

Geology 1002.1

Project 1

Plate Motions

Plate Tectonics explains how the earth's lithosphere has evolved over geologic time. This theory explains why the Pacific Northwest has earthquakes and volcanoes and Louisiana does not. It also explains how and when major mountain ranges (e.g., Rocky Mountains) or ocean basins (e.g., Gulf of Mexico) formed. Plate boundaries and plate motions controls the distribution of important natural resources such as oil and gold. This exercise asks you to use information about the age distribution of the sea floor (isochron map) to reconstruct processes at plate boundaries and the motion of continents over the last 180 Ma.

Use the Isochron Map (Figure 2.12 in the textbook or the attached [jpeg file](http://userpage.fu-berlin.de/~data/database/oceanage/jgr_paper.html)) to answer the following questions (a similar map is at http://userpage.fu-berlin.de/~data/database/oceanage/jgr_paper.html.)

Recall that at divergent boundaries new oceanic lithosphere is created, at convergent boundaries old oceanic lithosphere is recycled back into the mantle, and at transform fault boundaries lithosphere slides horizontally past each other. Thus, seafloor isochrons reveal the positions of divergent (ridge) boundaries in earlier times. Seafloor of a particular age that is now missing has been subducted back into the mantle.

Part I - Atlantic Ocean

1. When did the North Atlantic Ocean first start to open?
2. Where is the oldest oceanic crust found in the Atlantic?
3. Has the rate of opening of the North Atlantic ocean changed over time or remained fairly constant?
4. When did the South Atlantic Ocean first start to open?
5. What is the average rate of opening of the Atlantic over the last 100 Ma (recall that rate is distance divided by time) at:
 - a) East Coast of U.S. to North Africa
 - b) Tip of South America to South Africa
- 6) Contrast the rate and style of opening of the North and South Atlantic.

Part II - Pacific Ocean

1. The oldest oceanic crust off the coast of South America is about 60 m.y. old. The oldest oceanic crust off the coast of the Philippines is about 200 m.y. old. If the East Pacific rise is creating this oceanic crust in a symmetric pattern, then what happened to the old oceanic crust in the eastern Pacific?
2. In the north Pacific Ocean off the coast of North America, the age (color) of oceanic lithosphere does not form continuous stripes or color bands. Rather, it is cut up into segments. Sketch/describe what is occurring at the boundary between stripes of different color (where oceanic crust of different ages is in direct contact with each other).

3. The boundary between the North American Plate and the Pacific plate in central California is currently a transform fault (San Andreas fault). The evidence in the isochron map indicates that the plate boundary was different in the past. What type of plate boundary or boundaries existed in the past? How do you know this? When did the change in plate boundaries occur?

Part III - Reconstruction

1. Make a copy of the isochron map (Black and White is OK) and using scissors remove seafloor that is less than 40 Ma (Red and Orange color).
2. Make a reconstruction of the Earth at 40 Ma by putting the remaining map pieces back together at the ridge boundaries assuming that Antarctica is stationary. Remember that the Earth isn't getting smaller so there will be gaps in your reconstruction representing subducted lithosphere (material that has gone back down into the mantle). The simplest way to conserve area is to draw a rectangle on a blank piece of paper that is the same size as the original map and then place the remaining map pieces inside the rectangle. Also keep in mind that some plate boundaries from 40 Ma do not exist today (e.g., when continents crash into each other). So you may need to cut your map into more pieces in order to get everything to fit together.
3. What does the reconstruction tell you about the relative (to Antarctica) motion of the continents and the plate boundaries? Can you suggest another frame of reference for the reconstruction? Why?

Helpful Materials

Plate Tectonics by Cox and Hart contains examples of two dimensional plate reconstructions which illustrate the basic ideas of how to restore plates to their configuration in the geologic past. These examples

The following web site also contains examples of reconstructions
<http://www.uky.edu/AS/Geology/webdogs/plates/reconstructions.html>