converging
diverging
plate boundary
transform motion



MATERIALS:

worksheet
relief map of the world

BACKGROUND:

According to the theory of plate tectonics, the Earth's crust and upper mantle are broken into moving plates of "lithosphere." The Earth has two types of crust. Continental crust underlies much of the Earth’s land surface. The ocean floors are underlain by oceanic crust. These materials have different compositions. Continental crust is less dense than oceanic crust.

All of the plates are moving. They are slow, moving at speeds of centimeters to tens of centimeters per year. They slide along on top of an underlying mantle layer called the asthenosphere, which is composed of a less rigid, almost viscous rock.

The plates are layers of rigid, solid rock. As they move, plates interact at their edges or boundaries. There are three basic directions or types of boundary interactions. In some places, two plates move apart from each other; this is called a diverging plate boundary. Elsewhere two plate move together called a converging plate boundary. Finally, plates can also slide past each other horizontally. This is called a transform plate boundary.

Volcanoes and earthquakes help define the boundaries between the plates. Volcanoes form mostly at converging and diverging plate boundaries, where much magma is generated. Earthquakes occur at all three types of boundaries. Because the plates are rigid, they tend to stick together, even though they are constantly moving. When the strength of the rocks at the plate boundary is exceeded, they move rapidly, “catching up” with the rest of the plates. We feel this release of energy as an earthquake.

PROCEDURE:

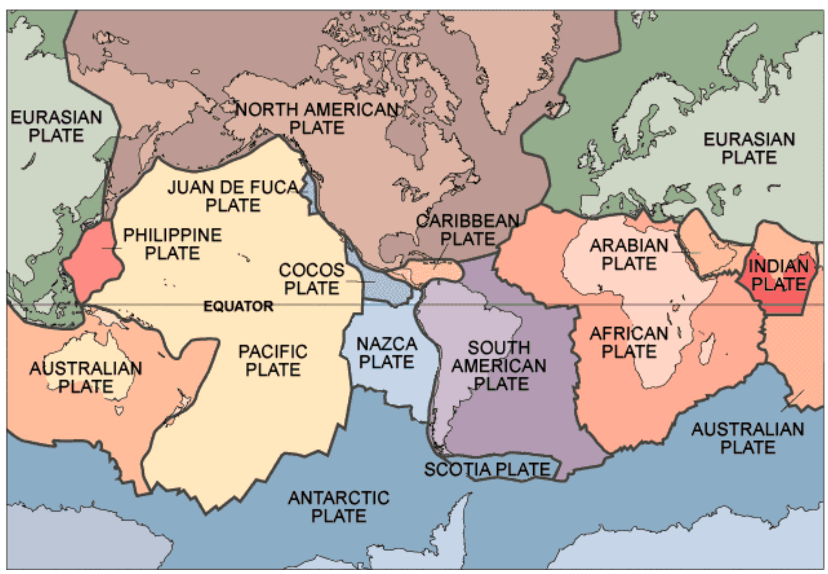
This exercise focuses on allowing the students to put the information that they have learned in previous years into perspective.

1. Show the students a world map with either plate boundaries or plots of Earthquakes and Volcanoes. The U.S. Geological Survey publishes a map called the "Dynamic Earth," that would be very useful. Point out the different plate boundaries to the class. These boundaries are not sharp lines but zones where the movement takes place. The lines on the map are just approximations. A relief map of the Earth, shows that mountain ranges seem to following the earthquake and volcano pattern.

2. Review the three ways plates move with the class. Draw pictures on the board like the ones at the top of the second image below, or use the image itself.

3. The plates were defined and named by geologists. Most of these scientists agree that there are 13 large plates, and many smaller ones. The exact total is not agreed upon. During lab, students will look at the data and decide for themselves if there are 13 plates or not. Using the worksheet, have the students make up names for the individual plates shown on the map. As a class, compare the students' names with the real names of the plates, which are listed below.

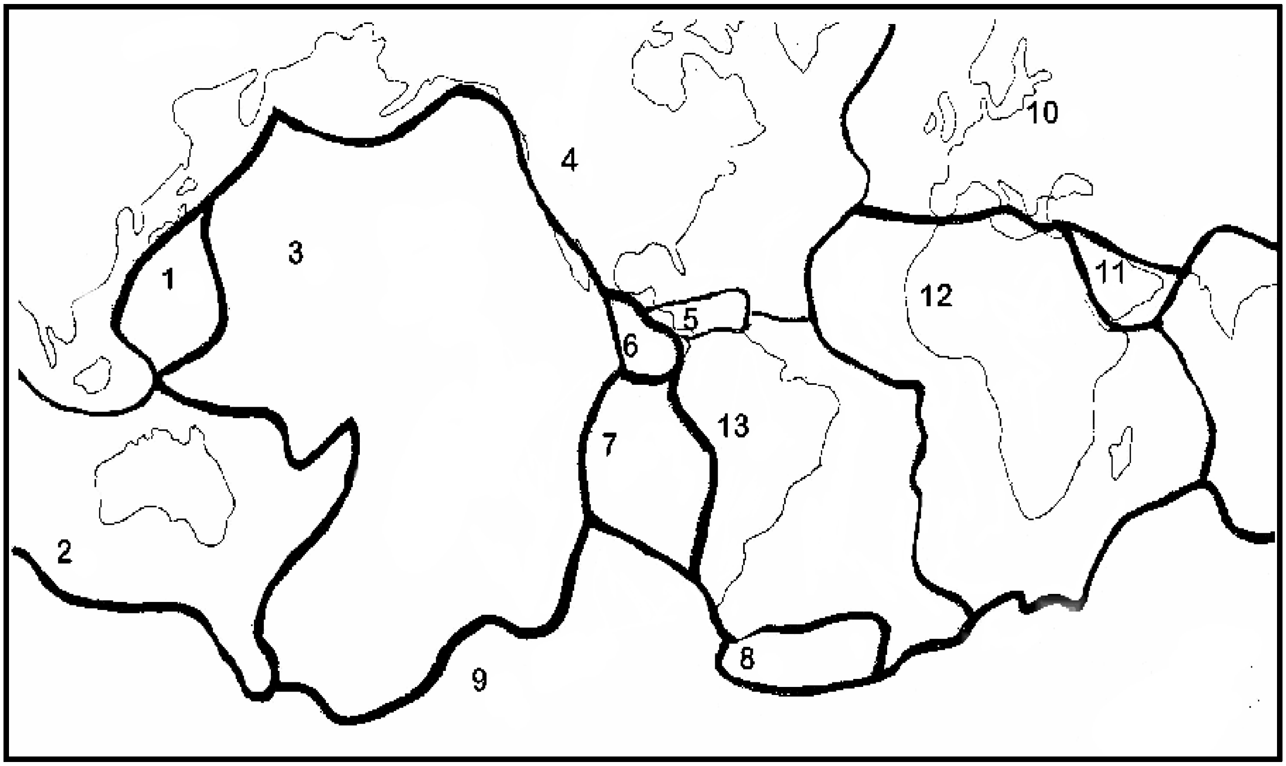
1. Philippine Sea Plate
2. Indian - Australian Plate
3. Pacific Plate
4. Caroline Plate
5. Caribbean Plate
6. Cocos Plate
7. Nazca Plate
8. Antarctic Plate
9. Scotia Plate
10. Eurasian Plate
11. Arabian Plate
12. African Plate
13. South American Plate



4. Students are also asked to look at features that might give them clues to plate boundaries. If they look at a generalized map, they will notice that mountain ranges are common to plate boundaries. In other areas volcanoes are common. If you live in a mountainous area and have a detailed local map, your students may notice that parallel mountains and valleys are common. These tend to form at converging plate boundaries in areas of compression.

PLATE TECTONIC CYCLE - PLATE TECTONICS (6) PRE LAB

Name the plates. Use your imagination! Look at a globe and relief map of the world and find features that might be associated with these boundaries. Label them on the map. Your teacher will go over the "real" names of the plates.



1	8
2	9
3	10
4	11
5	12
6	13
7	

PLATE TECTONIC CYCLE - PLATE TECTONICS (6)

LAB

Students define plate boundaries using earthquakes.

OBJECTIVES:

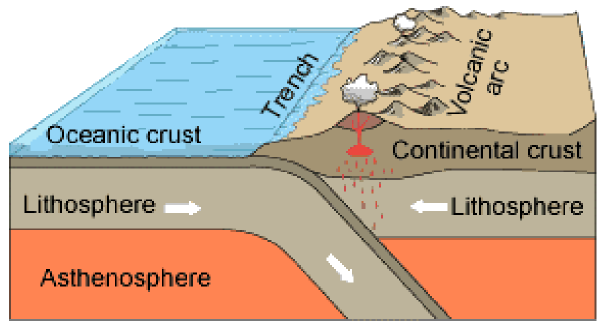
1. Illustrating the difficulty in defining and counting plates.
2. Determining plate boundaries.

VOCABULARY:

plate boundary
seismicity

MATERIALS:

worksheet
wall map of earthquakes and/or volcanoes of the world



A converging plate boundary showing subduction.

BACKGROUND

As described in the Pre Lab, there are three types of plate boundaries. In some places, two plates move apart from each other called a diverging plate boundary. Elsewhere two plate move together called a converging plate boundary. Finally, a transform plate boundary occurs when two plates can slide past each other horizontally.

Geologists use many types of evidence to locate the boundaries between plates. Most of these indicators are signs of stress, which develop as the two plates interact. The clearest indicators are patterns in the locations of earthquakes and volcanoes. From examining a map of earthquake and volcanic activity, it is very apparent that these events do not occur randomly. Both tend to occur in linear belts which mark the plate boundaries. Each type of plate boundary has a somewhat different pattern of earthquakes and/or volcanoes. At converging plate boundaries, two situations are possible. First, both volcanoes and earthquakes form where one plate sinks under the other. This process, called subduction, takes place because one plate is denser than the other. The denser plate, which invariably has oceanic crust on its top, does the sinking. Earthquakes occur along this plate as it sinks and is pulled into the upper mantle. Second, only earthquakes occur when two plates collide (obduct), building a mountain range. This situation is common when two plates with continental crust on top converge. The density of continental crust is too low for it to subduct; it is like wood floating on water. Instead, the two plates have a head on collision - building a mountain range. The Himalaya Mountains in Asia formed this way, from a collision between the Indian and Asian Plates. At transform plate boundaries, the two plates slide by each other. This generates little volcanic activity (there is no “gap” between the plates) or mountain building. Earthquakes, however, are common. At diverging plate boundaries, earthquakes occurs as the plates pull away from each other. Volcanoes also form between the plates, as magma rises upward from the underlying mantle. We rarely see these volcanoes erupt, as most of them are on the ocean floor. Transform plate boundaries commonly have only earthquakes.

In this lab, students will try to recognize plate boundaries using the locations of earthquake epicenters. Their work will be based on a map produced by the Earthquake Data Service of the National Oceanic and Atmospheric Agency, which shows the locations (epicenters) of all earthquakes of magnitude 4.5 or greater on the Richter scale for the years 1963 - 1974. The students will also color, cut out, and fold the map into an icosahedron (24-sided) globe.

PROCEDURE:

1. Before lab, print copies of the icosahedron map for each student. We have provided a color version of this map below. It can also be printed in black and white in the larger format.

2. Instruct the students to trace the plate boundaries on the map. Tell them to carefully think about where the plate boundaries are located, and not to just draw a zig zag puzzle. Remind the students to use the large world earthquake map (if available) for reference. Have the students color the continents to observe where the plates are located. When they have completed coloring the map and tracing the plate boundaries, have the students cut the map out and put it together. Make sure that they cut along the outside border, including the tabs. The globe assembles best if it is folded along the black lines before being glued.

3. Use drawings or other the presentation images from the Pre Lab to show converging, diverging, and transform fault plate movements. Stress that one kind of plate movement in an area means that plates in adjacent areas are affected by that movement.

4. Review the questions on the lab sheet. Discuss why students might have different results. Compare their Lab results with their Pre Lab findings. Tell the students that geologists sometimes debate about how many plates there really are!

ANSWERS:

1. Will vary from student to student.

2. Yes, there are many problem areas. Hawaii, Yellowstone, Africa, Arctic, Antarctica, Mediterranean area. Students may find more. Ask them why they called it a problem.

3. Africa, Antarctica, Eurasian continent, many other areas depending on how detailed the students get. Conclusion is that earthquakes can occur just about anywhere.

4. On the west coast (including Alaska) of the United States you have the North American Plate meeting the Pacific plate.

PLATE TECTONIC CYCLE - PLATE TECTONICS (6) LAB

PROBLEM: What do earthquakes and volcanoes have to do with plate tectonics?

PREDICTION: ____

MATERIALS: Wall map of earthquakes and/or volcanoes of the world; NOAA/NESDIS icosahedron globe, crayons

PROCEDURE:

Using the information about what defines a "plate", color the continents so they can be easily seen. Use a pencil to draw on the map, where you think the plates are. Look at the larger maps for more detailed information to help you decide. Cut, fold, and paste the globe together.

ANSWER THE FOLLOWING QUESTIONS:

1. How many plates have you defined? ____

2. Are there any "problem" areas?__________ List them:
____
____
____

3. Where are there earthquakes and no plate edges? ____________________________
____
____

4. Where do two plates meet in the United States?_______________________________
____
____

CONCLUSION:

How many plates did you find? What was your criteria for defining these plates?
____
____
____

PLATE TECTONIC CYCLE - PLATE TECTONICS (6)

LAB

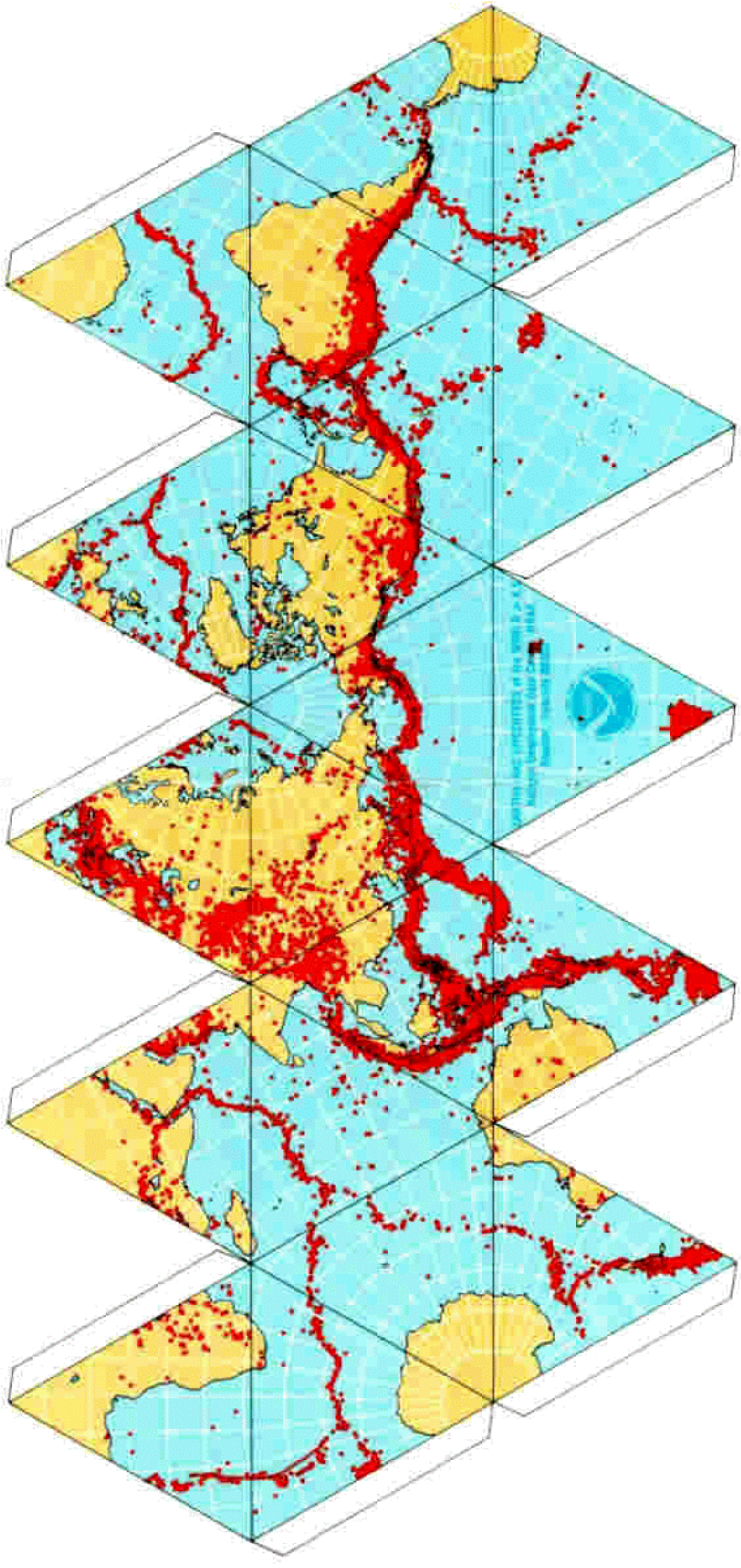


PLATE TECTONIC CYCLE - PLATE TECTONICS (6)

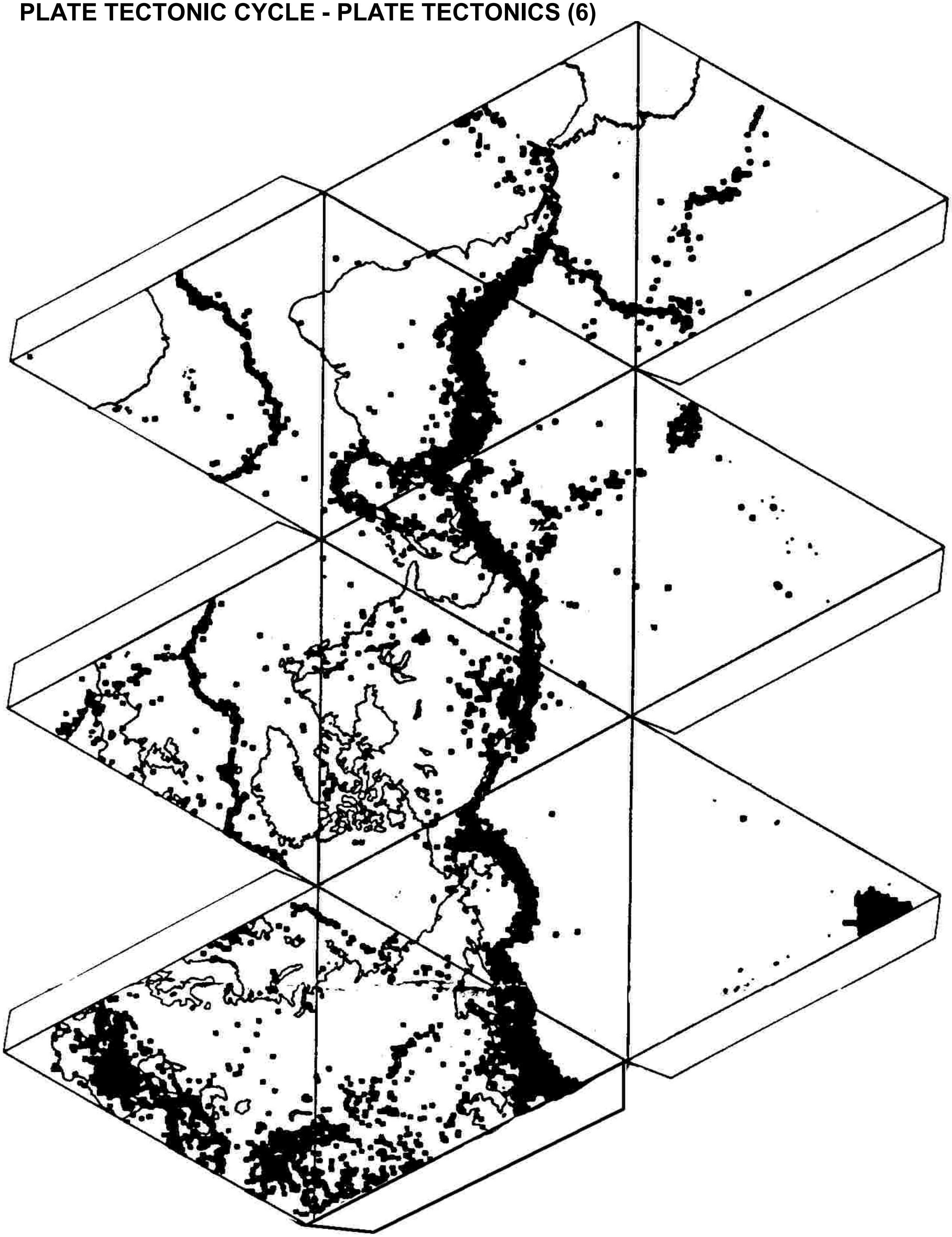


PLATE TECTONIC CYCLE - PLATE TECTONICS (6)

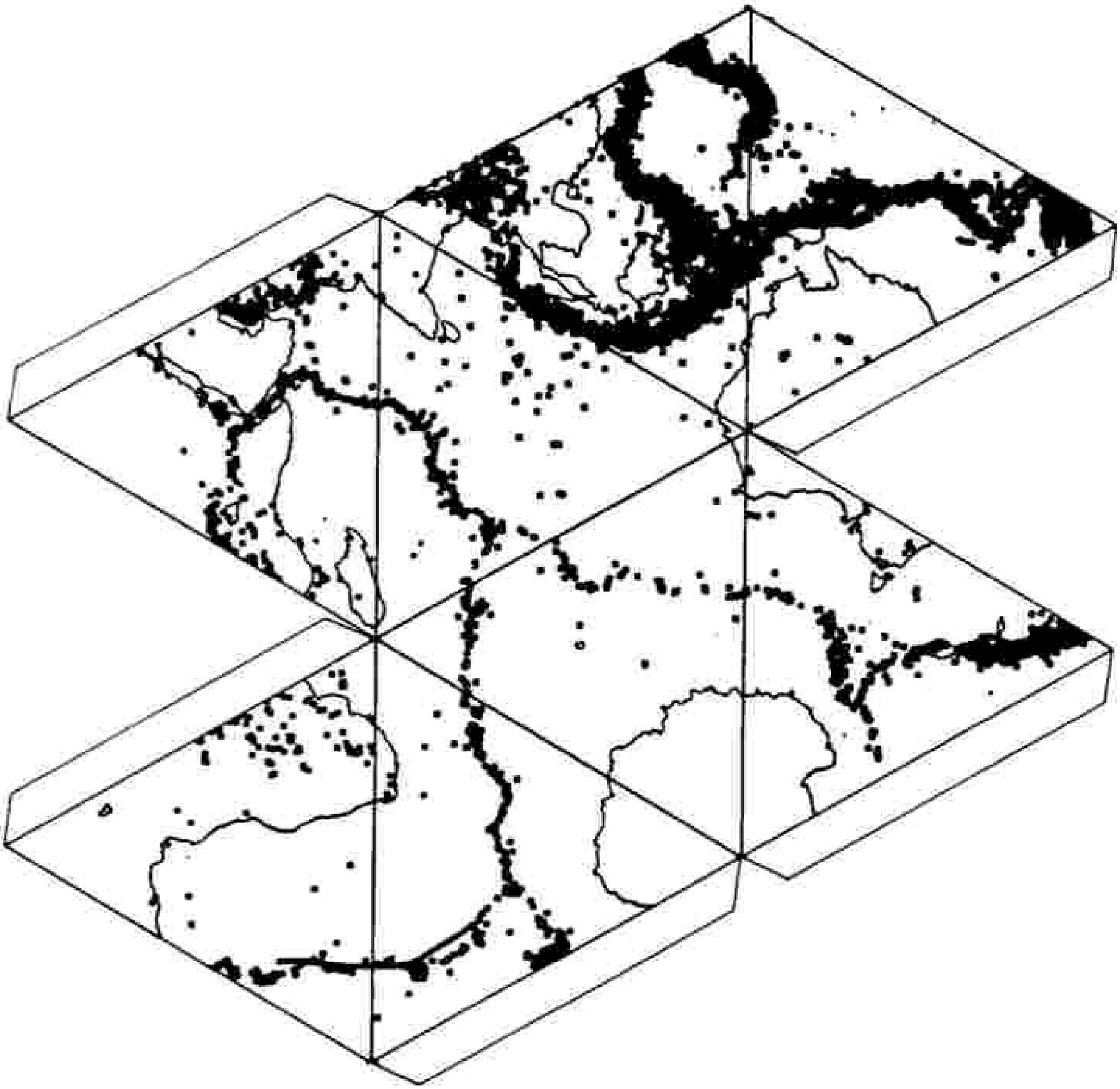


PLATE TECTONIC CYCLE - PLATE TECTONICS (6)

POST LAB

Students investigate plate movements.

OBJECTIVES:

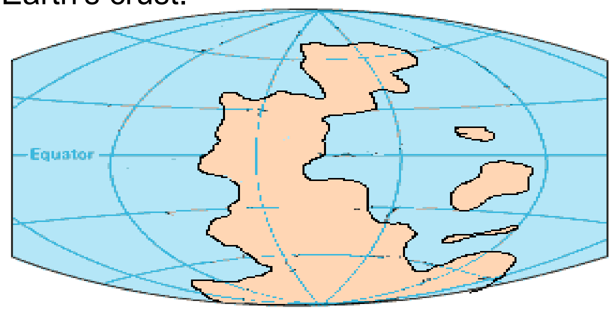
1. Comparing continental drift with plate tectonics.
2. Observing the movement of Earth's crust.

VOCABULARY:

continental drift

MATERIALS:

worksheet



The positions of the continents about 300 million years ago.

BACKGROUND:

One of the first observations used to suggest that the outer portion of the Earth is mobile is the fit of the continents, particularly the west coast of Africa against the east coast of South America. This observation predates plate tectonics. It was first noticed in the 18th century, and proposed by a German scientist, Alfred Wegener in 1912. Wegener called his theory called "continental drift", referring to the apparent movement of continents alone. However, “continental drift” is a historical term, that may give the wrong notion to children. We now know It is not the continents that move, but the plates, in which the continents are embedded. South America and Africa were once together, but were split apart by the formation of a diverging plate boundary. This is confirmed by matches between the rocks and fossils of the two continents. Plate motion, not continents drifting, explains this. The two continents are still moving away from each other today.

Even through it has been established that the plates, and thus the continents, have moved through time, many unanswered questions remain on how the plates move, as well as where they have been in the past. In this post lab, the students will examine maps which show the positions of the plates and continents at several times over the past 510 million years. The evidence for these locations is difficult to understand, but real. The maps show only the continental parts of plates. The remainder, composed of oceanic crust, is destroyed through time by subduction and collision at convergent plate boundaries.

Several websites have excellent images of past plate configurations. Two that are particularly good are;

http://www.ucmp.berkeley.edu/geology/tectonics.html - The plate tectonics page at the University of California, Berkeley Paleontology museum. Good animations of plate motions, and explanations for how it works.

http://www.scotese.com/ - The Paleomap Project - detailed plate location reconstructions for the past 650 million years. Also simple animations of plate motion.

PROCEDURE:

1. Explain to the students that plate motions have made the continents move through time. Make sure that they understand that the plates move, and the continents ride on their backs.

2. At the elementary school level the reason why geologists feel that the maps are accurate cannot be explained effectively to students. Just try to have fun with your class, and try to understand the differences between the maps. Here are some suggested activities and questions:

(1) Have your students chart the differences from one time frame to another.
(2) See if some continents have been at the equator at some point in the past. (Yes, North America, 510 million years ago).
(3) Would the rocks on a continent record a different climate if the continent was in a different place on the Earth? (Yes)
(4) Have your students make a "flip movie" by placing the pictures in the chronological order. If you wish to do this activity, we suggest you print the maps on thicker paper.
(5) If you have studied fossils in your class, you might want to discuss whether or not the fossils in rocks can provide any clues about the continents' past positions. (Yes, for example in Antarctica, paleontologists have found fossil trees. Looking at the maps, when could this have happened? 500-520 million years ago.)
(6) Which continents have moved a lot? North America, Australia
(7) Did we always have the Pacific Ocean and Atlantic Ocean? No
(8) Color one continent one color, and trace it throughout the different maps This makes it easy to identify.
(9) Cover one of the maps on each sheet and see if your students can recreate what the missing map should look like.

PLATE TECTONIC CYCLE - PLATE TECTONICS (6) - POST LAB

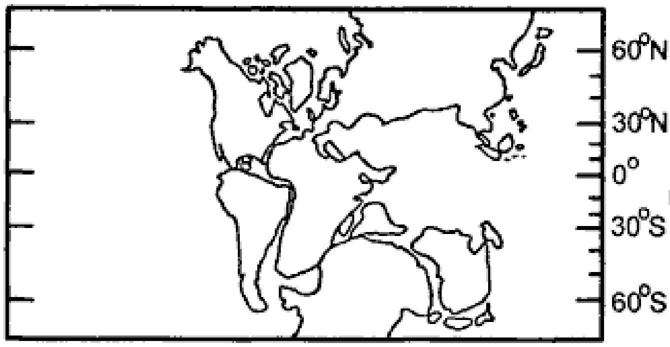
(Oldest)
510
million years ago

380
million years ago

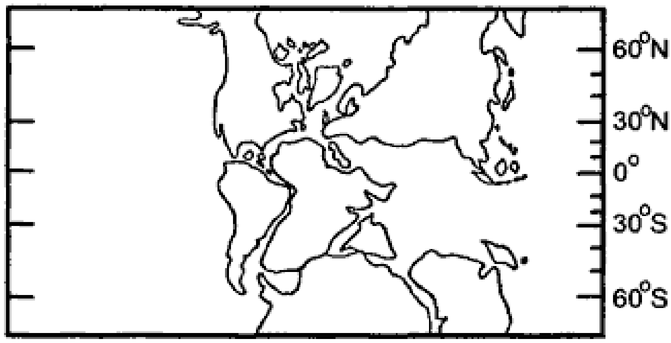
340
million years ago

250
million years ago

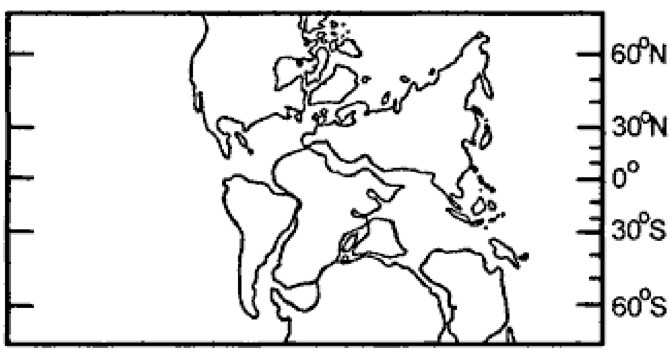
PLATE TECTONIC CYCLE - PLATE TECTONICS (6) - POST LAB



220
million years ago



170
million years ago



100
million years ago

50
million years ago