Name _____

Plate Tectonics & Sea Floor Geography Lab

In this lab, you will explore how the movements of the Earth's tectonic plates relate to earthquakes, volcanoes, and the major geographic features of the ocean floor. You will also expand your skills in map reading and interpretation, building on what you did in the Maps & Charts lab.

PART 1: Earthquakes, Volcanoes, and Plate Tectonics

(adopted from an exercise by Professor Tanya Atwater, UC Santa Barbara)

Form a work group of 2 or 3 students. Each group will receive one **transparency world map**, a set of world maps showing tectonic plates, earthquakes, and arc volcanoes, and two erasable colored pens. Appoint one member of your group to be the artist. The artist will draw on the transparency overlay. Work together with the other members of your group to discuss the results and answer the questions. Your group should reach a consensus on the questions, but each member of the group is responsible for recording his/her own answers in the lab notebook.

First, use shallow earthquakes to locate world plate boundaries.

Overlay the **transparency world map** onto the **SHALLOW SEISMICITY map (Map #2)**, so that the edges match exactly. Using the darker-colored erasable pen, draw neat, narrow lines that follow the lines of earthquakes. ***Be sure that the edges of the maps stay matched as you draw, and be as neat and accurate as you can; precision is important.***

Now overlay the transparency map onto the **WORLD PLATE BOUNDARIES MAP (Map #1)**, so that the edges match, and compare them.

1. How well do the shallow earthquakes locate divergent plate boundaries (i.e. places where places separate, such as at mid-ocean ridges)? What major processes of plate tectonics occur at these places?

2. How well do the shallow earthquakes locate convergent plate boundaries, (i.e. subduction zones at ocean trenches, or continental collision zones)? What major processes of plate tectonics occur at these places?

3. How well do the shallow earthquakes locate transform plate boundaries, such as the San Andreas fault? What major processes of plate tectonics occur at transform boundaries?

4. Notice that the zones of earthquakes narrowly delineate plate boundaries in most areas of the map. But for some plate boundaries, the earthquakes are spread out over a broader area. Which type of plate boundary is characterized by *the broadest* zones of earthquakes? Circle one option below. (*Hint: Look in the area where the African Plate and Indo-Australian Plate are colliding with the Eurasian Plate.)* Circle one option below.

   spreading center *transform fault* *subduction zone* *continental collision zone*

5. Do earthquakes occur only at plate boundaries? Estimate the proportion earthquakes that occur at plate boundaries versus in the interiors of plates.

6. According to what you see on the maps, which of the following statements is correct? (Check one answer.)

    - Most plate boundaries correspond to the edges of the continents.
    - Most plate boundaries occur within the continents.
    - Most plate boundaries occur within the ocean basins.

Now use deep earthquakes to locate major subduction zones.

Overlay the **transparency world map** onto the **DEEP SEISMICITY map (Map #3)** so that the edges match. You should notice that the lines of deep quakes run parallel to, but don't exactly overlap with, the lines of shallow quakes. Using the same dark pen, draw triangular "teeth" on your shallow earthquake lines pointing in the direction of the deep earthquakes.

Now overlay the transparency map onto the **WORLD PLATE BOUNDARIES MAP (Map #1)** and compare them.

7. What type of plate boundary—*divergent, convergent,* or *transform*—has deep earthquakes? What major process of plate tectonics is responsible for making deep earthquakes?

8. By convention, the "teeth" symbols on lines that trace subduction zones on a map point in the direction that the plate is slanting downward as it subducts. (For example, if the teeth point east, it means that the subducting plate is slanting down toward the east from where it enters the trench.) How does the direction that the plate slants relate to why deep earthquakes are offset in map view from shallow earthquakes? In other words, why do the deep quakes occur parallel to, but not exactly overlapping with, the shallow quakes? Include with your answer a simple cross-section sketch of a subduction zone.

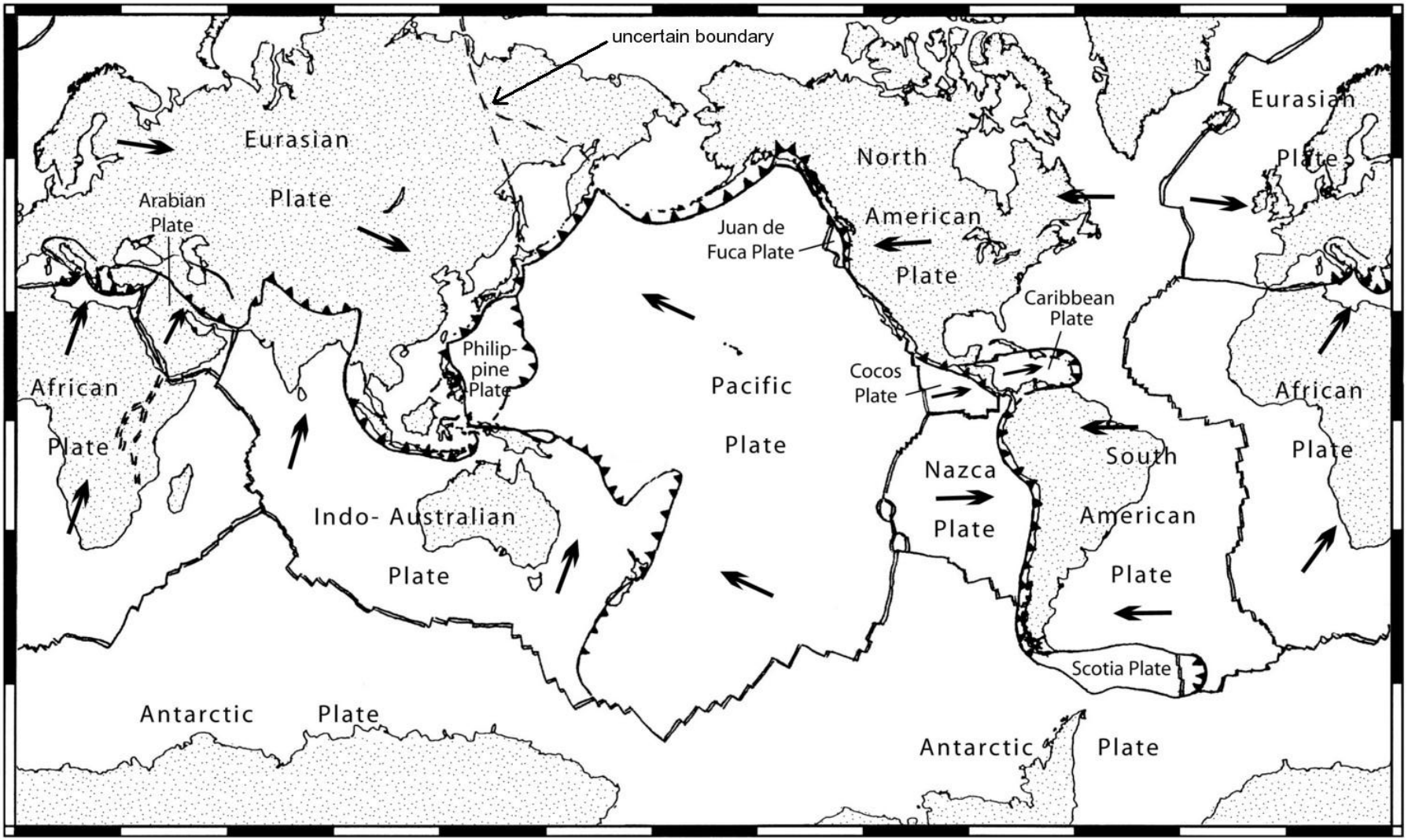
Now add arc volcanoes to your map.

Overlay the **transparency world map** onto the **ARC VOLCANOES map (Map #4).** Using the lighter-colored erasable pen, draw neat, narrow lines that follow the lines of arc volcanoes. Then overlay the transparency map onto the **WORLD PLATE BOUNDARIES MAP (Map #1)** and compare them.

9. How is the location of arc volcanoes related to the location of earthquakes? Are arc volcanoes more closely associated with the shallow earthquakes or with the deep earthquakes? Explain the connection between the two phenomena in terms of plate tectonic processes. (Your explanation should refer back to your cross-section sketch in question #8.)

10. The term "**Pacific Ring of Fire**" reflects what type of spectacular geologic activity found around the edge of the Pacific Ocean basin? Why isn't there a "ring of fire" all around the Atlantic Ocean or Indian Ocean basins? *Hint: the answer comes down to the presence or absence of one specific plate tectonic process.*

MAP 1 - WORLD PLATE BOUNDARIES



divergent plate boundary: spreading center of mid-ocean ridge or continental rift valley

transform (side-by-side-moving) plate boundary: oceanic or continental transform fault

convergent plate boundary: subduction zone or continental collision zone

PART 2: Make your OWN Map of the Earth's Tectonic Plates

Compare the WORLD PLATE BOUNDARIES MAP (Map #1) with your copy of the large blank ocean floor map provided to you. The comparison shows that the edges of the Earth's tectonic plates correspond mostly to major geographic features within the ocean basins, particularly mid-ocean ridges and ocean trenches. *(Tip: this is the answer to question #6 earlier; did you get it right?)*

- **mid-ocean ridges** (sometimes called "rises") represent divergent plate boundaries. These are places where plates move apart from one another through the process of sea floor spreading.

- **ocean trenches** represent convergent plate boundaries. These places, also called subduction zones, are where subduction occurs as one plate dives down beneath another.

- **transform faults** are large faults that represent transform plate boundaries where plates slide side-by-side past one another. These include the fracture zones that divide segments of mid-ocean ridges, as well as some major continental transform faults (ex: California's San Andreas fault; the Dead Sea fault).

With two colored pencils, and **using MAP #1 as a guide**, do the following on your copy of the blank sea floor map. Put your finished map in your lab notebook along with today's exercise.

- Use one color to draw a line along all DIVERGENT boundaries, including spreading centers at all **mid-ocean ridges** and any **continental rift zones**. Use the same color to mark all TRANSFORM boundaries, the locations of the world's major side-by-side sliding **transform faults**.

- With a second color, draw a line along all CONVERGENT boundaries: the **ocean trenches** and the **continental collision zones**. *(Note: continental collision zones are places where subduction has closed ocean basins and brought continents into collision; your instructor can help you identify these).*

- Label clearly the **names** of the major plates.

- Show with **arrows** the direction that each plate is moving.

*****Fold your map in half, three-hole punch it along the folded edge, and insert it at this location in your lab notebook*****

PART 3: Map Interpretation & Sea Floor Geography

In this part of the lab, you'll continue to build on the map-reading skills you began in the Maps and Charts lab.

Approaches to San Diego Bay Map

1. Determine the latitude and longitude of the following. Be sure to indicate N, S, E or W:

   Middle Coronado Island off the coast of Mexico (not in San Diego Bay):_____

   The northwest corner of the Explosives Dumping Area: _____

For the next three questions, use the compass rose and the parallel rulers to get compass bearings.

2. Suppose you want to sail from Pt. Loma to the southeast corner of the Explosives Dumping Area. What compass direction (bearing) would you follow?

3. From the southeast corner of the Explosives Dumping Area, what compass direction (bearing) would you follow to get to North Coronado Island off the coast of Mexico?

4. To return from North Coronado Island to Point Loma, what compass direction (bearing) would you follow?

Topography of the North Pacific Map

1. This map extends from _____ latitude at the bottom to _____ latitude at the top (indicate N or S along with the number)

2. This map extends from _____ longitude on the left side to _____ longitude on the right side (indicate E or W along with the number). *Note: be careful on this one. Remember that the Pacific Ocean is on the opposite side of the world from the Prime Meridian. Longitudes increase east or west from the Prime Meridian, and the 180-degree meridian marks where longitude values switch between East and West.*

3. Find the latitude and longitude of the following. Be sure to indicate N, S, E, or W in your answers, keeping in mind the information in #2 above.

   Hawaii (the big island): _____

   Kodiak Island (part of Alaska): _____

   Southern tip of Baja California, Mexico: _____

   Southern tip of the Kamchatka Peninsula, Russia: _____

4. The depth contours on this map are in fathoms.

   What is the contour interval (the difference between adjacent contour lines)? _____

   What is the depth of the **Hawaiian Arch**? _____ fathoms

   What is the depth of the shallowest part of the **Shatsky Rise**? _____ fathoms

   The deepest place on Earth is called the **Challenger Deep**, located in the Mariana Trench. You can find it labeled *(very small!)* next to the "M" in Mariana Trench. How deep is the Challenger Deep in the following units? (Note: 1 fathom = 6 feet; 1 mile = 5280 feet.)

   fathoms: _____

   feet: _____

   miles: _____

5. Starting with the Mariana Trench and following the trenches clockwise around the edge of the Pacific Ocean all the way to Panama, list the names of all the ocean trenches, in the order that you encounter them.

6. What is the tectonic connection between the Pacific trenches on this map and the Pacific earthquakes and arc volcanoes that you studied in PART 1? *Hint: they are all related to the same plate tectonic process.*