Introduction to Plate Tectonics

By

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Description: In this lab students interpret bathymetric, topography, sea floor ages, and earthquake distributions to reinforce concepts about the different types of plate boundaries. Each student must interpret several sets of data to determine the location and type of plate boundary. To develop a set of basic analytical skills, the students draw several diagrams and graphs to reinforce the data presented in figures. Students are also asked to think critically about plate rates and what happens to the crust at the different plate boundaries. Figures were created using Google Earth. Most of the data sets were downloaded from the Google Earth Community webpage. Earthquake data are M4.5+ earthquakes that occurred Jan-June 2006 from the USGS global catalog; however more complete earthquake datasets are now available through Google Earth.

Introduction to Plate Tectonics

In this lab you will learn the basics of plate tectonics, including locations of the plate boundaries, distribution of earthquakes, and bathymetry and topography. This exercise uses Google Earth, Google Earth overlays created by various members of the scientific community, and information from the USGS website, including seismic data and maps. Updated seismic data can be found at: http://earthquake.usgs.gov/eqcenter/recenteqsww/

The Atlantic Ocean:

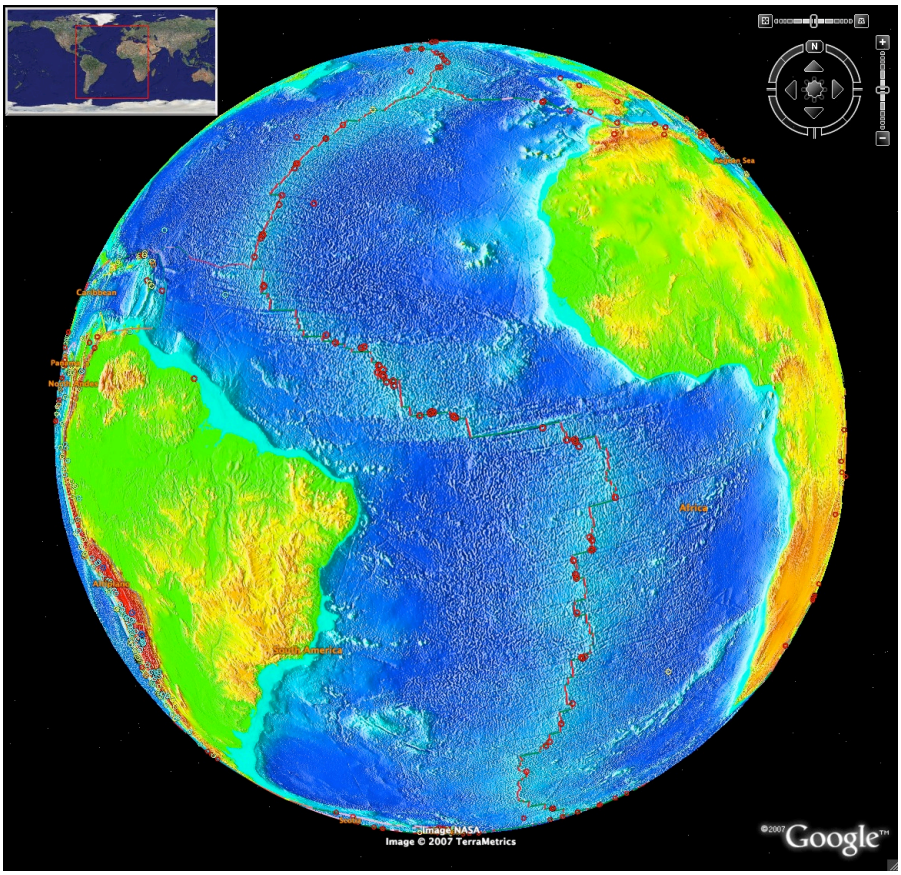

Figure 1: Shown is the mid-Atlantic Ocean region of the globe. The bathymetry of the sea floor is shown with dark blues representing deeper ocean water and light blue representing shallower ocean water. Topography of the continents is also shown with light green representing elevations near sea level and warm colors (yellow and reds) representing high elevations. Solid lines show the plate boundaries and plate names are given by orange label. Dots give earthquake locations and are colored by depth beneath the surface of the Earth (red = shallow and blue = deep).

Question 1: Where is the plate boundary located that separates the South American and African Plates?

Question 2: If the boundary was not shown how might you determine the location? Please give two ways.

Question 3: Where do most of the earthquakes in the Atlantic Ocean occur? And, are they shallow or deep?

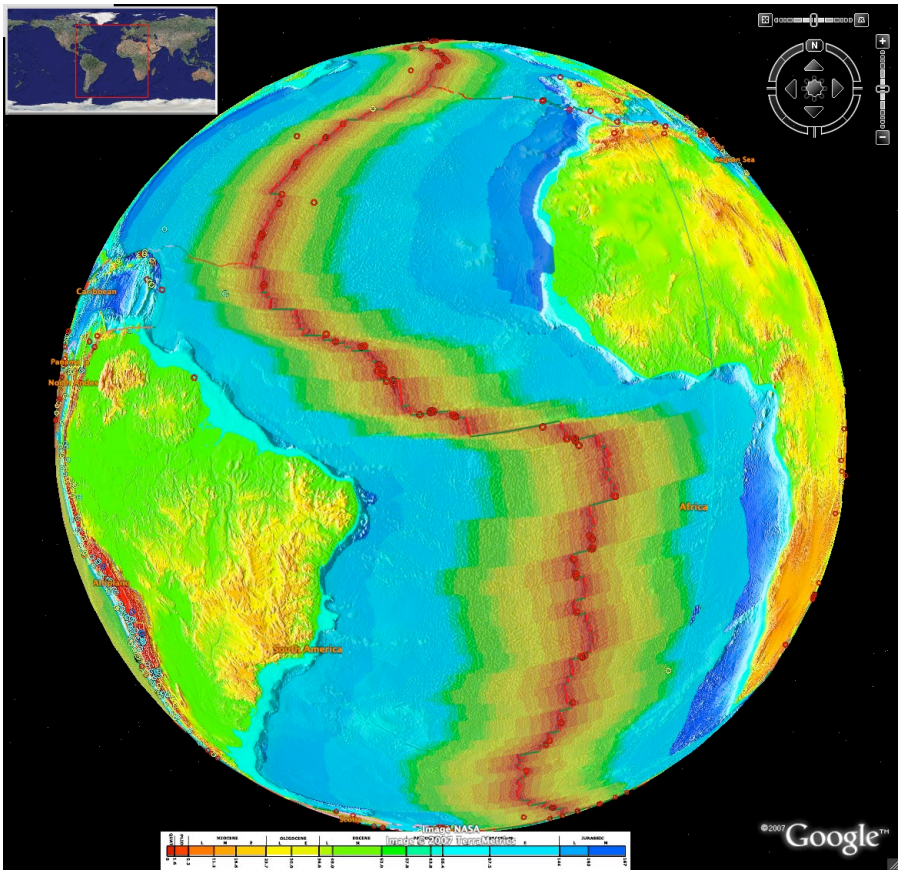

Figure 2: The age of the sea floor is shown for the mid-Atlantic Ocean. Young/recent sea floor ages are shown by warm colors (orange and red) and old sea floor ages are shown by cool colors (blue).

Question 4: Describe how the sea floor age changes as you go from the plate boundary toward the east coast of South America.

Question 5: Describe the relationship between sea floor age, bathymetry (look at figure 1), and the mid-Atlantic plate boundary.

Question 6: Is crust being created or destroyed at this plate boundary? Is this plate boundary divergent, convergent, or transform?

New Zealand:

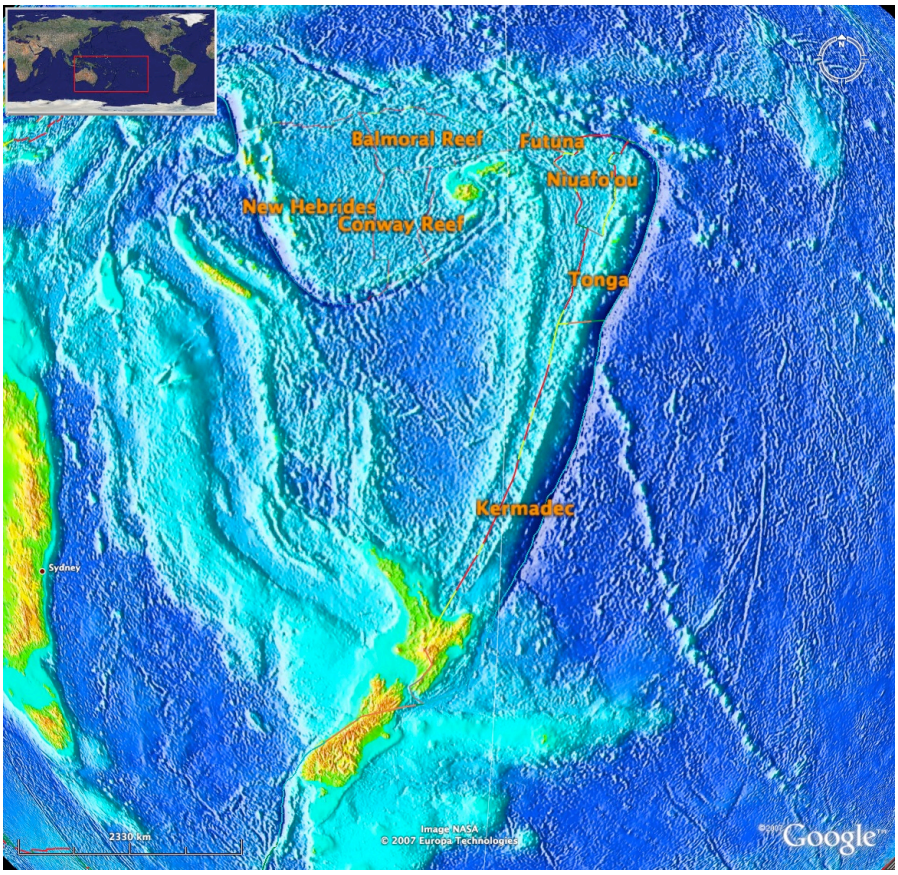

Figure 3: Map of the Tonga-Kermadec plate boundary, located just north of New Zealand. The bathymetry of the sea floor is shown with dark blues representing deeper ocean water and light blue representing shallower ocean water. The main plate boundary is shown in light blue.

Question 7: Draw a rough profile of ocean depth perpendicular to the Tonga-Kermadec plate boundary. Locate you profile just beneath the "Tonga" label.

Question 8: Describe how the ocean depth changes as you approach and cross the Tonga-Kermadec plate boundary from East to West.

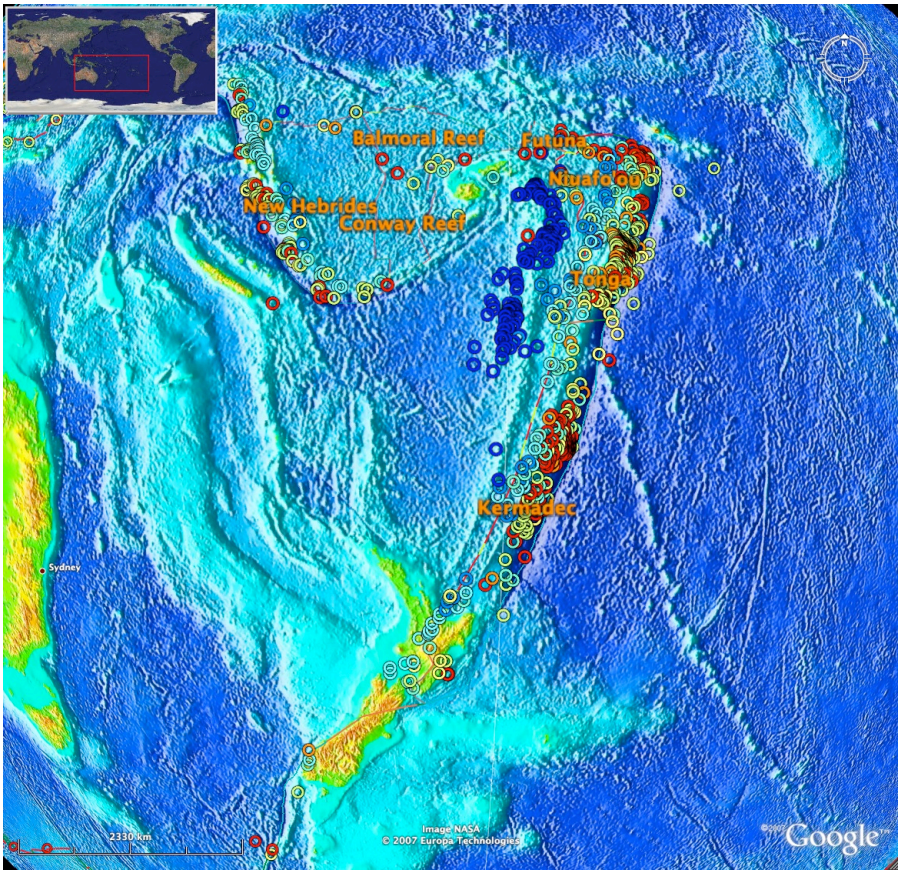

Figure 4: Map of the Tonga-Kermadec plate boundary, located just north of New Zealand. The bathymetry of the sea floor is shown with dark blues representing deeper ocean water and light blue representing shallower ocean water. The main plate boundary is shown in light blue. Earthquakes are shown by circles and earthquake depths ranges are shown by circle color : red (0-10 km), orange (10-20 km), yellow (20-30 km), light green (30-50 km), blue-green (50-100 km), light blue (100-200 km), blue (200-400 km), dark blue (400+ km).

Question 9: Compare the distribution of earthquakes shown for the mid-Atlantic plate boundary (see Figure 1) and the Tonga-Kermadec plate boundary shown above.

Question 10: Draw a cross-section of earthquake depth versus distance along a profile perpendicular to the plate boundary just beneath the "Tonga" label. Include where the main plate boundary is located and note there is a scale on the bottom of the map to assist with your distance vs. depth plot.

Question 11: Describe the distribution of earthquakes. Why do you think the earthquakes happen at these locations and depths? What is this zone of earthquakes called?

Question 12: Compare the bathymetric profile you created in Question 7 and the earthquake profile created in Question 10. Where do the shallowest earthquakes occur?

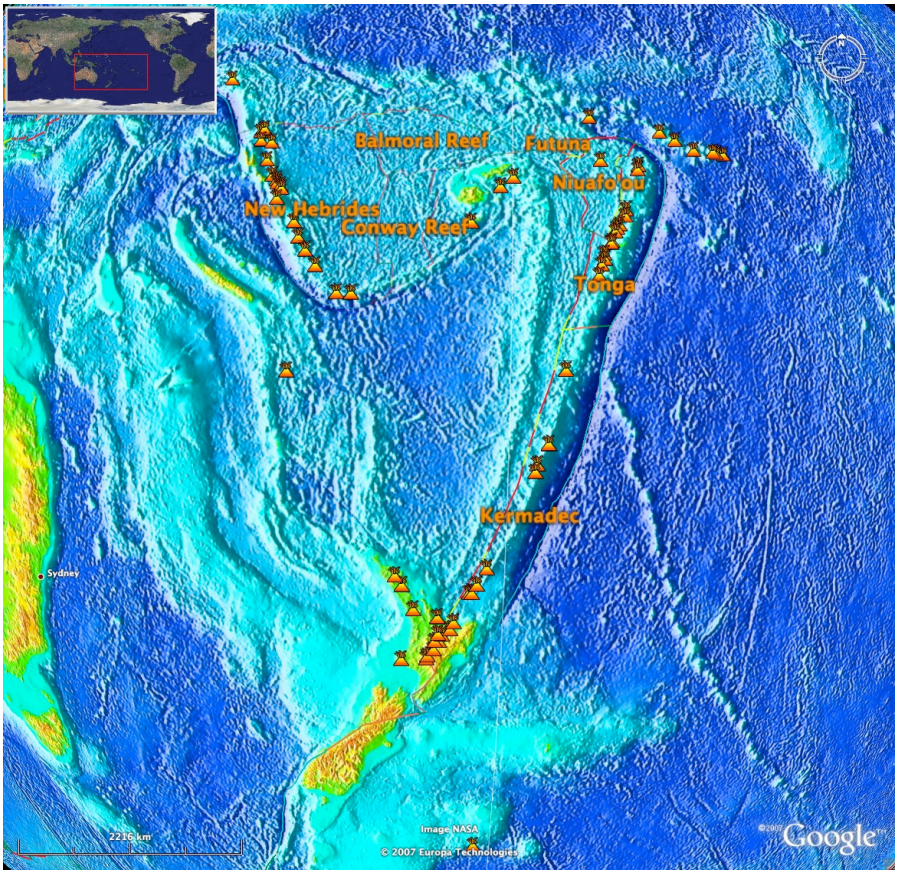

Figure 5: Map of the Tonga-Kermadec plate boundary, located just north of New Zealand. The bathymetry of the sea floor is shown with dark blues representing deeper ocean water and light blue representing shallower ocean water. The main plate boundary is shown in light blue. Volcanoes are shown by the small orange symbols.

Question 13: Describe the distribution of volcanoes along the Tonga-Kermadec plate boundary. Be sure to discuss where the volcanoes are located in terms of bathymetry and earthquake depth using the figures above.

Question 14: Is crust being created or destroyed at this plate boundary? Is this plate boundary divergent, convergent, or transform? Draw a schematic of what the plate boundary looks like in cross-section. Be sure to think about the bathymetry and earthquake locations.

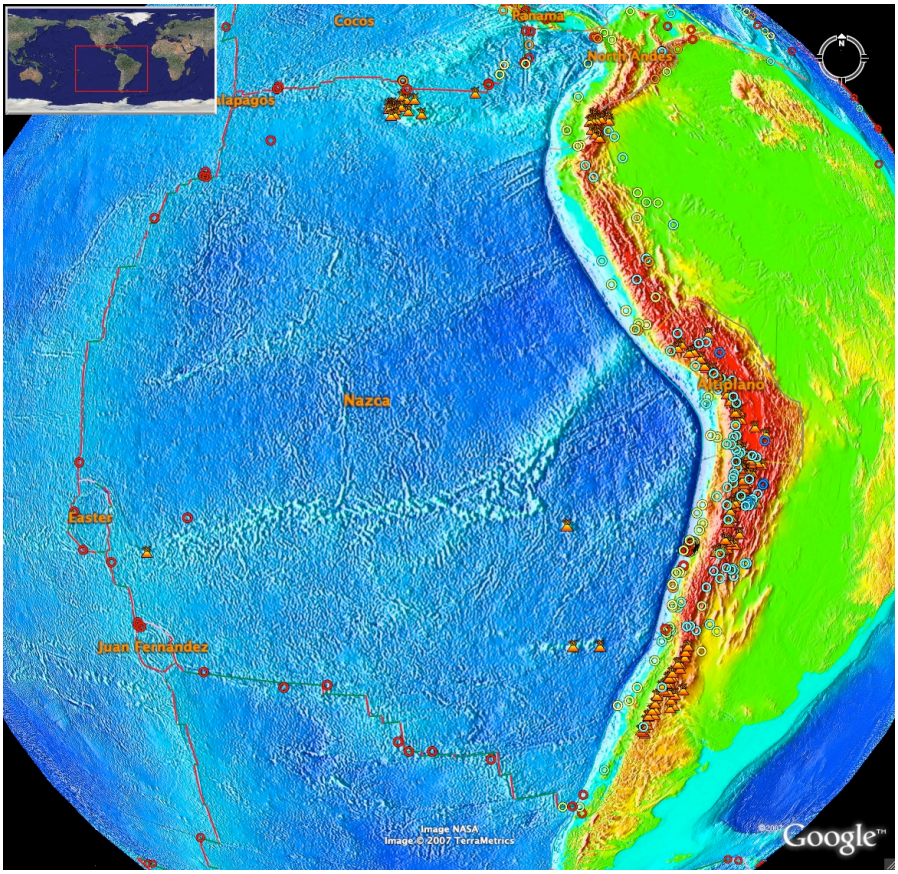

Figure 6: The map shows Nazca Plate that is located in the Pacific Ocean and bordered by South America. Bathymetery, plate boundaries, earthquakes, and volcanoes are shown.

Question 15: Is the northern portion of the plate boundary convergent, divergent or transform? What about the east, south, and west plate boundaries? Describe what you used to choose your answer.

Question 16: Draw a rough sketch of what you think the age of the ocean floor is on the Nazca plate. Hint: recall what happens to ocean crust at the different types of plate boundaries.

Question 17: Do you think the Nazca plate will get bigger or smaller in the next million years, include what assumptions you made about the rate of plate motion at each of the boundaries.

Question 18: The edge of the Pacific Plate is often called the ring of fire. From the case studies above, can you guess what type of plate boundaries are most commonly found at the edge of the Pacific Plate.